Ds 2009:63

Sweden's Fifth National Communication on Climate Change

Under the United Nations Framework Convention on Climate Change

REGERINGSKANSLIET

Ministry of the Environment
Sweden

This report is on sale in Stockholm at Fritzes Customer Service,
which sells reports in the series Swedish Government Official Reports (SOU)
and in the Ministry Publications Series (Ds).

Address:	Fritzes, Customer Service SE-106 47 Stockholm Sweden
Fax:	08 598 191 91 (national) +46 8 598 191 91 (international)
Telephone:	08 598 191 90 (national) +46 8 598 191 90 (international)
E-mail:	order.fritzes.@nj.se
Internet:	www.fritzes.se

Cover photo: Peter Lilja/N
Graphic design/figures/illustrations: IdéoLuck AB #091101
Printed by Edita Sverige AB, Stockholm 2009

ISBN 978-91-38-23319-1
ISSN 0284-6012

Ds 2009:63

Sweden's fifth National Communication on Climate Change

Under the United Nations Framework Convention on Climate Change

REGERINGSKANSLIET

Ministry of the Environment
Sweden

Foreword

Sweden's fifth national communication is formulated in accordance with the guidelines adopted by the parties to the United Nations Framework Convention on Climate Change. It presents basic facts on Swedish society and reviews the various sectors of society in accordance with the classification agreed upon within UNFCCC. Emissions and removals of different greenhouse gases are reported for each sector and as an aggregate for each year since 1990, together with the impact of various policy instruments on emissions.

The assessments presented in the report show that Sweden has succeeded in breaking the link between economic growth and greenhouse gas emissions. The policy instruments introduced have had a significant effect, and emissions have fallen by around 9 per cent since 1990. At the same time, Sweden can point to relatively high economic growth. The report also contains projections for emissions up to 2020. According to these projections, emissions will continue to decrease, but additional measures are needed to meet Sweden's national targets for 2020. The Government has announced measures tonnes for tonnes in order to achieve the national target of 40 per cent reduction by the year 2020.

The national communication describes Sweden's vulnerability and what the country is doing to adapt to climate change. Sweden's international efforts in relation to development assistance with relevance to climate change are presented, as are research and development. Finally, an account is given of Sweden's work on education, training and public awareness with regard to the problem of climate change.

The material on which the national communication has been based has been obtained through extensive activity on the part of government agencies, led by the Swedish Environmental Protection Agency and the Swedish Energy Agency and with input from around ten different agencies. Most of the work on the fifth national communication was done over the period from the end of 2008 to the summer of 2009.

In March 2009 the Swedish Government presented a coherent climate and energy policy which lay the foundation for the future efforts that need to be made in order to contribute to a stablisation of the greenhouse gas concentration at a level that enable the 2 degrees Celsius target to be reached.

Sweden's targets for climate and energy policy by 2020 are:

- 40 per cent reduction in greenhouse gas emissions
- at least 50 per cent renewable energy
- 20 per cent more efficient energy use
- at least 10 per cent renewable energy in the transport sector

The target of a 40 per cent reduction in greenhouse gas emissions relates to the non-trading sector, i.e. sectors not encompassed by the EU Emissions Trading Scheme. It therefore relates for example to transport, housing, waste facilities and parts of industry. The reduction for activities encompassed by the EU Emissions Trading Scheme is jointly determined at EU level. How the targets indicated above will be met is outlined in the Government's Climate and Energy Bills.

It should be emphasised in particular that the basic projection for Swedish greenhouse gas emissions does not take account of decisions taken and policy instruments introduced after June 2008. When the policy instruments and measures presented in the new climate policy are implemented, the projection by 2020 will be updated.

The projection was, however, subsequently supplemented to include additional measures taken as a consequence of decisions in the EU and measures announced in the Government's Climate Bill in the spring of 2009. These additions are discussed in section 5.4.

Stockholm, December 2009

Innehåll

1 Summary

Greenhouse gas emissions in Sweden, excluding emissions and removals from land use and forestry (LULUCF) decreased by 9 per cent over the period 1990 to 2007 and are expected to continue to decline. Emissions in 2020 are estimated to be around 16 per cent below 1990 levels with the additional EU-wide and national policy instruments decided during 2009. These additional policies are expected to by 2020 result in emissions from sectors not included in the EU emission trading scheme to be around 25 per cent below the 1990 levels. Further national measures have been announced in the 2009 climate policy resolutions together with investments in other countries. Sweden's commitments on emissions under the Kyoto Protocol and EU burden sharing are that emissions as an annual average for the period 2008-2012 will be no more than 104 per cent of 1990 emissions. Sweden is on track to comfortably meeting the commitment.

This is Sweden's Fifth National Communication, under the UN Framework Convention on Climate Change (UNFCCC), which presents the national activities implemented in order to fulfil the commitments in accordance with UNFCCC, the Kyoto Protocol and the separate Conferences of the Parties (COP) which have to be reported in a national communication.

1.1 National circumstances

Factors that have an impact on a country's level of and trend in greenhouse gas emissions include population, climatic conditions, energy and transport systems, industrial structure and economy.

The Swedish population was 9.2 million in 2007, and has risen in average by 0.4 per cent per year since 1990 with a higher rate of increase since 2000.

Average annual temperature over the period 1991-2007 was around 1°C higher than in the period 1961-1990. The need for energy for heating has been very low in the 1990s and 2000s. 1996 is the only year to date since 1990 in which there was a greater need for heating than the average for the period 1965-1995.

The economy grew by an average of 2.3 per cent annually over the period 1990-2007, with the highest rate of growth in the periods 1994-1995, 1998-2000 and 2004-2006, with an annual average of 4–4.5 per cent.

Sweden's final primary energy use increased by 8 per cent between 1990 and 2007 and in the past 5 years has been around 400 TWh. There is no recovery of oil, natural gas or coal in Sweden. The total primary energy supply is principally based on domestic supply of bioenergy, hydropower, nuclear power and, to a lesser extent, ambient heat for heat pumps and imports of oil, natural gas, coal and biomass products. 40 per cent of oil products have been replaced by non-fossil energy sources since the 1970s. A substantial change has taken place in energy supply for homes and commercial premises. The infrastructure for district heating production and distribution has been expanded starting in the late 1960s, and district heating production has risen by 370 per cent since 1970 and by 32 per cent since the period 1990 to 2007. At the same time, the proportion of biofuels for production increased from 2 per cent to 70 per cent over the period 1970-2007. This proportion rose by 14 percentage points between 2004 and 2007. District heating has been essential for environmentally sound heating of buildings based on biofuels and crucial in enabling national policy instruments for renewable energy to bring about the extensive phasing-out of fossil fuels for the heating of buildings that has occurred. The share of renewable energy in Sweden increased by a total of 10 percent-

age points to 44 per cent between 1990 and 2007. Naturally good access to watercourses for hydropower production, combined with national energy policy and investments in non-fossil-based electricity, has resulted in Sweden having almost entirely fossil-free electricity supply.

Except for a brief period in the early 1990s, distance travelled in both passenger and freight transport has increased since 1990. The trend was stronger in the period 2004 to 2007 than the average since 1990, and there was a particularly sharp increase in freight transport. Green cars have taken an increasingly large share of new car sales since 2005, accounting for 33 per cent in 2008. Ethanol vehicles make up 70 per cent of green cars. The use of renewable motor fuels has risen sharply, to 5 per cent of energy use by road traffic in 2008.

The impact of industry on greenhouse gas emissions comes principally from its energy use and from process emissions in the mineral industry and the iron and steel industry. Industry accounted for just under 40 per cent of final primary energy use in Sweden in 2007. The paper and pulp industry accounts for nearly half the total energy consumption of industry, principally in the form of electricity and black liquors. The iron and steel industry has a significant impact on Swedish greenhouse gas emissions as 14 per cent of the country's total carbon dioxide emissions in 2007 originate from this industry. Production increased by 35 per cent between 1990 and 2004 but then declined by 10 per cent, principally in 2008 as a result of the financial crisis. Most of the residual gases from coke furnaces and blast furnaces are used for electricity production, internal heat supply and district heating for homes and commercial premises.

1.2 Greenhouse gas emissions

Total greenhouse gas emissions in Sweden, calculated as carbon dioxide equivalent, were approximately 65.4 million tonnes in 2007 (excluding LULUCF), of which 79 per cent was carbon dioxide. Just over 90 per cent of carbon dioxide emissions came from the energy and transport sectors. The breakdown of other emissions was 8 per cent methane (principally agriculture and waste), 11 per cent nitrous oxide (principally agriculture) and 2 per cent fluorinated greenhouse gases. Emissions decreased by around 6.5 million tonnes or 9 per cent between 1990 and 2007. Aggregated greenhouse gas emissions varied, but over the period 1999-2007 they were below the 1990 level in all cases. Calculated on a per capita basis, emissions decreased from 8.4 tonnes of CO_2 eq in 1990 to 7.1 tonnes in 2007. The greatest decreases in emissions over the period occurred in the residential and service, agriculture and waste sectors. Emissions have increased principally in the transport sector and in some industries.

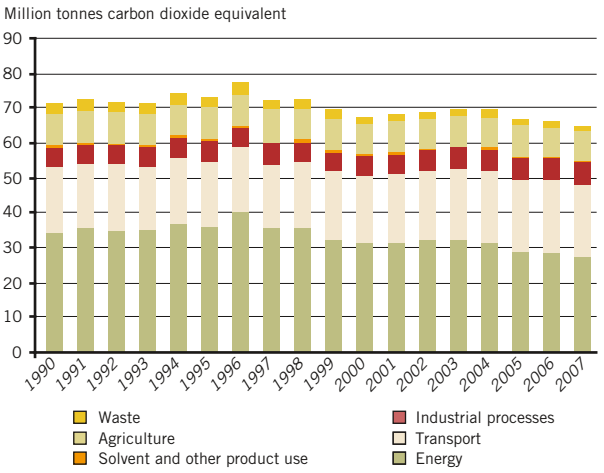


Figure 1.1 **Total greenhouse gas emissions from different sectors**

The decrease in emissions from the residential and service sector is principally due to oil for heating having been replaced by biomass-based district heating and in recent years also by heat pumps and pellet-fired boilers. Methane emissions from waste have decreased as a result of household waste no longer being landfilled and the collection and disposal of methane gas from landfills for energy recovery having increased. The most significant reasons for the reduced emissions from agriculture are reduced numbers of cattle and lower use of both mineral fertiliser and manure.

Emissions from domestic transport increased by 12 per cent between 1990 and 2007. Diesel for freight transport by road increased in particular. Use of petrol has instead declined somewhat. Vehicle fuel taxes, together with high petrol prices, have contributed to a switch to renewable fuels and increased demand for energy-efficient new cars. [Fig 1.1]

Emissions from international bunkering of fuels have increased by 170 per cent since 1990. The net sink for the land use, land-use change and forestry sector (LULUCF) was around 21 million tonnes of carbon dioxide equivalent in 2007.

1.3 Policies and measures

Sweden's climate strategy has developed steadily since the end of the 1980s. The strategy consists of objectives, policy instruments and measures and recurrent follow-up and assessment of established objectives and strategies. Sweden is striving with the

other EU Member States to achieve a global agreement which is compatible with limiting the rise in temperature to no more than 2 degrees Celsius above the pre-industrial level.

A new climate policy decision was adopted by the Swedish Parliament (Riksdag) in June 2009. Sweden's international efforts will be focused on the level of greenhouse gases having to be stabilised in the long term at a level no higher than 400 ppm carbon dioxide equivalent. The target for 2020 is that emissions for activities not covered by the EU Emissions Trading Scheme should be 40 per cent lower than emissions in 1990. To enable this target to be achieved, policy instruments and changes in policy instruments already decided upon in the EU will be supplemented by further elaborated tax instruments and mitigation measures in other countries.

Sweden has introduced a number of policy instruments that directly or indirectly limit greenhouse gas emissions. The use of cross-cutting economic policy instruments is emphasised in Swedish climate strategy, but these instruments are also supplemented in many cases by more targeted initiatives, for instance to support technological development and market introduction.

Energy and carbon dioxide taxes on fossil fuels have contributed to sharp reductions in emissions in the residential and service sector and in the district heating sector, as well as curbing the growth in emissions in the transport sector. The level of carbon dioxide tax in future should, in addition to the annual adjustment in accordance with the consumer price index, be adapted to an extent and at a rate which, together with other changes in economic instruments, results in an aggregate reduction in greenhouse gas emissions outside EU ETS of 2 million tonnes by 2020.

The EU Emissions Trading Scheme (EU ETS) has become the principal control mechanism in industry since 2005. Emissions from Swedish installations in the ETS were equivalent to around 33 per cent of total greenhouse emissions in Sweden over the period 2005-2007. Around 80 per cent were from industrial installations and 20 per cent from electrical and district heating installations. The annual emissions cap in the period 2008-2012 was lowered by around 10 per cent compared with the cap that applied during the first period 2005-2007. Emissions from Swedish installations in the scheme are estimated to have decreased in 2007 and 2008 in comparison with emissions during the first two years.

Government grants to local climate investment programmes (Klimp) were made from 2003 to 2008. The preliminary outcome for Klimp programmes, together with the previous local investment grant (LIP) is that they may contribute to a reduction in emissions of up to 1.8 million tonnes annually from 2010.

The energy sector

As well as being included in EU ETS since 2005, combustion installations for electricity and district heating are covered by carbon dioxide and energy taxes, electricity certificate system, the provisions of the Environmental Code and special support for wind power. It is estimated that emissions from the electricity and district heating sector would have been around 15 milliion tonnes higher in 2007 if economic policy instruments applicable in 1990 had been retained in the sector instead of being further developed and tightened. Coal in particular would have been profitable to use more widely if the policy instruments had not been tightened.

The decrease in emissions from the residential and service sector in 2007 in comparison with 1990 was nearly 7 million tonnes. As well as energy and carbon dioxide taxes, energy use has also been affected by grants (for example for the expansion of and connection to district heating), energy efficiency requirements for new and existing buildings and EC Directives, for example the Energy Performance of Buildings Directive, the Ecodesign Directive and the Energy Labelling Directive.

The industrial sector

Policy instruments influencing emissions from the industrial sector were already in place before 1990. Policy instruments introduced later are not deemed to have had any significant guiding effect. However, EU ETS is expected to have a major impact on the industrial sector as a policy instrument in the longer term. Emissions of fluorinated gases are governed by the EU regulation and directive on emissions of certain flourinated greenhouse gases.

Carbon dioxide and energy taxes are due to be raised in 2011 and 2015 for industry not covered by EU ETS.

The transport sector

Taxes on vehicle fuels have been raised in several stages since 1990. Tax increases, together with rises in fuel prices, have curbed growth in transport, encouraged more energy-efficient vehicles and eased the introduction of biofuels. The taxes are supplemented by targeted policy instruments for the introduction of renewable energy into the road transport sector and for more energy-efficient vehicles.

The strategy for vehicle biofuels contains a tem-

porary exemption from energy and carbon dioxide taxes for all vehicle biofuels until 2013. To increase the availability of biofuels, all larger filling stations are required by law to sell at least one renewable fuel.

A government green-car rebate has been paid since 2007 on the purchase of vehicles capable of running on E85 or biogas, electric and electric hybrid cars and particularly fuel-efficient vehicles that do not emit more than 120 grams CO_2/km. Since 2006, Sweden has also differentiated annual vehicle tax for passenger cars according to the vehicle's CO_2 emissions. As well as the Swedish policy instruments, from 2012 car-makers selling cars within the EU will have to comply with the directive on maximum average carbon dioxide emissions from new cars of 130 grams CO_2/km by 2015.

The rises in vehicle fuel taxes since 1990 are estimated to lead to 1.9 milliion tonnes CO_2/year lower emissions in 2010 and 2.4 milliion tonnes CO_2/year lower emissions in 2020 than if the nominal tax level in 1990 had been retained. The encouragement of vehicle biofuels has led to the use of biofuels in 2008 totalling 4.3 TWh, which is equivalent to 1.1 milliion tonnes CO_2 in emissions if petrol and diesel had been used instead.

The energy efficiency of the Swedish car fleet has improved from a relatively low level in recent years. Part of the explanation is that the proportion of diesel-engined cars, which are more energy-efficient than cars running on petrol, has risen sharply.

Waste

Requirements for municipal waste plans and the introduction of producer responsibility for various product groups in the 1990s, the introduction of tax on waste sent to landfill (2000) and subsequent bans on the landfilling of separated combustible (2002) and organic material (2005) have substantially reduced emissions from landfills. Only 4 per cent of the total volume of household waste was landfilled in 2007.

The combined effect is estimated to be emissions 1.4 million tonnes of carbon dioxide equivalent lower in 2010 than with 1990 policy instruments. The difference is estimated to be 1.9 tonnes of carbon dioxide equivalent in 2020. At the same time as emissions from landfills have decreased, the combustion of waste in the electricity and district heating sector has increased by around 6 TWh in comparison with 1990 levels, leading to further mitigation, in addition to the decrease in methane emissions at landfills, if waste is assumed to replace fossil fuels.

The agricultural sector

There are few policy instruments to date that are directly aimed at limiting greenhouse gas emissions in the agricultural sector. However, the Swedish Government has taken a number of initiatives in recent years to limit the use of fossil fuels in agriculture, to increase knowledge and encourage measures leading to reduced greenhouse gas emissions from manure management and land use. The Swedish Board of Agriculture has been asked to draw up a combined action programme to reduce plant nutrient losses and greenhouse gas emissions from agriculture. In the framework of the ongoing reform of EU agricultural policy, more resources will be set aside for measures that limit the climate impact of the agricultural sector. The level of energy and carbon dioxide taxes for heating fuels and vehicle fuels used in the land-based industries will also be raised.

The flexible mechanisms of the Kyoto Protocol

Sweden is engaged in work on the project-based mechanisms under the Kyoto Protocol. The Swedish Parliament has granted appropriations for international climate change interventions in CDM and JI totalling around SEK 1200 million for the period up to 2011.

The Swedish CDM and JI programme is intended to contribute to the development of CDM and JI as effective climate policy instruments. The programme has been focused on assistance with individual projects and on participation in multilateral CDM and JI funds. The individual projects are in the areas of renewable energy and energy efficiency, and funds have been selected on the basis of an endeavour to achieve geographic spread as well as the possibility of influencing the work of the fund. Sweden at present has agreements with 24 individual CDM projects and 2 JI projects.

Sweden is taking part in five multinational funds: Testing Ground Facility, Prototype Carbon Fund, Asia Pacific Carbon Fund, Future Carbon Fund and Multilateral Carbon Credit Fund.

The total funding granted by the Swedish Parliament for the period 2003-2011 is expected to generate 11-14 of emission reduction units for Sweden.

1.4 Projections and combined effects of policies and measures

Projections

A new projection of greenhouse gas emissions and removals has been produced for this national communication. The main projection is based on the policy instruments adopted by the EU and the

Swedish Parliament up to June 2008. In addition to the main projection with sensitivity alternatives, a projection with "additional measures" decided by EU and the Swedish Parliament by December 2009 is presented.

The projection result points towards total greenhouse gas emissions (excluding the LULUCF sector) being at the same level as the emission levels of the last few years up to 2010. The effects of the financial crisis now in progress and the sharp economic downturn are thus not integrated into the projection. Emissions are estimated to continue to decrease further after 2010, and total greenhouse gas emissions in 2020 are estimated to be around 16 per cent lower than in 1990 when the additional EU-wide and national measures decided by December 2009 are included. These additional measures are estimated to by 2020 result in emissions outside the EU emissions trading scheme to be 25 per cent lower than 1990. For the main projection (based on existing measures June 2008) total emissions are estimated to be 12 per cent below the 1990 levels.

The land use, land-use change and forestry sector (LULUCF) contributed to a net sink for Sweden over the period 1990-2007 and is expected to continue to do so up to 2020.

The trend in emissions in the main projection differs between different sectors of society. Total emissions from the energy sector are estimated to remain at roughly the same level over the period 2007 to 2020, while emissions from the transport sector are estimated to increase somewhat. Emissions by the agriculture sector have decreased and are expected to continue to decrease so that they are around 25 per cent below the 1990 level in 2020. Emissions from the waste sector are expected to be halved by 2010 in comparison with 1990 and then to continue to decrease. [Table 1.1]

The projection in this national communication shows 9 per cent lower emissions for 2010 and 18 per cent lower emissions in 2020 than the projection in the Fourth National Communication (NC4). The

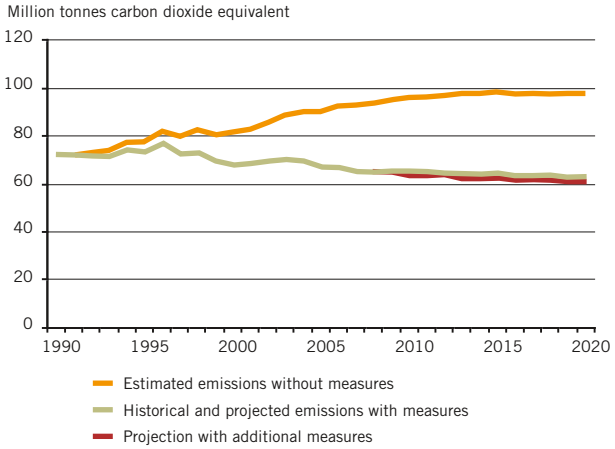


Figure 1.2 **Estimated emissions without implemented measures and with additional measures compared with historical emissions and projected emissions with existing measures.**

main reason for the wide differences in outcomes is new assumptions on substantially higher future fossil fuel prices, longer life for nuclear power facilities and greater use of vehicle biofuels, as well as new policy instruments implemented since the Fourth National Communication.

In the "additional measures" alternative, which comprises the EU requirements for the carbon dioxide emissions of new cars, inclusion of aviation in the EU Emissions Trading Scheme, raising the permitted low admixture of ethanol in petrol to 10 per cent and the climate policy decision adopted by the Swedish Parliament in July 2009, it is estimated that emissions can decrease by 2020 by more than 2 million tonnes of carbon dioxide equivalent.

Aggregate effects of introduced policy instruments

The total effect of the policy instruments introduced and tightened since 1990 has been estimated at 30-35 million tonnes of carbon dioxide equivalent annually over the period from 2010 to 2020. The calculations of how emissions would have developed without implemented policies and measures since 1990 compared with historical and projected emis-

Table 1.1 **Historical and projected emissions and removals of greenhouse gases by sector (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Energy excl. transport	34.7	28.6	27.4	27.7	27.5	27.4	-20%	-21%	-21%
Transport	18.6	20.9	20.8	21.2	21.5	21.5	14%	16%	16%
Industrial processes	5.8	6.6	6.5	6.2	6.2	6.2	7%	7%	7%
Solvents	0.33	0.3	0.29	0.29	0.29	0.28	-12%	-14%	-15%
Agriculture	9.4	8.6	8.4	8.1	7.6	7.0	-14%	-20%	-25%
Waste	3.1	2.2	1.9	1.5	1.0	0.8	-52%	-67%	-76%
Total emissions	**71.9**	**67.2**	**65.4**	**65.0**	**64.1**	**63.1**	**-10%**	**-11%**	**-12%**
With additional measures	**71.9**	**67.2**	**65.4**	**64.0**	**62.0**	**60.4**	**11%**	**14%**	**16%**
LULUCF	-32.1	-29.1	-20.5	-20.0	-20.2	-19.1	-38%	-37%	-40%

sions in Sweden up to 2020 and calculation with additional planned policies and measures are presented in Figure 1.2.

Fulfilment of commitment under the Kyoto Protocol

Swedish greenhouse gas emissions are not allowed to exceed 104 per cent of the assigned amount for the base year under the Kyoto Protocol and EU burden sharing. Emissions in the base year, when the assigned amount was established, were 72.2 milliion tonnes. Sweden's greenhouse gas emissions may therefore total a maximum of 75 million tonnes per year, as an average for 2008-12. The result of the projection points towards Swedish greenhouse gas emissions in 2010 being around 65 million tonnes of carbon dioxide equivalent in the main alternative, which indicates that Sweden will comfortably fulfil its commitment. Sweden has chosen to account the part of Article 3.4 of the Kyoto Protocol that relates to forestry. Forestry is expected to be a net sink for the commitment period, and Sweden can register a maximum sink of 2.13 million tonnes. Preparations have been made to enable JI and CDM credits to be used (see Chapter 4.3), but even without these Sweden is estimated to comfortably meet its commitment for the period 2008-2012. [Table 1.2]

Table 1.2 **Historical and projected greenhouse gas emissions relative to the Kyoto base year and Kyoto target for Sweden (millions of tonnes of carbon dioxide equivalent)**

Kyoto base year	72.2 Mtonnes
Kyoto target (Kyoto base year - 2008/2012)	4 %
Kyoto target 2008-2012 per year	75.0 Mtonnes
2007 emissions	65.4 Mtonnes
2010 projection	65 Mtonnes
Kyoto base year – 2010 projection	-10 %
Carbon sink in accordance with Articles 3.3 and 3.4	2.13 Mtonnes
2010 projection including Articles 3.3 and 3.4	62.9 Mtonnes
Kyoto base year - 2010 projection including Articles 3.3 and 3.4	-12.9 %
EU ETS allocation 2008-2012 per year	22.3 Mtonnes
EU ETS projection 2010	21.8 Mtonnes

1.5 Vulnerability assessment, climate-change impacts and adaptations

There is more extensive material today on potential regional climate changes than was reported in the Fourth National Communication. The results mainly confirm the previous scenario of significant warming and changes in precipitation. The role of natural variability is significant in the shorter-term perspective. In a longer-term perspective (100-year perspective) the choice of emission scenario has a considerable bearing on the extent of climate change. The mean values of all scenario analyses indicate a rise in temperature in wintertime in northern Sweden of 5.7°C and an increase in precipitation of 25 per cent and for the summer a rise in temperature of 2.9°C and an increase in precipitation of 11 per cent. The mean values in Southern Sweden are a rise in temperature in winter of 4.4°C and an increase in precipitation of 21 per cent, and in summertime an increase of 2.8°C and a change in precipitation of +3 per cent.

Few activities will remain totally unaffected in a changed climate in Sweden with rising temperature and changed patterns of precipitation. In particular the risk of flooding, landslides and erosion is expected to increase in many parts of the country. The risk of flooding is increasing around some of the largest lakes in Sweden, and parts of central Stockholm are expected to be affected. The need to be able to regulate water flows with new water-discharging strategies is under discussion and planning is in progress for increased water-discharging capacity.

Work on climate adaptation has been intensified in various ways in Sweden since 2005. The Planning and Building Act was amended in 2008 so that buildings are only allowed to be erected at suitable locations, and account has to be taken of the risk of accidents, flooding and erosion in municipal comprehensive plans and detailed development plans. In the area of energy, the vulnerability of the energy sector to extreme weather events has been analysed, and work to replace overhead power lines with buried cables for electricity distribution has been speeded up following the storms of 2005 and 2007. The risks to the road and rail networks of landslides, washing-away and flooding have been analysed and remedial action has been taken where necessary. Continued climate adaptation efforts have been intensified in the Budget Bill in the autumn of 2008 and in the 2009 Climate and Energy Bill. A sum of SEK 400 million has been earmarked for climate change adaptation measures for the period 2009-2011.

There is no government agency in Sweden with overarching responsibility for the issue of climate change adaptation at national level, but many agencies have a designated role in climate change adaptation activity. The county administrative boards, which have regional administrative responsibility, have the role of supporting and coordinating the implementation of adaptation measures. Responsibility for operational adaptation is held at the local level, i.e. it is borne by the municipalities. The municipalities are responsible for public planning, contingency planning and emergency services, as well as being the

authorities responsible for technical supplies. Practical adaptation measures to date have been principally commenced in municipalities recently affected by extreme weather events. This work has been principally concerned with measures in physical planning and construction. Many municipalities have raised the minimum level for construction, carried out bunding measures and invested in pumping systems against flooding.

1.6 Financial resources and transfer of technology

Tackling climate change in developing countries from a Swedish perspective is closely linked with poverty reduction and attaining development objectives such as the Millennium Development Goals. The objective of Swedish environmental development cooperation is to contribute to environmentally sustainable development, in order to enable poor people to improve their living conditions. On this basis, Sweden is working in the long term to integrate consideration of climate change into a broader spectrum of poverty reduction, for instance in water and sanitation, agriculture and forestry, food security, energy, infrastructure, health and education.

Swedish development cooperation since 2006 has totalled 1 per cent of Gross Domestic Income (GDI), and Swedish support for developing countries therefore surpasses the development assistance target agreed by the OECD Member States of 0.7 per cent. The Swedish climate-related initiatives therefore ought not to have occurred at the expense of other development goals. From the Swedish point of view there is no reason to distinguish climate financing from development financing, as consideration of the environment and climate change is so clearly essential to sustainable development.

Half of Swedish development cooperation is multilateral support, which is channelled through the Ministry of Foreign Affairs, the Swedish International Development Cooperation Agency (Sida) and the Ministry of the Environment, including regular and voluntary funding of the UN Framework Convention on Climate Change and the Kyoto Protocol. The other half is channelled as bilateral aid through Sida, to developing countries and countries with economies in transition. In the area of climate change, Sida works on capacity building, technology cooperation and research cooperation related to adaptation and mitigation in developing countries, and collaborates with non-governmental organisations, Swedish authorities, the private sector and research institutes.

Multilateral contributions

Sweden provides assistance to the Global Environment Facility (GEF), most of which is used for climate change-related purposes. Swedish payments to the GEF Trust Fund for 2004-2008 total SEK 947 million. For the fourth replenishment, negotiations on which were completed in 2006, Sweden undertook, in addition to the share decided upon, to make a voluntary contribution of SEK 356 million, and the total contribution is SEK 838 million, which will be paid over a ten-year period up to 2016.

Over the period 2004-2008, Sweden also contributed voluntary assistance totalling SEK 40 million to the Special Climate Change Fund (SCCF) and to the Least Developed Countries Fund (LDCF), which was created in connection with the Marrakesh Accords.

Sweden provides assistance to the core budget of the UN Framework Convention on Climate Change according to the agreed UN scale with an additional charge for the Kyoto Protocol, but also to the fund for participation and the fund for supplementary activities, contributions to which are voluntary. Sweden's voluntary support of UNFCCC increased substantially between 2004 and 2008, reflecting the importance Sweden attaches to the Convention's work. Sweden also provides assistance to the CDM Executive Board.

Bilateral and regional contribution

For bilateral cooperation, the Swedish contribution is based on developing countries' own strategies for poverty reduction, both in the area of climate change and in other areas. The issue of climate change has had a greater impact in recent years. Bilateral climate change assistance comprises initiatives in adaptation and mitigation, technology cooperation and capacity building, including research cooperation, institutional strengthening and training efforts.

The greatest share of support has gone to adaptation, around SEK 5 billion, and to mitigation efforts, just over SEK 3 billion over the period 2004-2008. The emphasis in Swedish support for adaptation is on contributions principally in the water and agriculture sectors, as well as programmes for disaster risk management, health contributions, training, capacity building and research. Initiatives in energy and waste management account for the majority of mitigation efforts.

Swedish development cooperation has long emphasised support to least developed countries and vulnerable countries with a low GDP per capita. The focus in these countries is on adaptation to the adverse effects of climate change in order to reduce

the vulnerability of poor people and improve their prospects of adapting to current and future climate change.

Technology development and capacity building

From the point of view of development, the issue of technology is more than physical transfer of hardware or software, it is more a matter of developing capacity in developing countries to receive, use and develop technology. This approach is crucial to the prospects of developing countries being able to acquire and themselves contribute to sustainable technological solutions adapted to their circumstances.

A Swedish environmental technology initiative is in progress in the areas of sustainable urban development and renewable energy. The assistance is targeted at Sweden's partner countries in Africa, Asia, Latin America and Eastern and Central Europe, and creates opportunities for authorities, local governments, institutions and companies in these countries to try out new technology in areas such as air pollution, water and sanitation, waste management, energy saving, renewable energy and urban transport.

1.7 Research and systematic observation

The combined research investment in climate change and climate change-related energy research increased sharply over the period 2005-2008 and on average totalled around SEK 1.2 billion annually. Most of this sum, averaging SEK 800-850 million annually, was addressed to climate-related energy research, a large part of which consists of development and demonstration projects.

The total appropriations for research are substantially increased in the government budget for 2010-2012. The annual research appropriations focused on climate and energy increase by just over SEK 500 million annually from 2012.

Climate-related research

Issues addressed in the research area of climate processes and climate modelling include the carbon cycle in coastal areas and how cloud formation is affected by the greenhouse gas and particulate emissions of modern society, the role of the greenhouse effect for the global climate and warming in the Arctic.

The Rossby Centre focuses on climate modelling and the development of regional scenarios that can be used in impact and adaptation studies. Through the Rossy Centre, Sweden takes part in joint European projects to develop credible climate scenarios for the 21st century and to improve understanding of, and opportunities to model, changed sea-ice conditions in the Arctic.

In the area of the effects of climate change, studies are in progress on changes in water resources and simulation of changes for the forests and forestry. Observation, experiments and modelling are in progress to gain an understanding of how increased carbon dioxide levels, UVB radiation, soil temperature, air temperature and snow depth affect ecosystems.

The scope of socio-economic research is very broad, encompassing the function of energy systems and environmental sustainability, research on policy instruments and international climate policy processes, tools for planning for climate change adaptation, loss of biodiversity and the impact of climate change on land use. Sweden also takes part in the European ERA-NET CIRCLE (Climate Impact Research Cooperation within a Larger Europe), which is focused on impacts and adaptation to a changed climate.

In the area of mitigation measures, research programmes are under way for instance on international climate policy, energy research for improved energy efficiency and bioenergy, on optimisation of measures that can meet both air pollution and climate change policy objectives at low cost and on ways in which Sweden can steer in the direction of low-carbon and sustainable energy and transport systems.

Swedish researchers also cooperate with developing countries in climate-related agricultural research, environmental technology, environmental economics and environmental policy and the greenhouse effects of forest fires and brown clouds from traditional burning of various biofuels in Asia.

Systematic observation

Sweden systematically gathers data on meteorology, hydrology and oceanography and monitors sources and sinks of greenhouse gases and climate-related effects on ecosystems. Sweden has a well developed systematic observation system, and the length of Swedish measurement series in many cases is unparalleled in the world.

Sweden contributes to GCOS with long-term observations and measurements of temperature, precipitation, wave height, icing, variations in glaciers and other "essential climate variables". Sweden supplies atmospheric data to WMO's World Weather Watch, contributes data on wind, temperature and precipitation to the Network of European Meteorological Services (EUMETNET), reports water runoff data to the Global Terrestrial Observing System (GTOS/Global Runoff Data Center) and contributes to satellite systems for climate change monitoring.

1.8 Education, training and public awareness

In Sweden communication on climate change and on climate-related measures is an important aspect of efforts to reduce emissions with an impact on climate change. There are several authorities to which those with an interest can turn for information on climate change, effects to combat climate change, energy issues etc. Swedish and international climate-related news is distributed through newsletters, contributing to broad media interest in climate change issues. Non-governmental organisations and study associations also contribute to public debate and knowledge on the issue of climate change. Climate change, its causes and its effects are thoroughly familiar today to the general public.

Pre-schools, schools and adult education in Sweden have a remit to contribute to socially, economically and ecologically sustainable development. Training and knowledge transfer at seminars have an important role to play in climate efforts in both authorities and companies. Training on the environment and climate often forms part of the work of companies on environmental certification. The number of public activities with a climate focus has increased steadily since 2005. Several authorities have purposefully expanded information on the Internet for households concerning climate change and what can be done about it. There are good opportunities in Sweden to ask questions and express views on an area of knowledge or a political proposal through consultation procedures, open meetings/hearings and seminars. Special measures have been taken to disseminate experience gained in Swedish climate strategy internationally.

The attitudes of the Swedish people and their knowledge of the problem of climate change have been studied by conducting surveys since 2002. The results indicate a gradual rise in awareness of climate change over the years, and provide a picture of the preparedness and willingness of the Swedish population for change in order to reduce emissions associated with their own lifestyle and consumption.

An information effort was made in 2006-2008 with the aim of increasing knowledge of the causes and consequences of climate change, passing on the latest research findings on the topic and identifying ways of reducing greenhouse gas emissions.

To foster knowledge building locally, public education and information initiatives relating to the problem of climate change have been a mandatory requirement in order to be awarded government investment grants for local-authority climate change measures.

2 National circumstances

2.1 Government structure

Sweden is a parliamentary and representative democracy governed by a government led by a Prime Minister. The Government is appointed by a popularly elected parliament, the Riksdag, elected every four years. The Riksdag is the legislative body, and controls the Government and government agencies. Political decisions, such as national climate policy and energy policy, have to be approved by parliament. The Government has to implement parliamentary decisions, submit new bills to Parliament, direct state administrative activity and represent Sweden in the European Union.

Swedish state administration is organised at central, regional and local levels. The central level consists of a number of authorities whose task is to be the Government's expert body and implement policies adopted by the Riksdag and Government. For regional and local administration there are 21 county administrative boards and 290 municipalities, and certain central government agencies have regional offices. Swedish municipalities have their own self-government whose board and municipal council are elected by the citizens of the municipality in separate elections.

With regard to implementation of the commitments under the United Nations Framework Convention on Climate Change it is the Riksdag, after discussions on Government bills, that decides and the Government and government agencies that have responsibility for implementing decisions.

The county administrative boards and municipalities have a special role to play in climate-change policy by formulating and implementing 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 with targets and action plans to limit greenhouse gas emissions and adapt society to climate change.

2.2 Population profile

The population of Sweden at the end of 2007 was just under 9.2 million, 23 per cent of whom were under 19 and 17 per cent were over 65 years of age. The annual average increase in population has been 0.4 per cent since 1990, with a more rapid increase during the 2000s. It is estimated that the population will rise to 10 million by 2030. The population density averages 22 inhabitants per km^2 but ranges between 3 inhabitants per km^2 in Northern Sweden and 100 inhabitants per km^2 in the south of the country[1]. [Table 2.1]

An increasing population is contributing to a rise in consumption of energy, foods etc., resulting in increased greenhouse gas emissions, and the population trend during the 2000s has driven increased emissions. Sweden's low population density means many

Table 2.1 **Sweden's population profile with projections[2]**

	1990	2000	2005	2006	2007	2008	% annual increase 2090-2005	% annual increase 2005-2007	2010	2020	2030
Population (mill.)	8.59	8.88	9.05	9.11	9.18	9.26	0.4	0.7	9.35	9.74	10.225
Aged 0-19 (% of population)	24.3	24.1	23.7	23.5	23.5	23.6			23.5	22.8	22.5
Aged >65 (% of population)	17.8	17.2	17.3	17.3	17.5	17.8			18.5	21.0	22.9
Population density (inh./km^2)	21.0	21.7	22.1	22.2	22.4	22.6			22.9	24.0	24.9

1 Statistics Sweden, BE 12 SM 0501.

2 Statistics Sweden, Sweden's future population 2009-2060, Statistics Sweden Demographic Reports 2009:1.

long journeys and a weak base for rail travel, and contributes to a high proportion of greenhouse emissions from road traffic.

2.3 Geographic profile

Sweden extends in a south-south-westerly/north-north-easterly direction between 55 and 69 degrees latitude north and between 11 and 23 degrees longitude east, with a total area of 450 295 km^2, of which 91 per cent is land and 9 per cent is water[3]. The breakdown of the total land area over the period 2004-2008 was forest land 70 per cent, barren land 12 per cent, other wooded land 5 per cent and other land 13 per cent[4]. Southern Sweden is low-lying, with agricultural land dominating in the far south. The only real mountain chain, with peaks rising to just over 2000 metres above sea level, is in the north-west, along the Norwegian border.

Land uplift is taking place in most of Sweden as a result of the melting of the massive land ice of the last ice age, but in the southernmost part of the country uplift has come to a halt. The ongoing rise in sea level is therefore leading to substantial coastal erosion along Sweden's southern coast where the land consists of easily eroded soils. Climate change as a consequence of future increased atmospheric temperature will strengthen this erosion.

Forest is an important natural resource that provides the basis for biobased energy supply. Over the past 50 years agricultural land has been successively converted to other land use, principally forest land, and this has contributed to reduced emissions from agriculture and increased carbon sequestration in forest biomass. In addition to forest, iron ore is an important natural resource and a basis of Swedish industrial production. An ample supply of flowing watercourses is a significant asset for the production of hydropower.

2.4 Climate profile

Sweden's proximity to the northern Atlantic and prevailing south-westerly to westerly winds result in a, for the latitude, mild climate during the winter months, but the northernmost part of the country has a sub-Arctic climate with long, cold, and snowy winters. Over the period 1961-1990 the average temperature in January was 0°C in the southernmost part of the country, while the coldest valleys in northern Sweden had an average temperature of –17°C. In July the maximum average 24-hour temperature was around +17°C in South-Eastern Sweden and just over 10°C in the north

Passing low-pressure systems result in fairly abundant precipitation which falls throughout the year, although most heavily in the summer and autumn. Annual precipitation is around 1000 mm. As most low-pressure systems 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. The lowest annual precipitation is along the eastern coasts, with just under 400 mm per year.

Over the period 1991-2007 the average temperature was around one degree higher than in the period 1961-1990. The increase was greatest during the winter at just over two degrees in the central and northern parts of the country. The increase was least during the autumn, with an almost unchanged temperature in south-western Sweden. As a consequence of the rise in temperature the densely populated areas, including Stockholm, have seen a shift from a cold-temperate to a warm-temperate climate, which reduces the frequency of winters bringing heavy snowfalls. The winter of 2007/08 was the warmest of all winters since 1858/59 in south-eastern Sweden. Precipitation has increased somewhat in most of the country. [Fig. 2.1-3]

Very severe storms with extensive uprooting of trees are rare, and it is difficult to identify trends for these. However, in January 2005 a storm with hurricane-force winds occurred in southern Sweden with by far the greatest number of uprooted trees in the past hundred years. Just two years later, southern Sweden was struck by another powerful storm. These storms are resulting in a temporary decrease in carbon sequestration in forest biomass.

The relatively cold climate entails a great need for energy for the heating of buildings during the greater part of the year, with subsequent greenhouse gas emissions. The need for heating is dependent on outdoor temperature, wind conditions and solar radiation, and varies from year to year. An energy index which takes account of these properties and is weighted according to the geographical distribution of the population provides a picture of how the need for heating has fluctuated from year to year. 1990 and 2000 were very warm, with a need for heating which was 13-14 per cent lower than the average for the reference period 1965-1995. The only year to date since 1990 with a greater need for heating (+4 per cent) than for the reference period is 1996. [Fig. 2.4]

Annual precipitation and runoff to the large rivers in north-western Sweden are of great significance for inflow of water to Swedish hydropower production.

3 Statistics SwedenCB, Markanvändningen i Sverige (Land Use in Sweden), 2008.

4 Swedish University of Agricultural Sciences (SLU), Skogsdata 2009, fördelning enligt internationell definition (Forest Data 2009, breakdown according to international definition).

5 Statistics Sweden, Markanvändningen i Sverige (Land use in Sweden), 2008.

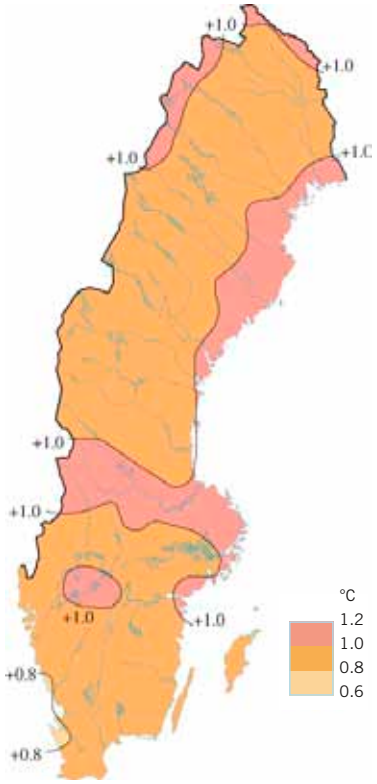


Figure 2.1 **Difference in annual mean temperature 1991-2007 compared with the period 1961-1990 (°C)**

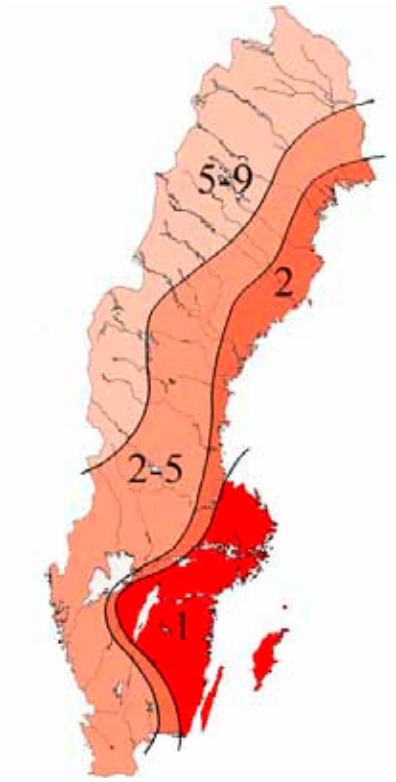


Figure 2.2 **The figures show how the winter of 2007/08 for different parts of Sweden ranks among the warmest winters since 1858/59**

Figure 2.3 **Relationship between annual precipitation 1991-2007 and the period 1961-1990 (%)**

Hydropower accounts for almost half of Swedish electricity production. The deficit of electricity in years of low inflow to hydropower production (see Figure 2.5) during the 1990s was offset by domestic fossil fuel-based electricity generation. The shortfall in the 2000s and in years of low inflow and low hydropower production has been made up for by importing electricity.

An average of 66.5 TWh hydropower per year was produced over the period 1990-2007. No significant expansion of production capacity took place in this period. 1996 was a year with a high need for heating and low water inflow/hydropower production (24 per cent compared with the average for 1990-2007), leading to higher carbon dioxide emissions than for a normal year. In 1990 and 2000 there was instead a low need for heating, relatively high hydropower production and relatively low carbon dioxide emissions. In addition to 1996, 2003 was also a year of extremely low hydropower production. There was generally low water inflow over the period 2002-2007 with the exception of 2005.

2.5 Economy

Sweden's gross domestic product adjusted for purchasing power parity, measured at 2000 price lev-

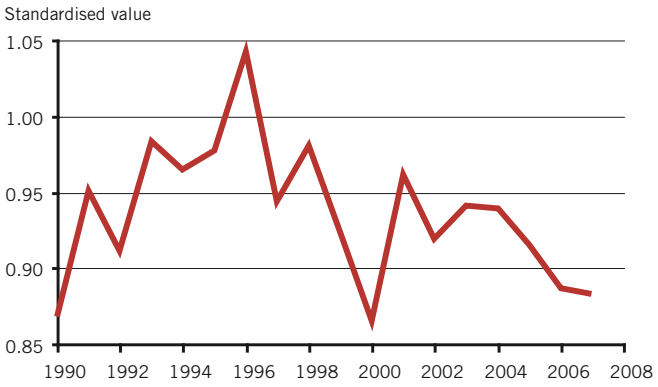


Figure 2.4 **Energy index[6] weighted according to the geographical distribution of the population shows how the annual need for heating varied in Sweden over the period 1990-2007.**

6 The energy index weighs together the effects on the heating needs of buildings during a year of sun, wind, temperature and the energy-related characteristics of buildings.

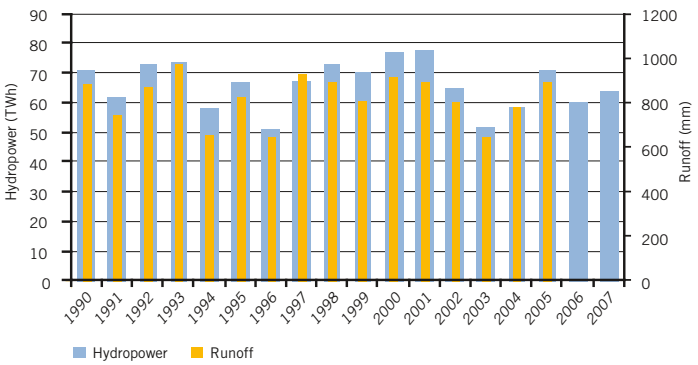


Figure 2.5 **Runoff to rivers in north-west Sweden and hydropower production in 1990-2007[7].**

7 Sources: Runoff data from Swedish Meteorological and Hydrological Institute, regional analysis of climate, water supply and high flow rates (2008); hydropower data from Swedish Energy Agency, Energiläget 2008 (Energy in Sweden 2008).

Table 2.2 **Macroeconomic data for Sweden in real terms (2000 price level)[8]**

	1990	1995	2000	2005	2006	2007	Growth 1990-2007 (%/year)	Growth 2005-2007 (%/year)
GDP (SEKm)	1846361	1909251	2249987	2552597	2660992	2729106	2.33	3.40
GDP (USDm 2000 PPP)	201854	208730	245981	279064	290914	298361		
GDP per capita (SEK)	214927	216040	253297	282125	291991	298329	1.93	2.73
GDP per capita (USD 2000 PPP)	23497	23619	27692	30843	31922	32615		
Imports (SEKm)	523621	599073	906984	1042362	1132639	1239455	5.20	9.05
Exports (SEKm)	499364	683048	1047940	1316073	1432897	1515733	6.75	7.32
Private consumption	955080	946003	1112316	1231230	1259957	1298037	1.82	2.68
Public consumption	538917	563245	585120	605919	618051	620488	0.83	1.20

els, totalled USD 300 billion (SEK 2 730 billion in 2007), which on a per capita basis is USD 32 600 (SEK 300 000). Production of services and goods accounted for 43 per cent and 28 per cent respectively of GDP. The share of agriculture in GDP is approximately 1 per cent, which is low compared with other countries.

The economy has grown by an average of 2.3 per cent annually since 1990, with the greatest rate of growth in the periods 1994-1995, 1998-2000 and 2004-2006, with an annual average rate of growth of 4–4.5 per cent.

Natural assets such as forest and iron ore are a basis of industrial production and together with the engineering industry have led to an export-oriented economy. Exports have grown more than imports since 1990, and the balance of trade has been in surplus since 1993. [Table 2.2]

Table 2.3 **Total primary energy supply 1990-2007**

	1990	1995	2000	2005	2006	2007
Total primary energy supply (TPES) (TWh)	576	599	581	639	622	624
TPES (MWh) per capita	67.1	67.8	65.4	70.6	68.3	68.0

2.6 Energy

2.6.1 Energy use

Primary energy use in Sweden has totalled between 620 and 650 TWh since 2001. A large proportion consists of nuclear-power conversion and distribution losses. [Table 2.3]

Total final energy use has increased by 8 per cent since 1990 and in the past 5 years has been approximately 400 TWh. Despite the marginal increase there have been some changes. Production volume in industry has almost doubled, but industrial energy use has only risen by just over 10 per cent. The increase in energy use has been accounted for by electricity and heating. Energy use in the residential and service sector has decreased despite an overall increase in total heated floor area in residential and commercial buildings. Increased globalisation of trade has increased energy use by transport. [Fig. 2.6]

There is no recovery of oil, natural gas or coal in Sweden. The total primary energy supply is principally based on domestic supply of biofuels, hydropower, nuclear power and, to a lesser extent, ambient heat for heat pumps and imports of oil, natural gas, coal and biofuels.

An energy policy was introduced from the early 1970s to make Sweden less dependent on oil. Almost 40 per cent of oil products have been replaced by

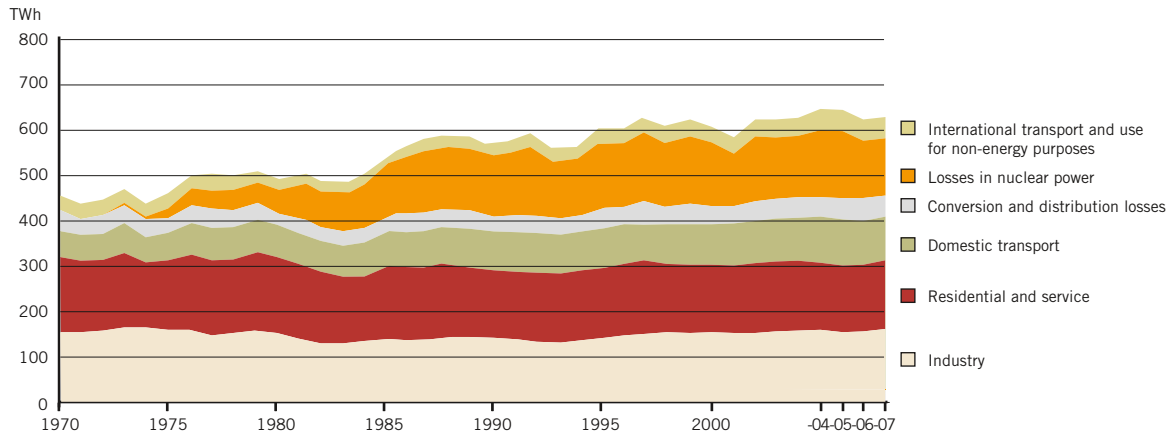


Figure 2.6 **Total primary energy use in Sweden 1970-2007[9]**

8 OECD and Statistics Sweden, National accounts 1980-2008.
9 Swedish Energy Agency, Energiläget 2008 (Energy in Sweden 2008).

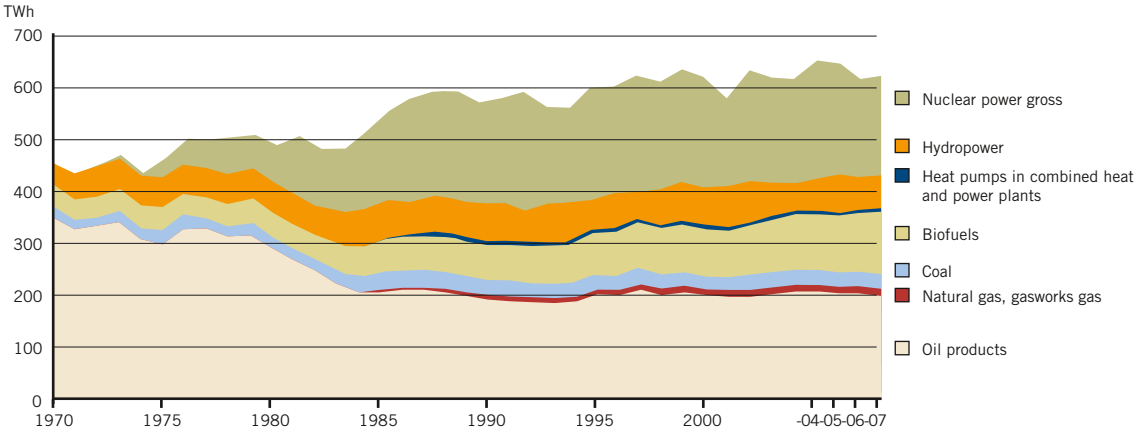


Figure 2.7 **Swedish energy supply 1970-2007, excl. net exports**

non-fossil energy supply, and with national incentives the share of bioenergy has risen to 20 per cent. [Fig. 2.7]

A major change has taken place in energy supply for homes and commercial premises. A consistent and sustained policy to expand the infrastructure for district heating and district-heating distribution was pursued from the late 1960s until the mid-1990s. The principal motive is to replace many small heating installations with large centralised installations for the heating of buildings was to improve air quality in towns and cities. The infrastructure for district heating has been crucially important for environmentally sound heating of buildings based on biofuels. It has also been essential in enabling the national policy instruments for renewable energy to cause the extensive phasing-out of fossil fuels for the heating of buildings.

Production of district heating has risen by 370 per cent since 1970 and rose by 32 per cent between 1990 and 2007. At the same time, the share of biofuels in production increased from 2 per cent to 25 per cent and to 70 per cent over the period 1970-1990-2007. Between 2004 and 2007 this share increased by 14 percentage points. [Fig. 2.8]

In addition to the substantial change-over from individual heating of buildings to district heating and the change-over from fossil energy to bioenergy for district-heating production, a conversion has taken place from oil to heat pumps or pellets in remaining individual heating of homes and commercial premises.

The share of renewable energy in Sweden since 1990 has risen by 10 percentage points, to 44 per cent in 2007. The principal contributions are made by hydropower, the use of by-products in the paper and pulp industry and biofuels for district-heating production. [Fig. 2.9]

The price of fuel oil and coal has risen 65-70 per cent since 2000, while the price of woodchips has remained stable at a low level. Carbon dioxide and energy taxes have a significant impact on fossil-fuel prices, which has contributed to making biofuels competitive for heating production in district heating and for individual heating. [Fig. 2.10]

2.6.2 Electricity supply

Hydropower accounted for 45 per cent, nuclear power for 44 per cent, biobased electricity for 6 per cent,

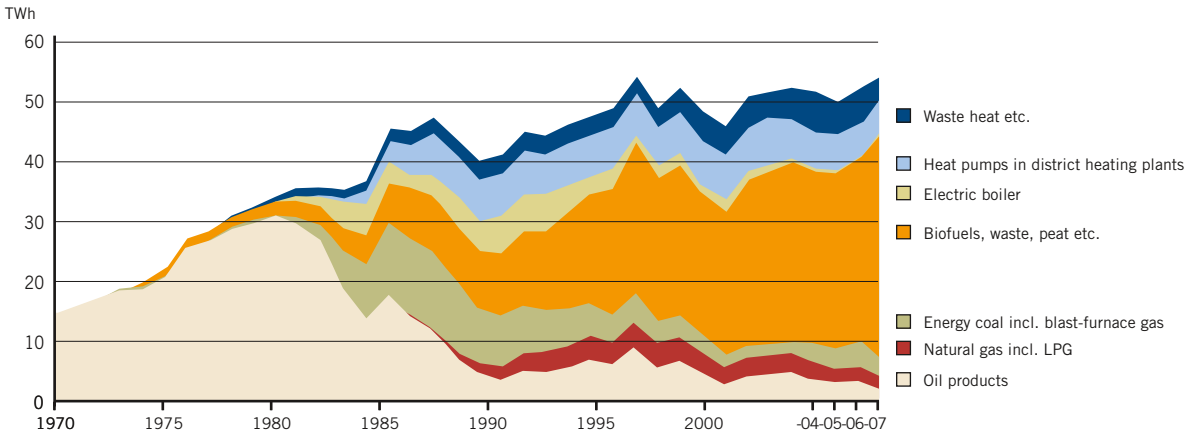


Figure 2.8 **Energy input for district heating 1970-2007**

fossil-based electricity for 3 per cent and wind power for 1 per cent of power production in 2007. Power production in the early 1970s was dominated by hydropower with additions of oil-condensing power. The expansion of nuclear power and to some extent hydropower by 1985 largely eliminated the use of oil for power production. The use of oil for electricity production has subsequently continued to decrease, except for 1996 – a cold year with extremely low water inflow for hydropower production – when decommissioned oil-condensing power plants were temporarily brought into production. Naturally good availability of watercourses for hydropower production, combined with national energy policy and investments in nonfossilfuel-based electricity production, have resulted in almost entirely fossil-free electricity production in Sweden. [Fig. 2.11]

Electricity use between 1970 and 1987 increased by 5 per cent per year, after which the rate of increase dropped to an average of 0.3 per cent per year. Consumption since 2000 has fluctuated between 145 and 150 TWh. The Swedish electricity system is linked to other Nordic countries, which makes it possible for the Nordic electric power installations to be utilised efficiently. Sweden's annual electricity balance consequently alternates between net imports and net exports. The deficit in years of low precipitation and therefore low hydropower production and when nuclear power cannot be produced at normal capacity is offset today by electricity imports. When Sweden has good hydropower and nuclear power supply, electricity is exported to neighbouring countries. In the

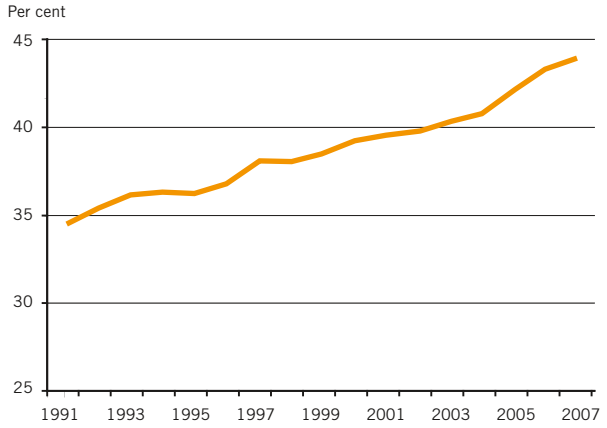


Figure 2.9 **Proportion of renewable energy sources in Sweden 1990-2007**

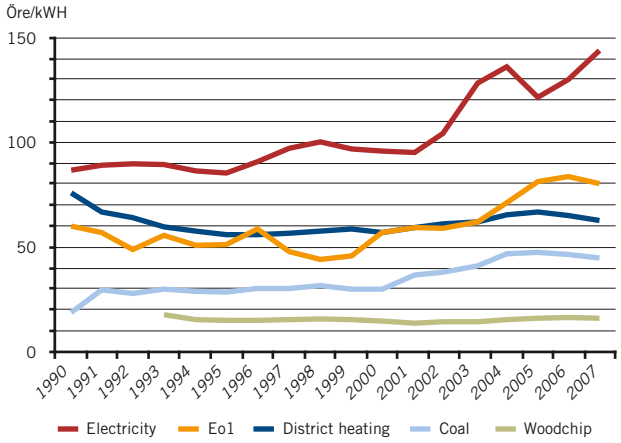


Figure 2.10 **Energy prices in Sweden including taxes, in real terms at 2007 price level**

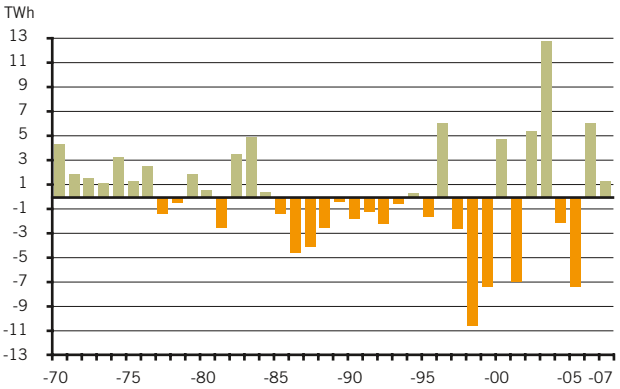


Figure 2.12 **Swedish annual net imports (+) and net exports (-) of electricity 1970-2007**

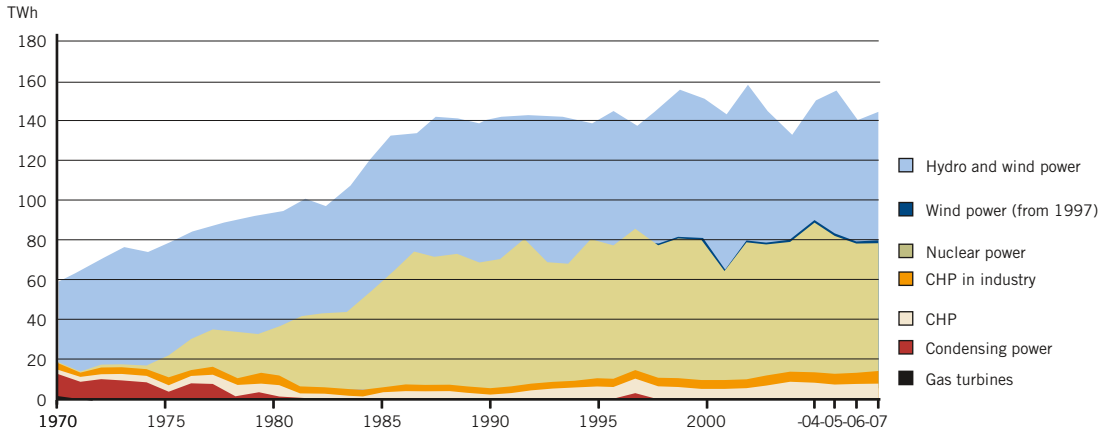


Figure 2.11 **Swedish electricity production by type of power plant 1970-2007**[10]

10 Swedish Energy Agency, Energiläget 2008 (Energy in Sweden 2008).

1990s hydropower and nuclear power deficits were offset by oil-based condensing power. [Fig. 2.12]

2.7 Building stock and urban structure

2.7.1 Building stock and residential floor space

The heated area of buildings in 2006 totalled 670 million m^2. There were 2 030 000 individual houses and 2 440 000 apartments in multi-dwelling buildings[11]. 78 per cent of the present-day housing stock was built before 1980[12].

The number of apartments increased by 12 per cent and the number of individual houses by 8 per cent over the period 1990-2007. The average residential floor space for newly built individual houses increased from 95 m^2 to 125 m^2 over the period 1990 to 2006. Average residential floor space for all individual houses was 110 m^2 in 2006. Average residential floor space rose from 41 m^2 to just over 56 m^2 on a per-capita basis between 1990 and 2006[13]. [Fig 2.13]

In 2007 there were 90 400 industrial buildings in Sweden, together making up a total floor space of 126.7 million m^2. Of this figure, 25.2 million m^2 was added over the period 1990-2006. In 2006 there was 155 million m^2 of premises, heated floor space.

2.7.2 Energy use in buildings

Final energy use in the residential and service sector, which is dominated by energy for heating, decreased between 1990 and 2007, even after normal-year correction of energy use. On the other hand, the use of electricity for household purposes and electricity for common purposes has increased.

The way in which individual houses are heated changed between 1990 and 2006. Around a third of individual houses have electric heating only. Oil and various heating combinations with oil have decreased and been replaced by heat pumps and pure biofuel heating. The proportion heated by district heating increased up to 2002 and then stabilised.

District heating dominates for multi-dwelling buildings with 76 per cent of heated floor space, and the proportion for commercial premises was 59 per cent. Oil has almost completely ceased to be used for the heating of multi-dwelling buildings. [Fig. 2.14-15]

The average energy efficiency of newly produced individual houses has improved. An average of 107 kWh/m^2 is used in individual houses built during the period 2001-2006, compared with 130 kWh/m^2 in individual houses built in 1991-2000. Energy use in

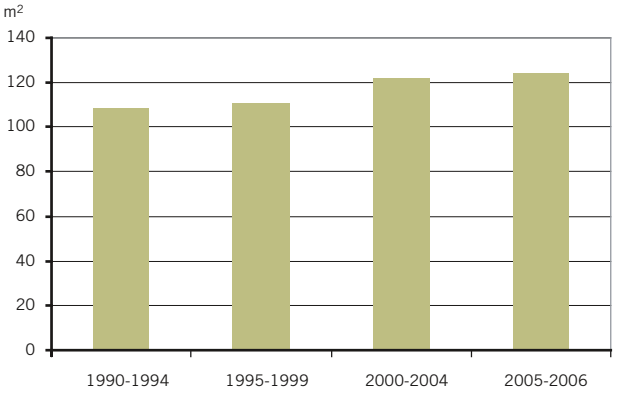


Figure 2.13 **Average residential floor space for individual houses by year of construction[14]**

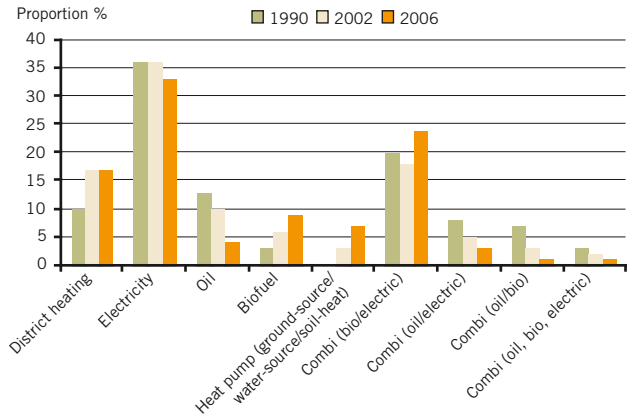


Figure 2.14 **Energy for heating in individual houses 1990 to 2006[15]**

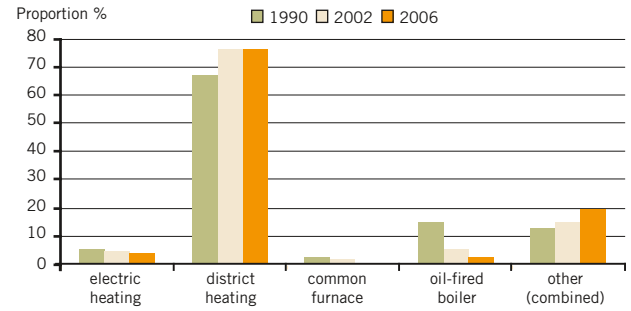


Figure 2.15 **Energy for heating in individual houses 1990 to 2006[16]**

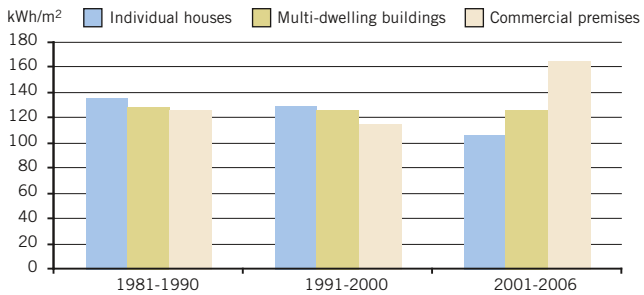


Figure 2.16 **Energy use for heating in homes and commercial buildings constructed 1981-1990, 1991-2000, 2001-2006[17]**

11 Statistics Sweden, 2009, Bostads och byggnadsstatistisk årsbok (Housing and building statistics yearbook) 2009.

12 General assessment of real estate in 2006 (www.scb.se), statistical database.

13 Statistics Sweden, BO 23 SM 0801.

14 Statistics Sweden, Allmän fastighetstaxering 2006 (General assessment of real estate in 2006) (www.scb.se), Statistisk databas (Statistical database).

15 Statistics Sweden, 2009, Bostads och byggnadsstatistisk årsbok (Housing and building statistics yearbook) 2009.

16 Statistics Sweden, 2009, Bostads och byggnadsstatistisk årsbok (Housing and building statistics yearbook) 2009.

17 Swedish Energy Agency, Energistatistik för småhus 2007 (Energy statistics for individual houses 2007), ES 2009:01, Energistatistik för flerbostadshus 2006 (Energy statistics for multi-dwelling buildings 2006), EN 16 SM 0702, Energistatistik för lokaler 2006 (Energy statistics for commercial premises 2006), EN 16 SM 0703.

new multi-dwelling buildings is 126 kWh/m^2, which is equal to that in multi-dwelling buildings built during the 1980s and 1990s. [Fig. 2.16]

2.7.3 Urban structure

As in other countries, migration from rural to urban areas is taking place in Sweden. In 2005, 84 per cent of the population were living in urban areas. The urban land area totalled 528 623 ha, representing 1.3 per cent of the total land area of Sweden[18].

The urban land area increased by 54 per cent and the urban population by 40 per cent between 1960 and 2005, which means that more land per person is being used for housing, infrastructure and services. However, between 2000 and 2005 the increase in the population of urban areas was somewhat greater than the expansion in land area, 2.2 per cent compared with an increase in land area of 1.2 per cent.

2.8 Industry

The industrial sector accounted for just under 30 per cent of GDP in 2007. The added value in the engineering industry is by far the highest, followed by the building industry and the chemical industry. Industry in Sweden is notable for being more based on raw materials than in many other countries, for example an extensive forest industry (wood products, paper and pulp) and iron and steel industry based on domestic natural resources which have a significant impact on the country's greenhouse gas emissions. [Fig. 2.17]

The impact of industry on greenhouse gas emissions comes principally from its energy use and from process emissions in the mineral products industry and the iron and steel industry. Industry accounted for just under 40 per cent of the country's final energy use in 2007, broken down into 36 per cent electricity, 35 per cent biofuels, 26 per cent fossil

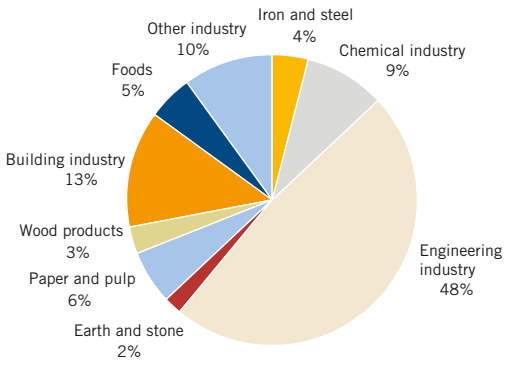


Figure 2.17 **Breakdown of the added value of industry, 2007**

18 Statistics Sweden, Markanvändningen i Sverige (Land Use in Sweden), 2008.

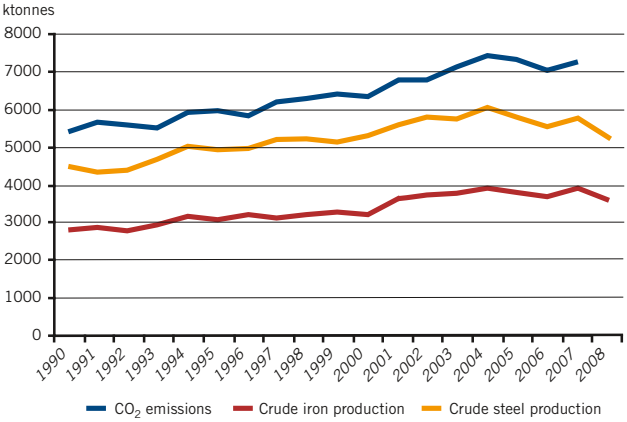


Figure 2.18 **Pig iron, crude steel production and carbon dioxide emissions related to the iron and steel industry, 1990-2007.**

energy and 3 per cent district heating. The paper and pulp industry accounts for nearly half the total energy consumption of industry, principally in the form of electricity and black liquors.

The iron and steel mills have a significant impact on Swedish greenhouse gas emissions as 14 per cent of the country's total carbon dioxide emissions in 2007 originate from this industry. The emissions come principally from pig iron and crude steel production (process emissions, combustion, coke oven plants, flaring and residual gases). Most of the residual gases from coke furnaces and blast furnaces are used for electricity production, internal heat supply and district heating for homes and commercial premises. Iron and steel production and emissions increased between 1996 and 2004. Variations in production then occurred, and emissions have followed these. Production for 2008 fell by 7 per cent in connection with the global financial crisis. [Fig. 2.18]

2.9 Transport

Domestic transport is dominated by road transport. Several factors influence greenhouse gas emissions from traffic, principally transport volume and what technology is used. Except for a brief period in the early 1990s, distance travelled in both passenger and freight transport has increased since 1990. This trend was stronger in the period 2004 to 2007 than the average since 1990, and the increase in freight transport was particularly sharp. [Fig. 2.19-20]

The rapid increase in passenger travel has been offset for greenhouse gas emissions by more energy-efficient cars and increased use of renewable fuels, which have meant that emissions per passenger-kilometre have decreased. The efficiency of freight trans-

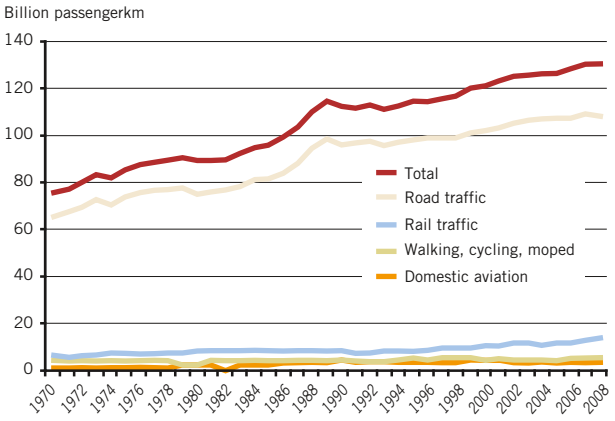


Figure 2.19 **Trend in passenger transport mileage 1970 – 2008**[19]

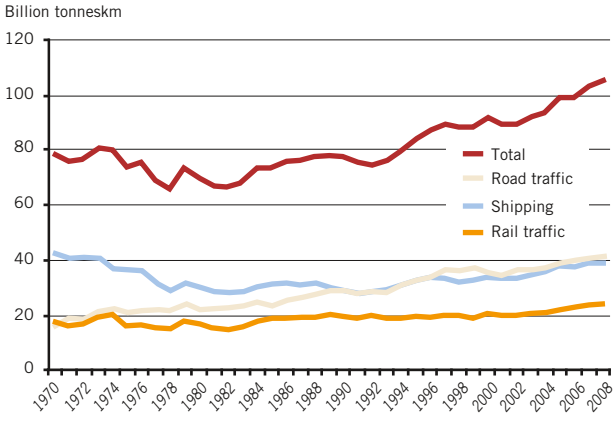


Figure 2.20 **Trend in freight transport mileage 1970 – 2008**

port also improved in the 1990s, but this trend came to a halt, and in the 2000s the energy use and carbon dioxide emissions of freight transport have increased with transport mileage.

Green cars, which are either energy-efficient cars with carbon dioxide emissions below 120 g/km or flexible-fuel vehicles that can run on renewable fuels, have taken an increasingly large share of new-car sales in Sweden. The share of green cars in sales rose from 18 per cent in 2007 to 33 per cent in 2008. Ethanol vehicles account for 70 per cent of green cars[20].

The share of green cars in the total car fleet is still limited, however, just over 200 000 at the end of 2008 out of a total of around 4.8 million light-duty vehicles. [Table 2.4]

Petrol and diesel accounted for 89 per cent of fuel use by transport in 2007. The use of petrol has been decreasing since 2002, partly as a result of the admixture of 5 per cent in petrol but also increased energy efficiency and the fact that diesel cars have taken market shares from petrol cars in new-vehicle sales. More diesel cars and increased freight transport have meant that use of diesel is increasing instead.

19 SIKA, Uppföljning av det transportpolitiska målet och dess delmål (Follow-up of the transport policy objective and its interim targets), Report 2008:1; SIKA statistics for transport mileage.

20 BilSweden 2009, Newly registered green cars in December 2008.

Table 2.4 **Number of green cars on the road 2000-2008**[21]

	2003	2004	2005	2006	2007	2008
Light-duty vehicles						
Electric cars	450	400	360	320	310	280
Electric hybrid cars	620	1350	3300	6100	9400	13500
Fuel-efficient 120 g CO_2	1260	2080	2300	7300	20000	42000
Gas cars	3440	4500	6600	10500	12900	15000
Ethanol cars	7980	13300	21400	46700	81300	138000
Heavy-duty vehicles						
Ethanol buses	400	380	370	490	490	510
Gas buses, trucks	680	780	900	1120	1160	1300
Electric and fuel cell	17	18	13	9	10	10

Renewable fuels (ethanol, FAME and biogas) accounted for just under 5 per cent of energy use by road traffic in 2008. There has been a rapid increase during the 2000s, initially through low admixture of ethanol in petrol, then increased sales of E85 for flexible-fuel ethanol cars and since 2005 increased admixture of biodiesel in diesel fuel. [Fig. 2.21]

The source for the 2008 ethanol use of 420 000 m^3 was around 75 per cent Brazilian sugar-cane ethanol, 15 per cent domestically produced ethanol (based on wheat and cellulose) and the rest imported from other EU Member States. The biodiesel used is mostly produced in Sweden but is based on imported vegetable oil, from Denmark among other countries.

2.10 Waste

Approximately 124 million tonnes of waste were generated in Sweden in 2006. The largest types of waste were mineral waste, at 70 million tonnes (of

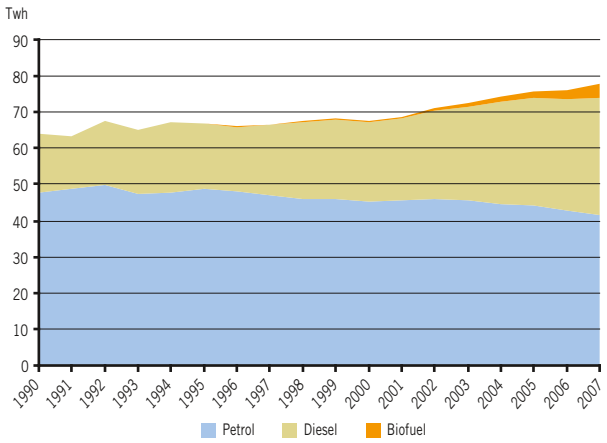


Figure 2.21 **Use of petrol, diesel and biofuels by road traffic in Sweden**

21 www.miljofordon.se.

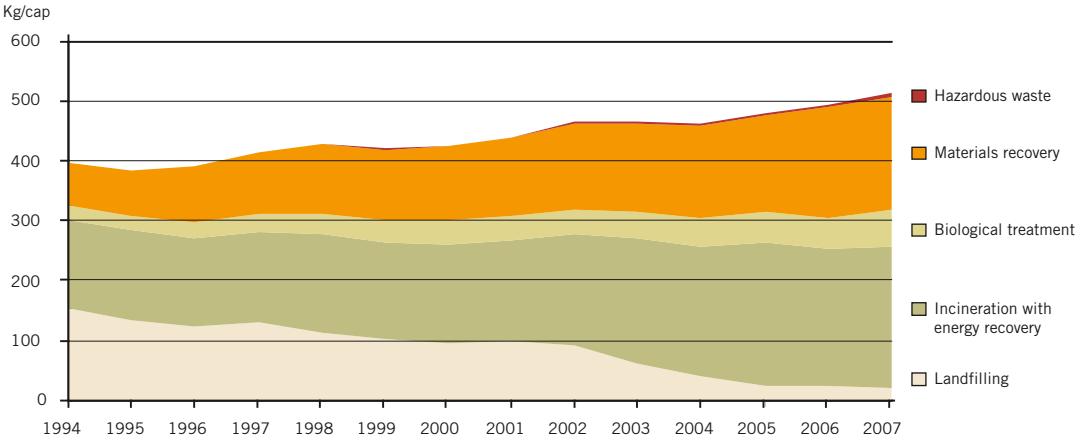


Figure 2.22 **Treated quantity of household waste per capita in Sweden 1994-2007**

which mining waste 62 million tonnes), wood waste 22 million tonnes and wastewater sludge from industry 4.5 million tonnes. Nearly half the waste is generated in the mining industry. Household waste accounts for a smaller portion of the total amounts. Household waste in 2007 totalled 4.7 tonnes, which is equivalent to 514 kg per person. The quantity of household waste has increased by 13 per cent since 2003. The increase is greatly affected by economic development, with a clear correlation between increased growth and increased quantities of waste. Increased quantities of waste mean that increasing volumes of waste have to be disposed of. However, the environmental impact of waste management has diminished as a result of the material and energy content in the waste having been utilised to a greater degree and waste management technology having improved.

Landfilling of waste has continued to decrease, and between 2003 and 2007 the landfilling of household waste fell by nearly 70 per cent. Today less than five per cent of household waste is sent to landfill. The remainder is sent for materials recovery, is incinerated with energy recovery or is treated biologically. If industrial and operational waste (not mining waste) is also included, just over half goes to materials recovery, just over a third is incinerated with energy recovery and eight per cent goes to landfill. In addition to conventional materials recovery of metal, paper, plastic and glass, materials recovery includes composting and digestion, as well as the use of waste for construction purposes. [Fig. 2.22]

The biological treatment of waste is increasing. In 2006 there were 22 composting plants and 15 digestion plants. Approximately 15 per cent of incoming substrate for the digestion plants is food waste, the remainder being made up of waste from the food industry and manure. Smaller amounts of food waste are also received at sewage treatment plants for digestion. Both biogas and biofertiliser are obtained in the digestion of waste. The biogas is principally used as a vehicle fuel. The market for vehicle fuel is developing strongly. Of the quantity of biofertiliser produced, 96 per cent is returned to agriculture.

Materials recovery from household has increased by a third since 2003, and in 2007 just under 1.7 million tonnes (37 per cent) of household waste was recovered. [Table 2.5]

Table 2.5 **Quantities of recovered household waste 2007 (tonnes)**

Newspapers, magazines, paper and packaging	1 397 500
Electronic waste	129 700
Refrigerators and freezers	30 500
Metal	180 000

The incineration of waste for energy recovery is increasing. In 2007 there were 30 incineration plants outside industry. These plants produce district heating and electricity. Half the need for heating in the Swedish building stock today is met by district heating, and waste incineration accounts for just over 20 per cent (in terms of TWh) of the fuel supply.

The collection of methane gas from landfills takes place at around 60 active and about 10 closed-down landfills. A total of 342 GWh of landfill gas was collected in 2007 and used for heating, electricity production and vehicle fuel. Landfill gas is flared to some extent to reduce the impact on the greenhouse effect.

Reduced landfilling of waste and collection of landfill gas are factors that have contributed to lower greenhouse gas emissions from the waste sector. In-

creased materials recovery generally means that both energy and material are saved, which reduces emissions. In addition, waste incineration with energy utilisation leads to limitation of the use of fossil fuels in the electricity and heating sector.

2.11 Agriculture

The total area of agricultural land in Sweden in 2007 was 3.4 million hectares, which is equivalent to around 8 per cent of the total land area of the coun-

Table 2.6 **Breakdown of agricultural land for farms with more than 2 hectares of arable land (thousands of hectares)**

	1990	1995	2000	2004	2005	2006	2007
Forage crops and green fodder	918	1 059	921	971	1 080	1 113	1 142
Cereals	1336	1 105	1 229	1 126	1 024	978	990
Set-aside	176	279	248	268	321	307	281
Rape and turnip rape	168	105	48	84	82	90	88
Potatoes	36	35	33	32	30	28	28
Sugar beet	50	58	56	48	49	44	41
Legumes	..	21	37	43	41	36	29
Other crops	..	46	55	46	42	41	40
Unspecified arable land	..	..	80	30	32	21	8
Unutilised arable land	46	60	..	14	2	2	2
Total acreage of arable land	**2 845**	**2 767**	**2 706**	**2 661**	**2 703**	**2 660**	**2 648**
Grazing land and hay meadows	332	425	..	523	513	503	488
Total acreage of agricultural land	**3176**	**3 192**	**..**	**3184**	**3 216**	**3 163**	**3 136**

Table 2.7 **Crop production in Sweden (tonnes)**

	1990	2007	Change (000 tonnes)	Change,%
Forage crops and green fodder	5219000	4154300	-1064700	-20
Cereals	6211300	5057600	-1153700	-19
Rape and turnip rape	380110	222400	-157710	-41
Potatoes	1186100	789000	-397100	-33
Sugar beet	2775500	2137700	-637800	-23
Total production of crops	**15772010**	**12361000**	**-3411010**	**-21**

Table 2.8 **Number of livestock, thousands**

	1990	1995	2000	2004	2005	2006	2007
Dairy cows	576	482	428	404	393	388	370
Cows for rearing of calves	75	157	167	172	177	178	186
Total cows	**651**	**639**	**595**	**576**	**570**	**566**	**556**
Heifers, bulls and steers	543	596	589	539	527	530	516
Calves below 1 year	524	542	500	514	509	496	489
Total cattle	**1 718**	**1 777**	**1 684**	**1 629**	**1 606**	**1 592**	**1 561**
Ewes and rams	161	195	198	220	222	244	242
Lambs	244	266	234	246	249	262	267
Total sheep and lambs	**405**	**461**	**432**	**466**	**471**	**506**	**509**
Sows and gilts	230	245	206	195	188	187	181
Pigs for slaughter	1025	1 300	1 146	1 095	1 085	1 002	1 015
Piglets	1009	768	566	528	538	492	480
Total pigs	**2 264**	**2 313**	**1 918**	**1 818**	**1 811**	**1 681**	**1 676**
Horses				283			

Table 2.9 **Livestock production in Sweden (tonnes)**

	1990	2007	Change (000 tonnes)	Change,%
Milk	3432000	2986000	-446000	-13
Beef	143780	133500	-10280	-7
Pigmeat	289150	264900	-24250	-8
Mutton, lamb	4880	4600	-280	-6

Table 2.10 **Sale of mineral fertiliser expressed as nitrogen nutrient (thousands of tonnes)**

	1999/00	2000/01	2003/04	2004/05	2005/06	2006/07
Nitrogen (N)	189,4	196,9	176,2	161,6	160,3	167,1

try. Agricultural land contains both arable and grazing land. The arable acreage has decreased by around 7 per cent since 1990. The trend towards fewer and larger agricultural enterprises has been in progress for many decades, and continued in 1990-2007. Arable land is predominantly used for the cultivation of forage crops, green fodder and cereals. The growing of forage and green fodder crops has increased at the expense of cereal cultivation since 2000. Set-aside land has increased, and total crop production has decreased by around 20 per cent since 1990. [Table 2.6-7]

In 2007 there were just under 1.6 million cattle, 0.5 million sheep and lambs and 1.7 million pigs. The number of cattle has fallen steadily since the 1980s and declined by 9 per cent over the period 1990-1007. It is the number of dairy cows that has decreased sharply, while cows for the rearing of calves have increased in number. Sheep and lamb production has increased, particularly over the period 2003-2006. The number of pigs is continuing to decline and has fallen by 12 per cent since 2003. Thanks to increased productivity, milk production has not decreased by anything like the same extent as the number of dairy cows. [Table 2.8-9]]

Total use of mineral fertiliser has decreased over a long period, and in 2005/2006 was at its lowest level since the 1960s. With rising cereal prices in 2007 some upturn can be seen when it became cost-effective to increase fertiliser application. The reduction in use of mineral fertiliser is principally related to reduced cereal cultivation. The result in terms of greenhouse gas emissions has been lower release of nitrous oxide. [Table 2.10]

The arable acreage, number of cattle and use of mineral fertiliser and manure has decreased since 1990, resulting in reduced methane and nitrous oxide emissions.

2.12 Forestry

The total area of forest land in Sweden is 28.4 million hectares[22], which is equivalent to 70 per cent of the land area of the country. It is for this land area that greenhouse gas emissions and removals in the forests are reported. Forest land is owned 48 per cent by individual owners, 29 per cent by private limited companies and other private owners and 23 per cent by central and local government.

4.4 million hectares of forest land are protected. The acreage of productive forest land[23] is 23.5 million hectares, of which 0.8 million hectares are protected, mostly montane forests in national parks or nature reserves. Approximately 1.1 million hectares out of the 22.7 million hectares that are not formally protected have, however, been voluntarily set aside for the purpose of preserving biodiversity.

Increased demand from the forest industry resulted in a significant increase in forest felling over the period 1990-2007, and timber use reached a new record level in 2004-2007. There were wide variations in felling between different years due to the two storms Gudrun (2005) and Per (2007).Gudrun, the worse of the two, brought down 80 per cent of the normal volume of annual felling in Sweden (Figure 2.23). Despite increased felling, the total timber stock has increased from around 2.8 billion m^3 to 3.3 billion m^3 since 1990.

Total use of biofuels from the forests excluding waste and recycled wood has increased by around 40 TWh since 1990 and now totals just over 100 TWh. The increase over the period 2004-2007 was of the order of 5 TWh. The area of regeneration felling where logging residuals are used for energy purposes was small in the early 1990s. It has since increased steadily and in 2007 totalled 60 000 hectares[24]. Ash is returned with the aim of counteracting the acidifying and nutrient-depleting effect in the ground of the harvesting of logging residuals. Ash return took place on around 9 000 hectares annually in 2007-2008.

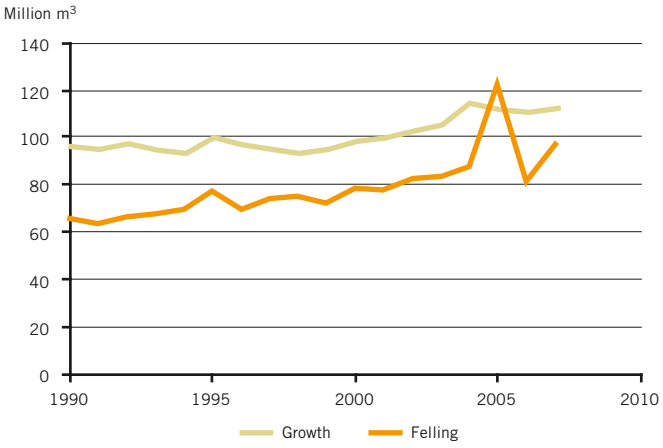


Figure 2.23 **Estimated annual forest growth and annual forest felling in Sweden[25]**

22 Swedish University of Agricultural Sciences (SLU), Skogsdata (Forest Data) 2009.
23 Forest land with production capacity of at least 1 m3 timber per hectare per year.

24 Source: Swedish Forest Agency studies of measures.
25 Swedish Forest Agency, National Forest Survey.

3 Greenhouse gas inventory 1990-2007

3.1 Total emissions and removals of greenhouse gases

Total greenhouse gas emissions in Sweden, calculated as carbon dioxide equivalent, were 65.4 million tonnes in 2007 (excluding LULUCF). Emissions decreased by around 6.5 million tonnes or 9.1 per cent between 1990 and 2007. Aggregated greenhouse gas emissions varied over the period 1999-2007 but in all cases were below the 1990 level. The information in this chapter is a summary of the 2009 reporting to the UN Framework Convention on Climate Change on greenhouse gas inventories[26]. [Fig. 3.1]

The net sink for the land use, land-use change and forestry sector (LULUCF) was just under 21 million tonnes of carbon dioxide equivalent in 2007. The size of the sink varied over the period. [Fig. 3.2]

GDP growth averaged 2.3 per cent over the period 1990-2007. GDP fell during the early 1990s but since 1994 has averaged just over 3 per cent. Despite economic growth of almost 50 per cent since 1990, it has been possible to reduce greenhouse gas emissions. Greenhouse gas emissions (excl. LULUCF) per capita have fallen from 8.4 tonnes 1990 to 7.1 tonnes in 2007. [Table. 3.1]

In 2007, emissions of carbon dioxide were 51.6 million tonnes (excl. LULUCF), which is equivalent to around 79 per cent of aggregated greenhouse gas emissions. Just over 90 per cent of carbon dioxide emissions came from the energy and transport sectors. Emissions of methane come principally from agriculture and waste and totalled 5.4 million carbon dioxide equivalent in 2007 (8 per cent of emissions). Emissions of nitrous oxide totalled 7.2 million tonnes, which is equivalent to 11 per cent of total emissions. Just over 70 per cent of nitrous oxide emissions come from the agricultural sector. Just under 2 per cent or 1.3 million tonnes of carbon dioxide equivalent out of aggregated greenhouse gas emissions were emissions of fluorinated greenhouse gases. [Fig. 3.3]

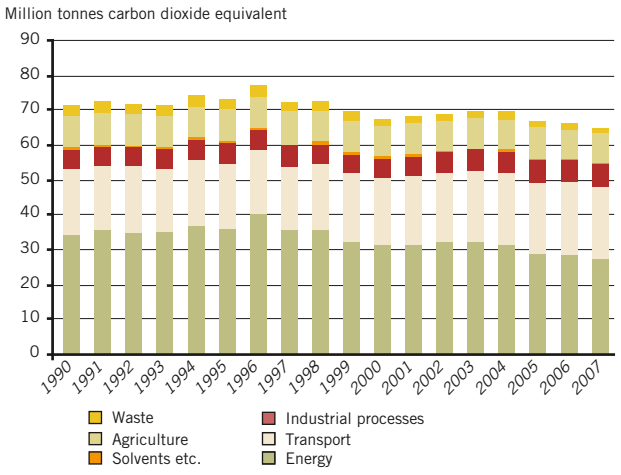


Figure 3.1 **Total greenhouse gas emissions from different sectors**

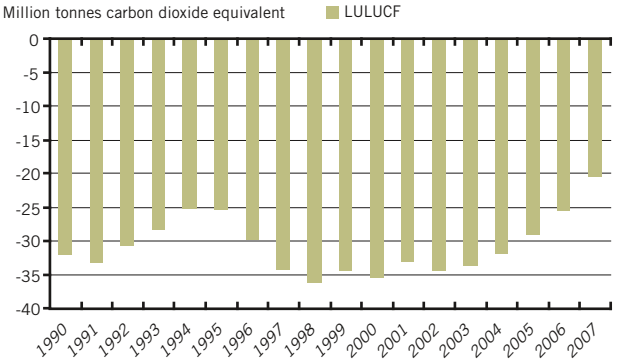


Figure 3.2 **Net removals of greenhouse gases from Land Use, Land-Use Change and Forestry**

26 National Inventory Report 2009 Sweden.

Table 3.1 **Greenhouse gas emissions per capita and GDP (real GDP at 2000 prices)**

	1990	1995	2000	2004	2005	2006	2007
CO_2 eq. (tonnes) per capita	8.4	8.3	7.7	7.7	7.4	7.3	7.1
CO_2eq (kg) GDP (SEK)	0.039	0.039	0.030	0.028	0.026	0.025	0.024
CO_2eq (kg)/GDP (USD PPP)	0.36	0.35	0.28	0.26	0.24	0.23	0.22
CO_2 (tonnes) per capita	6.6	6.6	6.0	6.1	5.9	5.8	5.6
CO_2 (kg)/GDP (SEK)	0.030	0.030	0.024	0.022	0.021	0.020	0.019
CO_2 (kg)/GDP (USD PPP)	0.28	0.28	0.22	0.21	0.19	0.18	0.17

PPP= Purchasing Power Parity

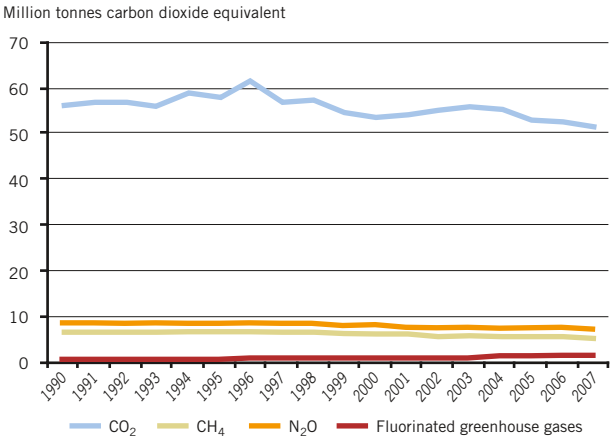


Figure 3.3 **Greenhouse gas emissions broken down by gas**

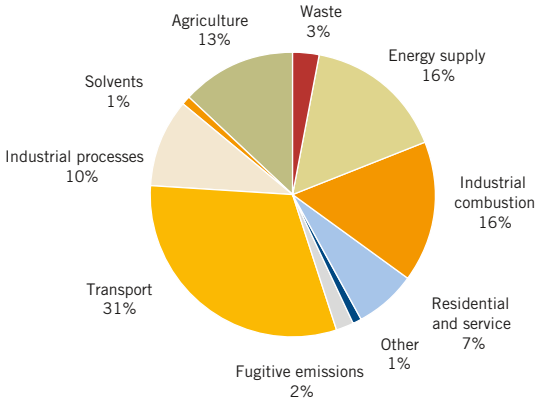


Figure 3.4 **Share of greenhouse gas emissions by sector (% of tonnes of CO_2 equivalent)**

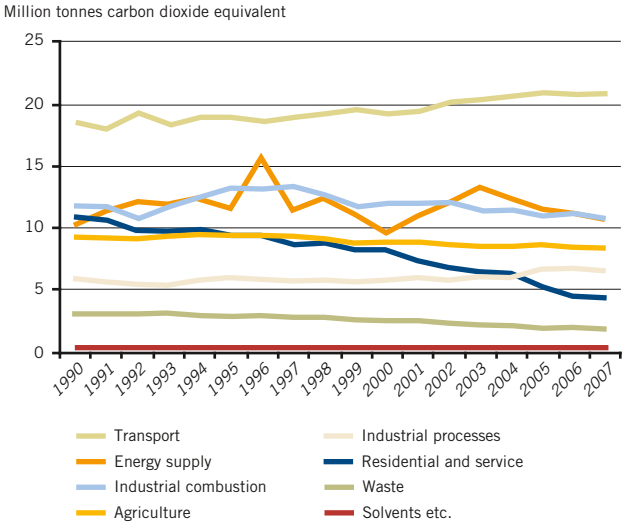


Figure 3.5 **Greenhouse gas emissions broken down by sector**

3.2 Emissions and removals of greenhouse gases per sector

The greatest emissions in 2007 were from the energy, transport and industrial sectors. Emissions from the energy sector were equivalent to 42 per cent of total greenhouse gas emissions, of which energy supply accounted for 16 per cent and industrial combustion for 16 per cent. Domestic transport accounted for 31 per cent of total greenhouse gas emissions and industrial processes for 10 per cent. [Fig. 3.4]

Emissions of greenhouse gases from different sectors of society developed in different directions over the period from 1990 to 2007. The greatest reductions in emissions over the period took place in the residential and service, agriculture and waste sectors. Emissions have increased principally in the transport sector and in some industries. [Fig. 3.5]

3.2.1 Energy excluding transport

Emissions of greenhouse gases by the energy sector[27] totalled just under 27 million tonnes of carbon dioxide equivalent in 2007, which represents 42 per cent of total emissions. Carbon dioxide emissions dominate the energy sector's emissions with 94 per cent, while methane and nitrous oxide emissions are low, at 2 per cent and 4 per cent respectively. Methane emissions increased by 37 per cent between 1990 and 2007, principally as a consequence of increased use of biofuels in the residential and service sector and in power and district-heating plants. Nitrous oxide emissions stayed at roughly the same level between 1990 and 2007.

Emissions by the energy sector vary with temperature and precipitation conditions and the state of the economy over the years, but the trend over the period 1990-2007 was for a slight reduction in emissions. Emissions were 21 per cent lower in 2007 than

27 Emissions by the energy sector include emissions from the production of electricity and district heating, refineries, manufacture of solid fuels, industrial combustion, fugitive emissions and the residential and service sector, including combustion in agriculture, forestry and fisheries.

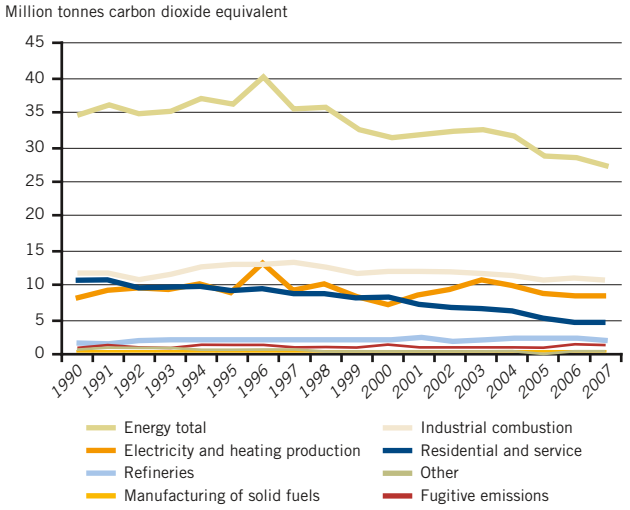


Figure 3.6 **Greenhouse gas emissions from the energy sector**

in 1990, and the decrease is principally due to the use of oil for heating in the residential and service sector having declined and having been replaced principally by district heating based on biomass fuels. [Fig. 3.6]

Energy industries (electricity and district heating production, refineries, manufacture of solid fuels)

Greenhouse gas emissions from electricity and district heating production were 8.5 million tonnes of carbon dioxide equivalent in 2007. Emissions varied with temperature and precipitation levels over the period 1990-2007, which has an effect on the need for heating and on hydropower production. Emissions are also affected by the increase in iron and steel production which has taken place since 1990, as residual gases are used to produce electricity and district heating. Electricity and district heating production increased between 1990 and 2007, but emissions did not increase to the same extent, as the expansion has mainly taken place through increased use of biofuel. Emissions per kWh have therefore fallen. Energy and carbon dioxide taxes, the electricity certificate system and fossil fuel prices have contributed to this trend.

Emissions from refineries increased from 1.8 million tonnes in 1990 to 1.9 million tonnes of carbon dioxide equivalent in 2007 as a result of increased production. Emissions from the manufacture of solid fuels totalled 0.3 million tonnes in 2007 and remained at roughly the same level between 1990 and 2007.

Residential and service sector

Greenhouse gas emissions in 2007 totalled 4.5 million tonnes of carbon dioxide equivalent from the residential and service sector, including emissions from individual heating and from combustion in agriculture, forestry and fisheries, which is a more than 59 per cent decrease in comparison with 1990. The decrease is due to emissions from individual heating of residential and commercial premises having fallen from 9.2 to 2.7 million tonnes between 1990 and 2007 as a result of a change-over from oil to district heating and in recent years also to heat pumps and pellet-fired boilers. The positive trend is principally due to energy and carbon dioxide taxes, rising oil prices and investment grants.

Emissions from energy use in agriculture, forestry and fisheries increased by 8 per cent between 1990 and 2007 and totalled 1.8 million tonnes in 2007.

Industrial combustion

Greenhouse gas emissions from industrial combustion were approximately 10.7 million tonnes of carbon dioxide equivalent in 2007. This is 9 per cent below the 1990 level, but emissions have varied over the years, principally due to economic fluctuations. A small number of energy-intensive industries account for a large proportion of emissions in the sector. The pulp and paper industry accounts for 16 per cent of emissions, the chemical industry for 15 per cent and the iron and steel industry for 12 per cent. Some decrease in emissions can be seen in recent years, principally due to reduced emissions from the pulp and paper industry.

Fugitive emissions and other

Emissions from the fugitive emissions sector come for example from refineries and flaring in the iron and steel industry. Emissions increased by almost 13 per cent between 1990 and 2007 to 1.3 million tonnes of carbon dioxide equivalent in 2007. Emissions from "Other" (principally military emissions) decreased between 1990 and 2007 and totalled just under 0.3 million tonnes of carbon dioxide equivalent in 2007.

3.2.2 Industrial processes

Emissions from industrial processes are in particular derived from the production of iron and steel and from the cement and lime industries. Emissions from industrial processes totalled 6.5 million tonnes of carbon dioxide equivalent in 2007, which is 10 per cent of Sweden's aggregate emissions. [Fig. 3.7]

In 2007 emissions were around 13 per cent higher than in 1990, but emissions have varied, principally due to variation in production volumes and economic fluctuations. Economic fluctuations differ, however, for different industries. Emissions from the mineral industry and the iron and steel industry, for example, have

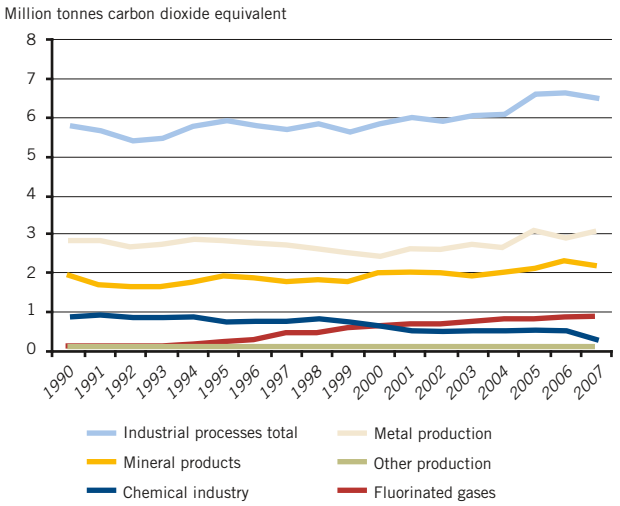


Figure 3.7 **Greenhouse gas emissions from industrial processes**

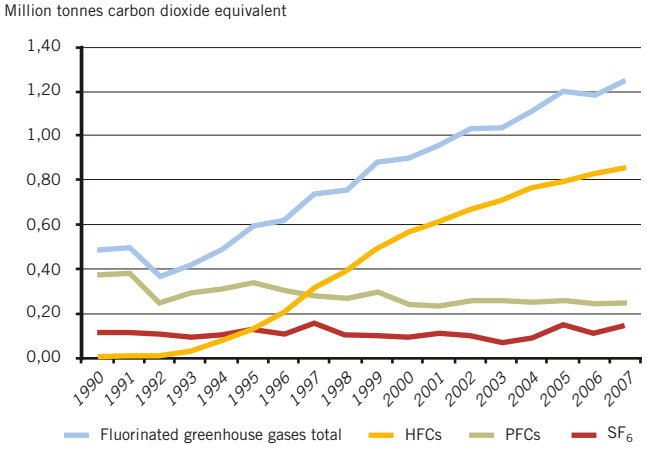


Figure 3.8 **Emissions of fluorinated greenhouse gases**

increased in recent years, while those from the chemical industry have decreased over the same period. Some of the increase in emissions from the iron and steel industry is also reported in industrial combustion and electricity and district heating production.

Fluorinated greenhouse gases (HFC, PFC, SF_6)

Total emissions of fluorinated greenhouse gases in 2007 were almost 1.3 million tonnes in 2007 in terms of carbon dioxide equivalent, just under 2 per cent of total emissions. Emissions increased by 157 per cent between 1990 and 2007 due to a sharp increase in emissions of HFCs. This is due to HFCs having replaced the ozone-depleting substances CFCs and HCFCs as refrigerants and the number of refrigerating and air-conditioning units, as well as heat pumps, having increased. [Fig. 3.8]

3.2.3 Solvent and other product use[28]

Emissions of carbon dioxide and nitrous oxide from the use of solvents and other products in 2007 totalled 0.3 million tonnes of carbon dioxide equivalent, which is 0.5 per cent of total emissions. In comparison with 1990 emissions fell by 11 per cent, principally due to a change-over from oil-based to water-based paints.

3.2.4 Transport

Domestic transport accounted for 31 per cent of total greenhouse gas emissions in 2007. Emissions increased by 12 per cent, from 18.6 million tonnes of carbon dioxide equivalent in 1990 to 20.8 million tonnes in 2007. Emissions of methane and nitrous oxide from transport are low and represent only 1 per cent of the sector's emissions, while carbon dioxide emissions account for 99 per cent of emissions. Methane emissions have decreased by 70 per cent since 1990 as a consequence of better exhaust gas treatment and totalled 0.03 million tonnes of carbon dioxide equivalent in 2007. Nitrous oxide emissions totalled 0.16 million tonnes of carbon dioxide emissions in 2007 and have decreased since 2000 as a result of better technology in vehicles. [Fig. 3.9]

Emissions from road traffic have increased. This is principally due to increased transport mileage with heavy-duty vehicles and an increased proportion of light-duty trucks and cars with diesel engines, resulting in increased use of diesel. This increased transport mileage with heavy goods vehicles is due among other things to the structural transformation in society towards greater specialisation, centralisation and globalisation, which has the result that goods are transported ever longer distances. Diesel consumption increased by 38 per cent between 1990 and 2007.

The increase in emissions from road traffic is counteracted by a decrease in use of petrol as there has been a significant shift from petrol to diesel for cars. Several factors have been significant in reducing emissions

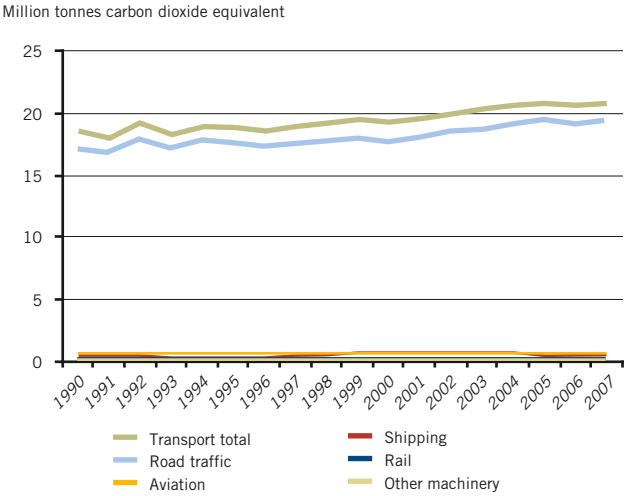


Figure 3.9 **Greenhouse gas emissions from transport**

28 This sector includes emissions for instance from the use of paints, nitrous oxide in healthcare, fire-extinguishing equipment and emissions from the use of chemical products in wood impregnating, the graphic industry, the textile industry and the leather industry.

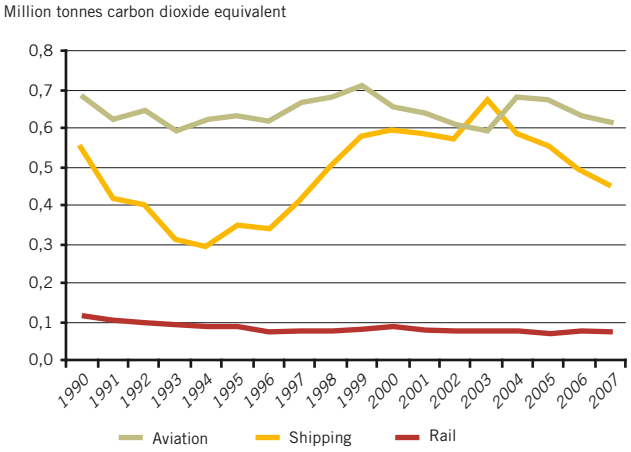


Figure 3.10 **Greenhouse gas emissions from domestic aviation, shipping and railways**

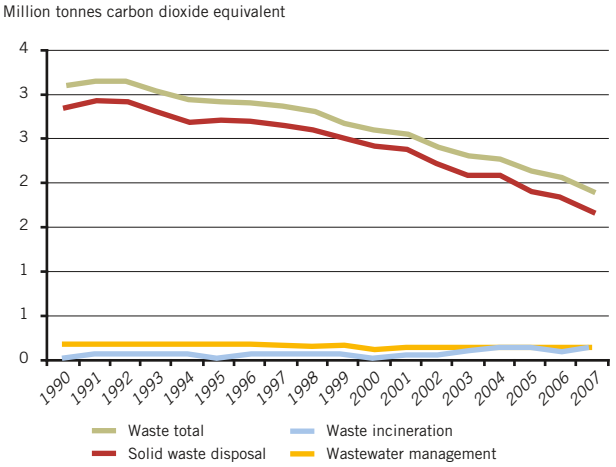


Figure 3.11 **Greenhouse gas emissions from the waste sector**

from petrol for road traffic. Vehicle fuel taxes, together with high petrol prices, have contributed to a switch to renewable fuels and to limiting consumption.

Greenhouse gas emissions from domestic aviation totalled 0.6 million tonnes in 2007, which was 11 per cent below the 1990 level. Emissions from domestic aviation have varied but have decreased in recent years as more people choose to travel by rail rather than air within the country. [Fig. 3.10]

Emissions from domestic shipping were estimated at 0.5 million tonnes in 2007. Emissions varied over the period 1990-2007 but have decreased since 2003.

The railways have reduced their emissions by around 34 per cent since 1990, to less than 0.1 million tonnes in 2007.

3.2.5 Waste

Emissions from the waste sector in 2007 totalled 1.9 million tonnes of carbon dioxide emissions or just under 3 per cent of aggregate greenhouse gas emissions. Emissions have decreased by 38 per cent since 1990. Emissions by the waste sector are dominated by methane emissions from landfills (87 per cent). [Fig. 3.11]

Landfills are the largest source for the emission of methane gas, after livestock farming, as methane is formed when organic waste breaks down. Emissions of methane have decreased steadily since the start of the 1990s, partly due to the quantity of waste sent to landfill having decreased and partly as a consequence of increased collection and disposal of methane gas from landfills. The quantity of waste sent to landfill has decreased principally as a result of the ban on landfilling, combustible and organic material introduced in 2002 and 2005. Producer responsibility, municipal waste plans and waste tax have also reduced the quantity of waste.

Emissions of nitrous oxide from wastewater have also decreased by 29 per cent since 1990. Carbon dioxide emissions from the incineration of hazardous waste have increased somewhat in recent years in comparison with the level of emissions in 1990-2002 as an increased quantity of waste was burnt.

3.2.6 Agriculture

Agriculture is the largest source of methane and nitrous oxide emissions. In 2007 the sector's emissions of these greenhouse gases totalled 8.4 million tonnes of carbon dioxide equivalent. Aggregate emissions from agriculture decreased by just under 4 per cent over the period 2000-2007 and have been reduced by 10 per cent since 1990. [Fig. 3.12]

Methane emissions come principally from the enteric fermentation and manure of cattle. The most important reason for the reduced emissions is reduced livestock farming. The number of dairy cows has decreased from 576 000 in 1990 to 370 000 in 2007. The number of pigs has also declined.

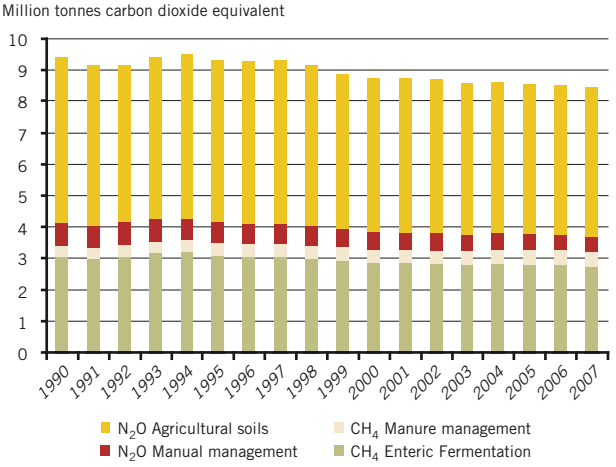


Figure 3.12 **Greenhouse gas emissions from agriculture**

The reduced emissions of *nitrous oxide* since 1990 are due to the use of both mineral 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 bring down nitrogen losses from agriculture has to some extent reduced indirect emissions of nitrous oxide from leached nitrogen and ammonia deposition. The expansion of slurry management for pigs and dairy cows has also reduced emissions.

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

The land use, land-use change and forestry sector contributed to an annual net sink in Sweden over the period 1990-2007. The sink ranged between 21 and 36 million tonnes of carbon dioxide equivalent over the period, but the trend points to a somewhat decreasing sink, due in part to felling having increased over the period. The sink has decreased at a somewhat higher rate in recent years. A contributory cause may be a severe storm in early 2005 which brought down a large quantity of forest, and this may continue to have an impact on the size of the sink in the years after 2005, at the same time as felling is increasing. According to Swedish Forest Agency statistics, felling ranged between 64 Mm^3 and 95 Mm^3 over the period 1990-2007, with the exception of 2005, when felling was estimated at 122 Mm^3. The uncertainty is, however, greater in data for 2004-2007 with regard to the LULUCF sector, as not all the sample plots have been inventoried for these years.

The size, variation and trend of the total net sink are principally affected by the change in the carbon stock in forests. Removals in living biomass in forest ranged between around 20 and 40 million tonnes of carbon dioxide over the period 1990-2007, while carbon dioxide emissions from soil carbon in forest land ranged between 1.5 and 7 million tonnes. Cropland accounts for a net source as cultivation of organogenic soils leads to carbon dioxide emissions. Emissions ranged between 3 and 4 million tonnes of carbon dioxide over the period 1990-2007. [Fig. 3.13]

3.2.8 International transport

Total emissions from international bunkering of fuels totalled 9.8 million tonnes of carbon dioxide equivalent in 2007. This is an increase of 170 per cent from 1990, and is principally due to increased emissions from international shipping. [Fig. 3.14]

Emissions from international shipping were just over 7.5 million tonnes of carbon dioxide equivalent in 2007, an increase of 230 per cent since 1990. International freight transport mileage has increased as a result of an increase in the quantity of transported freight and globalisation of trade and production systems having led to freight being transported longer distances. Another explanation is that Swedish refineries are producing low-sulphur ship fuel (fuel oil 2-5) which meets strict environmental requirements. This has led to more shipping lines having chosen to refuel in Sweden. The fluctuations in bunkered volumes between different years also depends heavily on the price of fuel in Sweden in comparison with other ports in other countries.

Greenhouse gas emissions from the international bunkering of aviation totalled 2.2 million tonnes of carbon dioxide equivalent in 2007, which was an increase of 0.9 million tonnes or 64 per cent in comparison with 1990. The trend points to increasing emissions, as international travel is increasing.

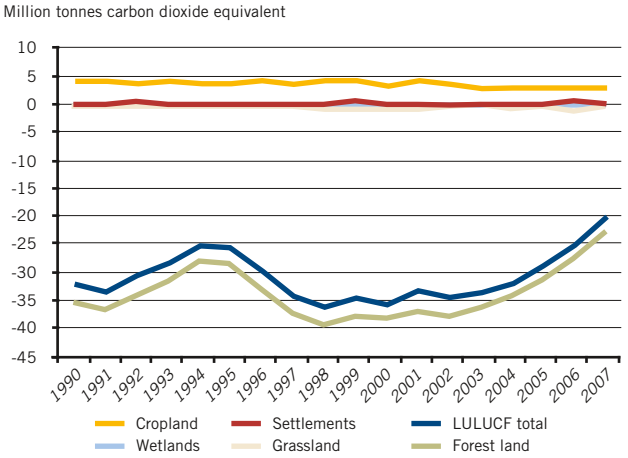


Figure 3.13 **Greenhouse gas emissions and removals from Land Use, Land-Use Change and Forestry**

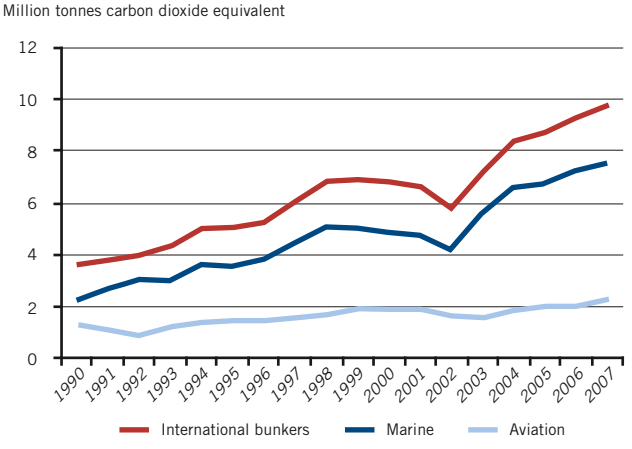


Figure 3.14 **Emissions from international bunkering**

4 Policies and measures

4.1 Swedish climate strategy

Sweden's climate strategy has developed steadily since the end of the 1980s. The strategy consists of objectives, policy instruments and measures and recurrent follow-up and evaluation of established objectives and strategies.

Work aimed at developing climate strategy has intensified over the past ten years, and the strategy has been developed to increasingly emphasise the international nature of the climate issue and the fact that climate change mitigation has to be resolved globally.

Sweden is working with the other EU Member States to achieve a global agreement which is compatible with the target of limiting the rise in temperature to no more than 2 degrees Celsius above the pre-industrial level.

During the first decade of the 21st century the Swedish Parliament (Riksdag) has decided on objectives and measures for the period up to 2010, the overall formulation of the climate objective and a long-term objective by 2050 (2002 climate policy resolutions). Regular assessments of national climate policy have been made to follow up objectives and strategies, resulting in part from the commitments under the Kyoto Protocol. A first review was carried out at a checkpoint started in 2004 (2006 climate policy resolutions), and a second review was initiated in 2007 (2009 climate policy resolutions). Extensive material was produced ahead of the 2009 decision by responsible authorities, an appointed scientific council and a parliamentary committee containing representatives of all the political parties in the Riksdag.

Sweden has adopted a new interpretation of the overarching formulation of the climate objective, signifying that Sweden shall act internationally for global efforts to be focused on limiting the rise in temperature to no more than 2 degrees Celsius above the pre-industrial level. A new concentration target is derived from the temperature target according to which the level of greenhouse gases in the long term has to be stabilised at a maximum level of 400 ppm carbon dioxide equivalent. The concentration target signifies a significant tightening in comparison with the formulation adopted in 2002.

The long-term target for 2050 has been replaced under the 2009 decision by the vision that in 2050 Sweden will not have any net emissions of greenhouse gases into the atmosphere.

Sweden has adopted a climate target for 2020. The target is for Swedish emissions in 2020 to be 40 per cent lower than emissions in 1990. This target applies to those activities not covered by the emissions trading scheme (EU ETS), see Facts Box 4.1. This means that greenhouse gas emissions in 2020 will be approximately 20 million tonnes of carbon dioxide equivalent lower for the non-EU ETS sector in comparison with the 1990 level. If this target is to be attained, instruments already decided upon and changes in instruments decided upon in the EU must be supplemented by further elaborated tax instruments and mitigation measures in other countries, through investments in developing countries or initiatives in other EU Member States. The initiatives in other countries will represent no more than a third of the aggregate reduction, i.e. a maximum of 6.7 million tonnes of carbon dioxide equivalent per year. The Riksdag has also decided that Sweden's use of renewable energy is to rise to 50 per cent of total energy use in 2020 and that energy use will be made 20 per cent more efficient than total energy use in 2008 per unit of GDP. These targets are described in Facts Boxes 4.2 and 4.3.

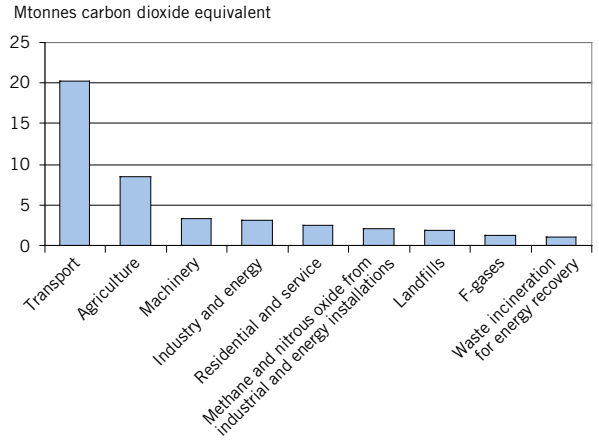
Under the 2009 climate and energy policy resolutions, Sweden has adopted a national climate target for 2020 that goes further than the burden sharing that applies between the EU Member States for the

Facts Box 4.1 **Emissions in and outside the EU Emissions Trading Scheme**

The European Union Emissions Trading Scheme (EU ETS) covers emissions of carbon dioxide from installations for the production of electricity and heating, refineries, installations that produce and process iron, steel, glass and glass fibre, cement and ceramics, and installations that produce paper and pulp. From 2012 emissions from aviation will also be included, and from 2013 so too will the aluminium industry and parts of the chemical industry. The expansion in 2013 covers, in addition to carbon dioxide, emissions by additional industries of perfluorinated hydrocarbons and nitrous oxide. In Sweden, emissions from the trading sector accounted for around 33% of total emissions in the country over the period 2005-2007.

Other emissions from activities outside the emissions trading scheme, the "non-trading sector", come from a number of different sources. The transport sector accounts for the largest share in Sweden, followed by emissions from agriculture (methane and nitrous oxide) and from machinery. Emissions from certain industries, such as the engineering industry, are partly included in emissions trading and partly excluded from it.

Emissions outside trading scheme in 2007



The table below shows how Swedish emissions developed to date between 1990 and 2007 and projections up to 2020 (Chapter 5), divided into emissions included and not included in the EU Emissions Trading Scheme, and the trend in emissions from some of the sectors not covered by the trading scheme. EU ETS covers the emissions included in the period 2008-2012 and emissions from aviation.

Emissions in and outside the trading scheme (Mtonnes per year)

		1990	2005	2006	2007	2010	2020
EU ETS		**21,2**	**21,8**	**22,2**	**21,3**	**21,8**	**22,2**
Non-EU ETS		**50,8**	**45,5**	**44,6**	**44,1**	**43,2**	**40,9**
Transport (incl. military)	CO_2-eq.	18,6	20,3	20,2	20,3	20,7	21,0
Agriculture	CO_2-eq.	9,4	8,6	8,5	8,4	8,1	7,0
Machinery (incl. fisheries)	CO_2	3,0	3,3	3,3	3,3	3,2	3,2
Industry and energy (incl. solvents)	CO_2	4,1	3,4	3,4	3,1	3,4	3,3
Residential and service	CO_2	9,1	3,3	2,7	2,4	2,1	1,3
Methane and nitrous oxide industry and energy	CO_2-eq.	2,4	2,1	2,1	2,0	2,0	2,1
Landfills	CO_2-eq.	3,1	2,2	2,1	1,9	1,5	0,8
F-gases	CO_2-eq.	0,5	1,2	1,2	1,3	0,9	0,4
Waste incineration for energy recovery	CO_2	0,6	1,2	1,1	1,3	1,3	1,8
Total		**71,9**	**67,2**	**66,9**	**65,4**	**65,0**	**63,1**

Emissions outside the EU trading scheme are estimated to have decreased by just under 7 tonnes of carbon dioxide equivalent between 1990 and 2007, a decrease of around 13%. According to the latest projection, emissions are estimated to continue to decrease, see also Chapter 5. The estimate made of the breakdown of emissions between EU ETS and non-EU ETS in 1990 is based on a rough estimate, partly because the trading scheme was not introduced until 2005.

EU's common energy and climate package. Under the sharing of responsibility decided upon for the EU's unilateral commitment (for a 20 per cent reduction in emissions between 1990 and 2020), Sweden is to reduce emissions outside the EU Emissions Trading Scheme (ETS) by 17 per cent between 2005 and 2020. This commitment is to be scaled up if the EU chooses to adopt a more ambitious commitment on emissions in the international negotiations. The Swedish objective of increased use of renewable energy by 2020 too goes somewhat further than Sweden's equivalent commitment according to EU burden sharing.

Action plans are being drawn up for the switch in order to meet these targets: for greater energy efficiency, for the promotion of renewable energy, for a fossil fuel-independent vehicle fleet and for reduced emissions and increased removal of greenhouse gases in agriculture and forestry. Sweden also needs to draw up the first two action plans mentioned in

Facts Box 4.2 **Sweden's renewables target for 2020**

The EU has adopted a binding target that the proportion of renewable energy has to increase from around 8.5% at present to 20% of total energy use over the period 2005-2020. Responsibility for attaining this target has been shared among the Member States. According to this burden sharing, Sweden has to increase its proportion from just under 44% (in 2007) to 49% in 2020. This is one percentage point lower than the national target for the same year. In the latest energy projection (Chapter 5), the proportion of renewable energy in total energy use increases by 2020. However, the projection contains significant uncertainties, the outcome being affected among other things by how requirements for biofuels to meet sustainability criteria are applied in practice and how energy use in heat pumps will finally be calculated. Despite these uncertainties, the trend is judged to be in the right direction. With policy instruments already decided upon and planned, Sweden appears capable of fulfilling its commitment towards the EU and meeting the national target. A particularly significant change in policy instrument is the proposal to raise the level of ambition in the electricity certificate system by 2020. To show how the renewables target is to be attained, an action plan is to be drawn up and submitted in 2010. The trend is then to be reviewed every two years, and a checkpoint is to be conducted in 2014.

Facts Box 4.3 **Sweden's target for energy efficiency improvement by 2010**

The EU had adopted a target of a 20 per cent improvement in energy efficiency by 2020. The target is not binding. Sweden has opted to formulate its target for improved energy efficiency by 2020 as 20 per cent reduced energy intensity between 2008 and 2020, which means that the energy supplied per unit of GDP at fixed prices is to decrease over the period. Sweden's energy intensity decreased by almost 30 per cent between 1990 and 2007. In the latest energy projection (see Chapter 5 and Annex 4), the intensity decreased by just under 14 per cent between 2008 and 2020. This target can be achieved with measures for more efficient energy use, but also by continued more rapid growth in less energy-intensive industrial sectors compared with energy-intensive industry.

Sweden has also adopted guidance targets for improved energy efficiency by 2010 and 2016 in accordance with the EU's Energy Services Directive. These targets relate to energy savings which, on average, are to amount to 6.5 per cent (in 2010) and 9 per cent (in 2016) of average energy use over the period 2001-2005.

The targets are accompanied by an action plan for energy efficiency. The plan relates to how the Energy Services Directive is to be implemented in Sweden, and therefore needs to be updated in 2011 and 2014. As well as existing policy instruments, the action plan includes a five-year energy efficiency programme over the period 2010-2014. The programme is to receive SEK 300 million of funding annually. The programme covers:

- Strengthened support for local and regional information and advice campaigns
- Support for technology procurement and market introduction
- Grants for energy surveys in small and medium-sized companies

Facts Box 4.4 **Parliamentary resolutions of significance to Swedish climate policy**

- The first climate-policy target for Sweden was adopted in 1988. The target only covered carbon dioxide and meant that emissions were to be stabilised at the "present-day level".
- An addition was made to the 1988 target in 1991. The new target covered all greenhouse gases and all sectors.
- In 1993 a national climate strategy was adopted in line with the target in the Convention on Climate Change to stabilise emissions in developed countries. The new national target stated that carbon dioxide emissions were to be stabilised at the 1990 level by 2000 and then to decrease.
- The Riksdag energy-policy guidelines from 1997 included a strategy for reduced climate impact of energy use and energy production.
- The target of carbon dioxide emissions from transport having to be stabilised at 1990 levels in 2010 was adopted in the Riksdag resolution on transport policy in 1998.
- In 1999 the Riksdag 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 climate impact".
- In 2002 the Government Bill "Sweden's Climate Strategy" was adopted, containing climate targets for 2010 and 2050
- In 2002 the Riksdag 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 resolution included a related climate strategy for the area.
- In the 2006 climate policy resolutions the national target for 2010 was evaluated and retained.
- In 2009 the government bills "An Integrated Climate and Energy Policy" were adopted, with climate targets, targets for an increased share of renewable energy by 2020, a vision for 2050 and a new interpretation of the overall formulation of the climate objective.

order to show how the country intends to fulfil its commitments under the EU's Renewables Directive and Energy Services Directive.

The combined action plan regarding how the 2020 climate target is to be met will also need to be presented to the EU according to provisions to be drawn up under the EU's monitoring mechanism. The trend towards meeting the target will need to be followed up annually.

Objectives and policy instruments are developed successively, and new changes in instruments may continue to need to be introduced and followed up continuously on the basis of knowledge of climate change and options for taking measures. A checkpoint is to be conducted in 2015 with the aim of analysing development in relation to objectives as well as the latest state of knowledge. The checkpoint does not cover the fundamental orientation of policy but may lead to adjustments to policies and instruments.

At the national level the Swedish Environmental Protection Agency is responsible for the environmental quality objective Reduced Climate Impact and for Sweden's regular climate reporting to UNFCCC and the EU. The Swedish Environmental Protection Agency is tasked with ensuring that new statistics are produced annually on the trend in emissions in the country and that projections and reports of initiatives taken for instruments in Swedish climate strategy are produced every two years. This work is undertaken in cooperation with responsible sector authorities. The Swedish Energy Agency has broad sector responsibility for energy supply and energy use in society, and among other things is responsible for the action plans drawn up for continued energy efficiency improvement and increased use of renewable energy as well as Sweden's work on flexible mechanisms. Sida, the transport agencies, the Swedish Forest Agency and the National Board of Housing, Building and Planning also have key tasks in efforts to follow up and develop Swedish climate strategy. No specific legislation or special administrative routines have been introduced for implementation of the Kyoto Protocol. The existing Swedish government administrative organisation and the system of government inquiries has also proved to work well in order to fulfil the country's commitments under the Kyoto Protocol.

The county administrative boards have been tasked since 1998 with regionally adapting the national environmental quality objectives. All the county administrative boards have decided on regional climate targets since a year ago. They have also been tasked since 2005 with developing regional action programmes to attain the environmental quality objectives. All the county administrative boards developed regional energy and climate strategies in 2008. In addition, a large number of municipalities have adopted local climate targets, and several municipalities have a comprehensive action programme to reduce emissions in the municipality.

Key parliamentary resolutions on Swedish climate policy are presented in Facts Box 4.4.

4.2 Policy instruments in Swedish climate strategy and their effects

4.2.1 Background

There are a number of policy instruments in Sweden that directly or indirectly affect greenhouse gas emissions. The use of cross-cutting economic policy instruments is emphasised in Swedish climate strategy, but these instruments are also supplemented in many cases by targeted initiatives, for instance to support technological development and market introduction, areas notable for the market itself not being able to create the necessary conditions for an economically optimal level for the society, and to overcome barrier effects. Examples of barrier effects may be conditions that prevent measures being put into effect despite being profitable such as households not being aware of the cost saving that certain measures can generate, or the depreciation period that households and businesses use being shorter than the economically optimal period for the society. While the former problem can be remedied by information campaigns and similar, the latter requires some form of investment aid. There may also be justification for other policy instruments if the cross-cutting policy instruments for distribution policy or competitive reasons are not fully utilised. Sweden has, for example, introduced tax exemption for renewable fuels, as well as a green car rebate and vehicle tax exemption instead of a sharp rise in the cross-cutting instrument of energy and carbon dioxide tax. Policy instruments that interact with carbon dioxide taxes and emissions trading have also been introduced in many cases because they contribute to other societal objectives other than the climate target, for example meeting targets in energy policy.

Among the policy instruments, energy and carbon dioxide taxes have been of key significance in reducing emissions in Sweden since the early 1990s. These taxes have at the same time been supplemented by other instruments such as technology procurement, information, differentiated vehicle taxes and investment grants. Legislation also contributes to emission reductions, principally in the waste sector. In recent years EU-wide policy instruments, principally the Emissions Trading Scheme, have played an increasingly significant role in Sweden.

At the same time, the formulation of public planning in Sweden and other policy instruments that have been applied over a period of many yeas have to a large degree set the framework (created opportunities and established obstacles) for development in recent decades. The investments made in earlier decades to expand district heating networks, public transport systems and carbon-free electricity production are of particular importance. [Table 4.1]

As there are many policy instruments and they have often been introduced to fulfil objectives other than climate targets, it may be difficult to evaluate exact fulfilment of objectives afterwards. As several instruments interact, it is also difficult to distinguish the impact of an individual policy instrument from that of the others. In addition, differentiating the effects of policy instruments from the impacts of other changes in the world at large is often a complicated task. This is particularly clear for development over

Table 4.1 **Existing instruments in Swedish policy of significance to climate strategy. EU policy instruments are highlighted.**

Cross-sectoral	Energy supply	Industry	Transport	Residential	Agriculture
• Energy and carbon dioxide taxes • **Emissions trading** • Environmental Code • Planning and Building Act • Climate investment programmes • Information • Research and development	• **Emissions trading** • Energy and carbon dioxide taxes • Electricity certificates • Special initiatives for wind and solar power	• **Emissions trading** • Energy and carbon dioxide taxes (outside EU ETS) • **F-gas regulation** • Programme for energy efficiency in industry (PFE)	• Infrastructure planning • Energy and carbon dioxide taxes • **CO_2 requirements for new vehicles** • Tax exemption for biofuels/ quota obligation • CO_2-differentiated vehicle tax • Incentives for green cars • Definition of green car • Car benefit taxation	• Energy and carbon dioxide taxes • **Energy declaration** • Building regulations • Energy advice • Technology procurement • Energy labelling	• Support for biogas • Advice • Energy and carbon dioxide taxes • Rural development programme

Källa: Kontrollstation 2008

the past decade. Several instruments of significance to climate strategy have been introduced or tightened in Sweden over this period, at the same time as energy prices have been rising sharply.

Another difficulty in evaluating policy instruments in Sweden is that the policy instruments that lead to reduced use of electricity or increased production of carbon-free electricity only influence emissions of carbon dioxide within the borders of Sweden to a limited extent, as electricity trading is done at the Nordic/Northern European level and since 2005 has also been covered by the EU ETS. For this reason we have chosen to report impacts of policy instruments that influence electricity use in energy terms rather than in the form of reduced emissions.

It should also be emphasised that there were already policy instruments in the energy sector before 1990 that steered in the same direction as in the period after 1990 by incentives being given early on for the introduction of bioenergy and for the expansion of district heating. It may consequently be difficult to distinguish the additional effect of the instruments introduced in Sweden after 1990 in the energy supply sector and the residential and service sector from the effects that would have occurred if the policy instruments had not been tightened.

4.2.2 Cross-sectoral instruments

Energy and carbon dioxide taxes

The present-day system of energy taxes is based on a combination of carbon dioxide taxes, energy taxes on fuel, nuclear power tax and consumption tax on electricity. Energy taxes and carbon dioxide taxes are levied on fossil fuels.

Figure 4.1 shows how energy and carbon dioxide tax developed for heating oil in the various sectors between 1990 and 2009.

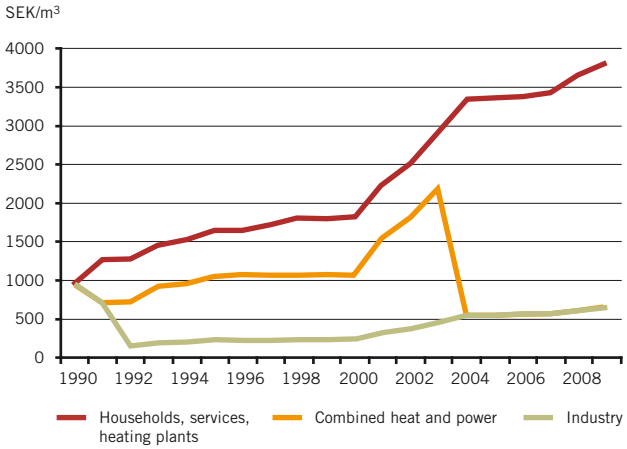


Figure 4.1 **Energy and carbon dioxide tax (nominal) on heating oil for different users**

Facts Box 4.5 **Energy and carbon dioxide taxes**

Carbon dioxide tax was introduced in 1991 and has increased from SEK 0.25/kg carbon dioxide to SEK 1.05/kg in 2009. Manufacturing industry outside the EU Emissions Trading Scheme, agriculture, forestry and aquaculture pay 21% of the general level of tax for fuel used for heating. In addition there are special rules for further tax relief for energy-intensive industry and for diesel used in land-based industries. With effect from 2004 fuel used in combined heat and power plants is covered by the same general tax relief as manufacturing industry. According to the 2009 parliamentary climate policy resolution, carbon dioxide tax on fossil fuels for heating in industry outside EU ETS and for agricultural, forestry and water activities is to be raised from 21% to 60% of the general level by 2015 with a first step of 30% by 2011. The special rule on tax relief for energy-intensive industry is also to be removed in stages over the same period (under the rule, companies in manufacturing industry as well as agriculture, forestry and aquaculture where carbon dioxide tax exceeds 0.8% of sales value are given further tax relief so that the excess carbon dioxide tax – over 0.8% – is reduced to 24% of the tax that would otherwise be payable). Carbon dioxide tax is being removed for industry covered by the EU ETS. Starting in 2011, the special repayment of carbon dioxide tax on diesel for machinery in the land-based industries will be lowered until it is SEK 0.90 per litre in 2015 instead of the present-day level of SEK 2.38 per litre.

Tax on energy has existed in Sweden for a long time. Tax on petrol and diesel was introduced as long ago as 1924, while tax on heating fuels has existed since the 1950s. The level of energy tax has changed over time and also varies between different fuels. In 2009 energy tax on natural gas was SEK 0.024/kWh, on coal SEK 0.045/kWh and on heating oil SEK 0.08/kWh. Energy tax on petrol, environmental class 1, is SEK 0.341/kWh and energy tax on diesel, environmental class 1, is SEK 0.134/kWh. However, biofuels for burning and for vehicles are completely exempt from energy tax. Nor are manufacturing industry and fuels for heating production in combined heat and power plants covered by energy tax. Fuels used in production of electricity are exempt from both energy and carbon dioxide tax. Under the 2009 climate policy resolution, energy tax is to be restructured. With effect from 2011 the level of tax is to be set on the basis of the energy content of the fossil fuel at SEK 0.08/kWh on fuels for households, services and district heating. Fossil fuels used for heating in industry, heating production in CHP plants and in land-based industries will also be covered by energy tax. In the EU ETS sector the tax is put on a par with the EU's minimum level for energy taxes. It is proposed that the energy tax on diesel as a vehicle fuel should be raised in two stages, in 2011 and 2013, by a total of SEK 0.40 per litre to come closer to the energy tax level for petrol.

Petrol and diesel for domestic transport are subject to the general level of carbon dioxide tax. Rises in carbon dioxide tax have, however, to a large extent been offset by a simultaneous lowering of energy tax on vehicle fuels. Tax on vehicle fuels has, however, increased overall since 1990.

Effects of introduced taxes

The energy and carbon dioxide taxes have contributed to sharp reductions in emissions in the residential and service sector and in the district heating sector

and have moderated the trend in emissions in the transport sector, see also sections 4.2.3, 4.2.4 and 4.2.6. The move towards lower emissions in district heating production and for the heating of homes was introduced before 1990, in part because biofuels were already exempt from energy tax at that time. The level of carbon dioxide tax (during the 2000s) for both sectors has been substantially above the technical costs of the measures that have principally been implemented, see also section 4.4.

The aggregate tax level in industry has been lowered since the early 1990s due to concern that a large proportion of Swedish industry is subject to international competition. The EU trading scheme has come to represent the principal means of policy instrument here instead since 2005.

Developed economic instruments are a key element in the climate-policy decision taken in 2009. Carbon dioxide tax and energy tax are significant in limiting climate impact in an economically effective way. The level of carbon dioxide tax in future should, in addition to the annual adjustment in accordance with the consumer price index, be adapted to an extent and at a rate which, together with other changes in economic instruments, results in an aggregate reduction in greenhouse gas emissions outside EU ETS of 2 million tonnes by 2020.

The EU emissions trading scheme

The EU's joint emissions trading scheme (ETS) began on 1 January 2005. The scope of EU ETS is described in Facts Box 4.1. The emissions trading scheme sets a cap at EU level for emissions in the sectors covered. The first trading period ran from 2005 to 2007. The scheme is now in the period also covered by international emissions trading under the Kyoto Protocol (2008-2012). The emissions trading scheme is an important element of the EU's decision to reduce emissions by 2020, and therefore also of Swedish climate efforts for the period up to 2020.

Emissions from Swedish installations under EU ETS were equivalent to around 33 per cent of total greenhouse emissions in Sweden over the period 2005-2007. The emissions came 80 per cent from industrial installations and 20 per cent from electricity and district heating installations. The Swedish breakdown differs substantially from the breakdown for EU ETS as a whole, where emissions from energy supply installations are greater (approx. 60 per cent) than emissions from industrial installations (approx. 40 per cent).

For the first introductory phase and the second period, emission allowances have been for the most part allocated free of charge according to various rules formulated nationally on the basis of EU-wide criteria. The annual emissions cap for the period 2008-2012 (second trading period) overall was reduced by around 10 per cent compared with the cap that applied during the first period, 2005-2007. The emissions cap is to be reduced on a straight-line basis from 2013 at 1.74 per cent per year, starting from the level of the cap during the second trading period. This is to result in reductions of 21 per cent in EU ETS up to 2020 in comparison with 2005. The emissions cap and the reduction trajectory will need to be revised if the EU commits itself to a more far-reaching emission reduction in a new international climate agreement. How the allocation will be lowered in individual Member States depends among other things on the breakdown between emissions from combustion installations and from industrial processes in the country's trading sector and the proportion of industry subject to competition. The proportion of emission allowances allocated free will be gradually reduced over the period 2013-2020.

Impact on carbon dioxide emissions

The effect of EU ETS on global emissions comprises the difference between the level set for the emissions cap and the baseline, i.e. the trend in emissions that would otherwise have taken place.

The emissions effect in an individual country, alongside the price of emission allowances, including the assessments made of future price changes and other strategic considerations, also depends on national circumstances, for example the existence of supplementary policy instruments and what the costs of measures and the reduction potential are like. The economic climate, weather variations between different years and the trend in energy prices are also of great significance to the trend in emissions in both the short and long terms.

If account is taken of the fact that more combustion installations were brought into EU ETS in 2008, actual emissions from Swedish installations in the scheme decreased in 2007 and 2008 in comparison with emissions during the first two years[29].

Swedish operators respond in interview-based surveys[30] that the trading scheme has influenced the companies to reduce their carbon dioxide emissions. Measures have principally been taken in installations in the energy supply sector and in the pulp and paper industry. Examples of measures that have been taken are: increased capacity in biofuel instal-

29 Emissions in the trading scheme in 2005, 2006, 2007 and 2008, Swedish Environmental Protection Agency.

30 Företagsstrategier för utsläppshandel och klimatåtaganden - en enkätstudie av företagens agerande och attityder inom ramen för EU:s handelssystem för utsläppsrätter (Company strategies for emissions trading and climate commitments – a survey-based study of the actions and activities of companies under the EU Emissions Trading Scheme). Swedish Environmental Protection Agency report 5679, 2007.

lations, investments in waste-fired boilers (industrial waste), measures for more efficient combustion, increased use of district heating, conversions of oil-fired boilers to biofuel-fired boilers and general implementation in the companies of programmes of measures to reduce energy use. It should be noted that other policy instruments may also have influenced this trend. Action programmes to make energy use more efficient are also being implemented as part of the Programme for Energy Efficiency in Energy-Intensive Industry (PFE) (section 4.2.5). The electricity certificate system (section 4.2.3) also provides incentives to increase capacity for the use of biofuel in combined heat and power plants.

It is apparent from the model calculation made of the combined effects of the economic instruments in the energy sector in Sweden, presented in 4.2.3, 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 in limiting emissions from the energy supply sector in the future. The trading scheme is judged to be the most important policy instrument for industry.

The environmental code and planning legislation

The overarching legislation in the area of the environment is collated in the Environmental Code. The overall aim of the Environmental Code is to promote sustainable development. The environmental quality objectives are to serve as a guide in putting the Code into practice. The Code contains, among other things, general rules on consideration which are to be observed in all activities and measures. Major environmentally hazardous activities are covered by an obligation to obtain a permit. Greenhouse gas emissions form part of the permit appraisal procedure. With effect from 2005 it is, however, no longer permitted to issue emissions limit values for carbon dioxide or to limit the use of fossil fuels for installations covered by the EU Emissions Trading Scheme. The Government also considers that the requirements laid down for measures for energy saving in companies in enforcement and appraisal under the Environmental Code should be better coordinated with the requirements that apply under PFE.

Measures in the area of public planning principally have an impact on emission trends in the longer term and may be of great significance from this point of view. Measures in public planning are principally governed by the Planning and Building Act, but many measures, for example major infrastructure projects, are also covered by the provisions of the Environmental Code. The significance of the development of the built environment for energy and transport needs in the longer term has been increasingly highlighted, and there are proposals to develop coordination and climate considerations in the planning of infrastructure, traffic and the built environment, for example by giving the county administrative boards clearer terms of reference to pursue coordination issues. This matter will be addressed in a forthcoming Government bill containing proposals on certain amendments to the Planning and Building Act.

Cross-sectoral investment grants

A Delegation for Sustainable Cities was appointed for the period 2009-2010. The Delegation is intended to stimulate the development of attractive urban environments with a reduced climate and environmental impact which can serve as models both nationally and internationally for sustainable urban development and applied environmental technology. The Delegation is intended to bring together central government, the business community and local government in a national platform for sustainable urban development. The aspiration is to put into effect visions for future cities and sustainable housing solutions in individual blocks of buildings, districts and local communities with the aid of new technology and forward-looking planning. The Delegation is to provide support to companies and municipalities for measures that contribute to the creation of attractive and sustainable urban environments with reduced climate impact. Support may relate to new construction or refurbishment and may contain measures in the fields of energy, water, waste and transport, but also in other sectors. There is special focus on city planning projects that substantially reduce greenhouse gas emissions. The Government has earmarked a total sum of SEK 340 million in 2009 and 2010 for this purpose.

The sustainable cities initiative replaces the grants to local climate investment programmes (Klimp 2003-2008), which itself was the successor to LIP (local investment programmes for ecological sustainable development 1998-2002). The preliminary outcome of LIP and Klimp up to 2006 was presented in Sweden's Fourth National Communication. A further sum of around SEK 800 million was subsequently earmarked under Klimp over the period from 2007 to 2008. In addition, final reporting of all projects in LIP has been completed. The LIP programme was intended to encourage the role of the municipalities

in development towards sustainable development based on local circumstances and priorities. The funds have gone to a number of areas, almost half of which have been climate-related. Of the SEK 6.2 billion originally granted, around 70 per cent (4.3 billion) has been used. Just over half the country's municipalities have received LIP grants. The LIP programmes are estimated to have led to total reductions in emissions corresponding to around 1 million tonnes of carbon dioxide emissions per year, and it is principally district heating projects that are considered to have contributed. The estimation of effect is highly uncertain as it is not possible to establish that the projects would not have been implemented in some form without grants. Klimp signified a greater focus on climate measures than LIP. Klimp grants totalled around SEK 1.8 billion, and the combined emissions effect of the projects receiving grants is estimated at around 1 million tonnes of carbon dioxide equivalent per year from 2012. Around a third of Klimp funds have been used for biogas investments. Just under 70 of the country's 290 municipalities have received Klimp grants. Evaluations of Klimp have shown that the programme has bolstered climate efforts at local level in those municipalities that have received grants but has also widened the differences between these municipalities and those that have not received grants[31]. The LIP measures were implemented and the Klimp grant was introduced at the same time as the green tax shift. Carbon dioxide taxes have therefore been raised sharply over the period at the same time as energy prices have risen, which has enhanced the cost-effectiveness of the measures implemented. Development makes it hard to distinguish retrospectively how great a proportion of the measures taken under LIP and Klimp would not have been implemented at all if the grants had not existed.

Information on climate change

Information is an important part of Swedish climate strategy. Several climate information initiatives have been taken in Sweden since 2002. A more detailed review of work relating to information on climate change in Sweden is presented in Chapter 9.

The purpose of work on climate information is to increase knowledge of the causes and consequences of climate change, disseminate the latest research knowledge, increase understanding of the adjustments in society that will be needed in the longer term for sustainable development and identify ways of mitigating greenhouse gas emissions.

31 Swedish Energy Agency/Swedish Environmental Protection Agency, Den svenska klimatstrategins utveckling (Development of Swedish climate strategy), 2008.

The Swedish Environmental Protection Agency has been conducting surveys of the Swedish population's knowledge of, and attitudes to, climate change since 2002. These surveys provide a basis for the formulation of information on climate change. The results show, for instance, that the public have great knowledge of the climate issue and are prepared to contribute to emission reductions, the proportion having increased since 2002[32].

Information on possible measures in different sectors is disseminated through several channels. Campaigns concerned with energy efficiency have been run nationally on several occasions, but the more continuous information is provided at local and regional level through the country's climate and energy advisers and regional energy agencies.

The Swedish Energy Agency makes an annual evaluation of advisory work. Public knowledge of the activity is assessed in the evaluation, but not the effects of energy advice on behaviour or the impact on the effectiveness of other policy instruments.

Advice to landowners and users traditionally plays a great role in the land-based industries. Both the Swedish Board of Agriculture and the Swedish Forest Agency have recently been commissioned to also prepare targeted information to pass on knowledge on more climate-sound agriculture and forestry.

Research and development

Society's investments in research and development in the area of technology can be regarded as a policy instrument principally aimed at improving the prospects of achieving the large emissions reductions required in the longer term.

Swedish climate-related research encompasses a broad area, from natural science and technology to social science and the humanities. The emphasis is on technical and scientific research and development. In the autumn of 2008 the Swedish Parliament (Riksdag) took a decision on a new research and innovation initiative which meant a substantial increase in the annual appropriations for research focused on climate and energy. In energy research, the raised appropriations were principally targeted at the following areas:

- large-scale renewable electricity production (e.g. wind power, wave power, solar power and electricity from the gasification of biomass) and its integration into the power grid.

32 Allmänheten och klimatförändringen 2008. Allmänhetens kunskap om och attityd till klimatförändringen, med fokus på egna åtgärder, konsumtionsbeteenden och företagens ansvar (The public and climate change 2008. Public knowledge of and attitudes to climate change, focusing on their own measures, consumption behaviour and the responsibility of companies.The public and climate change 2008. Public knowledge of and attitudes to climate change, focusing on their own measures, consumption behaviour and the responsibility of companies). Swedish Environmental Protection Agency Report 5904, November 2008.

- electric propulsion systems and hybrid vehicles,
- energy combines, biofuels and renewable materials, as well as fundamental energy research, in areas such as new nuclear technology and CCS. A more detailed description of Swedish climate research efforts is provided in Chapter 8.

4.2.3 Production of electricity and district heating

Emissions from electricity and district heating account for a relatively small proportion (just over 10 per cent) of aggregate greenhouse gas emissions in Sweden. The low emissions from electricity production are explained by the fact that nuclear power and hydropower account for a dominant share of production, while the additional production of electricity in recent years has principally come from biomass combined heat and power plants and wind power. Aggregate emissions from electricity and district heating production were 0.5 million tonnes above the 1990 level in 2007. District heating production has increased by just over thirty per cent since 1990 while emissions have diminished. The explanation lies in the fact that the use of biomass and waste fuels has increased sharply in district heating plants while the use of fossil fuels has fallen. According to the latest projection, see Chapter 5, aggregate emissions from the production of electricity and district heating will increase slightly up to 2020 despite the assumption of a significant increase in electricity production.

Policy instruments in the electricity and district heating sector

The trend in fuel supply to electricity and district heating is largely explained by the energy and climate policy instruments that have acted and are acting in the sector. Most combustion installations for electricity and heating production have been included in EU ETS since 2005. In addition, the sector is covered by energy and carbon dioxide taxes, an electricity certificate system, the provisions of the Environmental Code and special support for technological development and the introduction onto the market of wind power. In the 1990s it was the energy and carbon dioxide taxes, together with targeted investment grants, that were of greatest significance to development in the sector. In the 2000s, the policy instruments in the sector have come to be influenced increasingly by the EU's common energy and climate policy, at the same time as new policy instruments are being introduced nationally. The policy instruments interact to a great extent. Continued development in the sector is of particularly great significance in enabling Sweden to meet its part of the EU target for increased use of renewable energy by 2020 (Facts Box 4.3). As the investments in energy supply installations often have a very long life, development in the sector is of particular significance to the prospects of achieving very low emissions in the longer term.

The electricity certificate system

The electricity certificate system is a market-based support system for the expansion of electricity production from renewable energy sources and peat which was introduced in Sweden in 2003. The currently applicable target is to increase electricity production by 17 TWh from the 2002 level by 2016. According to the 2009 Energy Policy Bill this target is to be raised so that renewable electricity production increases by 25 TWh by 2020. The Swedish Energy Agency is to analyse how this level of ambition is to be met. The proposal is a key element in the Swedish action plan to attain the country's renewables target by 2020.

Under this system electricity producers are allocated a certificate for every MWh of renewable electricity produced. The electricity certificates are then sold to electricity users who, by law, are obliged to purchase electricity certificates equivalent to a particular proportion of their use. This proportion is successively raised year by year.

In 2007 electricity users were obliged to purchase electricity certificates corresponding to 15.1 per cent of their electricity use. The production of renewable electricity in the electricity certificate system was 12.7 TWh in 2007, when electricity production from peat is deducted. The electricity certificate system contributed to an increase of 6.2 TWh in renewable electricity production between 2002 and 2007.
The portion of electricity production eligible for certificates has increased since the system started. The increase principally consists of increased production of electricity from biofuels in existing combined heat and power plants, at the same time as an expansion of capacity has taken place in biofuel plants. The system also led to new plants entering service between 2003 and 2007. Altogether there have been 469 new plants. These plants together produced around 1.6 TWh of electricity in 2007.

Calculation of the aggregate effects of the economic instruments in the electricity and district heating sector

A calculation with the model tool MARKAL-NORDIC in 2008 shows that emissions from electricity and district heating production might have been 70 per cent higher, which is equivalent to 15 million

tonnes in 2007, if 1990 economic policy instruments had been retained in the sector instead of being further developed and tightened in the way done up to and including 2007.

The instruments included in the analysis are energy taxes on fuels and electricity, carbon dioxide taxes, emissions trading, the electricity certificate system and targeted support for renewable energy production in the form of investment support and operating grants. The latter policy instruments were mostly in use before the electricity certificate system was introduced. In the counterfactual scenario with 1990 instruments, the use of coal and in combined heat and power plants and some coal-condensing plants increases, which explains the wide difference in emissions compared with the case with present-day instruments. The model also analyses development ex-ante with 1990 instruments and present-day instruments. According to the result of the model, the EU Emissions Trading Scheme assumes greater significance for emissions from 2015, so that emissions for this sector are substantially below the level given by development for the case with 1990 policy instruments. 2008 model calculation produces a result that differs from the analyses made with the MARKAL NORDIC model presented in the Fourth National Communication. The differences are principally due to higher fossil fuel prices having been used in the new calculation and to the model in the new analysis being based on nuclear power installations having a lifetime of 60 years instead of 40 years as assumed in the previous analysis. The former results in present-day policy instruments being estimated to produce a greater effect than 1990 policy instruments up to 2010 in the new analysis, while the latter signifies a lower effect in 2020 than the result in the Fourth National Communication.

Table 4.2 **Estimated aggregate effects on emissions from electricity and district heating production in Sweden of the policy instruments introduced after 1990, compared with a reference case with 1990 policy instruments (Mtonnes of carbon dioxide equivalent per year)**

2002	2007	2010	2015	2020
11	15	16	17	16

Further initiatives for wind power and solar power

Alongside the electricity certificate system, wind power is covered by special support for technological development and market introduction in marine and mountain areas as well as by a general environmental bonus. The prospects for further production of wind power have also been improved by the rules for permit appraisal of wind power being simplified and requirements being laid down for planning to be implemented for wind power establishments focused on a size corresponding to 30 TWh in 2020, of which 10 TWh is offshore – the 'planning framework for wind power'.

A special grant to energy technology which is not yet commercially competitive has been created for the budget years 2009-2011. It will be possible for the grant to go to photovoltaic cell technology.

4.2.4 Residential and service sector

Greenhouse gas emissions from individual heating of homes and commercial premises are estimated to have decreased from 9.2 million tonnes to 2.7 million tonnes per year between 1990 and 2007. Projections point to further reductions, so that the use of fossil fuels for heating in this sector can be largely phased out by 2020.

Energy use in the sector makes up just over a third of total use in the country, and the potential for energy savings is judged to be particularly great in this sector.

Policy instruments in the residential and service sector

There are a number of policy instruments that affect energy use and greenhouse gas emissions from homes and commercial premises. Energy and carbon dioxide taxes are estimated to be the policy instruments that have been most significant in reducing the use of fossil fuels in the sector over the past two decades, as these taxes have produced powerful financial incentives throughout the period to change from using fossil fuels to other forms of energy. Figure 4.2 illustrates that the effect of policy instruments has steadily increased in this sector since 1990.

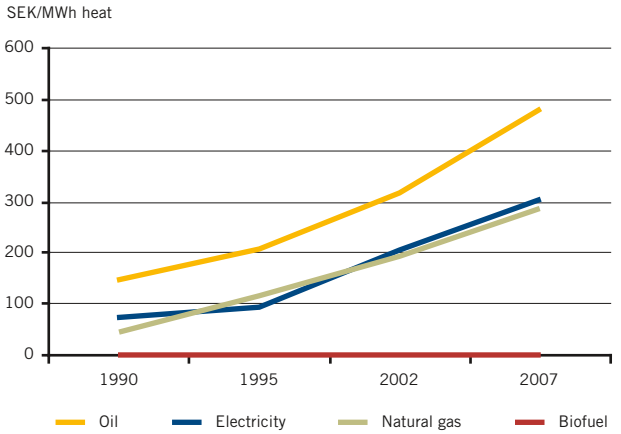


Figure 4.2 **Economic effect of policy instruments on heating fuels for residential and service sector**

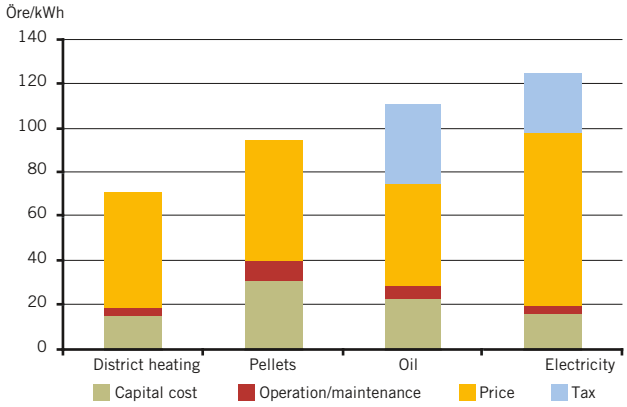


Figure 4.3 **Estimation of costs (2005-2007) of different heating alternatives in individual houses**

The aggregate costs of different heating alternatives are affected by the level of energy and carbon dioxide taxes. Figure 4.3 shows how the annual costs of different alternatives have developed in recent years. As the figure shows, heating with oil would have been a competitive alternative without taxes.

Grants, for example for the expansion of and connection to district heating, have also stimulated development. Legislation influences energy use in new and existing buildings and energy consumption in new products. Significant European Community directives in this area are the Energy Performance of Buildings Directive, the Ecodesign Directive and the Energy Labelling Directive. The EC directives are supplemented by national building regulations and targeted efforts to improve energy efficiency, principally in the form of technology procurements and grants for market introduction, as well as information at local, regional and national level.

Calculation of the aggregate effects of the economic instruments in the residential and commercial premises sector

The previously mentioned analysis with MARKAL-NORDIC also covered the residential and service sector. According to the model result, 1990 policy instruments together with high prices for fossil fuels already in themselves provide sufficient incentives to phase out the use of oil in the sector. The effect of the tightening of instruments introduced after 1990 does not appear in the model result, which does not, however, take account of the fact that private individuals often require very high profitability for the (additional) investments made for example in replacing heating systems. The tightening of instruments introduced after 1990 has sharply increased the profitability of investments in fossil fuel-free heating alternatives and has consequently in practice contributed to the extensive reduction in emissions of nearly 7 million tonnes/year we have seen in the sector since 1990, which is projected to rise to 9 million tonnes/year by 2020. On the other hand, it is difficult to distinguish the effect of present-day instruments from the effect that might nevertheless theoretically have arisen in the sector if 1990 policy instruments had been retained.

Building regulations

Building regulations have been used in Sweden since the 1960s among other things to set minimum requirements for energy use in new buildings. The building regulations for new buildings underwent a major change in 2006 and tightening of the requirements for electrically heated buildings came into effect on 1 February 2009. It is planned that the energy requirements for new buildings will be tightened in further stages starting in 2011. A review of the implementing rules so that energy requirements will also have to meet in the modification of existing buildings is in progress. It is important that opportunities to improve energy efficiency are also taken in refurbishment.

Energy declarations

The requirement for energy declarations for buildings is based on EC Directive 2002/91/EC on the Energy Performance of Buildings. Owners of individual houses, multi-dwelling buildings and commercial premises are obliged to declare the energy use of the buildings and certain parameters in the indoor environment in an energy declaration. The intention is to promote efficient energy use and a good indoor environment in buildings by requiring the property owners themselves to learn more about what measures are cost-effective to implement to improve the energy performance of the buildings. The system of energy declarations has recently been initiated as it did not come fully into force until 1 January 2009. A first follow-up of experience from the introduction of the system will be made in 2009.

Technology procurement

Technology procurement is aimed at promoting the development of energy-efficient products and services. Fifty-five different technology procurements were initiated and part-financed in the field of energy between 1990 and 2005. The procurements are judged to have increased involvement among both purchasers and manufacturers, and new contact networks have been created. The procurement has primarily covered the area of multi-dwelling buildings and commercial premises. A new feature for 2009

is that technology procurement is also to be organised for land-based industries. At least SEK 50 million is being invested in technology procurement and market introduction in 2009. The five-year energy efficiency programme 2010-2014 includes increased support for technology procurement and market introduction in the industrial, residential and service and transport sectors.

A combined estimate by the Energy Efficiency Inquiry (SOU2008:110) was that the efficiency-improving effect of previously implemented technology procurements and market introduction efforts in the residential and service sector may have amounted to around 2.3 TWh final energy.

Mandatory energy labelling

Mandatory energy labelling of domestic appliances has existed in the EU since 1995. Sweden has supplemented this labelling with enforcement at retailers. If half of all Swedish households are assumed to have chosen a fridge/freezer which is one labelling tier more efficient than they would otherwise have chosen, the labelling of white goods over the period 1995-2005 is estimated to have contributed an improvement in energy efficiency of around 0.3 TWh final energy use[33].

Energy labelling has been further developed through the Ecodesign Directive (2005/32/EC). The Ecodesign of Energy-Using Products Act came into force in Sweden in the spring of 2008. Under the Act, energy consumption and other environmental factors become an even more important part of product development when certain minimum requirements are laid down. The Directive in principle applies to all energy-using products (except modes of transport) and covers all energy sources. In a first stage, conventional light bulbs will have to be phased out as a result of future requirements for lighting equipment. It is estimated that this may lead to an electricity saving of around 2 TWh in Sweden. Several product groups will follow, for example circulation pumps and television sets.

Investment support for conversion of heating systems and energy efficiency measures

Until the end of 2010 there is also support for conversion from electric heating with radiators in residential buildings and for the installation of solar heating. There was also support earlier during the period 2005-2008 for the installation of energy-efficient windows or renewable heating systems in individual houses, support for energy investments in public buildings and support for conversion from oil heating in apartment blocks, but these forms of support have come to an end. The support for conversion from oil heating has been deemed to have had a low effect on emissions and low cost-effectiveness, as it is only considered to have led to measures that would have been implemented anyway being brought forward[34].

33 Energy Efficiency Inquiry SOU 2008:110.

4.2.5 Industrial emissions from combustion and processes (including emissions of fluorinated greenhouse gases)

Industrial combustion emissions in 2007 totalled around 10.7 million tonnes, which is approximately 9 per cent lower than the 1990 level. It is the pulp and paper industry that has principally contributed emissions reductions in recent years.

Industrial process emissions and emissions of fluorinated gases in 2007 totalled 6.5 million tonnes, which is around 13 per cent higher than the 1990 level. Combined process emissions vary from year to year depending on economic climate, transformation of the industrial structure and how the use of fluorinated gases has developed.

Instruments in the industrial sector

The instruments that principally influence combustion-related emissions from industry are the EU Emissions Trading Scheme, energy and carbon dioxide taxes, the electricity certificate system, the programme for energy efficiency in energy-intensive industry (PFE) and the rules of the Environmental Code. Industrial process emissions will be almost entirely covered by the trading scheme with the expansion proposed from 2013. Emissions of fluorinated gases are regulated through the EC Regulation and Directive on emissions of fluorinated greenhouse gases.

Calculation of the aggregate effects of the economic instruments in the industrial sector

The calculation using the model tool MARKAL-NORDIC mentioned above shows that control by policy instruments in the sector would have been somewhat greater if the 1990 instruments had been retained, but that the EU Emissions Trading Scheme may lead to a greater instrument impact in the sector in the longer term. The difference in emissions between the scenario with 1990 instruments and the scenario with present-day instruments is consistently small.

34 Swedish Energy Agency/Swedish Environmental Protection Agency, Den svenska klimatstrategins utveckling (Development of Swedish climate strategy), 2008.

Proposals for reduced lowering of carbon dioxide tax for industry outside the EU Emissions Trading Scheme and for the introduction of energy tax on fossil fuels for heating in industry

As mentioned in Facts Box 4.5 on energy and carbon dioxide taxes, it is proposed that the taxation of fossil fuels used in industry not covered by the EU Emissions Trading Scheme will be raised. The share of energy costs among the total costs of companies outside the scheme is generally low. It is therefore considered that a higher carbon dioxide tax than at present can be charged, without this meaning to any great extent that emissions of carbon dioxide and other greenhouse gases move to other countries so that global emissions do not decrease. It is also proposed that energy taxation will be restructured so that energy tax is charged on fossil fuels according to energy content. It is proposed that fossil fuels used for heating in industry be covered by an energy tax in line with the EU's minimum tax level for light fuel oil under the Energy Tax Directive.

The proposed tax increases are estimated to lead to combined emission reductions of 0.4 million tonnes of carbon dioxide equivalent in 2015 and 2020 beyond projection. This estimate covers both use of fuels for heating in industry outside EU ETS and the same use in agriculture, forestry and aquaculture.

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

A policy instrument for energy efficiency in industry is the "programme for energy efficiency in energy-intensive industry" (PFE). By taking part in the five-year programme, companies receive tax relief for the energy tax on electricity they otherwise would have had to pay. In exchange, the company undertakes during the first two years to introduce an energy management system to implement an energy survey to analyse the company's potential to take measures that improve the efficiency of energy use. The companies also undertake during the programme period to implement efficiency-improving measures with a repayment period of less than three years.

At the end of 2008 there were 110 companies taking part in the programme. These companies together account for around a fifth of Sweden's total electricity use. The participating companies submitted their first reports in the autumn of 2006. The report shows that the companies have undertaken to improve the efficiency of their electricity use by a total of 1 TWh per year at a total investment cost of just over SEK 1 billion. The measures often have a very short payback time. The profitability of the measures has been improved by electricity prices for industry having risen sharply (doubled) over the past five years. It is therefore difficult to distinguish the specific effect of the PFE programme as there are likely to be efficiency measures that would have been implemented anyway if the programme had not been introduced.

The industrial plants included in PFE also have to take account of the life cycle cost in the purchasing of power-intensive equipment and in project planning, modifications and renovations. The total electrical efficiency improvement among the PFE companies is anticipated to be greater than that reported to date.

Expanded energy advice and contributions to energy surveys in small and medium-sized enterprises

To stimulate increased energy efficiency in small and medium-sized enterprises, the Swedish Government plans to introduce a grant for energy surveys, an "energy survey cheque" from 2010 at the same time as strengthening resources for energy advice to smaller companies. It is to be possible for the energy survey cheque to be given to companies with annual energy consumption exceeding 0.5 GWh/year.

Regulation and Directive on certain fluorinated greenhouse gases

Emissions of fluorinated greenhouse gases (F-gases) totalled around 1.3 million tonnes of carbon dioxide equivalent in 2007. It is estimated that these emissions altogether will decrease to around 0.4 million tonnes/year in 2020, principally as a result of the EU-wide regulation of certain fluorinated greenhouse gases and measures in aluminium production.

In 2006 the EU decided on a Regulation (No 842/2006) on Certain Fluorinated Greenhouse Gases. The Regulation came into effect on 4 July 2006. However, most of the provisions did not start to apply until 4 July 2007. During the same period decisions were also taken on a directive that regulates the use of HFCs in air-conditioning units in cars, Directive 2006/40/EC.

Implementation of the EU's F-gas legislation in Sweden will lead to decreases in annual emissions of around 0.2 milliion tonnes of carbon dioxide equivalent/year by 2010 and 0.7 milliion tonnes of carbon dioxide equivalent/year by 2020 compared with if the legislation had not been introduced.

A government inquiry has proposed that an environmental tax on HFCs be introduced in Sweden to further lower emissions of F-gases.

Facts Box 4.6.

Programme for a transport sector independent of fossil fuels in 2030.

- Energy and CO_2 taxation that provide incentives for a more climate-efficient transport sector
- Strategy for increased use of vehicle biofuels
- CO_2-differentiated vehicle tax
- Successively tightened EU requirements for the carbon dioxide emissions of new cars
- Efficiency labelling of vehicles
- Incentives for eco-driving
- Better speed monitoring
- Applied research for the development of 2nd generation vehicle biofuels and electric vehicles and plug-in hybrids
- Requirements for long-term community and infrastructure planning make a more climate-efficient transport system possible

4.2.6 Transport

Greenhouse gas emissions from the transport sector are equivalent to around 31 per cent of Sweden's total reported emissions of greenhouse gases and are dominated by the road-traffic sector. Unlike other sectors of society, emissions from the transport sector have continued to increase steadily since 1990, despite increased energy efficiency and increased use of biofuels. This increase in emissions is explained by a continued rise in transport activity on Swedish roads, heavy-duty vehicles in particular continuing to increase in line with economic development. The increase in passenger transport activity, on the other hand, has come to a halt in recent years. According to the latest projection (Chapter 5), the transport sector's emissions will continue to rise until 2020 unless additional measures are implemented. This is a trend which makes it difficult for Sweden to achieve climate targets by 2020 and 2050. The Swedish Government has therefore adopted a programme of further tightening of policy instruments with the objective of making the transport sector independent of fossil energy by 2030 (Facts Box 4.6).

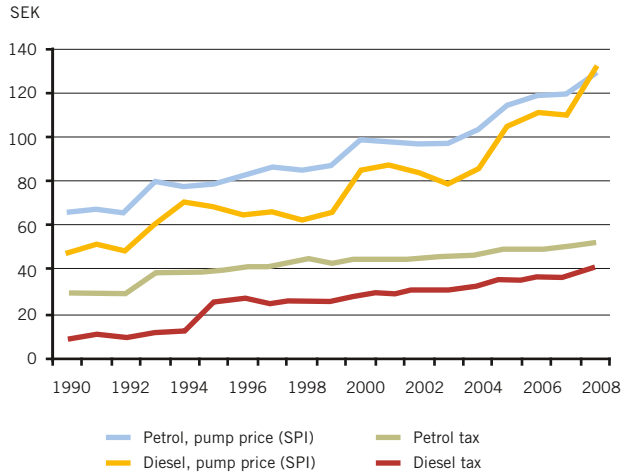


Figure 4.4 **Selling price and energy and CO_2 taxes for diesel and petrol (annual averages). Nominal prices[35].**

35 Source: Swedish Petroleum Institute http://www.spi.se/.

The programme is based on the existing instruments in the climate policy implemented to date and consists of general economic instruments in the form of energy and carbon dioxide taxes combined with targeted instruments for more efficient vehicles and renewable fuels, as well as infrastructure measures targeted at a more transport-efficient society.

Cross-cutting policy instruments – vehicle fuel taxes

Petrol and diesel are covered by both an energy tax and a carbon dioxide tax. Value-added tax is also charged on the sale value.

Carbon dioxide tax on vehicle fuels was introduced in 1991 and has been raised in several steps since. The rise in and introduction of carbon dioxide tax have, however, been partially offset by a simultaneous reduction in energy tax. The tax on vehicle fuels overall has increased, but in 2007 and 2008 rises in total vehicle fuel tax were overshadowed by increasing product prices for petrol and diesel due to increased crude oil prices (see Figure 4.4). The increased product costs for petrol and diesel have further curbed the growth in transport, encouraged more energy-efficient vehicles and eased the introduction of vehicle biofuels. According to the 2009 climate policy resolutions, energy tax on diesel is to be raised in two stages by a total of SEK 0.40/litre. [Fig. 4.4]

Targeted instruments: the renewable vehicle fuel strategy

The strategy for introducing renewable energy into the road transport sector contains a temporary exemption from energy and carbon dioxide tax for all vehicle biofuels. CO_2 tax and the temporary exemption from energy tax altogether today signify a cost advantage for biofuels over petrol of SEK 5.52/litre and over diesel of SEK 4.34/litre in 2009. The local climate investment grants (the 'Klimp' grants and before that the LIP grants) have also contributed to the production and use of biogas in local vehicle and bus fleets.

To improve the availability of vehicle biofuels, the Swedish Parliament (Riksdag) decided that with effect from 1 January 2006 all larger filling stations must sell at least one renewable fuel. Due to higher costs of installing pumps for gaseous fuels compared for example with ethanol, filling stations that wish to sell biogas have received extra investment support. The number of filling stations that supply a renew-

able fuel has increased from 300 to 1300 since the requirement was introduced, and it is anticipated that by 2010 around 60 per cent of all filling stations will be covered by the requirement. The extra investment grant to biogas stations to date has been allocated to just over 60 new filling stations. Low admixture of ethanol in petrol has long been possible, while the fuel specifications for diesel were adapted for max. 5 per cent admixture of biodiesel with effect from 2006. Under the EC's Fuel Quality Directive the fuel specifications will be amended to allow 10 per cent ethanol in petrol and 7 per cent in diesel by 2011.

Long-term initiatives in Swedish biofuels strategy have been research, demonstration and pilot support for the development of new biofuels technology. Around SEK 120 to 170 million per year has been committed to research and development of biofuels in recent years. In 2009 an appropriation was made for a further SEK 875 million over a three-year period for research and development of vehicle biofuels. Over the next few years Sweden is also increasing targeted research efforts in vehicle technology by around SEK 450 million a year, focusing on the development of electric and hybrid vehicle technology in the Swedish vehicle cluster.

Targeted instruments: composition of the vehicle fleet

Sweden also has several policy instruments aimed at influencing the design and choice of passenger cars.

To promote environmentally friendly cars, a green car rebate of SEK 10 000 has been granted on the new purchase of an eco-classified car over the period 2007-2009. Green-car classification covers firstly a category of vehicles that use E85 or biogas and secondly vehicles that are very energy-efficient and do not emit more than 120 g CO_2/km, which is equivalent to 0.5 l petrol per 10 km or 0.45 l diesel per 10 km. Petrol consumption of 0.92 l per 10 km applies to E85 vehicles, while the limit for biogas is 0.97 Nm^3per 10 km. The green car rebate has been abolished with effect from 1 July 2009 and replaced by an exemption from vehicle tax for the first five years for new green cars.

Since 2006, Sweden has also differentiated the annual vehicle tax with respect to the vehicle's CO_2 emissions per km. The CO_2-related vehicle tax is SEK 15 per g CO_2/km beyond the first 100 g CO_2/km that new vehicles emit. This tax is due to be raised to SEK 20 per year per g CO_2/km beyond 120 grams per kilometre by 2011. Light commercial vehicles and light vans will also be brought into the system of CO_2-differentiated vehicle tax from 2011.

Around half of all cars sold in Sweden are bought by legal entities. Many of these are what are known as company cars which are used privately, where the benefit of using the vehicle is taxed. The benefit value on which the tax private individuals have to pay tax for the car benefit has been lowered for electric and hybrid cars and cars capable of running on biofuels in order to increase the incentives to choose these cars.

A number of local benefits are also provided on the purchase of an eco-classified car, such as exemption from congestion tax in Stockholm and free parking in Stockholm, Gothenburg and Malmö. The value of the local benefits may amount to large sums, as free parking in Stockholm, for example, is worth at least SEK 7 200 per year.

In addition to the Swedish policy instruments, car manufacturers who sell cars in the EU have also adapted to the 1995 voluntary agreement between the European Commission and car manufacturers to achieve average CO_2 emissions in new car sales of 140 CO_2/km by 2008/2009 and 120 g CO_2/km by 2012. The voluntary agreement and the target for 2012 were replaced in the EU's climate package by a directive containing a requirement for new car sales with an EU average of 130 g CO_2/km by 2015. The average for new car sales in Sweden was 174 g CO_2/km in 2008, and the average for the whole vehicle fleet was 200 g CO_2/km. With spontaneous technical development only (business as usual), the Swedish Road Administration estimates that the average for the vehicle fleet in Sweden would fall by 1 per cent per year to 169 g CO_2/km in 2020. With the EU requirement for 2015, the Swedish Road Administration estimates that the average will instead fall to 159 g CO_2/km.

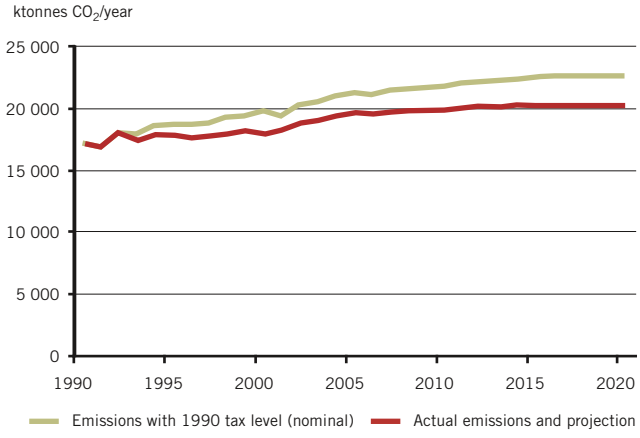


Figure 4.5 **Historical emissions of carbon dioxide from the road transport sector and estimated emissions without introduced vehicle fuel taxes since 1990[36].**

36 Calculation with sliding elasticities from 0.3 to 0.7 for passenger traffic and from 0.1 to 0.2 for commercial traffic.

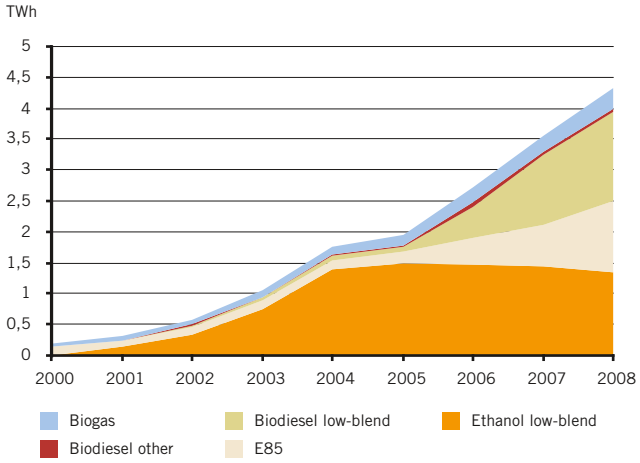


Figure 4.6 **Energy supply for vehicles[37].**

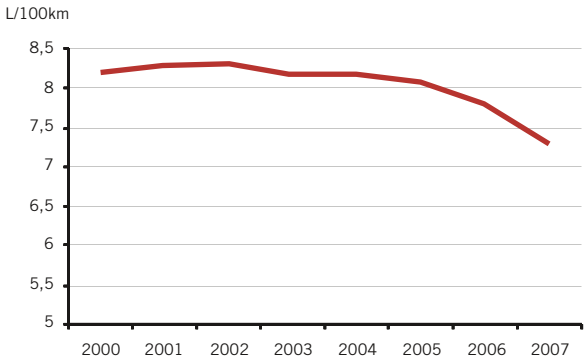


Figure 4.7 **Average fuel consumption of new cars in Sweden**

Effects of all policy instruments

Emissions from the transport sector in Sweden have continued to increase despite new policy instruments having been introduced and the existing policy instruments having been tightened in the sector. Without this development, the increase would probably have been significantly greater as transport volumes increased by more than emissions over the period. Figure 4.5 shows the actual emissions and an estimate of what the trend in emissions would have been like without the tax increases implemented since 1990. The decision to raise the taxes in line with inflation, taken in 1994, is also counted among such tax increases. The combined effect on emissions of the increases in tax on diesel and petrol since 1990 is estimated to be 1.9 milliion tonnes CO_2/year in 2010 and 2.4 milliion tonnes CO_2/year lower emissions in 2020 than if the 1990 nominal tax level had been retained. The calculation does not include the tax increases which it is now proposed will be implemented in two stages for diesel. These increases are estimated to reduce emissions by a further 0.1 million tonnes/year for 2015 and by 0.2 milliion tonnes/year for 2020.

37 Swedish Energy Agency ER2008:01.

The targeted policy instruments had a great impact over the period in particular on the introduction of biofuels and on the energy efficiency of the car fleet. Figure 4.6 shows how ethanol, biodiesel and biogas have increased since the biofuels strategy was introduced. Biofuels in 2008 altogether replaced around 4.3 TWh of petrol and diesel equivalent to 1.1 million tonnes of CO_2 emissions. Use is expected to continue to increase, and in principal alternative projection (see Chapter 5) petrol and diesel equivalent to 1.8 milliion tonnes are replaced in 2010, and 3 milliion tonnes in 2020 on the assumption that the present-day tax exemption is extended beyond 2013.

The energy efficiency of the Swedish passenger car fleet has improved from a relatively low level in recent years. The fuel consumption of new cars has fallen in the past 3-4 years (Figure 4.7). Part of the explanation is that the proportion of diesel-powered cars, which are more energy-efficient than petrol vehicles, has risen sharply. [Fig. 4.7]

It is difficult to weigh the many different factors that have steered towards improved fuel efficiency, but a rise in crude oil prices and increased awareness of the problem of climate change in society have contributed. An evaluation suggests that the targeted policy instruments in the direction of greater energy efficiency are the CO_2-differentiated vehicle tax and the rising fuel taxes of significance. The "ACEA commitment" (140 g CO_2/km) has also contributed[38].

Other vehicle-specific instruments such as the green car rebate, the change in benefit value for environmentally classified company cars and local instruments such as subsidised parking have had very little effect in guiding towards energy efficiency and have instead encouraged flexible-fuel vehicles.

Consideration of climate in long-term infrastructure planning

The long-term planning for the development of new infrastructure has an impact on the prospects of society fulfilling its objectives for accessibility in an efficient and environmentally friendly way. Swedish infrastructure planning is based on all investments having to be economically viable and external factors being internalised in the cost estimate, including greenhouse gas emissions. Infrastructure planning is coordinated between the various transport agencies to utilise opportunities for intermodal measures and coordination gains. A transport mode-transcending approach is of key importance in the planning of measures to handle the combined environmental effects of the transport system. This ap-

38 Vilka styrmedel har ökat personbilarnas energieffektivitet i Sverige? (What policy instruments have improved the energy efficiency of cars?), Sprei F, 2009.

proach is to be strengthened, and from 2009 infrastructure planning has been brought under a new government agency.

4.2.7 Waste

Methane emissions from landfills are estimated to have decreased by around 1.2 million tonnes of carbon dioxide equivalent between 1990 and 2007. This is equivalent to a decrease of just over 40 per cent. Methane emissions have steadily declined since the start of the 1990s, firstly as a result of expansion of the collection and disposal of methane gas from landfills and secondly as a result of a decrease in the quantity of organic material sent to landfill. At the same time there has been a substantial increase in the recovery of materials and energy recovery through waste incineration. It is anticipated that emissions from landfills will continue to decline sharply over the next ten-year period, see Chapter 5. The introduction of producer responsibility for a number of different groups of articles, for example packaging, waste paper, stationery and tyres, has contributed to a rise in recycling. The requirement for municipal waste planning, which was introduced in 1991, has probably also contributed to this trend. A tax on waste sent to landfill was introduced in 2000, and a ban on the landfilling of separated combustible (2002) and organic material (2005) has subsequently been introduced. The bans have been implemented gradually as exemptions have been granted when treatment capacity for the recovery of materials and for waste incineration has not yet been expanded sufficiently quickly. The bans have led to an extensive change in Swedish waste management in a short period of time. Landfilling of household waste only accounted for 4 per cent of the total quantity of household waste in 2007. The remaining part of household waste in 2007 went for incineration with energy recovery (46 per cent) or material recovery including biological treatment (49 per cent). A large proportion of organic industrial waste went for incineration with energy recovery.

Aggregate effect of the instruments in the field of waste

Sweden's Third National Communication (2001) presented the result of an analysis of the combined effect of those policy instruments that have an impact on 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 and have since been introduced. The analysis showed that emissions in the scenario with policy instruments decided upon at present would end up around 1.4 million tonnes of carbon dioxide equivalent lower than emissions in the scenario with 1990 policy instruments in 2010. The difference was estimated to be 1.9 tonnes of carbon dioxide equivalent in 2020. The result is still deemed to be a reasonable estimate.

While emissions from landfills have decreased, the incineration of waste in the district heating sector increased by around 6 TWh by 2007 in comparison with 1990 levels. The incineration of household waste leads to certain greenhouse gas emissions because it partly contains material of fossil origin, principally plastic.

However, the incineration of waste leads to further emission reductions, in addition to the reduced discharges of methane at the landfills, if it is assumed to replace electric and district heating that otherwise would have been produced with fuels with a higher content of fossil carbon, e.g. coal and oil.

The effect of the increased incineration of waste in Sweden since 1990 is included in the estimation of the combined effects of the economic instruments in the energy supply sector in Sweden presented in section 4.2.3.

4.2.8 Agriculture and forestry

Agricultural production causes greenhouse gas emissions via land use, livestock (in particular ruminants such as cattle and sheep) and manure management, as well as through the use of fossil fuels.

Emissions in this sector have decreased and are expected to continue to decrease according to the projection in Chapter 5, principally as a result of decreased use of mineral fertiliser, manure and a reduced number of dairy cows. At the same time as the number of cows is expected to decrease in Sweden, however, there is expected to be an increase in the consumption and importing of beef. Carbon dioxide flows for land use, land-use change and forestry (LULUCF) represent both sources and sinks for carbon dioxide. LULUCF normally represents a net sink for carbon dioxide in Sweden.

Emissions of methane and nitrous oxide from agriculture in 2007 represented around 13 per cent of total Swedish greenhouse gas emissions. These emissions have decreased by around 10 per cent since 1990, principally because the number of dairy cows has declined together with the use of mineral fertiliser and manure. Emissions of methane and nitrous oxide account for a significant share, around 20 per cent, of the Swedish greenhouse gas emissions not covered by the EU Emissions Trading Scheme.

The *"land use, land-use change and forestry"* (LULUCF) sector was a net sink for carbon dioxide over the period 1990-2007. The sink ranged between 21 and 36 million tonnes of carbon dioxide per year over this period and has decreased in recent years. The decreasing sink is probably due to forest felling having increased and to a large number of trees being felled by the storm "Gudrun" in 2005. The size and variation of, and the trend in, the sink in the LULUCF sector is principally due to changes in the carbon stock in the forests. Changes in the carbon stock in biomass have the greatest impact, but emissions of carbon dioxide from soil carbon are also significant.

The discharge of carbon dioxide from agricultural land, principally from organogenic soils, also contributes to reducing the total net removal in the LULUCF sector. Emissions from organogenic soils are declining as these soils become covered in vegetation or are used as grazing land or for the growing of forage crops. The net discharge of carbon dioxide from arable land in 2007 totalled around 2.7 milliion tonnes per year, which is a decrease in comparison with 1990 when the discharge was estimated at 4.0 milliion tonnes.

Energy use in land-based industries principally consists of the use of diesel for agricultural and forestry machinery. This use has increased slightly since 1990 despite growth in the production volumes of the two sectors. The use of heating oil for heating of operating premises and greenhouses, on the other hand, is decreasing. Total emissions from energy use are estimated in 2007 to have totalled around 1.6 milliion tonnes, evenly divided between the two sectors.

Policies and measures in the agricultural sector

There are relatively few policy instruments to date that are directly aimed at limiting greenhouse gas emissions in the agricultural sector in Sweden. Interest in reducing the sector's climate impact has, however, increased, and the Government has taken a number of initiatives in recent years to limit the use of fossil fuels in the sector and to increase knowledge and encourage measures that lead to reduced greenhouse gas emissions from manure management and from land use.

The Swedish Board of Agriculture has been tasked with drawing up a combined action programme to reduce nutrient losses and greenhouse gas emissions from agriculture. This remit is due to be reported in 2010. Further restrictions on the spreading of fertiliser will be simultaneously introduced in 2010. Under the review of EU agricultural policy, additional resources have been earmarked to meet new challenges such as climate change and the production of renewable energy.

EU Common Agricultural Policy

The EU Common Agricultural Policy has a significant bearing on the extent, orientation and profitability of agriculture in Sweden. An agreement was reached in 2003 on a reform of the EU Common Agricultural Policy (MTR, Mid-Term Review). The reform in principle means that agricultural aid has now been decoupled from production.

The new rural development programme for the period 2007-2013 covers support for the development of rural areas, payments for environmental measures and aid to boost competitiveness in agriculture, forestry, horticulture, reindeer herding and food processing. Each county administrative board has to prepare regional implementation strategies for the rural development programme. These strategies establish priorities for instance in investment and project aid in the programme.

The environmental payments have been designed to attain environmental objectives such as *A Varied Agricultural Landscape. Zero Eutrophication*, *Thriving Wetlands, A Non-Toxic Environment* and *Sustainable Forests*. Most of the measures and forms of payment introduced, in addition to a positive effect on inputs of nutrients to water, have a positive impact principally in reducing nitrous oxide emissions.

In 2008 the Swedish Government decided to introduce investment aid for agricultural biogas production under the rural development programme 2007-2013, totalling SEK 200 million for the period 2009–2013. Investment aid is also provided for the growing of perennial energy crops that contribute to reduced greenhouse gas emissions in other sectors.

Aid for energy switching/improved efficiency of energy use in greenhouses and agricultural buildings may also be relevant for grants under the rural development programme.

The Agriculture and Fisheries Council in December 2008 reached a political agreement under a review of the 2003 reform of the EU's Common Agricultural Policy, also known as the Health Check. The review meant among other things that funds from direct aid were transferred to the budget for rural development in order to meet new challenges in the areas of climate change, renewable energy, water management, protection of biodiversity and competitiveness in the dairy sector. A proposal for amendments and additions to measures and forms of payment in the Swedish rural development programme for 2007-2013 has now been developed.

Some of the measures proposed are wide-ranging information and advice to strengthen knowledge among farmers and foresters of suitable measures to mitigate the climate impact of their operations and encourage production of renewable energy and sustainable removal of biomass for energy purposes. Additional initiatives include aid for investments in renewable energy and investments aimed at reducing the climate impact of agriculture and other rural businesses and expansion of agri-environmental payments to limit inputs of nutrients to water.

Changes in energy and carbon dioxide taxation for fuels used in the land-based industries

It is proposed that carbon dioxide tax on fuels consumed for heating in industry outside the trading scheme, agricultural, forestry and aquaculture activities should be raised in accordance with the Swedish Parliament's latest 2009 climate change resolution, see sections 4.2 and 4.5 above.

It is additionally proposed that the present-day refunding of carbon dioxide tax for diesel in agricultural and forestry machinery be reduced in several steps. The first step in reduction is due to come into effect in 2011.

As well as the generally lowered tax level, companies in the present-day situation can also obtain further relief of carbon dioxide tax through what is known as the 0.8 per cent rule. This tax relief principally comes into effect for companies in the greenhouse industry. In the 2009 Climate Bill the Government gives notice that this rule will be completely abolished in 2015.

Policy instruments and measures in forestry

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

- Promoting a long-term increase in growth of biomass in the forests in order to bring about sustainable harvesting of renewable raw material and maintain or increase the forest carbon stock.
- Avoiding the use of forestry methods that increase greenhouse gas emissions and otherwise adapting forestry so that greenhouse gas emissions decrease.
- Replacing fossil fuels with biofuel
- Replacing energy-intensive materials with forest raw material
- Increasing the quantity of carbon stored in wood products

It is principally measures of the first two types mentioned that affect the capture of carbon in forest biomass and soil, while the last three measures can contribute to lowering emissions in other sectors. Management methods that have an impact on the carbon stock of the forests include length of rotation period, thinning, choice of tree species and fertiliser application. Longer rotation periods generally increase the carbon stock in the tree biomass, while the potential to replace fuels with biofuels from the forests decreases. Intensive fertiliser application in forests may increase growth in so doing increase the potential to replace fossil fuels with forest fuels, while also increasing carbon sequestration in the tree biomass[39]. On the other hand, intensive fertiliser application may come into conflict with other environmental objectives such as biodiversity and reduced nutrient leaching[40].

Politics, legislation and certification systems

Two overarching objectives have been formulated in Swedish forest policy, a production objective and an environmental objective. These objectives have equal status and mean that the forests must be managed so that they sustainably produce a good return at the same time as biodiversity is preserved and cultural heritage assets and social assets are safeguarded. The Government Bill "A Forest Policy in Line with the Times" (Government Bill 2007/2008:108) stresses the role of the forests for climate and the need for increased growth in the forests. The Swedish Government is therefore now putting extra effort into production-oriented advice.

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 current provisions directly affects the development of carbon storage in various ways. These include in particular:

- Provisions on forest stewardship etc. in the Forestry Act. Forest stewardship with measures that have been well adapted to the growing site for a good environment creates the necessary conditions for robust and vigorous forests with a high rate of growth, which is favourable to carbon storage in forest biomass.
- Provisions on land drainage in the Environmental Code. Applications for drainage permits are mandatory and are appraised by the county administrative board. Ditching of peat bogs may entail increased emissions of carbon dioxide and other greenhouse gases, while increased forest production on this land may increase carbon removal in tree biomass. The Government has asked the

39 Högberg P, Nature 447, 781-782, 2007.

40 Larsson S, Lundmark T, Ståhl G; Möjligheter till intensivodling av skog (Options for intensive cultivation of forests, SLU (Swedish University of Agricultural Sciences), Final report on Government remit JO2008/1885, 2009.

Swedish University of Agricultural Sciences to investigate how the filling-in of ditches affects flows of greenhouse gases.
- 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. The Swedish forest, which in comparison to the boreal natural forests has a low average age, additionally has high carbon storage capacity, even a long 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. As this is exempt from felling, its ability to store carbon in biomass and soil in the long term is greater than that of production forest. Alongside the legislation, the target for voluntary set-aside (an increase by 2010 of 500 000 hectares in comparison with 1998) in the FSC and PEFC forest certification schemes is favourable to carbon storage.

The Government emphasises that it is important now to analyse the conditions that need to be met for policy instruments and regulations that may be considered for forestry to contribute further to cost-effective fulfilment of the objectives of Swedish climate policy. It is proposed that the analysis should cover studies of possible incentives to increase the capture of carbon in carbon sinks where appropriate and minimise greenhouse gas emissions from the soil. The potential measures have to be such as not to conflict with the production objective and the environmental objective for Swedish forestry.

Implementation of articles 3.3 and 3.4 of the Kyoto Protocol

Beyond the mandatory accounting of emissions and removals of greenhouse gases under Article 3.3, Sweden has decided to utilise the forestry part in Article 3.4 to calculate emissions and removals of greenhouse gases from land use (LULUCF). Sweden follows the criteria that apply as a definition of forest land according to the FAO definition and the IPCC's good practice guidelines. The methodology and database for calculating changes in carbon stocks have been developed. This has been previously reported by Sweden[41].

Under the Kyoto Protocol, national legal or administrative arrangements to ensure that implementation of Articles 3.3 and 3.4 also contributes to the preservation of biodiversity and conservation of natural resources have to be reported in the national communication. Sweden's current forest policy puts great emphasis on conservation of forests as a natural resource and for the preservation of biodiversity. Under the Forestry Act, the forests have to be managed and removal of forest has to take place so that it contributes to sustainable forestry, which means that felling at most can amount to the annual growth. The rules of environmental legislation on nature reserves and habitat protection provide long-term formal protection for biologically valuable forest areas, and under the Forestry Act the forests have to be managed with measures that are adapted to requirements for a good environment. No need has been found for supplementary legislation to preserve biodiversity and conserve natural resources as a consequence of implementation of Articles 3.3 and 3.4. In the period since 1990 Sweden has annually reported a net sink from land use (LULUCF) which has substantially surpassed the maximum net sink of 2.13 milliion tonnes that Sweden is allowed to credit itself. The total timber stock of forest land has increased by 0.5 billion m^3 since 1990 without any special carbon capture promoting measures having been introduced.

4.2.9 Transport by shipping and aviation including international bunkering in Sweden

Emissions from domestic shipping and aviation are declining in Sweden and only make up 2 and 3 per cent of aggregate emissions from domestic transport. Shipping is an energy-efficient mode of transport, and an opportunity is therefore being given for the extent of maritime transport to increase with increasing intermodal measures to support the development of an economically efficient and long-term sustainable transport system. Domestic aviation increasingly competes with high-speed trains in Sweden and is therefore decreasing. Both flights within the EU and flights to and from the EU will be covered by the EU Emissions Trading Scheme from 2012.

Emissions from the bunkering in Sweden of fuels for international shipping and aviation, on the other hand, are larger and totalled around 9.8 milliion tonnes of carbon dioxide equivalent in 2007. Emissions have increased by as much as 170 per cent compared with 1990, which is significantly more than the EU average. Fuels for maritime transport are increasing most. Emissions from international transport are not included in the Swedish national commitments under the Kyoto Protocol, as it does not cover these forms of transport. According to the provisions of the

41 Sweden's initial report under the Kyoto Protocol, calculation of assigned amount, Dec 2006.

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 and the EU have pressed for measures to be taken to limit aviation emissions within the framework of ICAO. The objective is for these emissions to be included in an international climate regime after 2012. A suitable scheme is for an agreement in UNFCCC to set limits on a sector commitment for aviation and for ICAO to assume a principal role in the implementation of this commitment. If such an agreement is not reached and if ICAO is unable to agree on measures, the EU should proceed alone. Sweden is also pressing for other emissions from aviation with a climate impact to be limited, alongside carbon dioxide. Emissions of nitrogen oxides should also be limited as a first step.

Sweden has assisted in work in the IMO to develop a design index for newly built ships. This index is intended to be usable as a basis for economic instruments. Sweden has also assisted in efforts to develop operating indices for existing ships. Sweden accords high priority to the work of the IMO on limiting emissions of nitrogen oxides and sulphur and considers these measures also to be favourable from the point of view of climate change. Sweden is continuing to work within IMO for a decision in principle to be taken and for specific measures that limit emissions to be presented in Copenhagen. Sweden considers that it would also be appropriate for international shipping, as well as for aviation, for the sector to be subject to international regulation through a special commitment and for IMO to be given a principle role in implementation. If this is not done, consideration should be given to whether emissions from shipping should also be included in the EU Emissions Trading Scheme.

4.2.10 Efforts to avoid adverse effects of introduced policy instruments and measures in the country's climate strategy

According to the provisions of Article 2 of the Kyoto Protocol, each party with quantified commitments under the Protocol is to introduce policies and measures to achieve the emission reductions to which it has made a commitment. The measures implemented are to be compatible with overarching objectives of sustainable development. Measures which would mean that all greenhouse gases regulated by the Protocol can decrease and cover all sectors of society are emphasised. The parties to the Kyoto Protocol are to aim to introduce policies and measures so that adverse effects are minimised. Such effects include adverse effects of a changed climate, effects on international trade and social, environmental and economic effects on other parties, particularly on developing countries.

In connection with the implementation of policies and measures, an impact assessment is carried out, including an environmental impact assessment as a basis for decision-making. Such an analysis as far possible also includes assessing the risk of adverse effects in other countries.

Knowledge development has to contribute to sustainable global development. There are therefore also several examples of interdisciplinary research efforts focused on improving knowledge of effects globally (socially, economically and ecologically) of large-scale introduction of measures to reduce greenhouse gas emissions. Sweden's focus on increased use of bioenergy, both through increased domestic production but also through increased imports in particular from developing countries, has meant that this area has been specially prioritised in systems-science research in the country.

Results from research have also already influenced, and will in future influence, the development of policy. The special sustainability criteria devised for vehicle biofuels under the EU Renewables Directive is one such example.

Both positive and negative effects must be taken into account. Sweden contributes to a number of measures being implemented that may have positive effects on the prospects of developing countries adapting to climate change and implementing their own measures to reduce their greenhouse gas emissions. A description is given in Chapter 7 of such efforts in the areas of technology transfer, knowledge building and support for adaptation measures.

Finally Sweden wishes to emphasise that its climate strategy with its broad focus on many different types of measures covering the majority of sectors of society (both in and outside the country) and all the greenhouse gases governed by the Kyoto Protocol has a formulation which fundamentally limits (minimises) the risk of adverse effects.

4.3 Work on project-based flexible mechanisms under the Kyoto Protocol

Sweden is involved in work on the project-based mechanisms under the Kyoto Protocol, CDM and JI. The task of the Swedish CDM and JI programme is

to contribute to developing CDM and JI as effective climate policy instruments, contribute to cost-effective reductions in greenhouse gases and contribute to sustainable development in the host countries. The programme has been focused firstly on assistance with individual projects and secondly on participation in multilateral CDM and JI funds. The individual projects are in the areas of renewable energy and energy efficiency. Funds have been chosen on the basis of their focus on project types, an endeavour to ensure geographical spread of projects and the possibility of exerting influence on the work of the fund.

The Swedish Parliament has granted appropriations for international climate initiatives in CDM and JI totalling around SEK 1200 million for the period up to 2011.

Sweden at present has signed agreements with 24 individual CDM projects and 2 JI projects:

- 3 biofuel-based combined heat and power projects in Brazil
- 1 biofuel-based power station in Tamil Nadu, India
- 1 energy efficiency project in the cement industry in China
- 15 wind energy projects in China
- 3 biogas projects in China
- 1 small-scale hydropower plant in Malaysia
- 1 energy efficiency project through installation of turbines for electricity production in a district heating plant in Romania (conversion to combined heat and power)
- 1 wind energy project in Estonia

Sweden is taking part in five multinational funds.

1) Testing Ground Facility (TGF) – established in the framework of regional energy cooperation in the Baltic Sea region, Baltic Sea Region Energy Cooperation (BASREC). The purpose of TGF is to finance joint JI projects in the Baltic Sea region. Sweden's share of the fund is nearly EUR 3.5 million out of the total of EUR 35 million. As well as the Baltic Sea countries, private companies are covered by the fund.
2) Prototype Carbon Fund (PCF) – this fund was launched by the World Bank in 1999 and has contributed to the development of climate projects under CDM and JI and to the regulations for these. The Fund's total capital is USD 180 million, and Sweden has contributed USD 10 million.
3) Asia Pacific Carbon Fund (APCF) – the CDM fund of the Asian Development Bank, focusing on developing countries in Asia and the Pacific Ocean area, including 'least developed countries' which find it difficult to launch CDM projects because of various types of barriers. With regard to project types, the Fund is focused on renewable energy production, energy efficiency and collection of methane gas. Emission reduction units are principally acquired from the CDM projects through advance payments, which makes it possible for financially weaker CDM projects also to be implemented. Sweden has contributed along with six other European countries, with a total of USD 152 million. Sweden's share is USD 15 million.
4) Future Carbon Fund (FCF) – the newly launched fund of the Asian Development Bank aimed at setting up projects after the first commitment period of the Kyoto Protocol in order to contribute to the market continuing to develop despite the uncertainties being caused at present by the lack of international regulations for the period after 2012. Like the APCF fund, FCF is focused on projects in renewable energy production, energy efficiency and collection of methane gas, and applies advance payment in acquisitions of emission reduction units. Sweden's contribution to the Fund totals USD 20 million. In addition to Sweden two other European countries are taking part in the fund, which is still open to additional participants.
5) Multilateral Carbon Credit Fund (MCCF) – administered by the European Development Bank and the European Investment Bank. The Fund is focused on CDM and JI projects in energy efficiency, transition to renewable fuels and renewable energy in Central Asia and Eastern Europe. The participants in the Fund are both national governments and private companies. The Fund's total capital is EUR 165 million, and Sweden has contributed EUR 2 million.

The total funding granted by the Swedish Parliament for the period 2003-2011 is expected to generate 11-14 million emission reduction units for Sweden.

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

4.4.1 Cost-effectiveness of instruments

Sweden's Fourth National Communication on Climate Change (Chapter 4.4) contained a theoretical examination of the concept of cost-effectiveness and policy instruments. It was emphasised that the primary aspect is to establish what objective the instrument is intended to contribute towards and to relate the instrument's emission reduction to the economic costs generated by the instrument.

Overarching conclusions were that cross-cutting instruments such as taxes and emissions trading which impose the same marginal cost of emissions on all actors have good prospects of attaining high cost-effectiveness. The more the marginal costs vary for measures to reduce emissions and the more sectors of society and countries are covered by the instrument, the greater the efficiency gains that can be expected compared with other types of instruments. In practice there is, however, a risk of cross-cutting economic instruments, because of a conflict with other societal objectives, not always being designed in a theoretically desirable way, which may reduce their effectiveness. This may apply to conflicts for example with energy policy objectives, business policy objectives (competitiveness of industry) and regional policy objectives.

This may justify the cross-cutting instruments being supplemented by targeted instruments to eliminate market obstacles, for example instruments to contribute to technological development and market introduction or to provide a knowledge-raising effect for potential measures. In addition, climate policy instruments often interact with instruments introduced in other policy areas to attain other societal objectives that also contribute to reduced greenhouse gas emissions. The synergistic effects of these instruments may in some cases lead to the climate objectives being attained with greater cost-effectiveness. This may apply for example in the areas of energy, agriculture and waste.

Globally very large reductions in emissions are required if it is to be possible to achieve the 'two-degree target'. Sweden considers a responsible and cost-effective climate policy to mean that international emission reductions are supplemented by initiatives that support emission reduction measures in developing countries, among other ways through flexible mechanisms. Investments in developing countries with low costs per kg emission reduction have the effect that global objectives can be attained at a lower total cost. Countries that have not introduced instruments for efficient use of energy, to move away from fossil fuels and from emissions of other greenhouse gases, can often implement emission reduction measures at lower cost than countries that have set a high price for greenhouse gas emissions. At the same time, these investments contribute to making developing countries better able to develop an energy system based on efficient and renewable energy supply and not locked into high fossil-dependent energy use.

Sweden has therefore chosen a climate policy that balances efforts to reduce emissions in the country with efforts in other countries under the flexible mechanisms of the Kyoto Protocol.

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

Several of the instruments that contribute to reduced greenhouse gas emissions are also aimed at attaining other societal objectives. When instruments additionally interact in a sector or area of use, it is a complex task to distinguish individual effects of the instruments. There is uncertainty over differentiating effects of the instrument from other external changes having effects on emissions, for example energy prices and spontaneous technological development. There is also uncertainty on transaction costs that arise among the actors and estimation of the effect of the instruments on the national macroeconomy.

A rough indication of the cost-effectiveness of the complete combined climate strategy can nevertheless be given by effects and costs being estimated for the technical measures implemented as a result of the instruments or packages of instruments introduced. Figure 4.8 presents the result of a calculation of the costs of a selection of conversion and new-investment measures in electricity and heating supply implemented over the period 1990-2007 in Sweden. An assessment has been made for each measure of the annual aggregate emission reduction it has led to over the period. The height of the bar for the measure concerned shows the calculated cost of the measure on the Y-axis, while the width of the bar shows the estimated annual emission reduction from the measure on the X-axis. The costs of the measures have been calculated without policy instruments such as taxes and grants and with 4 per cent cost of capital, which reflects a macroeconomic perspective and not the costing for an investor. The costs of measures in the figure thus do not coincide with the cost to the households or companies that have implemented the measures.

The result largely depends on what fuel costs and therefore what differences in price between different fuels have been assumed to apply during the period. The fuel costs in the calculations are close to the 1990-2007 average. The difference in fuel prices over the period (the relative prices) varied most between biofuels and oil and less between coal and biofuels. As a result, the costs of measures in which coal is replaced varied quite little over the period, while equivalent costs of measures where oil is replaced fell sharply in line with rising oil prices, even

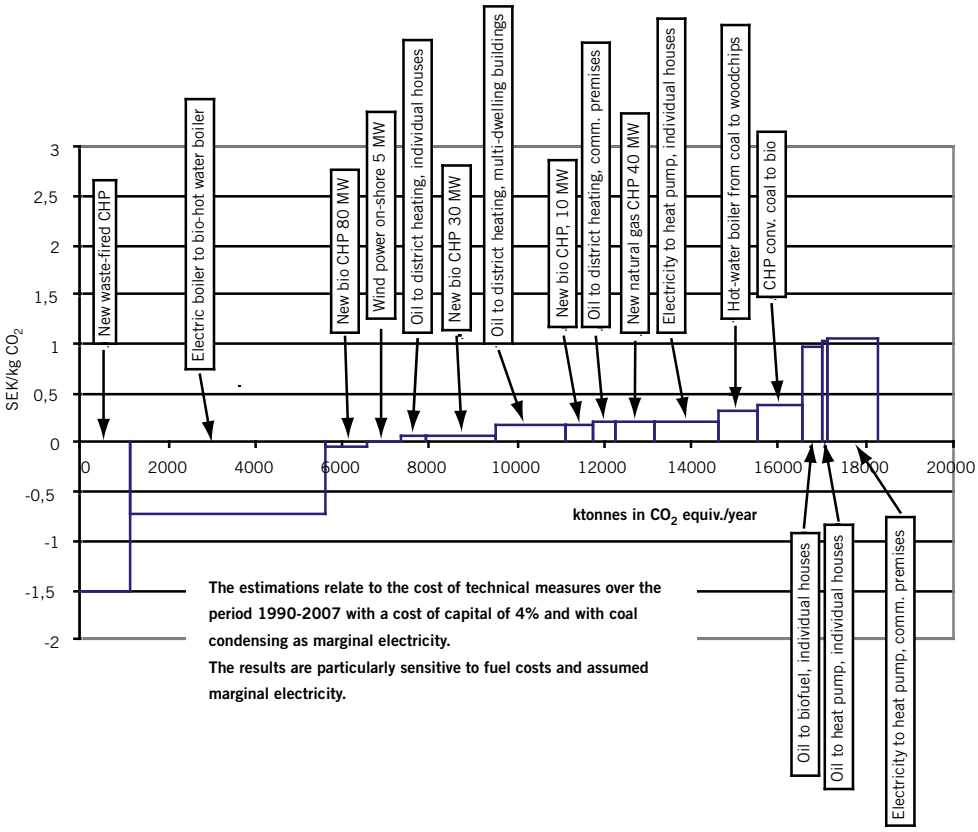


Figure 4.8 **Estimated cost of measure and annual emission reduction for different typical measures in electricity and heating supply implemented in Sweden 1990-2007**

to negative values (profitable measures for society), as biofuel prices did not increase to the same extent. The alternative investment for measures in electricity production has been assumed to be coal condensing in Sweden (see Section 4.2.3).

The diagram shows estimated historical costs of measures and does not represent an estimation of future costs of measures.

There are sources of error and limitations in the method and the data. The effects of fuel conversions may be overestimated as they do not take account of the fact that energy-efficiency measures have also been taken, reducing total energy use. At the same time there are additional conversion measures which it has not been possible to calculate owing to limitations in the statistics. An average energy price has been adopted in the calculations for the whole period, but the measures may very well not have been implemented until the electricity and fossil fuel prices were higher than the average or until the price ratio between fossil and renewable fuels was most favourable. A large proportion of the conversion from oil in the residential sector, for example, took place during the 2000s when oil prices were high.

It is worth noting that the costs of the measures in most cases are substantially lower than the level that has applied for carbon dioxide tax during the 2000s in Sweden. Carbon dioxide tax has thus been at such a level that it has been able comfortably to overcome:

- households and companies demanding a greater return on their investments (than central government),
- transaction costs,
- other market obstacles.

The cost of combined heat and power from waste becomes particularly low in the calculation because the operation of a waste incinerator generates revenue as a special treatment charge can be levied at the installations.

4.5 Instruments taken out of use

In comparison with the account given in the Fourth National Communication only one instrument has been taken out of use and replaced by another instrument. A small number of instruments have been introduced and concluded between the fourth and fifth national communications. These are mentioned in Chapter 4.

Table 4.3 **Instruments taken out of use since the Fourth National Communication**

Instruments	Primarily replaced by
Local climate investment grants (Klimp)	Delegation for Sustainable Cities

4.6 Summary table of instruments

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 compared with 1990 (N.E. = not estimated) 2005	2010	2015	2020
Cross-sectoral instruments									
Local investment programme (LIP)	Change-over to ecological sustainability at local level	All	Economic	Concluded (1998-2008)	Swedish Environmental Protection Agency	Up to 1	Up to 1	Up to 1	Up to 1
Climate investment programme (KLIMP)	Subsidies for projects that reduce climate impact	All	Economic	Concluded (2003-2008)	Swedish Environmental Protection Agency	Up to 0.5	Up to 0.8	Up to 1	Up to 1
Delegation for Sustainable Cities	Change-over to ecological sustainability at local level	All	Economic	Ongoing (2009-	National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.
Environmental Code	Ecologically sustainable development	All	Legislation	Ongoing (1999-	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Climate information campaign	Increased knowledge of problem of climate change	All	Information	Concluded (2002-2003)	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Research and development	Development of technology with very low climate impact	All	Economic	Ongoing 1990-	Swedish Energy Agency (principally)	N.E.	N.E.	N.E.	N.E.
Production of electricity and district heating									
Energy tax	Improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (57-	Swedish Tax Agency	13	16	17	16
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (91-	Swedish Tax Agency				
The electricity certificate system	Increase supply of electricity from renewable forms of energy	Carbon dioxide	Economic	Ongoing (2003-	Swedish Energy Agency and Svenska Kraftnät				
EUEmissions Trading Scheme	Reduce use of fossil fuels in the trading sector	Carbon dioxide	Economic	Ongoing (2005-	Swedish EPA and Swedish Energy Agency				
Residential and service sector									
Energy and carbon dioxide taxes	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing	Swedish Tax Agency	Up to 7	Up to 8	Up to 8	Up to 9
Building regulations - standards for energy efficiency	More efficient energy use	Carbon dioxide	Legislation	Ongoing	National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.
Energy declarations	More efficient energy use	Carbon dioxide	Information on legislation	Ongoing (2009-	National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.
Technology procurement	More efficient energy use and increased use of renewable energy	Carbon dioxide	Economic	Ongoing	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Mandatory energy labelling	More efficient energy use	Carbon dioxide	Information	Ongoing	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Investment aid for replacement of heating systems and energy efficiency measures	More efficient energy use and increased use of renewable energy	Carbon dioxide	Economic	Completed	National Board of Housing, Building and Planning County administrative boards	N.E.	N.E.	N.E.	N.E.
Industrial emissions from combustion and processes (including emissions of fluorinated greenhouse gases)									
Energy tax	Economic	Carbon dioxide	Economic	Ongoing (57-	Swedish Tax Agency	-	-	-	-
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (91-	Swedish Tax Agency				
The electricity certificate system	Increase supply of electricity from renewable forms of energy	Carbon dioxide	Economic	Ongoing (2003-	Swedish Energy Agency and Svenska Kraftnät				
EU Emissions Trading Scheme	Reduce use of fossil fuels in the trading sector	Carbon dioxide	Economic	Ongoing (2005-	Swedish EPA and Swedish Energy Agency				

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 compared with 1990 (N.E. = not estimated)			
						2005	2010	2015	2020
Proposals for reduced lowering of carbon dioxide tax for industry outside the EU Emissions Trading Scheme and for the introduction of energy tax on fossil fuels for heating in industry	Reduce use of fossil fuels	Carbon dioxide	Economic	Planned (with start 2011-2015)	Swedish Tax Agency	-	-	0.4	0.4
Programme for energy efficiency improvement	Reduce electricity use	Carbon dioxide	Voluntary/ negotiated agreement	Ongoing (2005-	Swedish Energy Agency	E.B.	E.B.	E.B.	E.B.
F-gas regulation including mobile air conditioners directive		HFCs	Legislation	Ongoing		0	0.2	0.5	0.7
Transport									
Vehicle-fuel taxes	Internalise the external effects of road transport including greenhouse gas emissions	Carbon dioxide	Economic	Ongoing	Swedish Tax Agency	1.7	1.9	2.3	2.4
Proposal for raised energy tax on diesel	Internalise the external effects of road transport including greenhouse gas emissions	Carbon dioxide	Economic	Planned 2011 and 2013	Swedish Tax Agency	-	-	0.1	0.2
Targeted instruments for introduction of renewable vehicle fuels	Increase use of renewable vehicle fuels	Carbon dioxide	Economic		Swedish Tax Agency (mainly)	0.6	1.8	2.6	3
Area of waste									
Rules on municipal waste planning, rules on producer responsibility for certain goods, tax on landfilling of waste (2000), prohibition of landfilling of non-separated 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	Ongoing	Swedish Environmental Protection Agency	0.8	1.4	1.7	1.9
Agriculture									
Targeted environmental grants under rural development programme	Reduced Climate Impact, A Varied Agricultural Landscape and Zero Eutrophication	Nitrous oxide and methane	Economic	Ongoing	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	Ongoing	National Board of Forestry	N.E.	N.E.	N.E.	N.E.
Provisions on drainage in the Environmental Code.	Biodiversity	Carbon dioxide and methane	Legislation	Ongoing	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	Biodiversity	Carbon dioxide	Legislation	Ongoing	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	Ongoing		N.E.	N.E.	N.E.	N.E.

5 Projections and aggregate effects of policies and measures

5.1 Aggregate projections

A new projection of emissions and removals of greenhouse gases has been produced for this national communication and for the reporting to the EU in accordance with the requirements laid down in the EU decision on the monitoring of greenhouse gases[42]. The main projection is based on the policy instruments adopted by the EU and the Swedish Parliament up to June 2008 and the economic future assessment applicable at that time. It means that the main projection does not include the EU climate- and energy package, nor the Swedish 2009 climate policy resolutions. The projection is the result of a number of assumptions, all of which are subject to uncertainty and can be primarily regarded as an impact assessment of the assumptions made. The result should be interpreted with this in mind.

The method of calculating the projection is principally structured to make a projection in the medium or long terms, which means that the projection for 2010 does not take account of more short-term variations. A partial sensitivity calculation for 2010 based on short-term variations 2008-2009 is therefore also presented.

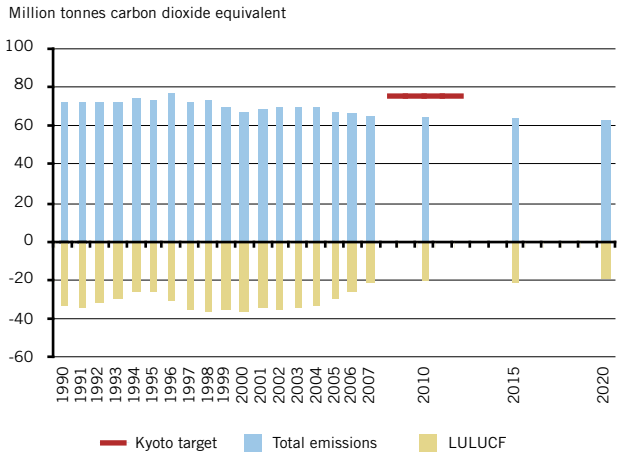


Figure 5.1 **Historical and projected greenhouse gas emissions and Sweden's Kyoto targets.**

In addition to the projection, two sensitivity alternatives have been calculated for the energy and transport sectors and one for the agricultural sector and fluorinated greenhouse gas emissions in the industrial processes sector. A projection with "additional measures", that includes EU-wide and national policy instruments decided by June 2009, is also presented in ch. 5.4.

Total greenhouse gas emissions in Sweden, calculated as carbon dioxide equivalent, were around 65.4 million tonnes in 2007, excluding greenhouse gas emissions and removals from the land use, land-use change and forestry sector (LULUCF). The projection result suggests that total greenhouse gas emissions (excluding LULUCF) will be in line with the emission levels of recent years up to 2010. The projection does not take account of the effects of the financial now in progress (September 2009) and the sharp economic downturn. Emissions are estimated to decrease further after 2010, and total greenhouse gas emissions in 2020 in the main projection are estimated to be around 12 per cent lower than in 1990. [Fig. 5.1]

The land use, land-use change and forestry sector (LULUCF) contributed over the period 1990-2007 to a net sink for Sweden and is expected also to do so by 2020. [Fig. 5.1, Table 5.1]

Approximately 80 per cent of emissions were carbon dioxide emissions in 2007, while methane emissions account for 8 per cent, nitrous oxide emissions for 11 per cent and fluorinated greenhouse gases for just under 2 per cent. Emissions of all gases decrease between 2007 and 2020, but the share of carbon dioxide emissions is expected to increase slightly to around 83 per cent in 2020. [Table 5.2]

With estimated GDP growth of 2.3 per cent as an annual average and a projected population growth of just over 0.5 per cent/year, the emissions projection

42 EU Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

Table 5.1 **Historical and projected emissions and removals of greenhouse gases by sector (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Energy excluding transport	34.7	28.6	27.4	27.7	27.5	27.4	-20%	-21%	-21%
Transport	18.6	20.9	20.8	21.2	21.5	21.5	14%	16%	16%
Industrial processes	5.8	6.6	6.5	6.2	6.2	6.2	7%	7%	7%
Solvents	0.33	0.3	0.29	0.29	0.29	0.28	-12%	-14%	-15%
Agriculture	9.4	8.6	8.4	8.1	7.6	7.0	-14%	-20%	-25%
Waste	3.1	2.2	1.9	1.5	1.0	0.8	-52%	-67%	-76%
Total emissions (excl. LULUCF)	**71.9**	**67.2**	**65.4**	**65.0**	**64.1**	**63.1**	**-10%**	**-11%**	**-12%**
LULUCF	-32.1	-29.1	-20.5	-20.0	-20.2	-19.1	-38%	-37%	-40%
Total emissions (incl. LULUCF)	**39.9**	**38.1**	**44.9**	**45.0**	**43.9**	**44.0**	**13%**	**10%**	**10%**

Table 5.2 **Historical and projected emissions of greenhouse gas emissions by gas (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	56.3	53.0	51.6	52.3	52.6	52.6	-7%	-7%	-6%
Methane	6.7	5.6	5.4	4.8	4.1	3.6	-29%	-38%	-46%
Nitrous oxide	8.5	7.4	7.2	7.0	6.7	6.4	-18%	-21%	-25%
Fluorinated greenhouse gases	0.5	1.2	1.3	0.9	0.7	0.4	84%	34%	-13%
Total emissions (excl. LULUCF)	**71.9**	**67.2**	**65.4**	**65.0**	**64.1**	**63.1**	**-10%**	**-11%**	**-12%**

Table 5.3 **Projected greenhouse gas emissions per capita and GDP (real GDP at 2000 prices).**

	1990	2005	2007	2010	2015	2020
CO_2 eq. (tonnes) per capita	8.4	7.4	7.1	6.9	6.7	6.4
CO_2eq (kg) GDP (SEK)	0.039	0.026	0.024	0.022	0.020	0.017
CO_2eq (kg)/GDP (USD PPP)	0.36	0.24	0.22	0.20	0.18	0.16
CO_2 eq. tonnes)/capita (incl. LULUCF)	4.6	4.2	4.9	4.8	4.6	4.5
CO_2 eq. (kg)/GDP (SEK) (incl. LULUCF)	0.022	0.015	0.016	0.015	0.014	0.012
CO_2eq (kg)/GDP (USD PPP) (incl. LULUCF)	0.20	0.14	0.15	0.14	0.13	0.11

indicates that emissions per capita would decrease to 6.4 tonnes of CO_2 equivalent in 2020 [Table 5.3].

The projected trend in emissions differs between different sectors of society. Total emissions from the energy sector are estimated to remain at roughly the same level over the period 2007 to 2020, while emissions from the transport sector are estimated to increase somewhat. Emissions by the agriculture sector have decreased to date and are estimated in the main alternative to continue to decrease to around 25 per cent below the 1990 level in 2020. Emissions from the waste sector are expected to be halved by 2010 in comparison with 1990 and then to continue to decrease. Emissions from industrial processes including fluorinated greenhouse gases, on the other hand, are estimated to decrease somewhat from the 2007 level by 2020. [Table 5.1, Fig. 5.2]

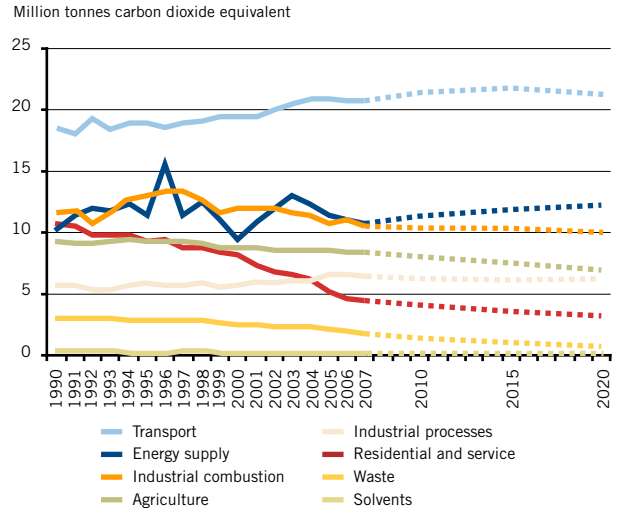


Figure 5.2 **Historical and projected greenhouse gas emissions from different sectors.**

Sensitivity calculations have been performed in some sectors, see section 5.3. As an aggregate for all the sectors, the result of the sensitivity calculations shows that total emissions are estimated to decrease by -11 per cent to -16 per cent by 2020 in comparison with 1990. In addition to this there are the general uncertainties applicable to all projection assumptions, for example on economic development, fuel prices, emission allowance prices, technical development etc., which are of great significance to the result.

5.2 Projections by sector

5.2.1 Energy excluding transport

Greenhouse gas emissions from the energy sector[43] excluding transport varied over the period 1990-2007, but the trend points towards decreasing emissions. Total emissions from the energy sector are es-

43 Emissions by the energy sector include emissions from the production of electricity and district heating, refineries, production of solid fuels, industrial combustion, fugitive emissions, other and residential and service including combustion in agriculture, forestry and fisheries.

timated to be at roughly the same level in 2007 and 2020 and are a result of emissions from the production of electricity and district heating and refineries being estimated to increase while emissions from the residential and service sector and industrial combustion are expected to decrease. [Table 5.4]

Energy industries (electricity and district heating production, refineries, manufacture of solid fuels)

Greenhouse gas emissions from production of electricity and district heating are estimated to increase somewhat from 2007 to 2020. The emissions increase as a result of increased production of electricity in particular, but also of district heating. On the other hand, emissions decrease to a far lesser extent than production, due to partially changed composition of fuel used. Increased use of natural gas, fuels from the iron and steel industry and to some extent waste contribute to increased emissions, but the increase is mitigated by increased use of biofuel and wind power, as well as reduced use of oil, coal and peat. Biofuel is used in particular in combined heat and power plants, which is favoured by both the electricity certificate system and the EU Emissions Trading Scheme. Electricity production is expected to increase more than the use of electricity between 2007 and 2020, which signifies a projected net export of 23 TWh in 2020. [Table 5.5]

Emissions from refineries are estimated to increase substantially between 2007 and 2020. The increase is due to increased production and increased emissions in production as a result of stricter product requirements. [Table 5.6]

Greenhouse gas emissions from the manufacture of solid fuels are estimated to remain at the same level as in the past few years by 2020, around 0.3 million tonnes of carbon dioxide equivalent.

Residential and service sector

Emissions from the residential and service sector including energy use in agriculture, forestry and fish-

Table 5.4 **Historical and projected greenhouse gas emissions from the energy sector (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	33.2	27.1	25.8	26.1	25.9	25.7	-21%	-22%	-23%
Methane	0.3	0.4	0.4	0.4	0.4	0.5	35%	42%	42%
Nitrous oxide	1.2	1.2	1.2	1.2	1.2	1.2	2%	5%	2%
Total emissions	**34.7**	**28.6**	**27.4**	**27.7**	**27.5**	**27.4**	**-20%**	**-21%**	**-21%**

Table 5.5 **Historical and projected greenhouse gas emissions and underlying energy use in electricity and district heating production (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	7.7	8.4	8.0	8.2	8.3	8.5	6%	8%	10%
Methane	0.02	0.07	0.07	0.09	0.09	0.09	312%	321%	330%
Nitrous oxide	0.3	0.4	0.4	0.4	0.5	0.4	41%	55%	42%
Total emissions	**8.0**	**8.8**	**8.5**	**8.7**	**8.9**	**9.0**	**8%**	**11%**	**12%**
Electricity production (TWh)	142	155	145	159		172	12%		21%
District heating production (TWh)	41	53	54	56		58	37%		41%

Table 5.6 **Historical and projected greenhouse gas emissions from the energy sector (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	1.8	2.2	1.9	2.3	2.6	2.8	30%	47%	59%
Methane	0.001	0.001	0.001	0.001	0.001	0.001	54%	79%	54%
Nitrous oxide	0.02	0.03	0.03	0.03	0.03	0.04	25%	51%	75%
Total emissions	**1.8**	**2.3**	**1.9**	**2.3**	**2.6**	**2.9**	**30%**	**47%**	**59%**

Table 5.7 **Historical and projected greenhouse gas emissions and underlying energy use in the residential and service sector and for combustion in agriculture. forestry and fisheries (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	10.3	4.7	3.9	3.5	3.0	2.7	-66%	-71%	-74%
Methane	0.24	0.26	0.3	0.29	0.3	0.3	18%	25%	24%
Nitrous oxide	0.28	0.24	0.25	0.24	0.23	0.23	-12%	-18%	-18%
Total emissions	**10.8**	**5.2**	**4.5**	**4.1**	**3.5**	**3.2**	**-62%**	**-67%**	**-70%**

eries decreased over the period 1990-2007 and are expected to continue to decrease up to 2020. The decrease is principally due to oil for heating and hot water in the residential and service sector being replaced by heat pumps, biofuel and district heating.

Emissions from energy use in agriculture are estimated to decrease between 2007 and 2020 as a result of reduced use of diesel for machinery and reduced use of oil for greenhouses and other agricultural buildings. Emissions from forestry machinery are estimated to increase somewhat by 2020 as a result of increased felling. [Table 5.7]

Industrial combustion

Emissions from industrial combustion in 2007 were lower than in 1990, but they have varied over the years, principally due to economic fluctuations. A small number of energy-intensive industries account for a large proportion of emissions in the sector. The pulp and paper industry, the chemical industry and the iron and steel industry together account for almost half the sector's emissions.

Total energy use in industry is estimated to increase between 2007 and 2020 as a consequence of an assumed increase in production. On the other hand, emissions from industrial combustion are estimated to decrease in particular because emissions from the pulp and paper industry are expected to decrease as a result of a switch from fossil fuels to increased use of biofuel. Emissions from the engineering, mineral and food industries also decrease somewhat. On the other hand, emissions from the chemical, metal, mining and iron and steel industries are estimated to increase somewhat. [Table 5.8]

Other and fugitive emissions

Emissions from "Other" (principally military emissions) decreased between 1990 and 2007. Over the period 2007 to 2020 emissions are estimated to remain at roughly the same level as in the past few years, around 0.2 million tonnes of carbon dioxide equivalent. Fugitive emissions are estimated to increase somewhat from 1.3 million tonnes in 2007 to 1.4 million tonnes of carbon dioxide equivalent in 2020. [Table 5.9-10]

5.2.2 Industrial processes

Total emissions from industrial processes were higher in 2007 than in 1990, but they varied somewhat, principally due to variation in production volumes and economic fluctuations. Carbon dioxide emissions are estimated to increase up to 2020, principally due to an assumed increase in production in the mineral industry and the iron and steel industry. Some of the increase in emissions from the iron and steel industry is also reported in industrial combustion and electricity and district heating production sectors.

Emissions of fluorinated greenhouse gases increased over the period 1990-2007 but are expected to de-

Table 5.8 **Historical and projected greenhouse gas emissions from industrial combustion (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	11.2	10.3	10.1	10.2	10.0	9.8	-9%	-10%	-12%
Methane	0.05	0.04	0.05	0.04	0.05	0.05	-3%	4%	9%
Nitrous oxide	0.5	0.5	0.5	0.5	0.5	0.5	-10%	-10%	-11%
Total emissions	**11.7**	**10.8**	**10.7**	**10.7**	**10.5**	**10.3**	**-9%**	**-10%**	**-12%**
Energy use (TWh)	140	155	157	158		161	13%		15%

Table 5.9 **Historical and projected greenhouse gas emissions from Other (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	0.8	0.2	0.3	0.2	0.2	0.2	-74%	-74%	-74%
Methane	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	-86%	-86%	-86%
Nitrous oxide	0.03	0.005	0.005	0.005	0.005	0.005	-83%	-83%	-83%
Total	**0.9**	**0.2**	**0.3**	**0.2**	**0.2**	**0.2**	**-74%**	**-74%**	**-74%**

Table 5.10 **Historical and projected greenhouse gas emissions from fugitive sources (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	1.1	0.9	1.2	1.4	1.4	1.4	24%	24%	24%
Methane	0.005	0.005	0.005	0.006	0.006	0.006	16%	16%	16%
Nitrous oxide	0.02	0.02	0.02	0.02	0.02	0.02	6%	6%	6%
Total	**1.1**	**0.9**	**1.3**	**1.4**	**1.4**	**1.4**	**-23%**	**-23%**	**-23%**

crease between 2007 and 2020. The decrease up to 2020 is principally due to bans on use that are successively coming into effect for several areas of use of fluorinated greenhouse gases as a result of new rules in the EU. [Table 5.11]

5.2.3 Solvent and other product use

Greenhouse gas emissions from solvent and other product use decreased somewhat between 1990 and 2007. It is estimated that up to 2020 emissions will remain at roughly the same level as in the past few years, around 0.3 million tonnes of carbon dioxide equivalent. [Table 5.12]

5.2.4 Transport

Greenhouse gas emissions from domestic transport increased over the period 1990-2007 and are expected to continue to increase up to 2010 and then stabilise somewhat until 2020. [Table 5.13]

Road traffic accounts for the greater part of the emissions, and the total increase in emissions between 2007 and 2020 is principally due to the rate of growth in transport-intensive industries with increasing heavy-goods transport and consequently increasing use of diesel. An increased proportion of light-duty trucks and passenger cars with diesel engines is also leading to an increase in diesel use.

The increase in emissions is mitigated by the fact that the use of petrol is expected to decrease up to 2020 and that the use of alternative fuels is expected to increase, in particular ethanol, FAME and biogas. In addition, energy efficiency is expected to increase in 2020, and aggregate emissions are expected to stabilise between 2015 and 2020.

Emissions from domestic aviation have decreased in recent years as a greater proportion of passenger traffic for shorter trips is being transferred to rail. This trend is expected to continue and emissions to decrease up to 2020. Emissions from domestic shipping are estimated to increase somewhat up to 2020.

Table 5.11 **Historical and projected emissions from industrial processes (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	4.4	4.9	4.9	5.0	5.1	5.3	13%	17%	21%
Methane	0.006	0.007	0.007	0.007	0.008	0.008	26%	35%	44%
Nitrous oxide	0.9	0.5	0.3	0.4	0.4	0.4	-61%	-57%	-54%
Fluorinated greenhouse gases	0.5	1.2	1.3	0.9	0.6	0.4	84%	34%	-13%
Total emissions	**5.8**	**6.6**	**6.5**	**6.2**	**6.2**	**6.2**	**7%**	**7%**	**7%**

Table 5.12 **Historical and projected emissions from solvent and other product use broken down by gas (million tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	0.2	0.17	0.16	0.16	0.16	0.15	-34%	-36%	-38%
Nitrous oxide	0.09	0.14	0.13	0.13	0.13	0.13	46%	46%	46%
Total emissions	**0.33**	**0.30**	**0.29**	**0.29**	**0.29**	**0.28**	**-12%**	**-14%**	**-15%**

Table 5.13 **Historical and projected greenhouse gas emissions from the transport sector (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	18.3	20.7	20.6	21.0	21.3	21.3	15%	16%	16%
Methane	0.1	0.03	0.03	0.03	0.02	0.02	-76%	-80%	-84%
Nitrous oxide	0.1	0.2	0.2	0.1	0.1	0.1	3%	-2%	-5%
Total emissions	**18.6**	**20.9**	**20.8**	**21.2**	**21.5**	**21.5**	**14%**	**16%**	**16%**
Petrol (TWh)	47.7	44	41.8	40.8	37.9	34.5	-14%	-21%	-28%
Diesel (TWh)	16.5	30	32.4	34.3	38.5	41.6	108%	133%	152%

Table 5.14 **Historical and projected greenhouse gas emissions from different modes of transport (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Road traffic	17.1	19.5	19.5	19.8	20.1	20.1	16%	18%	18%
Aviation	0.7	0.7	0.6	0.6	0.6	0.5	-18%	-20%	-22%
Shipping	0.6	0.6	0.5	0.6	0.6	0.6	2%	4%	7%
Rail traffic	0.1	0.07	0.08	0.07	0.06	0.06	-42%	-47%	-53%
Other*	0.2	0.2	0.2	0.2	0.2	0.2	7%	7%	7%

* Also includes machinery not used in industry. agriculture and forestry or households.

Rail travel is expected to increase up to 2020, but emissions are not expected to increase as most rail services are electric. [Table 5.14]

5.2.5 Waste

Methane emissions from landfills have decreased since 1990 as a result of bans on landfilling, municipal waste plans and waste tax having contributed to smaller quantities of waste being sent to landfill. A further reduction has taken place through the collection of methane gas. It is expected that emissions will continue to decrease up to 2020 as a result of a continued decrease in quantities of waste sent to landfill and methane collection.

Carbon dioxide emissions from the incineration of hazardous waste and nitrous oxide from waste management are low and are expected to remain at the same level as in 2005 up to 2020. [Table 5.15]

5.2.6 Agriculture

Emissions from the agricultural sector have decreased since 1990, and it is estimated that emissions will continue to decline up to 2020. Nitrous oxide accounts for a somewhat greater percentage decrease than methane but also for a greater share of emissions.

The decrease is largely due to a reduced number of cattle, contributing to lower release of methane from the animals' metabolism and reduced emissions of methane and nitrous oxide from manure. It is also expected that nitrous oxide emissions will decrease as a result of reduced cereal acreage, reduced use of mineral fertiliser, reduced nitrogen leaching and a change-over to slurry management.

A reduced number of dairy cows and a continued decrease in the acreage of cereal cultivation by 2020 are principally a result of increased productivity, the trend in agricultural prices and continued adaptation to the latest reform of EU agricultural policy from 2005 with decoupling of aid from production. [Table 5.16-17]

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

The land use, land-use change and forestry sector (LULUCF) contributed to an annual net sink in Sweden over the period 1990-2007. The sink varied over the period, but the trend points towards a somewhat decreasing sink from this sector.

The net removal from LULUCF is principally due to the removal of carbon dioxide in living biomass in forest, which in turn is affected chiefly by felling and growth. A projection has been calculated which is based on a scenario where the level of felling is equivalent to the sustainably fellable growth in production forest. Growth is assumed to increase by a further 2 per cent per year up to 2020 as a consequence of assumed climate change. The assumed increase in felling which results in reduced removals of carbon in the forest biomass is counteracted by the expected increase in forest growth, resulting in a net sink by 2020 estimated to be at around the present-day level.

The size of the sink for the projection years is influenced by what the level of felling is assumed. Felling increased between 1990 and 2007 but on average

Table 5.15 **Historical and projected emissions from the waste sector (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Carbon dioxide	0.04	0.09	0.1	0.1	0.1	0.1	27%	27%	27%
Methane	2.9	1.9	1.7	1.2	0.8	0.5	-57%	-72%	-82%
Nitrous oxide	0.2	0.1	0.1	0.1	0.1	0.1	-29%	-29%	-29%
Total emissions	**3.1**	**2.2**	**1.9**	**1.5**	**1.0**	**0.8**	**-52%**	**-67%**	**-76%**

Table 5.16 **Historical and projected emissions from the agricultural sector (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Methane	3.4	3.3	3.2	3.1	2.8	2.6	-10%	-16%	-23%
Nitrous oxide	6.0	5.3	5.2	5.0	4.7	4.4	-16%	-21%	-27%
Total emissions	**9.4**	**8.6**	**8.4**	**8.1**	**7.6**	**7.0**	**-14%**	**-20%**	**-25%**

Table 5.17 **Historical and projected emissions from the agricultural sector, broken down into enteric fermentation, manure management and agricultural soils (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2020
Enteric fermentation	3.1	2.8	2.7	2.6	2.4	2.2	-28%
Manure management	1.1	1.0	1.0	0.9	0.9	0.8	-24%
Agricultural soils	5.2	4.8	4.7	4.6	4.3	4.0	-24%
Total emissions	**9.4**	**8.6**	**8.4**	**8.1**	**7.6**	**7.0**	**-25%**

for the period was below the maximum sustainable level assumed for the projection period. The whole of the available growth has not been utilised during the period concerned, principally as a result of more intensive forestry. [Table 5.18]

5.2.8 International transport

Total emissions from international transport increased between 1990 and 2007 and are expected to continue to increase up to 2020, although not at the same rate as previously. The increase in emissions up to 2020 is principally due to increased emissions from internationally shipping resulting from increased exporting of goods.

Greenhouse gas emissions from international aviation are also estimated to increase up to 2020. This increase is explained by the fact that private consumption is expected to increase, bringing increased travel. [Table 5.19]

5.3 Sensitivity analysis

Sensitivity analyses have been conducted for the energy sector, the agricultural sector and fluorinated greenhouses gases in the industrial processes sector. The analyses have combined in an alternative with "lower emissions" and one with "higher emissions".

The alternative with "lower emissions" includes:

- the energy sector's alternative with higher fossil fuel prices
- lower emissions of fluorinated greenhouse gases

The alternative with "higher emissions" includes:

- the energy sector's alternative with higher GDP
- the agricultural sector's alternative with higher production
- higher emissions of fluorinated greenhouse gases

The result shows that in the alternative with lower emissions there is a further decrease in emissions compared with the main alternative, to 16 per cent between 1990 and 2020. In the alternative with higher emissions the decrease is reduced to 11 per cent between 1990 and 2020. [Table 5.20]

5.3.1 Energy (including transport)

Two sensitivity alternatives have been developed for the energy sector including transport, one with higher fossil fuel prices and one with higher GDP.

The prices for fossil fuels in the alternative with higher fossil fuel prices are around 30 per cent higher than in the main alternative. The higher fossil fuel prices are assumed to have implications for the Swedish economy, in the form of lower growth. In addition, electricity and district heating prices and the price of emission allowances are assumed to become higher. The assumptions are otherwise identical to those that apply to the main alternative (see Annex 5).

The alternative with higher economic growth assumes higher growth in GDP and therefore also higher growth in industry and increased transport mileage in the transport sector.

The result shows that the alternative with higher

Table 5.18 **Historical and projected emissions and removals from LULUCF (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Forest land[44]	-35.4	-31.3	-22.8	-23,0	-23,2	-22,1	-35%	-34%	-38%
Cropland	4.1	2.8	2.8	3.5	3.5	3.5	-14%	-14%	-14%
Grassland	-0.6	-0.5	-0.4	-0.5	-0.5	-0.5	-30%	-30%	-30%
Wetlands	0.04	0.06	0.06	0.06	0.06	0.06	56%	56%	56%
Settlements	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	16%	16%	16%
Total emissions	**-32.1**	**-29.1**	**-20.5**	**-20,0**	**-20,2**	**-19,1**	**-38 %**	**-37 %**	**-40 %**

Table 5.19 **Historical and projected emissions from international transport (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Shipping	2.3	6.7	7.5	7.8	8.2	8.5	246%	260%	275%
Aviation	1.4	2.0	2.2	2.3	2.6	2.8	71%	92%	107%
Total emissions	**3.6**	**8.7**	**9.8**	**10.2**	**10.8**	**11.3**	**181%**	**197%**	**212%**

Table 5.20 **Historical and projected greenhouse gas emissions for different sensitivity alternatives excluding LULUCF (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2020
Main alternative	71.9	67.2	65.4	65.0	64.1	63.1	-10%	-12%
Alternative with lower emissions	71.9	67.2	65.4	64.6	62.4	60.1	-10%	-16%
Alternative with higher emissions	71.9	67.2	65.4	66.3	65.3	64.3	-8%	-11%

44 Note that the projected values for forest land differ from the projection supplied under the EU monitoring mechanism in March 2009. The difference is due to the methodology used at that time not taking sufficient account of the variations in the ratio between the volumes, ages and carbon contents of the trees.

fossil fuel prices, as expected, provides lower emissions up to 2020 while emissions are higher with higher GDP. With approximately 30 per cent higher fossil fuel prices, emissions are estimated to decrease further to 46 million tonnes of carbon dioxide equivalent by 2020, which is around 14 per cent lower than 1990 emissions. The higher fossil fuel prices increase the incentives to replace fossil fuels and improve energy efficiency. The rate of investment to phase out fossil fuels in industry is therefore expected to increase, as are investments in energy efficiency. In the residential and commercial premises etc. sector, all fuels are expected to decrease except for biofuel and district heating. Conversion of heating oil to other methods of heating in the residential and service sector and agriculture is speeding up. A higher oil price in the transport sector is expected to mitigate the increase in passenger transport, and the rate of efficiency improvement for freight transport is increasing as a result of both improved technology and more efficient logistics. The higher fossil fuel prices lead to higher electricity prices, which favours wind power in this scenario.

In the alternative with higher GDP emissions are estimated to be 49.4 million tonnes of carbon dioxide equivalent in 2020 or around 7 per cent higher than in 1990. Stronger economic growth means higher production in industry, which in turn results in higher energy use and higher emissions. Higher GDP also leads to higher imports and exports and in addition to private individuals having more money to travel around with. This will lead to greater demand for transport, both passenger and freight. [Table 5.21]

5.3.2 Fluorinated greenhouse gases

Fluorinated greenhouse gas emissions were estimated in the main alternative at 0.4 million tonnes in 2020 and are dominated by HFCs. A sensitivity analysis indicates that emissions of fluorinated greenhouse gases in 2020 may be in a range between 0.3 and 0.6 million tonnes of carbon dioxide equivalent. The uncertainty in the analysis depends in part on the extent of leakage of refrigerants in the future. Even a modest change in the leakage factor used for stationary and mobile installations results in relatively large changes. [Table 5.22]

5.3.3 Agriculture

One factor of uncertainty in the agricultural projection is the assumption on productivity. A sensitivity alternative has been estimated with higher productivity. The alternative is based on the growth in productivity required to retain production as it was in 2007. The result shows that emissions do not decrease to the same extent as in the main alternative as production is higher due to increased profitability. [Table 5.23]

5.3.4 Partial sensitivity calculation for 2010

A sharp economic downturn began in the autumn of 2008, and a partial sensitivity calculation has been made of how the economic downturn may affect the emission results in the long-term projection for 2010. Based on a long-term projection of the supply and use of energy, sensitivity calculations of greenhouse gas emissions for 2010 have been performed for electricity and district heating production, industrial combustion, domestic transport and the residential and service sector.

Table 5.21 **Historical and projected greenhouse gas emissions in the energy sector (incl. transport) in the main alternative and in the sensitivity alternatives (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2010	2015	2020	1990-2010	1990-2015	1990-2020
Main alternative	53.3	49.6	48.9	49.1	48.9	-8%	-8%	-8%
1. Higher fossil fuel prices	53.3	49.6	48.7	47.4	46.0	-9%	-11%	-14%
2. Higher GDP	53.3	49.6	49.9	49.9	49.4	-6%	-6%	-7%

Table 5.22 **Historical and projected fluorinated greenhouse gas emissions in the main alternative and in the sensitivity alternatives (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Main alternative	0.5	1.2	1.3	0.9	0.7	0.4	84%	34%	-13%
Lower emissions	0.5	1.2	1.3	0.8	0.6	0.3	60%	20%	-40%
Higher emissions	0.5	1.2	1.3	1.1	0.9	0.6	120%	80%	20%

Table 5.23 **Historical and projected emissions from the agricultural sector in the main alternative and in the sensitivity alternative (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Main alternative	9.4	8.6	8.4	8.1	7.6	7.0	-14%	-20%	-25%
Higher productivity	9.4	8.6	8.4	8.3	7.9	7.5	-12%	-16%	-20%

The short-term projection also includes updated assessments of assumptions other than the economic trend to 2010 based on the latest statistics.

The calculations indicate that greenhouse gas emissions may be around 4 million tonnes lower in 2010 from these sectors compared with the main projection we have presented. Emissions from industry and transport decrease in particular. The decline in production in industry leads to reduced energy use. Reduced production in the iron and steel industry leads to fewer residual gases and lower emissions from electricity and heating production. The recession also leads to lower demand for freight transport and therefore lower diesel consumption. Petrol consumption also decreases as a result of lower household consumption. No calculations have been made of how the economic downturn might affect the projection to 2020.

5.4 Projection with additional measures

The climate policy decision adopted by the Swedish Parliament in July 2009 contained a strategy of policy instruments to ensure that the new national climate objective to reduce the emissions with 40 per cent by 2020 compared with 1990 for emissions outside the EU emissions trading scheme is attained. The principal measures are increased taxes on carbon dioxide and energy. In the first stage this is done through:

- requirements for the carbon dioxide emissions of new cars which must not exceed 130 g/km up to the end of 2015 and must then fall to 95 g/km by 2020. It is estimated that this will reduce emissions by 1260 ktonnes.
- Aviation is included in the EU Emissions Trading Scheme with effect from 2012, which is estimated to result in a decrease in emissions of 65 tonnes for domestic aviation.
- Permitted low admixture of ethanol in petrol is raised over the projection period from 5 per cent to 10 per cent, resulting in an estimated decrease in emissions of 265 ktonnes.

These measures mean that emission decrease in the transport sector up to 2020, and total emissions are estimated to decline by 14 per cent by 2020 in comparison with 1990.

The climate policy decision adopted by the Swedish Parliament in July 2009 contained a strategy of policy instruments to ensure that the national climate objective is attained by 2020. The principal measures are increased taxes on carbon dioxide and energy. In the first stage this is done through:

- the sectors outside the trading scheme at present paying reduced carbon dioxide tax having to pay higher rates of tax,
- a shift in energy tax to heating fuels, which means that industry outside the EU ETS, district heating and agriculture have to pay energy tax at SEK 0.025 per kWh,
- raised energy tax on diesel as a vehicle fuel,
- increased carbon dioxide differentiation of vehicle tax and extending carbon dioxide-differentiated vehicle tax to all light vehicles.

Examples of other measures of the strategy are environmental tax on F-gases, which a government inquiry in July 2009 proposed should be introduced on HFCs, and increased support for biogas production and dissemination of new energy technology. Adjusted carbon dioxide and energy tax in industry outside the EU ETS and on heating fuels in land-based industries, raising of tax on diesel for vehicles by a total of SEK 0.40 in two stages (in 2011 and 2013) and changed vehicle taxation are overall estimated to give a reduction of 0.6 Mtonnes by 2020. Implementation of tax on HFC and support for energy technology dissemination and biogas production is in the climate bill estimated to reduce emissions by 0.5 Mtonnes by the year 2020. In addition, the carbon dioxide tax together with other economic policy instruments will in the future be adjusted to the extent and speed necessary to reduce emissions of greenhouse gases outside the EU ETS for the 2020 target to be reached. [Table 5.24]

5.5 Comparison with the Fourth National Communication

The projection in the Fourth National Communication (NC4) showed a decrease in total greenhouse gas emissions of 1 per cent between 1990 and 2010 and an increase of 6 per cent between 1990 and 2020. The projection presented here in the Fifth National Communication (NC5) uses different assumptions and es-

Table 5.24 **Historical and projected greenhouse gas emissions in the main alternative and with additional EU instruments and additional national instruments in 2009 climate policy resolutions (millions of tonnes of carbon dioxide equivalent)**

	1990	2005	2007	2010	2015	2020	1990-2010	1990-2015	1990-2020
Main alternative	71.9	67.2	65.4	65.0	64.1	63.1	-10%	-11%	-12%
With additional EU measures	71.9	67.2	65.4	64.0	62.8	61.5	-11%	-13%	-14%
With additional measures in 2009 climate strategy*	71.9	67.2	65.4	64.0	62.0	60.4	-11%	-14%	-16%

* These additional measures are not included in reporting to the EU (March 2009).

Table 5.25 **Some assumptions for projections in the Fourth National Communication (NC4) and the Fifth National Communication (NC5), see Annex 5**

	NC4		NC5	
	2000-2010	2010-2020	2005-2010	2010-2020
GDP (annual% change)	1.76	1.82	2.6	2.1

	2010	2020	2010	2020
Crude oil. USD/barrel	21	25	90	90
Coal (USD/tonne)	39	41	96	96
Natural gas USD/Mbtu	2.8	3.3	9.2	9.2
Emissions trading (EUR/tonnes CO_2)	10	10	30	30
Electricity certificates (new renewable electricity)	10 TWh in 2010		17 TWh in 2016	
Nuclear power (economic life)	40 years		60 years	

timates based on trends over the past few years. The new projection shows a decrease in total greenhouse gas emissions of almost 10 per cent between 1990 and 2010 and a decrease of around 12 per cent between 1990 and 2020.

The projection for the *energy sector excluding transport* shows a greater reduction in emissions by both 2010 and 2020 in comparison with the projection in NC4. The difference is principally due to different assumptions, for example on fossil fuel prices, nuclear fuel and electricity certificates. [Fig. 5.3]

The new projection shows a smaller increase in emissions by both 2010 and 2020 for the *transport* sector. The difference is due in part to assumptions of higher fossil fuel prices and greater use of transport biofuels. [Table 5.25]

The projection for emissions from *industrial processes* shows a smaller increase in emissions by 2020 than is presented in NC4. This is principally due to emissions of fluorinated greenhouse gases being estimated to be lower as EU legislation gradually introduces bans on the use of certain fluorinated greenhouse gases.

The projection for *agricultural* emissions shows a greater reduction in emissions by 2020. The difference is due to a new projection by 2020 having been produced which points to further decreases in emissions by 2020. Only an extrapolation from 2010 to 2020 was reported in NC4.

The projection for the *waste sector* shows a somewhat smaller decrease in emissions by 2010. The differences are partly due to the complete time series of emissions having been revised as part of data quality improvement.

Emissions from *solvent and other product use* do not decrease as much in the projection as they did in NC4. The difference is partly due to new assumptions having been made, while the projection in NC4 was based on trend extrapolation.

The projection for the *land use, land-use change and forestry* sector points to a larger net sink than NC4. This is due firstly to the time series from 1990 to 2007 having been updated and secondly to a new projection with new assumptions having been made.

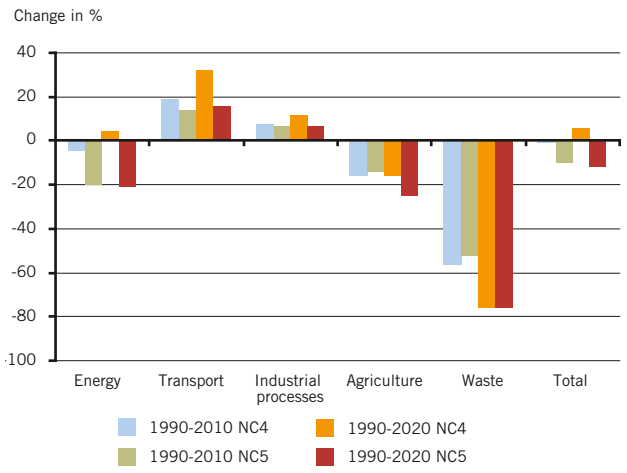


Figure 5.3 **Percentage trend in emissions between 1990 and 2010 and 2020 according to the projections in NC4 and NC5, total and by sector.**

5.6 Assessment of total effects of policies and measures

This section describes the aggregate effects of the instruments introduced since 1990, which are reported and quantified in Chapter 4, and the effect of additional EU-wide instruments and additional national instruments according to the 2009 climate policy decisions reported in Chapter 5.4.

Table 5.26 presents the total effects of implemented instruments which have been calculated. For the supply of electricity in Sweden the effect is calculated as replacement of coal with renewable energy.

For local investment programmes (LIP and Klimp) and policy instruments in the residential and service sector we have judged that the mitigating measures that have been implemented have also been affected by other policy instruments and the rises in fossil fuel prices that have occurred since 2000. For local invest-

Table 5.26 **Estimated effects of implemented instruments broken down by sector (millions of tonnes of carbon dioxide equivalent) (summary of presentation in Chapter 4.2)**

Sector /Year	2010	2020
Cross-sectoral (local investment programmes LIP/Klimp)	Up to 1.8	Up to 2
Electricity and district heating	16	16
Residential and service	Up to 8	Up to 9
Industry	0.2	0.7
Transport	3.7	5.4
Waste	1.4	1.9
Total	**Up to 31**	**Up to 35**

ment programmes (LIP and Klimp) and policy instruments in the residential and service sector our assessment is that the emission-limiting measures that have been implemented have also been affected by other instruments and by the rises in fossil fuel prices that have occurred since 2000. Introduced instruments may possibly have merely brought some of these measures forward and, if this is the case it means that the total effect is overestimated. These policy instruments are therefore stated as "up to" a maximum estimated emissions effect. The higher effect for measures in some sectors in 2020 than in 2010 can be explained by some of the approved Klimp projects not having been implemented until 2010 and the effects of some measures running over a longer period and therefore possibly being greater at a later stage when better knowledge has been obtained on the measure itself (a 'learning-by-doing' effect).

In addition to the effects of policy instruments in Table 5.26, a number of electricity efficiency improvements have been presented in Chapter 4 for which no emission effects have been calculated. These efficiency improvements total 5-6 TWh.

Figure 5.4 shows the estimated effects of implemented policies and measures since 1990 from Table 5.26 and the effects of the additional planned policies and measures presented in Chapter 5.4, in comparison with historical emissions and projected future emissions in Sweden until 2020.

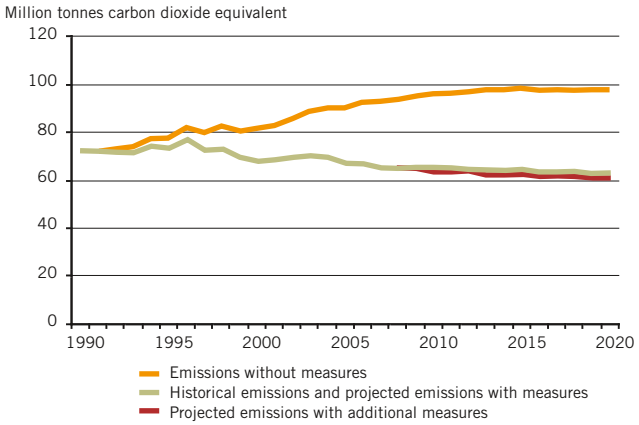


Figure 5.4 **Estimated emissions without implemented measures, with additional measures compared with historical emissions and projected emissions with existing measures**

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

According to Sweden's commitment under the Kyoto Protocol and EU burden sharing, Sweden's greenhouse gas emissions excluding LULUCF must not exceed 104 per cent of the allocated amount for the base year. The base year is 1990 for all emissions except fluorinated greenhouse gases, for which it is 1995. Emissions in the base year, when the allocated amount was established, were 72.2 milliion tonnes. This means that Sweden's greenhouse gas emissions may total a maximum of 75 million tonnes year, as an average for 2008-12. The result of the projection points towards Sweden being able to post greenhouse gas emissions in 2010 under the rules of the Kyoto Protocol averaging around 62.9 million tonnes of carbon dioxide equivalent in accordance with the main alternative, which indicates that Sweden will comfortably fulfil its commitment. [Table 5.27]

LULUCF contributed to an annual net sink in Sweden over the period 1990-2007. The sink varied between 21 and 36 million tonnes of carbon dioxide equivalent over the period, but the trend points to a somewhat decreasing sink. However, only part of this carbon sink can be accounted for in relation to the Kyoto commitment. It is mandatory to account in accordance with Article 3.3 of the Kyoto Protocol, while countries can choose activities under Article 3.4. Sweden has chosen to account the part of Article 3.4 that relates to forestry.

Article 3.3 of the Kyoto Protocol is calculated to give a net emission for Sweden for the commitment period, as emissions from deforestation are greater than removals in afforestation and reforestation. An estimate

Table 5.27 **Historical and projected greenhouse gas emissions relative to the Kyoto base year and Kyoto target for Sweden (millions of tonnes of carbon dioxide equivalent)**

Kyoto base year	72.2 Mtonnes
Kyoto target (Kyoto base year - 2008/2012)	4 %
Kyoto target 2008-2012 per year	75.0 Mtonnes
2007 emissions	65.4 Mtonnes
2010 projection	65 Mton
Kyoto base year – 2010 projection	-10 %
Carbon sink in accordance with Articles 3.3 and 3.4	2.13 Mtonnes
2010 projection including Articles 3.3 and 3.4	62.9 Mtonnes
Kyoto base year - 2010 projection including Articles 3.3 and 3.4	-12.9 %
EU ETS allocation 2008-2012 per year	22.3 Mtonnes
EU ETS projection 2010	21.8 Mtonnes

shows that emissions would be 0.6 million tonnes per year, but this calculation is highly uncertain. Sweden is expected overall to have a net sink for Article 3.4 from LULUCF which is larger than the net emissions for Article 3.3. This means that Sweden can neutralise the emissions for Article 3.3 and then credit itself with a carbon sink of a maximum of 2.13 million tonnes.

Sweden has made the necessary preparations to enable it to use project-based mechanisms, JI and CDM (see Chapter 4.3), but even without these Sweden is estimated to comfortably meet its commitment for the period 2008-2012.

5.8 Target fulfilment in relation to Swedish and EU climate targets

Under the EU climate and energy package, emissions from the installations included in the EU Emissions Trading Scheme (EU ETS) have to decrease by 21 per cent between 2005 and 2020 for the whole of the EU. Emissions from Swedish installations included in EU ETS were 19.4 million tonnes of carbon dioxide in 2005. If estimated emissions from the installations added during the second trading period 2008-2012 and emissions from domestic aviation are added, emissions of 21.8 million tonnes are calculated for 2005. A price of emission allowances of EUR 30 per tonne for the period 2007-2020 has been assumed in the projection. This price affects the sectors included in EU ETS in the models that have been used, together with other prices and instruments. It estimated in the projection that emissions will be 21.8 million tonnes in 2010 and 22.2 million tonnes in 2020 for the installations included in EU ETS. [Table 5.28]

The allocation in Sweden for the period 2008-2012 is 22.3 million tonnes per year to date. Another 0.2 million tonnes can be allocated for new entrants. The allocation for Sweden until 2020 has not yet been decided. As emission reductions as a result of the trading scheme can be implemented in Sweden or in other Member States, it is not possible to calculate the effect of the trading scheme on Swedish emissions. Target fulfilment can therefore only be assessed at EU level.

Under the EU Directive on the Promotion of Energy from Renewable Sources, the proportion of renewable energy is to increase to 49 per cent in 2020 in Sweden. The calculations in the main alternative of the projection show that renewable energy use is around 48-49 per cent in 2020, while it is 51-52 per cent in the alternative with higher fossil fuel prices.

Sweden's commitment for the non-trading sectors according to the EU climate and energy package is that emissions have to decrease by 17 per cent between 2005 and 2020. The Swedish target according to the climate policy resolutions of the Swedish Parliament in June 2009 is that emissions have to decrease by 40 per cent or around 20 million tonnes between 1990 and 2020. This is equivalent to around 32 per cent between 2005 and 2020. Emissions from the non-EU ETS sectors totalled 45.4 million tonnes of carbon dioxide equivalent in 2005. In the main projection with existing measures, emissions are estimated to be 40.9 million tonnes in 2020. This means a decrease in emissions of nearly 10 million tonnes compared with 1990. The projection with additional measures include EU-wide measures which are estimated to reduce emissions by 1.6 million tonnes. It is planned that climate investments in other countries will be made to reduce emissions by 6.7 million tonnes, which is equivalent to a third of the emission reductions between 1990 and 2020. To attain the target to reduce emissions by 20 million tonnes by 2020, additional national measures will be implemented and the 2009 climate policy resolutions include a strategy with developed economic instruments which covers about 2 million tonnes of additional reductions in emissions. To date (December 2009), decisions have been taken that are estimated to produce reductions in emissions of more than 1 million tonnes. This is estimated to contribute to reductions in emissions from activities outside the EU ETS by 25% by the year 2020 compared to 1990. Is the entire announced strategy with developed economic instruments included a decrease of 27% is achieved. [Table 5.29]

Table 5.28 **Historical and projected emissions from EU ETS and emissions from sectors not included in EU ETS in Sweden**

	1990 (Mt CO_2-eq.)	2005 (Mt CO_2-eq.)	2010 (Mt CO_2-eq.)	2020 (Mt CO_2-eq.)
Emissions from EU ETS		21.8	21.8	22.2
Emissions from non-EU ETS sectors	50.8*	45.4	43.2	40.9
Total emissions	*71.9*	*67.2*	*65*	*63.1*

* 1990 emissions for non-EU ETS sectors have been calculated by assuming the same share of total emissions as in 2005. Note that this only provides a rough estimate of emissions from non-EU ETS sectors in 1990.

Table 5.29 **Target fulfilment in relation to EU target and national targets**

	2005-2020	1990-2020	1990-2020
EU target EU ETS for EU	**-21%**		
EU target non-EU ETS sectors for Sweden	**-17%**		
National target non-EU ETS sectors		**-40%**	**20 Mtonnes**
Emission reduction 1990-2007			6.7 Mtonnes
Projection for emission reduction 2007-2020 (existing measures)			3.2 Mtonnes
Further planned measures in EU			1.6 Mtonnes
Further measures nationally to 2020			2 Mtonnes
of which decided by december 2009			*1.1 Mtonnes*
Climate investments in other countries			6.7 Mtonnes

6 Vulnerability assessment, climate change impacts and adaptations

6.1 Introduction

Climate change and its consequences affect large parts of Swedish society. Efforts to adapt society to a changed climate have been strengthened in Sweden in recent years. A number of climate policy decisions have been taken that have contributed to an increased focus on the issue of climate adaptation.

There is no authority at national level in Sweden with overarching responsibility for the issue of climate adaptation, but many government agencies have a designated role in climate adaptation work. The work on climate change adaptation will be integrated into the agencies' sector responsibility, and a national follow-up of how adaptation efforts are progressing will be made for the next climate policy review. Responsibility for operational work on adaptation is borne at local level, i.e. by the municipalities. The county administrative boards, which have regional public service responsibility, now have a key role in supporting and coordinating implementation of adaptation measures by the municipalities and other actors.

The work to date has been principally concerned with knowledge building on the vulnerability and adaptation needs of society as a consequence of climate change. In 2005 a Commission on Climate and Vulnerability, in which researchers and government agencies actively participated, was appointed[45] to clarify the vulnerability of Swedish society. The Commission evaluated climate effects and adaptation needs for the sectors of society.

6.2 The Swedish climate in a state of change

In order to be able to make more realistic and extensive vulnerability analyses of climate change, a number of new studies on regional climate changes have been undertaken at the Rossby Centre of the Swedish Meteorological and Hydrological Institute in recent years, using the regional climate model RCA.

There is more extensive material today than was reported in NC4. Data from six different climate models have been used in the regional climate scenarios. A larger regional climate scenario ensemble makes it easier to evaluate both uncertainties and robust features in regional climate scenarios. Studies have also covered a more developed view of the internal variability of the climate system, which may conceal or reinforce the climate change signals. The role of internal variability in the context of climate adaptation is particularly important in the short-term perspective, a few decades ahead.

6.2.1 Temperature and precipitation

The new regional climate scenario ensemble is based on a new version of the Swedish regional climate model[46] principally under emission scenario A1B. Simulations with several global climate models have been used as marginal data. As local and regional variations in the climate may be quite large, the regional climate scenario ensemble also contains calculations based on different simulations with a single emission scenario and global model. A list of these regional climate modellings is contained in Table 6.1. The table also contains previous simulations reported in NC4.

The results for the most part confirm the previous regional scenario material which in particular talks of significant warming and changes in precipitation. The expanded material also illustrates how the choice of global model particularly influences the magnitude of the changes. The role of natural

45 SOU 2007:60, Sweden Facing Climate Change – Threats and Opportunities, Final Report of the Swedish Commission on Climate and Vulnerability.

46 Kjellström, E., Bärring, L., Gollvik, S., Hansson, U., Jones, C., Samuelsson, P., Rummukainen, M., Ullerstig, A., Willén U. and Wyser, K., 2005. A 140-year simulation of European climate with the new version of the Rossby Centre regional atmospheric climate model (RCA3). Reports Meteorology and Climatology, 108, SMHI, SE-60176 Norrköping, Sweden, 54 pp.

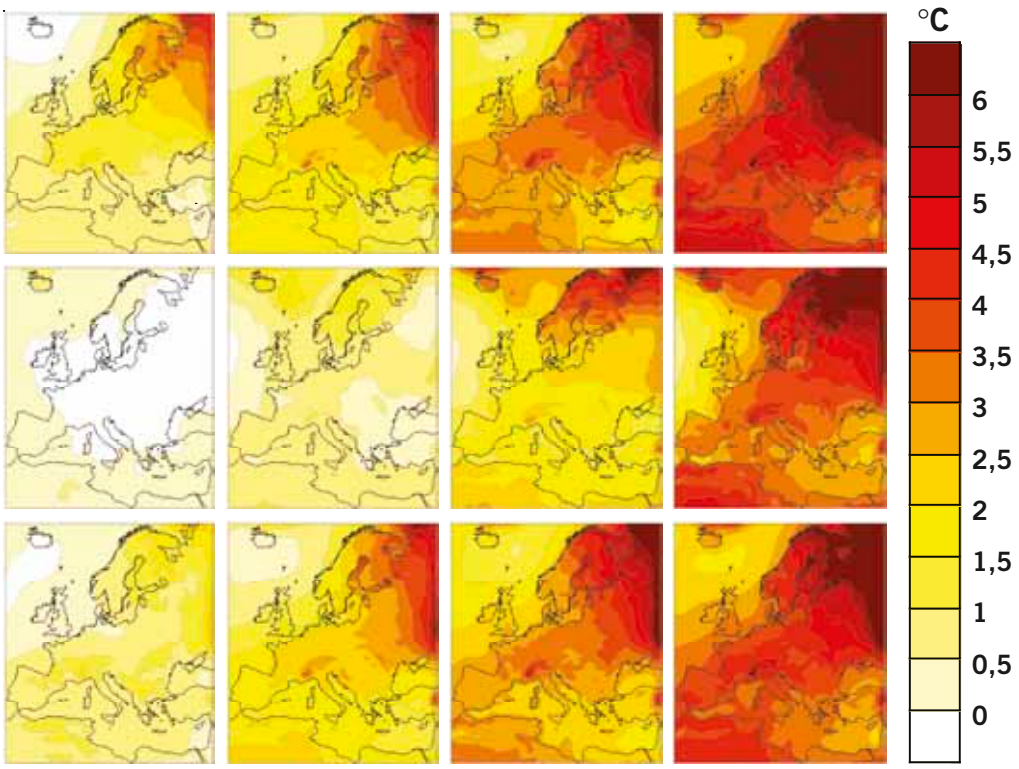


Figure 6.1 **Estimated changes in wintertime temperature (°C) (December, January and February) from 1961-90 till 2100 (from left to right: 1981-2010, 2011-2040, 2041-2070 and 2071-2100). The different cases from top to bottom are: RCA3/ECHAM4-A2, RCA3/ECHAM5-A1B, RCA3/ECHAM4-B2. The differences during the first periods are principally due to the different progressions of simulated variability. The significance of emission scenario becomes apparent in the longer term[47].**

Table 6.1 **Global climate models and emission scenarios used to develop marginal data for regional climate scenarios and the resolution in the regional climate model simulation ("horizontal resolution") with RCA.**

AOGCM (institute, country)		Emissions scenario	Horizontal resolution (km)
Arpège (CNRM, France)		A1B	50
BCM (NERSC, Norway)		A1B	50 25
ECHAM4 (MPI-Met, Germany)		CTL	50
		A2	50
		B2	50
CCSM3 (NCAR, USA)		A2	50
		A1B	50
		B2	50
ECHAM5 (MPI-Met, Germany)		A1B	50 50 50
		A1B	25
		B1	50
HadCM3 (Hadley Centre, UK)	ref	A1B	50
	low		50
	high		50
	low		25
HadAM3H/HadCM3 (Hadley Centre, UK)		CTL	50
		A2	50
		B2	50

variability is significant in the shorter-term perspective (see Figure 6.1, where one simulation shows a far weaker initial increase in temperature than the other two). In a longer-term perspective the choice of emission scenario has a dominant impact on the magnitude of climate change.

Equivalent changes for seasonal precipitation are shown in Figure 6.2. A clear difference between an increase in Northern Europe and a decrease in Southern Europe is visible. In addition it can be seen how the dividing line between increase and decrease moves in a north-south direction during the year. All three scenarios point to reduced summer precipitation in Southern Sweden but otherwise increased precipitation throughout the country[48]. Precipitation increases most during the winter. In one scenario the increase is more than 50 per cent in large parts of the country.

As both the choice of emission scenario and the choice of climate model play a role in the magnitude of imaginable changes, regional calculations have been set in a broader perspective using a regional analysis of the global model ensemble in IPCC (2007 – AR4/WGO, Chapter 10). The results are shown

47 Persson, G., Bärring, L., Kjellström, E., Strandberg, G. and Rummukainen, M., 2007. Climate indices for vulnerability assessments. Reports Meteorology and Climatology, 111, SMHI, SE64 Norrköping, Sweden.

48 Among the global climate scenarios presented in IPCC 2007 there are also cases where summer precipitation does not decrease in Southern Sweden.

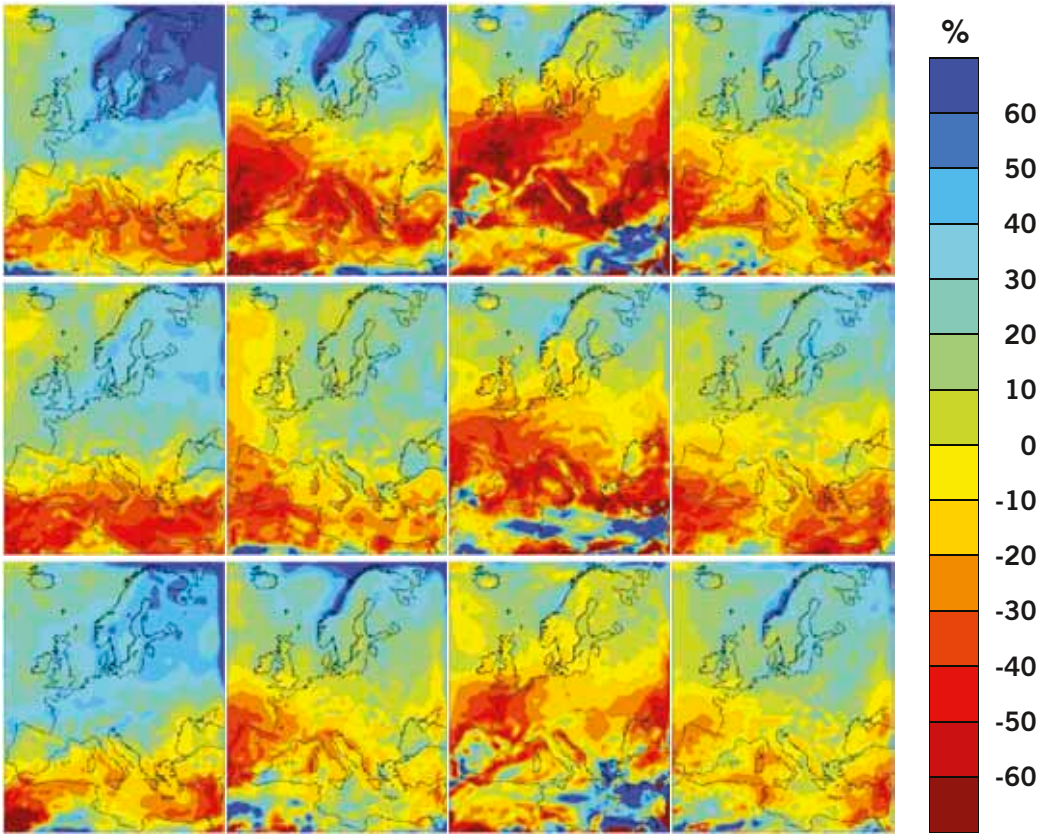


Figure 6.2 **Estimated changes in seasonal precipitation from 1961-90 to 2100 (from left to right): DJF, MAM, JJA and SON). The different cases from top to bottom are: RCA3/ECHAM4-A2, RCA3/ECHAM5-A1B, RCA3/ECHAM4-B2.**

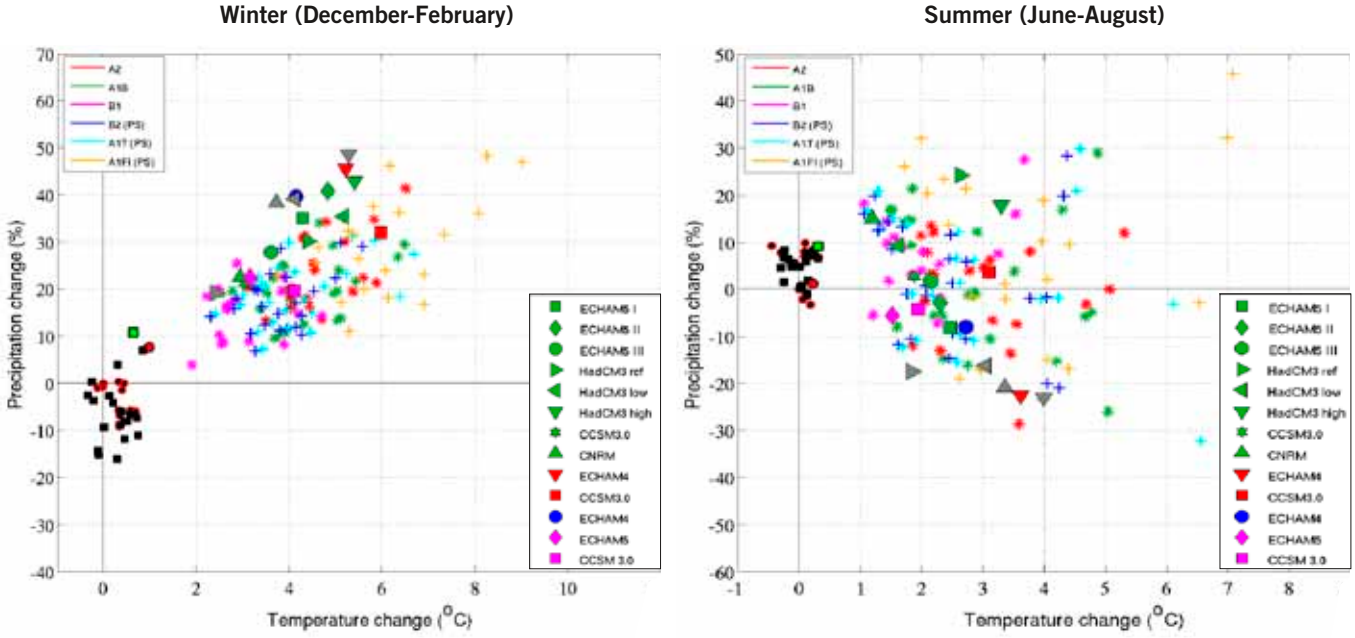


Figure 6.3 **Estimated changes in temperature and precipitation in the winter and in the summer (2071-2100 vs 1961-1990) for Southern Sweden. This includes all the regional climate scenarios described in NC4, but also several new ones (see Table 6.1). Asterisks (*) describe results from 23 global models with different emission scenarios. Three scenarios have been developed using "pattern scaling" (+). The colours correspond to the emission scenario concerned. On the far left of each diagram observation data are shown for the 20th century for partially overlapping 30-year periods[49].**

49 Lind, P., and Kjellström, E., 2008. Temperature and precipitation changes in Sweden; a wide range of model-based projections for the 21st century. Reports Meteorology and Climatology, 113, SMHI, SE-60176 Norrköping, Sweden.

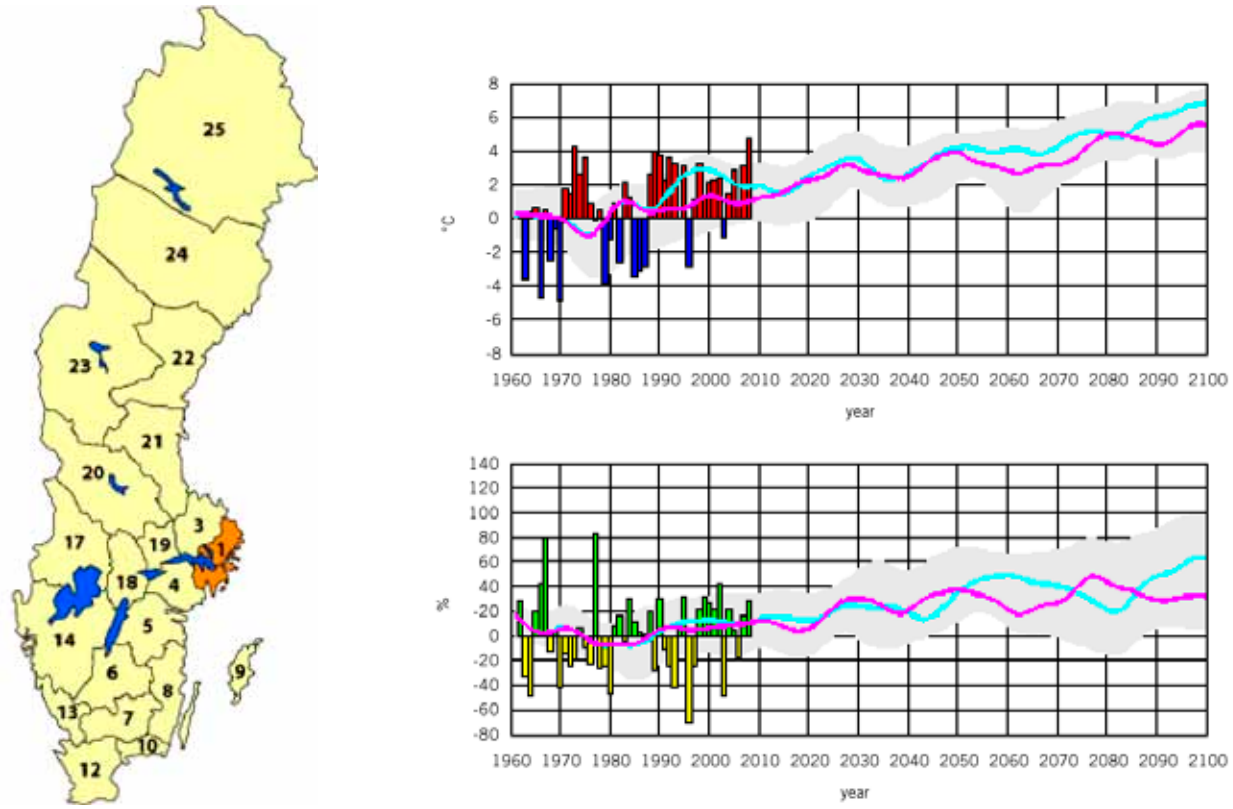


Figure 6.4 **Presentation of data from observations of historical trend in the climate and how it may develop during the 21st century. Data present the deviation from the mean value for 1961-1990. Scenario results are stated as running averages. The grey area represents simulated variations. Stockholm County is shown as an example, with winter temperature in the top diagram and winter precipitation in the bottom diagram[50].**

in Figure 6.3. The mean value of all the scenarios gives a rise in temperature in winter-time in Northern Sweden of 5.7 degrees and an increase in precipitation of 25 per cent. In Southern Sweden there is a rise in temperature of 4.4 degrees and an increase in precipitation of 21 per cent. In the summer there is a rise in temperature in the north of 2.9 degrees and an increase in precipitation of 11 per cent, and in Southern Sweden of 2.8 degrees and 3 per cent.

6.2.2 Measured changes in temperature and precipitation

Noted changes in temperature and precipitation in recent years in Sweden tie in well with the observed global warming and are in line with estimated changes due to anthropogenic climate impact. The winters in particular have become milder in all Swedish counties. Changes are also seen during other seasons and on a whole-year basis. An illustrative analysis of how the climate may develop in all Swedish counties in the 21st century and how it has developed up to 2008 has been made using some scenarios and observations. An example of this is shown in Figure 6.4.

Figure 6.5 shows observations of mean run-off and mean temperature in Sweden from 1901 to 2005 and compared with a regional climate scenario. The observed trend points in the same direction as the regional climate scenario. Other climate scenarios also show similar qualitative agreement with obser-

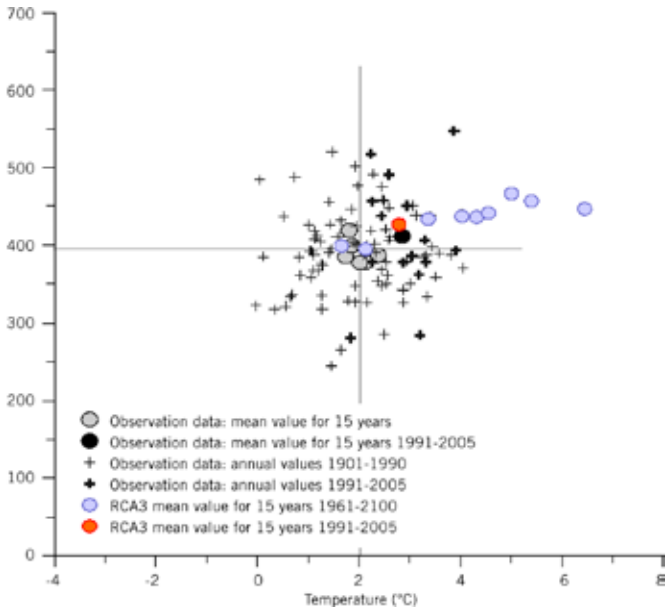


Figure 6.5 **Temperature and run-off for the whole of Sweden, for individual years and 15-year periods according to observations 1901-2005, and a regional scenario for 1961-2100 based on RCA3-ECHAM/B2[51].**

50 www.smhi.se.

51 Hellström, S. & Lindström, G. (2008) Regional analys av klimat, vattentillgång och höga flöden (Regional analysis of climate, water supply and high flow rates). SMHI Report Hydrology No 110.

vations, but there are differences, particularly with regard to the magnitude of changes in run-off.

For precipitation there is some difference between estimated climate scenarios and the measurements of the past few years. In larger ensembles of climate modellings there are trends towards a decrease in summer precipitation in Southern Sweden (Figure 6.3), but this is not entirely clear. No such decrease has been observed. A possible explanation is that insofar as the estimated regional decreases are relatively small they may be overshadowed for short periods of time by natural variations.

Changes in Sweden's water resources vary in different climate models. A consistent result is, however, that the greatest increases in water supply occur in Northern Sweden, in the western part of Central Sweden and the western part of Southern Sweden. The circumstances are more varied in other parts of the country. In the south-east, increasing evaporation contributes to the possibility of a decline in water supply. Overall the water supply increases on average by 5-25 per cent for the whole country, but decreases occur locally[52].

6.2.3 Wind

Future changes in wind conditions are highly uncertain as global models show great differences in change in large-scale circulation over the North Atlantic/Europe. A feature common to most scenarios is a decrease in wind speed in the Mediterranean and some increase in the North Sea area and increased wind speeds over those parts of the Baltic Sea that remain ice-free in a future warmer climate (Bay of Finland, Bothnian Sea and Bay of Bothnia).

6.2.4 Variability and extremes

Simulated changes in extremes, for example changes in maximum and minimum temperature, are often more marked than corresponding changes in mean values. This is illustrated for minimum temperature in Figure 6.6. The very large changes of more than 10°C in large parts of Sweden can be compared with the corresponding change in mean winter temperature of around 5°C in Figure 6.1.

The calculated change in extreme rains and downpours in a future climate shows a relatively fragmented picture with wide differences between different climate scenarios. There is, however, more to suggest an increase than a decrease in the risks in a future climate. This signifies an increase in the risks of flooding linked to stormwater systems and other direct run-off of rainwater in almost all parts of the country.

6.3 Climate impacts and vulnerability assessment

Few activities will remain unaffected in a changed climate in Sweden with rising temperature and changed patterns of precipitation. The risk of flood-

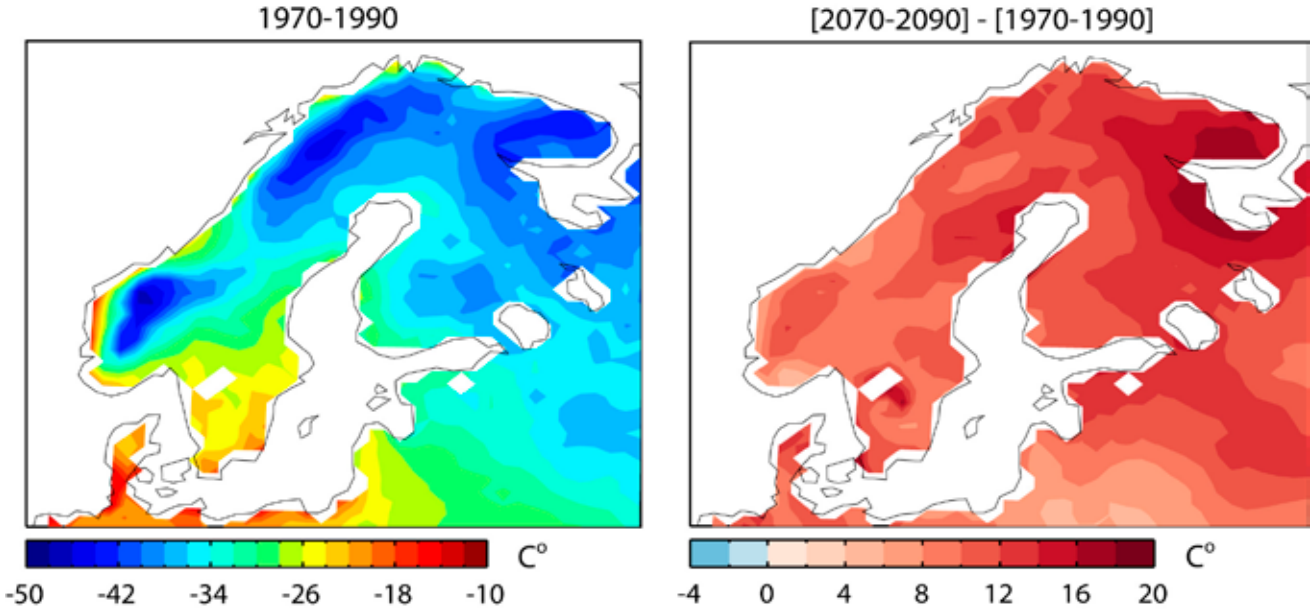


Figure 6.6 **Level of 50-year extreme minimum temperature based on data from three ECHAM5-driven A1B simulations in Table 6.1. The left-hand side of the figure shows the levels in a control period (1970-1990) and the right-hand side points to a simulated change for the period 2070-2090 compared with the control period[53].**

52 Bergström, Sten, Sara-Sofia Hellström, Johan Andréasson, 2006, Nivåer och flöden i Vänerns och Mälarens vattensystem (Levels and flows in the water systems of Lakes Vänern and Mälaren, SMHI Reports Hydrology, No. 20.

53 Venäläinen, A., Saku, S., Jylhä, K., Nikulin, G., Kjellström, E. and Bärring, L., 2009. Climate extremes and safety of nuclear power plants: Extreme temperatures and enthalpy in Finland and Sweden in a changing climate. Nordisk Kärnsäkerhet NKS-194. pp 33. ISBN 978-87-7893-261-7.

ing, landslides and erosion is expected to increase in many parts of the country, and it is important that measures are taken now, for buildings, roads, railways, electricity and telecommunications networks and water and sewage systems. Account must also be taken of climate change in physical planning so that no further risks are built into society.

The following sections describe the consequences of a changed climate for different sectors of society. For a more detailed account, see the report of the Climate and Vulnerability Commission[54].

6.3.1 Infrastructure

The technical infrastructure consisting of roads, railways, buildings and water and wastewater systems is affected by the climate. As infrastructure often consists of systems and installations that may exist for a long time, it is crucial to plan for climate change when infrastructure investments are due to be made.

Communications

Climate change may have significant consequences for road networks. These are often constructed close to water, and the expected increase in precipitation and increased flow rates will bring with it flooding, the washing-away of roads and road verges and damaged bridges. High flow rates pose increased risks of landslides, which in turn increase the risk of damage to roads. The road networks are also affected by increased temperature and reduced depth of ground frost. A reduced depth of ground frost means reduced deformations in road superstructure and road surface. Increased maintenance may be required where road construction is based on ground frost. A higher temperature and higher groundwater levels may, however, result in increased rutting. Overall, measures are shifted from being related to ground frost to being related to heat and water load.

The consequences will also be significant for railways. Increased and more intensive precipitation means flooding and washing-away of bank structures, with the risk of accompanying landslides and landslips. The expected rise in temperature during the summer brings an increased risk of sun kinks. Stronger winds, particularly in Southern Sweden, may bring an increased risk of storm felling of forest and of damage to the power supply for the railway network.

Climate change will probably not affect shipping and aviation to any great extent. A higher water level may have an adverse impact on port activity, particularly in the southernmost parts of the country. A reduced occurrence of sea ice, on the other hand, means that winter shipping in Swedish ports is made easier, particularly along the coast of Northern Sweden.

Telecommunications with overhead power lines and masts will be affected by a changed climate. In particular there will be an increased risk of storm felling due to reduced occurrence of ground frost and increased extreme wind speeds.

Settlements

Settlements have often been located in areas next to lakes and watercourses, but also close to the coast. Waterside development, which today is already exposed to the danger of flooding, is particularly exposed to impacts of climate change. Flooding is expected to occur more often or far more often in the western and south-western parts of the country in particular.

A warmer and damper climate increases the risk of damp and mould on buildings. Historic buildings may be particularly vulnerable, as they are often older and located in areas close to the coast.

Drinking water supply and wastewater management

A changed climate will affect the drinking water supply, although Sweden will continue to have good water resources. Water resources are expected to increase in many places, except in the south-eastern parts of the country, where there is a risk instead of water shortages. In those parts of the country where precipitation is expected to increase this may lead to floods that may have consequences for the water supply. In conjunction with floods upstream of water sources pollution may be carried to lakes and watercourses, including the risk of spread of waterborne infection and viruses. The increased risk of floods, landslides and landslips may also mean that pollution from contaminated soil and old landfills can be dispersed. The quality of the raw water in water sources will be adversely affected with increased temperature, as a rise in temperature results in increased leaching of nutrients and humus, leading to brown-coloured water and increased eutrophication. The piped distribution of water may be damaged by downpours causing landslides. A rise in sea level may increase the risk of saltwater penetration into wells close to the coast in Southern Sweden.

Increased frequency of extreme rainfall increases the risk of sewage pipes being overloaded. There is an increased risk of back-flowing water and flooding

54 SOU 2007:60, http://www.sweden.gov.se/sb/d/8704/a/89334.

of basements. Overloaded sewage pipes may lead to frequent and extensive overflowing of sewage, and therefore increased risks to health.

Supply and use of energy

The expected climate change will affect both the need for energy and prospects of producing energy. A climate with milder winters means that the need for heating in the residential and service sector will decease sharply. The peak load on electricity production and electricity networks will thus decrease. On the other hand, a greater need for cooling will arise when summer temperatures increase. The need for energy overall decreases, which signifies cost savings.

Hydropower production is favoured by an increase in water inflow and the fact that a more balanced annual rhythm of water flow is expected. Wind power production may also increase as the energy content of wind is expected to increase in the long term in the Baltic Sea region. Excessively windy conditions and icing may, however, cause problems for wind power production. Bioenergy production is also expected to increase in a milder climate and with a longer growing season.

Changed climatic conditions may also have consequences for security of supply in the energy sector. Heavy rains may cause dam bursts in the hydropower industry, which may have extensive consequences for society.

6.3.2 Land-based industries and tourism

Climate change is expected to increase production in the forests as a result of a longer growing season and the carbon dioxide level in the atmosphere increasing, which contributes to increased growth. The quality of the wood raw material may, however, be adversely affected by faster growth. Other potentially adverse effects are that when the growing season is extended growth will begin earlier in the spring, which may lead to a greater risk of frost damage. A change in wind conditions and the fact that the ground thaws more often may result in large numbers of trees being brought down by storms. Insect and fungal attack may also become more common with a warmer and wetter climate.

Climate change may have both positive and negative effects on agriculture. Agriculture in Sweden is favoured by a warmer climate and a higher level of carbon dioxide in the atmosphere. The conditions for cultivation are generally better as growing periods are extended and it becomes possible to harvest more crops during the same period. It will also be possible to cultivate new crops. But a warmer and damper climate is also favourable to the growth of pests, plant diseases and insects. The weed flora may increase, leading to an increased need for pesticides. As soil moisture is expected to decrease in Southern Sweden, periods of drought stress for certain groups may become more common. Water resources may vary across the country due to increased precipitation in some areas and more drought in others. This will lead to differing conditions for agricultural production. There may be a great need for irrigation in some areas, while in others increased precipitation may make it difficult to grow crops.

A warm climate may mean great changes for fisheries. Water temperature is of crucial significance to the living conditions of fish. There are both cold-water species and warm-water species in Sweden. Warming in the Baltic Sea combined with a decrease in salt level might mean that fish species important to the fishing industry such as Baltic herring, cod and salmon are eliminated. How extensive the changes become depends on how great the decrease in salinity becomes. In freshwater, cold-water species will be replaced by warm-water species. The consequences for fisheries on the west coast, on the other hand, are not so clear.

The length of the vegetation period and plant production during the summer will increase for reindeer herding. Higher temperatures and precipitation may exacerbate insect harassment for the reindeer. Winter conditions will become more unstable, with icing and recurrent periods of thawing. Formation of ice under snow makes it difficult for reindeer to find food and support feeding has to be carried out. The reduced areas of bare mountain may lead to greater conflicts of interest between reindeer herding and other business and public interests. If conditions for the reindeer herding industry deteriorate, Sami culture will also be under threat.

Conditions for summer tourisms will improve in a changed climate with warmer summers. Bathing tourism and outdoor leisure close to seas and lakes will benefit in particular. Climate change may lead to reduced tourist flows to the Mediterranean areas and increased flows to Scandinavia during the warmest months of the year. An important issue for the trend in summer tourism will be water quality and algal bloom in the lakes and seas of Scandinavia. For winter tourism, the season for many ski resorts in Sweden will be shortened. Cross-country skiing and snowmobiling will be affected in particular as it is not possible to produce artificial snow for these activities.

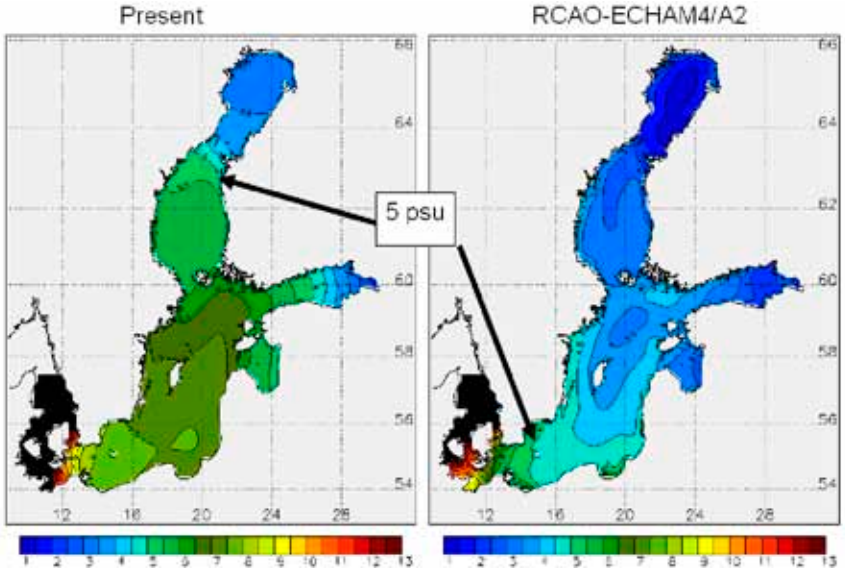


Figure 6.7 **The salinity of the surface water of the Baltic Sea (psu). Left: present-day conditions. Right: one of the regional scenarios showing a large decrease up to 2071–2100 (RCAO-ECHAM4/A2)[55].**

6.3.3 The natural environment and biodiversity

Climate change is expected to lead to changes in biodiversity and ecosystems and consequently in the ability of ecosystems to supply goods and services. Climate change will affect biodiversity both directly through changed temperature and precipitation and indirectly through changed land use. Ecosystems with rich biodiversity have a greater ability to withstand disturbance, i.e. they are more resilient. This means that ecosystems with preserved biodiversity in themselves cope better with the disruption that arises as a result of a change in climate.

When the climate becomes warmer, climatic zones and vegetation zones move northwards. There are effects on the reproduction of plants and animals, the distribution and size of populations and the occurrence of pest organisms. Uncommon species may disappear while new species may become established. The mountain areas are particularly sensitive to climate change. The areas of bare mountain in Sweden are expected to decrease substantially when the tree line rises. The tree line rose around 100-150 m in the Swedish mountains in the 20th century. Downy birch forests will shrink as the snow cover becomes thinner and less permanent. On the other hand, tree species such as pine and spruce will become more dominant along the mountain slopes.

The temperature in the Baltic Sea will rise. The extent of ice will decrease dramatically, and at the end of this century it is anticipated that ice will only be present in the inner part of the Bay of Bothnia. An increase in global sea level will mean that the level of the Baltic Sea rises. Salinity in the Baltic Sea is expected to change as a result of changed wind conditions and the supply of freshwater from increased precipitation and inflow from watercourses. It is still uncertain at present how great the changes in salt level will be as there are great uncertainties in the wind and precipitation scenarios. Model calculations in mean salinity in the whole of the Baltic Sea (see Figure 6.7) range between a non-statistically significant change and a decrease of around 50 per cent. Changed conditions in the Baltic Sea will mean great changes for biodiversity.

6.3.4 Human health

A changed climate with extremely high temperatures during the summer months may have direct consequences for particularly vulnerable groups. Elderly persons and individuals with cardiovascular and lung diseases may be particularly affected when severe heat waves occur.

When it becomes warmer, the growing season will be extended, affecting the length and intensity of the pollen season and bringing about a possible change in the spread of pollen-producing species. This will probably lead to increased pollen allergies. A milder winter climate, on the other hand, will reduce the number of cold-related health problems.

Higher temperatures in the summer may also increase the risk of infections spread with food and

55 Meier, H.E.M., E. Kjellström, and L.P. Graham, 2006: Estimating uncertainties of projected Baltic Sea salinity in the late 21st century. Geophys. Res. Lett., Vol. 33, No. 15.

water. The risk of flooding may also have direct consequences for human health as drinking water quickly becomes polluted when sewage overflows or when water from polluted land reaches water sources.

A change in ecosystems and the geographic ranges of species may mean that new diseases enter the country, particularly vector-borne diseases. An example of this is the expanded geographic range of ticks, which today covers almost the whole of Sweden and their spreading of the diseases borrelia and TBE.

6.4 National adaptation measures

Work on climate adaptation has been intensified in various ways in Sweden since 2005. At national level, government agencies with special sector responsibility have launched inquiries to build up knowledge of risks linked to climate change in their particular areas.

In the area of legislation, the Planning and Building Act was amended in 2008 so that buildings may only be erected at suitable places and account has to be taken of the risk of accidents, flooding and erosion in municipal comprehensive plans and detailed development plans. Guidance has been prepared on how clearer and stronger consideration should be given to these risks, and methods have been developed for adapting planning and construction to prevent, avoid and minimise the adverse effects of climate change.

In the area of energy, the vulnerability of the energy sector to extreme weather events has been analysed, for instance how the safety of hydropower dams and tailings dams and the risk of flooding are affected by climate change. Work to replace overhead power lines with buried cables for electricity distribution has been intensified since the storms of 2005 and 2007.

The risks to the road and rail networks of landslides, washing-away and flooding have been analysed and remedial action has been taken where necessary. An extensive tree-securing project is also underway for the railway network, where trees are felled to enhance safety in the event of strong winds.

Knowledge on the consequences of climate change and options for action is passed on to forest owners and farmers (see Chapter 9.5).

Cooperation has been in progress since 2005 between the National Board of Housing, Building and Planning, the Swedish Environmental Protection Agency, the Swedish Civil Contingencies Agency, the Swedish Geotechnical Institute and the Swedish Meteorological and Hydrological Institute to facilitate work on climate adaptation for municipalities, county administrative boards and other affected actors in the area of climate adaptation. The Swedish Mapping, Cadastral and Land Registration Authority (Lantmäteriet) and the Swedish Energy Agency have also joined this cooperation. This network of agencies has set up a web portal on adaptation to a changed climate in order to disseminate information to those actors who work to adapt society to a changed climate, and has been in discussion with other sector agencies and county administrative boards.

At regional level the county administrative boards, assisted by national agencies, are responsible for passing on data needed locally to plan and implement measures to make society more robust to climate change. Many county administrative boards have chosen to cooperate in various networks, as expected climate effects are often transboundary or otherwise common to different actors. In Central Sweden seven county administrative boards have issued joint recommendations on how to take account of the risk of flooding in municipal physical planning. The county administrative boards in Southern Sweden have jointly studied how a rising sea level affects the coastal environment, and the knowledge base provides support to physical planning along the coast, taking account of climate change.

Future climate change may mean flooding around Sweden's largest lake, Vänern, and along the River Göta Älv. The county administrative board in Västra Götaland agreed with Vattenfall on a change in water-discharging strategy to prevent the risk of flooding around Lake Vänern and of landslides along the River Göta Älv. Using a forecasting model, discharging of water is to be dictated by the current water level and the estimated inflow.

Expected climate change may mean that large areas around Lake Mälaren and parts of Stockholm city centre will be flooded. The need to be able to regulate water flow will increase, and planning work is currently under way to increase the release capacity from Lake Mälaren in conjunction with the reconstruction of Slussen in Stockholm.

Responsibility for practical climate adaptation work is generally held by the municipalities. It is the municipalities that are responsible for physical planning, contingency planning and emergency services. The municipalities are also the authorities responsible for technical supplies. Many municipalities in Sweden are working on measures to reduce their exposure in the prevailing climatic conditions and to respond to future climate change.

Practical adaptation measures to date have been principally commenced among municipalities recently affected by extreme weather events. This work has been principally concerned with measures in physical planning and construction. Many municipalities are conducting a climate and vulnerability analysis in their work on new comprehensive plans. Essential facilities and services, transport infrastructure, technical supply systems, environmentally hazardous activity and contaminated sites that may be in the risk zone for flooding, landslides, landslips and erosion are being identified. Proposals in principle for measures are being drawn up for areas at risk. Many municipalities have raised the minimum level for construction, carried out bunding measures and invested in pumping systems against flooding. Some municipalities have started working on measures in water and wastewater systems to avoid being affected by the effects of intensive rainfall.

6.4.1 Planned measures

The continued work on climate adaptation has been intensified in the Budget Bill in the autumn of 2008 and in the 2009 Climate and Energy Bill. A sum of SEK 400 million has been earmarked for climate adaptation measures for the period 2009-2011, and additional resources are proposed for 2012. Among other things:

- A new national altitude model to improve the knowledge base for the assessment of risks and for the planning of measures to minimise the risks of landslides is being developed.
- The state of knowledge and the basis for decision-making are being improved for example with regard to flooding of the three major lakes and landslide risks along the River Göta Älv at increased water flow rates.
- The need to further adapt physical planning to increased risks of landslides and flooding is being managed in conjunction with the ongoing review of the Planning and Building Act.
- The Swedish University of Agricultural Sciences is to improve its knowledge of the management of climate change in forestry. The Swedish Forest Agency is to pass on knowledge to the forest owners on climate change and possible adaptation measures. The Swedish Board of Agriculture is to compile an update of current knowledge to prevent and manage increasing problems with weeds, plant diseases and pests.

6.5 International work

Sweden is not currently taking part in any direct international cooperation on the development of joint adaptation strategies. However, the Swedish Meteorological and Hydrological Institute is taking part in several international projects aimed in particular at developing a basis for vulnerability analyses that can serve as a basis for adaptation strategies. But work on the EU White Paper on adaptation will be stepped up:

- ENSEMBLES, which is a large EU project that prepares global and regional climate scenarios and develops scenario analysis in probabilistic terms. Allied to this, impact studies are undertaken on agriculture, health, food safety, energy, water sources and risk management. Final reporting on ENSEMBLES is due in 2009.
- CES is an ongoing Nordic project on impact studies on renewable forms of energy and energy systems (biofuels, hydropower, wind power, solar power). CES contains a climate scenario section.
- CIRCLE is an EU/FP6 ERA-Net on climate effects and climate adaptation, with the aim among other things of reviewing the prospects of joint methods for adaptation strategies.
- SAWA and CPA are EU Interreg projects, the Swedish parts of which are analysing the risks of landslides in the valley of the Göta Älv.
- CLARIS-LPB is an EU FP7 project that studies hydrological effects of climate change in the La Plata Basin, South America.
- Geoland2 is an FP7 project attached to GMES principally aimed at creating satellite-based products, but one area of which is concerned with hydrological applications which among other things contain pan-European modelling of the water sources in a changed climate.
- GENESIS is another FP7 project that studies climate effects on European hydrology, principally aquifers.
- ECOSUPPORT is a BONUS project concerned with biogeochemical effects of a changed climate in the drainage basin of the Baltic Sea (both land and sea) and options for implementing the Baltic Sea Action Plan in the future.
- The BONUS project AMBER, which is concerned with implementation of ecosystem methods in other Baltic Sea projects, the BalticWay project on significant reductions in environmental risks posed by the marine industry and INFLOW on changes in saltwater inflow into the Baltic Sea.

7 Financial resources and transfer of technology

7.1 Introduction

Tackling climate change in developing countries is, from a Swedish perspective, closely linked with poverty reduction and attaining development goals such as the Millennium Development Goals (MDGs). A large proportion of development projects are in danger owing to climate change, and several development goals will not be attained unless measures are taken and further funding is injected. The objective of Swedish environmental development cooperation is to contribute to environmentally sustainable development, in order to enable poor people to improve own their living conditions. Women, men, girls and boys living in poverty have to be given an opportunity to adapt to the adverse impacts of climate change and also in the long term be able to take action to limit greenhouse emissions in accordance with their national objectives on sustainable development. This support is guided by principles such as ownership, harmonisation and alignment to the country's systems and processes. On this basis, Sweden is working towards integrating climate change considerations into a broader spectrum of poverty reduction, for instance in sectors such as water and sanitation, agriculture and forestry, food security, energy, infrastructure, health and education.

Under Sweden's Policy on Global Development (PGU), reduced environmental and climate change impact is a key element in the country's development cooperation. Development cooperation is, however, just one of the instruments needed to work proactively on climate change issues in developing countries. Initiatives by other Swedish public institutions, non-governmental organisations, the private sector and other actors in Swedish society are also of great significance. A number of different instruments and forms of cooperation are used to channel development cooperation. The funds channelled through development cooperation only represent a small proportion of the total sum of climate change-related finance required in developing countries. Resources therefore need to be mobilised from other sources, both private and public. Cooperation with other Swedish and international actors in this context is judged to be of great value and provides better leverage of the resources invested and ensures that the comparative advantages of the different institutions are benefited from.

7.2 Objective and funding

Sweden works broadly on the climate change issue in developing countries. In line with the Swedish policy on Swedish global development, a large number of actors such as ministries, government agencies, state-owned companies, non-governmental organisations, universities and the private sector in Sweden assist in climate change-related cooperative actions and activities with regard to financial support such as technology development, research and various forms of capacity development in developing countries. There are a number of different forms of cooperation, policy instruments and forms of support, and finance is provided from both public and private sources.

7.2.1 Governing policies and priorities

Policy on global development

The current policy on global development (PGU) was adopted in 2003 and specifies that all policy areas are to contribute jointly to a fair and sustainable global development. The overarching objective of development cooperation remains to enable people living in poverty to improve their living conditions.

PGU represents the framework in which Swedish development policy is to be pursued and includes other policy areas and actors in society in order to clarify that Sweden speaks with one voice and strives to attain the same development goals. To put PGU into practice, work for the period 2007-2010 is presented as six global challenges, of which climate change and environmental impact is one. The Swedish Government has identified those challenges as being of key importance in attaining the objective of the policy and where Sweden is deemed to be in a position to make an effective contribution.

The thematic priority environment and climate change

With the aim of moving away from the clear trend to prioritise a large number of policy areas in development cooperation, the Swedish Government has decided to focus on three thematic priorities during the 2007-2010 parliamentary term: equality, democracy and human rights, and environment and climate change. With regard to the latter it is stipulated that work on environment and climate change has to be intensified and permeate the whole of development cooperation and that efforts in relation to environment and climate change are to be concentrated on four areas closely linked to climate change: climate change adaptation, energy, environment and safety, and water. This priority with its strong emphasis on environment and climate change provides increased weight and political guidance so that development cooperation can be focused on these issues. A close look at the cooperation strategies drawn up in 2008 also shows that the issues of environment and climate change have had a greater impact on Swedish priorities in partner countries. Most cooperation strategies indicate the thematic priorities of environment and climate change as overarching goals, a priority area of cooperation or as a dialogue issue.

The Paris Declaration and the Accra Agenda on aid effectiveness

The principles contained in the Paris Declaration from 2005 and the Accra Agenda from 2007 are of key significance to Swedish development cooperation. These principles are relevant regardless of whether or not development cooperation (ODA) is concerned and should also guide initiatives relating to climate change. National ownership should also guide climate change-related initiatives, as are external actors (including donors) should ensure improved coordination and alignment to national systems and processes of developing countries and ensure better reporting of results and mutual accountability.

The Commission on Climate Change and Development

Against the backdrop of a strong wish to integrate consideration of climate change in development cooperation and to link together climate change and development issues, the Swedish Government in 2007 took the initiative to establish an international Commission on Climate Change and Development with the aim of preparing recommendations for ways in which adaptation and risk could be integrated into development cooperation. The final report was issued in May 2009 and underlines the need to prevent vulnerability, manage risks, strengthen the local level where a large part of the adaptation will take place and improve the functioning of ecosystems, emphasising at the same time that successful development in future will depend on how well climate change risks and other risks are managed. Moreover, the Commission advocates that USD 1-2 billion urgently be committed to climate change adaptation while waiting for a new financial architecture resulting from an agreement in Copenhagen in December 2009 to be put in place. The Commission's report is expected to play a major role in shaping Swedish development cooperation.

7.2.2 Forms of cooperation and instruments

Swedish development cooperation has received 1 per cent of Gross Domestic Income (GDI) since 2006, and Swedish ODA to developing countries is thus at a level that surpasses the agreed 0.7 per cent target, which only a few other OECD countries have fulfilled. The Swedish climate change-related initiatives therefore ought not to have occurred at the expense of other development goals. From the Swedish point of view there is no reason to distinguish between climate change financing and development financing, as consideration of the environment and climate change so clearly is essential to sustainable development. On the other hand, it is clear that increased sums over and beyond present-day levels of assistance will be required to fund adaptation and mitigation in developing countries.

Sweden considers it very important to ensure that environmental and climate change aspects, including disaster risk reduction, are integrated into development cooperation. Environmental and climate change analyses, environmental impact assessment

(EIA) and strategic environmental assessment (SEA) are existing tools already used in Swedish development cooperation to ensure integration and maximise outcome with regard to adaptation and mitigation. It is important to take a broad approach to the climate change issue, and Sweden therefore engages both in integration and specially targeted initiatives that complement one another.

Half of Swedish development cooperation is channelled as bilateral aid through the Swedish International Development Cooperation Agency (Sida), to developing countries and countries with economies in transition. In the area of climate change, Sida works on capacity building, technology cooperation and research cooperation related to adaptation and mitigation in developing countries, and in doing so collaborates with non-governmental organisations, Swedish authorities, the private sector and research institutes. Section 7.4 provides an overall picture of bilateral cooperation, while the examples (I-IV) relate to different forms of cooperation. In 2007 Sweden decided to reduce the number of countries involved in development cooperation with the aim of improving efficiency and quality. The number of countries has been reduced from 67 to 33, and the countries have been divided into five categories distinguishing between the forms of cooperation used. The range is wide and extends from countries with traditional long-term development cooperation to countries where there is greater focus on new cooperation partners and creating platforms for collaboration as traditional development cooperation is no longer needed. There is also to be a clearer focus on results in all development cooperation.

The other half of development cooperation is made up of multilateral aid, which is channelled through the Ministry of Foreign Affairs, Sida and the Ministry of the Environment, including regular and voluntary funding of the UN Framework Convention on Climate Change and the Kyoto Protocol. Dialogue and advocacy are important in relation to multilateral aid, and Sweden attaches great importance to other forums, in addition to UNFCCC, where the climate change issue of is great relevance, such as UNDP, UNEP, the World Bank, FAO, ISDR etc. (see section 7.3).

I) Specially targeted initiatives

The Government took a decision in 2006 on a special climate change initiative for 2007 totalling SEK 100 million with the intention of strengthening Swedish partner countries' knowledge of and capacity to deal with the effects of climate change. The initiative's resources have been shared equally between the areas of climate change adaptation and risk management, sustainable energy and environmental technology and are channelled bilaterally, regionally and globally (see examples in 7.4.1 and 7.6). Efforts have been made to strengthen institutional capacity at national level as well as targeted efforts in the forest and water areas. In addition, emphasis has been put on reforming the energy sector, sustainable urban development and energy efficiency and the development of sustainable energy systems. These initiatives were also chosen to utilise expertise and resources among Swedish actors and in the private sector.

In international development cooperation the Government has given notice of a special climate change initiative totalling around SEK 4 billion over the period 2009-2012. The primary goal is to contribute effectively to long-term efforts for adaptation to climate change in the poorest countries, but also to contribute to measures in developing countries to limit greenhouse gas levels, for instance through greater energy efficiency, increased access to better technology and alternative energy sources and reforestation projects. Grants are primarily to be made through existing multilateral initiatives but also in bilateral cooperation, focusing on Africa.

In addition, the Swedish Government decided in 2009 on a new unrestricted system of loans and guarantees solely for investments in social development and environment/climate in developing countries. The system's budget is SEK 250 million annually over a 3-year period. The system originates from the fact the large investment needs in infrastructure, environment and climate change in Sweden's partner countries cannot be managed solely with development cooperation or through market actors. Loans and guarantees mobilise domestic capital, strengthen local financial markets and make it easier for partner countries to attract private investments.

II) Support through non-governmental organisations

Cooperation with civil society in the area of climate change, both in Sweden and in developing countries, is significant to Sweden as these actors focus closely on the local level in developing countries and work with important local partners. Government financial support from Sida is allocated to, among others, the Swedish Society for Nature Conservation, the World Wide Fund for Nature (WWF), the Swedish Cooperative Centre and Diakonia (see example in section 7.4). WWF works actively to strengthen cooperation

between donors and the commercial sector, principally with regard to technology transfer, and also assists developing countries in preparing national adaptation plans.

III) Support through swedish authorities to institutions in developing countries

Strengthening capacity among authorities in partner countries is an important role for development cooperation, and as well as long-term cooperation with environmental authorities in countries such as Vietnam, Laos, Kenya and Burkina Faso, Sida channels money to and cooperates with several Swedish authorities and universities to enable them to run programmes and project activities in developing countries focused on their particular areas of expertise (see sections 7.5 and 7.6). The Swedish Environmental Protection Agency assists several countries with economies in transition, for example, in establishing environmental legislation and new environmental institutions. It works together with the country's environmental authority and international organisations such as UNEP. The present-day programme includes several countries in Eastern Europe and China.

IV) Cooperation with the private sector

The dominant global capital flows are private, and to be able to manage climate change it is of the utmost importance to link these flows to efforts both to tackle climate change and to adapt to its negative effects. Sida's new systems for environmental loans and guarantees is one component of this work. The development of national and international regulations is a fundamental aspect. An increased focus on both adaptation and mitigation measures additionally signifies increased demand for new products and services. Cooperation between different policy areas – business, environment, research, trade and development cooperation – is important here in order to bring about greater involvement among Swedish innovators and companies.

In addition, Sida and other government actors play an important catalytic role by creating meeting places for an exchange of experience and information, for the development of skills and expertise and also with the aim of preparing for further investments by providing catalytic contributions. The Swedish Trade Council, Swedfund and the Swedish Agency for Economic and Regional Growth assist with support in this context, which is described in more detail in section 7.5.

7.3 Multilateral contributions

Nearly half of Swedish development cooperation is allocated to international multilateral development bodies, and a new multilateral strategy was prepared in 2007 to ensure higher quality. The strategy contains guidelines aimed at more strategic actions, better result orientation and advanced accounting and evaluation functions, as well as a clearer sharing of roles between the actors in the Swedish system. Relevance and effectiveness are the principal criteria in prioritising different multilateral channels.

Sweden provides assistance to the financial mechanism of the UN Framework Convention on Climate Change, the Global Environment Facility (GEF), according to an agreed scale, and most of this is used for climate change purposes. Table 7.1 clarifies Swedish payments to the GEF Trust Fund for the period 2004-2008. For the fourth replenishment, on which negotiations were completed in 2006, Sweden undertook, in addition to the share decided upon, to make a voluntary contribution of SEK 356 million, and the total budget was SEK 838 million, which will be paid out over a 10-year period up to 2016 (see Table 7.2). Over the period 2004-2008 Sweden also contributed voluntary assistance to two climate change funds created under the Marrakesh Accords: a total of SEK 40

Table 7.1 **Payments into GEF in 2005-2008 (SEK millions)**

Swedish contributions	2004	2005	2006	2007	2008
GEF Trust Fund	132	138	165	251	261
SCCF – Special Climate Change Fund - of which adaptation SEK 37 million - of which technology transfer SEK 3 million			10*	15	15
LDCF – Least Developed Countries Fund				7	

* Combined contribution for the period 2004-2006

Table 7.2 **Payments into fourth replenishment of GEF (SEK millions)**

Replenishment	Swedish total payment	Swedish voluntary contribution	Pay-out period
GEF-4	838 (76.2 SDR*)	356 (32.4 SDR)	Up to 2016

* Special Drawing Right: the exchange rate on 31 January 2006 has been used for calculation.

million to the Special Climate Change Fund (SCCF) and SEK 7 million to the Least Developed Countries Fund (LDCF). Sweden has not contributed to the Adaptation Fund under the Kyoto Protocol, which is not yet operational, but is following its development of the Fund with great interest.

Sweden provides assistance to the core budget of the UN Framework Convention on Climate Change according to the agreed UN scale with an additional charge for the Kyoto Protocol, but also to the fund for participation and the fund for supplementary activities, contributions to which are voluntary (see Table 7.3). Sweden's voluntary support of UNFCCC increased substantially between 2004 and 2008, reflecting the weight the country attaches to the work of the Convention and also the fact that the increased intensity of work and meetings in recent years demand more financial resources in particular to ensure participation from developing countries. Sweden also provides assistance to the CDM Executive Board, and in 2006 contributed USD 140 000 to the Board's administrative expenses.

In the context of the work of UNFCCC, Sweden has also supported weADAPT, an initiative devised by the Stockholm Environment Institute (SEI) as an 'action pledge' under the Nairobi Work Programme. This is a web-based platform that brings together a broad range of organisations with experience of adaptation in theory and practice. The platform's tools and methods are aimed at supporting the sharing of knowledge of others for example on climate models, projections and instruments and also to pass on personal experience.

In addition to assistance to UNFCCC, GEF and its climate change funds, Sweden considers it important also to operate through assistance to a number of other multilateral specialised bodies and international and regional organisations, banks and institutes in order to influence their climate change work in various sectors, see also Table 7.3. Under several UN bodies, programmes and development banks, Sweden conducts a proactive policy dialogue, and advocacy takes place for instance with regard to climate research, tools, methods and policies for adaptation and mitigation etc. Sweden additionally attaches great importance to cooperation with international research bodies such as the Consultative Group on International Agricultural Research (CGIAR), the Centre for International Forestry Research (CIFOR) and the World Agroforestry Centre (ICRAF) and has also cooperated over a long period with the Asian Institute of Technology (AIT) in the area of technology and capacity building.

Renewable Energy Technologies (RETs) is a ***regional research programme focused on renewable energy technology*** which is assisted by Sida and coordinated by the Asian Institute of Technology (AIT). The third phase of the programme, 2002-2004, was aimed at consolidating and disseminating the experience gained to date. RET packages for different areas have been developed and demonstrated on a commercial basis. Three renewable technologies have been selected: solar energy and biomass drying, biomass briquettes and briquette-fired cookers.

In addition, institutions such as the International Union for the Conservation of Nature and Natural Resources (IUCN), the International Institute for Environment and Development (IIED) and SEI undertake valuable work in the area of climate change with financial support from Sweden.

In 2008 SENSA (Swedish Environmental Secretariat for Asia) together with UNEP and SEI established a ***regional knowledge platform in Asia for climate change adaptation***. The principal purpose, in line with the Nairobi Work Programme and the Bali Action Plan, is to focus on both adaptation planning and experience and adaptation methods and tools. Various actors from governments and authorities to the private sector in the region are to benefit from the platform with a view to interacting, strengthening their capacity and strengthening knowledge of climate adaptation and how it is integrated at national level.

As in the multilateral dialogue and cooperation with other donors, harmonisation is significant. Harmonisation is one of the principal aims of the European Commission's Global Climate Change Alliance (GCCA). Sweden supports the initiative aimed at creating a platform for dialogue and exchange between the EU and the least developed countries and small island states (SIDS). The overarching objective is to assist the countries most at risk in increasing their capacity to adapt to the negative effects of climate change, while at the same time fulfilling the MDGs. Assistance is to be provided principally through budget support from a donor pool. Sweden contributed a one-off sum of SEK 50 million in 2008. The selected pilot countries are Cambodia, the Maldives, Vanuatu and Tanzania.

7.4 Bilateral and regional contribution

With regard to bilateral cooperation, the Swedish contribution is based on developing countries' own strategies for poverty reduction, both in the area of climate change and other areas. Common cooperation strategies between Sida and the partner country are being devised to provide guidance for continued cooperation. The climate change issue has had a great impact in recent years thanks to the themat-

Table 7.3 **Payments to multilateral institutions and other relevant organisations and institution, 2004-2008 (USD million) (The SEK/USD exchange rate at 11 December each year has been used for conversion)**

Multilateral institutions and programmes	2004	2005	2006	2007	2008
1. World Bank group (incl. IBRD, IDA, IFC, MIGA)	206.8	121.6	247.4	241.4	332.3
2a. African Development Bank	-	-	-	2.8	3.2
2b. African Development Fund	62.6	48.5	54.7	67.7	68.5
3a. Asian Development Bank	9.2	24.8	14.7	9.4	18
3b. Asian Development Fund	14.8	21.5	23.8	22.8	10.3
4. European Bank for Reconstruction and Development	0.9	0.7	10.1	8.4	8.2
5a. Development cooperation in the EU budget	141.1	100.6	165.9	155.5	123.7
Global Climate Change Alliance					6.2
5b. European Development Fund	99.3	81.6	97.2	110.7	101.5
6. Inter-American Development Bank	2.1	1.4	5.1	-	1.5
7. United Nations Development Programme	171.2	104.1	138	130.9	208.1
8. United Nations Environmental Programme	9.6	13.1	9.4	22	15.5
9. United Nations International Strategy for Disaster Reduction	6.5	0	7.5	8.1	14.5
10. UNFCCC					
- Core support	0.11(Conv)	0.16(Conv) 0.07(KP)	0.15(Conv) 0.1 (KP)	0.15(Conv) 0.12(KP)	0.18(Conv) 0.13(KP)
- Supplementary Fund	0.036	0.043	0.66	0.20	0.31
- Trust Fund for Participation	0.14	0.42	0.20	0.31	0.31
- CDM Executive Board			0.14		
11. Examples of assistance to other international, regional organisations and institutions					
- Centre for International Forestry Research	2.7	2.9	4.6	6.3	4.8
- Consultative Group on International Agricultural Research	9.0	8.0	7.8	10.4	4.4
- Asian Institute of Technology	23	15.9	30.7	31.7	14.9
- World Maritime University	25	22.6	23.4	20.9	11.1
- World Agroforestry Centre	28.4	25.6	25.7	4.3	5.8
- Mekong River Commission	9.5	13.9	11.6	14.9	13.1
- West Africa Rice Development Association	0	3.3	3.3	3.3	1.6
- International Union for the Conservation of Nature and Natural Resources	37.6	42.1	57.8	42	45.9
- International Institute for Environment and Development	7	9	12.9	19.2	18.9

Table 7.4 **Bilateral and regional support 2004-2008 (SEK million)**

	Mitigation						Adaptation				Other	Total
	Energy	Transport	Forestry	Agriculture	Waste	Industry	Water	Forestry	Agriculture	Other adapt.		
2004	160	0.09	71	43	103	0.3	146	89	202	112	74	**998**
2005	153	59	86	92	321	23	252	108	344	429	232	**2100**
2006	286	45	137	102	127	26	351	135	292	392	224	**2116**
2007	233	49	90	77	124	22	313	118	342	239	170	**1777**
2008	427	84	83	121	147	27	400	97	322	327	147	**2182**
Total	**1259**	**238**	**467**	**435**	**822**	**97**	**1462**	**547**	**1502**	**1497**	**848**	**9170**
	Total emission reduction: approx. 3300						**Total adaptation: approx. 5000**				**Tot: approx. 850**	

ic priority of environment and climate change that emphasises that these issues have to be considered and permeate cooperation, but also a growing need from partner countries. Bilateral climate change support comprises bilateral, regional and global initiatives[56] in adaptation and mitigation, technology cooperation and capacity building, including research cooperation, institutional strengthening and training efforts. In the spirit of the Paris Declaration, development cooperation has increasingly to focus on budget support and sector programme support, reducing Sweden's opportunity to influence in detail how the funds are used and instead putting greater demands on dialogue with the partner country.

Table 7.4 shows Swedish bilateral and regional assistance which has been classified as climate change related for the period 2004-2008. The emphasis in the support for adaptation is on interventions in water and agriculture and other sectors containing for example disaster risk management, health contributions, education and research. Contributions to energy and waste management dominate in mitigation. The group of "other" contains initiatives that have promoted implementation of UNFCCC but

56 Global initiatives are bilateral and regional assistance channelled through multilateral and other institutions.

are not directly linked to adaptation or emission limitation, e.g. institutional strengthening and capacity building, legislation, support for organisations and support for negotiators from developing countries. The greatest share of support has gone to adaptation measures, around SEK 5 billion, while emission reduction-related initiatives have received around SEK 3.3 billion and other initiatives around SEK 850 million. This division reflects the significance Sweden, together with many partner countries, attaches to adaptation measures. The contributions also produce important synergies in the agriculture and forestry sectors between adaptation and mitigation measures.

Annex 6 shows how the financial support is broken down by country, region, sector and year for the period 2004-2008. The individual countries to have received the largest shares of climate change-related aid are Tanzania, Mozambique and Vietnam, which represent countries where Sweden has engaged in development cooperation for many years. From a Swedish perspective it is important that capacity building and technology transfer are integrated in bilateral and regional projects and programmes at sector level, for both emission reduction and adaptation. Because of its interdisciplinary nature, the financial support for these operations is not differentiated in Swedish development cooperation. On the other hand, specific examples are presented in sections 7.5 and 7.6.

Adaptation in the agricultural sector for AIDS victims in Zimbabwe

The Swedish Co-operative Centre undertakes operations aimed at households affected by AIDS in Zimbabwe, focused on adaptation in agriculture. The project has been implemented since 2003 at village level with families where one or more members have AIDS, where parents have died and where children are heads of household. Training and advice are given on the cultivation of crops such as sweet potato, cassava and beans, which are less labour-intensive and require less water. The nutritional value is also high, which is important in delaying the progression from HIV to AIDS. The project also runs study circles which are led by the women in the villages to spread knowledge of sustainable development, climate change and adaptation strategies. The support for each district is phased out after 2-3 years when the villages are able to work at full scale without external support.

Bilateral and regional climate change work is undertaken at various levels of society and relates to many strategically important sectors in development cooperation such as water, agriculture, forestry, infrastructure and energy and is integrated with other support. Two examples of adaptation described below are related to water resource management and improved climate information, data and projections.

The programme ZACPRO 6.2 on ***Integrated water resource management strategy for the River Zambezi area*** is aimed at improving integration of water source management in the River Zambezi area, promoting social and economic development and protecting against floods, drought, pollution of water resources and environmental degradation. To facilitate joint work to bring about long-term sustainable utilisation of water resources, the project is seeking to establish a framework for regular exchange of information and cooperation between the countries bordering the river basin. The programme has developed a joint integrated water resource management strategy for the countries bordering the river area which enables the water resources in the area to be quickly evaluated.

SMHI is cooperating with the Botswana Department of Meteorological Services (DMS) in the establishment of a weather service in Botswana to strengthen capacity in weather-related disaster management and climate change adaptation. The first phase in the project out of two planned was run between 2006 and 2008, The phase was initiated with a detailed inventory of present-day activity to identify the most relevant areas for development. DMS personnel have been trained in meteorological observation stations, data collection, remote sensing, meteorological projection methods etc. The quality of Botswana's weather service has improved through a combination of capacity development among personnel and technical improvements. Sida has supported the project with SEK 3.2 million.

Sweden's work on climate change in developing countries also includes contributing to decreased greenhouse gas emissions to the atmosphere. Sida is therefore working with its partner countries to enable them to invest in technology and know-how that is both environmentally and economically sustainable. Regulatory instruments that encourage more efficient use of energy and renewable energy sources are supported. Access to sustainable and modern energy is crucial from a development perspective. See examples of technology cooperation in the area of energy in section 7.5.

Since 2007 the Swedish Energy Agency has working with support from Sida on a ***capacity building project for CDM*** (Clean Development Mechanism) in Tanzania, Kenya and Uganda. The number of CDM projects in Africa to date has been very low, and a problem in many African countries is the shortage of economic and institutional infrastructure for managing CDM projects. The project is therefore aimed at building the necessary capacity among authorities, energy companies, banks and industrial companies concerned that is required to be able to receive and implement CDM projects. The intention is for capacity to be developed through 'learning-by-doing'. To date the Swedish Energy Agency has clarified the needs for capacity development and what experience of CDM exists in the countries, and will build on these in its continued work.

7.4.1 Initiatives specially focused on the least developed countries

Swedish development cooperation has long emphasised support to least developed countries and vulnerable countries with a low GDP per capita. Poor people are to a greater extent dependent on natural resources and agriculture for their survival, and their livelihoods are therefore directly affected by how the climate changes. A changed climate also changes access to clean water, which is already in short supply in many poor countries, and this can lead to conflicts. Sweden considers that the principal focus in these countries should be on adaptation to the negative effects of climate change and consequently on reducing poor people's vulnerability and improving their prospects of adapting to climate change that has already happened and is continuing to happen. From the Swedish point of view this is manifested in finding new methods to assist people in adapting to new living conditions, for example through a greater focus on food safety, energy supply and water resource management. In addition, Sweden contributes humanitarian assistance to those affected by extreme weather conditions.

Climate change adaptation and conflicts in Kenya
NCCK (National Council of Churches of Kenya) has been one of Diakonia's partner organisations since 2002. Diakonia and NCCK cooperate principally to reach peaceful resolutions of the conflicts between ethnic groups that arise in the Turkana area of Northern Kenya due to scarce natural resources. The drought, worsened by climate change, threatens to intensify the conflict. NCCK is working to bring young warriors from the parties to the conflict together for talks. NCCK has also developed a system that helps people to recognise when the risk of drought increases so that the population of the area has an opportunity to prepare for an imminent period of drought.

It is often difficult to distinguish pure adaptation interventions from development interventions Adaptation to a large degree overlaps what is defined as sustainable development. Sustainable development provides gains in terms of building resilience and reducing vulnerability, two factors that are crucial to the capacity of individuals and societies to adapt. Sweden emphasises that it is crucial to ensure that the effects of climate change are integrated into the analysis of any risks for the contribution. There is a otherwise a risk of "maladaptation", which means that people's vulnerability increases as a consequence of the contribution.

Adaptation in some cases requires cooperation across sector boundaries and often regionally across national boundaries, particularly in relation to administration of shared resources such as in the ICIMOD programme, which Sweden supports.

International Centre for Integrated Mountain Development
Global warming poses a serious threat to the Himalayan region. The melting of glaciers will affect the water suppliers of 1.3 billion people, and ecosystems in the area are under threat. Sida therefore supports the work of the International Centre for Integrated Mountain Development aimed at developing adaptation strategies and improving resilience in the region. The five modules of the programme include developing a satellite-based system for monitoring change in the region's icecap, vulnerability and analysis of adaptation in communities close to dams at high risk of bursting, mapping of present-day water management, development of more efficient energy use and increased regional collaboration on these issues.

Sweden is also working to enhance the understanding of how climate change affects the development prospects of countries. In addition to regional and bilateral operations, Sida therefore supports the pan-African programme Climate Information for Development in Africa (ClimDev-Africa), which aims to integrate management of climate change into decision-making process by producing climate data and projections. The programme is a joint effort between the African Union Commission (AUC), the African Development Bank (AfDB) and the Economic Commission for Africa (UNECA) in Addis Abeba in Ethiopia. In the short term, the programme aims at helping African countries to become better able to cope with climate variability that already exists and in the long term at reducing the risks and improving resilience to the effects of climate change. The initiative is driven by a number of African countries that have joined forces to jointly raise awareness, increase the availability of data, communicate climate change information, improve the quality of planning processes and develop support for risk management.

The Kenya Water and Sanitation Programme (KWSP) is aimed at supporting the implementation of reforms in the Kenyan water sector, improving the management of water resources and making investments in water supply and sanitation for poor people in rural areas. KWSP comprises a budget of €50 million over five years (2005-2009) and is funded by Sweden, together with Denmark and Kenya. The programme includes the sub-component *Flood and Drought Mitigation*, which is aimed at supporting the *Water Resource Users' Association* on water resource management issues to enable them to adapt to floods and drought and to ensure equitable access to water. A development cycle containing four categories has been designed in this work: reduced risk of conflict, regulation for equitable control and distribution of water resources, preservation of water reserves and resources, and improved efficiency in the use and management of water resources.

7.5 Technology development and diffusion

Swedish environmental technology exports totalled SEK 33 billion in 2007. The largest individual sector is waste management and recycling, but many of the current environmental technology solutions such as district heating, biogas, underground waste transport, geothermal heating and geothermal cooling have existed on a large scale in Sweden for many years. The Swedish Trade Council is working to facilitate exports by Swedish companies, in areas such as environmental technology and waste management, recycling, bioenergy, solar energy, wind power and energy efficiency. Bilateral technological cooperation with China focused on sustainable urban development has been in progress since April 2008. Sino-Swedish Environmental Technology Cooperation involves three Swedish ministries and their Chinese counterparts in the region concerned. An example of a specific project is the development of biofuel and distribution for the city of Wuhan.

SymbioCity is a new export concept driven by the Swedish Trade Council that supports holistic and sustainable urban development. The initiative involves the private sector and is aimed at highlighting the synergies that exist between different supply systems in the modern city and that have the potential to provide both environmental and financial gains, including reduced greenhouse gas emissions. Work on holistic urban development and efficient resource management has been in progress in Sweden for more than 50 years, and this experience forms the basis of SymbioCity. The SymbioCity concept has been applied in other cities around the world, such as in Luodian Town, Tianjin Guangdong in China, Buffalo City in South Africa and Pune in India.

Sweden considers the private sector to have an important role in technological development and diffusion. However, with the aim of creating the necessary conditions for the private sector becoming involved in developing countries support is often required to reduce the risk, and loans and guarantees or risk credit can be used for this purpose.

From the point of view of development, the issue of technology is more than physical transfer of hardware or software, it is more a matter of developing capacity in developing countries to receive, use and develop technology. Development cooperation has an important role to play in this context, and Sweden undertakes technology and research cooperation with significant elements of capacity development with a number of partner countries. This approach is crucial to the opportunities for developing countries to benefit from and themselves contribute to the development of sustainable technological solutions adapted to their circumstances.

Distance master's programme on sustainable energy engineering

The Royal Institute of Technology (KTH), with support from Sida, conducts a distance Master's programme on sustainable energy technology in partnership with universities in Uganda, Mozambique, Ethiopia, Tanzania, Zambia, Mexico, the Maldives and Sri Lanka, with a total of around 150 distance students admitted annually. 80 students a year receive scholarships from Sida. KTH has developed an interactive web platform which contains, for example, all educational material, including lectures, study visits and individual laboratory and calculation exercises. It is intended that the programme will be transferred to the partner university after 5-7 years with continued closed contact with KTH.

Sweden attaches great importance to adapting technological solutions to local circumstances in developing countries, utilising national knowledge and recruiting national expertise in the area concerned. An example is the project relating to Energy Services Companies (ESCO) in Zambia, where Sida and SEI created a network of existing privately owned companies in the energy sector. Instead of implementing ready-made technological solutions directly at the end-users, a long-term sustainable solution was established for energy supply in the form of local companies that could procure system solutions for leasing and offer user training, servicing and maintenance of the installations.

The Swedish Agency for Economic and Regional Growth is implementing on Sida's behalf the Demo-Miljö project, which relates to environmental technology initiatives in the areas of sustainable urban development and renewable energy. The assistance is targeted at Sweden's partner countries in Africa, Asia, Latin America and Eastern and Central Europe, and creates opportunities for authorities, local governments, institutions and companies in these countries to try out new technology in areas such as air pollution, water and sanitation, waste management, energy saving, renewable energy and urban transport. A waste management project in Chennai in India which is being implemented under Demo-Miljö is aimed at reducing greenhouse gas emissions by generating biogas from utilised biological waste. The biodigestor for the project comes from Sweden.

The StartSyd and StartÖst programmes offer small and medium-sized enterprises in around 40 of Sida's partner countries in Africa, Asia, Latin America and Eastern Europe the opportunity to apply for financial support for knowledge transfer and equipment. The aim is to contribute to improved prospects for eco-

Table 7.5 **Examples of support containing environmental technology transfer**

Project: Pilot Project Providing Electricity Services Using Photovoltaic Solar Systems through Energy Service Companies in Rural areas in Zambia

Aim: Develop guidelines for the necessary economic, institutional and governing conditions required for successful development of energy service companies (ESCOs) in rural areas.

Recipient country:	Sector:	Total support:	Length of the project:
Zambia	Energy	SEK 12.8m	1998-2006

Description: The project supports the formation of local "energy service companies" that can supply energy services to the rural population. The companies receive financial support to purchase PV systems, which they lease to the local population and local contractors. The companies install and maintain the system.

Factors that led to success: Considerable account was taken of the service life of the system in choosing heating systems and maintenance. To make the systems sustainable, there has been a strong focus on increasing administrative capacity. A maintenance charge for the user has also been introduced. As the system is expensive for the average citizen, a platform has been developed to facilitate grants and loans.

Technology transferred: PV energy technology, leadership and administrative skills, marketing capacity

Effect on greenhouse gas emissions: (no information available)

Programme: Asia Sustainable and Alternative Energy Programme

Aim: Increase the use of alternative and renewable energy sources and improve the efficiency of energy use in Asia

Recipient country:	Sector:	Total support:	Length of the project:
China, Vietnam, Indonesia, India and Bangladesh	Energy	SEK 15m	2007-2009

Description: The project has been implemented in a selection of Asian countries in one million households in order to improve access to renewable energy while promoting energy savings, for instance through information campaigns and documentary films. Other donors are the Netherlands, the United Kingdom and the United States.

Factors that led to success: "Innovative Investment Delivery Mechanisms", development of institutional and legal frameworks, exchange of training and knowledge. The programme has also generated additional investments from the GEF, the World Bank and local financiers totalling hundreds of millions of dollars.

Technology transferred: Institutional support in the form of the energy and infrastructure sector, development of energy services for 1.1 million households (coconut oil, wind, biomass, small-scale hydropower etc.), increase in generating capacity of 1 455 MW.

Effect on greenhouse gas emissions: direct reduction of 2.2 million tonnes/year (indirect reduction 515 million tonnes/year)

nomic growth for sustainable, profitable and productive small and medium-sized enterprises. With effect from 2009 Swedfund is taking over implementation of the programmes to develop the business-oriented development cooperation in accordance with Swedish global development policy. Swedfund also offers venture capital and expertise for investments in developing countries to create profitable companies in the formal sector, strengthen the local business community in poor countries and consequently contribute to sustainable poverty reduction. The work is partly focused on what are known as Clean Tech investments in developing countries with major environmental problems. [Table 7.5]

7.6 Capacity building

Capacity development is a critical factor in enabling developing countries to face up to climate change. Capacity is required to receive financial and technology-related support for adaptation and mitigation and to ensure that such support is sustainable. National expertise and know-how on climate change and its effects is significant, as well as strengthening institutions so that the countries in the longer term will themselves be able to integrate climate change into their planning process and pursue a national climate change policy. Sweden has found that the best results are achieved when capacity development is based on countries' own needs and priorities and is a joint learning process owned and operated nationally but taking place in partnership. It is therefore important to strengthen the national systems instead of creating new ones.

Sida has been funding a training programme **'International Training Programme' (ITP) focused on emissions mitigation and adaptation,** which is implemented by the Swedish Meteorological and Hydrological Institute (SMHI) in cooperation with SWECO and SEI since 2006. The aim is to improve knowledge of climate change and its effects and provide the 25 selected participants with tools to identify vulnerable sectors in their countries and develop projects in their homelands with support from the organisers. The target group is individuals in leading positions in administration, national or local, non-governmental organisations, universities or companies. Evaluations show that the participants rate the course highly and that the training has greatly increased their knowledge of climate change. A large majority of the participants also thought that the contents were of great or very great significance to their continued work, and a number of important contacts had been established with experts in Sweden.

Capacity development is primarily an integral part of the programmes and projects supported by Sida. The integrated approach is of key significance as capacity cannot develop in a vacuum and is always linked to the relevant activity. It is important to ask 'capacity for what?'. Sweden considers it important to take a broader grip on capacity development in training and research, but also to raise capacity institutionally through various forms of support to and cooperation with the national and local institutions. In addition, Sweden considers it crucial to ensure that the developing countries' negotiators are supported in the climate change negotiation process.

The **European Capacity Building Initiative (ECBI)** programme is directly linked to UNFCCC and is aimed at strengthening the negotiating group for developing countries, G77, in the climate change negotiations. Climate change negotiators from G77 and the EU are offered a unique platform for meetings and capacity development at which key concepts and technology transfer are discussed and analysed. According to an evaluation, the programme has contributed to developing countries having become more successful at speaking with one voice in the negotiations, and there has been increased understanding between negotiators from the different blocks. The developing countries have in a short time improved their prospects of achieving the long-term aim of strengthening the perspective of poor and vulnerable countries in the climate change negotiations. Swedish support totalled SEK 4.8 million over the period 2005-2007.

Sustainable City Planning in Pune

Sustainable City Planning Pune (SCPP) is a project in which Pune Municipal Corporation (PMC) and Sida cooperate. The programme aims to enhance skills in sustainable urban planning, focusing on mobility and physical planning. The project contains a number of different activities in the areas of physical planning, sustainable transport systems and high-quality public transport. The participants visited Sweden in May 2008 to hear about Swedish experience, for example, including from the eco-towns of Hammarby Sjöstad in Stockholm and Västa Hamnen in Malmö.

Sida's research cooperation is aimed at strengthening the research capacity of partner countries and promoting development-oriented research. This contains support to cooperating countries to create enabling research environments and training of research scientists and to develop methods to plan and prioritise research. Promoting development-oriented research means both financially and scientifically supporting the opportunities of partner countries to identify new knowledge in areas that are significant for their development.

Innovative climate research in Southeast Asia

Sida has cooperated with regional environmental economics research networks in Southeast Asia, Africa and Latin America for almost 15 years. The networks are based to varying degrees on the successful model EEPSEA (Economy and Environment Programme for Southeast Asia), which has been devised to strengthen research capacity in the area of environmental economics. Swedish support for 2005-2007 totalled SEK 29 million. The network is one of the more significant in southern Asia and assisted in the IPCC (Intergovernmental Panel on Climate Change) investigative protocol in 2007. The network's innovative research on the role of mangrove swamps in reducing the negative effects in cyclones and tsunamis has attracted great attention both locally and internationally. The network has also undertaken extensive mapping with regard to five climate change and disaster risk reduction-related threats – tropical cyclones, floods, earthquakes, drought and rising sea levels – which has been of great importance both for national policies and for international development assistance.

The cooperation pursued in natural science and technology, natural resources and the environment is relevant from the point of view of climate change. In addition, a contribution is made to capacity building for instance through support for the build-up of universities and research councils in developing countries. The 'sandwich method' used by Sida, which is based on alternating studies in the home country with studies abroad, has proved successful in enabling researchers and students to remain in their countries on completing their education and therefore not allowing the capacity to be lost through a 'brain drain'. Thematic research programmes in natural resources and the environment, technology and industrialisation, as well as natural science, are also funded.

Support for research on sustainable development in Mozambique

Since 1989, SIDA has been supporting work at the Department of Physics at the Eduardo Mondlane University (UEM) in Maputo in Mozambique to establish a fundamental structure for research and a favourable scientific climate. These initiatives have led to the first attempt to develop complex research in the area of sustainable environment in Mozambique. Swedish resources have contributed greatly to the development of capacity in the department with regard to both research and research training. UEM has identified greenhouse gas emissions due to uncontrolled forest fires, desert spread due to overuse of forest and land and air and soil pollution in connection with energy production, industry and mining as the environmental and climate change problems with the greatest potential to seriously undermine sustainable development in Mozambique. Sida has been supporting a research programme for energy, environment and climate change that conducts research on these areas since 2006.

8 Research and systematic observation

8.1 Policy, organisation and funding of R&D and systematic observation

8.1.1 Climate research policy

Swedish research efforts since the Fourth National Communication (NC4) have continued to focus on sustainable development and an interdisciplinary approach, but according to the latest research policy bill[57] Sweden's position as a research nation focused on innovation and competitiveness in a globalised world is to be strengthened. The research is largely to be undertaken in areas that are, or are likely to become, significant to human prosperity, the development of society and the competitiveness of trade and industry. The Government considers that climate impact is one of the great challenges facing humanity which cannot be addressed without new knowledge.

In the 2009 Climate Bill[58] there is feedback to those new strategic research efforts that are climate related. The climate-related strategic efforts relate to i) climate models, ii) effects on natural resources, energy research (including alternatives to fossil fuels, environment- and climate-adapted production of biomass for raw materials and biofuels, including industrial biotechnology), and iv) security and emergency preparedness (research to enhance emergency preparedness and strengthen security in a broad range of risks, threats, emergencies and disasters).

The greatest new resources go to energy research and the development of technologies that reduce the climate change impact of the energy and transport sectors, such as wind power, second-generation vehicle biofuels and hybrid vehicles. Closely linked to energy issues is sustainable exploitation of natural resources when there is need for an increase in energy sources from the agricultural and forestry sectors.

Research on the Baltic Sea has been further strengthened, and climate is a new area in this investment. Other important areas that relate to work on climate change are being strengthened, such as research on the vulnerability of society to and preparedness for climate change, as well as sustainable public planning, where large climate gains can be achieved.

Swedish research is also being strengthened for the Arctic, and the Swedish Polar Research Secretariat has been given new and expanded tasks, including responsibility for the scientific research station at Abisko in northern Sweden. The Swedish Polar Research Secretariat was already responsible for expeditions and research activity in the Arctic and Antarctic. As climate change has become an increasingly important social issue, polar research has come to focus on climate change and its consequences. Sweden has taken part in a large number of projects for the country during the International Polar Year and offers important research platforms for international collaboration on climate research in the Arctic, Antarctic and Northern Sweden, such as the icebreaker Oden, the satellite Odin and the research stations Abisko and Tarfala.

Nordic collaboration aimed for

The Nordic prime ministers have decided that the Nordic countries should invest in top-level research in the area of climate, energy and environment (the 'Top Research Initiative') with a joint programme totalling SEK 480 million over five years. By utilising networks that are already established, such NordForsk, the Nordic Innovation Centre and Nordic Energy Research, the programme is to coordinate initiatives on a Nordic level to integrate top-level research, innovation, trade and industry, national interests, Nordic added value and globalisation.

57 Ett lyft för forskning och innovation (A boost for research and innovation), Government Bill 2008/09:50.

58 An Integrated Climate and Energy Policy, Government Bill 2008/09: 162.

European collaboration

Sweden supports EU cooperation and takes part in several EU-funded networks, such as ERA-NET, which is a form of cooperation between funders to develop European research cooperation, exchange experience and conduct joint calls for proposals for research funds (see 8.2).

Participation in the European Space Agency (ESA) and the European Southern Observatory (ESO) principally contributes to the supply of observational data.

Global collaboration

Sweden and Swedish researchers take part in several global research activities, for example IPCC, World Climate Research Programme (WCRP), International Geosphere and Biosphere Programme (IGBP), International Human Dimension Programme (IHDP). Swedish research also contributes to cooperation in international facilities. By participating in the nuclear research organisation Conseil Européen pour la Recherche Nucléaire (CERN), Sweden has contributed to creating a platform for data storage, which as a secondary effect also assists with the storage of large quantities of climate data.

8.1.2 Organisation

Research funders

Central government and other parts of the public sector are the largest funders of research at universities and colleges. The most important public providers of research funding alongside the direct appropriations to universities and colleges from central government are research councils and some other research-funding authorities in support of their own activities. Research foundations and the EU, municipalities and county councils also fund research. If the private sector is also included, the business community is the largest funder of R&D.

Two research councils, the Swedish Research Council (VR) and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), are significant sources of funding for climate-related research. Government agencies that fund climate-related research and development are the Swedish Energy Agency, the Swedish Agency for Innovation Systems (VINNOVA) and the Swedish Environmental Protection Agency.

Public funds for research and development also include research funded by certain research foundations. Among these, the Swedish Foundation for Strategic Environmental Research (MISTRA) is particularly significant in the context of climate. The Foundation is not controlled by the Government or the Swedish Government, but the Government appoints board members.

The Swedish Space Agency funds satellite measurements relevant to climate as part of its national research and remote-sensing programmes.

The Swedish Energy Agency, MISTRA and the Swedish Environmental Protection Agency have had a joint website[59] since 2004 on which they present their current climate-oriented research programmes.

Performers

Almost two-thirds of publicly funded research in Sweden is performed at universities and colleges. Among other public research performers there are industry research institutes and certain sector agencies.

All the universities and university colleges have their own research resources and undertake research. Other research-performing institutions of significance to climate research are the Stockholm Environment Institute, the Stockholm Resilience Centre[60] at Stockholm University, the Swedish University of Agricultural Sciences and the Swedish Institute of Agricultural and Environmental Engineering. The Bert Bolin Centre for Climate Research[61] focusing on climate and geosciences has recently been established at Stockholm University. The Rossby Centre at the Swedish Meteorological and Hydrological Institute is responsible for national climate modelling. In addition there is a Centre for Climate Science and Policy Research at Linköping University.

Centres or other forms of organisation have been created at most universities in order to improve the prospects for coordination of research and training, often in dialogue with industry and society.

8.1.3 Funding

The combined research investment in climate and climate-related energy research totalled an average of around SEK 1.2 billion over the period 2005-2008. The majority, averaging SEK 800-850 million annually, was addressed to climate-related energy research via the Swedish Energy Agency's research programme, whereof a large part to development and demonstration projects. Around SEK 80 million per year has been distributed to research on the climate system and climate models, just over SEK 180 million/year to research on effects and adaptation and socio-economic analyses. This does not in-

59 www.sweclipp.se.
60 www.stockholmresilience.org.
61 www.bbcc.su.se.

clude the faculties' general basic state funding. Nor do these sums include state funds for research in developing countries.

The total appropriations for research were sharply increased in the government budget for 2010-2012. Together with the 2009 increase, total public allocations reach one per cent of GDP, which follows the Government's definition of the formulation in the Lisbon Agenda. The annual research appropriations increase by SEK 5 billion from 2012, of which just over SEK 500 million relates to research focused on climate and energy.

Research funding over the period 2005-2008 indicates a greatly increased focus on climate-related issues. The principal funders the Swedish Research Council, FORMAS, VINNOVA, and where appropriate the Swedish Space Agency have had several initiatives targeted at the climate system, the effects of climate change and adaptation.

The Foundation for Strategic Environmental Research (Mistra), which adopts a broad approach in its research funding, has also invested in research on changed processes in industry to reduce emissions of greenhouse gases with an environmental and climate impact, particulates and other pollutants.

Sector funders such as the Swedish Energy Agency and the Swedish Environmental Protection Agency fund several long-term research programmes focused on climate, or climate-related issues.

The Swedish Space Agency part-funds the satellite Odin and contributes to the European Space Agency (ESA) and Global Monitoring for the Environment and Security (GMES), which mostly relates to improved environmental monitoring.

The Swedish International Development Cooperation Agency (Sida) provides support to the capacity building of developing countries by undertaking its own research as a basis for work among other things on adaptation to climate change.

As well as financing research, government funds are spent on infrastructure for data storage.

8.1.4 Systematic 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 effects on ecosystems, for example changes in vegetation and soil.

Demands for measurements related to vegetation and soil conditions are increasing. Some government agencies[62] have created a joint archive of satellite data[63]. Multispectral, optical satellite data covering the whole of Sweden is added to the archive annually at 10-30 metres resolution, gathered during the vegetation period. The archive helps users to study changes in the Swedish landscape and the environment over the past three decades. Sweden has a well developed systematic observation system, and the length of Swedish measurement series in many cases is unparalleled in the world.

Responsible organisations

The **Swedish Meteorological and Hydrological Institute** (SMHI) provides society with meteorological, hydrological and oceanographic data and is responsible for the long-term build-up and operation of the national databases. Through SMHI, Sweden contributes to establishing monitoring systems in certain developing countries.

SMHI represents Sweden at the World Meteorological Organisation (WMO), the Intergovernmental Oceanographic Commission and the Group on Earth Observations (GEO). GEO has been tasked with establishing, by 2015, a world-wide system, Global Environment Observation System of Systems (GEOSS), containing earth observation data from various space- and ground-based sources. SMHI represents Sweden on ECMWF and in the Europe-wide satellite programmes in EUMETSAT, of which climate monitoring has become an increasingly essential part.

The Swedish Environmental Protection Agency is responsible for the coordination of environmental monitoring. Environmental monitoring contributes to following the effects of climate change in all biogeochemical systems, but also to following the long-term trend in the effects of the measures on ecosystems and society. Government-funded environmental monitoring is divided into ten different programme areas: air, coast and sea, freshwater, wetland, forest, agricultural land, mountain areas, landscape, toxic substances coordination and health-related environmental monitoring.

The Swedish Environmental Protection Agency represents Sweden at the European Energy Agency (EEA), which coordinates European monitoring, and in the UN Environmental Programme, and is the Focal Point for the UN's Intergovernmental Panel on Climate Change (IPCC).

The **Swedish Space Agency** represents Sweden at the European Space Agency (ESA), FP 7 Theme Space and on the GMES[64] Advisory Council (GAC).

62 The national land survey organisation Lantmäteriet, the Swedish Environmental Protection Agency, the Swedish Forest Agency and the Swedish Meteorological and Hydrological Institute (SMHI).

63 www.saccess.lantmateriet.se.

64 Global Monitoring for the Environment and Security.

The Swedish Space Agency additionally works on bilateral and multilateral satellite projects, one example of which is the satellite ODIN, with stratospheric ozone monitoring.

The **Swedish University of Agricultural Sciences** (SLU), through its continuous environmental analysis, is responsible for a large part of Swedish environmental monitoring. It conducts an inventory of forest and land in the National Forest Inventory (RIS) programme, which covers everything from forest and soil status to environmental monitoring of biodiversity and carbon sequestration in forest and soil.

8.2 Programmes for and funding of climate-related research

It is becoming increasingly difficult to place research initiatives under a particular heading as programmes are tending to become increasingly interdisciplinary. The research programme SWECIA[65], *Mistra SWEdish research programme on Climate, Impacts and Adaptation*, can be taken as an example of this. SWECIA (divided below into various areas) is an interdisciplinary research programme that covers climate processes, climate impacts, climate economics and adaptation to a changed climate. The research areas are studied in an integrated manner and are to contribute to building knowledge of impact and adaptation research in Sweden with climate modelling and the development of regional scenarios as key elements of the programme.

Another problem is that the research funds awarded for example by the Swedish Research Council go to individual projects that are in competition. It is therefore difficult to ascertain whether these funds are also used in larger programme initiatives.

8.2.1 Climate processes and climate systems, including palaeoclimatic studies

The Climate Evolution, Variability and Sensitivity Programme focuses on transboundary research on climate trends. It has five main themes: climate variations, atmospheric and oceanic circulation, boundary conditions for the modelling of atmospheric and oceanic circulation, small-scale processes with large-scale climate effects, biochemical cycles (carbon and water cycles). Questions addressed include whether cloud formation is affected by emissions of greenhouse gases and particulates by modern society, the role of the greenhouse effect for the global climate and warming in the Arctic.

Research on the carbon cycle in offshore areas of the Baltic Sea contributes knowledge for climate researchers who attempt to incorporate the seas into their models. The research does not just apply specifically to the Baltic Sea but is also intended to describe processes in other seas.

Stockholm University, SMHI and the Rossby Centre are taking part in several international projects, contributing for instance to the EU project BALTEX, which focuses on hydrology, climate and water management in the catchment area of the Baltic Sea.

Swedish researchers are taking part in programmes for research on sustainable development in developing countries, with projects for instance on carbon dynamics in agricultural soils in sub-Saharan Africa.

8.2.2 Modelling and scenarios (including GCMs)

The Rossby Centre focuses on climate modelling and the development of regional scenarios that can be used in impact and adaptation studies, among other things in the research programme SWECIA. Sweden takes part through the Rossby Centre in the EU FP6 project ENSEMBLES and Climate and Energy Systems (CES), which is funded by the Nordic Council. A common feature is the development of credible climate scenarios for the 20th century for Europe. Sweden is also taking part in the EU FP6 project DAMOCLES, which is intended to increase understanding of, and examine the options for modelling, changed sea-ice conditions in the Arctic. Rossby has contributed to this cooperation with the very first linked regional climate scenarios for the Arctic.

Sweden is also active in the European Earth Modelling Consortium, which is to develop a Global Earth System Model. The work is taking place at the European Centre for Medium Range Weather Forecasts (ECMWF), which is to contribute a large ensemble of General Circulation Model (GCM) scenarios to the international cooperation to compare models (5th Coupled Model Intercomparison Project (CMIP5)) under the WCRP (World Climate Research Programme). CNIP5 is the principal tool for the next IPCC evaluation. The Rossby Centre also takes part in the efforts of the WCRP to coordinate work on a down-scaling of CMIP5 of the global scenarios to assist in obtaining better resolution for Africa in particular.

65 The programme is funded by the Swedish Foundation for Strategic Environmental Research (MISTRA) and is a cooperation between SMHI, the Stockholm Environment Institute (SEI), the Department of Meteorology (MISU) and the Institute for International Economic Studies at Stockholm University (IIES), as well as the Department of Physical Geography and Ecosystem Analysis (INES) at Lund University.

8.2.3 Impacts of climate change

The SWECIA programme looks at impacts on the basis of modelling as a tool. Changes in water resources in Lake Mälaren, for instance, are studied by converting climate scenarios into hydrological models. Another impact study in the programme is the stimulation of forests and forestry by developing a dynamic vegetation model that also includes forest stewardship and disturbance dynamics. SWECIA is also developing models that cover Arctic terrestrial ecosystems.

Monitoring, experimental and modelling activity takes place at the Abisko Scientific Research Station (ANS). ANS hosts a unique set of long-term experiments of environmental manipulation that attract researchers from all parts of the world. The purpose of the experiments is to understand how increased carbon dioxide levels, UVB radiation, ground temperature, air temperature and snow depth affect ecosystems and their processes. Recently, a study has been initiated on how ecosystems are affected by warm periods in mid-winter. Research on permafrost and methane emissions has been in progress over a long period, and carbon flows in the catchment area are measured continuously.

At the research station in Tarfala annual glacier measures have been made since 1946. Research that also contributes to monitoring is done in meteorology, hydrology, snow-chemistry and ice-chemistry measurements and permafrost.

During the International Polar Year ice-core samples were taken for analysis of the changing climate. Further, carbon flows from Siberia out to the Arctic Ocean, permafrost melting and coastal erosion were studied, as well as the significance of Arctic summer clouds for the climate system in the Arctic.

8.2.4 Socioeconomic analyses (incl. impacts of climate change, adaptation needs and possible adaptation measures)

A 10-year programme[66] focusing on the interface between social science and natural science, between knowledge and action, is being funded at Lund University[67] with the emphasis on problem-solving research and critical examination among other things of climate change, loss of biodiversity and how land use is changing.

The Stockholm Resilience Centre[68] conducts interdisciplinary research and integrates social sciences, the humanities and natural science. The focus is on continued production of ecosystem services for human prosperity, and building resilience for long-term sustainable development.

The principal task of the research programme CLIMATOOLS[69] is to develop new tools that can be used for local/regional and sectoral climate adaptation work. The focus is on the ability to deal with the uncertainties climate change brings with it in the short and medium term. The programme is intended, for instance, to devise a new method for scenario-based decision support (convergence seminars) suited to climate adaptation and a manual for the analysis of the health effects of climate change and provide guidance instructions for adaptation strategies.

The International Climate Policy Programme[70] comprises several research projects focused on market-based instruments, such as the flexible mechanisms of the Kyoto Protocol and the EU's emissions trading scheme, research on the development and formulation of future international climate agreements and on the interaction between policy, legislation and economics and the impact this has on the outlook for climate-policy measures.

The General Energy Systems Studies Programme[71] (AES) and the Energy Systems Programme[72], are both aimed at contributing to wide-ranging knowledge of how the energy system works and of 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. Several of the research projects in the programmes are closely linked to the issue of climate change.

The ELAN programme[73] focuses on the energy use of households and man's use of technology. The research under this programme is undertaken by multidisciplinary research teams in technological and behavioural science.

The Nordic Energy Perspectives project analyses political objectives at national and international level in the area of energy, their impact on the Nordic energy markets and the various energy systems. The objective is to analyse and identify consequences of different strategic decisions in a dialogue between research scientists and decision-makers, as well as for market players and the general public.

66 Linneaus grant around SEK 10m for 10 years.

67 Lund University Centre of Excellence for integration of social and natural dimensions of sustainability (LUCID).

68 Stockholm University, Beijer Institute of Ecological Economics at the Royal Swedish Academy of Sciences and the Stockholm Environment Institute (SEI). Funded by MISTRA, among others.

69 Cooperation between the Swedish Defence Research Agency (FOI), the Royal College of Technology and Umeå University, and funded by the Swedish Environmental Protection Agency.

70 Funded by the Swedish Energy Agency.

71 Funded by the Swedish Energy Agency.

72 Funded by the Swedish Energy Agency.

73 Funded by Elforsk.

The LUCSUS[74] centre at Lund University is intended to pursue issues of sustainable development by initiating and coordinating interdisciplinary research proposals. A large part of this research takes place under EU programmes such as Adaptation and Mitigation Strategies (ADAM).

Sweden takes part in the European ERA-NET CIRCLE (Climate Impact Research Cooperation within a Larger Europe), which is focused on impacts of and adaptation to a changed climate. Sweden has conducted a joint call for proposals within this ERA-NET with Finland and Norway on the consequences of climate change on climate policy.

8.2.5 Measures for emissions reduction and adaptation to climate change

An interdisciplinary research programme[75], studying ways in which Sweden can steer towards low-carbon and sustainable energy and transport systems in 2050, will run until 2012 at Lund University in cooperation with Luleå University.

The Clipore programme[76], in which several universities both in Sweden and in India, Norway and the United States are involved, is focused on the implementation of future international climate policy. This programme was launched in 2004 and was renewed in 2007 for another five years. The programme is to be implemented during this second period in close integration with the negotiation process in UNFCCC and the formulation of policy after Kyoto and EU greenhouse gas emissions trading. Alternative policy instruments, particularly for sectors not included in the trading scheme, are analysed and how these could be linked to the trading scheme. The programme is also focused on developing countries and policy instruments.

IVL is developing a national Integrated Assessment Modelling (IAM) model in close cooperation with IIASA. This activity is intended to contribute assessments of future policy on air pollution and provide a basis for optimising measures that can achieve both air and climate policy goals at low cost.

A research programme for forest[77], which takes the form of a strategy for forest and forest-industry research, is intended to develop new knowledge for sustainable forestry. Examples of such knowledge are water quality, nutrient cycles, biodiversity and adaptations to – and mitigation of – climate change.

Several parallel programmes[78] are aimed at closing the cycle for the paper and pulp industry, processes in the steel industry to reduce the use of resources, reduce energy use and use the energy that is formed in the processes.

Five centres of expertise and around fifty research and development programmes in various scientific areas are funded under the Energy Research Programme[79] . The programme was presented in NC4, and only a brief summary therefore follows here.

- Issues relating to sustainable energy production principally with biofuels are studied in fuel-based energy systems. Particular attention is paid to measures concerned with the commitments under the Kyoto Protocol, as well as the EU's climate targets and targets for renewable energy by 2020.
- The research area of transport focuses on production of renewable vehicle fuels and more efficient vehicle engines powered by alternative fuels. The research is intended to study the relationship between powertrains, renewable vehicle fuels and emissions, particularly carbon dioxide.
- In the research area of electricity production and power transmission there is research on the renewable forms of energy wind power, solar power and tidal power and the development and modernisation of hydropower and combined heat and power.
- In the area of construction, research is focused on reducing the energy needs of buildings and replacing fossil fuels with renewable ones.
- In the area of industry, efforts are focused on the pulp and paper industry, as well as the steel, chemical and mining and mineral industries. More efficient utilisation of energy in energy-demanding process stages is aimed for in particular here. This applies both to electricity and heating, and to both fossil and renewable energy sources. Vehicle fuels derived from forest biomass are an important area of development.

8.2.6 International cooperation on climate-related research and support for developing countries

Swedish researchers cooperate with developing countries on agricultural research through CGIAR[80], in which 16 different research institutions in developing countries take part. Swedish Research Links promotes collaboration between Swedish researchers and scientists in Asia, the Middle East, North Africa and South Africa. There are a number of re-

74 Lund University Centre for Sustainability Studies, LUCSUS.

75 www.lets2050.se Funded by the Swedish Environmental Protection Agency, the Swedish Energy Agency, VINNOVA and the Swedish Road Administration.

76 Climate Policy Research Programme, funded by Mistra.

77 Future Forests, funded by Mistra.

78 Read about the programmes at www.mistra.se.

79 Funded by the Swedish Energy Agency.

80 The Consultative Group on International Agricultural Research is funded by Sida/SAREC.

search networks with different orientation, for example in environmental technology[81], environmental economics[82] and policy. Research cooperation in Mozambique relates to energy, the environment and climate, where greenhouse gases are studied as a consequence of uncontrolled forest fires, desert spread as a consequence of overexploitation of forest and arable land, and air and soil pollution associated with energy production, industry and mining. A research cooperation programme in Honduras together with Uppsala University is studying how adapting the courses of rivers can reduce the risks of flooding.

Atmospheric Brown Clouds (ABC) Asia is a research cooperation programme between Asia, the United States and Europe relating to how brown clouds from the burning of wood and cowpats regionally can contribute to warming of the climate. Sweden supported the project through Sida between 2003 and 2008, principally for operations in Asia. New measuring stations have been installed, and studies have been done on impacts on agriculture, access to water and health. Asian research scientists have taken part in order to enhance their expertise and improve the prospects of their institutions taking part in international cooperation.

8.3 Programmes and funding for systematic observation

The basic part of systematic observation comprises measures in meteorology, hydrology and oceanography. 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 in which there are particularly great deficiencies at present, including in the Nordic region.

In the framework of the International Polar Year, a compilation[83] has been made of previous and ongoing measurements of a monitoring nature relating primarily to the Scandinavian polar region. The observation network within the Arctic is to be included in the Global Climate Observing System (GCOS), where the Sustaining Arctic Observing Network (SAON), is also intended in the longer term to be part of the Global Environment Observation System of Systems (GEOSS). Sweden will be able to contribute a large quantity of climate-related data from the north of the country.

8.3.1 National plans, programmes and support for ground-based and space-based climate observations and participation in international cooperation

The principles of systematic monitoring established in GCOS have an impact on Swedish systematic observations. Efforts have been made to ensure that uninterrupted series of observations of high quality are retained, by managing automation with the greatest precision when stations at remote sites are converted from being manned to automatic.

An important aspect in the ongoing development of observation systems in Sweden is creating synergies between meteorology, hydrology, oceanography and climate and environment systems. The significance of older data for a deeper understanding of the climate and its variations has increased as a result of improved methods for carrying out re-analyses of different variables. Continuous work on digitising older data is in progress.

Satellites have created a new dimension in climate and environmental monitoring by providing an overview of surface values and the vertical distribution of climate or environmental components. It is now possible to measure total dimensions and tropospheric columns of a number of greenhouse gases and reactive gases from space, as well as concentration profiles.

Sweden has developed a National Geodata Strategy. This strategy is based on EU directives such as PSI and Inspire, but is linked to access to national and international environmental and climate data. There are Swedish activities for archiving and creating better access to climate data from research programmes. An assessment of quality and usability and of whether these observations can be included in a sustainable climate observation network will be made from the large supply of research results.

Data and measurements in Swedish environmental monitoring contribute to follow-up of climate effects regionally, which is an important step towards global understanding of the problem of climate change. The Swedish monitoring of terrestrial systems which may be of particular interest regionally covers, for example, soil type, land use, vegetation type, biomass and groundwater.

Monitoring of biomass and land use

The National Inventory of Landscapes in Sweden (NILS) is a programme under the national environmental monitoring of the Swedish Environmental Protection Agency. The primary aim is to monitor

81 ARRPET, Asian Institute of Technology.
82 SANDEE and EEPSEA Climate Vulnerability in Southeast Asia.
83 Swedish Environmental Monitoring North of 60oN: Grip, H. and Olsson H. ISBN 978-91-7307-152-9, (in the press).

the essential conditions for biodiversity in a landscape perspective. Monitoring takes place through the interpretation of aerial photography and field inventories, in a network of over 600 fixed sample plots of 5x5 km over all kinds of soil types. Satellite-based monitoring of changes in vegetation and physical excavations in wetlands came into operation in 2007. A project aimed at following the impacts of climate change focusing on the mountain areas started in 2009. The shift in the tree and forest line will be monitored.

Under the Swedish Space Agency's national remote sensing programme, a project relating to satellite monitoring of protected tropical forests (World Heritage Tropical Forests) and mapping of illegal logging is being supported.

Monitoring of change in carbon balance

Climate-related environmental monitoring is undertaken through the National Forest Inventory, which encompasses the National Forest Survey and the Forest Soil Inventory. These monitoring programmes are important in tracking changes in forest and soil, and the quantity of carbon sequestrated in vegetation. The National Forest Survey forms part of the Official Statistics of Sweden, and there are data going back to 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 has made a substantial contribution to better quality in recent years.

Other national observing systems

There are further databases containing terrestrial data with potential for climate-related work through climate research and climate observation at the Swedish Mapping, Cadastral and Land Registration Authority (Lantmäteriet), the Swedish University of Agricultural Sciences (SLU), the SLU Environmental Data Centre (freshwater, coast and sea), the Geological Survey of Sweden (SGU) (groundwater), the Swedish Meteorological and Hydrological Institute (SMHI).

8.3.2 Participation in international cooperation for systematic climate observations incl. GCOS

Sweden contributes to GCOS with long-term observations and measurements of temperature, precipitation, wave height, icing, variations in glaciers etc., "Essential Climate Variables" (ECV). Measurement from satellite-based systems is also required for observations with global, regional and national coverage. Sweden contributes to several international programmes within the task to fulfil the objectives of the *"Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC"*.

Atmospheric monitoring

SMHI contributes atmospheric data to the WMO's World Weather Watch (WWW), which is forwarded to GCOS. In cooperation within EUMETNET, Sweden contributes data on wind and temperature obtained at various levels through civil aviation, and weather radar contributes information on wind and precipitation. Nordic cooperation and cooperation with EUMETNET are in progress for studies on moisture in the atmosphere.

Monitoring of the sea

SMHI hosts the European EuroGOOS secretariat, and is taking part at the European scale to increase access to data and improve measurement activity, particularly in coastal zones (SEPRISE).. Similar activities are taking place in the Baltic Sea, where the Baltic Operational Oceanographic System (BOOS) is responsible for coordination and buoys have been established by Sweden, among other nations.

Monitoring of land

SMHI reports water flow data to the Global Terrestrial Observing System, GTOS/ Global Runoff Data Centre (GRDC).

As well as the transfer of observational data, Swedish institutions are taking part in research and development of systematic observation, for example in the EU-funded project Carbo-North, which is focused in improving methods for the quantification of discharge and removal of carbon dioxide from soil in northern Russia.

Sweden's contributions to satellite data for climate monitoring; EUMETSAT – ESA – GMES – GEOSS

Under the EUMETSAT programme, Sweden contributes to the development of satellite products for climate monitoring at various scales and assists through Jason-2 in the monitoring of the dynamics of the oceans and of sea levels.

One of Sweden's most important research and development contributions is refined mapping of clouds and cloud characteristics obtained from data

provided by the combination of operational and research satellites.

Under the cooperation programme of the European Space Agency (ESA), the Swedish Space Agency assists in the development of new generations of meteorological satellites and other remote-sensing satellites for studies of the Earth and its climate system. In addition, the Swedish Space Agency, together with ESA, contributes towards ensuring continued operation of the Swedish-cooperated satellite Odin. Research satellites, including the environmental satellite ENVISAT, have contributed since 2001, and will continue to contribute, to our understanding of climate.

Sweden joined a new ESA programme for Global Monitoring of Essential Climate Variables (ECV) in 2008. This programme is aimed at utilising old, existing data that can be used to improve the reliability of climate models, for example through re-analyses. There is an understanding in the climate research community today that the ESA's previous and current satellites with research assignments are of great significance for climate issues, particularly terrestrial EC variables.

Sweden contributes to the development of a new infrastructure for global observation systems and services based on remote analysis in the European programme Global Monitoring for Environment and Security (GMES). GMES provides strong development of new measuring systems, processing and integration of satellite and ground-based data relating to land, sea and atmosphere. The aim of the programme is to commission continuous observation systems and develop a range of different services for operational purposes. Essential climate variables (ECV) will be dealt with under climate-related services and will contribute to knowledge for instance on the carbon cycle and its relationship to carbon dioxide.

GMES is the EU's contribution to GEOSS. GMES is therefore a programme that comprises objectives both in the implementation plan for CGOS and in an equivalent plan for GEOSS. Sweden consequently also contributes in this way to the international monitoring system demanded in the climate negotiations.

9 Education, training and public awareness

9.1 Policy for education, training and public awareness

In Sweden communication on climate change and on climate-related measures is an important aspect of efforts to reduce emissions with a climate impact. Swedish agencies such as the Swedish Environmental Protection Agency, the Swedish Energy Agency and the Swedish Road Administration communicate on the issue of climate change on behalf of the Government in their areas of responsibility and have many years of experience of knowledge transfer and information as a policy instrument.

Non-governmental organisations and other information centres also contribute to knowledge building and dialogue about the problems of and solutions to climate change. Climate change, its causes and its effects today are thoroughly familiar to the general public.

An information effort was conducted in 2006-2008 with the aim of increasing knowledge of the causes and consequences of climate change, passing on the latest research findings on the topic and identifying ways of reducing greenhouse gas emissions. To stimulate knowledge building locally, public education and information initiatives relating to the problem of climate change have been a mandatory requirement in order to be awarded government investment grants for local-authority climate measures.

9.2 Mass media and the issue of climate change

News reporting on the issue of climate change in the media has increased steadily over the past five years. 2007 was a record year in terms of the number of articles published, prompted by the breakthrough brought about by Al Gore in public debate, the publication of the IPCC's Fourth Assessment Report and the Stern report.

The Swedish media in several cases have taken the step from merely reporting on climate events to becoming part of the efforts to take remedial action. Several major newspapers and television channels now have climate websites which, among other things, offer guidance or tips on how individuals can reduce their climate impact.

9.3 Public awareness

The attitudes of the Swedish people and their knowledge of the problem of climate change have been studied by conducting surveys since 2002. The results indicate a gradual rise in awareness of climate change over the years, and provide a picture of the preparedness and willingness of the Swedish population for change in order to reduce emissions associated with their own lifestyle and consumption.

According to the 2008 survey on public attitudes to climate change the willingness of Swedish people to reduce their own greenhouse gas emissions has continued to increase. People are increasingly prepared to move from words to action. A large majority of the Swedish population also want to see Swedish initiatives to reduce climate impact. An ambitious climate policy can therefore be assumed to have public backing.

9.4 Climate information centres

The ***Swedish Environmental Protection Agency (Swedish 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 envi-

ronmental efforts of other actors by developing and passing on knowledge, formulating requirements and levels of aspiration and following up and evaluating. Climate is a priority area, and the Agency has gradually expanded the website www.naturvardsverket.se/klimat to include news reporting, facts and information on climate change, measures and research in this area. Promoting reporting on climate by the media in various ways has been an important strategy in the efforts of the Swedish Environmental Protection Agency in recent years to increase awareness and knowledge of the problem of climate change and solutions to it among the public. Special electronic newsletters with the function of summarising and disseminating Swedish and international climate-related news have contributed to broad media interest in climate issues.

The ***Swedish Energy Agency*** is the government agency for energy issues and as such is responsible for information and advice on more efficient energy use aimed at both the general public and companies. The Agency's website www.energimyndigheten.se contains extensive information on the energy use of households and what can be done to reduce it. Alongside energy-saving tips for the general public there is also special information for schools (energy knowledge for teachers and pupils). The results of tests on the energy consumption of various appliances have been published on the website since 2008. The Swedish Energy Agency organises, funds and takes part in a number of activities based on the local or regional level.

The ***Swedish Consumer Agency*** is Sweden's central administrative authority for consumer issues, with principal responsibility for implementing government consumer policy. The Agency's remit includes having to integrate the work that follows from its responsibility for environmental and sustainability issues and its special responsibility for efforts relating to environmental objectives into its regular activities. Notable among its climate information efforts aimed at the general public is information on the climate label Svanen (The Swan). The Agency's website www.konsumentverket.se serves as a portal for its own consumer information and that of other authorities.

The ***Swedish Meteorological and Hydrological Institute (SMHI)*** develops and distributes information on weather, water and climate with the aim of providing knowledge and a high-quality basis for decision-making for the functions of society, the business community and the general public. The website www.smhi.se contains extensive material: general information on climate change and analyses of regional and local climate impacts. It is also possible to download a selection of climate scenario data (maps) and study climate indicators (temperature, precipitation, extreme precipitation, sea levels).

The ***Swedish Road Administration*** is a government agency tasked with ensuring that the road transport system is of a good standard, is economically efficient and is accessible to everyone. The agency has sector responsibility for the environment, which encompasses all environmental issues associated with the road transport system. The Swedish Road Administration works to reduce climate-impacting emissions by working towards more efficient vehicles, an increased share of renewable fuels and reduced demand for travel and transport. The website www.vv.se contains information on the environmental impact of road transport and how individual motorists can lower their emissions, for example through eco-driving and by choosing fuel-efficient vehicles.

Other information centres

The Swedish Museum of Natural History in Stockholm is a knowledge centre and meeting place for the public and experts with an interest in nature and the environment. Since 2004 it has housed a climate exhibition which is designed to provide basic knowledge of climate issues and about what can be done to curb climate change. The exhibition intersperses facts with experiences, and to date has been seen by around 800 000 people. A special "climate card", a free CD, enables visitors to access a website which is shaped by the choices the visitor makes in the exhibition – a way for the public to build their own website on climate on their home computers. The contents of the exhibition have been devised in cooperation between Stockholm University, the Swedish Environmental Protection Agency, the World Wide Fund for Nature (WWF) and SMHI.

The two largest study associations in Sweden are prioritising the issue of climate. The adult education association Studieförbundet Vuxenskolan offers courses around the country on a number of climate-related subjects such as eco-driving, the climate impact of foods etc. A campaign was launched in 2008 to improve knowledge of climate change in the Nordic region and the prospects of the Nordic region being an active player in the run-up to the negotiations on a new climate agreement at COP 15 in Copenhagen in 2009 (www.arenanorden.org). The Study Promotion Asso-

ciation (Studiefrämjandet) offers nationwide study circles with the goal of improving knowledge of the significance of the problem of climate change and what can be done to turn the trend in the right direction. Personal study materials on sustainable development form the basis for a series of study circles on everything from building solar panels to locally adapted courses on sustainable development. Cooperation takes place with several of the country's environmental organisations, including the Swedish Society for Nature Conservation and Swedish Friends of the Earth.

Swedish non-governmental organisations play an active part in the public debate on the climate issue, by creating arenas and meeting places for discussion, debate and action. The Internet is an important channel for knowledge transfer and the mobilisation of involvement.

- Swedish Society for Nature Conservation (SNF) – www.snf.se
- Keep Sweden Tidy Foundation – www.hsr.se
- Swedish Association of Green Motorists – www.gronabilister.se
- WWF – www.wwf.se
- Greenpeace – www.greenpeace.se
- Swedish Friends of the Earth – www.mjv.se

9.5 Initiatives and activities

Notable international compilations of knowledge, such as the IPCC's Fourth Assessment Reports (2007), Swedish compilations of knowledge such as the Swedish Commission on Climate and Vulnerability (2007)[84], and the report of the Swedish Government's Scientific Council on Climate Issues[85] have dominated information initiatives taken by Swedish authorities, organisations and other knowledge centres. A selection of initiatives and activities is presented here according to the structure of New Delhi Work Programme.

9.5.1 Education – activities targeted at schools

Pre-schools, schools and adult education in Sweden have a clear remit to contribute to socially, economically and ecologically sustainable development. The remit is formulated in national policy documents such as the Schools Act, curricula and syllabuses. The National Agency for Education is responsible for the *School for Sustainable Development* award (initiated in 2005), an initiative that has contributed to increased motivation for and interest in work on sustainable development in primary and lower secondary school. In-depth teaching on the climate issue is common at upper-secondary level.

Several universities and colleges of higher education offer courses on the scientific basis of climate and climate-related subjects, such as energy science and forest issues. There are various networks and centres of expertise. At the University of Karlstad, for example, there is a Centre for Climate and Safety which has the objective of gathering knowledge and experience of risks due to climate change.

Several authorities of knowledge centres offer climate information on the Internet targeted at schoolchildren of various ages. The Keep Sweden Tidy Foundation assists an increasing number of Swedish schools with targets and a structure for their environmental work through the *Green Flag* award. The problem of climate change, energy efficiency and economical use of resources are dealt with under the overarching objective of sustainable development.

SMHI receives school groups every year to inform them about the climate issue. There is a clear trend towards increasing numbers of schoolchildren wanting information in order to carry out special school projects.

Volunteers from Greenpeace, known as "green speakers", give lectures in schools on request. Interest in lectures has increased, and considerable scope has been given to the climate issue, which is a key issue for Greenpeace.

Information campaigns targeted at schools include the following:

- The school material *Energy Around the Baltic Sea* establishes links between energy, the environment and climate. This material is available in Swedish, English, Estonian, Latvian, Lithuanian, Polish and Russian[86].
- The EU projects *Active Learning* and *The Rainmakers*, which are targeted at school pupils and teachers, are aimed at teaching schoolchildren in the lower and middle stages of school (ages 7 to 13) to manage energy in a responsible and sustainable way[87].
- The project *The Forest in School* links theory and practice, with the aim of increasing knowledge of and interest in the forests and all the assets they represent, including the significance of forests for the climate[88].
- The *Climate Battle (Klimatkampen)* is a nationwide competition for upper-secondary students that rewards young people's ideas and suggestions for new solutions to the climate issue. The task is to find different ways of reducing contributions to the greenhouse effect[89].

84 http://www.sweden.gov.se/sb/d/574/a/96002.
85 http://www.regeringen.se/content/1/c6/08/69/66/fd457e80.pdf.
86 Swedish Energy Agency.
87 Swedish Energy Agency.
88 The Swedish Forest Agency together with the Swedish Forest Industries Federation, the Federation of Swedish Farmers and WWF.
89 IVL Swedish Environmental Research Institute, Swedish Society for Nature Conservation and E.ON Sweden.

9.5.2 Training – seminars etc.

Training and knowledge transfer at seminars have an important role to play in climate efforts in both authorities and companies. Training on the environment and climate often forms part of the work done by companies on environmental certification according to international standard (ISO and EMAS). The involvement of the business community in the climate issue is particularly evident in an increased number of seminars on climate and the environment as a driver of business development, and climate and energy experts from authorities and organisations are often among the speakers.

The Internet is often used for knowledge transfer and exchange of experience between and within authorities and organisations. An example is the *Climate Adaptation Portal*[90], containing factors and guidance for adaptation to a warmer climate. This portal is administered by SMHI. A larger number of lectures are also held at SMHI every year, and the audiences include companies, politicians, schools and organisations. Demand for the lectures has increased sharply since 2006.

Several regional authorities (county administrative boards) have held series of seminars on the climate issue during the period. Training courses on how requirements relating to the environment and climate can be set in procurement are held by a number of parties at national, regional and local level. The Swedish Environmental Protection Agency in 2008 published a new training package, "Climate Facts" on its website, containing facts, questions and answers on the greenhouse effect and climate change[91].

Two major conferences, Climate Forum and the Swedish National Energy Convention (Energitinget)[92] on the topic of climate and energy are held every year and attract thousands of listeners.

Sectors that have increased their level of communication on the consequences of climate change include agriculture and the forest industry. Under an internal Climate Project, the Swedish Board of Agriculture has held a number of lectures, seminars and workshops for employees.

Forest owners have also increasingly been provided with information on the impact of climate change on forestry, such as climate scenarios, adapted insect control and more storm-proof forestry methods. The Internet and the magazine Skogseko are important channels[93].

Of note in the agricultural area is the nationwide advisory project *Focus on Nutrients*, with the objective of reducing the environmental impact of agriculture through information and training for farmers. Climate has been a focal area since the autumn of 2008, and climate training is offered to the advisors in Focus on Nutrients. The target is firstly for the climate issue to be fully integrated into advice by 2010, and secondly for farmers to be offered special climate advice. In addition, information is provided on new findings regarding how future climate change will affect the technical systems of the farmed landscape, such as subsoil drainage, bunding and irrigation systems.

9.5.3 Public awareness – campaigns and activities targeted at the public

The number of public activities with a climate focus has increased steadily since 2005. Several authorities have purposefully expanded information on the Web for households concerning climate change and what can be done. There is a noticeable trend towards consumption being increasingly linked to the problem of climate change. There is, for example, a noticeably increased quantity of books, Internet sites and information materials offering advice and guides on how personal carbon footprints can be reduced. The climate impact of foods has come into sharp focus over the period.

Of note in the local climate investment programmes that have been carried out at municipal level are information activities such as campaigns to increase travel by public transport, exhibitions, information to owners of houses on the environmental gains in replacing heating systems etc.

Causes/impacts/adaptation

Substantial efforts were made in 2007 to ensure that the IPCC's Fourth Assessment was available to broad target groups[94]. The reports from the IPCC's three working groups, as well as the *Summary for policymakers*, were translated into Swedish and the conclusions were highlighted at three full-day seminars open to the public.

Greenpeace's *Palm Oil Campaign* (2007) was aimed at informing the public about the harmful impact of palm oil on the rainforest in Indonesia and its consequences for the climate.

Transport

The Swedish Vehicle Inspection has sent out some 2.4 million environmental booklets since 2006 together with notice of the annual mandatory vehicle inspection. In this booklet, car owners can read about how the adverse impact of cars on the environment

90 http://www.smhi.se/cmp/jsp/polopoly.jsp?d=9315&l=sv.
91 www.naturvardsverket.se/kunskap.
92 http://www.sverigesenergiting.se/.
93 http://www.svo.se/episerver4/templates/SNormalPage.aspx?id=11310.
94 Swedish Environmental Protection Agency with several cooperating partners.

can be reduced, for example through changes in driving style and better car maintenance.

The Swedish Consumer Agency every year produces the brochure *Nybilsguiden (New Car Guide)*, which contains tips on the fuel consumption and carbon dioxide emissions of new cars and tips on how the fuel consumption and other environmental impact of cars can be reduced. There are also climate messages in the information distributed by the Swedish Road Administration to private motorists on the importance of correct tyre pressure and on reduced speed for improved road safety.

The Swedish Association of Green Motorists pushes the development of environmentally sound road transport for instance by examining proportions of green cars in local authorities. This organisation also assists with advice and support in the purchasing of green cars, publishes an annual list of the greenest cars and in various ways highlights climate initiatives in the road transport sector.

The Swedish Environmental Protection Agency, the Swedish Road Administration and the Swedish Consumer Agency annually present statistics on the climate impact of new cars. Statistics show the vehicle population broken down by county and municipality and broken down by owner – legal entities and physical persons and men and women. They also contain information on what types of cars are bought and present an aggregate picture of the Swedish vehicle population and how it is changing over time.

Energy use

The multi-year campaign *Become Energy-Smart* was initiated in 2006 and provides the public with advice on how energy use in the home can be reduced. The campaign includes the exhibition "The Energy-Smart House", which visits several locations every year. The information material contains an energy calculator which calculates the costs of investments that reduce energy needs in houses. Information is also given on the impact of the investment on the environment in terms of greenhouse gas emissions.

The *municipal energy and climate advisers* are an important channel to the public. Households and companies can obtain advice and support free of charge here on heating, energy costs, energy efficiency, transport, climate, government grants in the area of energy and much else besides. The advisory activity is aimed at the public, small and medium-sized enterprises and organisations. It is offered in the majority of Swedish municipalities and is financially supported by central government through the Swedish Energy Agency. The municipalities' climate and energy advisory service is supported by the regional energy offices, which provide training and coordinate information activities.

Swedish variants of international campaigns such as *Power Switch* and *Coal Train* occurred during the period, with the aim of instigating a switch to sustainable energy supply.

Consumption/climate labelling

The Internet-based tool the *Envirometer* (Swedish Consumer Agency) identifies a person's environmental impact in an easy-to-understand way. It enables an estimate to be made of what a change in behaviour means for energy use.

Information on food that has a lower climate impact and simple ways of saving electricity in the kitchen is distributed by a number of actors. Work on the development of a climate-labelling scheme for foods is under way as a cooperative venture between central government and various industry bodies.

The Swedish Environmental Management Council offers a method for the climate declaration of products under the international EPD system (www.klimatdeklaration.se[95]). The climate declaration takes an overall view of the climate impact of products and can be used by manufacturing companies, but also by procurement officers and consumers wishing make climate-sound purchases.

The National Food Administration endeavours to increase consumers' knowledge of what the climate and environmental impact of food production and consumption ("the food chain") looks like. The agency works on the development of dietary advice to help people make "environment and climate smart" food choices. Initiatives have been taken at the same time for climate-labelled foods.

9.5.4 Public participation and public access to information – strategies for and examples of opportunities for public participation

There are good opportunities in Sweden to ask questions and express views on an area of knowledge or political proposal through consultation procedures and open meetings/hearings and seminars. Special initiatives are also taken to increase public participation in climate work. The activities range from Internet-based question boxes to open consultation. Non-governmental organisations often establish Internet-based forums or appeals which the public are encouraged to think about.

95 For further information on international EPD see: www.environdec.com.

Authorities and organisations at national level also regularly answer verbal and written questions from the public.

9.5.5 International cooperation – efforts to pass on Swedish results abroad

Special measures have been taken to pass on experience gained in Swedish climate strategy. Presentations on the Swedish climate campaign have been made in Iceland, with participants from all the Nordic countries, but also in New Zealand. In Hungary, Eastern European countries were informed about the newsletter *Global News on Climate Action*.

There has been great interest from foreign media in Swedish efforts relating to information as a policy instrument. Examples of countries that have shown interest are the United States, Canada, Vietnam, Poland, China, Germany, Ireland, the United Kingdom and Lithuania. This work has also been the subject of side-events at the national climate negotiations. On Bali in 2007 (COP 13) a joint side-event was held with France and the United Kingdom to report on the strategic work involving measurements of public attitudes to and knowledge of the climate issue and work on special newsletters. The issue was also illustrated at a side-event in Poznan in 2008 (COP 14).

SMHI, in cooperation with the consultancy SWECO and the Stockholm Environment Institute, has conducted information campaigns since 2007 under the international training programme *Climate Change – Mitigation and Adaptation*. The training is funded by Sida (Swedish International Development Cooperation Agency), with the overarching aim of increasing knowledge of the causes and effects of climate change in developing countries. The target group is individuals in leading positions in administration, national or local, non-governmental organisations, universities or companies.

Sida's Civil Society Centre has created a platform on which Swedish and international NGOs can interact and take part in the global dialogue on climate and justice issues.

The Swedish Forest Agency in 2007 initiated cooperation with forest authorities in US states in the mid-west. This cooperation covers activities focused on exchange of experience and knowledge concerning opportunities and problems regarding the role of the forests in work on climate change. Since 2008 Sweden has also been leading a development process on bioenergy and climate through the Swedish Forest Agency in the pan-European cooperation body on forest policy development MCPFE (Ministerial Conference on the Protection of Forests in Europe).

To contribute to improved effectiveness of climate information around the world and implementation of the New Delhi Work Programme, Sweden held an international workshop in 2009 in cooperation with the UNFCCC secretariat. The purpose was to contribute to knowledge building on climate information by passing on experience of successful climate information initiatives in Europe. All the examples of best practice contributed by the countries will be collated in an on-line publication on the UNFCCC website Climate Change Information Network (CC:iNet).

9.5.6 Networking – networks that are used to pass on information and communicate the climate issue – in Sweden and abroad

A number of networks with a differing orientation focus on the climate issue.

The Network for Climate and Vulnerability is a network of national authorities aimed at providing regional and local authorities with information linked to public planning and adaptation to a warmer climate. The Network communicates through the Internet-based Climate Adaptation Portal.

Networking in programmes or projects is a common form of cooperation at local level. An example is Sustainable Municipality – a programme in which 63 municipalities have taken part since the summer of 2008. Several professional groups are involved, such as public planning officers and energy officers. The municipalities are putting together a strategy on energy and climate.

The network *Climate-Neutral Goods Transport* is a cooperative project between the Centre for Environment and Sustainability at Chalmers and Gothenburg University, Preem AB, Schenker AB, Volvo Trucks and the Swedish Road Administration. Its work is aimed at reducing carbon dioxide emissions, with the target of halving the climate impact of goods transport by road by 2020.

For food producers there is the network *Food and Climate*, which is aimed at providing greater knowledge and understanding of the climate impact of producers and strengthening their market positions. The participants meet regularly and benefit from each other's experiences *(SIK – Swedish Institute for Food and Biotechnology)*.

BLICC Sverige (Business Leaders Initiative on Climate Change) forms part of the international climate network Respect BLICC. BLICC Sweden contains several large Swedish companies which are endeavouring to reduce their greenhouse gas emissions.

Annex 1: Acronyms and abbreviations

ACEA	European Automobile Manufacturers' Association
AES	Allmänna energisystemstudier (General Energy System Studies)
AfDB	African Development Bank
AMBER:	Assessment and Modelling Baltic Ecosystem Response; Bonus Era-Net
AOGCM	Atmosphere-Ocean General Circulation Model
APCF	Asia Pacific Carbon Fund
AR4/WGI	Assessment Report 4/Working Group 1
Arpège	Action de Recherche Petite Echelle Grande Echelle, climate model at METEO France, France
AUC	African Union Commission
BALTEX	Baltic Sea Experiment
BASREC	Baltic Sea Region Energy Cooperation
BCM	Bergen Climate Model, climate model at Nansen Environmental Remote Sensing Centre, Norway
GDP	Gross Domestic Product
BONUS:	Baltic Organisations Network for Funding Science
C	Celsius
CCSM3	Community Climate System Model, version 3.0, developed at NCAR, USA
CDM	Clean Development Mechanism
CES	Climate and Energy Systems (funded by Nordic Energy Research)
CFC	Chlorofluorocarbons
CIRCLE	Climate Impact Research Coordination for a Larger Europe.
CLARIS LPB	A Europe-South America Network for Climate Change Assessment and Impact Studies La Plata Basin
CO_2-eq:	Carbon dioxide equivalent
CNRM	Centre National de Recherches Météorologiques at METEO France, France
CPA:	Climate Proof Areas
ECHAM	Global climate model developed from the atmospheric model ECMWF in Hamburg, at the Max-Planck-Institut für Meteorologie, Germany
ECMWF	European Centre for Medium Range Weather Forecasts
ECOSUPPORT	Advanced tool for scenarios of the Baltic ECOsystem
EIA	Environment Impact Assessment
EMAS	Eco-Management and Audit Scheme
ENSEMBLES	Collective expertise of 66 institutes to produce a reliable quantitative risk assessment of long-term climate change and its impacts.
ERA	European Research Area
ERA-NET	European research cooperation between regional and national funders
ERA-NET-CIRCLE	Climate Impact research Cooperation within a larger Europe
EU	European Union
EU ETS	The EU emissions trading scheme
EU/FP6	The EU's sixth framework programme for research and development
EU/FP7	The EU's seventh framework programme for research and development
EUMETSAT	European organisation for satellite cooperation in meteorology
FAME	Fatty acid methyl esters
FORMAS	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
UN	United Nations
FSC	Forest Stewardship Council.
GCCA	Global Climate Change Alliance
GCM	General Circulation Model
GEF	Global Environment Facility
GEO	Group on Earth Observations

GMES	Global Monitoring for the Environment and Security
Geoland2	Main programme for terrestrial applications in GMES
HadCM3	Hadley Centre Coupled Model, version 3
HadAM3H/ HadCM3	Linked atmosphere-ocean model at Hadley Centre
HCFC	Hydrochloroflurocarbons
HFC	Incompletely halogenated fluorocarbons
IBRD	International Bank for Reconstruction and Development
ICAO	International Civil Aviation Organisation
IDA	International Development Association
IFC	International Financial Corporation
IIED	International Institute for Environment and Development
IMO	International Maritime Organisation
INFLOW	Holocene saline water inflow changes into the Baltic Sea, ecosystem responses and future scenarios, BONUS Era-Net.
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
IVL	IVL Swedish Environmental Research Institute
JI	Joint Implementation
KTH	Royal Institute of Technology
kWh	KiloWatt-hour
LDCF	Least Developed Countries Fund
LUCSUS	Lund University Centre for Sustainability Studies
LULUCF	Land Use, Land-Use Change and Forestry
MDG	Millennium Development Goals
MIGA	Multilateral Investment Guarantee Agency
Mistra	Foundation for Strategic Environmental Research
MPI-Met	Max-Planck-Institut für Meteorologie in Hamburg, Germany
MSEK	Million Swedish kronor
MTR	Mid Term Review
MUSD	Million US dollars
MWh	MegaWatt-hour
NC	National Communication
NCAR	National Center for Atmospheric Research, USA
NERSC	Nansen Environmental Remote Sensing Centre, Norway
NGOs	Non-Governmental Organisations
PCF	Prototype Carbon Fund
PEFC	Promoting Sustainable Forest Management
PFC	Perfluorocarbons
PFE	Programme for energy efficiency in energy-intensive industry
PPP	Purchasing Power Parity
RCA	The Rossby Centre's regional climate model
RCA3/ ECHAM4	The Rossby Centre's regional climate model RCA3, with boundary conditions from the global climate model ECHAM4
RCAO-ECHAM4	The Rossby Centre's regional linked atmosphere-ocean model with boundary conditions from the global climate model ECHAM4
RET	Renewable Energy Technologies
SCB	Statistics Sweden
SCCF	Special Climate Change Fund
SEA	Strategic Environmental Assessment
SEI	Stockholm Environment Institute
SENSA	Swedish Environmental Secretariat for Asia
SF_6	Sulphur hexafluoride
Sida	Swedish International Development Cooperation Agency
SIDS	Small Island Developing States
SIKA	Swedish Institute for Transport and Communications Analysis
SLU	Swedish University of Agricultural Sciences
SMHI	Swedish Meteorological and Hydrological Institute
SWECIA	Swedish research programme on Climate, Impacts and Adaptation
TGF	Testing Ground Facility
TPES	Total primary energy supply
TWh	TeraWatt-hour
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
VINNOVA	Swedish Agency for Innovation Systems
VR	Swedish Research Council
WCRP	World Climate Research Programme
WMO	World Meteorological Organisation
WWF	World Wide Fund for Nature

Annex 2:
Summary emissions tables

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1990
Submission 2009 v1.1
SWEDEN

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]	**24 122,70**	**6 710,69**	**8 559,41**	**3,85**	**376,82**	**107,49**	**39 880,94**
1. Energy	**51 570,17**	**421,78**	**1 321,01**				**53 312,96**
A. Fuel Combustion (Sectoral Approach)	50 469,88	416,90	1 304,31				52 191,08
1. Energy Industries	9 830,65	22,15	328,53				10 181,32
2. Manufacturing Industries and Construction	11 150,05	46,08	529,07				11 725,20
3. Transport	18 332,78	104,70	144,61				18 582,09
4. Other Sectors	10 311,30	243,00	276,50				10 830,80
5. Other	845,11	0,96	25,60				871,67
B. Fugitive Emissions from Fuels	1 100,29	4,88	16,70				1 121,87
1. Solid Fuels	789,03	0,07	2,20				791,31
2. Oil and Natural Gas	311,26	4,81	14,50				330,56
2. Industrial Processes	**4 400,73**	**5,75**	**897,85**	**3,85**	**376,82**	**107,49**	**5 792,48**
A. Mineral Products	1 919,29	NA	NA				1 919,29
B. Chemical Industry	68,80	0,53	831,61	NA	NA	NA	900,94
C. Metal Production	2 412,64	0,11	NA	NA	376,82	23,90	2 813,47
D. Other Production	NE	5,11	66,24				71,35
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				3,85	NA,NE,NO	83,59	87,43
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**242,27**		**90,22**				**332,49**
4. Agriculture		**3 407,22**	**5 975,70**				**9 382,92**
A. Enteric Fermentation		3 058,06					3 058,06
B. Manure Management		349,16	728,02				1 077,17
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 247,68				5 247,68
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, Land-Use Change and Forestry[1]	**-32 134,32**	**1,72**	**79,22**				**-32 053,37**
A. Forest Land	-35 471,29	1,50	57,50				-35 412,29
B. Cropland	4 047,99	IE,NE	21,70				4 069,69
C. Grassland	-645,57	0,22	0,02				-645,32
D. Wetlands	39,60	IE,NE,NO	IE,NE,NO				39,60
E. Settlements	-105,05	IE,NE	IE,NE				-105,05
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**43,85**	**2 874,22**	**195,40**				**3 113,48**
A. Solid Waste Disposal on Land	NE,NO	2 874,22					2 874,22
B. Waste-water Handling		IE,NE,NO	195,40				195,40
C. Waste Incineration	43,85	NE	NE				43,85
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	3 563,03	0,51	53,24				3 616,78
Aviation	1 335,16	0,20	16,67				1 352,03
Marine	2 227,87	0,31	36,57				2 264,75
Multilateral Operations	**0,05**	**0,00**	**0,00**				**0,05**
CO_2 Emissions from Biomass	**11 436,68**						**11 436,68**
		Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry					71 934,32
		Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry					39 880,94

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1991
Submission 2009 v1.1
SWEDEN

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]	**23 523,00**	**6 697,36**	**8 446,00**	**7,94**	**380,25**	**108,51**	**39 163,05**
1. Energy	**52 407,33**	**437,07**	**1 350,89**				**54 195,29**
A. Fuel Combustion (Sectoral Approach)	51 212,79	432,22	1 335,80				52 980,81
1. Energy Industries	11 005,80	25,78	355,49				11 387,06
2. Manufacturing Industries and Construction	11 172,48	45,31	543,69				11 761,48
3. Transport	17 874,06	108,06	131,68				18 113,80
4. Other Sectors	10 091,09	251,96	273,59				10 616,64
5. Other	1 069,36	1,11	31,35				1 101,83
B. Fugitive Emissions from Fuels	1 194,54	4,85	15,09				1 214,48
1. Solid Fuels	938,27	0,09	2,55				940,91
2. Oil and Natural Gas	256,27	4,76	12,54				273,57
2. Industrial Processes	**4 239,34**	**6,08**	**945,35**	**7,94**	**380,25**	**108,51**	**5 687,47**
A. Mineral Products	1 739,06	NA	NA				1 739,06
B. Chemical Industry	69,55	0,53	874,55	NA	NA	NA	944,63
C. Metal Production	2 430,73	0,11	NA,NO	NA,NO	379,44	23,90	2 834,18
D. Other Production	NE	5,44	70,80				76,24
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				7,94	0,81	84,61	93,35
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**231,12**		**89,06**				**320,18**
4. Agriculture		**3 334,58**	**5 811,32**				**9 145,91**
A. Enteric Fermentation		2 993,01					2 993,01
B. Manure Management		341,57	707,89				1 049,46
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 103,44				5 103,44
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, Land-Use Change and Forestry[1]	**-33 407,00**	**1,61**	**60,92**				**-33 344,47**
A. Forest Land	-36 662,92	1,38	33,62				-36 627,92
B. Cropland	3 832,70	IE,NE	27,28				3 859,98
C. Grassland	-493,84	0,22	0,02				-493,59
D. Wetlands	36,59	IE,NE,NO	IE,NE,NO				36,59
E. Settlements	-119,53	IE,NE	IE,NE				-119,53
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**52,20**	**2 918,01**	**188,46**				**3 158,67**
A. Solid Waste Disposal on Land	NE,NO	2 918,01					2 918,01
B. Waste-water Handling		IE,NE,NO	188,46				188,46
C. Waste Incineration	52,20	NE	NE				52,20
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	3 727,88	0,53	57,13				3 785,55
Aviation	1 088,16	0,16	14,25				1 102,56
Marine	2 639,73	0,37	42,88				2 682,98
Multilateral Operations	**0,05**	**0,00**	**0,00**				**0,05**
CO_2 Emissions from Biomass	**12 152,72**						**12 152,72**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				72 507,52
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				39 163,05

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1992
Submission 2009 v1.1
SWEDEN

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]	**26 013,51**	**6 783,62**	**8 340,05**	**10,12**	**252,42**	**108,40**	**41 508,11**
1. Energy	**52 351,26**	**438,45**	**1 354,91**				**54 144,62**
A. Fuel Combustion (Sectoral Approach)	51 305,50	433,54	1 338,46				53 077,50
1. Energy Industries	11 614,09	22,71	364,28				12 001,08
2. Manufacturing Industries and Construction	10 205,40	52,43	523,73				10 781,55
3. Transport	18 991,60	101,27	156,21				19 249,09
4. Other Sectors	9 373,01	256,06	261,40				9 890,47
5. Other	1 121,39	1,07	32,85				1 155,31
B. Fugitive Emissions from Fuels	1 045,76	4,91	16,44				1 067,12
1. Solid Fuels	749,89	0,07	2,19				752,15
2. Oil and Natural Gas	295,87	4,84	14,25				314,96
2. Industrial Processes	**4 093,91**	**6,09**	**912,55**	**10,12**	**252,42**	**108,40**	**5 383,49**
A. Mineral Products	1 649,76	NA	NA				1 649,76
B. Chemical Industry	53,26	0,56	842,04	NA	NA	NA	895,86
C. Metal Production	2 390,89	0,11	NA,NO	NA,NO	251,61	23,90	2 666,52
D. Other Production	NE	5,42	70,51				75,93
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				10,12	0,81	84,50	95,42
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**218,72**		**107,57**				**326,29**
4. Agriculture		**3 418,58**	**5 731,25**				**9 149,83**
A. Enteric Fermentation		3 065,55					3 065,55
B. Manure Management		353,03	724,09				1 077,12
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 007,16				5 007,16
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, Land-Use Change and Forestry[1]	**-30 708,70**	**1,62**	**52,24**				**-30 654,84**
A. Forest Land	-34 136,25	1,40	23,70				-34 111,15
B. Cropland	3 638,94	IE,NE	28,52				3 667,46
C. Grassland	-441,66	0,22	0,02				-441,42
D. Wetlands	39,60	IE,NE,NO	IE,NE,NO				39,60
E. Settlements	190,67	IE,NE	IE,NE				190,67
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**58,33**	**2 918,88**	**181,52**				**3 158,73**
A. Solid Waste Disposal on Land	NE,NO	2 918,88					2 918,88
B. Waste-water Handling		IE,NE,NO	181,52				181,52
C. Waste Incineration	58,33	NE	NE				58,33
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	3 908,85	0,55	61,96				3 971,37
Aviation	899,65	0,12	12,97				912,74
Marine	3 009,20	0,43	49,00				3 058,62
Multilateral Operations	**0,05**	**0,00**	**0,00**				**0,05**
CO_2 Emissions from Biomass	**13 066,89**						**13 066,89**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				72 162,95
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				41 508,11

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1993
Submission 2009 v1.1
SWEDEN

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]	**27 749,38**	**6 831,20**	**8 466,64**	**29,66**	**290,97**	**96,66**	**43 464,51**
1. Energy	**51 807,48**	**439,58**	**1 395,87**				**53 642,93**
A. Fuel Combustion (Sectoral Approach)	50 772,90	434,15	1 378,22				52 585,27
1. Energy Industries	11 464,38	29,33	358,00				11 851,71
2. Manufacturing Industries and Construction	10 979,89	52,40	556,74				11 589,02
3. Transport	18 113,98	89,81	179,06				18 382,85
4. Other Sectors	9 333,52	261,80	261,55				9 856,88
5. Other	881,13	0,81	22,87				904,81
B. Fugitive Emissions from Fuels	1 034,58	5,43	17,65				1 057,66
1. Solid Fuels	718,01	0,07	2,07				720,15
2. Oil and Natural Gas	316,57	5,36	15,58				337,51
2. Industrial Processes	**4 140,12**	**6,19**	**891,00**	**29,66**	**290,97**	**96,66**	**5 454,60**
A. Mineral Products	1 670,60	NA	NA				1 670,60
B. Chemical Industry	54,76	0,51	818,50	NA	NA	NA	873,77
C. Metal Production	2 414,76	0,11	NA,NO	NA,NO	288,41	23,90	2 727,18
D. Other Production	NE	5,57	72,50				78,07
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				29,66	2,56	72,76	104,97
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**207,88**		**107,26**				**315,14**
4. Agriculture		**3 563,14**	**5 835,25**				**9 398,39**
A. Enteric Fermentation		3 160,20					3 160,20
B. Manure Management		402,94	659,65				1 062,60
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 175,60				5 175,60
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, Land-Use Change and Forestry[1]	**-28 454,11**	**1,67**	**55,66**				**-28 396,78**
A. Forest Land	-31 844,24	1,45	20,92				-31 821,87
B. Cropland	3 851,43	IE,NE	34,72				3 886,15
C. Grassland	-477,32	0,22	0,02				-477,08
D. Wetlands	38,39	IE,NE,NO	IE,NE,NO				38,39
E. Settlements	-22,37	IE,NE	IE,NE				-22,37
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**48,02**	**2 820,61**	**181,60**				**3 050,22**
A. Solid Waste Disposal on Land	NE,NO	2 820,61					2 820,61
B. Waste-water Handling		IE,NE,NO	181,60				181,60
C. Waste Incineration	48,02	NE	NE				48,02
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	4 252,34	0,59	65,12				4 318,04
Aviation	1 229,95	0,16	15,99				1 246,10
Marine	3 022,39	0,43	49,13				3 071,94
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**14 206,56**						**14 206,56**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			71 861,28
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			43 464,51

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1994
Submission 2009 v1.1
SWEDEN

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)]	**33 590,09**	**6 753,92**	**8 527,45**	**72,73**	**311,73**	**100,20**	**49 356,12**
1. Energy	**54 221,64**	**444,39**	**1 424,51**				**56 090,54**
A. Fuel Combustion (Sectoral Approach)	52 866,07	438,77	1 408,57				54 713,41
1. Energy Industries	11 960,53	34,46	374,55				12 369,53
2. Manufacturing Industries and Construction	12 033,65	58,55	591,88				12 684,08
3. Transport	18 739,16	92,49	166,81				18 998,46
4. Other Sectors	9 357,19	252,57	257,16				9 866,92
5. Other	775,54	0,71	18,17				794,41
B. Fugitive Emissions from Fuels	1 355,58	5,62	15,94				1 377,13
1. Solid Fuels	1 094,70	0,10	2,98				1 097,78
2. Oil and Natural Gas	260,87	5,52	12,97				279,35
2. Industrial Processes	**4 397,56**	**6,24**	**863,66**	**72,73**	**311,73**	**100,20**	**5 752,12**
A. Mineral Products	1 755,66	NA	NA				1 755,66
B. Chemical Industry	57,14	0,60	791,81	NA	NA	NA	849,55
C. Metal Production	2 584,76	0,12	NA,NO	NA,NO	308,05	26,29	2 919,22
D. Other Production	NE	5,53	71,85				77,38
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				72,73	3,68	73,91	150,32
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**197,12**		**95,79**				**292,91**
4. Agriculture		**3 597,72**	**5 904,92**				**9 502,64**
A. Enteric Fermentation		3 191,71					3 191,71
B. Manure Management		406,01	669,34				1 075,35
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 235,58				5 235,58
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, Land-Use Change and Forestry[(1)]	**-25 275,31**	**1,60**	**56,89**				**-25 216,81**
A. Forest Land	-28 258,05	1,38	18,43				-28 238,24
B. Cropland	3 605,74	IE,NE	38,44				3 644,18
C. Grassland	-576,61	0,22	0,02				-576,37
D. Wetlands	41,98	IE,NE,NO	IE,NE,NO				41,98
E. Settlements	-88,37	IE,NE	IE,NE				-88,37
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**49,08**	**2 703,96**	**181,68**				**2 934,72**
A. Solid Waste Disposal on Land	NE,NO	2 703,96					2 703,96
B. Waste-water Handling		IE,NE,NO	181,68				181,68
C. Waste Incineration	49,08	NE	NE				49,08
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	4 910,50	0,68	74,91				4 986,10
Aviation	1 350,69	0,17	17,20				1 368,07
Marine	3 559,81	0,51	57,71				3 618,03
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**15 698,09**						**15 698,09**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				74 572,93
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				49 356,12

(1) For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1995
Submission 2009 v1.1
SWEDEN

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]	**32 469,98**	**6 667,14**	**8 397,66**	**127,13**	**343,43**	**126,68**	**48 132,02**
1. Energy	**53 261,29**	**451,39**	**1 436,42**				**55 149,10**
A. Fuel Combustion (Sectoral Approach)	51 849,05	445,50	1 418,51				53 713,07
1. Energy Industries	11 061,07	37,90	350,33				11 449,31
2. Manufacturing Industries and Construction	12 492,34	57,01	609,88				13 159,23
3. Transport	18 636,11	85,47	188,75				18 910,34
4. Other Sectors	8 955,25	264,35	253,50				9 473,10
5. Other	704,27	0,76	16,05				721,09
B. Fugitive Emissions from Fuels	1 412,23	5,89	17,91				1 436,04
1. Solid Fuels	1 110,37	0,10	2,97				1 113,44
2. Oil and Natural Gas	301,87	5,79	14,94				322,60
2. Industrial Processes	**4 504,30**	**6,31**	**798,76**	**127,13**	**343,43**	**126,68**	**5 906,61**
A. Mineral Products	1 967,53	NA	NA				1 967,53
B. Chemical Industry	57,77	0,63	726,46	NA	NA	NA	784,86
C. Metal Production	2 479,00	0,11	NA,NO	NA,NO	334,65	26,29	2 840,05
D. Other Production	NE	5,57	72,31				77,87
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				127,13	8,78	100,39	236,30
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**184,86**		**123,69**				**308,55**
4. Agriculture		**3 510,92**	**5 789,13**				**9 300,06**
A. Enteric Fermentation		3 094,98					3 094,98
B. Manure Management		415,95	635,59				1 051,53
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 153,55				5 153,55
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, Land-Use Change and Forestry[1]	**-25 523,21**	**1,61**	**63,71**				**-25 457,89**
A. Forest Land	-28 550,73	1,39	21,53				-28 527,81
B. Cropland	3 547,22	IE,NE	42,16				3 589,38
C. Grassland	-552,15	0,22	0,02				-551,91
D. Wetlands	46,20	IE,NE,NO	IE,NE,NO				46,20
E. Settlements	-13,75	IE,NE	IE,NE				-13,75
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**42,74**	**2 696,91**	**185,94**				**2 925,59**
A. Solid Waste Disposal on Land	NE,NO	2 696,91					2 696,91
B. Waste-water Handling		IE,NE,NO	185,94				185,94
C. Waste Incineration	42,74	NE	NE				42,74
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	4 937,53	0,76	74,80				5 013,09
Aviation	1 437,04	0,26	18,21				1 455,52
Marine	3 500,48	0,50	56,58				3 557,57
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**16 495,50**						**16 495,50**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				73 589,91
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				48 132,02

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1996
Submission 2009 v1.1
SWEDEN

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]	**31 592,34**	**6 631,79**	**8 523,86**	**205,35**	**302,91**	**108,40**	**47 364,66**
1. Energy	**56 856,51**	**467,34**	**1 601,26**				**58 925,11**
A. Fuel Combustion (Sectoral Approach)	55 629,82	461,44	1 583,96				57 675,22
1. Energy Industries	15 001,85	52,30	529,07				15 583,21
2. Manufacturing Industries and Construction	12 532,60	55,27	596,48				13 184,34
3. Transport	18 386,39	81,84	185,15				18 653,38
4. Other Sectors	9 044,47	271,38	257,15				9 573,00
5. Other	664,52	0,65	16,12				681,29
B. Fugitive Emissions from Fuels	1 226,69	5,91	17,30				1 249,89
1. Solid Fuels	956,13	0,09	2,61				958,82
2. Oil and Natural Gas	270,56	5,82	14,69				291,07
2. Industrial Processes	**4 424,05**	**6,24**	**769,34**	**205,35**	**302,91**	**108,40**	**5 816,31**
A. Mineral Products	1 877,86	NA	NA				1 877,86
B. Chemical Industry	58,90	0,65	698,14	NA	NA	NA	757,68
C. Metal Production	2 487,30	0,11	NA,NO	NA,NO	289,65	31,07	2 808,13
D. Other Production	NE	5,48	71,21				76,69
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				205,35	13,26	77,33	295,94
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**174,48**		**137,33**				**311,81**
4. Agriculture		3 482,72	5 774,48				9 257,20
A. Enteric Fermentation		3 061,25					3 061,25
B. Manure Management		421,47	634,16				1 055,63
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 140,32				5 140,32
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, Land-Use Change and Forestry[1]	**-29 911,83**	**1,72**	**64,34**				**-29 845,76**
A. Forest Land	-33 466,78	1,50	19,37				-33 445,91
B. Cropland	4 013,52	IE,NE	44,95				4 058,47
C. Grassland	-395,24	0,22	0,02				-394,99
D. Wetlands	40,81	IE,NE,NO	IE,NE,NO				40,81
E. Settlements	-104,13	IE,NE	IE,NE				-104,13
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**49,12**	**2 673,76**	**177,10**				**2 899,98**
A. Solid Waste Disposal on Land	NE,NO	2 673,76					2 673,76
B. Waste-water Handling		IE,NE,NO	177,10				177,10
C. Waste Incineration	49,12	NE	NE				49,12
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	5 183,66	0,73	79,21				5 263,61
Aviation	1 475,52	0,21	18,99				1 494,71
Marine	3 708,14	0,53	60,22				3 768,89
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**18 044,90**						**18 044,90**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			77 210,41
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			47 364,66

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1997
Submission 2009 v1.1
SWEDEN

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]	**22 532,79**	**6 578,70**	**8 431,13**	**313,40**	**279,69**	**153,10**	**38 288,81**
1. Energy	**52 494,99**	**435,61**	**1 441,84**				**54 372,45**
A. Fuel Combustion (Sectoral Approach)	51 326,36	429,71	1 424,73				53 180,81
1. Energy Industries	11 041,92	43,76	364,84				11 450,52
2. Manufacturing Industries and Construction	12 735,71	53,64	597,39				13 386,74
3. Transport	18 647,82	73,77	197,95				18 919,54
4. Other Sectors	8 292,19	257,96	250,28				8 800,43
5. Other	608,72	0,59	14,27				623,58
B. Fugitive Emissions from Fuels	1 168,63	5,90	17,11				1 191,64
1. Solid Fuels	886,28	0,08	2,44				888,80
2. Oil and Natural Gas	282,35	5,81	14,67				302,84
2. Industrial Processes	**4 200,44**	**6,61**	**766,19**	**313,40**	**279,69**	**153,10**	**5 719,43**
A. Mineral Products	1 746,27	NA	NA				1 746,27
B. Chemical Industry	58,40	0,64	690,00	NA	NA	NA	749,03
C. Metal Production	2 395,77	0,11	NA,NO	NA,NO	265,09	40,63	2 701,60
D. Other Production	NE	5,87	76,20				82,06
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				313,40	14,61	112,47	440,48
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**179,20**		**141,67**				**320,87**
4. Agriculture		**3 480,10**	**5 848,09**				**9 328,19**
A. Enteric Fermentation		3 067,79					3 067,79
B. Manure Management		412,31	647,35				1 059,66
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 200,74				5 200,74
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, Land-Use Change and Forestry[1]	**-34 392,44**	**8,79**	**65,06**				**-34 318,59**
A. Forest Land	-37 279,79	8,43	16,05				-37 255,31
B. Cropland	3 557,82	IE,NE	48,98				3 606,80
C. Grassland	-535,91	0,36	0,04				-535,51
D. Wetlands	48,58	IE,NE,NO	IE,NE,NO				48,58
E. Settlements	-183,15	IE,NE	IE,NE				-183,15
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**50,60**	**2 647,59**	**168,27**				**2 866,46**
A. Solid Waste Disposal on Land	NE,NO	2 647,59					2 647,59
B. Waste-water Handling		IE,NE,NO	168,27				168,27
C. Waste Incineration	50,60	NE	NE				50,60
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	5 908,66	0,82	90,82				6 000,30
Aviation	1 560,26	0,20	20,18				1 580,64
Marine	4 348,41	0,62	70,64				4 419,67
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**16 812,44**						**16 812,44**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				72 607,40
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				38 288,81

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1998
Submission 2009 v1.1
SWEDEN

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]	**21 167,51**	**6 404,72**	**8 419,54**	**386,42**	**271,86**	**99,38**	**36 749,43**
1. Energy	**52 973,52**	**407,83**	**1 426,03**				**54 807,38**
A. Fuel Combustion (Sectoral Approach)	51 831,83	401,94	1 409,37				53 643,13
1. Energy Industries	12 061,99	46,31	381,47				12 489,77
2. Manufacturing Industries and Construction	12 093,78	53,47	580,09				12 727,34
3. Transport	18 965,70	67,51	192,09				19 225,30
4. Other Sectors	8 228,08	234,18	244,45				8 706,71
5. Other	482,28	0,46	11,27				494,01
B. Fugitive Emissions from Fuels	1 141,70	5,89	16,66				1 164,25
1. Solid Fuels	847,33	0,08	2,29				849,70
2. Oil and Natural Gas	294,37	5,82	14,36				314,55
2. Industrial Processes	**4 244,87**	**6,51**	**849,44**	**386,42**	**271,86**	**99,38**	**5 858,48**
A. Mineral Products	1 802,06	NA	NA				1 802,06
B. Chemical Industry	54,01	0,65	774,68	NA	NA	NA	829,34
C. Metal Production	2 388,81	0,10	NA,NO	NA,NO	258,15	38,24	2 685,31
D. Other Production	NE	5,76	74,76				80,52
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				386,42	13,71	61,14	461,26
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**173,52**		**144,15**				**317,67**
4. Agriculture		**3 385,48**	**5 774,65**				**9 160,13**
A. Enteric Fermentation		2 977,63					2 977,63
B. Manure Management		407,85	648,01				1 055,86
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	5 126,64				5 126,64
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, Land-Use Change and Forestry[1]	**-36 273,57**	**0,46**	**65,46**				**-36 207,66**
A. Forest Land	-39 559,49	0,41	15,54				-39 543,54
B. Cropland	4 101,67	IE,NE	49,91				4 151,58
C. Grassland	-859,24	0,05	0,01				-859,18
D. Wetlands	40,19	IE,NE,NO	IE,NE,NO				40,19
E. Settlements	3,30	IE,NE	IE,NE				3,30
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**49,16**	**2 604,43**	**159,82**				**2 813,42**
A. Solid Waste Disposal on Land	NE,NO	2 604,43					2 604,43
B. Waste-water Handling		IE,NE,NO	159,82				159,82
C. Waste Incineration	49,16	NE	NE				49,16
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	6 690,30	0,94	103,25				6 794,49
Aviation	1 673,00	0,23	21,75				1 694,98
Marine	5 017,29	0,71	81,50				5 099,51
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**16 874,10**						**16 874,10**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			72 957,09
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			36 749,43

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1999
Submission 2009 v1.1
SWEDEN

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]	**20 184,45**	**6 258,19**	**7 984,54**	**489,45**	**291,29**	**101,65**	**35 309,57**
1. Energy	**50 385,95**	**398,25**	**1 365,68**				**52 149,88**
A. Fuel Combustion (Sectoral Approach)	49 221,81	392,92	1 347,98				50 962,71
1. Energy Industries	10 643,07	47,61	347,87				11 038,56
2. Manufacturing Industries and Construction	11 121,22	50,59	541,03				11 712,84
3. Transport	19 255,71	61,95	204,33				19 521,99
4. Other Sectors	7 792,89	232,37	245,08				8 270,35
5. Other	408,92	0,40	9,66				418,98
B. Fugitive Emissions from Fuels	1 164,13	5,32	17,71				1 187,16
1. Solid Fuels	864,21	0,08	2,35				866,65
2. Oil and Natural Gas	299,92	5,24	15,35				320,52
2. Industrial Processes	**4 011,34**	**6,30**	**762,63**	**489,45**	**291,29**	**101,65**	**5 662,66**
A. Mineral Products	1 750,09	NA	NA				1 750,09
B. Chemical Industry	53,63	0,37	686,83	NA	NA	NA	740,83
C. Metal Production	2 207,61	0,09	NA,NO	NA,NO	282,97	38,24	2 528,91
D. Other Production	NE	5,84	75,80				81,64
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				489,45	8,32	63,41	561,18
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**164,38**		**134,54**				**298,92**
4. Agriculture		**3 357,75**	**5 499,80**				**8 857,55**
A. Enteric Fermentation		2 951,06					2 951,06
B. Manure Management		406,69	606,63				1 013,32
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 893,17				4 893,17
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, Land-Use Change and Forestry[1]	**-34 425,41**	**2,96**	**70,05**				**-34 352,40**
A. Forest Land	-37 936,25	2,91	20,45				-37 912,89
B. Cropland	4 080,14	IE,NE	49,60				4 129,74
C. Grassland	-854,47	0,05	0,01				-854,41
D. Wetlands	58,19	IE,NE,NO	IE,NE,NO				58,19
E. Settlements	226,97	IE,NE	IE,NE				226,97
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**48,20**	**2 492,93**	**151,84**				**2 692,96**
A. Solid Waste Disposal on Land	NE,NO	2 492,93					2 492,93
B. Waste-water Handling		IE,NE,NO	151,84				151,84
C. Waste Incineration	48,20	NE	NE				48,20
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	6 788,19	0,94	103,03				6 892,16
Aviation	1 879,29	0,23	24,20				1 903,72
Marine	4 908,90	0,71	78,83				4 988,44
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**17 145,12**						**17 145,12**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				69 661,97
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				35 309,57

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2000
Submission 2009 v1.1
SWEDEN

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]	**17 689,93**	**6 074,77**	**7 891,86**	**564,63**	**240,52**	**93,59**	**32 555,30**
1. Energy	**48 967,43**	**383,19**	**1 331,81**				**50 682,44**
A. Fuel Combustion (Sectoral Approach)	47 753,83	377,86	1 314,01				49 445,70
1. Energy Industries	9 204,55	46,07	311,24				9 561,86
2. Manufacturing Industries and Construction	11 433,39	42,47	534,65				12 010,52
3. Transport	19 011,66	55,66	210,86				19 278,18
4. Other Sectors	7 704,82	233,35	247,59				8 185,76
5. Other	399,41	0,30	9,66				409,37
B. Fugitive Emissions from Fuels	1 213,61	5,33	17,80				1 236,74
1. Solid Fuels	860,64	0,08	2,29				863,01
2. Oil and Natural Gas	352,96	5,25	15,51				373,73
2. Industrial Processes	**4 202,70**	**7,16**	**737,86**	**564,63**	**240,52**	**93,59**	**5 846,46**
A. Mineral Products	1 987,03	NA	NA				1 987,03
B. Chemical Industry	47,74	0,56	653,47	NA	NA	NA	701,78
C. Metal Production	2 167,92	0,09	NA,NO	NA,NO	232,70	52,58	2 453,29
D. Other Production	NE	6,51	84,39				90,90
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				564,63	7,82	41,01	613,46
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**155,40**		**122,14**				**277,54**
4. Agriculture		**3 267,02**	**5 480,16**				**8 747,18**
A. Enteric Fermentation		2 877,05					2 877,05
B. Manure Management		389,97	594,15				984,12
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 886,01				4 886,01
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, Land-Use Change and Forestry[1]	**-35 680,04**	**2,95**	**73,77**				**-35 603,32**
A. Forest Land	-38 034,07	2,84	20,13				-38 011,09
B. Cropland	3 065,78	IE,NE	53,63				3 119,41
C. Grassland	-758,02	0,10	0,01				-757,91
D. Wetlands	62,41	IE,NE,NO	IE,NE,NO				62,41
E. Settlements	-16,13	IE,NE	IE,NE				-16,13
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**44,44**	**2 414,46**	**146,11**				**2 605,01**
A. Solid Waste Disposal on Land	NE,NO	2 414,46					2 414,46
B. Waste-water Handling		IE,NE,NO	146,11				146,11
C. Waste Incineration	44,44	NE	NE				44,44
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	6 696,87	0,90	100,97				6 798,74
Aviation	1 926,37	0,20	24,88				1 951,45
Marine	4 770,51	0,70	76,09				4 847,29
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**15 719,35**						**15 719,35**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				68 158,62
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				32 555,30

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2001
Submission 2009 v1.1
SWEDEN

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]	**21 865,98**	**6 045,35**	**7 750,77**	**611,88**	**235,61**	**111,49**	**36 621,08**
1. Energy	**49 445,59**	**388,17**	**1 363,26**				**51 197,03**
A. Fuel Combustion (Sectoral Approach)	48 353,18	382,99	1 346,27				50 082,43
1. Energy Industries	10 544,70	56,29	355,19				10 956,18
2. Manufacturing Industries and Construction	11 408,46	54,64	550,84				12 013,95
3. Transport	19 227,36	49,82	196,55				19 473,73
4. Other Sectors	6 896,93	222,06	237,33				7 356,32
5. Other	275,72	0,18	6,36				282,26
B. Fugitive Emissions from Fuels	1 092,41	5,19	17,00				1 114,60
1. Solid Fuels	775,97	0,07	2,05				778,10
2. Oil and Natural Gas	316,44	5,12	14,94				336,50
2. Industrial Processes	**4 467,03**	**7,30**	**575,91**	**611,88**	**235,61**	**111,49**	**6 009,21**
A. Mineral Products	2 031,33	NA	NA				2 031,33
B. Chemical Industry	46,74	0,76	492,59	NA	NA	NA	540,09
C. Metal Production	2 388,95	0,11	NA,NO	NA,NO	227,18	55,50	2 671,73
D. Other Production	NE	6,43	83,32				89,75
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				611,88	8,43	55,99	676,31
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**150,13**		**118,42**				**268,55**
4. Agriculture		**3 276,26**	**5 476,50**				**8 752,76**
A. Enteric Fermentation		2 846,74					2 846,74
B. Manure Management		429,52	551,13				980,65
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 925,36				4 925,36
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, Land-Use Change and Forestry[1]	**-32 244,24**	**3,01**	**74,71**				**-32 166,52**
A. Forest Land	-35 862,91	2,88	17,03				-35 843,00
B. Cropland	4 148,66	IE,NE	57,66				4 206,32
C. Grassland	-686,47	0,13	0,01				-686,33
D. Wetlands	62,99	IE,NE,NO	IE,NE,NO				62,99
E. Settlements	93,50	IE,NE	IE,NE				93,50
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**47,47**	**2 370,61**	**141,97**				**2 560,05**
A. Solid Waste Disposal on Land	NE,NO	2 370,61					2 370,61
B. Waste-water Handling		IE,NE,NO	141,97				141,97
C. Waste Incineration	47,47	NE	NE				47,47
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	6 525,56	0,86	98,05				6 624,46
Aviation	1 870,86	0,18	24,15				1 895,19
Marine	4 654,69	0,68	73,90				4 729,28
Multilateral Operations	**0,76**	**0,00**	**0,00**				**0,77**
CO_2 Emissions from Biomass	**18 850,32**						**18 850,32**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			68 787,59
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			36 621,08

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2002
Submission 2009 v1.1
SWEDEN

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]	**20 546,81**	**5 871,27**	**7 679,15**	**664,27**	**260,91**	**103,85**	**35 126,26**
1. Energy	**50 510,84**	**388,46**	**1 367,35**				**52 266,64**
A. Fuel Combustion (Sectoral Approach)	49 439,23	382,83	1 351,66				51 173,72
1. Energy Industries	11 586,14	59,26	382,80				12 028,20
2. Manufacturing Industries and Construction	11 365,45	47,91	535,04				11 948,40
3. Transport	19 802,36	46,99	190,79				20 040,14
4. Other Sectors	6 366,46	228,48	235,56				6 830,49
5. Other	318,83	0,19	7,46				326,49
B. Fugitive Emissions from Fuels	1 071,60	5,63	15,69				1 092,92
1. Solid Fuels	768,66	0,07	2,05				770,77
2. Oil and Natural Gas	302,95	5,56	13,64				322,15
2. Industrial Processes	**4 344,13**	**7,23**	**539,73**	**664,27**	**260,91**	**103,85**	**5 920,12**
A. Mineral Products	2 000,03	NA	NA				2 000,03
B. Chemical Industry	50,00	0,76	457,38	NA	NA	NA	508,14
C. Metal Production	2 294,10	0,10	NA,NO	NA,NO	247,69	65,87	2 607,76
D. Other Production	NE	6,38	82,35				88,73
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				664,27	13,22	37,98	715,47
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**148,45**		**127,14**				**275,59**
4. Agriculture		**3 256,71**	**5 431,90**				**8 688,61**
A. Enteric Fermentation		2 829,69					2 829,69
B. Manure Management		427,02	550,79				977,81
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 881,11				4 881,11
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, Land-Use Change and Forestry[1]	**-34 517,34**	**4,86**	**73,34**				**-34 439,14**
A. Forest Land	-37 656,06	4,54	11,93				-37 639,58
B. Cropland	3 674,63	IE,NE	61,38				3 736,01
C. Grassland	-510,95	0,32	0,03				-510,59
D. Wetlands	61,20	IE,NE,NO	IE,NE,NO				61,20
E. Settlements	-86,17	IE,NE	IE,NE				-86,17
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**60,73**	**2 214,01**	**139,69**				**2 414,43**
A. Solid Waste Disposal on Land	NE,NO	2 214,01					2 214,01
B. Waste-water Handling		IE,NE,NO	139,69				139,69
C. Waste Incineration	60,73	NE	NE				60,73
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	5 715,32	0,74	86,43				5 802,48
Aviation	1 611,37	0,14	21,03				1 632,53
Marine	4 103,95	0,60	65,40				4 169,95
Multilateral Operations	**0,84**	**0,00**	**0,00**				**0,84**
CO_2 Emissions from Biomass	**18 355,08**						**18 355,08**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			69 565,39
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			35 126,26

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2003
Submission 2009 v1.1
SWEDEN

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]	**22 251,55**	**5 733,46**	**7 648,39**	**709,46**	**258,30**	**68,88**	**36 670,03**
1. Energy	**51 202,28**	**400,11**	**1 400,64**				**53 003,04**
A. Fuel Combustion (Sectoral Approach)	50 212,52	395,21	1 383,61				51 991,34
1. Energy Industries	12 671,64	63,76	434,47				13 169,87
2. Manufacturing Industries and Construction	11 039,07	44,47	510,09				11 593,63
3. Transport	20 115,79	42,94	187,14				20 345,86
4. Other Sectors	6 086,55	243,87	244,88				6 575,30
5. Other	299,48	0,17	7,03				306,68
B. Fugitive Emissions from Fuels	989,75	4,91	17,04				1 011,69
1. Solid Fuels	671,12	0,06	1,83				673,01
2. Oil and Natural Gas	318,64	4,84	15,21				338,69
2. Industrial Processes	**4 453,34**	**7,65**	**533,13**	**709,46**	**258,30**	**68,88**	**6 030,76**
A. Mineral Products	1 939,42	NA	NA				1 939,42
B. Chemical Industry	47,74	0,76	445,73	NA	NA	NA	494,23
C. Metal Production	2 466,17	0,11	NA,NO	NA,NO	248,60	35,06	2 749,95
D. Other Production	NE	6,78	87,40				94,17
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				709,46	9,70	33,82	752,98
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**156,05**		**136,38**				**292,43**
4. Agriculture		**3 231,88**	**5 358,59**				**8 590,47**
A. Enteric Fermentation		2 783,28					2 783,28
B. Manure Management		448,60	520,28				968,89
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 838,30				4 838,30
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, Land-Use Change and Forestry[1]	**-33 636,62**	**6,05**	**80,90**				**-33 549,67**
A. Forest Land	-36 095,27	5,65	14,21				-36 075,41
B. Cropland	2 739,88	IE,NE	66,65				2 806,53
C. Grassland	-167,13	0,40	0,04				-166,68
D. Wetlands	56,39	IE,NE,NO	IE,NE,NO				56,39
E. Settlements	-170,50	IE,NE	IE,NE				-170,50
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**76,51**	**2 087,77**	**138,74**				**2 303,02**
A. Solid Waste Disposal on Land	NE,NO	2 087,77					2 087,77
B. Waste-water Handling		IE,NE,NO	138,74				138,74
C. Waste Incineration	76,51	NE	NE				76,51
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	7 086,90	0,94	107,96				7 195,80
Aviation	1 566,51	0,13	20,41				1 587,05
Marine	5 520,39	0,81	87,55				5 608,76
Multilateral Operations	**0,76**	**0,00**	**0,00**				**0,77**
CO_2 Emissions from Biomass	**19 059,18**						**19 059,18**
						Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	70 219,71
						Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	36 670,03

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2004
Submission 2009 v1.1
SWEDEN

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]	**23 187,26**	**5 754,09**	**7 639,16**	**769,68**	**253,98**	**81,21**	**37 685,39**
1. Energy	**50 610,57**	**400,55**	**1 367,65**				**52 378,77**
A. Fuel Combustion (Sectoral Approach)	49 462,99	394,98	1 350,18				51 208,15
1. Energy Industries	11 934,35	65,25	410,83				12 410,43
2. Manufacturing Industries and Construction	10 950,14	44,40	508,49				11 503,03
3. Transport	20 471,01	39,09	181,70				20 691,80
4. Other Sectors	5 829,13	246,07	242,95				6 318,15
5. Other	278,36	0,17	6,22				284,74
B. Fugitive Emissions from Fuels	1 147,58	5,57	17,47				1 170,62
1. Solid Fuels	837,69	0,07	2,19				839,96
2. Oil and Natural Gas	309,89	5,50	15,28				330,66
2. Industrial Processes	**4 452,27**	**7,54**	**530,08**	**769,68**	**253,98**	**81,21**	**6 094,77**
A. Mineral Products	1 998,17	NA	NA				1 998,17
B. Chemical Industry	53,38	0,78	444,30	NA	NA	NA	498,46
C. Metal Production	2 400,72	0,11	NA,NO	NA,NO	248,94	40,44	2 690,20
D. Other Production	NE	6,66	85,78				92,44
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				769,68	5,05	40,77	815,50
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**164,88**		**146,18**				**311,06**
4. Agriculture		**3 273,63**	**5 366,96**				**8 640,58**
A. Enteric Fermentation		2 824,41					2 824,41
B. Manure Management		449,21	526,63				975,84
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 840,33				4 840,33
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, Land-Use Change and Forestry[1]	**-32 129,36**	**5,39**	**91,07**				**-32 032,89**
A. Forest Land	-34 087,53	5,29	17,59				-34 064,66
B. Cropland	2 739,27	IE,NE	73,47				2 812,74
C. Grassland	-681,51	0,11	0,01				-681,39
D. Wetlands	48,00	IE,NE,NO	IE,NE,NO				48,00
E. Settlements	-147,58	IE,NE	IE,NE				-147,58
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**88,90**	**2 066,97**	**137,23**				**2 293,10**
A. Solid Waste Disposal on Land	NE,NO	2 066,97					2 066,97
B. Waste-water Handling		IE,NE,NO	137,23				137,23
C. Waste Incineration	88,90	NE	NE				88,90
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	8 274,55	1,12	124,99				8 400,66
Aviation	1 771,54	0,15	22,69				1 794,38
Marine	6 503,01	0,97	102,30				6 606,28
Multilateral Operations	**0,76**	**0,00**	**0,00**				**0,77**
CO_2 Emissions from Biomass	**19 161,07**						**19 161,07**
						Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	69 718,28
						Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	37 685,39

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2005
Submission 2009 v1.1
SWEDEN

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]	**23 702,55**	**5 628,85**	**7 532,82**	**796,94**	**257,15**	**142,48**	**38 060,80**
1. Energy	**47 817,80**	**417,05**	**1 343,64**				**49 578,49**
A. Fuel Combustion (Sectoral Approach)	46 931,99	412,11	1 327,82				48 671,92
1. Energy Industries	10 970,77	71,70	403,63				11 446,10
2. Manufacturing Industries and Construction	10 287,52	43,51	503,59				10 834,62
3. Transport	20 730,16	37,22	178,56				20 945,93
4. Other Sectors	4 720,68	259,54	237,59				5 217,81
5. Other	222,86	0,13	4,46				227,45
B. Fugitive Emissions from Fuels	885,80	4,94	15,82				906,57
1. Solid Fuels	576,63	0,05	1,52				578,21
2. Oil and Natural Gas	309,17	4,89	14,30				328,36
2. Industrial Processes	**4 875,61**	**7,40**	**534,33**	**796,94**	**257,15**	**142,48**	**6 613,91**
A. Mineral Products	2 119,66	NA	NA				2 119,66
B. Chemical Industry	52,63	0,64	448,77	NA	NA	NA	502,05
C. Metal Production	2 703,31	0,11	NA,NO	NA,NO	255,38	99,86	3 058,67
D. Other Production	NE	6,64	85,55				92,20
E. Production of Halocarbons and SF_6				NA,NO	NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6				796,94	1,76	42,63	841,34
G. Other	NO	NO	NO	NA,NO	NO	NO	NA,NO
3. Solvent and Other Product Use	**165,04**		**136,46**				**301,50**
4. Agriculture		**3 276,80**	**5 276,04**				**8 552,84**
A. Enteric Fermentation		2 793,82					2 793,82
B. Manure Management		482,97	489,56				972,53
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 786,48				4 786,48
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, Land-Use Change and Forestry[1]	**-29 247,07**	**4,99**	**102,81**				**-29 139,28**
A. Forest Land	-31 356,52	4,89	25,92				-31 325,71
B. Cropland	2 674,20	IE,NE	76,88				2 751,08
C. Grassland	-478,59	0,10	0,01				-478,47
D. Wetlands	61,78	IE,NE,NO	IE,NE,NO				61,78
E. Settlements	-147,95	IE,NE	IE,NE				-147,95
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**91,18**	**1 922,62**	**139,54**				**2 153,34**
A. Solid Waste Disposal on Land	NE,NO	1 922,62					1 922,62
B. Waste-water Handling		IE,NE,NO	139,54				139,54
C. Waste Incineration	91,18	NE	NE				91,18
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	8 575,32	1,15	129,63				8 706,11
Aviation	1 935,67	0,16	24,04				1 959,87
Marine	6 639,65	0,99	105,60				6 746,24
Multilateral Operations	**1,78**	**0,00**	**0,01**				**1,79**
CO_2 Emissions from Biomass	**20 582,31**						**20 582,31**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				67 200,07
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				38 060,80

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2006
Submission 2009 v1.1
SWEDEN

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]	**27 013,44**	**5 542,67**	**7 544,95**	**825,63**	**245,32**	**111,31**	**41 283,31**
1. Energy	**47 563,91**	**410,71**	**1 371,04**				**49 345,65**
A. Fuel Combustion (Sectoral Approach)	46 201,80	405,05	1 353,33				47 960,18
1. Energy Industries	10 656,03	74,37	420,37				11 150,78
2. Manufacturing Industries and Construction	10 596,99	48,88	531,87				11 177,74
3. Transport	20 549,75	33,86	168,86				20 752,47
4. Other Sectors	4 152,41	247,80	227,34				4 627,56
5. Other	246,61	0,14	4,88				251,63
B. Fugitive Emissions from Fuels	1 362,11	5,66	17,71				1 385,48
1. Solid Fuels	578,88	0,05	1,61				580,54
2. Oil and Natural Gas	783,23	5,61	16,10				804,94
2. Industrial Processes	**4 929,58**	**7,57**	**552,40**	**825,63**	**245,32**	**111,31**	**6 671,80**
A. Mineral Products	2 275,28	NA	NA				2 275,28
B. Chemical Industry	48,26	0,79	466,08	NA	NA	NA	515,13
C. Metal Production	2 606,05	0,09	NA,NO	NA,NO	243,51	76,94	2 926,58
D. Other Production	NE	6,70	86,31				93,01
E. Production of Halocarbons and SF_6				NA,NO	NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6				825,63	1,81	34,37	861,80
G. Other	NO	NO	NO	NA,NO	NO	NO	NA,NO
3. Solvent and Other Product Use	**162,89**		**131,29**				**294,18**
4. Agriculture		**3 267,11**	**5 235,31**				**8 502,42**
A. Enteric Fermentation		2 793,50					2 793,50
B. Manure Management		473,61	487,48				961,10
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 747,82				4 747,82
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, Land-Use Change and Forestry[1]	**-25 713,45**	**12,21**	**114,08**				**-25 587,16**
A. Forest Land	-27 793,12	12,10	28,51				-27 752,51
B. Cropland	2 804,86	IE,NE	85,56				2 890,42
C. Grassland	-1 196,36	0,12	0,01				-1 196,23
D. Wetlands	37,22	IE,NE,NO	IE,NE,NO				37,22
E. Settlements	433,95	IE,NE	IE,NE				433,95
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**70,51**	**1 845,06**	**140,84**				**2 056,42**
A. Solid Waste Disposal on Land	NE,NO	1 845,06					1 845,06
B. Waste-water Handling		IE,NE,NO	140,84				140,84
C. Waste Incineration	70,51	NE	NE				70,51
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	9 145,77	1,25	137,96				9 284,99
Aviation	2 006,20	0,19	24,68				2 031,06
Marine	7 139,57	1,07	113,29				7 253,93
Multilateral Operations	**2,73**	**0,00**	**0,01**				**2,74**
CO_2 Emissions from Biomass	**21 885,54**						**21 885,54**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				66 870,47
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				41 283,31

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

SUMMARY TABLE FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2007
Submission 2009 v1.1
SWEDEN

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]	**31 043,36**	**5 359,57**	**7 296,11**	**855,34**	**247,60**	**150,43**	**44 952,41**
1. Energy	**46 421,54**	**466,08**	**1 349,52**				**48 237,14**
A. Fuel Combustion (Sectoral Approach)	45 179,69	460,95	1 333,07				46 973,71
1. Energy Industries	10 283,17	74,65	406,41				10 764,23
2. Manufacturing Industries and Construction	10 099,45	47,13	512,94				10 659,51
3. Transport	20 642,37	31,08	163,00				20 836,44
4. Other Sectors	3 898,35	307,94	245,54				4 451,84
5. Other	256,35	0,14	5,19				261,68
B. Fugitive Emissions from Fuels	1 241,85	5,13	16,45				1 263,44
1. Solid Fuels	614,93	0,05	1,57				616,56
2. Oil and Natural Gas	626,92	5,08	14,88				646,88
2. Industrial Processes	**4 933,23**	**7,52**	**338,49**	**855,34**	**247,60**	**150,43**	**6 532,61**
A. Mineral Products	2 179,72	NA	NA				2 179,72
B. Chemical Industry	47,21	0,76	252,23	NA	NA	NA	300,19
C. Metal Production	2 706,31	0,07	NA,NO	NA,NO	245,80	113,17	3 065,35
D. Other Production	NE	6,69	86,27				92,96
E. Production of Halocarbons and SF_6				NA,NO	NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6				855,34	1,80	37,26	894,39
G. Other	NO	NO	NO	NA,NO	NO	NO	NA,NO
3. Solvent and Other Product Use	**162,89**		**131,29**				**294,18**
4. Agriculture		**3 208,46**	**5 222,24**				**8 430,70**
A. Enteric Fermentation		2 736,05					2 736,05
B. Manure Management		472,41	478,40				950,81
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NO	4 743,84				4 743,84
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, Land-Use Change and Forestry[1]	**-20 577,65**	**2,39**	**115,56**				**-20 459,70**
A. Forest Land	-22 838,59	2,33	37,13				-22 799,14
B. Cropland	2 723,73	IE,NE	78,43				2 802,16
C. Grassland	-428,51	0,06	0,01				-428,44
D. Wetlands	61,78	IE,NE,NO	IE,NE,NO				61,78
E. Settlements	-96,07	IE,NE	IE,NE				-96,07
F. Other Land	IE,NE	IE,NE	IE,NE				IE,NE
G. Other	NA	NA	NA				NA
6. Waste	**103,35**	**1 675,12**	**139,01**				**1 917,48**
A. Solid Waste Disposal on Land	NE,NO	1 675,12					1 675,12
B. Waste-water Handling		IE,NE,NO	139,01				139,01
C. Waste Incineration	103,35	NE	NE				103,35
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	9 612,05	1,30	144,91				9 758,27
Aviation	2 194,54	0,20	27,24				2 221,97
Marine	7 417,52	1,11	117,67				7 536,30
Multilateral Operations	**1,96**	**0,00**	**0,01**				**1,97**
CO_2 Emissions from Biomass	**22 704,30**						**22 704,30**
			Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				65 412,11
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				44 952,41

[1] For CO_2 from Land Use, Land-use Change and Forestry, removals are always negative (-) and for emissions positive (+).

TABLE 10 EMISSION TRENDS
CO_2
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**51 570,17**	**52 407,33**	**52 351,26**	**51 807,48**	**54 221,64**	**53 261,29**	**56 856,51**	**52 494,99**	**52 973,52**	**50 385,95**
A. Fuel Combustion (Sectoral Approach)	50 469,88	51 212,79	51 305,50	50 772,90	52 866,07	51 849,05	55 629,82	51 326,36	51 831,83	49 221,81
1. Energy Industries	9 830,65	11 005,80	11 614,09	11 464,38	11 960,53	11 061,07	15 001,85	11 041,92	12 061,99	10 643,07
2. Manufacturing Industries and Construction	11 150,05	11 172,48	10 205,40	10 979,89	12 033,65	12 492,34	12 532,60	12 735,71	12 093,78	11 121,22
3. Transport	18 332,78	17 874,06	18 991,60	18 113,98	18 739,16	18 636,11	18 386,39	18 647,82	18 965,70	19 255,71
4. Other Sectors	10 311,30	10 091,09	9 373,01	9 333,52	9 357,19	8 955,25	9 044,47	8 292,19	8 228,08	7 792,89
5. Other	845,11	1 069,36	1 121,39	881,13	775,54	704,27	664,52	608,72	482,28	408,92
B. Fugitive Emissions from Fuels	1 100,29	1 194,54	1 045,76	1 034,58	1 355,58	1 412,23	1 226,69	1 168,63	1 141,70	1 164,13
1. Solid Fuels	789,03	938,27	749,89	718,01	1 094,70	1 110,37	956,13	886,28	847,33	864,21
2. Oil and Natural Gas	311,26	256,27	295,87	316,57	260,87	301,87	270,56	282,35	294,37	299,92
2. Industrial Processes	**4 400,73**	**4 239,34**	**4 093,91**	**4 140,12**	**4 397,56**	**4 504,30**	**4 424,05**	**4 200,44**	**4 244,87**	**4 011,34**
A. Mineral Products	1 919,29	1 739,06	1 649,76	1 670,60	1 755,66	1 967,53	1 877,86	1 746,27	1 802,06	1 750,09
B. Chemical Industry	68,80	69,55	53,26	54,76	57,14	57,77	58,90	58,40	54,01	53,63
C. Metal Production	2 412,64	2 430,73	2 390,89	2 414,76	2 584,76	2 479,00	2 487,30	2 395,77	2 388,81	2 207,61
D. Other Production	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	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	242,27	231,12	218,72	207,88	197,12	184,86	174,48	179,20	173,52	164,38
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry	**-32 134,32**	**-33 407,00**	**-30 708,70**	**-28 454,11**	**-25 275,31**	**-25 523,21**	**-29 911,83**	**-34 392,44**	**-36 273,57**	**-34 425,41**
A. Forest Land	-35	-36	-34	-31	-28	-28	-33	-37	-39	-37
	471,29	662,92	136,25	844,24	258,05	550,73	466,78	279,79	559,49	936,25
B. Cropland	4 047,99	3 832,70	3 638,94	3 851,43	3 605,74	3 547,22	4 013,52	3 557,82	4 101,67	4 080,14
C. Grassland	-645,57	-493,84	-441,66	-477,32	-576,61	-552,15	-395,24	-535,91	-859,24	-854,47
D. Wetlands	39,60	36,59	39,60	38,39	41,98	46,20	40,81	48,58	40,19	58,19
E. Settlements	-105,05	-119,53	190,67	-22,37	-88,37	-13,75	-104,13	-183,15	3,30	226,97
F. Other Land	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**43,85**	**52,20**	**58,33**	**48,02**	**49,08**	**42,74**	**49,12**	**50,60**	**49,16**	**48,20**
A. Solid Waste Disposal on Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
B. Waste-water Handling										
C. Waste Incineration	43,85	52,20	58,33	48,02	49,08	42,74	49,12	50,60	49,16	48,20
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Total CO_2 emissions including net CO_2 from LULUCF	**24 122,70**	**23 523,00**	**26 013,51**	**27 749,38**	**33 590,09**	**32 469,98**	**31 592,34**	**22 532,79**	**21 167,51**	**20 184,45**
Total CO_2 emissions excluding net CO_2 from LULUCF	**56 257,02**	**56 929,99**	**56 722,21**	**56 203,50**	**58 865,40**	**57 993,19**	**61 504,17**	**56 925,23**	**57 441,08**	**54 609,87**
Memo Items:										
International Bunkers	**3 563,03**	**3 727,88**	**3 908,85**	**4 252,34**	**4 910,50**	**4 937,53**	**5 183,66**	**5 908,66**	**6 690,30**	**6 788,19**
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
Marine	2 227,87	2 639,73	3 009,20	3 022,39	3 559,81	3 500,48	3 708,14	4 348,41	5 017,29	4 908,90
Multilateral Operations	0,05	0,05	0,05	0,32	0,32	0,32	0,32	0,32	0,32	0,32
CO_2 Emissions from Biomass	11 436,68	12 152,72	13 066,89	14 206,56	15 698,09	16 495,50	18 044,90	16 812,44	16 874,10	17 145,12

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from 1990 to 2007
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**48 967,43**	**49 445,59**	**50 510,84**	**51 202,28**	**50 610,57**	**47 817,80**	**47 563,91**	**46 421,54**	**-9,98**
A. Fuel Combustion (Sectoral Approach)	47 753,83	48 353,18	49 439,23	50 212,52	49 462,99	46 931,99	46 201,80	45 179,69	-10,48
1. Energy Industries	9 204,55	10 544,70	11 586,14	12 671,64	11 934,35	10 970,77	10 656,03	10 283,17	4,60
2. Manufacturing Industries and Construction	11 433,39	11 408,46	11 365,45	11 039,07	10 950,14	10 287,52	10 596,99	10 099,45	-9,42
3. Transport	19 011,66	19 227,36	19 802,36	20 115,79	20 471,01	20 730,16	20 549,75	20 642,37	12,60
4. Other Sectors	7 704,82	6 896,93	6 366,46	6 086,55	5 829,13	4 720,68	4 152,41	3 898,35	-62,19
5. Other	399,41	275,72	318,83	299,48	278,36	222,86	246,61	256,35	-69,67
B. Fugitive Emissions from Fuels	1 213,61	1 092,41	1 071,60	989,75	1 147,58	885,80	1 362,11	1 241,85	12,87
1. Solid Fuels	860,64	775,97	768,66	671,12	837,69	576,63	578,88	614,93	-22,07
2. Oil and Natural Gas	352,96	316,44	302,95	318,64	309,89	309,17	783,23	626,92	101,42
2. Industrial Processes	**4 202,70**	**4 467,03**	**4 344,13**	**4 453,34**	**4 452,27**	**4 875,61**	**4 929,58**	**4 933,23**	**12,10**
A. Mineral Products	1 987,03	2 031,33	2 000,03	1 939,42	1 998,17	2 119,66	2 275,28	2 179,72	13,57
B. Chemical Industry	47,74	46,74	50,00	47,74	53,38	52,63	48,26	47,21	-31,38
C. Metal Production	2 167,92	2 388,95	2 294,10	2 466,17	2 400,72	2 703,31	2 606,05	2 706,31	12,17
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	0,00
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
3. Solvent and Other Product Use	155,40	150,13	148,45	156,05	164,88	165,04	162,89	162,89	-32,76
4. Agriculture									
A. Enteric Fermentation									
B. Manure Management									
C. Rice Cultivation									
D. Agricultural Soils									
E. Prescribed Burning of Savannas									
F. Field Burning of Agricultural Residues									
G. Other									
5. Land Use, Land-Use Change and Forestry	**-35 680,04**	**-32 244,24**	**-34 517,34**	**-33 636,62**	**-32 129,36**	**-29 247,07**	**-25 713,45**	**-20 577,65**	**-35,96**
A. Forest Land	-38 034,07	-35 862,91	-37 656,06	-36 095,27	-34 087,53	-31 356,52	-27 793,12	-22 838,59	-35,61
B. Cropland	3 065,78	4 148,66	3 674,63	2 739,88	2 739,27	2 674,20	2 804,86	2 723,73	-32,71
C. Grassland	-758,02	-686,47	-510,95	-167,13	-681,51	-478,59	-1 196,36	-428,51	-33,62
D. Wetlands	62,41	62,99	61,20	56,39	48,00	61,78	37,22	61,78	56,02
E. Settlements	-16,13	93,50	-86,17	-170,50	-147,58	-147,95	433,95	-96,07	-8,55
F. Other Land	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**44,44**	**47,47**	**60,73**	**76,51**	**88,90**	**91,18**	**70,51**	**103,35**	**135,66**
A. Solid Waste Disposal on Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
B. Waste-water Handling									
C. Waste Incineration	44,44	47,47	60,73	76,51	88,90	91,18	70,51	103,35	135,66
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0,00**
Total CO_2 emissions including net CO_2 from LULUCF	**17 689,93**	**21 865,98**	**20 546,81**	**22 251,55**	**23 187,26**	**23 702,55**	**27 013,44**	**31 043,36**	**28,69**
Total CO_2 emissions excluding net CO_2 from LULUCF	**53 369,97**	**54 110,22**	**55 064,15**	**55 888,17**	**55 316,62**	**52 949,62**	**52 726,89**	**51 621,01**	**-8,24**
Memo Items:									
International Bunkers	**6 696,87**	**6 525,56**	**5 715,32**	**7 086,90**	**8 274,55**	**8 575,32**	**9 145,77**	**9 612,05**	**169,77**
Aviation	1 926,37	1 870,86	1 611,37	1 566,51	1 771,54	1 935,67	2 006,20	2 194,54	64,37
Marine	4 770,51	4 654,69	4 103,95	5 520,39	6 503,01	6 639,65	7 139,57	7 417,52	232,94
Multilateral Operations	0,32	0,76	0,84	0,76	0,76	1,78	2,73	1,96	3 577,68
CO_2 Emissions from Biomass	15 719,35	18 850,32	18 355,08	19 059,18	19 161,07	20 582,31	21 885,54	22 704,30	98,52

TABLE 10 EMISSION TRENDS
CH_4
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	20,08	20,81	20,88	20,93	21,16	21,49	22,25	20,74	19,42	18,96
A. Fuel Combustion (Sectoral Approach)	19,85	20,58	20,64	20,67	20,89	21,21	21,97	20,46	19,14	18,71
1. Energy Industries	1,05	1,23	1,08	1,40	1,64	1,80	2,49	2,08	2,21	2,27
2. Manufacturing Industries and Construction	2,19	2,16	2,50	2,50	2,79	2,71	2,63	2,55	2,55	2,41
3. Transport	4,99	5,15	4,82	4,28	4,40	4,07	3,90	3,51	3,21	2,95
4. Other Sectors	11,57	12,00	12,19	12,47	12,03	12,59	12,92	12,28	11,15	11,07
5. Other	0,05	0,05	0,05	0,04	0,03	0,04	0,03	0,03	0,02	0,02
B. Fugitive Emissions from Fuels	0,23	0,23	0,23	0,26	0,27	0,28	0,28	0,28	0,28	0,25
1. Solid Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Oil and Natural Gas	0,23	0,23	0,23	0,26	0,26	0,28	0,28	0,28	0,28	0,25
2. Industrial Processes	**0,27**	**0,29**	**0,29**	**0,29**	**0,30**	**0,30**	**0,30**	**0,31**	**0,31**	**0,30**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	0,03	0,03	0,03	0,02	0,03	0,03	0,03	0,03	0,03	0,02
C. Metal Production	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	0,00
D. Other Production	0,24	0,26	0,26	0,27	0,26	0,27	0,26	0,28	0,27	0,28
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**162,25**	**158,79**	**162,79**	**169,67**	**171,32**	**167,19**	**165,84**	**165,72**	**161,21**	**159,89**
A. Enteric Fermentation	145,62	142,52	145,98	150,49	151,99	147,38	145,77	146,09	141,79	140,53
B. Manure Management	16,63	16,27	16,81	19,19	19,33	19,81	20,07	19,63	19,42	19,37
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Prescribed Burning of Savannas	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
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,08**	**0,42**	**0,02**	**0,14**
A. Forest Land	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,40	0,02	0,14
B. Cropland	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
C. Grassland	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,00	0,00
D. Wetlands	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
E. Settlements	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
F. Other Land	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**136,87**	**138,95**	**138,99**	**134,31**	**128,76**	**128,42**	**127,32**	**126,08**	**124,02**	**118,71**
A. Solid Waste Disposal on Land	136,87	138,95	138,99	134,31	128,76	128,42	127,32	126,08	124,02	118,71
B. Waste-water Handling	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Total CH_4 emissions including CH_4 from LULUCF	**319,56**	**318,92**	**323,03**	**325,30**	**321,62**	**317,48**	**315,80**	**313,27**	**304,99**	**298,01**
Total CH_4 emissions excluding CH_4 from LULUCF	**319,47**	**318,85**	**322,95**	**325,22**	**321,54**	**317,41**	**315,72**	**312,85**	**304,97**	**297,87**
Memo Items:										
International Bunkers	0,02	0,03	0,03	0,03	0,03	0,04	0,03	0,04	0,04	0,04
Aviation	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
Multilateral Operations	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CO_2 Emissions from Biomass										

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from 1990 to 2007
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	18,25	18,48	18,50	19,05	19,07	19,86	19,56	22,19	10,50
A. Fuel Combustion (Sectoral Approach)	17,99	18,24	18,23	18,82	18,81	19,62	19,29	21,95	10,57
1. Energy Industries	2,19	2,68	2,82	3,04	3,11	3,41	3,54	3,55	237,07
2. Manufacturing Industries and Construction	2,02	2,60	2,28	2,12	2,11	2,07	2,33	2,24	2,27
3. Transport	2,65	2,37	2,24	2,04	1,86	1,77	1,61	1,48	-70,32
4. Other Sectors	11,11	10,57	10,88	11,61	11,72	12,36	11,80	14,66	26,72
5. Other	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	-85,01
B. Fugitive Emissions from Fuels	0,25	0,25	0,27	0,23	0,27	0,24	0,27	0,24	5,18
1. Solid Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-28,56
2. Oil and Natural Gas	0,25	0,24	0,26	0,23	0,26	0,23	0,27	0,24	5,70
2. Industrial Processes	**0,34**	**0,35**	**0,34**	**0,36**	**0,36**	**0,35**	**0,36**	**0,36**	**30,85**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Chemical Industry	0,03	0,04	0,04	0,04	0,04	0,03	0,04	0,04	42,54
C. Metal Production	0,00	0,01	0,00	0,01	0,01	0,01	0,00	0,00	-32,25
D. Other Production	0,31	0,31	0,30	0,32	0,32	0,32	0,32	0,32	30,97
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
3. Solvent and Other Product Use									
4. Agriculture	**155,57**	**156,01**	**155,08**	**153,90**	**155,89**	**156,04**	**155,58**	**152,78**	**-5,83**
A. Enteric Fermentation	137,00	135,56	134,75	132,54	134,50	133,04	133,02	130,29	-10,53
B. Manure Management	18,57	20,45	20,33	21,36	21,39	23,00	22,55	22,50	35,30
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Agricultural Soils	NO	NO	NO	NO	NO	NO	NO	NO	0,00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	0,00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
5. Land Use, Land-Use Change and Forestry	**0,14**	**0,14**	**0,23**	**0,29**	**0,26**	**0,24**	**0,58**	**0,11**	**38,63**
A. Forest Land	0,14	0,14	0,22	0,27	0,25	0,23	0,58	0,11	55,19
B. Cropland	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0,00
C. Grassland	0,00	0,01	0,02	0,02	0,01	0,00	0,01	0,00	-72,39
D. Wetlands	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	0,00
E. Settlements	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0,00
F. Other Land	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**114,97**	**112,89**	**105,43**	**99,42**	**98,43**	**91,55**	**87,86**	**79,77**	**-41,72**
A. Solid Waste Disposal on Land	114,97	112,89	105,43	99,42	98,43	91,55	87,86	79,77	-41,72
B. Waste-water Handling	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	0,00
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	0,00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0,00**
Total CH_4 emissions including CH_4 from LULUCF	**289,27**	**287,87**	**279,58**	**273,02**	**274,00**	**268,04**	**263,94**	**255,22**	**-20,13**
Total CH_4 emissions excluding CH_4 from LULUCF	**289,13**	**287,73**	**279,35**	**272,73**	**273,75**	**267,80**	**263,35**	**255,10**	**-20,15**
Memo Items:									
International Bunkers	0,04	0,04	0,04	0,04	0,05	0,05	0,06	0,06	155,73
Aviation	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	-1,66
Marine	0,03	0,03	0,03	0,04	0,05	0,05	0,05	0,05	256,39
Multilateral Operations	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1 010,20
CO_2 Emissions from Biomass									

TABLE 10 EMISSION TRENDS

N_2O

(Part 1 of 2)

Inventory 2007

Submission 2009 v1.1

SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**4,26**	**4,36**	**4,37**	**4,50**	**4,60**	**4,63**	**5,17**	**4,65**	**4,60**	**4,41**
A. Fuel Combustion (Sectoral Approach)	4,21	4,31	4,32	4,45	4,54	4,58	5,11	4,60	4,55	4,35
1. Energy Industries	1,06	1,15	1,18	1,15	1,21	1,13	1,71	1,18	1,23	1,12
2. Manufacturing Industries and Construction	1,71	1,75	1,69	1,80	1,91	1,97	1,92	1,93	1,87	1,75
3. Transport	0,47	0,42	0,50	0,58	0,54	0,61	0,60	0,64	0,62	0,66
4. Other Sectors	0,89	0,88	0,84	0,84	0,83	0,82	0,83	0,81	0,79	0,79
5. Other	0,08	0,10	0,11	0,07	0,06	0,05	0,05	0,05	0,04	0,03
B. Fugitive Emissions from Fuels	0,05	0,05	0,05	0,06	0,05	0,06	0,06	0,06	0,05	0,06
1. Solid Fuels	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	0,05	0,04	0,05	0,05	0,04	0,05	0,05	0,05	0,05	0,05
2. Industrial Processes	**2,90**	**3,05**	**2,94**	**2,87**	**2,79**	**2,58**	**2,48**	**2,47**	**2,74**	**2,46**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	2,68	2,82	2,72	2,64	2,55	2,34	2,25	2,23	2,50	2,22
C. Metal Production	NA	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production	0,21	0,23	0,23	0,23	0,23	0,23	0,23	0,25	0,24	0,24
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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
4. Agriculture	**19,28**	**18,75**	**18,49**	**18,82**	**19,05**	**18,67**	**18,63**	**18,86**	**18,63**	**17,74**
A. Enteric Fermentation										
B. Manure Management	2,35	2,28	2,34	2,13	2,16	2,05	2,05	2,09	2,09	1,96
C. Rice Cultivation										
D. Agricultural Soils	16,93	16,46	16,15	16,70	16,89	16,62	16,58	16,78	16,54	15,78
E. Prescribed Burning of Savannas	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
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0,26**	**0,20**	**0,17**	**0,18**	**0,18**	**0,21**	**0,21**	**0,21**	**0,21**	**0,23**
A. Forest Land	0,19	0,11	0,08	0,07	0,06	0,07	0,06	0,05	0,05	0,07
B. Cropland	0,07	0,09	0,09	0,11	0,12	0,14	0,15	0,16	0,16	0,16
C. Grassland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Wetlands	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
E. Settlements	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
F. Other Land	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**0,63**	**0,61**	**0,59**	**0,59**	**0,59**	**0,60**	**0,57**	**0,54**	**0,52**	**0,49**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0,63	0,61	0,59	0,59	0,59	0,60	0,57	0,54	0,52	0,49
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Total N_2O emissions including N_2O from LULUCF	**27,61**	**27,25**	**26,90**	**27,31**	**27,51**	**27,09**	**27,50**	**27,20**	**27,16**	**25,76**
Total N_2O emissions excluding N_2O from LULUCF	**27,36**	**27,05**	**26,73**	**27,13**	**27,32**	**26,88**	**27,29**	**26,99**	**26,95**	**25,53**
Memo Items:										
International Bunkers	**0,17**	**0,18**	**0,20**	**0,21**	**0,24**	**0,24**	**0,26**	**0,29**	**0,33**	**0,33**
Aviation	0,05	0,05	0,04	0,05	0,06	0,06	0,06	0,07	0,07	0,08
Marine	0,12	0,14	0,16	0,16	0,19	0,18	0,19	0,23	0,26	0,25
Multilateral Operations	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CO_2 Emissions from Biomass										

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from 1990 to 2007
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**4,30**	**4,40**	**4,41**	**4,52**	**4,41**	**4,33**	**4,42**	**4,35**	**2,16**
A. Fuel Combustion (Sectoral Approach)	4,24	4,34	4,36	4,46	4,36	4,28	4,37	4,30	2,20
1. Energy Industries	1,00	1,15	1,23	1,40	1,33	1,30	1,36	1,31	23,70
2. Manufacturing Industries and Construction	1,72	1,78	1,73	1,65	1,64	1,62	1,72	1,65	-3,05
3. Transport	0,68	0,63	0,62	0,60	0,59	0,58	0,54	0,53	12,71
4. Other Sectors	0,80	0,77	0,76	0,79	0,78	0,77	0,73	0,79	-11,20
5. Other	0,03	0,02	0,02	0,02	0,02	0,01	0,02	0,02	-79,74
B. Fugitive Emissions from Fuels	0,06	0,05	0,05	0,05	0,06	0,05	0,06	0,05	-1,50
1. Solid Fuels	0,01	0,01	0,01	0,01	0,01	0,00	0,01	0,01	-28,56
2. Oil and Natural Gas	0,05	0,05	0,04	0,05	0,05	0,05	0,05	0,05	2,61
2. Industrial Processes	**2,38**	**1,86**	**1,74**	**1,72**	**1,71**	**1,72**	**1,78**	**1,09**	**-62,30**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Chemical Industry	2,11	1,59	1,48	1,44	1,43	1,45	1,50	0,81	-69,67
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
D. Other Production	0,27	0,27	0,27	0,28	0,28	0,28	0,28	0,28	30,24
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
3. Solvent and Other Product Use	0,39	0,38	0,41	0,44	0,47	0,44	0,42	0,42	45,51
4. Agriculture	**17,68**	**17,67**	**17,52**	**17,29**	**17,31**	**17,02**	**16,89**	**16,85**	**-12,61**
A. Enteric Fermentation									
B. Manure Management	1,92	1,78	1,78	1,68	1,70	1,58	1,57	1,54	-34,29
C. Rice Cultivation									
D. Agricultural Soils	15,76	15,89	15,75	15,61	15,61	15,44	15,32	15,30	-9,60
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	0,00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
5. Land Use, Land-Use Change and Forestry	**0,24**	**0,24**	**0,24**	**0,26**	**0,29**	**0,33**	**0,37**	**0,37**	**45,87**
A. Forest Land	0,06	0,05	0,04	0,05	0,06	0,08	0,09	0,12	-35,44
B. Cropland	0,17	0,19	0,20	0,22	0,24	0,25	0,28	0,25	261,43
C. Grassland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-72,39
D. Wetlands	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	0,00
E. Settlements	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0,00
F. Other Land	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**0,47**	**0,46**	**0,45**	**0,45**	**0,44**	**0,45**	**0,45**	**0,45**	**-28,86**
A. Solid Waste Disposal on Land									
B. Waste-water Handling	0,47	0,46	0,45	0,45	0,44	0,45	0,45	0,45	-28,86
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	0,00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0,00**
Total N_2O emissions including N_2O from LULUCF	**25,46**	**25,00**	**24,77**	**24,67**	**24,64**	**24,30**	**24,34**	**23,54**	**-14,76**
Total N_2O emissions excluding N_2O from LULUCF	**25,22**	**24,76**	**24,53**	**24,41**	**24,35**	**23,97**	**23,97**	**23,16**	**-15,33**
Memo Items:									
International Bunkers	**0,33**	**0,32**	**0,28**	**0,35**	**0,40**	**0,42**	**0,45**	**0,47**	**172,16**
Aviation	0,08	0,08	0,07	0,07	0,07	0,08	0,08	0,09	63,42
Marine	0,25	0,24	0,21	0,28	0,33	0,34	0,37	0,38	221,73
Multilateral Operations	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3 887,04
CO_2 Emissions from Biomass									

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs - (Gg CO_2 equivalent)	**3,85**	**7,94**	**10,12**	**29,66**	**72,73**	**127,13**	**205,35**	**313,40**	**386,42**	**489,45**
HFC-23	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-32	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,01	0,01	0,01	0,01
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	0,00	0,01	0,01	0,02	0,04	0,07	0,12	0,18	0,23	0,30
HFC-152a	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,06	0,15	0,14	0,14
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,01	0,01	0,01	0,01
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of PFCs - (Gg CO_2 equivalent)	**376,82**	**380,25**	**252,42**	**290,97**	**311,73**	**343,43**	**302,91**	**279,69**	**271,86**	**291,29**
CF_4	0,05	0,05	0,04	0,04	0,04	0,05	0,04	0,04	0,04	0,04
C_2F_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF6 - (Gg CO_2 equivalent)	**107,49**	**108,51**	**108,40**	**96,66**	**100,20**	**126,68**	**108,40**	**153,10**	**99,38**	**101,65**
SF_6	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,01	0,00	0,00

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from 1990 to 2007
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs - (Gg CO_2 equivalent)	**564,63**	**611,88**	**664,27**	**709,46**	**769,68**	**796,94**	**825,63**	**855,34**	**22 145,32**
HFC-23	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-32	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	100,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-125	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	100,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-134a	0,34	0,37	0,40	0,42	0,47	0,48	0,50	0,52	17 453,63
HFC-152a	0,15	0,18	0,15	0,22	0,20	0,21	0,23	0,22	100,00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-143a	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	100,00
HFC-227ea	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed HFCs - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of PFCs - (Gg CO_2 equivalent)	**240,52**	**235,61**	**260,91**	**258,30**	**253,98**	**257,15**	**245,32**	**247,60**	**-34,29**
CF_4	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,04	-33,77
C_2F_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-47,24
C_3F_8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed PFCs - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of SF6 - (Gg CO_2 equivalent)	**93,59**	**111,49**	**103,85**	**68,88**	**81,21**	**142,48**	**111,31**	**150,43**	**39,95**
SF_6	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,01	39,95

Annex 3: The national system

In accordance with the Kyoto Protocol and its associated Decision 20/CP7[1], and the EU Decision (280/2004/EC) concerning a mechanism for monitoring greenhouse gas emissions, Sweden has built up a national system for the inventory and reporting of greenhouse gas emissions and removals. The national system came into effect on 1 January 2006 and is described in detail in Sweden's annual National Inventory Report, which is sent to the UNFCCC Secretariat.

Name and contact information of responsible organisation

Ministry of the Environment
Contact person: Sandra Pettersson
Address: 103 33 Stockholm, SWEDEN
E-mail: sandra.pettersson@environment.ministry.se

Organisational structure and roles and responsibilities of various government agencies

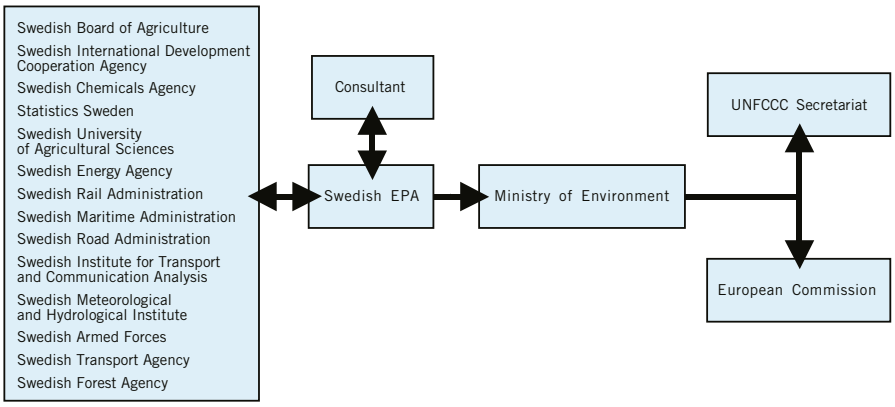
In order to establish the annual inventory report and other reporting, there is cooperation between the Ministry of the Environment, the Swedish Environmental Protection Agency, government agencies and consultants.

The Ministry of the Environment 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 the Environment, for producing material for the required reporting. The Swedish Environmental Protection Agency is thus responsible 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 received from the various government agencies and data they have produced themselves and carry out calculations of Swedish greenhouse gas emissions and removals.

Various government agencies take part in the national system (see figure above) and are responsible for different parts of the inventory process. The ***Swedish Energy Agency*** also takes part by providing figures on the use of flexible mechanisms and figures from the national registry.

Organisation of national system



1 UNFCCC. 2002. FCCC/CP/2001/13/Add.3.

2 SMED is a consortium known in full as Svenska MiljöEmissionsData and comprises Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute (SMHI), IVL Swedish Environmental Research Institute (IVL) and the Swedish University of Agricultural Sciences (SLU).

Legal structure

The legal basis for the national system is provided by an "Ordinance (2005:626) Concerning Climate Reporting". Under this ordinance, the Swedish Environmental Protection Agency has specific responsibilities for coordinating national work for Swedish climate reporting and for 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 legal responsibility of SMED (the consultants) is described in a framework contract between the Swedish Environmental Protection Agency and SMED.

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 in order 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. Calculations are performed by SMED and then undergo quality assurance and review. SMED supplies data, including the inventory report, to the Swedish Environmental Protection Agency, and a national peer review is then conducted. The report is sent to the Ministry of the Environment in good time before the applicable reporting date for preparation and onward reporting to the European Commission and UNFCCC.

Collection of activity data and choice of calculation methods

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.

Analysis of priority emission sources

In accordance with IPCC Good Practice Guidance, Chapter 7, the Swedish Environmental Protection Agency, supported by SMED, conducts an annual analysis to identify the emission sources to which priority should be accorded in the inventory work.

The quality system

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 quality system is based on the structure described in UNFCCC Decision 20/CP7. The Swedish Environmental Protection Agency has established an overarching quality plan. This 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 Swedish Environmental Protection Agency is responsible for conducting a peer review at national level in cooperation with affected government agencies, according to the routines established for this purpose. This review takes place annually when the inventory has been 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. Affected government agencies and consultants are available to answer any questions.

Approval of the inventory

The Swedish Environmental Protection Agency sends the climate reporting to the Ministry of the Environment for preparation at least 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 the Environment it is sent to the European Commission and the UNFCCC Secretariat.

Annex 4: The national registry

Registry administrator	
Name: Titti Norlin	Country: Sweden
Address: Box 310	Phone: +46 (0)16 544 22 73
Postcode: SE-631 04	Facsimile number: +46 (0)16 544 2099
City: Eskilstuna	E-mail: titti.norlin@energimyndigheten.se

The Swedish national registry has been established as a Swedish registry and not as part of a consolidated transboundary registry. Sweden purchases the registry software under licence together with Norway, Estonia, Hungary, Ireland, Italy, Lithuania, the Netherlands, the United Kingdom and the UK Department of Energy and Climate Change (DECC).

The Swedish national registry for emissions trading (SUS – Svenskt utsläppsrättssystem (Swedish emission allowances system) was established at the Swedish Energy Agency in 2005 under the European Commission's Registry Regulation, and until September 2008 was directly linked to the CITL (Community Independent Transaction Log), which has been developed and is managed by the European Community.

The Swedish registry is adapted in accordance with the technical standards on data exchange of the UN and the European Commission (UNFCCC Data Exchange Standard (DES ver 1.1.1) and Commission Registry Regulation (No 2216/2004 and No 916/2007)) specified for the Kyoto Protocol, and has advanced functions for issuing, external transactions, cancellation, redemption and comparison (reconciliation) of data with the UN's independent transaction log (ITL). The software has passed tests of interoperability in relation to the test environments of both CITL and ITL. On 16 October 2008 all registries established within the EU Emission Trading Scheme completed a direct link-up to the UN's independent transaction log (ITL). This enabled transfers of international emission units (assigned amount units) and reduction units (certified emission reductions and emission reduction units) between registries operating under the Kyoto Protocol.

The Swedish registry consists of a normalised 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 over-sized so that there is no risk of insufficient capacity. To ensure, maintain and re-use data with the aim of guaranteeing integrity of storage, the Swedish Energy Agency uses IBM's Tivoli Storage Manager (TSM) for backup, 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. 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 around virtual servers on different physical servers.

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 transaction log (Decision 19/CP.7, paragraph 1). The European Commission in June 2008 approved a new software version of the Swedish registry for operation in accordance with DES#7. The Swedish registry fulfils all requirements for procedures to minimise discrepancies in issuing, transactions, acquisition, cancellation and redemption 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 three 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 of the Swedish Energy Agency and CITL, a transaction always takes place according to the requirements contained in DES. A transaction is not concluded until both registries have received acknowledgement that the transaction is registered on the server concerned. If a transaction which is initiated in the Swedish registry contains a non-conformity, this will be identified by CITL sending a message with an error code. If an error code is sent, the transaction is terminated in the registry. An error message is presented to the person who initiated the transaction. If the registry fails to terminate 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 at ITL or CITL.

The Swedish Energy Agency's IT environment including routines meets the requirements stated in the Kyoto Protocol for a national registry. Prior to the link-up to ITL, the European Commission approved SUS through tests performed in June 2008. SUS also assisted in a full-scale run-through of the link-up over the period 18 July – 4 August 2008. Documentation on the functionality of the registry was sent to the ITL administrator in August 2008. SUS was approved for link-up to ITL by the ITL administrator on 29 August 2008. A prior check on communication between SUS and ITL was conducted in September 2008.

A new version of the software entered service at the end of September 2008. The purpose of the new version was to make it possible to cancel the emission allowances from the period 2005-2007 that were still on the account in the registry. The version containing all the functionalities required under the Kyoto Protocol was implemented in conjunction with the link-up.

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 Registry Regulation. Security is also kept at a high level by SiriusIT being responsible for validation.

The Swedish registry publishes the information specified in Annex XVI of the Registry Regulation at www.utslappshandel. se[1]. The Internet address of the Swedish registry is http://www1.stem.se/etjanster.

.

1 http://www.energimyndigheten.se/sv/Foretag/Utslappshandel/Om-SUS/Registerutdrag-ur-SUS--/.

Annex 5: Projection methodology and basis of calculation

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 calculated on the basis of projections for energy use in the energy sector. Carbon dioxide emissions are obtained by multiplying the consumption of each fuel by emission 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 combustion installations in the energy sector.

Different models are used for each sub-sector in drawing up projections of trends in the energy system . 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 B.5.1. Expert assessments are an important element at all stages in the process.

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

The projections for economic development are prepared using a general equilibrium model, EMEC, by the National Institute of Economic Research. 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 Swedish Energy Agency's assumptions on energy prices are also used as input data in the EMEC model. The advantage in using this type of model is that it encompasses the whole economy.

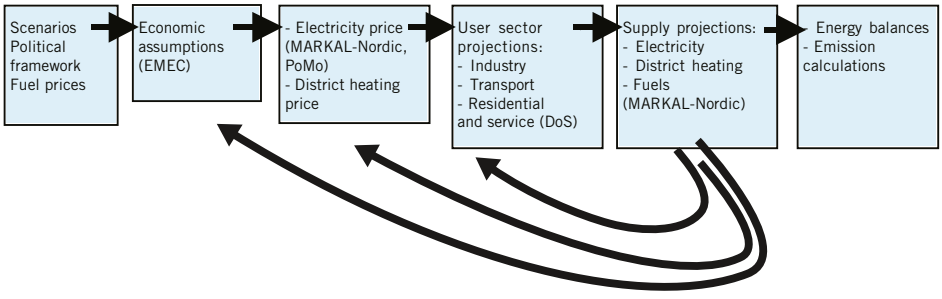


Figure B.5.1 **The projection process for emissions from the energy sector. Models used are shown in brackets.**

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 point of departure for projections on development in the energy system is the trend in 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 vehicle fuels and fuels for heating before it can be used on the Swedish market. The results of the model are domestic future fuel prices for fuel oil 1 (light fuel oil, domestic heating oil), fuel oil 5 (heavy fuel oil), coal, LPG, petrol and diesel for different types of customers. Applicable taxes and VAT are then applied to the fuel and customer category concerned. The estimation of future natural gas prices is based on the European import price for natural gas. Biofuel prices are calculated using historical series from 1995 to 2007, together with analyses of future demand for and supply of biofuel based on other projection assumptions. The trend in biofuel prices is assumed, with the exception of prices for liquid vehicle biofuels, to be dependent on demand in the Swedish energy system.

The projections on using fuels for *electricity and district-heating* production are based on the MARKAL-Nordic model. The future need for energy represents exogenic data for the model which, through its optimisation algorithm, works out the most cost-effective fuel and energy mix that meets the energy need in the whole stationary energy system. MARKAL-Nordic represents the other Nordic countries (excluding Iceland) and permits electricity trading between neighbouring countries. Not just the Swedish energy system but the Nordic energy system is therefore optimised.

The projections of energy use in the *residential and service* sector are prepared by combining the model results from the DoS model (Demand and Supply model), MARKAL-Nordic and assessments by industry experts. The DoS model is a bottom-up model which produces projections on the basis of assumptions on such things 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 strength of the model is that, on the basis of very detailed information on energy use in the sector and on the trend in influencing factors of decisive significance to the sector, it provides projections of energy use which are consistent with the trend in these influencing factors.

The projections on the energy use of the *industrial* sector come from an Excel-based bottom-up model, economic conditions and assumed energy prices. This result is harmonised through contacts with energy-intensive companies and industry organisations. Account is also taken of the results from the energy system model MARKAL-Nordic, which uses the projections on industrial energy use as input.

The projections on carbon dioxide emissions from the *transport* sector are calculated on the basis of projections of 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. those fitted with a catalytic converter) and emissions factors. The transport sector has been divided into four sub-sectors: road traffic, aviation, rail traffic and shipping. The projections for all types of transport have been calculated on the basis of present-day energy use.

The projection for petrol use has been calculated using a bottom-up model that calculates total petrol use based on an assumption on the composition of the car fleet. The Swedish Road Administration's projections for the vehicle fleet, in which new car sales and fuel efficiency are calculated for each year of projection, are used as input for the model. This model has also been used for projections on the fuel use of diesel cars. The projections on other diesel use have been made using a top-down demand model. The model includes assumptions on the price of diesel, trends in various industries and technical development.

The carbon dioxide emissions of *industrial processes* have been calculated using Excel-based trend analysis of historical emissions and based on the growth projections used in the industrial combustion sector.

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 conditions 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 emission factors.

The same method has been used to calculate emissions in the projections for the *agriculture* sector as is used when historical emissions are presented. 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 for activity data are based on results from the SASM model, which makes assumptions regarding productivity and future agricultural policy.

The projections for net removals in the *Land Use, Land-Use Change and Forestry* sector are analysed using the Hugin calculation system, which simulates the future development of the forests on the basis of assumptions regarding how they are managed and exploited over a hundred-year period. In Hugin, sustainable logging is estimated as mean values per year for ten-year periods (2005-2014, 2015-2024, etc.). The total carbon stock is calculated for the first year of each such period. Net removal is calculated in the projections as the difference between stocks at different times. The calculations encompass biomass in living trees on forest soil. Trends are extrapolated for other types of ownership and carbon pools.

Assumptions underlying calculation

Assumptions underlying calculation for the energy sector

General assumptions made in calculation for the energy sector

The general assumptions made in calculations for the whole energy and transport sector are presented below. Specific assumptions made for each sub-sector are then presented for the sector concerned.

- Nuclear power plants are assumed to have a life of 60 years, which means that no reactors are decommissioned during the projection period.
- A price of emission allowances of 30 euros per tonne of carbon dioxide in the EU Emissions Trading Scheme has been assumed throughout the projection period up to 2020.
- It has been assumed on the basis of current decisions on the electricity certificate system that the system will remain in force throughout the projection period and will lead to 17 TWh of new renewable electricity production in 2016 in comparison with the 2002 level. This level is assumed to persist through to 2020.
- Current taxes and other policy instruments in 2008 are otherwise assumed to remain until 2020.

National Institute of Economic Research estimation of economic development (development in %/year)*

	2005-2010	2010-2020	2005-2020
GDP	2.6	2.1	2.3
Private consumption	2.5	3.2	2.9
Exports	5.9	4.9	5.3
Imports	6.5	5.6	5.9

* The assessment was made before the economic downturn of 2008.

Swedish Energy Agency estimates for the trend in fossil fuel prices, current prices:

	2005	2007	2010-2020
Crude oil (USD/barrel)	54.4	72.2	90
Coal (USD/tonne)	61.1	88.8	96
Natural gas (USD/Mbtu)	6.0	8.6	9.2

Swedish Energy Agency estimates for the price trend for biofuels and waste: (Prices in SEK/MWh (2005 price level))

	2005	2010	2020
Solid forest-industry by-products	95-121	130-145	180-196
Forest chips	135-165	159-201	206-252
Short-rotation forest	137	165	217
Processed wood fuels	204	249	328
Recycled wood	80	83	96
Combustible waste	-150-0	-150-0	-150-0
Peat	112	100	119

The projections are based on normal production, and no account has been taken of changes due to future climate effects.

Assumptions underlying calculation for energy industries

Swedish area price for electricity i 2005 and for the projection years 2010, 2015 and 2020. Annual average, 2005 price level (SEK/kWh).

Year	2005	2010	2015	2020
Electricity price	27.2	48	47	47

Electricity production from hydropower (incl. small-scale hydropower) and nuclear power has been assumed to be (kWh):

	2005	2010	2020
Hydropower production	72.2	67.5	68.0
Nuclear power production	69.5	68	72.4

- Emissions for the refineries sector are estimated to increase by 2015 in accordance with the industry's plans for expansion. An increase in emissions has been assumed for the period 2015-2020 which is in line with the economic trend for the petrochemical industry according to the National Institute of Economic Research estimate of 1.25 per cent growth per year.

Assumptions underlying calculation for industrial combustion

The projections on industrial combustion are based on assumptions on production trends in particular industries, the extent of energy efficiencies and trends in energy prices.

Annual percentage change in added value for individual industries between 2005 and 2010 and between 2010 and 2020 according to National Institute of Economic Research estimates.

	Ann. % change 2005-2010	Ann. % change 2010-2020
Pulp and paper industry	0.64	1.5
Chemical industry	2.2	2.85
Iron and steel industry	2.23	2.1
Earth and stone industry	2.42	2.1
Metalworks	0.8	2.35
Engineering industry	4.5	4.36
Mining and minerals	1.97	1.69
Pharmaceutical industry	2.2	2.86
Other manufacturing industr	1.04	2.1

- The projections are based on existing policy instruments which are assumed to apply throughout the projection period.
- The baseline year for the projections is 2005. Growth in 2006-2007 is only partially included in the estimates for the projection years. The emissions in absolute terms may therefore be lower still, for example for the pulp and paper industry, although the trend is regarded as reasonable.

Assumptions underlying calculation for residential and service sector

The projections on energy use in the residential and service sector are based on assumptions on temperature conditions, population trend, the stock of housing and commercial premises, energy prices, investment costs, technological development and economic development.

Assumptions on numbers of homes and commercial premises and population trend

	Unit	2005	2010	2020
Individual houses	thousands	1 777 000	1 845 000	1 970 000
Apartments	thousands	2 490 000	2 592 000	2 778 000
Commercial premises	million m^2	165	170	180
Population	millions	9	9.4	9.7

- The proportion of individual houses in new construction is estimated at 40 per cent and the proportion of apartments in multi-dwelling buildings at 60 per cent. Individual houses are assumed principally to install electric heating, including heat pumps, while multi-dwelling buildings are assumed primarily to install district heating.
- The projections for the residential and service sector have been subjected to normal-year correction, while the historical emissions are actual emissions. Consequently, as recent years have been warmer than normal the projections are somewhat high in relation to the historical time series.

Assumptions underlying calculation for the transport sector

- Projections for the trend in transport are based on economic development and social development in general. Projections for passenger transport are also based on assumptions on private consumption and fuel prices. Projections for freight transport are principally affected by how industry and commerce develop and are based on industrial production, exports and imports, broken down into different industries.
- The calculations are based on existing decisions on policy instruments, and these policy instruments are assumed to apply throughout the projection period.
- The assumptions for road traffic contain assumptions on the trend in fuel prices, technical development for vehicles, improved efficiency of fuel use and the introduction of renewable fuels.

New car sales for the projection period have been calculated using a model based on fuel price, historical trend and estimation of the future car supply. The principal trend over the period is for the proportion of diesel cars and cars that can run on biofuels to increase in the vehicle fleet, while the proportion of cars running on petrol declines.

Fuel prices, SEK/litre, incl. energy and environmental taxes (incl. VAT)

Fuel	2005	2010	2020
Petrol. env. class 1	8.91	10.27	10.27
Diesel. env. class 1	8.39	10.37	10.37

- The price of ethanol (E85) is assumed to be lower than the price of petrol in terms of litres of petrol equivalent over most of the projection period.
- Only fuels currently on the market are included in the projections.
- During the projection years it is assumed that 93 per cent of all petrol contains 5 per cent low-blend ethanol and that 85 per cent of all diesel contains 5 per cent FAME.
- Some improvement in efficiency takes place during the projection period with regard to the use of aviation fuel.
- The proportion of domestic aviation was 26 per cent in 2005. The proportion of domestic aviation in 2020 has been assumed to be 17 per cent.

Assumptions underlying calculation for industrial processes

The projections are based on assumptions on production trends in individual industries and, in part, on extrapolations from historical trends. The assumptions on future growth in production are the same as for industrial combustion.

Assumptions underlying calculation for solvent and other product use

The projections for solvent and other product use are based among other things on assumptions on the use of solvents for different products and the carbon content of solvents.

Assumptions from 2007 to 2030

Code	Solvents	Carbon content of solvents
3A Paints	-5%	-10%
3B Dry-cleaning etc.	Unchanged	Unchanged
3C Chemical products	-5%	Unchanged
3.D.5 Leather industry	Unchanged	-10%
3.D.5 Printing	-5%	-10%
3.D.5 Textile treatment	Unchanged	Unchanged
3.D.5 Pressure impregnation	Unchanged	Unchanged
3.D.5 Other	-5%	-10%

Assumptions underlying calculation for the agricultural sector

The projections are based in part on the results of analyses of what the situation will be like in 2020 with present-day agricultural policy and assuming that the OECD price forecasts for agricultural products are correct. The analyses have been made using the SASM model.

- Input prices are assumed to be unchanged in real terms
- Assumed oil price: 100 dollars per barrel

Assumed change in productivity:

Increase in return per year:	
Cereals	+0.5% per ha
Milk	+1.5% per dairy cow
Pigs	+1.5% per sow
Use of inputs:	
Labour	-2% per year
Other inputs	-1% per year

- No direct measures against greenhouse gas emissions have been included, but indirect effects of reduced emissions of substances which cause eutrophication and acidification have.
- The trend for an increasing proportion of slurry management is assumed to continue for pigs and dairy cows, and a slightly prolonged grazing period is assumed for cattle. For other types of livestock, both grazing period and manure management systems are assumed to remain unchanged in comparison with 2000.

Assumptions underlying calculation for the waste sector

The projections are based on the existing instruments 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[1].

Assumptions underlying calculation for LULUCF

The projections for changes in living biomass in productive forest land have been made using the HUGIN model, which is structured to describe the future development of the forests under specified assumptions on future forest management.

- Logging is assumed to be at the maximum level possible without reducing the timber stock in the future. Over the period 2010-2030 it is assumed that logging can total 95 million cubic metres standing volume per year. Logging over the period 2004-2009 averaged around 81 million cubic metres standing volume excluding the loss of timber directly attributable to a severe storm in 2005. If the effects of the storm are included, the level of logging becomes 90 million cubic metres standing volume.
- The scenario principally assumes continued forest management similar to that which applied at the beginning of the 2000s.
- 956 000 ha is set aside for nature reserves, and 2 030 000 ha has been set aside for various forms of nature conservation. No logging takes place here. No other measures are included in the projections.
- The climate effect included in the calculations is based on Sweclim's B2 scenario. The effect provides an addition to annual growth of around 2 per cent by 2020.
- The projections for the other types of ownership and the carbon pools are based on extrapolations of trend and are assumed to be at the same level throughout the projection period.

1 Swedish Environmental Protection Agency, report 5169.

Assumptions underlying calculation for sensitivity analysis in the energy sector

1. Higher fossil fuel prices

Import prices for crude oil, coal and natural gas and exchange rates, current prices

			Main alternative	Higher fossil fuel prices
	2005	2007	2010-2020	2010-2020
Crude oil (USD/barrel)	54.4	72.7	90	120
Carbon, USD/tonne at port	61.1	88.8	96	128
Natural gas, USD/Mbtu	6.0	8.6	9.2	12.2
Exchange rate, USD/SEK	7.48	6.76	6.76	6.76

- The price of emission allowances is assumed to be 35 euros per tonne of carbon dioxide in the alternative with a higher fossil-fuel price.

Economic development in the main alternative and in the alternative with higher fossil fuel prices

Growth in %/year	Main alternative		Higher fossil fuel prices	
	2005-2010	2010-2020	2005-2010	2010-2020
GDP	2.64	2.06	2.53	2.05
Private consumption	2.5	3.16	2.05	3.16
Exports	5.91	4.94	5.9	4.95
Imports	6.47	5.57	6.26	5.59

Swedish area price (SEK/kWh) for electricity in 2005 and for the projection years 2010, 2015 and 2020, annual average, 2005 price level.

	2005	2010	2015	2020
Main alternative	27.2	48	47	47
Higher fossil fuel price	27.2	55	54	54

2. Higher growth

Economic development in the main alternative and in the alternative with higher growth

Growth in %/year	Main alternative		Higher growth	
	2005-2010	2010-2020	2005-2010	2010-2020
GDP	2.64	2.06	2.90	2.68
Private consumption	2.5	3.16	2.65	3.89
Exports	5.91	4.94	6.21	5.54
Imports	6.47	5.57	6.77	6.17

Assumptions underlying alternative with additional measures

Measures included:

- Regulation of the carbon dioxide emissions of new cars not exceeding 130 g/km on average with effect from 2015. The regulation already applies to 65 per cent of the new car fleet in 2012. The requirement in 2020 is that carbon dioxide emissions do not exceed 95 g/km.
- Aviation is included in the EU Emissions Trading Scheme from 2012.
- Permitted admixture of ethanol in petrol is raised from 5 per cent to 10 per cent in the projection period.

Assumptions underlying partial sensitivity calculation 2010

- The calculations are based a short-term projection of energy use (July 2009)
- The short-term projection is based on policy instruments decided upon by June 2009.

Economic assumptions (%/year)

	2008	2009	2010
GDP	-0.2	-5.4	0.8
Industrial production	-3.4	-23.5	2.5
Household consumption	-0.2	-1.9	2

Oil price assumption (2008 price)

	2008	2010
Crude oil (USD/barrel)	97.6	57

Annex 6:
Bilateral and regional financial support 2004-2008 related to implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol

Bilateral and regional financial support related to implementation of UNFCCC and the Kyoto Protocol in 2004 (SEK million)

		Mitigation						Adaptation				Other
Region	Total 2004	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Water	Forestry	Agriculture	Other adaptation	
Albania	50,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	50,0	0,0
Bangladesh	13,9	0,0	0,0	8,8	0,0	0,0	0,0	5,0	0,0	0,0	0,0	0,0
Bosnia-Herzegovina	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0
Burkina Faso	50,7	2,2	0,1	11,8	7,8	2,2	0,0	4,9	5,9	13,7	0,1	2,1
Philippines	94,6	5,5	0,0	7,4	1,4	0,0	0,0	22,4	15,3	13,3	14,5	14,7
Honduras	18,8	0,0	0,0	0,0	0,0	0,0	0,0	11,0	0,0	0,0	7,8	0,0
Caucasus	27,7	0,0	0,0	0,0	5,7	5,3	0,0	5,3	0,0	5,7	0,0	5,7
Kenya	45,0	0,0	0,0	0,0	0,0	45,0	0,0	0,0	0,0	0,0	0,0	0,0
Congo	9,6	9,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Kosovo	28,4	0,0	0,0	8,0	4,5	0,0	0,0	3,4	8,0	4,5	0,0	0,0
Laos	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
Macedonia	29,4	29,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Malawi	93,9	56,8	0,0	23,6	7,4	0,0	0,0	0,0	0,0	6,1	0,0	0,0
Mozambique	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0
Montenegro	107,5	0,0	0,0	5,4	6,8	20,8	0,0	37,7	3,3	33,7	0,0	0,0
Pakistan	46,6	5,0	0,0	1,4	1,4	0,0	0,0	11,4	1,4	16,2	5,0	4,8
Reg. Africa	21,3	0,0	0,0	0,0	0,0	15,0	0,0	0,0	0,0	6,3	0,0	0,0
Reg Asia	13,0	0,0	0,0	4,0	4,0	0,0	0,0	5,0	0,0	0,0	0,0	0,0
Reg South-East Asia	8,2	0,0	0,0	0,0	0,0	0,0	0,0	3,0	0,0	0,0	0,0	5,2
Reg Southern Africa	10,0	0,0	0,0	0,0	0,0	0,0	0,0	2,6	0,0	2,6	0,0	4,8
Reg. Lake Victoria	15,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	15,2
Reg. West Africa	8,6	0,0	0,0	0,0	0,0	8,6	0,0	0,0	0,0	0,0	0,0	0,0
Reg. East Africa	7,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,8	0,0	0,0
Rwanda	15,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	15,3	0,0
Serbia	42,3	21,2	0,0	0,0	0,0	6,0	0,0	0,0	0,0	15,1	0,0	0,0
Sri Lanka	25,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	25,0	0,0	0,0	0,0
Sudan	21,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	21,0
Tajikistan	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0
Tanzania	99,9	29,8	0,0	0,0	0,0	0,0	0,0	24,2	14,6	14,6	16,8	0,0
Uganda	13,4	0,0	0,0	0,0	3,8	0,0	0,0	5,8	0,0	3,8	0,0	0,0
Vietnam	34,9	0,3	0,0	0,3	0,3	0,0	0,3	2,4	15,6	15,6	0,1	0,0
Zambia	44,6	0,0	0,0	0,0	0,0	0,0	0,0	1,6	0,0	41,4	1,6	0,0
Total	**998,4**	**159,9**	**0,1**	**70,6**	**43,1**	**102,9**	**0,3**	**145,7**	**89,0**	**201,6**	**111,6**	**73,6**

Bilateral and regional financial support related to implementation of UNFCCC and the Kyoto Protocol in 2005 (SEK million)

		Mitigation						Adaptation				Other
Region	Total 2004	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Water	Forestry	Agriculture	Other adaptation	
Albania	10,1	0,0	0,0	5,0	0,0	0,0	0,0	0,0	5,0	0,0	0,0	0,0
Bangladesh	152,8	0,0	0,0	0,0	17,8	17,8	0,0	0,0	0,0	0,0	51,8	65,3
Bolivia	8,9	0,0	0,0	4,4	0,0	0,0	0,0	4,5	0,0	0,0	0,0	0,0
Bosnia-Hercegovina	48,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	48,0	0,0
Burkina Faso	2,1	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	1,0	0,0	0,0
Ethiopia	104,3	1,4	1,4	21,8	19,9	1,4	0,0	15,4	16,9	24,8	1,4	0,0
Global	198,4	3,8	0,0	7,4	1,4	12,9	3,9	23,3	15,9	64,2	43,4	22,2
Guatemala	6,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,3
India	30,7	0,0	0,0	0,0	0,0	10,1	0,0	19,0	0,0	0,0	1,7	0,0
Indonesia	105,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	80,0	25,0
Kenya	118,6	4,6	19,7	0,0	12,4	0,0	0,0	51,4	0,0	12,4	0,0	18,1
Kosovo	16,6	9,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,6	0,0
Laos	29,7	0,0	0,0	8,5	4,3	0,0	0,0	4,2	8,5	4,3	0,0	0,0
Macedonia	0,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0
Mozambique	86,4	39,2	0,0	25,6	7,5	0,0	0,0	0,0	0,0	14,1	0,0	0,0
Montenegro	5,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,6	0,0
Nicaragua	116,3	0,0	0,0	5,1	7,8	20,2	1,6	29,6	1,6	50,4	0,0	0,0
Reg. Africa	43,9	6,0	0,0	1,6	1,6	0,0	0,0	10,7	1,6	14,0	5,0	3,3
Reg. Asia	53,7	0,8	7,8	0,8	0,8	18,0	0,8	0,0	0,0	8,7	0,0	16,0
Reg. Central America	16,4	0,0	0,0	3,0	3,0	0,0	0,0	10,3	0,0	0,0	0,0	0,0
Reg South-East Asia	28,8	0,0	0,0	0,0	0,0	0,0	0,0	25,7	0,0	0,0	0,0	3,2
Reg Southern Africa	16,6	0,0	0,0	0,0	0,0	0,0	0,0	8,5	0,0	3,5	0,0	4,6
Reg. Lake Victoria	20,4	0,0	0,0	0,0	0,0	3,4	0,0	0,0	0,0	0,0	0,0	17,0
Reg. West Africa	6,5	0,0	0,0	0,0	0,0	6,5	0,0	0,0	0,0	0,0	0,0	0,0
Reg. East Africa	13,0	0,0	0,0	0,0	0,0	7,6	0,0	0,0	0,0	5,4	0,0	0,0
Rwanda	22,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	22,1	0,0
Serbia	29,3	18,1	0,0	0,0	0,0	1,8	0,0	0,0	0,0	9,4	0,0	0,0
Sri Lanka	240,0	0,0	20,0	0,0	0,0	210,0	0,0	0,0	0,0	0,0	0,0	10,0
Tajikistan	7,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,3	0,0	0,0
Tanzania	138,9	56,7	10,3	0,0	5,9	0,0	14,4	18,1	6,7	6,7	20,1	0,0
Uganda	29,0	1,3	0,0	0,0	6,5	1,3	0,0	12,1	0,0	6,5	0,0	1,3
Vietnam	135,1	2,2	0,0	2,9	2,9	0,0	2,2	16,4	52,0	51,3	5,2	0,0
West Bank	195,4	9,5	0,0	0,0	0,0	10,0	0,0	0,0	0,0	0,0	135,9	40,0
Zambia	63,7	0,0	0,0	0,0	0,0	0,0	0,0	1,6	0,0	60,5	1,6	0,0
Total	**2100**	**153,4**	**59,2**	**86,2**	**91,9**	**321,0**	**22,9**	**251,9**	**108,3**	**344,6**	**428,9**	**232,3**

Bilateral and regional financial support related to implementation of UNFCCC and the Kyoto Protocol in 2006 (SEK million)

		Mitigation						Adaptation				Other
Region	Total 2004	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Water	Forestry	Agriculture	Other adaptation	
Albania	10,5	0,0	0,0	5,3	0,0	0,0	0,0	4,1	1,1	0,0	0,0	0,0
Bangladesh	137,1	0,0	0,0	0,0	17,8	17,8	0,0	0,0	0,0	0,0	35,5	66,0
Bolivia	17,4	0,0	0,0	9,4	0,0	0,0	0,0	8,0	0,0	0,0	0,0	0,0
Bosnia-Herzegovina	14,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	14,0	0,0	0,0
Burkina Faso	4,2	0,0	0,0	0,0	0,0	0,0	0,0	2,1	0,0	2,1	0,0	0,0
Ethiopia	95,7	0,1	0,1	21,8	18,0	0,1	0,0	15,7	17,2	22,6	0,1	0,0
Philippines	5,0	0,0	0,0	0,0	0,0	0,0	0,0	5,0	0,0	0,0	0,0	0,0
Global	218,9	6,2	0,0	12,1	9,1	6,2	6,2	45,6	14,1	17,1	64,3	37,8
Guatemala	37,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	26,4	11,1
Honduras	11,9	0,0	0,0	0,0	0,0	0,0	0,0	11,9	0,0	0,0	0,0	0,0
India	29,7	0,0	0,0	0,0	0,0	5,0	0,0	17,0	0,0	0,0	7,8	0,0
Indonesia	90,0	0,0	0,0	0,0	0,0	0,0	0,0	5,0	0,0	0,0	70,0	15,0
Iraq	43,8	43,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Kenya	170,3	1,2	30,9	29,4	10,7	2,5	0,0	43,7	26,9	13,1	0,0	12,0
Kyrgyzstan	13,0	0,0	0,0	0,0	0,0	13,0	0,0	0,0	0,0	0,0	0,0	0,0
Kosovo	14,3	1,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	12,7	0,0
Laos	29,9	0,0	0,0	9,9	5,1	0,0	0,0	0,0	9,9	5,1	0,0	0,0
Macedonia	4,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,8	0,0
Mozambique	180,1	99,8	0,0	43,6	13,6	0,0	0,0	0,0	0,0	16,6	0,0	6,5
Montenegro	15,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	15,0	0,0
Nicaragua	105,0	0,0	0,0	3,2	6,0	21,7	1,0	24,8	5,0	43,3	0,0	0,0
Reg. Africa	52,7	6,0	0,0	0,8	0,8	15,6	0,0	10,8	0,8	10,8	7,0	0,0
Reg. Asia	57,8	1,7	1,8	1,7	1,7	17,3	1,7	17,0	0,0	8,6	0,0	6,5
Reg. Central America	7,5	0,0	0,0	0,0	0,0	0,0	0,0	7,5	0,0	0,0	0,0	0,0
Reg South-East Asia	43,7	0,0	0,0	0,0	0,0	0,0	0,0	15,9	0,0	0,0	0,0	27,7
Reg. Sub-Saharan Africa	10,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	10,5	0,0
Reg. Southern Africa	15,1	0,0	0,0	0,0	0,0	0,0	0,0	7,7	0,0	2,7	0,0	4,6
Reg. Lake Victoria	27,7	0,0	0,0	0,0	0,0	9,3	0,0	12,1	0,0	0,0	0,0	6,3
Reg. West Africa	1,5	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0
Reg. East Africa	15,3	0,0	0,0	0,0	0,0	15,3	0,0	0,0	0,0	0,0	0,0	0,0
Rwanda	23,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	23,0	0,0
Serbia	25,5	13,1	0,0	0,0	0,0	-0,9	0,0	0,0	0,0	5,7	7,5	0,0
Sri Lanka	20,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	20,0
Tajikistan	7,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,6	0,0	0,0
Tanzania	138,8	51,4	12,6	0,0	10,4	0,0	13,6	16,1	6,5	6,5	12,4	9,3
Uganda	129,2	49,0	0,0	0,0	8,2	2,5	0,0	58,7	0,0	8,2	0,0	2,5
Vietnam	146,7	3,0	0,0	0,4	0,4	0,0	3,0	20,1	53,5	56,1	10,3	0,0
West Bank	90,6	9,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	82,6	-0,9
Zambia	55,1	0,0	0,0	0,0	0,0	0,0	0,0	1,8	0,0	51,4	1,8	0,0
Total	**2 116**	**285,9**	**45,4**	**137,5**	**101,7**	**126,9**	**25,5**	**350,7**	**135,0**	**291,6**	**391,7**	**224,4**

Bilateral and regional financial support related to implementation of UNFCCC and the Kyoto Protocol in 2007 (SEK million)

		Mitigation						Adaptation				Other
Region	Total 2004	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Water	Forestry	Agriculture	Other adaptation	
Albania	8,6	0,0	0,0	4,3	0,0	0,0	0,0	4,3	0,0	0,0	0,0	0,0
Bangladesh	10,2	0,0	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,5	9,5
Bolivia	10,0	0,0	0,0	0,0	0,0	0,0	0,0	10,0	0,0	0,0	0,0	0,0
Bosnia-Herzegovina	7,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,9	0,0	0,0
Burkina Faso	4,9	0,0	0,0	0,0	0,0	0,0	0,0	2,5	0,0	2,5	0,0	0,0
Ethiopia	76,9	2,9	0,0	18,9	12,3	0,0	0,0	11,8	12,3	18,9	0,0	0,0
Philippines	8,0	0,0	0,0	0,0	0,0	0,0	0,0	8,0	0,0	0,0	0,0	0,0
Global	319,5	38,9	0,0	14,8	9,3	4,3	4,3	35,4	14,8	45,9	97,1	54,8
Guatemala	31,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	13,6	17,5
Honduras	12,0	0,0	0,0	0,0	0,0	0,0	0,0	12,0	0,0	0,0	0,0	0,0
India	21,0	0,0	0,0	0,0	0,0	0,0	0,0	11,3	0,0	0,0	9,7	0,0
Indonesia	14,0	0,0	0,0	0,0	0,0	0,0	0,0	8,2	0,0	0,0	5,9	0,0
Iraq	9,1	9,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cambodia	8,4	0,0	0,0	0,0	0,0	0,0	0,0	8,4	0,0	0,0	0,0	0,0
Kenya	123,7	0,7	33,6	7,1	18,6	4,1	0,0	24,8	3,0	21,6	0,0	10,2
China	3,5	0,0	0,0	0,0	0,0	0,0	1,8	1,8	0,0	0,0	0,0	0,0
Kyrgyzstan	19,0	0,0	0,0	0,0	0,0	19,0	0,0	0,0	0,0	0,0	0,0	0,0
Congo	6,3	0,0	0,0	6,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Kosovo	6,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,5	0,0
Laos	38,9	0,0	0,0	11,5	7,5	0,0	0,0	4,0	11,5	4,3	0,0	0,0
Macedonia	7,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,2	0,0
Mozambique	113,6	44,9	0,0	19,9	6,2	0,0	0,0	0,0	0,0	34,2	0,0	8,5
Montenegro	13,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	13,6	0,0
Nicaragua	101,1	0,0	0,0	4,6	7,4	8,0	1,4	19,1	4,5	56,1	0,0	0,0
Pakistan	20,0	0,0	0,0	0,0	0,0	0,0	0,0	6,7	6,7	6,7	0,0	0,0
Reg. Africa	24,6	5,0	0,0	-0,7	-0,7	15,3	0,0	4,3	-0,7	-0,7	3,0	0,0
Reg. Asia	77,0	37,1	8,5	1,9	1,9	16,3	1,9	0,4	0,0	8,7	0,0	0,0
Reg. Central America	8,7	0,0	0,0	0,0	0,0	0,0	0,0	8,7	0,0	0,0	0,0	0,0
Reg South-East Asia	55,7	0,0	0,0	0,0	0,0	0,0	0,0	16,6	0,0	0,0	0,0	39,1
Reg Southern Africa	9,2	0,0	0,0	0,0	0,0	0,0	0,0	7,1	0,0	2,1	0,0	0,0
Reg. Lake Victoria	33,9	0,0	0,0	0,0	0,0	19,8	0,0	13,9	0,0	0,0	0,0	0,3
Reg. East Africa	20,1	0,0	0,0	0,0	0,0	15,3	0,0	0,0	0,0	4,8	0,0	0,0
Rwanda	25,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	25,8	0,0
Serbia	12,9	2,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	9,4	0,0
Sri Lanka	32,4	0,0	0,0	0,0	0,0	17,4	0,0	0,0	0,0	0,0	0,0	15,0
South Africa	10,0	0,0	3,3	0,0	0,0	3,3	3,3	0,0	0,0	0,0	0,0	0,0
Tajikistan	4,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,0
Tanzania	147,6	72,1	3,9	0,0	8,1	0,0	8,2	11,4	3,4	3,4	23,0	14,1
Turkey	5,8	5,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Uganda	77,4	2,6	0,0	0,0	5,3	1,3	0,0	61,6	0,0	5,3	0,0	1,3
Vietnam	169,6	0,7	0,0	1,3	1,3	0,0	0,7	20,0	62,4	61,8	21,4	0,0
West Bank	2,8	10,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-7,2	0,0
Zambia	63,2	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	53,3	9,0	0,0
Totalt	**1777**	**232,7**	**49,4**	**89,9**	**77,2**	**124,1**	**21,5**	**313,0**	**117,9**	**342,0**	**238,6**	**170,2**

Bilateral and regional financial support related to implementation of UNFCCC and the Kyoto Protocol in 2008 (SEK million)

		Mitigation						Adaptation				Other
Region	Total 2004	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Water	Forestry	Agriculture	Other adaptation	
Albania	22,8	0,0	0,0	11,4	0,0	0,0	0,0	4,3	7,1	0,0	0,0	0,0
Bangladesh	72,2	0,0	0,0	0,0	18,0	18,0	0,0	0,0	0,0	0,0	36,1	0,0
Bolivia	10,0	0,0	0,0	0,0	0,0	0,0	0,0	10,0	0,0	0,0	0,0	0,0
Bosnia-Herzegovina	5,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,1	0,2	0,0
Burkina Faso	4,9	0,0	0,0	0,0	0,0	0,0	0,0	2,5	0,0	2,5	0,0	0,0
Ethiopia	58,8	0,2	0,0	11,4	17,9	0,0	0,0	8,4	9,6	11,4	0,0	0,0
Philippines	9,5	0,0	0,0	0,0	0,0	0,0	0,0	9,5	0,0	0,0	0,0	0,0
Global	289,4	18,3	0,0	9,9	9,9	3,0	3,0	34,8	14,9	21,1	123,7	51,0
Guatemala	88,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	48,0	40,0
India	18,7	0,0	0,0	0,0	0,0	2,0	0,0	12,3	0,0	0,0	4,4	0,0
Indonesia	13,8	0,0	0,0	0,0	0,0	0,0	0,0	9,5	0,0	0,0	12,0	-7,7
Iraq	14,0	3,5	0,0	0,0	0,0	0,0	0,0	10,5	0,0	0,0	0,0	0,0
Cambodia	9,7	0,0	0,0	0,0	0,0	0,0	0,0	9,7	0,0	0,0	0,0	0,0
Kenya	223,3	0,5	33,1	13,3	42,7	10,0	0,0	68,3	3,3	45,9	0,0	6,3
China	7,5	0,0	0,0	0,0	0,0	0,0	3,8	3,8	0,0	0,0	0,0	0,0
Kyrgyzstan	31,3	0,0	0,0	0,0	0,0	31,3	0,0	0,0	0,0	0,0	0,0	0,0
Congo	3,9	0,0	0,0	3,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Kosovo	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,0
Laos	42,6	0,0	0,0	11,5	8,0	0,0	0,0	3,6	11,5	8,0	0,0	0,0
Macedonia	4,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,0	0,0
Mozambique	153,8	77,9	0,0	8,9	0,0	0,0	0,0	0,0	0,0	44,8	0,0	22,2
Montenegro	14,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	14,4	0,0
Nicaragua	123,7	0,0	0,0	5,7	7,0	29,7	0,9	29,4	5,7	45,3	0,0	0,0
Pakistan	10,0	0,0	0,0	0,0	0,0	0,0	0,0	3,3	3,3	3,3	0,0	0,0
Reg. Africa	81,2	5,0	0,0	5,9	5,9	16,3	0,0	37,0	5,9	5,3	0,0	0,0
Reg. Asia	91,7	49,5	18,9	1,2	1,2	1,2	1,2	8,1	0,0	10,5	0,0	0,0
Reg. Central America	9,3	0,0	0,0	0,0	0,0	0,0	0,0	9,3	0,0	0,0	0,0	0,0
Reg South-East Asia	31,8	0,0	0,0	0,0	0,0	0,0	0,0	2,2	0,0	0,0	0,0	29,7
Reg. Sub-Saharan Africa	40,0	0,0	6,0	0,0	0,0	6,0	0,0	6,0	0,0	0,0	22,0	0,0
Reg. Lake Victoria	39,4	0,0	0,0	0,0	0,0	10,3	0,0	29,1	0,0	0,0	0,0	0,0
Reg. East Africa	16,0	0,0	0,0	0,0	0,0	7,6	0,0	0,0	0,0	8,4	0,0	0,0
Rwanda	27,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	27,1	0,0
Serbia	18,1	9,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	9,2	0,0
Sri Lanka	13,4	0,0	20,0	0,0	0,0	5,1	0,0	0,0	-11,7	0,0	0,0	0,0
South Africa	16,0	0,0	5,3	0,0	0,0	5,3	5,3	0,0	0,0	0,0	0,0	0,0
Tajikistan	22,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	22,5	0,0	0,0
Tanzania	221,7	190,9	0,2	0,0	6,4	0,0	10,4	2,1	0,0	0,0	7,1	4,7
Turkey	6,4	6,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Uganda	129,0	52,3	0,0	0,0	3,9	1,6	0,0	65,6	0,0	3,9	0,0	1,6
Vietnam	132,3	2,0	0,0	0,1	0,1	0,0	2,0	20,7	47,3	49,2	10,9	0,0
West Bank	11,5	11,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Zambia	42,9	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	34,9	7,3	0,0
Grand total	**2182**	**427,0**	**83,6**	**83,0**	**120,9**	**147,5**	**26,6**	**400,4**	**96,9**	**322,2**	**326,7**	**147,7**

Annex 7: Information in accordance with Article 7.2 of the Kyoto Protocol

Reported information	NC5 section
National system for inventory of emissions	Annex 3
National registry	Annex 4
Supplementarity related to mechanisms under Articles 6, 12 and 17.	Chap. 5.7
Policy instruments implemented to promote sustainable development (Art. 2)	Chap. 4.2
Initiatives in IMO and ICAO to reduce emissions from international transport (Art. 2)	Chap. 4.2.9
Minimise adverse effects (Art. 2)	Chap. 4.2.10
Programmes, legislative arrangement and administrative procedures for implementation of the Kyoto Protocol	Chap. 4.1
Implementation of Art. 3.3, 3.4 and contribution to conservation of biodiversity and of natural resources	Chap. 4.2.8
Information in accordance with Article 10	
a. improve data for inventory of emissions	Annex 3
b. activities for emission limitation and adaptation	Chap. 4.2, 4.3, 6.1, 6.4
c. activities for technology transfer and capacity building	Chap. 7.5
d. cooperation in research and systematic observation	Chap. 8.2.6, 8.3
e. international participation in information and training	Chap. 9.5.5
Financial resources and capacity building (Art. 11)	Chap. 7.2.2, 7.3, 7.4
Implementation of New Delhi programme (Art. 6)	Chap. 9.5

Departementsserien 2009

Kronologisk förteckning

1. Förstärkt integritetsskydd vid signalspaning. Fö.
2. Skyddade beteckningar på jordbruksprodukter och livsmedel. Jo.
3. Fordonsbesiktning. N.
4. Översyn av vissa mediemyndigheter – en effektivare administration. Ku.
5. Författningsändringar med anledning av VISförordningen. Ju.
6. Ekonomiska villkor för ledamöter av Europaparlamentet. Ju.
7. Effektivare regler och bättre beslutsunderlag för arbetsmarknadspolitiken. A.
8. Genomförandet av delar av Prümrådsbeslutet. Ju.
9. Förbättrad utslussning från sluten ungdomsvård och ändrade gallringsregler i belastningsregistret. Ju.
10. Stärkt finanspolitiskt ramverk – översyn av budgetlagens bestämmelser om utgiftstak. Fi.
11. Oberoendet i den kommunala revisionen. Fi.
12. Registrering av personuppgifter vid katastrofer utomlands. Ju.
13. Konsumenttjänster m.m. Ju.
14. Konsumentombudsmannen – en översyn IJ.
15. En enklare ledighetslagstiftning. A.
16. Produktsäkerhet vid offentliga tjänster. IJ.
17. Straffrättsliga åtgärder till förebyggande av terrorism. Ju.
18. Behovsbedömning av annat än ekonomiskt bistånd enligt socialtjänstlagen. S.
19. Insatser för en alkohol- och narkotikafri graviditet. S.
20. Rätt till gymnasial vuxenutbildning och gymnasial särvux. U.
21. Bortom krisen. Om ett framgångsrikt Sverige i den nya globala ekonomin. U.
22. Genomförande av FN:s vapenprotokoll m.m. Ju.
23. Det nya punktskattedirektivet. Fi.
24. Effektivare skatter på klimat- och energiområdet. Fi.
25. Den nya skollagen – för kunskap, valfrihet och trygghet. Del 1+2. U.
26. Förbättringar i arbetslöshetsförsäkringen. A.
27. Ny lag om ekologisk produktion. Jo.
28. Ny delgivningslag m.m. Ju.
29. Återbetalningsskyldighet i straffrättsliga förfaranden, m.m. Ju.
30. Nya rättsmedel m.m. på upphandlingsområdet. Fi.
31. Patientnämnderna – begränsning av sekretessbrytande bestämmelse. S.
32. Teknisk sprit m.m. S.
33. Förändringar i Lex Sarah-bestämmelsen m.m. S.
34. Ett undantag från skyldigheten att upprätta koncernredovisning. Ju.
35. Vad kräver krisen av främjandet? UD.
36. Upphandling från statliga och kommunala företag. Fi.
37. Nya avfallsregler. M.
38. Myndigheternas skrivregler. SB.
39. Åtgärder mot familjeseparation inom migrationsområ det. Ju.
40. Vissa samepolitiska frågor. Jo.
41. Betalningsansvaret för underårigas avgifter inom hälso- och sjukvården och tandvården. S.
42. Ett skärpt skadeståndsansvar för föräldrar. Ju.
43. Närvaroliggare och kontrollbesök. En utvärdering och förslag till utvidgning. Fi.
44. Vidareutnyttjande av handlingar – genomförande av PSI-direktivet. Fi.
45. Stöd till personer som lämnar sjukförsäkringen – kompletterande förändringar i lagen om allmän försäkring. S.
46. Stöd till personer som lämnar sjukförsäkringen – temporära förändringar i arbetslöshetsförsäkringen. A.
47. Reformen skydd mot olyckor – en uppföljning med förslag till utveckling. Fö.
48. Pionjärbanor för spårbilar. Analys av aktuella förutsättningar. N.
49. Vissa apoteksfrågor. S
50. Statligt stöd till riksdagspartiernas kvinnoorganisationer. IJ.
51. Ansvaret i vissa län för regionalt tillväxtarbete och transportinfrastrukturplanering. Fi.
52. Uppehållstillstånd för skyddspersoner. Ju.
53. Detta är pensionsöverenskommelsen. S.
54. Behörighet för lokförare. N.
55. En ny försäkringsrörelselag. Fi.
56. Statsluftfarten. N.
57. Nytt EG-direktiv om tidsdelat boende m.m. Ju.
58. Mervärdesskatt för den ideella sektorn, m.m. Fi.
59. Exportkontroll m.m. av produkter med dubbla användningsområden. UD.
60. Allmännyttiga kommunala bostadsaktiebolag – överväganden och förslag. Fi.
61. Leveransplikt för elektroniska dokument. U.
62. Placering av barn över nationsgränser med stöd av Bryssel II-förordningen och 1996 års Haagkonvention m.m. Ju.
63. Sveriges femte nationalrapport om klimatförändringar. I enlighet med Förenta nationernas ramkonvention om klimatförändringar. M.

Departementsserien 2009

Systematisk förteckning

FRITZES

www.fritzes.se ▪ order.fritzes@nj.se
Tel 08-690 91 90 ▪ Fax 08-690 91 91
106 47 Stockholm

ISBN 978-91-38-23319-1 ▪ ISSN 0284-6012