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Sweden's Sixth National Communication on Climate Change

Under the United Nations Framework Convention on Climate Change

REGERINGSKANSLIET

Ministry of the Environment
Sweden

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Foreword

In this report, Sweden's Sixth National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), a comprehensive summary of Sweden's efforts to combat climate change is provided in accordance with the guidelines adopted by the parties to the UNFCCC. Emissions and removals of different greenhouse gases are reported for each sector according to the UNFCCC classification and in aggregate for each year since 1990. Policy measures adopted and their impact on emissions are described. 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 16% in absolute numbers between 1990 and 2011. Moreover, preliminary statistics for 2012 show a decrease of almost 20% since 1990. At the same time, Sweden has seen relatively high economic growth with an increase in GDP of almost 60% since 1990.

The Riksdag (the Swedish Parliament) has adopted sixteen environmental quality objectives. At the forefront of these is the objective for *Reduced Climate Impact*. The objective originally adopted in 1999 was in 2009 further specified by the Riksdag, which stated that the increase in global average temperature should be limited to no more than 2 °C above pre-industrial levels, while global atmospheric concentrations of greenhouse gases should be limited to 400 ppm CO_2 equivalent.

Further, Sweden has a national milestone target for climate, calling for a 40% reduction in greenhouse gas emissions by 2020. The target applies to sectors not included in the EU Emissions Trading System, such as transport, housing, waste facilities, agriculture and non-energy-intensive industry. The reduction rate for activities encompassed by the EU Emissions Trading System is determined by existing EU law and will achieve emission cuts in this sector by 21 per cent in 2020 compared to 2005.

In addition to these objectives, Sweden has defined a priority of phasing out all fossil fuels used for heating in the housing sector by 2020 and a priority of having a vehicle fleet independent of fossil fuels by 2030. Furthermore, the long-term vision is that Sweden will be a country with no net emissions of greenhouse gases to the atmosphere by 2050.

The report also contains projections for emissions up to 2020 and 2030. According to these projections, emissions will continue to decrease, and the national target for 2020 is within reach.

The National Communication also describes Sweden's vulnerability and efforts to adapt to climate change. Sweden's contributions to climate finance, *inter alia* through development assistance of relevance to climate change, are presented, as are research and development. Finally, a description is provided of Sweden's work on education, training and public awareness with regard to climate change. The material on which the National Communication is based has been obtained through extensive activity on the part of government agencies, led by the Swedish Environmental Protection Agency with input from around ten other government agencies.

Most of the work on the Sixth National Communication was done over the period from the end of 2012 to the summer of 2013. Since then a number of important policy decisions have been made that are of relevance for the Swedish Climate Strategy, notably a common declaration in September 2013 between the USA and the Nordic countries agreeing to continue their work to reduce the use of domestic fossil fuel subsidies globally, to end public financing for new coal-fired power plants overseas except in rare circumstances, and to undertake peer reviews of domestic fossil fuel subsidies. Further, the Government announced in the Budget Bill for 2014 that it intends to establish a new investment fund focusing on energy and clean tech investments, and the Riksdag has decided on funding for a pilot project aimed at increasing the share of

anaerobic digestion of manure, leading to a double climate benefit as it reduces emissions of methane and increases the supply of renewable fuel. Sweden has also announced that it will provide approximately SEK 300 million to the Green Climate Fund, provided that it becomes operational in 2014, with all the necessary arrangements and standards in place.

Stockholm, December 2013

Lena Ek
Minister for the Environment

Contents

1 Executive summary

1.1 Introduction

This is Sweden's Sixth National Communication (NC6), presenting the national activities that have been undertaken to meet the country's commitments under the UN Framework Convention on Climate Change (UNFCCC) and which, as provided by the UNFCCC, the Kyoto Protocol and separate Conferences of the Parties (COPs), are to be reported in a national communication.

Emissions of greenhouse gases in Sweden, excluding emissions and removals from land use, land-use change and forestry (LULUCF), fell by 16% over the period 1990–2011 and are expected to continue to decline. By 2020, emissions are currently projected to be some 19% below 1990 levels, based on existing measures. Sweden's commitment on emissions under the Kyoto Protocol and EU burden sharing is to ensure that, as an annual average for the period 2008–12, emissions are no more than 104% of base-year emissions. A preliminary gap analysis indicates that Sweden will meet its commitment by a good margin.

1.2 National circumstances

Factors affecting a country's level of and trends in greenhouse gas emissions include population, climate, energy and transport systems, industrial structure and the economy.

Sweden's population in 2012 was 9.6 million, with an annual growth rate since 1990 of 0.5%. By 2030 the population is expected to have risen to 10.7 million.

Over the period 1991–2012, the mean temperature was about 1 °C higher than in 1961–90. However, there may still be major variations from year to year. To date, 1996 and 2010 are the only years since 1990 with a greater heating requirement than the average for 1965–95. Winter 2007/08 was the warmest of all winters since 1860, while those of 2009/10 and 2010/11 were the coldest since the late 1980s, resulting in very high demand for energy for heating.

From 1990 to 2010, the economy grew by an average of 2.2% a year, with the strongest growth, averaging 3–7% a year, in the periods 1994–95, 1998–2000 and 2004–06 and in 2010. Natural resources such as forests and iron ore form a basis for industrial production and, along with the engineering industry, have resulted in a strongly export-oriented economy in Sweden.

Total energy supplied in Sweden has shown a rising trend since 1970, from some 450 TWh to about 600 TWh from the mid-1990s. Final energy use (i.e. total energy supplied minus distribution losses) increased by about 12% from 1970 to 2010, and has stood at approximately 450 TWh for the past five years. Sweden produces no oil, natural gas or coal. Its total energy supply is based chiefly on domestic supply of biofuels, hydropower and, to a lesser extent, ambient heat from heat pumps, and on imports of uranium, oil, natural gas, coal and biofuels. Since 1970, the energy supply mix has changed, with crude oil replaced to a large extent by nuclear power and biofuels. Beginning in the late 1960s, the infrastructure for district heating production and distribution has been extended. By 2010, production of district heat had risen by 356% since 1970 and 62% since 1990. Meanwhile, the share of biofuels in production had grown from 2% in 1970 to 25% in 1990 and 63% in 2010. A major shift has occurred in the use of energy for homes and non-residential premises.

In 2011, district heating accounted for more than 90% of energy use for heating and hot water in multi-dwelling buildings and for 75% in commercial and institutional premises.

The energy efficiency of newly produced single-family houses has improved by over 20%. In houses built in the period 2001–11, average energy use is 107

kWh/m^2, compared with 130 kWh/m^2 in those built in 1991–2000.

District heating has promoted biofuel-based heating of buildings and has been a crucial factor in enabling national policy instruments for renewable energy to bring about the extensive phase-out of the use of fossil fuels for this purpose that has been achieved. Between 1990 and 2010, the share of renewable energy in Sweden rose by 15 percentage points to 48%. The renewable energy sources contributing to this trend are hydropower, wind power, use of by-products in the paper and pulp industry, and biofuels for district heating. Ample watercourses for hydropower production, combined with national energy policy and investments in non-fossil-based generation, have enabled Sweden to produce electricity by almost entirely fossil-free means.

Emissions from the transport sector have increased sharply since 1970. For goods transport, road transport and shipping account for roughly equal proportions, while rail represents a smaller share. The past few years' fluctuations in economic trends have had a greater influence on freight than on passenger transport activity.

In terms of greenhouse gas emissions, the rapid rise in passenger travel has been offset by more energy-efficient cars and increased use of renewable fuels, which have reduced emissions per passenger-kilometre. The efficiency of freight transport also improved in the 1990s.

Swedish industry is characteristically based more on raw materials than in many other countries. The forest (wood products, paper and pulp) and iron and steel industries, for example, are based on domestic natural resources. Energy use and process emissions in the minerals and iron and steel industries have a substantial impact on Sweden's greenhouse gas emissions.

In 2010, some 118 million tonnes of waste was generated in Sweden, roughly 76% of it in the mining and quarrying industry. The total volume is affected by economic trends and fluctuations. Landfill disposal of waste has decreased sharply in the past decade, to just under 1% of household waste today (compared with 21% in 2001), mainly owing to new policy objectives and associated instruments. Materials recovery from household waste has increased by 13% since 2001. In 2011, 270 GWh of landfill gas (18% of total biogas energy) was recovered and used mainly for heating, but also for electricity production and as a vehicle fuel.

The area of agricultural land in Sweden in 2012 was 3 million ha in all, representing some 7% of the country's total land area. The area under cultivation has shrunk by roughly 8% since 1990. Since 2000, there has been an increase in cultivation of forage and green fodder crops at the expense of cereal growing. Since 1990, the arable area, number of cattle and use of mineral fertiliser and animal manure have decreased, reducing emissions of methane (CH_4) and nitrous oxide (N_20).

1.3 Greenhouse gas inventory

Greenhouse gas emissions in Sweden in 2011, excluding LULUCF, amounted to some 61.4 million tonnes of carbon dioxide equivalent (Mt CO_2 eq). Of this total, carbon dioxide made up 79%, or 48.7 Mt. The majority (88%) of carbon dioxide emissions come from the energy and transport sectors. Other emissions consisted of nitrous oxide (chiefly from agriculture), accounting for 11% of the total or 6.7 Mt CO_2 eq, methane (mainly from agriculture and waste), 8% or 5 Mt CO_2 eq, and fluorinated greenhouse gases, just under 2% or 1.1 Mt CO_2 eq. Total emissions fell by around 11 Mt CO_2 eq, or 16%, between 1990 and 2011. Apart from high levels in 2010, the trend in emissions since 1998 has been downward. Between-year variations are largely due to fluctuations in temperature and precipitation and to the economic situation.
Emissions from the energy industries sector (electricity and heat production, refineries and manufacture of solid fuels) totalled 10.7 Mt CO_2 eq in 2011. The dominant share of these emissions came from district heating plants. District heat is produced largely from biofuels, with fossil fuels serving as a complement, for example in very cold weather. Emissions can therefore vary widely from one year to another, depending on the temperature.

Industrial emissions comprise emissions from both fuel combustion in industry and industrial processes. In 2011, these emissions came to 9.5 and 6.7 Mt CO_2 eq, respectively. Variations occur from year to year, chiefly owing to economic fluctuations. In recent years there has been a downward trend in emissions from industrial combustion, due to a shift from oil to electricity and biofuels. Industrial process emissions have also shown a modest decline over recent years.

Emissions from domestic transport in 2011 were 20 Mt CO_2 eq, a third of the national total. This represents an increase of 4% compared with 1990. The majority of emissions in this sector come from cars (11.7 Mt CO_2 eq) and heavy-duty vehicles (6.7 Mt CO_2 eq). Emissions from cars have fallen by 9% since 1990, despite growth in traffic. This is the result of a shift to more energy-efficient vehicles and to biofuels. Over the same period, emissions from heavy vehicles have

risen by 44%, owing to more goods being transported over ever greater distances.

Emissions from 'Other sectors', i.e. fuel combustion in the commercial and institutional, residential, and agriculture, forestry and fisheries sectors, come primarily from stationary combustion (heating), and to a lesser extent from mobile combustion (mobile machinery, off-road vehicles and fishing boats). In 2011, they totalled 3.7 Mt CO_2 eq, a decrease of 67% since 1990. The most important factor behind this trend is switching from oil-based to district and electric heating. In addition, most winters since 1990 have been mild. Emissions from mobile combustion in these sectors are very low, but rising.

Greenhouse gas emissions from the use of solvents and other products amounted to 0.3 Mt CO_2 eq in 2011. Compared with 1990, this represents a reduction of 11%, chiefly due to a shift from oil- to water-based paints.

In 2011, total emissions from the agricultural sector came to some 7.8 Mt CO_2 eq, of which 63% was nitrous oxide and 37% methane. Agriculture is the largest source of emissions of these two gases. Emissions from the sector have fallen by 14% since 1990. The main reasons for the decrease are a decline in livestock numbers and reduced use of fertilisers and manure in agriculture.

Total emissions from the waste sector in 2011 were just over 1.7 Mt CO_2 eq, half of what they were in 1990. Emissions from this sector come from landfill sites, wastewater and incineration of hazardous waste. Landfills are the second largest source of methane emissions, after livestock farming. The reduction in emissions from the waste sector is primarily due to the bans on landfill disposal introduced in 2002 and 2005.

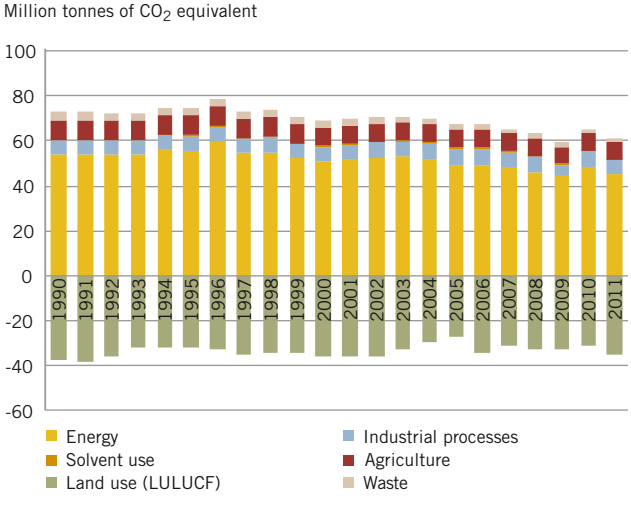


Figure 1.1 **Total greenhouse gas emissions from different sectors.**

Emissions from international shipping and aviation, known as international bunkers, amounted to 8.3 Mt CO_2 eq in 2011, an increase of 129% since 1990. The majority of these emissions come from shipping. Emissions fluctuate, depending on fuel prices in Sweden compared with other countries. These emissions are not covered by any international commitments, but as from 2012 aviation is included in the EU Emissions Trading System (EU ETS).

Over the period 1990–2011, the LULUCF sector represented an annual net sink, as a result of carbon dioxide from the atmosphere being taken up by biomass. During the period, this net removal varied between 27 and 38 Mt CO_2 eq. In 2011, it amounted to 35 Mt CO_2 eq, corresponding to 57% of national greenhouse gas emissions. Forest land accounts for the majority of removals from land use, and the trend points to a slight decline in removals in this sector, due to increased felling. Cropland is a net source of greenhouse gases (1.3–2.7 Mt CO_2 eq between 1990 and 2011), as the cultivation of organic soils gives rise to emissions. The contributions from grassland, wetlands and settlements are very small, owing to the limited areas devoted to these types of land use in Sweden.

1.4 Policies and measures

Sweden's climate strategy has progressively developed since the late 1980s. It consists of objectives, policy instruments and measures, together with regular follow-up and evaluation. In recent years, the country's climate policy has continued to evolve towards stronger EU integration and closer international cooperation. Sweden is working with the other EU member states to achieve a global agreement compatible with the goal of limiting the rise in temperature to no more than 2 °C above pre-industrial levels.

The environmental quality objective *Reduced Climate Impact*, adopted by the Riksdag (the Swedish Parliament), forms the basis for action on climate change in Sweden. Current climate policy is set out in two Government Bills, entitled *An Integrated Climate and Energy Policy*, passed by the Riksdag in June 2009. The first of these Bills establishes an interpretation of the *Reduced Climate Impact* objective in terms of a temperature target and a concentration target. The temperature target is that the increase in global average temperature should be limited to no more than 2 °C above pre-industrial levels. From this target a concentration target is derived, according to which Swedish climate policy is to be designed to contribute to ensuring that the concentration of greenhouse gases in the atmos-

phere is stabilised in the long term at no more than 400 parts per million of carbon dioxide equivalent. The Bill also sets a national milestone target for climate, calling for a 40% reduction in emissions by 2020, compared with 1990. This target applies to activities not included in the EU Emissions Trading System (EU ETS). It is more ambitious than Sweden's commitment under the Effort Sharing Decision implementing the EU Climate and Energy Package. In addition, the Bill makes it a priority for Sweden to have a vehicle fleet independent of fossil fuels by 2030, and sets out a vision of Sweden as a country with no net emissions of greenhouse gases to the atmosphere by 2050.

Sweden has introduced a range of policies and measures directly or indirectly affecting greenhouse gas emissions. The emphasis in the country's climate strategy is on the use of general economic instruments, but in many cases these are supplemented with targeted measures, for example to support the development and market introduction of technology and eliminate barriers to energy efficiency.

Since the early 1990s, two key instruments in reducing Swedish emissions have been the energy and carbon dioxide taxes. These taxes have been supplemented with other instruments, however, such as an electricity certificates system, technology procurement, information, a differentiated annual vehicle tax and investment grants. Legislation also plays a part in curbing emissions, primarily in the waste sector. In recent years, EU-wide policy instruments, in particular the Emissions Trading System, have assumed growing importance in Sweden.

The EU ETS, with a fixed emissions cap that decreases every year, is an important part of the EU's strategy to reduce emissions within the Union, and is also key to Sweden's efforts to achieve climate targets for 2020 at EU level. Emissions from Swedish installations included in the EU ETS made up around 33% of total greenhouse gas emissions in Sweden over the period 2008–12. Some 80% of these emissions came from industrial plants and 20% from power and district heating installations. Overall, the emissions cap for 2008–12 was some 10% lower than the cap for 2005–07.

The design of spatial planning and other instruments long established in Sweden has very much defined the framework for the developments of recent decades. Of particular importance are the early investments made in an expansion of district heating networks, public transport systems and carbon-free production of electricity.

Funding for climate research has increased, amounting to almost SEK 2 billion in 2010, or around 7% of all central government support for research. In 2012, the Government decided to extend and progressively strengthen investments in energy research, setting a funding level of some SEK 1.3bn for the years 2013–15 and about SEK 1.4bn from 2016 onwards. Most of these funds are directed to realising energy and climate objectives, long-term energy and climate policy, and energy-related environmental policy goals.

Energy sector

Since 1990, the production of electricity and district heating has been marked by a very substantial expansion of renewable fuels. The use of fossil fuels in this sector has in recent decades been affected by energy and carbon dioxide taxes. The aggregate level of taxes on fossil fuel use in the sector has risen steadily since 1990, making it considerably more expensive to burn these fuels than it would have been if energy taxation had been kept at its 1990 level. Since 2005, most combustion installations for power and heat production have been included in the EU ETS, which is a key policy instrument for the sector.

Model estimates show that emissions from the electricity and district heating sector (including industrial back-pressure power) could have been almost 14 Mt CO_2 eq higher in 2010 if policy instruments had remained at their 1990 levels. The difference in modelled emissions is due above all to significantly greater use of coal in the scenario based on 1990 instruments than in the one based on current levels of instruments.

Alongside the energy and carbon dioxide taxes, there are a number of policy instruments targeted at energy use in homes and commercial and institutional premises. These include new building regulations, energy performance certificates, the EU Energy Labelling and Energy Efficiency Directives, and the Ecodesign Directive, which results in energy savings by prohibiting the least energy-efficient products. In addition, there are instruments such as technology procurement, network initiatives and information campaigns at the local, regional and national levels.

Industrial sector

The policies and measures primarily affecting combustion emissions from industry are the EU ETS, energy and carbon dioxide taxes, the electricity certificates system, the Programme for Energy Efficiency in Energy-Intensive Industry (PFE) and the Environmental Code.

Industrial process emissions have come almost entirely within the scope of the EU ETS since its expansion for the third trading period (2013–20). Emissions of

fluorinated greenhouse gases are governed by an EU regulation and directive covering certain emissions of fluorinated gases.

Transport sector

Support for research, development, demonstration and piloting of biofuels in the transport sector is an important policy instrument. On average, some SEK 240m annually has been made available for this purpose in recent years. Research in support of a fossil-independent vehicle fleet is a priority area, and in 2012 SEK 1,240m was allocated for the period 2013–16.

Another instrument of great importance is vehicle fuel taxes. Petrol and diesel are subject to both an energy tax and a carbon dioxide tax. In addition, value added tax is charged on the sales value. The carbon dioxide tax on vehicle fuels was introduced in 1991 and has since been raised in several stages. In accordance with the climate policy decision of 2009, the energy tax on diesel has been increased in two stages, in 2011 and 2013, by a total of SEK 0.40/litre.

The effect of the tax increases on diesel and petrol since 1990 is estimated to be around 2 Mt CO_2 eq/year lower emissions in 2010 and 2 Mt CO_2 eq/year lower emissions in both 2015 and 2020, compared with if the 1990 nominal level of taxation had been retained.

Waste

Overall, the bans on landfill are judged to have had the greatest impact in terms of reducing landfill disposal of organic material, which will result in lower emissions of methane in the future. Demand for waste as a fuel for district heating has also strongly encouraged diversion from landfill to incineration.

An analysis of the combined effect of policy instruments influencing methane emissions from landfill sites showed that, in a scenario based on instruments decided on at the time of the analysis, emissions would end up around 1.4 Mt CO_2 eq lower in 2010 than in a scenario based on 1990 instruments. By 2020, the difference was projected to be 1.9 Mt CO_2 eq.

Agriculture and forestry

Although, as yet, there are relatively few policy instruments directly targeted at limiting greenhouse gas emissions from Swedish agriculture, interest in mitigating the sector's climate impact has grown. Sweden has taken a number of initiatives recently to reduce fossil fuel use in farming, and to increase awareness and encourage the use of measures that will curb emissions of greenhouse gases from manure and fertiliser management and from land use.

The EU's Common Agricultural Policy significantly affects the extent, direction and profitability of agriculture in Sweden. Reform of the policy in 2003 decoupled agricultural support from production and made more resources available for measures to limit the climate impact of the farming sector.

It is estimated that the effect of the climate and energy initiatives expected to be implemented under the new Rural Development Programme for 2007–13 will be to reduce annual greenhouse gas emissions by 0.5 Mt CO_2 eq, primarily through switching from fossil energy to renewable energy from agriculture and through greater energy efficiency.

Swedish forest policy has two overarching objectives, a production objective and an environmental one. According to the latter, forests are to be protected, at the same time as biodiversity, cultural heritage and social values are safeguarded. As part of the 'Forest Kingdom' initiative, central government advice to the forestry sector has been stepped up, with a view to promoting effective and functional consideration for the environment and improved forest management. Sweden is also developing a strategy for long-term sustainable land use, aimed at achieving the generational goal for the environment and the environmental quality objectives. Final proposals for this strategy are to be presented in 2014. Existing legislation also indirectly affects trends in carbon dioxide removals in various ways, in particular through provisions on forest management in the Forestry Act, the land drainage provisions of the Environmental Code, site protection and nature conservation agreements. Furthermore, as a result of the sectoral responsibility that applies in Sweden, most of the country's forest owners have joined voluntary certification schemes, which are designed to raise the level of ambition as regards the ecological, economic and social aspects of forestry. This has also led to more land being set aside, helping to increase uptake of carbon dioxide.

Flexible mechanisms under the Kyoto Protocol

Sweden has an active programme to implement the project-based mechanisms of the Kyoto Protocol, the Clean Development Mechanism (CDM) and Joint Implementation (JI). Under its CDM and JI programme, the country has participated in both individual projects, chiefly in the areas of renewable energy and energy efficiency, and multilateral CDM and JI funds. Up to and including 2013, Sweden has approved funding for international climate initiatives under the CDM and JI totalling some SEK 2.5bn for the period up to 2022, and it has currently signed contracts for 67 individual CDM projects and 2 JI projects. Priority

is being given to CDM projects in least developed countries, small island developing states and in Africa.

Sweden is participating in seven multinational funds: the Prototype Carbon Fund, Asia Pacific Carbon Fund, Future Carbon Fund, Multilateral Carbon Credit Fund and Testing Ground Facility, as well as the Umbrella Carbon Facility Tranche 2 and Carbon Partnership Facility, which the country has joined since 2009.

Sweden's aim is to achieve emission reductions of at least 40 Mt CO_2 eq through international climate initiatives under the CDM and JI programme, as a contribution to meeting its national target for 2020. Total funding appropriated by the Riksdag, including the authorisation framework for the period up to and including 2013, is expected to be sufficient to acquire credits corresponding to around 27–29 Mt CO_2 eq.

1.5 Projections and the total effect of policies and measures

Projections

The reference scenario takes into account policies and measures currently adopted by the EU and the Riksdag, together with an assessment of future economic trends.

The results of the projection (see Table 1.1) indicate a gradual decline in total emissions of greenhouse gases (excluding LULUCF) over the projection period. By 2020 and 2030, aggregate emissions are projected to be 19% and 21% lower, respectively, than in 1990. The LULUCF sector represented a net sink for Sweden over the period 1990–2011, and is projected to continue to do so up to 2030.

Projections of greenhouse gas emissions differ between sectors. Over the period from 2011 to 2020 and 2030, emissions from domestic transport, for example, are projected to decrease, while total emissions from the energy industries remain unchanged. Emissions from industrial combustion are expected to rise somewhat up to 2020, before showing a modest fall. Emissions in the remaining sectors decrease slightly over the period of the projection.

Between 2011 and 2030, emissions from the energy industries (production of electricity and district heating, refineries and the manufacture of solid fuels) are projected to show differing trends in each of the subsectors, but to remain at approximately the same level overall throughout the projection period. Emissions from electricity generation and district heating are expected to fall slightly, despite an increase in the production of electricity in particular, but also of district heat, whereas refinery emissions show a significant rise. Emissions from the manufacture of solid fuels remain at the roughly same level over the projection horizon. During this period, production of electricity is assumed to grow more than consumption, resulting in a projected net export of around 23 TWh by 2020.

Emissions from fuel combustion in the commercial and institutional, residential, and agriculture, forestry and fisheries sectors fell sharply from 1990 to 2011 and are expected to continue to decrease somewhat up to 2020 and 2030. The decline is primarily due to heat pumps, biofuels and district heating replacing the use of oil for space and water heating.

Energy use in industry is expected to rise between 2011 and 2020, as a result of assumed growth in production. Industrial combustion emissions, on the other hand, are projected to fall, above all because of an expected reduction in emissions from the pulp and paper industry, driven by a shift from fossil fuels to greater use of biofuels. Emissions from industrial processes are expected to decline slightly overall over the projection horizon. This is because, owing to new EU regulations, a decrease in fluorinated greenhouse gases is projected that is larger than the expected rise in methane and carbon dioxide emissions.

Greenhouse gas emissions from domestic transport are expected to fall, and while the decline may slow down, according to the projection it will continue up to 2030. The majority of emissions in this sector come from road transport. The main factors behind the decrease are reduced use of petrol, switching to diesel and more energy-efficient vehicles.

Emissions from the use of solvents and other products are projected to remain at roughly the same level as in the last few years throughout the projection period.

Owing to a number of measures, emissions of methane from landfill sites have fallen since 1990. This downward trend is expected to continue over the projection horizon, thanks to methane recovery and smaller quantities of waste going to landfill.

Emissions from the agricultural sector have declined since 1990, a trend that is projected to continue up to 2020 and 2030. The chief reasons for the historical decrease are a reduction in livestock numbers, declining use of mineral fertilisers, reduced leaching of nitrogen and a shift to slurry systems for manure management. Over the projection period, the reduction in emissions is attributed to increased productivity. With production expected to be maintained at the same level in 2030 as today, there will be a smaller dairy herd and continued decline in the area under cereals up to 2020 and 2030.

Emissions from energy use in agriculture are projected

Table 1.1 **Historic and projected emissions and removals of greenhouse gases, by sector (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Energy, excl. transport	34.4	25.0	25.0	25.2	24.7	24.2	–27%	–30%
Transport	19.3	20.0	19.8	19.1	18.9	18.7	–1%	–3%
Industrial processes	6.3	6.7	6.3	6.2	6.2	6.2	–2%	–2%
Solvent use	0.3	0.3	0.3	0.3	0.3	0.3	–6%	–11%
Agriculture	9.0	7.8	7.5	7.3	7.3	7.2	–19%	–20%
Waste	3.4	1.7	1.3	1.1	0.9	0.8	–69%	–77%
Total emissions	**72.8**	**61.4**	**60.3**	**59.2**	**58.2**	**57.3**	**–19%**	**–21%**
LULUCF	–37.2	–35.2	–24.9	–23.0	–21.9	–23.9	–38%	–36%

to fall between 2011 and 2030, owing to reduced consumption of diesel for mobile machinery and of oil for greenhouses and other agricultural buildings. Emissions from forestry machinery are expected to remain level over the projection period.

Progress towards meeting Sweden's commitment under the Kyoto Protocol

Under Sweden's commitment for the first commitment period of the Kyoto Protocol (2008–12) and EU burden sharing, greenhouse gas emissions in Sweden, excluding LULUCF, are not to exceed the country's assigned amount, which was 104% of base-year emissions as an average for the years 2008–12 when assigned amount units (AAUs) were allocated. This means that Sweden's assigned amount of emissions was set at 75 Mt CO_2 eq per year, as an average for 2008–12, taking no account of flexibilities. Of this amount, around 22.4 Mt CO_2 eq has been allocated to the EU Emissions Trading System (EU ETS). The limit on emissions not included in the trading system is thus 52.6 Mt CO_2 eq as an average for 2008–12.

Preliminary average emissions outside the EU ETS for the period 2008–12 come to 41.5 Mt CO_2 eq. A gap analysis has been performed in relation to the target of 52.6 Mt CO_2 eq for non-EU ETS emissions. The preliminary analysis shows that emissions are 11.1 Mt CO_2 eq below this target. When the carbon sink is included, emissions are on average 13.3 Mt CO_2 eq below the target, taking into account the effect of the EU ETS. Table 1.2 shows that Sweden's Kyoto target can be met with national measures alone, even with no allowance made for the carbon sink. Preparations have been made to be able to use JI and CDM credits, but the Riksdag has decided that the country is to meet its commitment without these mechanisms, which the projection shows that it will do by a good margin.

Table 1.2 **Historic and projected greenhouse gas emissions in relation to Kyoto base year and Sweden's Kyoto target (million tonnes of CO_2 equivalent)**

Kyoto base-year emissions	72.2 Mt
Kyoto target, base year to first commitment period (2008–12)	4%
Kyoto target for 2008–12, per year	75 Mt
EU ETS allocation (2008–12)	22.4 Mt
Preliminary non-EU ETS emissions (2008–12)	41.5 Mt
EU ETS allocation + preliminary non-EU ETS emissions, per year	63.9 Mt
Carbon sink under Articles 3.3 and 3.4	2.13 Mt
Emissions 2008–12 per year, incl. carbon sink	61.7 Mt
Average surplus of AAUs, per year	13.3 Mt
Emissions 2008–12 incl. carbon sink, relative to base-year emissions	–18 %

1.6 Vulnerability assessment, climate change impacts and adaptation measures

Climate change affects large parts of Swedish society. Today, more extensive data are available on conceivable regional changes in climate than have been reported in earlier national communications. Recent results point, in particular, to substantial warming and changes in precipitation, broadly confirming the findings of earlier scenario work.

An analysis of possible climate trends in all Swedish counties during the 21st century, and of historic trends up to and including to 2012, shows that the largest changes in temperature in Sweden can be expected in the winter months, especially in the far north. The scenarios indicate, in most cases, rising precipitation throughout the country, but with decreases in some cases in the far south in summer. The

largest increases in precipitation can be expected in winter.

In a changed climate in Sweden, involving rising temperatures and altered precipitation patterns, few activities will remain entirely unaffected. Risks of flooding, landslides and erosion are expected to increase in many parts of the country. There could be a heightened risk of flooding around some of Sweden's largest lakes, making an ability to regulate the flow of water increasingly necessary.

Since 2005, adaptation to climate change has been stepped up in various ways in Sweden. In autumn 2012, a summary from spring 2010 of government agencies' adaptation remits and activities, entitled *Climate Adaptation in Sweden: An Overview*, was updated.

Responsibility for climate change adaptation is shared among several government agencies which, as part of their sectoral responsibilities, have important roles to play. Based on their respective sectoral remits, these agencies are working to carry out preventive measures, achieve greater skills and knowledge, and foster better preparedness for the challenges which climate change poses. Since 2011, a new Planning and Building Act has been in force, with several provisions that were added in response to the problems of climate change. The Swedish National Board of Housing, Building and Planning has developed an online guide for communication and information on the new Act (the 'PBA Knowledge Bank'). Since 2012, the Swedish Meteorological and Hydrological Institute (SMHI) has been tasked by the Government with establishing a National Knowledge Centre for Climate Change Adaptation and, jointly with a number of other agencies, has run a national portal for adaptation. A new heatwave warning system was also launched in 2012. The Swedish Civil Contingencies Agency is charged with supporting municipalities and county administrative boards with overview mapping of stability and flood risks. In the energy sector, vulnerability to extreme weather events has been analysed, for example with respect to how the safety of hydropower and tailings dams and the risk of flooding are affected by climate change.

Since 2009, county administrative boards have had a Government remit to coordinate climate change adaptation regionally. Responsibility for practical adaptation measures is usually located at local, municipal level. Municipalities are responsible for spatial and emergency planning and the rescue services, and are the commissioning authorities for public utilities and other technical services.

To date, concrete adaptations have been started, above all, in municipalities hit by extreme weather events. In particular, this has involved measures in the areas of physical planning and building. Some municipalities have also raised the minimum level for construction, built levees and invested in pump systems to protect against flooding. Some have begun to modify water and sewerage systems to avoid the harmful effects of heavy downpours.

1.7 Financial resources and transfer of technology

Sweden has a long history of supporting work on climate change issues in developing countries, in an array of sectors and on a long-term basis. A large number of Swedish actors, such as ministries, government agencies, state-owned companies, non-governmental organisations, universities and the private sector, assist in climate change-related cooperative actions and activities such as technology development, research and various forms of capacity development. A number of different modes of cooperation, policy instruments and forms of support exist. Climate finance is provided from both public and private sources.

Sweden's policy for global development, the Government's policy for environmental and climate issues in development cooperation, and the principles of development effectiveness from Paris, Accra and Busan are central to the planning and implementation of Swedish climate finance from public sources.

Over the period 2009–12, Sweden provided almost SEK 12 billion of public climate finance for developing countries. Additional support is given to a range of development institutions and organisations which likewise contribute to climate change mitigation and adaptation.

A flagship during this period was the Government's Special Climate Change Initiative, which channelled resources through multilateral climate funds and initiatives such as the Adaptation Fund, the Least Developed Countries Fund (LDCF), the World Bank Group's Climate Investment Funds (CIFs) and the United Nations Office for Disaster Risk Reduction (UNISDR), as well as bilaterally to countries exposed to a high climate risk combined with high vulnerability, including Burkina Faso, Mali, Bangladesh, Cambodia and Bolivia.

The Climate Change Initiative formed part of Sweden's contribution to 'fast-start finance', a collective commitment made by developed countries at COP 15 in Copenhagen in 2009. The total Swedish fast-start contribution amounted to more than SEK 8bn for 2010–12, making Sweden one of the largest per capita contributors to this commitment.

Several Swedish government agencies and institutions, such as the Swedish International Development Cooperation Agency (Sida), Swedish Energy Agency, Swedish Agency for Economic and Regional Growth, Swedfund and Business Sweden, are also involved in technology transfer to developing countries and economies in transition. Key areas of technology include waste management, biogas, recycling, bioenergy, solar power, wind power and energy efficiency. Transfer of technology is often combined in an integrated way with capacity development, to ensure long-term sustainability.

1.8 Research and systematic observation

In 2004, Sweden established new forms of support for strong research environments at higher education institutions. These were later extended in the Research Policy Bill, *A Boost to Research and Innovation*, for the period 2009–12. In addition to this support, the Government identified 24 strategic research areas, including climate models, effects on natural resources, ecosystem services and biodiversity, and research on the marine environment. Overall funding for climate research and climate-related energy research rose substantially over the last reporting period. In 2010, at least SEK 2bn was spent on climate research.

Climate-related research

During the period under review, the focus of research relating to climate was on energy research and development of technologies to mitigate the climate impact of the energy and transport sectors. Strongly linked to energy issues is research on sustainable use of natural resources, given the growing need to obtain energy raw materials from the farm and forestry sectors.

The Top-Level Research Initiative launched by the Nordic prime ministers in 2007, focusing on cutting-edge research in the areas of climate, energy and environment, is now in its final phase. Sweden is taking part in several of the projects, including NORD-STAR and NORDCLAD-net.

Through the Rossby Centre, Sweden is engaged in climate modelling and the development of regional scenarios for use in impact and adaptation studies. The Centre also heads a European initiative for future development of high-resolution global climate models. It has recently contributed to the international CMIP5 project, which is the primary modelling basis for the fifth Intergovernmental Panel on Climate Change (IPCC) assessment.

Socio-economic research is very wide-ranging, covering areas such as impacts of climate change, adaptation needs, scope for protective measures and international climate policy.

Research in support of global negotiations takes place, for instance, in the International Climate Policy research programme. Support is given to research projects, synthesis, advanced investigation and global trend analysis, to provide an evidence base in the area of climate policy. For the current programme period (2011–14), funds have been awarded for research focusing on land use: measures for reforestation and to preserve and enhance carbon sinks in forests and wetlands, and their potential for reducing greenhouse gas emissions. Research is also being conducted on the development of models for emission baselines, CO_2 convergence, development of new flexible mechanisms, scope for improving measurements, verification and follow-up of measures to reduce greenhouse gas emissions in developing countries, and surveys of emission trajectories for short-lived climate pollutants. The programme also supports research on countries' National Appropriate Mitigation Actions (NAMAs).

Sweden is engaged in various global scientific research activities with a climate perspective, such as the IPCC, World Climate Research Programme (WCRP) and International Geosphere-Biosphere Programme (IGBP). By participating in the International Council for Science (ICSU), Swedish researchers have taken a lead in the endeavour to integrate global change programmes in the international Future Earth initiative, with its focus on integrating research in social and natural sciences as one means of bridging the gap between policy and practice.

To link Swedish research initiatives in global development in a more strategic and powerful way, the joint Swedish Secretariat for Environmental Earth System Sciences (SSEESS) has been set up by several research funders: the Swedish Research Council Formas, Swedish Research Council (VR), Swedish Research Council for Health, Working Life and Welfare (Forte), Swedish Governmental Agency for Innovation Systems (VINNOVA), Sida and the Royal Swedish Academy of Sciences (KVA). The purpose of SSEESS is to work for greater Swedish involvement in international interdisciplinary research on global environmental and resource issues and simultaneously serve as a reliable information source for Swedish decision makers. Within the framework of the Arctic Council and the Swedish Chairmanship in 2011–13, the Swedish Environmental Protection Agency and Formas are funding a circum-Arctic project on threshold effects, the Arctic Resilience Report. This joint project involving the Arctic states is headed by the Stockholm Environment Institute.

Systematic observation

In Sweden, there are monitoring systems with great potential to help bring about systematic, coherent gathering of information concerning changes in terrestrial systems. The country systematically collects data on meteorology, hydrology and oceanography, as well as monitoring sources and sinks for greenhouse gases and climate-related effects on ecosystems. Sweden has a well-developed system of environmental monitoring and its measurement series are, in many cases, of unique length worldwide. Funding is provided in the form of grants to government agencies, which contract out assignments.

1.9 Education, training and public awareness

In Sweden, communication on climate change and related measures is a key part of efforts to reduce emissions with a climate impact. There are a range of public agencies to which those with an interest can turn for information on climate change, action to address it, energy issues and so on. Swedish and international climate-related news is disseminated through newsletters and has helped attract broad media interest in climate change issues. Non-governmental organisations and adult education associations also contribute to public debate on and awareness of these issues. Today, the concepts of climate change and its causes and effects are thoroughly familiar to the general public.

In Sweden, preschools, schools and adult education have a clear remit to foster socially, economically and ecologically sustainable development. This remit is formulated in national governance documents such as the Education Act, curricula and syllabuses. Several higher education institutions offer courses on the scientific basics of climate and/or climate-related subjects like energy and forestry. Training on environmental and climate issues is often among the steps taken by companies to achieve environmental certification. The number of public activities with a climate focus has steadily increased since 2005. Climate and energy experts from agencies and organisations are often among the speakers. Municipal energy and climate advisers are an important channel of information to the public, providing advice and support on energy efficiency to households and businesses.

Several public agencies and knowledge centres offer online climate information, aimed at pupils of various ages. The issues of climate change, energy efficiency and resource conservation are dealt with under the overarching objective of sustainable development. A growing volume of reports and information offering advice and guidance on how people can reduce their own emissions have become available.

The Internet is frequently used for knowledge transfer and exchange of experience among and within agencies and organisations. Training courses on how environmental and climate requirements can be imposed in procurement are held by a range of providers at national, regional and local level. Several major conferences on climate and energy themes are held in Sweden every year.

There is ample scope in Sweden to ask questions and express views on an area of knowledge or a policy proposal, through consultation procedures and open meetings, hearings and seminars. Special initiatives are also taken to increase public participation in climate work.

Between 2002 and 2009, surveys were conducted of Swedish public attitudes towards, and understanding of, the climate problem. The 2009 survey indicated that Swedes remain highly prepared to reduce their own greenhouse gas emissions, and want more information about how this can be done. It also demonstrated their openness to change with a view to curbing emissions resulting from their own lifestyle and consumption.

2 National circumstances

2.1 Government structure

Sweden is a parliamentary, representative democracy that is ruled by a government headed by a prime minister. The Government is appointed by a popularly elected parliament, the Riksdag, which is elected every four years. As the national legislature, the Riksdag controls the Government and government agencies, and must approve political decisions such as Swedish climate and energy policies. The Government implements Riksdag decisions, submits new proposals (Bills) to the Riksdag, directs state administration and represents Sweden in the European Union.

Swedish public administration is organised at central, regional and local levels. The central level consists of a number of agencies[1] serving as the Government's expert bodies and implementing the policies adopted by the Riksdag and Government. For regional and local public administration, there are 21 county administrative boards and 290 municipalities, and some central government agencies have regional offices. Swedish municipalities are autonomous, with boards and councils elected by their respective citizens in separate elections.

As for fulfilling commitments under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, it is the Riksdag that decides (on the basis of Government Bills) and the Government and its agencies that are responsible for implementing the decisions.

County administrative boards and municipalities play a key role in climate policy, since they shape and implement plans for land use, energy management, transport and waste. Many Swedish municipalities are actively engaged in pursuing targets and following 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 2012 was just under 9.6 million, with 23% aged up to 19 and 18% 65 and over (Table 2.1). Since 1990, the mean annual growth rate has been 0.5% and by 2030 the population is expected to total 10.7 million. Average population density is 23 inhabitants per square kilometre, ranging from 3/km^2 in northern Sweden to 100/km^2 in the south (Statistics Sweden 2013a).

2.3 Geographic profile

Sweden extends in a south-south-westerly/north-north-easterly direction from latitudes 55 to 69

Table 2.1 **Sweden's population profile, with projections (Statistics Sweden 2013b)**

	1990	2000	2009	2010	2011	2012	Annual increase, 1990–2012, %	Annual increase, 2009–2012, %	2020	2030	2040
Population (million)	8.59	8.88	9.34	9.42	9.48	9.56	0.5	0.8	10.3	10.7	11.01
Aged up to 19 years (% of population)	24.6	24.1	23.4	23.2	22.95	22.77			23.4	23.4	22.4
Aged 65+ years (% of population)	17.8	17.2	18.10	18.45	18.82	19.13			19.3	21.1	22.8
Population density (inhabitants/km^2)	21.0	21.7	22.8	22.9	23.2	23.4			22.8	23.8	24.4

[1] In 2013 there were 468 central government agencies in Sweden. There are also local authorities and various companies that exercise public authority.

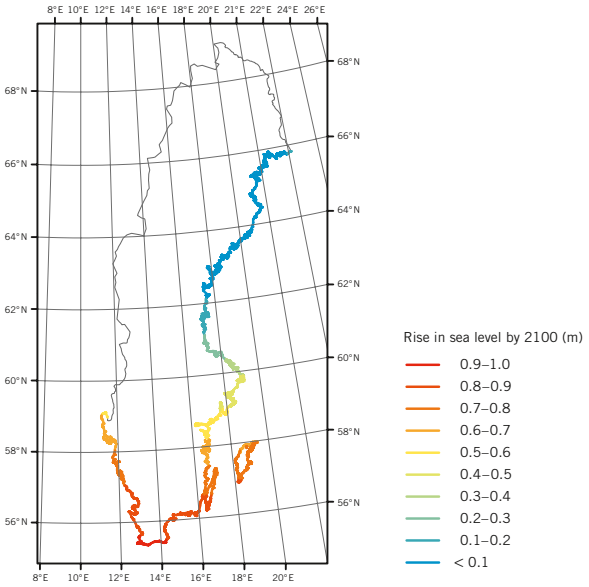


Figure 2.1. **Net effect of rise in sea level (minus land rise) in Sweden, assuming a global sea level rise of 1 metre in 100 years. The land rise estimates are based on the Swedish National Land Survey's model NKG2005LU (Ågren & Svensson 2007).**

degrees north and from longitudes 11 to 23 degrees east, with a total area of 450,295 km^2. Built-up areas make up 3% of this total, while forests account for 53%, farmland 8%, wetlands 9%, heath, moorland and mountains 10% and water 9% (Statistics Sweden 2008). Southern Sweden is low-lying, with agricultural land predominating in the far south. The only real mountain chain, with peaks rising to over 2,000 m above sea level, is along the Norwegian border in the north-west.

Land rise (postglacial rebound) is taking place in most of Sweden because of the melting of land ice after the last ice age, but has ceased in the far south (see Fig. 2.1).

The ongoing rise in sea level is causing substantial erosion along the south coast, which is characterised by easily eroded soils. Climate change due to future increases in atmospheric temperature will accelerate this erosion.

Forest land is an important natural resource that provides scope for biobased energy supply. In the past 50 years, farmland has successively given way to other land uses, mainly forest land. This has helped to reduce emissions from agriculture and increase carbon sequestration in forest biomass. Besides forests, another key natural resource is iron ore, a pillar of Swedish industrial production. Abundant flowing watercourses are a significant resource for hydropower production.

2.4 Climate profile

Passing low-pressure systems bring precipitation that is fairly copious all year round, but heaviest in the summer and autumn. Annual precipitation is some 1,000 mm. Since most low-pressure systems move in across the country from the west or south-west, the western parts of Sweden receive the most precipitation. Locally, in the mountains near the Norwegian border, precipitation reaches 1,500–2,000 mm a year. The lowest annual precipitation, just under 400 mm, falls along the eastern coasts.

Sweden's proximity to the North Atlantic and prevailing south-westerly to westerly winds result in a climate that, for the latitude, is mild in the winter months, but the northernmost part of the country has a sub-Arctic climate with long, cold and snowy winters. In the period 1961–90 the mean temperature in January was 0 °C in southernmost Sweden, while the coldest northern valleys had 17 °C. The maximum daily mean July temperature was approximately +17 °C in south-eastern Sweden and just over 10 °C in the north.

The mean temperature was about 1° higher in the years 1991–2012 than in 1961–90. The largest rise, over 2°, took place in the northern parts of Sweden in winter and the smallest was in autumn, when the temperature in south-west Sweden remained almost unchanged. Overall, owing to the rise in temperature, the densely populated areas (including Greater Stockholm) have undergone a shift from a cold-temperate to a warm-temperate climate. In the long term, this should entail a reduced incidence of winters with heavy snowfall. However, there may still be major variations from year to year. Winter 2007/08 was the warmest of all winters since 1860, while those of 2009/10 and 2010/11 were the coldest since the late 1980s. Precipitation has increased slightly in most of the country. The differences in temperature and precipitation between the periods 1961–90 and 1991–2012 are illustrated in Figs. 2.2 to 2.4.

Extremely severe storms with widespread windthrow (uprooting of trees) are rare, and trends are difficult to identify. In January 2005, however, there was

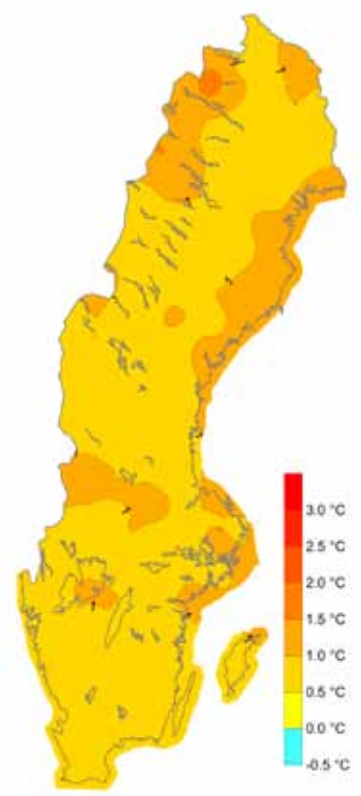


Figure 2.2 **Difference in annual mean temperature between 1991–2012 and 1961–90 (°C).**

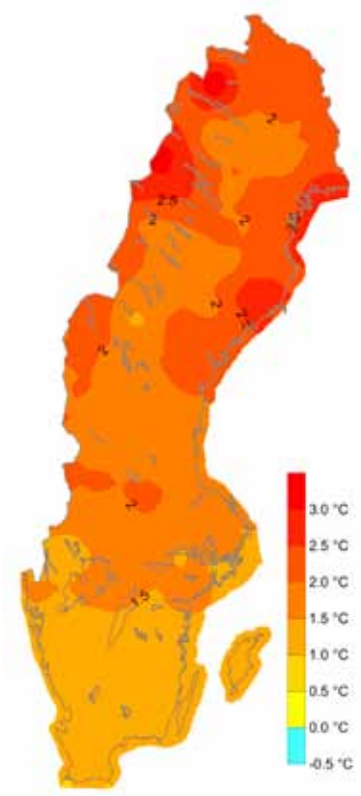


Figure 2.3 **Difference in mean winter temperature between 1991–2012 and 1961–90 (°C).**

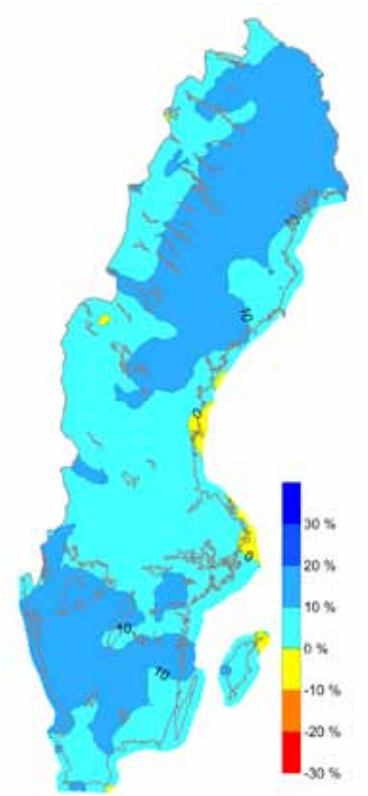


Figure 2.4 **Difference in annual precipitation between 1991–2012 and 1961–90 (%).**

a storm with hurricane-force winds in the south of Sweden, with by far the most extensive windthrow for 100 years. Just two years later, southern Sweden was hit by another violent storm. These storms cause a temporary reduction in carbon sequestration in forest biomass.

The relatively cold climate entails high energy requirements to heat buildings for most of the year, with resulting high greenhouse gas emissions. Heating requirements are dependent on outdoor temperature, wind conditions and insolation, and vary from one year to the next. An energy index that takes these parameters into account and is weighted according to the geographical distribution of the population provides a picture of how heating needs have fluctuated from year to year (see Fig. 2.5). The years 1990 and 2000 were very warm, with heating requirements 13–14% below the average for the reference period 1965–95, while 1996 and 2010 have been the only years since 1990 with greater heating requirements (+4%) than in the reference period.

Annual precipitation and run-off to the large rivers in north-west Sweden have a major bearing on the water inflow volume for Swedish hydropower production. Hydropower accounts for nearly half of Sweden's electricity production. In a normal year (based on the period 1960–2010) 65.5 TWh is generated in Sweden, where the water inflow can vary by 30 TWh from the lowest to the highest figures noted (Swedish Energy 2013).

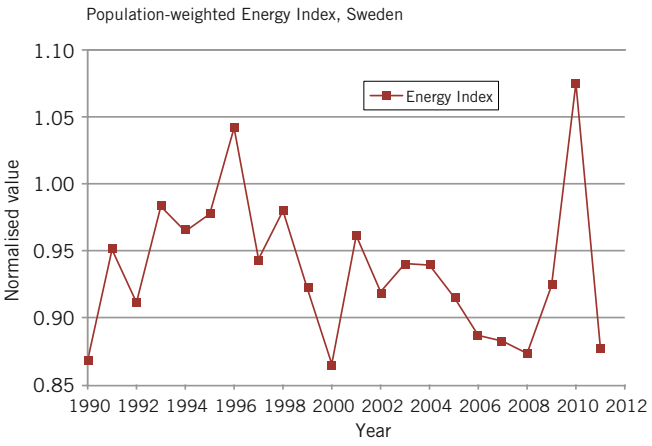


Figure 2.5 **The Energy Index[2], weighted according to the geographical distribution of the population, showing variation in annual heating requirements in Sweden over the period 1990–2012.**

[2] The Energy Index weights the effects on heating requirements for buildings, over one year, of solar, wind and temperature conditions and the technical energy characteristics of buildings.

Table 2.2 **GDP by expenditure, at constant prices, reference year 2012 (National Institute of Economic Research 2013)**

	1990	1995	2000	2005	2010	Projection 2011	Projection 2012	Growth, 1990–2012 (%/year)	Growth, 2010–2012 (%/year)
GDP (SEK m)	2 240 059	2 317 054	2 754 700	3 145 796	3 409 329	3 535 701	3 561 903	2.17	3.67
GDP per capita (SEK)	257 086	262 553	310 552	348 451	363 601	374 238	374 232	1.68	2.86
Imports (SEK m)	604 053	691 114	1 051 103	1 207 287	1 425 163	1 515 485	1 515 841	4.48	6.12
Exports (SEK m)	537 476	735 151	1 139 094	1 429 992	1 608 582	1 722 213	1 735 619	5.66	6.41
Private consumption (SEK m)	1 144 746	1 134 984	1 343 226	1 500 082	1 657 186	1 692 719	1 717 866	1.88	2.54
Public consumption (SEK m)	773 216	805 798	840 180	870 799	939 178	949 498	956 482	0.98	1.31

2.5 Economic profile

Sweden's GDP was SEK 3,409 billion in 2010. Per capita at constant prices, with 2012 as the reference year, this makes more than SEK 360,000 (National Institute of Economic Research 2013, see Table 2.2).

From 1990 to 2010, the economy grew by an average of 2.2% a year. The most rapid growth, averaging 3–7% a year, took place in the periods 1994–95, 1998–2000 and 2004–06 and the year 2010.

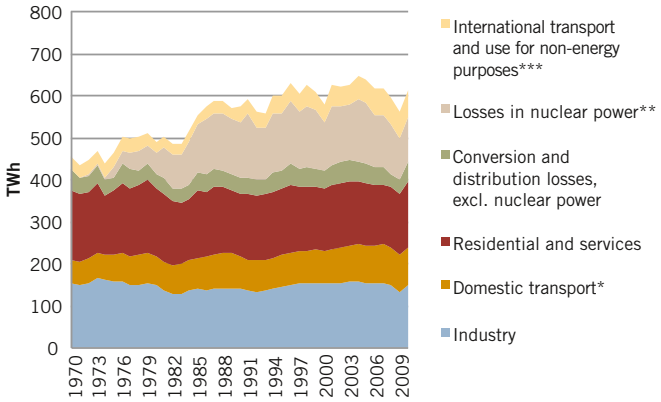
Natural resources, such as forest and iron ore, are a basis for industrial production and, along with the engineering industry, have brought about a strongly export-oriented economy. Since 1990, exports have grown faster than imports and the trade balance has been positive.

2.6 Energy

2.6.1 Energy use

Total energy supplied in Sweden has shown a rising trend since 1970, from some 450 TWh to about 600 TWh from the mid-1990s (see Fig. 2.6 and Table 2.3). A high proportion of this increase represents conversion and distribution losses associated mainly with nuclear power production, and the remainder goes to final use. The composition of the energy supply in this period has been transformed, with crude oil largely being superseded by nuclear power and biofuels.

Total final energy use has increased by 12% since 1970, and has stood at approximately 450 TWh for the past five years. These figures relate to industry, domestic transport, residential property and services, international transport, use for non-energy purposes, and conversion and distribution losses. Despite the moderate overall increase in energy use during the period, some changes in use within the sectors have taken place. Industrial production volume has almost doubled, but industrial energy use has risen by only just over 4%. The residential and service sector has reduced its energy use although the aggregate heated floor space both of homes and of commercial and institutional premises has increased. The rise in the volume of goods on the roads is what underlies the rise in energy use by transport (Swedish Transport Administration 2013).



* Data up to and including 1989 include international flights.
** Acording to the method used by the United Nations Economic Commission for Europe (UNECE) to estimate supply from nuclear power.
*** From 1990, data include international flights.

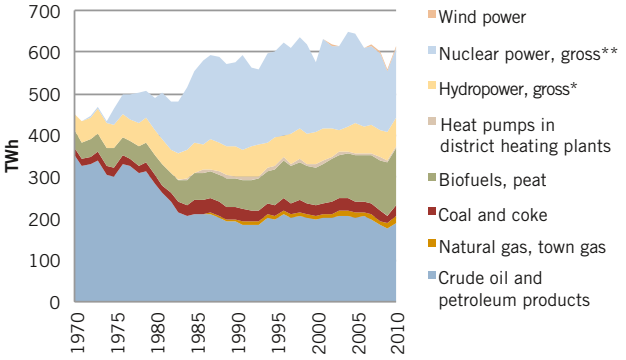
Figure 2.6 **Sweden's TPES in 1970–2010, including conversion and distribution losses (Swedish Energy Agency 2012d).**

Table 2.3 **Total primary energy supply (TPES) in TWh, 1990–2010**

	1990	1995	2000	2005	2006	2007	2008	2009	2010
TPES (TWh)	576	599	581	639	617	618	597	563	614
TPES (MWh) per capita	67	68	65	71	68	67	65	60	65

Sweden's TPES is based on domestic supply of energy from biofuels, hydropower and, to a lesser extent, ambient heat from heat pumps, and on imported energy carriers such as uranium, oil, natural gas, coal and biofuels (see Fig. 2.7).

In the early 1970s an energy policy was introduced to reduce Sweden's dependence on oil. Almost 40% of petroleum products have now been largely superseded by non-fossil energy sources, and with national incentives the share of bioenergy has risen to 20%.



* Incl. wind power up to and including 1996.
** According to the method used by UNECE to estimate supply from nuclear power.

Figure 2.7 **Sweden's energy supply in 1970–2010, excl. net electricity exports (Swedish Energy Agency 2012d).**

A major shift has taken place in energy supply to homes and to commercial and institutional premises. A consistent, sustained policy to extend infrastructure for district heating production and distribution was pursued from the late 1960s to the mid-1990s. The main motive for this investment, which involved replacing numerous small heating plants with large, centralised installations to heat buildings, was to improve air quality in urban areas. The infrastructure for district heating was a precondition for environmentally sound heating of buildings based on biofuels. It was also essential to enable the national policy instruments for renewable energy to bring about the extensive phase-out of fossil fuels to heat buildings that has been achieved.

By 2010, production of district heating had risen by 356% since 1970 and 62% since 1990 (see Fig. 2.8). At the same time, the share of biofuels in production had grown from 2% to 25% and 63% in 1970–90 and 1970–2010 respectively.

In addition to the extensive changeover from heating of individual buildings to district heating and from fossil energy to bioenergy for district heating production, there has been a switch from oil to heat pumps or pellets in remaining homes and non-residential premises that are individually heated.

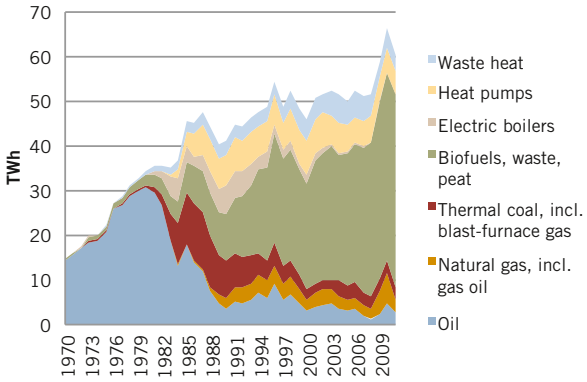


Figure 2.8 **Energy supply for district heating, 1970–2010 (Swedish Energy Agency 2012d).**

Between 1990 and 2010, the share of renewable energy in Sweden rose by 15 percentage points to 48% (see Fig. 2.9). The renewable energy sources contributing to this trend were hydropower, wind power, by-products used in the paper and pulp industry, and biofuels for district heating production.

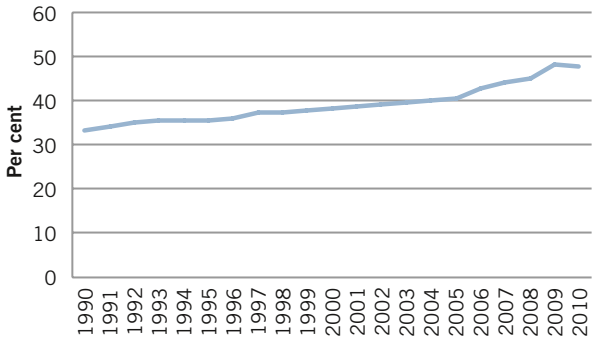


Figure 2.9 **Share of renewable energy used in Sweden, 1990–2010 (Swedish Energy Agency 2012d).**

Between 2000 and 2010, the price of fuel oil rose by 77% while that of wood chips remained relatively stable at a low level (see Fig. 2.10). Carbon dioxide and energy taxes had a substantial impact on fossil fuel prices, which helped to make biofuels competitive for heat production in district heating and for heating individual buildings.

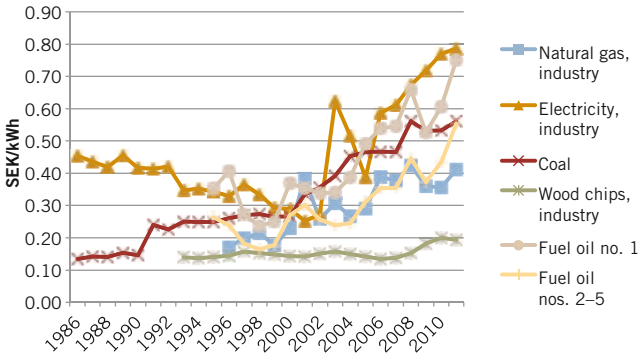
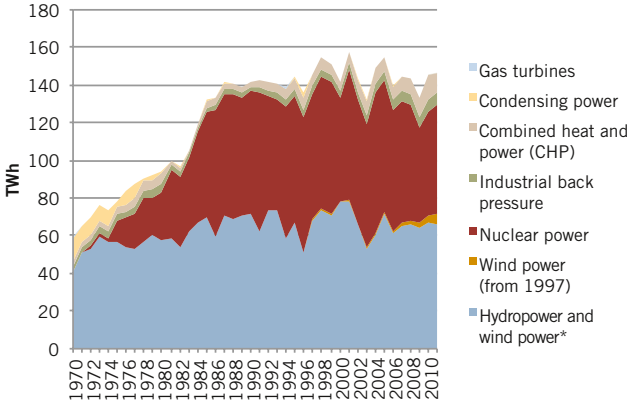


Figure 2.10 **Real energy prices for industry in Sweden, including energy taxes, 1986–2011, expressed in SEK/kWh, 2010 prices (Swedish Energy Agency 2012d).**

2.6.2 Electricity supply

Of total electricity production in 2011, hydropower accounted for 45%, nuclear power 40% and wind power 4%, while biofuels and fossil-based production made up the remaining 11% (see Fig. 2.11). In the early 1970s hydropower, supplemented by oil-condensing power, dominated production. The expansion of nuclear and to some extent hydropower up to 1985 largely eliminated oil-fired power generation. Since then, the use of oil for electricity production has continued to decrease, except in 1996 – a cold year with extremely low water inflow for hydropower production – when decommissioned oil-condensing power plants were temporarily restarted. Ample natural watercourses for hydropower production, combined with national energy policy and investments in non-fossil-fuel-based power production, have enabled Sweden to produce electricity by almost entirely fossil-free means.



* Wind power and hydropower are reported in the same category up to and including 1996.

Figure 2.11 **Sweden's electricity production by power source, 1970–2010 (Swedish Energy Agency 2012d).**

Between 1970 and 1987, electricity use rose by 5% a year. The rise then slowed to an annual average of 0.3% until 2000. In the subsequent decade, the figure fluctuated between 145 and 150 TWh. The Swedish electricity system is linked with the other Nordic systems, making efficient use of the Nordic countries' power plants possible. Consequently, Sweden's annual electricity balance alternates between net imports and net exports (see Fig. 2.12). In years of low precipitation and thus low hydropower production, and when nuclear power cannot be produced at normal capacity, the deficit is offset by electricity imports; and when Sweden has an ample supply of hydro and nuclear power, this country's electricity is exported to neighbouring countries. In the 1990s, oil-based condensing power was used to compensate for hydro and nuclear power deficits.

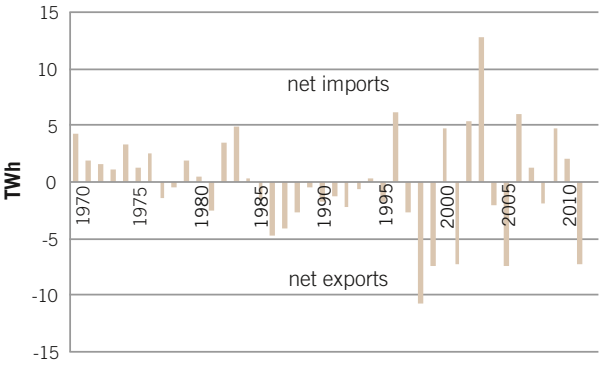


Figure 2.12 **Sweden's annual net imports (+) and net exports (–) of electricity, 1970–2010 (Swedish Energy Agency 2012d).**

2.7 Building stock and urban structure

2.7.1 Building stock and residential floor area

In 2012 there were 2,015,000 single-family houses for year-round occupation and 2,536,000 apartments in multi-dwelling buildings (Statistics Sweden 2013c). Of the current stock of apartments, 78% were built before 1980. Total floor space in single-family houses, including weekend and holiday homes, amounted to 285 million square metres. For multi-dwelling buildings, floor area totalled 168 million m^2.

A 17% increase in the number of apartments and a 7% increase in the number of single-family houses took place between 1990 and 2012. In the latter, the average residential floor area rose from 125.1 to 145.9 m^2 in the period 1990–2012 (Statistics Sweden 2013c). The average residential floor area for all single-family houses for year-round occupation was 124.7 m^2 in 2012 (Statistics Sweden 2013c). Between 1990 and 2011, average living space increased from 41 to just over 56 m^2 per capita (Statistics Sweden 2013e).

In 2012 there were 94,034 industrial buildings in Sweden. Altogether, these premises contained floor space of 127 million m^2 (Statistics Sweden 2013c).

Total floor space in other taxable non-residential premises was 91 million m^2 (Statistics Sweden 2013c). This figure does not include the floor area of schools, hospitals and other buildings for key public services.

2.7.2 Energy use in buildings

Final energy use in residential and service-sector buildings, in which energy for heating predominates, decreased between 1990 and 2011 even after weather correction of energy use. On the other hand, use of electricity for non-heating purposes increased. Household electricity use increased slightly, while the increase in energy used for building services was relatively large (Swedish Energy Agency 2013).

The use of energy for heating and hot water has changed since 1990. As Fig. 2.13 shows, the use of oil has decreased sharply in single-family houses, in favour of district heating, biofuels and electric heating.

For multi-dwelling buildings, too, there has been a marked decrease in oil and increase in district heating (see Fig. 2.14). In this type of housing, district heating accounted for more than 90% of energy use for heating and hot water in 2011 (Swedish Energy Agency 2012a). For commercial and institutional premises, the proportion of district heating was 75% in 2011 (Swedish Energy Agency 2012b).

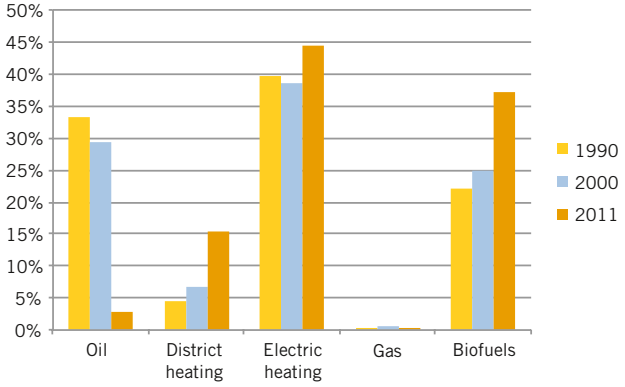


Figure 2.13 **Use of energy for heating in single-family houses in 1990, 2000 and 2011 (Swedish Energy Agency 2012c).**

Average energy efficiency of newly produced single-family houses has improved. In homes built in the period 2001–11, average energy use is 107 kWh/m^2. This may be compared with 130 kWh/m^2 in homes built in 1991–2000. In new multi-dwelling buildings the figure is 126 kWh/m^2, which is the same as for this category of housing built in the 1980s and 1990s (see Fig. 2.15).

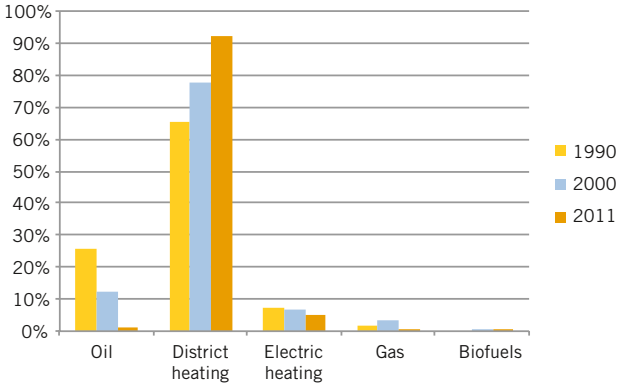


Figure 2.14 **Use of energy for heating in multi-dwelling buildings in 1990, 2000 and 2011 (Swedish Energy Agency 2012a).**

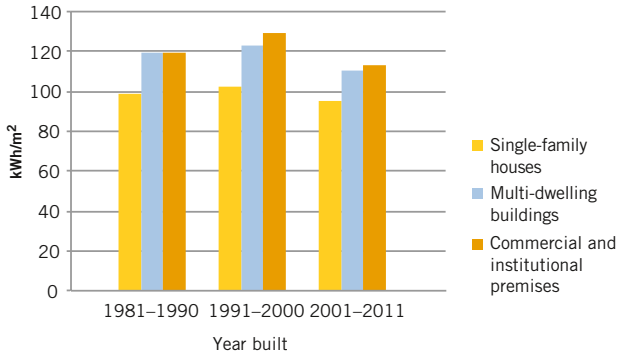


Figure 2.15 **Use of energy for heating of residential and commercial/institutional premises built in 1981–90, 1991–2000 and 2001–11 (Swedish Energy Agency 2012a, b, c).**

2.7.3 Urban structure

In Sweden, as in other countries, migration from rural to urban areas is under way. In 2010, 85% of the population lived in towns and cities. Urban areas amounted to 537,615 ha, which was 1.3% of Sweden's land area (Statistics Sweden 2010).

Between 1960 and 2005, the urban area increased by 54% and the urban population by 47%. Accordingly, more land per capita was used for housing, infrastructure and services. Between 2005 and 2010, population density in towns and cities rose from 1,446 to 1,491 inhabitants per km^2.

2.8 Industry

Industrial[3] added value accounted for just over 20% of added value in the entire business sector in 2010 (Statistics Sweden 2013e, see Fig. 2.16). Added value in the metal products, machinery and transport equipment industries (C25–C30) accounted for nearly 40% of aggregate industrial added value, the construction industry (F41–F43) for 25% and manufacture of petroleum, chemical, rubber and plastic products (C19–C22) for

[3] Corresponding to C10–C33 and F41–F43 in the Swedish Standard Industrial Classification 2007 (SNI 2007).

just over 15%. Swedish industry is characteristically based more on raw materials than in many other countries. For example, the extensive forest industry (wood products, paper and pulp) and also the iron and steel industry are based on domestic natural resources, and thus have a substantial impact on Sweden's greenhouse gas emissions.

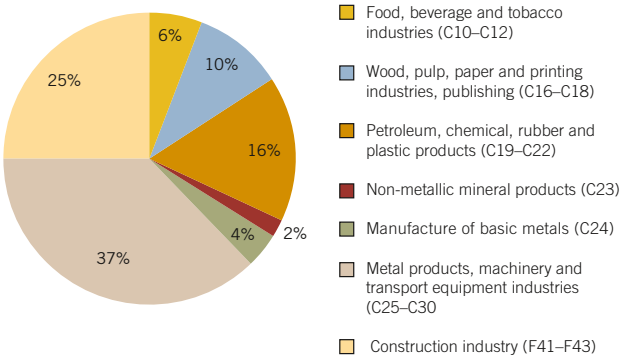


Figure 2.16 **Distribution of industrial (C10–C33, F41–F43) added value, 2010. Swedish Standard Industrial Classification (SNI) designations in brackets (Statistics Sweden 2013f).**

2.9 Transport

Domestic transport is dominated by road traffic. Several factors affect greenhouse gas emissions from traffic, especially transport volume and the technology used. Transport activity for passengers and goods alike has increased since 1970, but the trends are somewhat different (see Figs. 2.17 and 2.18). For goods transport, road transport and shipping account for roughly equal proportions while rail represents a smaller share. The past few years' fluctuations in economic trends have exerted more influence on freight than on passenger transport activity.

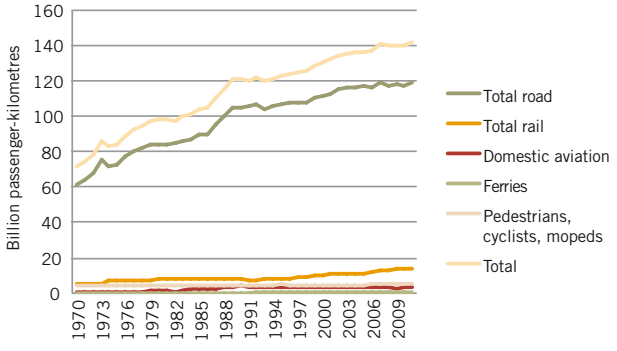


Figure 2.17 **Trends in passenger transport activity, 1970–2011 (Transport Analysis 2013).**

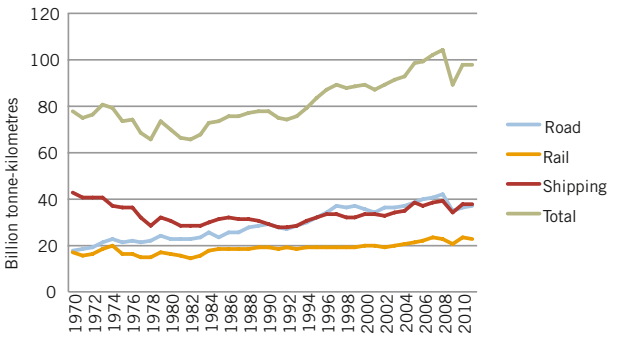


Figure 2.18 **Trends in goods transport activity, 1970–2011 (Transport Analysis 2013).**

In terms of greenhouse gas emissions, the rapid rise in passenger travel has been offset by more energy-efficient cars and increased use of renewable fuels, which have resulted in a decrease in emissions per passenger-kilometre. The efficiency of freight transport also improved in the 1990s, but this trend levelled off and since 2000 the energy use and carbon dioxide emissions of freight transport have grown along with transport activity.

In 2011 petrol and diesel accounted for 93% of the energy used by transport, while the remainder consisted of biofuels (Swedish Energy Agency 2012e, see Fig. 2.19). Use of petrol has been decreasing since 2002, partly owing to the blending of 5% ethanol in the fuel, but also because of greater energy efficiency and the growing market share of diesel vehicles in relation to petrol-driven ones. More diesel vehicles and increased goods transport have, on the other hand, brought about a rise in the use of diesel as fuel.

Use of biofuels – biogas, pure and low-blend FAME (fatty acid methyl ester), ethanol and HVO (hydrotreated vegetable oil) – amounted to 7.0% of energy use by road transport in 2011 (Swedish Energy Agency 2013). The rise has been rapid since 2000, initially owing to low blends of ethanol in petrol and subsequently to

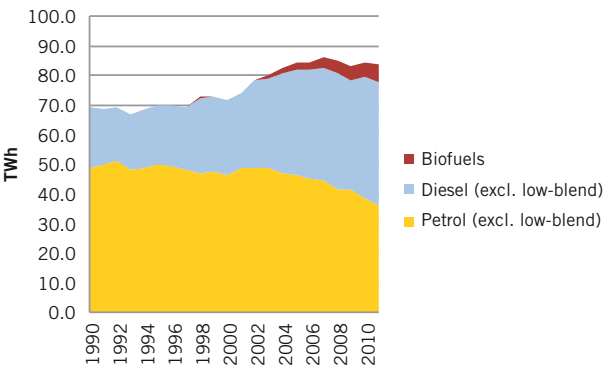


Figure 2.19 **Use of petrol, diesel and biofuels by road transport in Sweden (Swedish Energy Agency 2012e).**

a rise in the sale of E85 (containing 85% ethanol) for flexible-fuel ethanol vehicles and also, since 2005, an increased admixture of biodiesel in diesel fuel.

2.10 Waste

Approximately 118 million tonnes (Mt) of waste was generated in Sweden in 2010 (Swedish Environmental Protection Agency 2012). The categories with the largest volumes were mining and mineral waste (89 Mt), soils and dredging spoils (8 Mt), metallic waste (2.5 Mt), wood waste (2 Mt), combustion waste, i.e. ashes (1.5 Mt) and paper and cardboard waste (just under 1.5 Mt). Accordingly, 76% of this waste was generated in the mining and quarrying industry. The aggregate volume is affected by economic trends and fluctuations. Larger quantities of waste mean that a growing amount requires management. However, since the material and energy content of waste are used to a higher degree and the technology of waste management has improved, the overall environmental impact of waste management has nonetheless decreased.

Owing to Sweden's new policy objectives and associated instruments, landfilling of waste has decreased sharply in the past decade to just under 1% of household waste today (in 2001 the proportion was 21%) (see Fig. 2.20). The remainder is sent for materials recovery, incinerated with energy recovery or treated biologically (composted or digested). If industrial and operational waste (not mining waste) are included, 43% goes to materials recovery, 28% is incinerated with energy recovery and 13% goes to landfill. Materials recovery includes various categories of material, such as metal, paper, plastic and glass, and also use of waste for construction purposes.

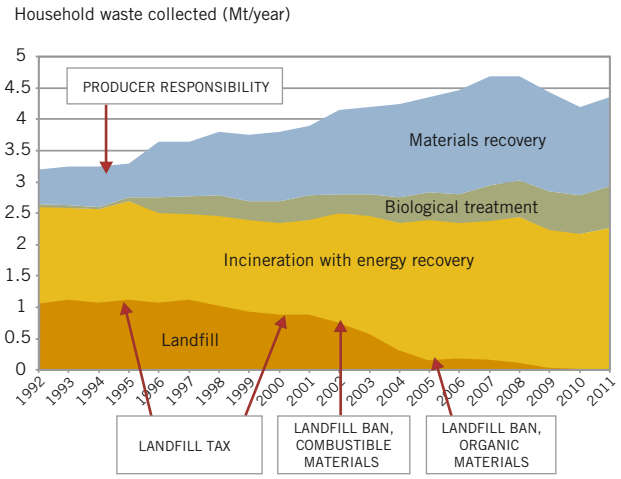


Figure 2.20 **Volume trends of household waste treated in Sweden, 1992–2011, under the influence of policy instruments adopted.**

The quantity of household waste treated in Sweden has increased to just over 4.3 million tonnes, according to Swedish Waste Management (2012). Since 2001, there has been an 11% increase in volume. In terms of household waste per capita in the years 2001–11, an upward trend is evident up to 2007, when the figure per capita was 493 kg, followed by a three-year downward trend. This was reversed in 2011, when the average inhabitant generated 459 kg of household waste, and it is likely that this reversal mainly reflected the improvement in economic trends that year.

Materials recovery from household waste has increased by 13% since 2001. In 2011, materials were recovered from 1.4 Mt (33%) of household waste, of which just under 1.1 Mt consisted of packaging and recyclable paper (newspapers).

Biological treatment of waste, except for wastewater sludge, is increasing and takes place at 26 composting facilities and 21 mixed-waste digestion plants. The latter receive food and slaughter waste, in particular, and produce most biogas after sewage treatment plants. Smaller quantities of food waste are also received for digestion at sewage treatment plants. In digestion, both biogas and biofertiliser are obtained. The biogas is used mainly as a vehicle fuel, since there is a growing demand for renewable transport fuels and, moreover, using it in this way affords the greatest environmental benefit. Of the volume of biofertiliser produced, amounting to 594,000 tonnes, more than 90% was returned to farmland in 2011.

In 2011 there were 30 incineration plants for household waste outside industry. These plants produce both district heating and electricity. Half of the heating requirement in Sweden's building stock is met by district heating, and in 2011 waste incineration accounted for 9,600 GWh (18%) of the total heat energy supplied and a further 3,665 GWh of electric energy supplied.

Recovery of methane gas takes place from 46 active and 11 disused landfills. In 2011, 270 GWh of landfill gas (18% of total biogas energy) was collected and used mainly for heating, but also for electricity production and as a vehicle fuel. Some landfill gas is flared to further reduce emissions of methane, a considerably stronger greenhouse gas than carbon dioxide.

Reduced landfilling of waste and improved collection of landfill gas are factors that have contributed to a fall in greenhouse gas emissions from the waste sector. Increased materials recovery generally means that both energy and materials are saved at the production stage, and this helps to reduce emissions further. In addition, waste incineration with energy recovery results in a reduction in the use of fossil fuels in the electricity and heating sectors.

2.11 Agriculture

The total area of agricultural land in Sweden in 2012 was 3.0 million hectares, which is equivalent to some 7% of the country's total land area. Farmland comprises both arable and grazing land. The area under cultivation has shrunk by roughly 8% since 1990. The trend towards fewer, larger farming enterprises has been under way for many decades and the period 1990–2012 was no exception. The predominant use of arable land is cultivation of forage crops, green fodder and cereals. Since 2000, there has been a rise in cultivation of forage and green fodder crops at the expense of cereal growing (see Table 2.4).

The area of arable land left fallow, which shows annual variation, was slightly lower in 2012 than in 1990. Total crop production has fallen by some 15% since 1990 (see Table 2.5).

In 2012 there were 1.5 million cattle, 0.6m sheep and lambs, and 1.4m pigs (see Table 2.6). The number of cattle has fallen steadily since the 1980s, and declined by 13% in the period 1990–2012. The number of dairy cows has fallen sharply, while that of cows used for calf rearing has risen. Sheep and lamb production has increased, especially in 2005–12. Pig numbers continue to decline, and have fallen by 40% since 1990.

Table 2.4 **Breakdown of agricultural land for farms with more than 2 ha of arable land ('000 ha)**

	1990	1995	2000	2005	2008	2009	2010	2011	2012
Forage and green fodder crops	918	1 059	921	1 080	1 159	1 175	1 195	1 195	1 177
Cereals	1 336	1 105	1 229	1 024	1 088	1 049	963	993	1 000
Fallow land	176	279	248	321	147	153	177	154	151
Oilseed rape and turnip rape	168	105	48	82	90	100	110	95	110
Potatoes	36	35	33	30	27	27	27	28	25
Sugar beet	50	58	56	49	37	40	38	40	39
Legumes	..	21	37	41	25	34	46	42	40
Other crops	..	46	55	42	52	59	67	63	56
Unspecified arable land	..	..	80	32	8	7	11	10	10
Unused arable land	46	60	..	2	0	0	..	..	..
Total area of arable land	**2 845**	**2 767**	**2 706**	**2 703**	**2 632**	**2 643**	**2 634**	**2 619**	**2 608**
Grazing land and hay meadows	332	425	..	513	458	436	452	447	441
Total area of farmland	**3 176**	**3 192**	**..**	**3 216**	**3 089**	**3 080**	**3 085**	**3 066**	**3 049**

Table 2.5 **Crop production in Sweden (tonnes)**

	1990	2012	Change (tonnes)	Change, %
Forage and green fodder crops	5 219 000	4 751 500	–467 500	–9
Cereals	6 211 300	5 070 500	–1 140 800	–18
Oilseed rape and turnip rape	380 110	321 900	–58 210	–15
Potatoes	1 186 100	805 400	–380 700	–32
Sugar beet	2 775 500	2 485 600 (2011)	–289 900	–10
Total crop production	**15 772 010**	**13 434 900**	**–2 337 110**	**–15**

Table 2.6 **Livestock numbers ('000)**

	1990	1995	2000	2005	2008	2009	2010	2011	2012
Cows for milk production	576	482	428	393	357	357	348	347	348
Cows for calf rearing	75	157	167	177	196	192	197	196	193
Total, cows	**651**	**639**	**595**	**570**	**553**	**549**	**545**	**543**	**541**
Heifers, bulls and steers	543	596	589	527	513	502	513	495	479
Calves below 1 year	524	542	500	509	492	488	478	475	481
Total, cattle	**1 718**	**1 777**	**1 684**	**1 606**	**1 558**	**1 538**	**1 537**	**1 512**	**1 500**
Ewes and rams	161	195	198	222	252	254	273	297	297
Lambs	244	266	234	249	273	287	292	326	314
Total, sheep and lambs	**405**	**461**	**432**	**471**	**525**	**541**	**565**	**623**	**611**
Sows and gilts	230	245	206	188	170	160	156	153	142
Pigs for slaughter	1 025	1 300	1 146	1 085	974	943	937	901	851
Piglets	1 009	768	566	538	465	426	427	429	370
Total, pigs	**2 264**	**2 313**	**1 918**	**1 811**	**1 609**	**1 529**	**1 520**	**1 483**	**1 363**
Horses							363		

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

	1990	2012	Change (tonnes)	Change, %
Milk	3 432 000	2 861 000	–571 000	–17
Beef	143 780	125 300	–18 480	–13
Pork	289 150	233 000	–56 150	–19
Mutton, lamb	4 880	5 000	+120	+2

Table 2.8 **Sales of mineral fertiliser expressed as nitrogen nutrient ('000 tonnes)**

	1989/1990	1994/1995	1999/00	2004/05	2007/08	2008/09	2009/10	2010/11	2011/12
Nitrogen (N)	225	198	189.4	161.6	186.5	142.4	168	170	148.1

Thanks to increased productivity, the quantity of milk produced has not shown as large a decrease as the number of dairy cows (see Table 2.7).

Total use of mineral fertiliser has decreased over a long period, and in 2011/12 was at its lowest level since the 1960s. Owing to rising cereal prices, a certain upturn may be noted in 2008–10 when applying more fertiliser became profitable. Since then, however, the long-term trend of declining sales has continued (see Table 2.8). One reason for this decline is decreasing cereal cultivation. Sales are also affected by changes in cereal and mineral fertiliser prices. The result in terms of greenhouse gas emissions has been lower release of nitrous oxide.

Since 1990, the arable area, number of cattle and quantities of mineral fertiliser and manure used have decreased, with falling methane and nitrous oxide emissions as a result.

2.12 Forestry

Sweden's forest land amounts to 28.3 million hectares, corresponding to 69% of the total land area. It is for this area that greenhouse gas emissions and removals in forests are reported. Fifty per cent of forest land is owned by individuals, 25% by privately owned limited companies, 6% by other private owners and 19% by state-owned limited companies, the central government and other public owners (Swedish Forest Agency 2012).

The area of forest land excluded from forestry is 7.1 million ha, protected through various regulations. Altogether, 4.0 million ha of forest land is unproductive land outside national parks, nature reserves, habitat protection areas and areas subject to nature conservation agreements. The area of productive forest land[4] is 23.2 million ha. Of this total, 0.8 million ha, the greater part of it montane forests in national parks, nature reserves and nature conservation areas, is formally protected[5]. Roughly 1.2 million ha of Sweden's productive forest area has been voluntarily set aside by the landowners, and this land includes areas of high natural and cultural value or of importance for recreation and outdoor activities (Swedish Forest Agency 2012).

Increased demand for forest raw materials from the forest industry brought about a sharp rise in felling in 1990–2011 (see Fig. 2.21). The volume felled varied greatly from year to year because of two storms, Gudrun (2005) and Per (2007). Gudrun, the more severe of the two, brought down some 80% of the normal annual volume felled in Sweden. Despite increased felling, the aggregate standing volume of timber rose from some 2.8 billion m^3 in 1990 to 3.3 billion m^3 in 2009 (Swedish University of Agricultural Sciences 2012).

Total use of biofuels, excluding waste, rose by 56 TWh between 1990 and 2010 and now accounts for 118 TWh. The area of regeneration felling in which forest residues were used for energy purposes was small at the beginning of the 1990s. Since then, it has successively expanded to some 80,000 ha in 2010. Wood ash is recycled to forest land for the purpose of counteracting acidifying, nutrient-depleting effects on the soil that occur when biomass is removed. In 2010, ash recycling was carried out on 10,158 ha (Swedish Forest Agency 2012).

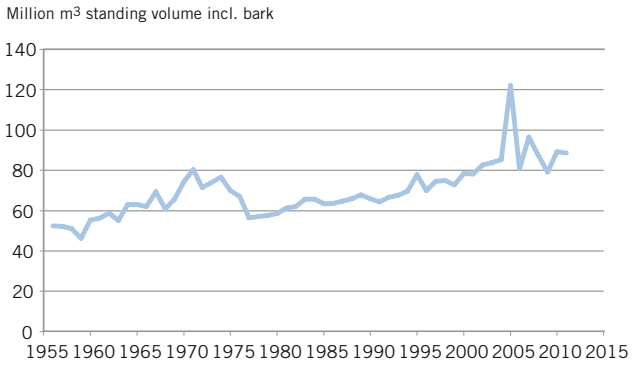


Figure 2.21 **Estimated gross annual volume felled in Sweden (Swedish Forest Agency 2012).**

[4] Forest land with an annual production capacity of at least 1 m^3 of timber per hectare.
[5] National parks, nature reserves, nature conservation areas, habitat protection areas and areas subject to nature conservation agreements.

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3 Greenhouse gas inventory 1990–2011

The information in this chapter is a summary of the 2013 inventory of emissions and removals of greenhouse gases, submitted under the UN Framework Convention on Climate Change and the Kyoto Protocol (*National Inventory Report Sweden 2013*).

3.1 Total emissions and removals of greenhouse gases

Total greenhouse gas emissions and removals in Sweden between 1990 and 2011, broken down by sector, are shown in Fig. 3.1. In 2011, Sweden emitted 61.4 million tonnes of carbon dioxide equivalent (Mt CO_2 eq) of greenhouse gases. Compared with 2010, that represents a reduction of 6%, and compared with 1990 a reduction of 16%. Apart from high levels in 2010, the trend in Swedish greenhouse gas emissions since 1998 has been downward. Emission levels have varied between a low of 59.3 Mt CO_2 eq in 2009 and a high of 78.3 Mt CO_2 eq in 1996. Between-year variations are largely due to fluctuations in temperature and precipitation and to the economic situation.

The net sink attributable to the land use, land-use change and forestry (LULUCF) sector has varied over the period. In 2011 it amounted to 35 Mt CO_2 eq, which corresponds to 57% of total greenhouse gas emissions.

The breakdown between the greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated greenhouse gases (HFCs, PFCs and SF_6), in carbon dioxide equivalent terms, is shown in Fig. 3.2. In 2011, carbon dioxide made up 79% of greenhouse gases emitted, or 48.7 Mt. The majority (88%) of carbon dioxide emissions come from the energy sector. Emissions of methane in 2011 totalled 5.0 Mt CO_2 eq (8% of emissions), the main sources being agriculture and waste. Nitrous oxide emissions amounted to 6.7 Mt CO_2 eq, or 11% of the total. Of these emissions, 73% originated from the agricultural sector. Emissions of fluorinated greenhouse gases, reported in the industrial processes sector, made up 2%, or 1.1 Mt CO_2 eq, of aggregate greenhouse gas emissions.

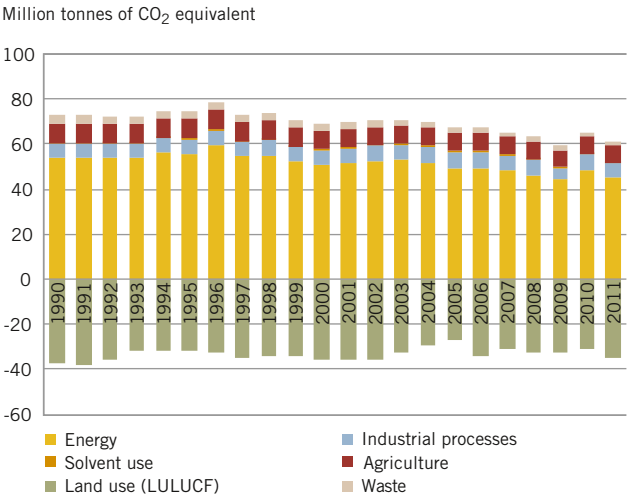


Figure 3.1 **Total greenhouse gas emissions from different sectors.**

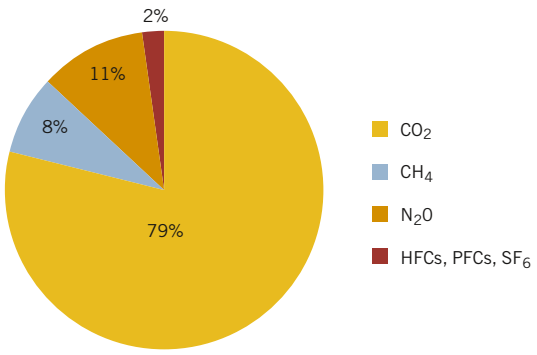


Figure 3.2 **Greenhouse gas emissions in 2011 (excl. LULUCF) by gas, in carbon dioxide equivalent terms.**

3.2 Emissions and removals of greenhouse gases by sector

The largest sources of emissions in 2011 were domestic transport (33%), manufacturing industries (26%, of which fuel combustion contributed 15% and industrial processes 11%), energy industries (electricity and heat production, refineries and manufacture of solid fuels) (17%) and agriculture (13%), as shown in Fig. 3.3.

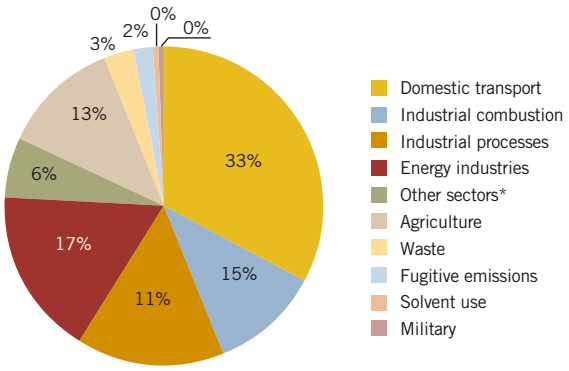


Figure 3.3 **Greenhouse gas emissions in 2011 (excl. land use), by sector.**

Apart from the sharp fluctuations of the last few years, there is a clear downward trend in emissions – see Fig. 3.4, which shows total emissions broken down by sector. The largest reductions in absolute terms are due to the replacement of oil with biofuels for the heating of homes and commercial and institutional premises. Emissions from the energy industries sector have varied from year to year and no clear trend can be discerned. Industrial use of energy has decreased since 1997, and emissions from industrial processes show a slight decline. Emissions in the transport sector had increased in 2011, compared with 1990. Agricultural emissions show a downward trend over the period.

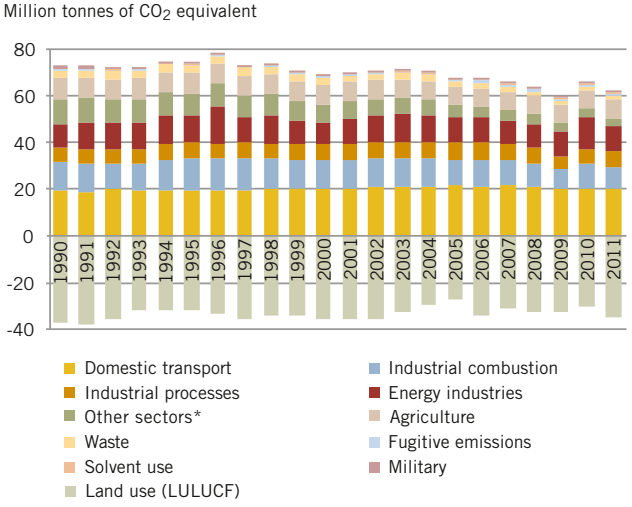


Figure 3.4 **Greenhouse gas emissions and removals (incl. land use), by sector.**

* i.e. fuel combustion in the commercial/institutional, residential, and agriculture/forestry/fisheries sectors.

3.2.1 Energy industries

The energy industries sector (see Fig. 3.5) includes production of electricity and district heating, refineries and the manufacture of solid fuels. Sweden's energy industries are based largely on hydropower, nuclear power and biofuels. Fossil fuels serve as a complement, often as a marginal fuel in cold weather. Greenhouse gas emissions therefore vary widely, depending on weather conditions in different years. In 2011, the sector emitted 10.7 Mt CO_2 eq of greenhouse gases, or 17% of the national total.

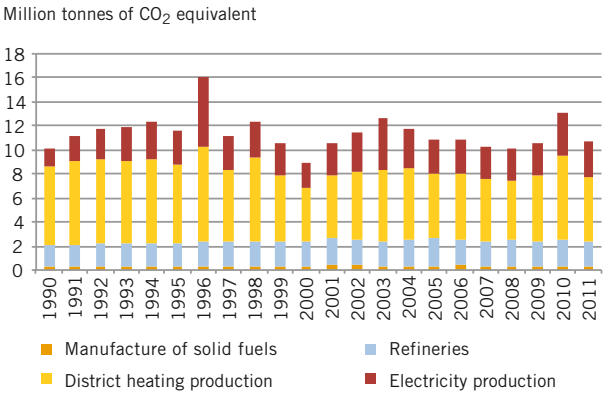


Figure 3.5 **Greenhouse gas emissions from the energy industries.**

Production of district heat is responsible for the largest greenhouse gas emissions in this sector (5.3 Mt CO_2 eq in 2011). Between 1990 and 2011, as the district heating system expanded, the amount of heat produced more than doubled. This expansion was based largely on biofuels, however, with the result that emissions of greenhouse gases remain at roughly the same level as in 1990. Fossil fuels are used as a complement to biofuels. Cold winters (like those of 1996 and 2010 in particular) increase the demand for district heating, leading to higher emission levels. Unusually mild winters (as in 2000) have the opposite effect, reducing heating demand and greenhouse gas emissions. Variations from one year to another can therefore be dramatic: in 2011, for example, emissions fell by 16% compared with 2010.

Emissions from electricity production (2.9 Mt CO_2 eq in 2011) show a similar pattern. Most of the electricity generated in Sweden comes from hydroelectric and nuclear power plants. Fossil fuels are burnt as a complement when the demand for electricity exceeds normal production. This happens, for example, on cold winter days. The high emissions of 1996 were due to a cold winter combined with a poor supply of hydropower resulting from a dry summer. Since 1996 opportunities to

import and export electricity have improved considerably, and variations have therefore been less pronounced in recent years. In 2010, emissions rose owing to cold winters and a reduced supply of nuclear power. In 2011 they fell again, thanks to a good supply of hydropower, (somewhat) increased production of nuclear power, and warmer weather.

Refinery emissions remained relatively constant over the period under review, at around 2 Mt CO_2 eq. Emissions from the manufacture of solid fuels are a minor category, amounting to some 0.3 Mt CO_2 eq annually.

3.2.2 Industrial combustion

Greenhouse gas emissions from fuel combustion in manufacturing industries were 9.5 Mt CO_2 eq in 2011 (see Fig. 3.6), or 15% of national emissions. That is 21% lower than in 1990. Emissions from this sector have varied up and down over the years, chiefly owing to economic fluctuations. In recent years (2002–11) there has been a downward trend, partly due to a shift from oil to electricity and biofuels.

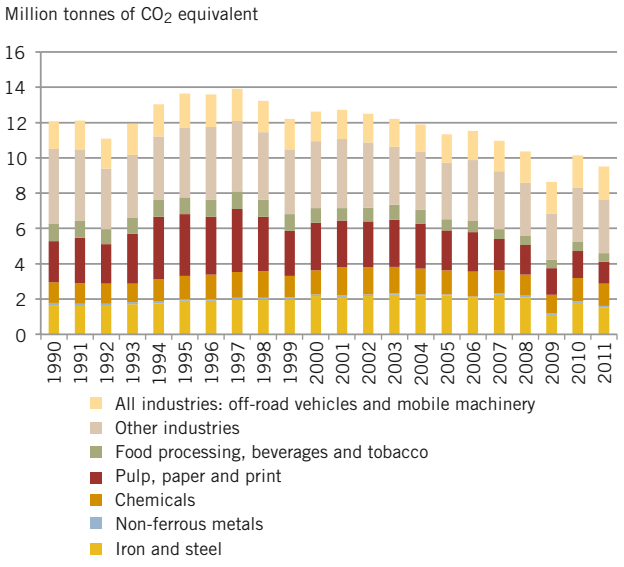


Figure 3.6 **Greenhouse gas emissions from industrial combustion.**

A small number of energy-intensive industries account for a large share of greenhouse gas emissions in this sector. Iron and steel (16% of emissions), pulp and paper (13%) and chemicals (13%) are responsible for almost equally large shares of the total. The heterogeneous subsector 'Other industries' accounted for 52% of emissions in 2011.

Over a long period, industry has reduced its use of oil and increased its consumption of electricity. Biofuels and electricity are now its most important sources of energy. Since 2002 emissions have shown a downward trend, one reason being the replacement of fossil fuels with biofuels. The biggest change has occurred in the pulp and paper industry, where the use of biofuels is most common.

The last recession saw a marked fall in emissions, especially in 2009. In 2010 they rose again, owing to higher volumes of production and demand for energy. In 2011, reduced energy demand and a modest decrease in production in some industries led to a decline in emissions compared with 2010.

3.2.3 Transport

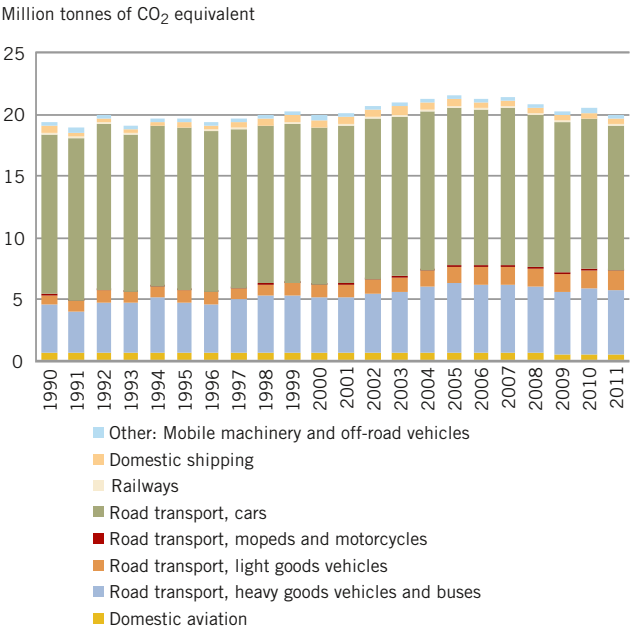


Figure 3.7 **Greenhouse gas emissions from transport.**

In 2011, emissions of greenhouse gases from domestic transport amounted to 20 Mt CO_2 eq, which is a third of the national total. Emissions were 4% higher in 2011 than in 1990. Since 2005, however, there has been a slight downward trend (see Fig. 3.7).

The majority of emissions come from cars (11.7 Mt CO_2 eq) and heavy-duty vehicles (6.7 Mt CO_2 eq). Emissions from cars have fallen by 9% compared with 1990, despite growth in traffic. This is a result of more energy-efficient vehicles and greater use of biofuels. The decrease for cars is offset by a 44% rise in emissions from heavy-duty vehicles over the same period. The increase in transport activity involving heavy vehicles is due partly to the restructuring of society towards specialisation, centralisation and globalisation, resulting in goods being transported over ever greater distances.

Greenhouse gas emissions from domestic aviation were 0.5 Mt CO_2 eq in 2011, 22% down on 1990 levels. The decline is due to more efficient aircraft and higher cabin factors, but also to stricter security requirements, which have made it more complicated and time-consuming to fly, reducing domestic aviation's advantages over rail and road transport.

For domestic shipping, emissions in 2011 were estimated at 0.5 Mt CO_2 eq. Over the period, emissions from this source varied in a pattern reflecting fluctuations in the economic situation. No trend can be discerned.

Sweden's railways are largely electrified, with only a few smaller lines served by diesel-hauled trains. Emissions from rail transport have been almost halved since 1990 and now stand at just 0.07 Mt CO_2 eq.

3.2.4 Other sectors

Greenhouse gas emissions from 'Other sectors', i.e. fuel combustion in the commercial and institutional, residential, and agriculture, forestry and fisheries sectors, come primarily from stationary combustion (heating in homes, non-residential premises, agriculture, forestry and fisheries), but also from mobile combustion (mobile machinery, off-road vehicles and fishing boats). In 2011, emissions were 3.7 Mt CO_2 eq, or 6% of the national total.

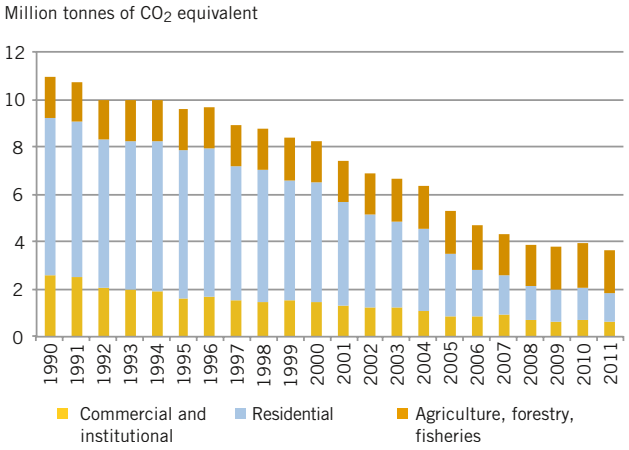


Figure 3.8 **Greenhouse gas emissions from 'Other sectors'.**

Since 1990, emissions have fallen by 67%, mainly owing to lower emissions from heating of homes and premises (see Fig. 3.8). There are several reasons for this trend: the shift from oil-based to district and electric heating, increased use of heat pumps and pellet-fired boilers, and measures to improve energy efficiency. Another contributory factor behind the positive trend is the mild weather experienced most years since 1990.

Emissions from mobile combustion are very low, but rising.

3.2.5 Military

Emissions from military transport have fallen sharply since 1990, reflecting restructuring of the Swedish Armed Forces over the period. In 2011, emissions amounted to 0.2 Mt CO_2 eq (see Fig. 3.9).

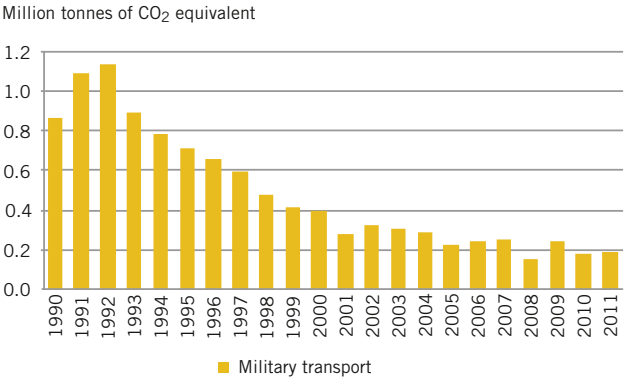


Figure 3.9 **Greenhouse gas emissions from military transport.**

3.2.6 Fugitive emissions

Fugitive emissions are a minor category, accounting for 1 Mt CO_2 eq or 1.6% of national emissions. Sources include refineries, flaring in the iron and steel industry, and handling of fuels, for example at filling stations. Emissions rose sharply in 2006 owing to the commissioning of two hydrogen production facilities, an increase that is clearly evident in Fig. 3.10.

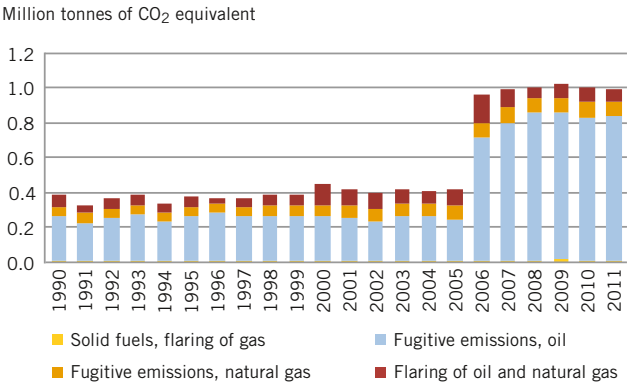


Figure 3.10 **Fugitive emissions.**

3.2.7 Industrial processes

Emissions of greenhouse gases from industrial processes totalled 6.7 Mt CO_2 eq in 2011, or 11% of national emissions. This represents a rise of 5% since 1990 (see Fig. 3.11).

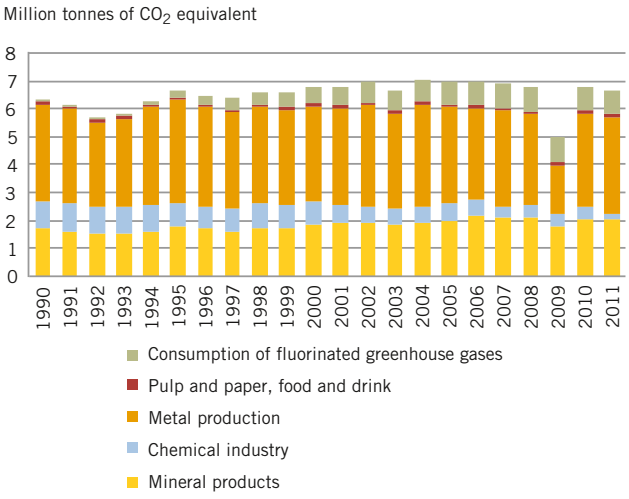


Figure 3.11 **Greenhouse gas emissions from industrial processes.**

The largest emission sources are iron and steel production and the cement and lime industry. Others include the use of coke in blast furnaces, of limestone and dolomite in the minerals industry, and of coal in copper production. Emissions of fluorinated greenhouse gases are also reported in this sector.

Emissions have varied since 1990, mainly owing to changing volumes of production linked to economic fluctuations. With the exception of 2009, which saw a dramatic fall in emissions due to the recession, overall emissions show a modest decline since 2004. Trends vary from one industry to another. Emissions from the mineral products sector have risen, while those from the chemical industry fell over the period. Emissions of fluorinated greenhouse gases – halocarbons and sulphur hexafluoride (SF_6) – have increased since 1992, but began to stagnate around 2008.

3.2.8 Solvent and other product use

Greenhouse gas emissions from the use of solvents and other products amounted to 0.3 Mt CO_2 eq in 2011, or 0.5% of national emissions. Compared with 1990, this represents a reduction of 11%, primarily due to a shift from oil- to water-based paints (see Fig. 3.12).

3.2.9 Agriculture

Agriculture is the largest source of emissions of methane and nitrous oxide. In 2011, the sector's emissions of these greenhouse gases came to 7.8 Mt CO_2 eq, representing 13% of national emissions. Total emissions from agriculture have fallen by 14% since 1990 (see Fig. 3.13).

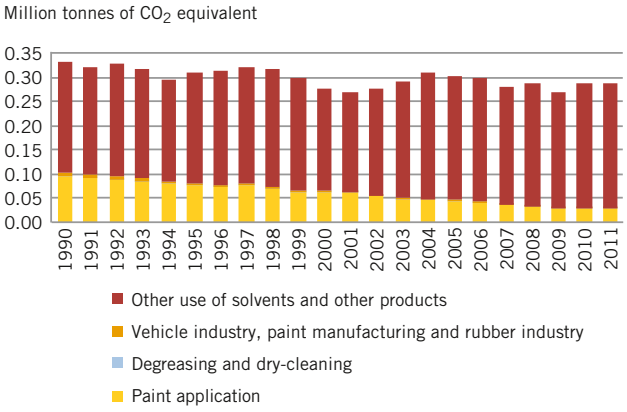


Figure 3.12 **Greenhouse gas emissions from solvent and other product use.**

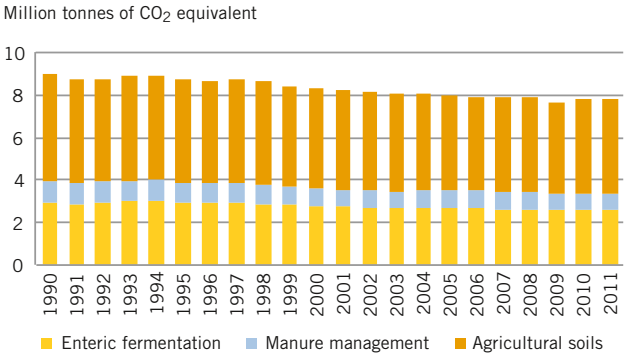


Figure 3.13 **Greenhouse gas emissions from agriculture.**

Enteric fermentation in livestock (chiefly cattle) gives rise to methane emissions. These emissions have fallen by 13% since 1990, amounting to 2.6 Mt CO_2 eq in 2011. The principal reason for the reduction is a decline in the livestock population, with a decrease of 12% in the number of cattle between 1990 and 2011.

Manure management produces emissions of methane and nitrous oxide. Aggregate emissions from this source have decreased by 23%, from 1.0 Mt CO_2 eq in 1990 to 0.7 Mt CO_2 eq in 2011. The main reason for the decline is a reduction in the quantities of animal manure, due to falling numbers of dairy cattle and pigs.

Agricultural soils are another major source of nitrous oxide emissions, contributing 4.4 Mt CO_2 eq in 2011, a reduction of 12% compared with 1990. The decrease is due to declining use of both mineral fertilisers and animal manure. To some extent, action programmes to curb nitrogen losses from agriculture have reduced indirect emissions of nitrous oxide from leached nitrogen and from ammonia deposition. An expansion of slurry management in pig and

dairy farming has also played a significant role in bringing down nitrous oxide emissions from the agricultural sector.

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

Over the period 1990–2011, the land use, land-use change and forestry sector represented an annual net sink, as a result of carbon dioxide from the atmosphere being taken up by vegetation and incorporated in biomass. This net removal varied between 27 and 38 Mt CO_2 eq (see Fig. 3.14). In 2011, it amounted to 35 Mt CO_2 eq, corresponding to 57% of national greenhouse gas emissions. Sweden has a rolling sampling system based on permanent plots. Data for 2008–11 involve greater uncertainty than the rest of the time series, as not all plots were surveyed for those years.

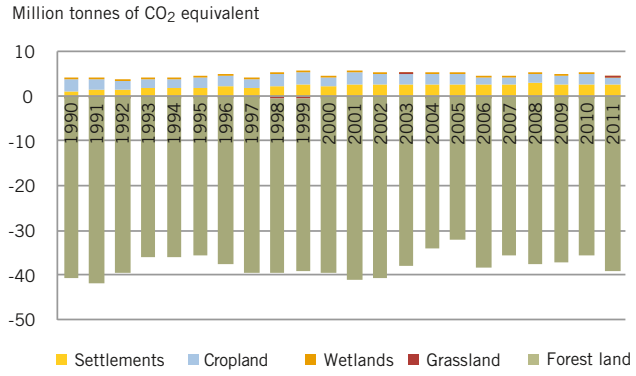


Figure 3.14 **Greenhouse gas emissions and removals from land use.**

Forest land is the land-use category accounting for the majority of removals in this sector (39.3 Mt CO_2 eq in 2011). The long-term trend points to a slight decline in removals from land use. This is due primarily to increased felling, but also to two severe storms: Gudrun at the beginning of 2005 and Per early in 2007. Winter storm Gudrun brought down a large quantity of timber, 75 million m^3 standing volume (Swedish Forest Agency 2006).

According to the Forest Agency, gross fellings varied between 64 and 96 million m^3 standing volume over the period 1990–2011, with the exception of 2005, when felling, including windthrow, was estimated at 122 million m^3 (Swedish Forest Agency 2013).

Cropland is a net source of greenhouse gases, as the cultivation of organic soils gives rise to emissions. These varied between 1.3 and 2.7 Mt CO_2 eq in the period 1990–2011.

At a national level, grassland, wetlands and settlements represent very small areas (and associated changes in carbon stocks) compared with forest land, resulting in greater uncertainty in the data. The change in the stock of carbon in grasslands and wetlands is small (0.06 Mt CO_2 eq in all in 2011). Emissions from settled land ranged from 1.3 to 2.9 Mt CO_2 eq between 1990 and 2011.

3.2.11 Waste

Emissions of greenhouse gases from the waste sector have been halved since 1990 and show a downward trend (see Fig. 3.15). In 2011, they stood at 1.7 Mt CO_2 eq, or around 3% of total greenhouse gas emissions.

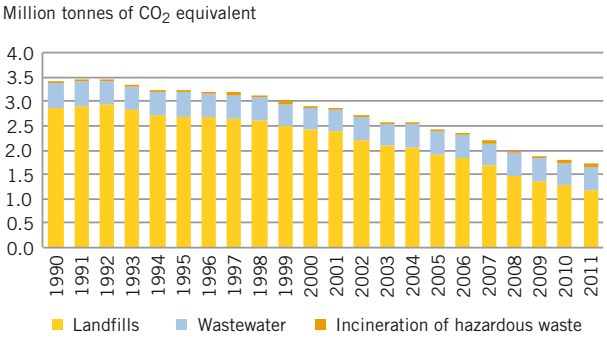


Figure 3.15 **Greenhouse gas emissions from waste.**

Of total emissions from the waste sector in 2011, methane from landfill sites accounted for just over two-thirds. After livestock farming, landfills are the largest source of methane emissions, as the gas forms when organic wastes decompose. Emissions of methane have steadily declined since the early 1990s, owing partly to less waste being landfilled and partly to increased recovery of methane from landfill sites. The main reason for the decrease in the quantities of waste sent to landfill is the bans on landfill disposal of combustible and organic material, introduced in 2002 and 2005 respectively. Producer responsibility, municipal waste plans and the waste tax have also reduced the amount of waste.

Emissions from wastewater have fallen by 10% since 1990, owing to improvements in sludge management.

Emissions from the incineration of hazardous waste have risen somewhat in recent years compared with 1990–2002, due to an increase in the quantities of waste incinerated.

3.2.12 International bunkers

Greenhouse gas emissions from international shipping and aviation, known as international bunkers, are considerably larger than those from domestic shipping and aviation. In 1990, they amounted to 3.6 Mt CO_2 eq. Since then, they have risen sharply, peaking in 2007. In 2011, emissions were 8.3 Mt CO_2 eq, a full 129% higher than in 1990. See Fig. 3.16.

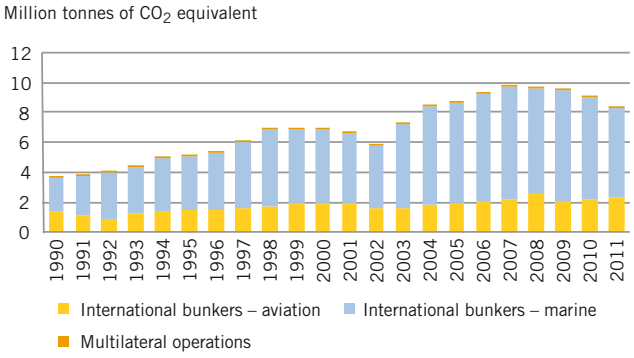


Figure 3.16 **Greenhouse gas emissions from international bunkers.**

The majority of these emissions come from shipping, which contributed just over 6.0 Mt CO_2 eq in 2011, a rise of 164% since 1990. International freight transport activity has increased, as the volume of goods transported has grown and globalisation of trade and production systems has led to goods being transported over greater distances. Another factor is that Swedish refineries produce low-sulphur marine fuels (fuel oil nos. 2–5), meeting strict environmental standards. This has led to more shipping companies choosing to refuel in Sweden. Fluctuations in bunker volumes between years are also dependent on fuel prices in Sweden compared with ports in other countries.

Greenhouse gas emissions from international aviation bunkers amounted to 2.3 Mt CO_2 eq in 2011, which was 70% higher than in 1990. The trend points to a rise in these emissions, owing to growth in foreign travel.

The Swedish Armed Forces bunker extremely small quantities of fuel in Sweden for operations abroad.

International bunker fuel emissions are not covered by any existing international commitments on emission reductions. As from 2012, however, aviation is included in the EU Emissions Trading System, although 2012 emissions from aircraft have in effect been exempted from the scheme.

3.3 References for Chapter 3

National Inventory Report Sweden 2013.

Swedish Forest Agency (2006). *Skogsstatistisk årsbok 2006 (Swedish Statistical Yearbook of Forestry 2006)*, p. 23.

Swedish Forest Agency (2013). Officiell statistik, Tabell 7.9 Beräknad bruttoavverkning i hela landet (Table 7.9 Gross fellings by assortments: The entire country), www.skogstyrelsen.se

4 Policies and measures

4.1 Swedish climate strategy

Sweden's climate strategy has progressively developed since the late 1980s. It consists of objectives, policy instruments and measures, together with regular follow-up and evaluation. In recent years, the country's climate policy has continued to evolve towards stronger EU integration and closer international cooperation. Sweden is working with the other EU member states to achieve a global agreement compatible with the goal of limiting the rise in temperature to no more than 2 °C above pre-industrial levels.

4.1.1 Strategy and objectives

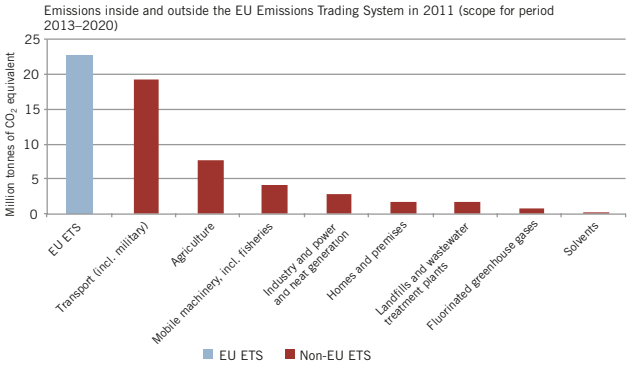
To give a clear structure to environmental efforts in Sweden, the Riksdag (the Swedish Parliament) has adopted a number of environmental quality objectives. One of these, *Reduced Climate Impact*, forms the basis for action on climate change in the country. Current climate policy is in addition set out in two Government Bills, entitled *An Integrated Climate and Energy Policy*, passed by the Riksdag in June 2009 (Govt. Bills 2008/09:162 and 163). The first of these Bills establishes an interpretation of the *Reduced Climate Impact* objective in terms of a temperature target and a concentration target. The temperature target is that the increase in global average temperature should be limited to no more than 2 °C above pre-industrial levels. From this target a concentration target is derived, according to which Swedish climate policy is to be designed to contribute to ensuring that the concentration of greenhouse gases in the atmosphere is stabilised in the long term at no more than 400 parts per million of carbon dioxide equivalent. The Bill also sets a national milestone target for climate, calling for a 40% reduction in emissions by 2020, compared with 1990. This target applies to activities not included in the EU Emissions Trading System (EU ETS, see Box 4.1). In addition, the Bill makes it a priority for Sweden to have a vehicle fleet independent of fossil fuels by 2030, and sets out a vision of Sweden as a country with no net emissions of greenhouse gases to the atmosphere by 2050.

The milestone target means that, by 2020, greenhouse gas emissions from the non-trading sector are to be some 20 million tonnes of carbon dioxide equivalent (Mt CO_2 eq) lower than in 1990. To achieve this target, policy instruments already adopted and changes in instruments decided on at EU level are to be supplemented with further elaborated tax instruments and with emission reduction measures in other countries, involving investments in developing countries or projects in other EU member states. The Government estimates that investments in other countries will deliver a third of the overall reduction, adding up to 40 Mt CO_2 eq over the period as a whole. With its climate and energy policy decision of 2009, Sweden has adopted a national climate target for 2020 that goes beyond the effort sharing put in place among the EU member states as part of the EU Climate and Energy Package. Under the Effort Sharing Decision reached for the purposes of the EU's unilateral commitment (a 20% cut in emissions between 1990 and 2020), Sweden is to reduce its emissions outside the EU ETS by 17% between 2005 and 2020. For activities included in the EU ETS, the level of ambition of the emissions reduction to be achieved is determined on a joint EU basis, under the rules of the trading system.

In 2009 the Riksdag also adopted two targets for more efficient use of energy, one for 2020 and the other for 2016 (see Box 4.3). In addition, the Riksdag has decided that Sweden's use of renewable energy is to increase to 50% of total energy use by 2020 (see Box 4.2). The Swedish target for greater use of renewable

Box 4.1 Emissions inside and outside the EU Emissions Trading System

The EU Emissions Trading System (EU ETS) covers emissions of carbon dioxide from installations for power and heat generation, refineries, plants producing and processing iron, steel, glass and glass fibre, cement and ceramics, and plants producing paper and paper pulp. As from 2012, it also includes aviation emissions, and from 2013, the aluminium industry, production and processing of non-ferrous metals, and parts of the chemical industry. In addition to carbon dioxide, the expansion in 2013 brings within the system emissions of perfluorocarbons from the aluminium industry and of nitrous oxide from certain parts of the chemical industry. In Sweden, emissions from the trading sector made up around 33% of the country's total emissions over the period 2008–12.



Other emissions, from activities outside the EU ETS, originate from a number of different sources. In Sweden, the transport sector accounts for the largest share, followed by emissions from agriculture (methane and nitrous oxide) and from mobile machinery. Emissions from certain industry sectors, such as engineering, are partly inside and partly outside the system.

The table (right) shows trends in Swedish emissions between 2005 and 2011 and projections for 2020 and 2030, broken down into emissions covered and not covered by the EU ETS, as well as emission trends for some of the sectors outside the scheme. The figures reflect the scope of the EU ETS for the period 2013–20 (Government Offices of Sweden 2013).

Emissions inside and outside the EU Emissions Trading System (scope for period 2013–2020)

($Mt CO_2eq$)	2005	2008	2009	2010	2011	2020	2030
Total emissions	**67.27**	**63.41**	**59.34**	**65.49**	**61.45**	**59.16**	**57.33**
EU ETS	**24.31**	**23.17**	**20.25**	**25.70**	**22.76**	**23.78**	**23.66**
Power and heat generation	4.99	4.44	5.76	7.61	5.41	4.52	4.31
Industry	18.66	18.14	13.99	17.61	16.82	18.63	18.76
Domestic aviation	0.66	0.59	0.49	0.48	0.53	0.62	0.59
Non-EU ETS	**42.96**	**40.23**	**39.09**	**39.78**	**38.69**	**35.38**	**33.67**
Transport (incl. military)	20.76	20.07	19.64	19.82	19.32	18.44	18.00
Agriculture	7.95	7.91	7.68	7.79	7.77	7.28	7.23
Mobile machinery, incl. fisheries	3.63	3.90	3.94	4.01	4.12	3.65	3.48
Industry and power and heat generation	3.49	3.06	2.74	3.11	2.86	2.79	2.69
Homes and commercial/ institutional premises	3.56	2.10	2.01	2.08	1.78	1.43	0.93
Landfills and wastewater treatment plants	2.43	2.00	1.89	1.80	1.71	1.06	0.77
Fluorinated greenhouse gases	0.83	0.90	0.92	0.89	0.85	0.45	0.29
Solvents	0.30	0.29	0.27	0.29	0.29	0.28	0.28

energy by 2020 also goes somewhat further than Sweden's corresponding commitment under EU burden sharing.

To meet these energy policy goals, action plans have been drawn up for greater energy efficiency and for the promotion of renewable energy (see Boxes 4.2 and 4.3). These plans have also been prepared in order to show how Sweden intends to fulfil its commitments under the EU's Renewable Energy and Energy Services Directives. The Government has set up an inquiry concerning a fossil-independent vehicle fleet. The Bills proposing *An Integrated Climate and Energy Policy* also called for a broad analysis to be made of future removals and emissions of greenhouse gases from forestry and of the potential to increase the uptake of carbon dioxide. In addition to policy on climate, renewable energy and energy efficiency, the Bills set out policy for the areas of fossil energy, efficient energy markets, research and development, and nuclear power.

In summer 2011, the Government commissioned the Swedish Environmental Protection Agency to undertake a background analysis for a Swedish 'roadmap', exploring how the vision for 2050 can be achieved. The Agency's analysis was presented in December 2012 and is now being considered in the Government Offices.

Riksdag decisions of key significance for Swedish climate policy are presented in Box 4.4.

4.1.2 Monitoring

Objectives and policy instruments are developed on an ongoing basis, and further changes to instruments may need to be introduced and monitored, based on understanding of climate change and the response options available. Monitoring takes place at both the EU and the national level.

Under the EU's monitoring mechanism (Regulation

(EU) No 525/2013), Sweden reports every two years on policies and measures implemented and planned to achieve the climate target for 2020. At a national level, based partly on commitments under the Kyoto Protocol, regular evaluations have been performed of the country's climate policy. The first was a 'checkpoint' review started in 2004 (leading to a climate policy decision in 2006), and the second was initiated in 2007 (resulting in the 2009 climate policy decision). To analyse progress towards the objectives, as well as the current state of knowledge, a further checkpoint review is to be undertaken in 2015. This will not cover the fundamental direction of policy, but could result in adjustments to policy instruments and measures.

4.1.3 Institutional arrangements

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 the UNFCCC and the EU. Its role thus includes ensuring that new statistics are produced annually on emission trends in the country, and that projections and reports on policies and measures forming part of Sweden's climate strategy are prepared every two years. This work is done in collaboration with the responsible sectoral authorities. The Swedish Energy Agency has a broad sectoral remit covering the supply and use of energy in society and is responsible, among other things, for the action plans being drawn up to achieve further improvements in energy efficiency and increase the use of renewable energy, as well as for Sweden's work on flexible mechanisms. The Swedish International Development Cooperation Agency (Sida), Swedish Transport Administration, Swedish Transport Agency, Swedish Forest Agency, Swedish Board of Agriculture and Swedish National Board of Housing, Building and Planning also have key roles in following up and developing the country's climate strategy. No specific legislation or special administrative procedures have been introduced to implement the Kyoto Protocol. The existing structure of central government administration and government inquiries has proved effective also for the purposes of fulfilling Sweden's commitments under the Protocol.

4.1.4 Regional and local action on climate change

Since 1998, Sweden's county administrative boards (CABs) have been tasked with applying the national environmental quality objectives at a regional level. All the country's CABs have adopted regional climate objectives. Since 2005 their role has also included developing regional action programmes to achieve the

Box 4.2 Sweden's renewables target for 2020

The EU has adopted a mandatory target requiring a 20% share of energy from renewable sources in overall energy consumption by 2020. Responsibility for meeting the target has been divided among the member states. Based on the burden sharing agreed, Sweden's renewable energy share in 2020 is to be 49%. The Riksdag has decided that, by that year, renewable sources are to provide at least 50% of total energy consumed. The share of renewable energy in the transport sector, meanwhile, is to be at least 10%. According to Sweden's national action plan for the promotion of renewable energy (Government Offices of Sweden 2010), these goals are to be achieved by the use of general policy instruments, investments in research, and targeted initiatives to support, among other things, the development and market introduction of pre-commercial technologies. Progress in relation to the EU target is to be reported every two years (Directive 2009/28/EC). A checkpoint review for the national target will take place in 2015.

Box 4.3 Sweden's energy efficiency target for 2020

The EU has adopted a target of a 20% improvement in energy efficiency by 2020. This target has not been broken down among the individual member states. Sweden has chosen to express its national target for improved energy efficiency by 2020 as a 20% reduction in energy intensity between 2008 and 2020, which means that the energy supplied per unit of GDP at constant prices is to decrease over that period. This target can be met by measures to use energy more efficiently, but also by continued faster growth in less energy-intensive industrial sectors, compared with energy-intensive industries. In addition, under the EU Energy Services Directive (2006/32/EC), Sweden has adopted indicative energy savings targets for 2010 and 2016. These call for savings in the end use of energy, amounting on average to 6.5% (by 2010) and 9% (by 2016) of average energy use over the period 2001–05. The targets are accompanied by an action plan, last updated in 2011, setting out the measures Sweden intends to introduce to attain them (Government Offices of Sweden 2011). The Government Bill *An Integrated Energy and Climate Policy – Energy* (Govt. Bill 2008/09:163) presented a five-year energy efficiency programme for 2010–14. Funding of SEK 300m a year over this period will be provided for the programme, which includes:

- Increased support for local and regional information and advice initiatives
- Support for technology procurement and market introduction
- Grants for energy surveys of small and medium-sized enterprises (SMEs).

A new Energy Efficiency Directive (2012/27/EU) came into force on 4 December 2012, replacing the Energy Services Directive and the Cogeneration Directive (2004/8/EC). It is to be implemented in Swedish legislation by 5 June 2014. Earlier the same year, a national energy efficiency action plan and a national strategy for the renovation of buildings are to be submitted to the European Commission. The directive requires each member state to take action to achieve annual energy savings of 1.5% of annual energy sales to final customers from 2014 to 2020 inclusive.

Box 4.4 Riksdag decisions of significance for Swedish climate policy

- In 1988, Sweden's first climate objective was adopted. It covered carbon dioxide only and called for emissions to be stabilised at 'present-day levels'.
- In 1991, the 1988 objective was extended to include all greenhouse gases and all sectors.
- In 1993 a national climate strategy was adopted in line with the UN Framework Convention on Climate Change (UNFCCC) objective of stabilising emissions in developed countries. The new national objective called for carbon dioxide emissions from fossil fuels to be stabilised at 1990 levels by 2000.
- The energy policy guidelines adopted by the Riksdag in 1997 included a strategy to reduce the climate impact of energy use and energy production.
- As part of its 1998 transport policy decision, the Riksdag adopted the goal of stabilising carbon dioxide emissions from transport at 1990 levels by 2010.
- In 1999 the Riksdag decided to introduce a system of 15 environmental quality objectives, including one relating to the greenhouse effect: the environmental objective *Reduced Climate Impact*.
- In 2002 a Government Bill entitled *Sweden's Climate Strategy* was passed, including climate goals for 2010 and 2050.
- The same year, the Riksdag decided to further develop the system of environmental quality objectives, among other things regarding the responsibilities of different stakeholders for attaining the objectives.
- The 2002 energy policy decision included a climate strategy related to that area.
- A climate policy decision in 2006 evaluated and retained the national target for 2010.
- In 2009 Government Bills proposing *An Integrated Climate and Energy Policy* were passed. They included climate targets, targets for an increased share of renewable energy and improved energy efficiency by 2020, a vision for 2050, and a new interpretation of the overall wording of the climate objective.
- The Government Bills on *An Integrated Climate and Energy Policy* also set out policy for the areas of fossil energy, efficient energy markets, and research and development. The Riksdag has since approved, for example, Govt. Bill 2009/10:133, *A Higher Target and Further Development of the Electricity Certificates System*; Govt. Bill 2010/11:155, *A New Electricity Certificates Act – Simplified Rules and a Single Electricity Certificates Market*; Govt. Bill 2010/11:153, *Strengthening the Role of the Consumer for a Developed Electricity Market and Sustainable Energy System*; Govt. Bill 2010/11:70, *Third Internal Energy Market Package for Electricity and Natural Gas*; Govt. Bill 2011/12:98, *Hourly Metering for Active Electricity Consumers*; Govt. Bill 2012/13:70, *Consideration of Network Concessions*; and Govt. Bill 2012/13:21, *Research and Innovation for a Sustainable Energy System*.
- The Government Bills proposing *An Integrated Climate and Energy Policy* also set out policy on nuclear power. The Riksdag subsequently passed Govt. Bill 2009/10:172, *Nuclear Power – Opening the Way to a Generation Change*, and Govt. Bill 2009/10:173, *Nuclear Power – Increased Liability*. These decisions repealed the Nuclear Phase-Out Act and made it possible to replace permanently closed reactors with new ones on the same site, as well as introducing unlimited liability for power producers for damage arising from nuclear accidents.

environmental quality objectives. In addition, since 2008 they have been entrusted with strategic coordination and leadership of regional efforts to implement Government policies for a transition to renewable energy and reduced impact on climate. CABs develop and implement regional action plans in collaboration with other stakeholders. They support the work of the business sector and municipalities in the area of climate and energy. By 2012, according to a status report (Swedish Energy Agency 2012a), CABs had come a long way in developing strategies and all of them had started to put measures in place.

In 2010, to further develop regional action on climate and energy, the Government designated three pilot counties for green development: Dalarna, Skåne and Norrbotten. The aim was that, by testing tools and policy instruments for a green transition in these counties, it would be possible to develop good practice examples that could serve as a stimulus to regional climate and energy efforts and promote a swifter transition.

There are also regional energy offices, which initiate and participate in a wide range of projects relating to energy efficiency and renewable energy sources, with funding from the Swedish Energy Agency, the EU, CABs, regional development councils and other organisations.

At the municipal level, a wide range of action is being taken on a voluntary basis. This assumes different forms, including climate strategies to reduce greenhouse gas emissions. In 2010, an evaluation was carried out of existing support for local authorities' climate strategy efforts (Swedish Environmental Protection Agency 2010). At that point, 88% of municipalities replying, or 163 in all, had already adopted a climate strategy, or intended to do so shortly. Work on climate strategies had resulted in concrete measures in around three-quarters of the municipalities. The evaluation also showed that both basic conditions and the options available differed between local authorities. According to a key figures report (Swedish Association of Local Authorities and Regions 2012), municipalities participating in a central government energy efficiency support scheme showed, among other things, a greatly increased share of renewable fuel use for public transport and some reduction in energy use in local authority-owned premises and homes.

4.2 Policies and measures in Sweden's climate strategy and their effects

4.2.1 Background

Sweden has introduced a range of policies and measures directly or indirectly affecting greenhouse gas emissions. The emphasis in the country's climate strategy is on the use of general economic instruments, but in many cases these are supplemented with targeted measures, for example to support the development and market introduction of technology and eliminate barrier effects. Many instruments which interact with carbon dioxide tax and emissions trading have also been adopted to achieve other policy goals than the climate objective, such as energy policy objectives.

Since the early 1990s, two key instruments in reducing Swedish emissions have been the energy and carbon dioxide taxes. These taxes have been supplemented with other instruments, however, such as technology procurement, information, a differentiated annual vehicle tax and investment grants. Legislation, for example involving prohibitions and relating to planning, also plays a part in curbing emissions, primarily in the waste sector. In recent years, EU-wide policy instruments, in particular the Emissions Trading System (EU ETS), have assumed growing importance in Sweden.

At the same time, the design of spatial planning and other instruments long established in Sweden has also very much defined the framework for the developments of recent decades. Of particular importance are earlier decades' investments in an expansion of district heating networks, public transport systems and carbon-free production of electricity.

Given the large number of policies and measures, many of them introduced to achieve other goals as well as those relating to climate, it can be difficult, after the event, to evaluate the exact progress made towards the objectives. And because several instruments interact, it is also hard to distinguish the effect of any one of them from those of the others. Furthermore, picking out the effects of policy instruments from the impacts of other, external changes is often complicated. This is particularly clear as regards developments over the past decade. During this period, several instruments of significance for the climate strategy have been introduced or tightened up in Sweden, in parallel with a sharp rise in energy prices. A solid conclusion, though, is that energy and carbon dioxide taxes have been key instruments in achieving policy objectives in the area of energy and climate.

Yet another difficulty in evaluating policies and measures in Sweden is that instruments which reduce electricity consumption or increase the production of carbon-free electricity have only a limited impact on carbon dioxide emissions inside Sweden's borders, owing to the fact that the electricity market is Nordic/north European and, moreover, has been covered by the EU ETS since 2005.

It should also be noted that, even before 1990, there were instruments in the Swedish energy sector with a similar steering effect to those used after 1990, in that incentives were created early on for the introduction of bioenergy and an expansion of district heating. For the energy supply sector and the residential and commercial/institutional sector, therefore, it may be difficult to distinguish the additional effects of policy instruments introduced in Sweden after 1990 from the effects that might otherwise have arisen if instruments had not been tightened up.

Fig. 4.1 illustrates an overall assessment of the impact of economic instruments affecting Sweden's stationary energy system. Forming the basis for the results is the MARKAL-NORDIC energy system model, in which a scenario based on policy instruments in place in 1990 has been compared with one

Table 4.1 **Existing policies and measures of significance for Sweden's climate strategy. EU instruments are marked in bold.**

Cross-sectoral	Energy supply	Industry	Transport	Residential	Agriculture	Waste
• **Emissions trading** • Energy and carbon dioxide taxes • Environmental Code • Planning and Building Act • Research and development	• **Emissions trading** • Energy and carbon dioxide taxes • Electricity certificates • Special initiatives in support of wind and solar power	• **Emissions trading** • Energy and carbon dioxide taxes • **F-gas Regulation**	• **CO_2 standards for new vehicles** • Energy and carbon dioxide taxes • Tax relief on transport biofuels/quota obligation • CO_2-based annual vehicle tax • Incentives for green vehicles • Definition of green vehicles • Car benefit taxation • Infrastructure planning	• **Energy performance certificates** • Energy and carbon dioxide taxes • **Ecodesign Directive and energy labelling** • Building regulations • Energy advice • Technology procurement	• **Rural Development Programme** • Energy and carbon dioxide taxes • Support for biogas • Advice	• **Bans on landfill disposal** • Methane recovery • Recycling • Producer responsibility • Municipal waste plans

Source: Government Offices of Sweden 2013

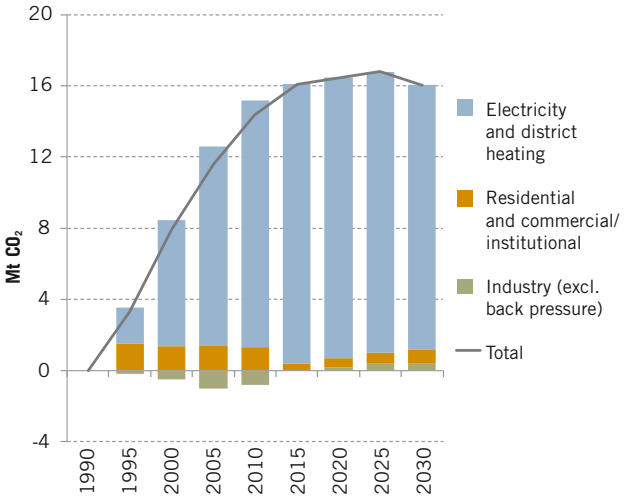


Figure 4.1 **Difference in carbon dioxide emissions between a scenario based on 1990 policy instruments and actual development of policy instruments (Profu 2013).**

reflecting the actual development of instruments (see Box 4.5). The different sectors are described in more detail in the relevant sections of this chapter.

4.2.2 Cross-sectoral instruments

Energy and carbon dioxide taxes

The Swedish system of energy taxation is based on a combination of a carbon dioxide tax, an energy tax on fuel, a tax on thermal capacity on nuclear power and a consumption tax on electricity. Taxes on energy have existed for a long time. A tax on petrol and diesel was introduced as early as the 1920s, while heating fuels and electricity have been taxed since the 1950s. An energy tax is levied on fossil fuels, based in the case of heating fuels on their energy content. In 2013 the energy tax on natural gas, coal and fuel oil was the equivalent of SEK 0.082/kWh. The energy tax on petrol (environmental class 1) corresponds to SEK 0.346/kWh and that on diesel (environmental class 1) to SEK 0.177/kWh (Swedish Tax Agency 2013a). The carbon dioxide tax was introduced in 1991 as part of a broader tax reform and has been raised in stages over the years, from SEK 0.25/kg CO_2 to SEK 1.08/kg CO_2 in 2012 (Swedish Environmental Protection Agency 2012a). It is charged at a rate that is expressed per unit of weight or volume of fuel, calculated on the basis of the fuel's fossil carbon content. This means that biofuels are not taxed. The carbon dioxide tax base can be summed up as comprising the fossil fuels covered by the EU's Energy Taxation Directive, which means that the tax does not apply to peat. Up to 2015, some relief from carbon dioxide tax will be granted for natural gas and liquefied petroleum gas (LPG) used in motor vehicles, ships and aircraft (Swedish Tax Agency 2013a). As from 2015, though, the same general level of carbon dioxide tax will apply in calculating the rates of this tax for all fossil fuels.

As from 1 January 2013, combined heat and power (CHP) production covered by the EU ETS is completely exempt from carbon dioxide tax, but is liable to an energy tax set at 30% of the standard rate (Swedish Tax Agency 2013b). The same rules have applied since 1 January 2011 to industries included in the trading system and to the generation of heat used in industrial manufacturing within the system (Swedish Tax Agency 2013c). The changes are designed to avoid overlap in the steering provided by the trading system and the carbon dioxide tax, thereby helping to make both instruments more cost-effective.

Manufacturing industries outside the EU ETS, as well as agriculture, forestry and pisciculture, pay 30% of the standard rates of energy and carbon dioxide tax (Swedish Tax Agency 2013c). Generation of heat in an installation included in the EU ETS, not used in industrial manufacturing, is subject to carbon dioxide tax at 94% of the standard rate (Swedish Tax Agency 2013d). In addition, there are special rules on further reductions of carbon dioxide tax for some energy-intensive industries and for diesel used in agriculture, forestry and pisciculture.

Table 4.2 **Energy and carbon dioxide taxes as per 1 January 2013, excl. VAT.**

Heating fuels[1]	Energy tax	CO_2 tax	Total tax	Tax SEK/kWh
Fuel oil, env. class 1, SEK/m³	817	3 093	3 910	**0.393**
Coal, SEK/tonne	621	2 691	3 312	**0.438**
LPG, SEK/tonne	1 050	3 254	4 304	**0.337**
Natural gas, SEK/1000 m³	903	2 316	3 219	**0.293**
Crude tall oil, SEK/m³	3 910	–	3 910	**0.399**
Transport fuels				
Petrol, unleaded, env. class 1, SEK/l	3.13	2.50	5.63	**0.623**
Diesel, env. class 1, SEK/l	1.76	3.09	4.86	**0.487**
Natural gas/methane, SEK/m³	–	1.853	1.85	**0.168**
LPG, SEK/kg	–	2.603	2.60	**0.204**
Electricity consumption				
Electricity, N Sweden, SEK/kWh	0.194	–	0.194	**0.194**
Electricity, rest of Sweden, SEK/kWh	0.293	–	0.293	**0.293**
Industry				
Electricity consumption, industrial processes and agriculture, forestry and pisciculture, SEK/kWh	0.005		0.005	**0.005**

Source: Swedish Tax Agency, collated by Swedish Energy Agency

[1] Some tax relief is available on the use of fuels in manufacturing industries, agriculture, forestry and pisciculture, and CHP and district heating production.

With effect from 1 February 2013, sustainable biofuels in petrol and diesel, in blends of up to 5% by volume, are exempt from the whole of the carbon dioxide tax and most of the energy tax (89% for biofuels in petrol and 84% for biofuels in diesel). E85 and other sustainable high-blend biofuels and biofuels with no fossil content are entirely exempt from carbon dioxide and energy tax on their biomass-based component.

Tax is payable on consumption of electricity, at a rate that depends on where in the country and how the power is used. For electricity used in manufacturing processes or in agriculture, forestry or pisciculture, anywhere in the country, the rate applied in 2013 is SEK 0.005/kWh. The tax on electricity consumed by households and service-sector enterprises is SEK 0.194/kWh in northern Sweden and SEK 0.293/kWh in the rest of the country (Swedish Tax Agency 2013a).

Effects of taxes introduced

Instruments to promote lower emissions from district heating production and residential heating began to be introduced before 1990, with biofuels, for example, already exempt from energy tax at that time. Analyses using the MARKAL-NORDIC modelling tool (see Box 4.5) show that the energy and carbon dioxide taxes have primarily helped to reduce emissions from district heating and from the residential and commercial/institutional sector. For homes and premises, both tax changes and oil price increases since the 1990s have meant that it has paid to switch from oil and electricity as sources of heating (Profu 2013). An analysis for each sector, based on MARKAL-NORDIC, can be found in the relevant sections of this chapter.

EU Emissions Trading System

The EU Emissions Trading System (EU ETS) was launched on 1 January 2005. The system puts a limit, or cap, on emissions across the EU from the sectors covered (the scope of the scheme is described in Box 4.1). The first trading period was from 2005 to 2007 and the second coincided with the first commitment period of the Kyoto Protocol, 2008–12. The EU ETS is an important part of the EU's strategy to reduce emissions within the Union, with a fixed emissions cap that will decrease every year up to 2020. The annual reduction in the cap will continue beyond 2020, but may be revised no later than 2025. The trading system is key to Swedish efforts to help achieve the EU's climate targets for 2020.

Emissions from Swedish installations included in the EU ETS made up around 33% of total greenhouse gas emissions in Sweden over the period 2008–12. Some 80% of these emissions came from industrial plants and 20% from power and district heating installations. The breakdown for Sweden differs appreciably from the average for the EU ETS as a whole, where emissions from energy supply plants are greater (about 60% of the total) than those from industrial installations (roughly 40%). During the first and second trading periods, emission allowances were allocated largely free of charge, under different rules drawn up nationally on the basis of EU-wide criteria. In Sweden, however, no free allocations were made to existing plants in the electricity and district heating sector between 2008 and 2012. Overall, the emissions cap for the period 2008–12 was some 10% lower than the cap for 2005–07.

For the third trading period, from 2013 to 2020, several changes have been made to the scheme. From 2013, the emissions cap is to decrease in a linear fashion by 1.74% per year, starting from the average annual level of the cap during the second trading period. This will result in a reduction of 21% within the EU ETS by 2020, compared with 2005. More sectors have been included, and some 50% of emission allowances are to be auctioned, with a gradual phase-out of free allocations over the period. The rules on the proportion allocated

Box 4.5

To assess the effects of economic instruments on Sweden's stationary energy system, we have used the results of estimates made with the MARKAL-NORDIC energy system model (Profu 2013). The 'stationary energy system' comprises production of electricity, district heating and process steam, together with final energy consumption in the residential sector, services and industry. The estimates covered two cases:

1. Actual development of policy instruments from 1990 to 2013. Current instruments are subsequently assumed to remain in use up to and including 2030.
2. A '1990 scenario', using the policy instruments in place in 1990 throughout the period studied (1990–2030). In other respects, this case is identical to (1).

Some methodological development has taken place in the modelling of policy instruments in the residential and services sector compared with the last National Communication, in that the cost of capital has been raised from 7% to 12%, to better reflect the 'inertia' built into the energy transition. Estimates have also been made of how large an improvement in energy efficiency in the sector can be linked to the instruments introduced (Profu 2011).

Modelling attempts to capture the most important variables that could conceivably influence the outcome we are interested in studying; all modelling therefore necessarily involves a simplification of reality and hence some uncertainty.

for free have been harmonised across the EU and are based on specific emissions per unit of production as an allocation methodology.

How large a share of allowances will be allocated free of charge in any given member state will depend on a number of factors, including production levels and the number of industries exposed to carbon leakage. In Sweden, the district heating and pulp and paper sectors, in particular, will receive a larger free allocation than in earlier trading periods, owing to the harmonised allocation rules and low specific emissions, while other sectors will receive a smaller allocation.

Impact on carbon dioxide emissions

The effect of the EU ETS on global emissions is equal to the difference between the level set for the cap and the baseline trajectory, i.e. the emissions trend which it is assumed would otherwise have occurred. The effect on emissions in an individual country will depend on a number of factors: alongside the price of emission allowances, these include national circumstances such as the existence of additional policy instruments, the costs of measures and the reduction potential. Since the trading system limits member states' aggregate emissions at EU level, national emission levels and the breakdown between countries are of secondary interest. The economic situation, variations in weather between years and trends in energy prices also have a major impact on emission trends, both short- and long-term. Allowing for the inclusion of more combustion installations in the EU ETS in 2008, average emissions from Swedish plants in the system in 2008–12 fell by about 10% compared with the average for 2005–07 (Swedish Environmental Protection Agency estimates, 2013). In interview surveys, over 50% of Swedish operators replied that the scheme had influenced their companies in such a way that they had reduced their carbon dioxide emissions (Swedish Energy Agency 2010a).

Measures have primarily been introduced at installations in the energy supply and pulp and paper industries. Action taken includes increasing the capacity of biofuel plants, investments in waste-fired boilers (burning industrial waste), measures to improve combustion efficiency, increased use of district heating, and conversion from oil- to biofuel-fired boilers. At the same time, companies have implemented action programmes to reduce overall energy use. It should be noted that other policy instruments, too, may be behind this trend. Energy efficiency action programmes are also being implemented as part of the Programme for Energy Efficiency in Energy-Intensive Industry (PFE, see section 4.2.5). And the electricity certificates system (section 4.2.3) has provided an incentive to increase biofuel-based CHP production.

Modelling of the aggregate effects of economic instruments in the Swedish energy sector (see Box 4.5) shows that the electricity certificates system, the EU ETS and the energy and carbon dioxide taxes are expected to be the key instruments for limiting emissions from the energy supply sector in the years to come. For industry, the trading system is judged to be the most important climate instrument. The price of emission allowances and assumptions regarding future prices will be of significance for the impact of this instrument. (Profu 2013.)

The Environmental Code and planning legislation

The Swedish Environmental Code (SFS 1998:808), whose overall objective is to promote sustainable development, brings together the principal legislative provisions in the area of the environment. In applying it, the environmental quality objectives are to serve as a guide. The Code includes general rules of consideration that are to be observed in connection with all activities and measures. Large-scale environmentally hazardous activities are subject to a permit requirement. Anyone seeking a permit to establish, operate or alter an environmentally hazardous activity has to prepare an environmental impact statement (EIS), as provided in Chapter 6 of the Code. The purpose of an EIS is to identify and describe the direct and indirect impacts which the planned activity or measure could have, for example on climate.

Greenhouse gas emissions are one of the factors considered as part of the permitting procedure under the Environmental Code. As from 2005, however, the authorities may no longer impose limits on carbon dioxide emissions or the use of fossil fuels by installations covered by the EU ETS.

Measures in the area of spatial planning chiefly affect emission trends in the longer term, and can be of great significance in that perspective. Physical planning measures are primarily governed by the Planning and Building Act (PBA). Many such measures, as well as major infrastructure projects regulated by the Roads Act and the Railway Construction Act, are also subject to some of the provisions of the Environmental Code. Growing attention has been paid to the impact of development of the built environment on energy and transport demand, and to the need for greater coordination of infrastructure, transport and settlement planning (cf. SOU 2008:110, p. 29; Govt. Bill 2008/09:162, pp. 130 f.; Govt. Bill 2011/12:118, pp. 89 ff.; Swedish National Board of Housing, Building and Planning 2009).

The Government Bill proposing a new Planning and Building Act (Ministry of the Environment 2009) also emphasised the important role municipal spatial planning has to play in addressing climate change, and the need for physical planning to be better coordinated with infrastructure planning. The earlier PBA did not include an express requirement to take climate into account, other than its provision that planning and siting decisions were to be taken with due consideration for the risks of accidents, flooding and erosion. The new Act (SFS 2010:900), which came into force on 2 May 2011, introduced a new requirement to take account of environmental and climate aspects in planning. The purpose of this addition, according to the Bill, is to promote good environmental conditions both by means of adaptation to climate change and by reducing human impact on climate and thereby helping to achieve the environmental quality objective *Reduced Climate Impact*. The new PBA also made it mandatory to consider inter-municipal and regional circumstances in planning. Here, too, a link can be found between transport issues and physical planning.

In the Infrastructure Bill (Ministry of Enterprise, Energy and Communications 2012a), the assessment was made that the development of an economically efficient, sustainable transport system needed to be coordinated to a greater extent with land use, housing supply and other public planning, as well as with initiatives in other areas of society, such as growth in the business sector, the labour market etc. This has also been a basic premise in an exercise, commissioned by the Government (Ministry of Enterprise, Energy and Communications 2012b), to prepare national and regional cross-modal plans for development of the transport system over the period 2014–25. The transport system and associated infrastructure are to be adapted to the requirements, economic, environmental and social, of long-term sustainable development. Proposals for a new national plan for Sweden's transport system for 2014–25, drawn up for the Government by the Swedish Transport Administration, state among other things that the Administration will participate in spatial planning in order to integrate planning of the transport system and the siting of housing, industry and services, and that this work is fundamental to sustainable accessibility in attractive urban areas and regions. It is also noted that early collaboration with other stakeholders paves the way for long-term efficiency in the use of resources; this may range from influencing the strategic direction of spatial planning in regional development plans and regional public transport provision programmes, for example, to involvement in municipal comprehensive plans and transport strategies (Swedish Transport Administration 2012a).

In their appropriation directions and conditions for 2013, county administrative boards, certain county councils and bodies for inter-municipal cooperation, which are responsible for regional development issues in their counties, have been tasked with reporting on and assessing the coordination of and mutual links between infrastructure and transport planning, growth programmes at the county level, and local authorities' comprehensive planning.

The Government has also appointed a cross-party committee of inquiry whose terms of reference include an evaluation of the regional planning system under Chapter 7 of the PBA (2010:900). The committee will examine how that system relates, on the one hand, to the systems of regional development strategies and county transport infrastructure plans, provided for in the County Coordinating Bodies Act (2002:34) and the Act on Regional Development Responsibility in Certain Counties (2010:630), and on the other, to regional transport provision programmes under the Public Transport Act (2010:1065).

Cross-sectoral investment grants

For the period 2009–12, the Government set up a Delegation for Sustainable Cities. Its purpose was to promote the development of attractive, socially and economically sustainable urban environments with a reduced impact on climate and the environment. The Delegation brought together central government, the business community and local authorities in a national platform for sustainable urban development. It also allocated financial support to enterprises and municipalities. The projects supported are intended to serve as models of sustainable urban planning and applied environmental technology.

Grants were available to all types of stakeholders, and from 2009 to 2012 a total of SEK 357m of state funding was awarded for almost a hundred investment and planning projects. All the investment projects are to be completed by 2014, and the last planning projects by 2016. The lessons learnt from the projects supported have been actively disseminated, nationally and internationally.

Under the Ordinance governing the scheme, support was primarily to be given for measures which, overall and in the long term, were judged to have the best prospects of delivering the largest reduction of greenhouse gas emissions in relation to the funding provided. The Delegation therefore paid particular attention to climate effects when assessing applications.

The National Board of Housing, Building and Planning is conducting an independent review of the support provided through the Delegation for Sustainable Cities.

Climate change information

Up to 2010, the Swedish Environmental Protection Agency received specific funding from the Government to provide information on climate change. Its efforts in this area focused on disseminating and making accessible facts about the climate issue, and especially about the associated problems and solutions, and on sharing Swedish experience internationally.

Both the Environmental Protection Agency and the Swedish Meteorological and Hydrological Institute (SMHI) have an ongoing responsibility for information, entrusted to them by the Government. SMHI has a specific remit to collate and disseminate information on climate change.

Between 2002 and 2009, the Environmental Protection Agency carried out surveys of public awareness of and attitudes to climate change. To sum up the results of the 2009 survey, 100% of Swedes are spontaneously aware or have heard of climate change. They demonstrate a very high level of readiness to reduce their own greenhouse gas emissions, and a growing number have done something in their everyday lives to reduce their climate impact (Swedish Environmental Protection Agency 2009).

Information on possible measures in different sectors is disseminated through a number of channels. Several energy efficiency campaigns have been run at a national level, but more continuous information is provided locally and regionally, through the country's climate and energy advisers and regional energy offices. They deal free of charge with enquiries concerning heating, energy costs, energy efficiency, transport, climate, and government grants in the area of energy.

The Swedish Energy Agency conducts an annual review of energy and climate advice services, assessing public awareness of these services and their impact in terms of kilowatt-hours saved. The assessment of their effect is regarded as uncertain, however, partly because the energy savings achieved cannot be assumed to be entirely the result of contact with the advice services, but may also be attributable to other policy instruments and factors. (Swedish Energy Agency 2013a.)

In agriculture and forestry, advice to landowners and managers plays a major role. Over the period 2009–11, the Swedish Forest Agency received special funding to inform forest owners and forest officers about the climate issue. Climate change information and advice have been provided at dedicated seminars or information days in various parts of the country. The Agency's website (Swedish Forest Agency 2013d) and the magazine *Skogseko* ('Forest Echo') have also been important channels.

Farming has a wide range of impacts on the environment. The Swedish Board of Agriculture maintains an informative website covering both the global aspects of climate change and issues relating to biodiversity and the individual farmer.

A more detailed account of information on climate change will be found in Chapter 9.

Research and development

Public investments in climate-related research and development are aimed at creating better conditions for achieving the substantial emission reductions that are required in the longer term.

Swedish climate-related research covers a broad spectrum, from natural sciences to humanities, but with an emphasis on technical and scientific R&D.

The Riksdag decided in 2012 to extend and progressively strengthen funding for energy research (Govt. Bill 2012/13:21), which focuses to a great extent on reducing carbon dioxide emissions. It set a level of some SEK 1.3 billion for the years 2013–15 and around SEK 1.4bn from 2016 onwards. The overarching aim is that the work undertaken should contribute to realising existing energy and climate objectives, long-term energy and climate policy, and energy-related environmental policy goals. Energy research is a central and integral part of energy policy, offering synergies with other policy instruments in that area.

A link exists between innovation initiatives and economic instruments, in that the latter can facilitate market introduction of the new technology, as with the green vehicle rebate, for example.

An audit of climate research in Sweden by the Swedish National Audit Office (2012) estimated that funding had risen to almost SEK 2bn in 2010, or around 7% of all central government support for research. The majority of these funds went to energy research. The study shows that Swedish climate research generates an internationally high proportion of academic articles, which are also frequently cited. In terms of patent applications, Sweden tops the statistics for the Nordic region. However, it is difficult to assess whether it is the increase in funding that is behind this growth in results.

4.2.3 Production of electricity and district heating

In 2011, greenhouse gas emissions from the production of electricity and district heating (including residual gases from industry) totalled 8.3 Mt CO_2 eq, a slight increase on 1990 (Swedish Environmental Protection Agency 2013a). Emissions from this sector, however, vary with temperature and precipitation. In a wet year they are generally lower, while in dry years they increase. Temperature affects heating requirements, with

greater demand for both electricity and district heating during cold years. Emissions from the sector have therefore fluctuated from year to year, with higher levels in years with cold winters, such as 2011.

Production of district heating rose from 41 TWh in 1990 to 60.5 TWh in 2011 (Swedish Energy Agency 2012b). At the same time, emissions from this source remained relatively stable, as the expansion was largely achieved by increased use of biofuels. The use of oil and coal, meanwhile, declined. The carbon dioxide tax is judged to be one of the main factors behind this trend. The low emissions from electricity generation are explained by the fact that nuclear and hydropower account for a dominant share of production, at the same time as additional production of electricity in recent years has chiefly come from biomass-fired combined heat and power (CHP) plants and wind power.

Policies and measures in the electricity and district heating sector

In the 1990s, the energy and carbon dioxide taxes were a major factor in the sector's development. The carbon dioxide tax on CHP production within the EU ETS was abolished on 1 January 2013, while heat production in heat-only boilers has continued to be taxed. Since 2000, policy instruments in this sector have increasingly been influenced by the EU's common energy and climate policy, at the same time as new national instruments have been introduced. The system of electricity certificates, established in 2003, is of significance for the development of new renewable electricity generating capacity. Since 2005, most combustion installations for power and heat production have been included in the EU ETS, which represents a key policy instrument for this sector. In addition, the sector is affected by the provisions of the Environmental Code and by support for the technological development and market introduction of wind power.

Electricity certificates system

The system of electricity certificates is a market-based scheme to support the expansion of electricity production from renewable energy sources and peat, introduced in Sweden in 2003. Under the system, electricity generators approved for an allocation of electricity certificates are allocated one certificate for every megawatt-hour (MWh) of renewable electricity produced. These certificates are then sold to electricity users, who are required by law to purchase electricity certificates corresponding to a certain share, or quota, of their consumption. This quota is gradually being increased year by year up to 2020. (Swedish Energy Agency 2012c.) The electricity certificates system is a key instrument in Sweden's action plan to achieve its 2020 target under the EU Renewables Directive.

As from 1 January 2012, Sweden and Norway have a common electricity certificates market. The two countries have now set a joint target of an increase in renewable electricity production of 26.4 TWh between 2012 and 2020. In 2011 and 2012, electricity users were required to buy certificates corresponding to 17.9% of their consumption. Production of renewable electricity under the certificates scheme in 2012 amounted to 21.5 TWh. At the end of that year, 1,411 generating plants were phased out of the certificates system (Swedish Energy Agency 2013b). The background to this is that plants in operation in 2003, when the scheme started, were only allocated certificates up to the end of 2012.

Effects of economic instruments in the electricity and district heating sector

Estimates using the MARKAL-NORDIC modelling tool (see Box 4.5) show that emissions from the electricity and district heating sector (including industrial back-pressure power) could have been almost 14 Mt CO_2 eq higher in 2010 if policy instruments had remained at their 1990 levels (see Table 4.3). The difference in modelled emissions is due above all to significantly greater use of coal in the scenario based on 1990 instruments than in the one based on current levels of instruments.

Since 1990, the production of electricity and district heating has been marked by a very substantial expansion of renewable fuels, and over the same period the influence of policy instruments has increased sharply for the portion of district heat production based on heat-only boilers. For combined heat and power, the pressure from instruments increased up to the beginning of the 21st century and subsequently decreased. The rationale behind the reduced pressure of taxation was to improve market conditions for CHP as a mode of production (Swedish Energy Agency 2003). The carbon dioxide tax on CHP production within the EU ETS was abolished on 1 January 2013, contributing to more cost-effective climate policy management in a European perspective.

According to the modelling results, moreover, the electricity certificates system is an important reason for the clear phase-out of fossil fuels seen in the scenario based on current instruments, in that it provides an incentive for biofuel-based CHP. Electricity production in Sweden qualifying for certificates grew by just over 13 TWh between 2002 and 2011. In the early years, the increase consisted mostly of electricity from biofuels

burnt at existing CHP plants and an expansion of capacity at existing biofuel plants. However, the system also resulted in 1,613 new installations being commissioned between 2003 and 2011, of which 1,344 were wind turbines. Between them, these new installations generated some 8.2 TWh of electricity in 2011 (Swedish Energy Agency 2012c).

Sensitivity analyses of the model's scenarios have shown that the certificates system would correspondingly 'resist' a shift towards fossil-based production if the EU ETS allowance price were to be €10 per tonne in 2030, rather than the €40 per tonne used as a base case. In such a situation, emissions from the sector would rise, but only to a limited extent. A sensitivity analysis involving lower fossil fuel prices points to an expansion of fossil-based generation of power and heat both in a scenario with policy instruments at their current level and in one retaining instruments at their 1990 level. Current policy instrument levels, however, are of great significance in slowing the rise in emissions, and the difference in emission levels between the two scenarios is therefore even larger than in the base case, where fossil fuel prices are higher and themselves help to reduce emissions. In this sensitivity case, too, the electricity certificates system is a major factor, as it helps to make bio-CHP competitive. (Profu 2013.)

Table 4.3 **Estimated aggregate effects of policy instruments introduced since 1990 on emissions from electricity and district heating production in Sweden, compared with a scenario based on 1990 instruments (Mt CO_2 eq per year) (Profu 2013)**

2005	2010	2015	2020	2025	2030
11	14	16	16	16	15

Further initiatives for the electricity sector

As well as from the electricity certificates system, wind power has benefited from a special 'Pilot Projects' scheme in support of technology development and market introduction in offshore and mountain areas. Projects granted support over the period 2003–12 are expected to generate some 1.44 TWh of renewable electricity per year (Swedish Energy Agency 2013c). This initiative ends in 2013.

The *Vindval* ('Wind Choices') programme is a network-oriented initiative aiming to strengthen the planning and permitting processes associated with wind power schemes, including research into effects on the environment, animals and humans. In 2012, the Swedish Energy Agency approved a new concerted commitment of SEK 4.6m for further processing and communication of the programme's results.

Designated areas of national interest for wind utilisation – which have been deemed particularly suitable for the generation of electricity from wind power – cover 2.2% of the area of Sweden and also include areas in the country's economic zone. New designations were decided in December 2013 (Swedish Energy Agency 2013d).

A Riksdag decision of 2009 requires there to be a 'planning frame' for wind power corresponding to 30 TWh by 2020, of which 10 TWh is to be offshore. This frame means that, in the context of spatial planning, conditions are to be created for an expansion of wind power to 30 TWh, but it does not represent a production target (Swedish Energy Agency 2013e). The planning frame replaces the earlier target for wind power development of 10 TWh by 2015. In 2012, just over 7 TWh of wind power was generated in Sweden, ten times as much as in 2003 when the electricity certificates system was introduced (Swedish Energy Agency 2013f).

The Guarantees of Origin of Electricity Act (SFS 2010:601) came into force on 1 December 2010. Its aim is to ensure that final customers are provided with clear information on the origins of the electricity they purchase (Swedish Energy Agency 2013h).

The earlier support scheme for solar heating was discontinued on 31 December 2011. The scheme resulted in additional solar heating corresponding to an annual output of about 20.3 GWh, primarily replacing biofuels and, to a lesser extent, direct-acting electric and district heating (Swedish National Board of Housing, Building and Planning 2012). Following withdrawal of the scheme, it is possible to apply instead for tax relief in the form of a property renovation (ROT) deduction, covering the labour costs of installing solar heating.

Since 2009 there has been a central government scheme to support the installation of solar cells. The installations granted support and built to date are estimated to be capable of producing around 8.4 GWh of renewable electricity a year (Informant 1, Swedish Energy Agency, 2013). The Government has allocated a further SEK 210m for this scheme for 2013–16 (Swedish Energy Agency 2013g).

4.2.4 Residential and commercial/institutional sector

Greenhouse gas emissions from individual heating of homes and commercial and institutional premises (i.e. heating other than district heating) fell dramatically from just under 9 Mt CO_2 eq to around 1.4 Mt CO_2 eq per year between 1990 and 2011 (Swedish Environmental Protection Agency 2013b). Direct

emissions from this sector now make up only around 3% of Sweden's total emissions of greenhouse gases (Swedish Energy Agency 2012f).

Energy use in the sector in 2011 accounted for some 40% of final energy use in Sweden (Swedish Energy Agency 2012e). The use of energy for heating showed a downward trend in the first decade of the 21st century. Use of electricity for domestic equipment and lighting and for common building services, on the other hand, increased (Swedish Energy Agency 2012f).

Policies and measures in the residential and commercial/institutional sector

The energy and carbon dioxide taxes can be regarded as instruments that have significantly contributed to reducing the use of fossil fuels in this sector in recent decades. The aggregate level of taxes on fossil fuel use for heating in the residential and commercial/institutional sector has risen steadily since 1990, making it considerably more expensive to burn these fuels than it would have been if energy taxation had been kept at its 1990 level (Profu 2013). This is shown in Fig. 4.2.

Alongside the carbon dioxide and energy taxes, there are a number of instruments targeted at energy use in homes and commercial and institutional premises. Some of the more important ones are building regulations, energy performance certificates, and the Ecodesign, Energy Labelling and Energy Efficiency Directives. In addition, there are instruments such as technology procurement, network initiatives and information campaigns at the local, regional and national levels.

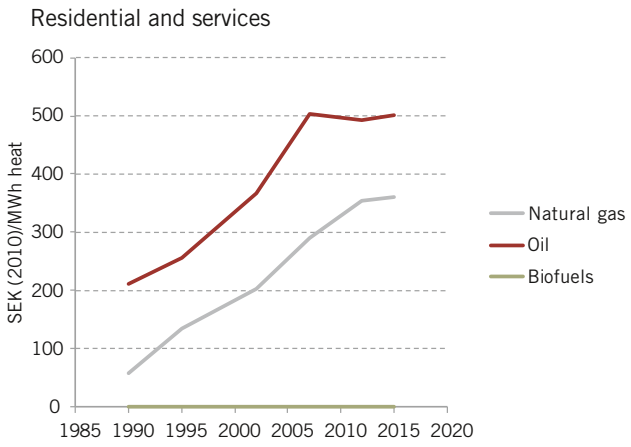


Figure 4.2 **Policy instruments affecting light fuel oil, biofuels and natural gas in the residential and services sector: development between 1990 and 2012, and model assumption for 2015 (constant 2010 prices) (Profu 2013).**

Estimate of aggregate effects of economic instruments in the residential and commercial/institutional sector

Between the early 1990s and the present day, carbon dioxide and energy taxes have helped to phase out oil-based and electric heating. Analysis of model estimates based on MARKAL-NORDIC shows that drivers for a switch to other heating options exist in both the scenario retaining 1990 policy instruments and the one based on current levels of instruments, but that the incentive to replace existing oil-fired heating is greater in the scenario in which taxes have been developed and raised to today's levels (see Fig. 4.3). It is reasonable to assume, moreover, that the reduction in emissions from this sector would have been slower if instruments had not been changed and tightened up since 1990. The proportion of heat pumps is also appreciably higher in the current instruments scenario, owing to higher electricity prices and higher taxes on

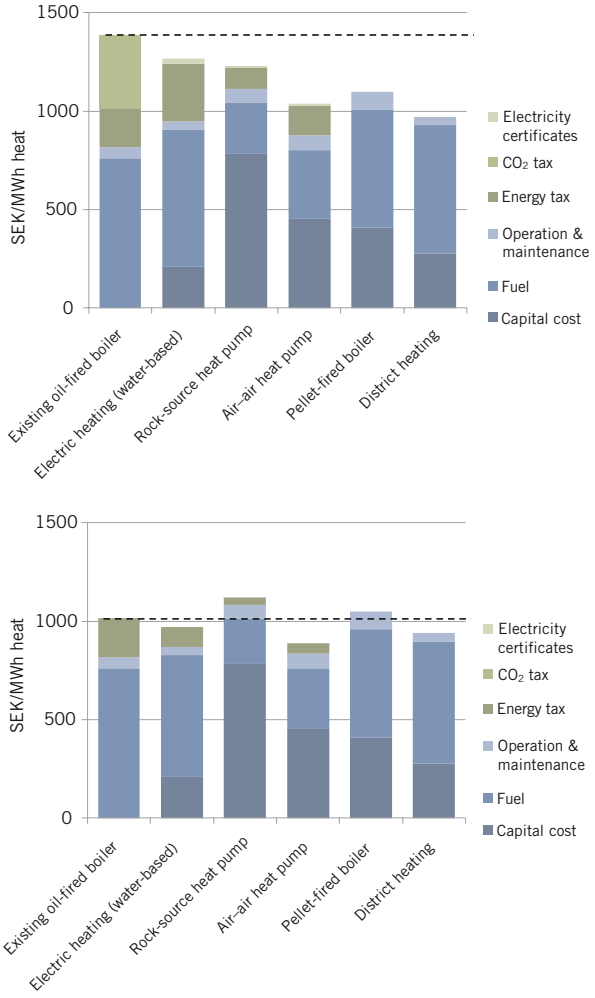


Figure 4.3 **Heat production costs in single-family houses with different heating alternatives, in the scenarios based on current (top diagram) and 1990 policy instrument levels (lower diagram) (Profu 2013).**

electricity, which discourage the use of other forms of electric heating.

By 2030, according to the model's scenarios, fossil-based heating will be phased out altogether in the residential sector with current instruments, whereas there would still have been a certain proportion of fossil fuels left if instruments had remained at 1990 levels (Profu 2013).

Building regulations

The earlier Act on Technical Requirements for Construction Works etc. (SFS 1994:847) was repealed in May 2011 with the introduction of the new Planning and Building Act (PBA). The Building Regulations of the Swedish National Board of Housing, Building and Planning (BBR) contain mandatory provisions and general recommendations to ensure compliance with the PBA, the new Planning and Building Ordinance and other statutes (Swedish National Board of Housing, Building and Planning 2011a). Buildings are to be designed in such a way that energy use is limited by low heat losses, low cooling requirements, and efficient use of heat, cooling and electricity (Swedish National Board of Housing, Building and Planning 2011b). The most recent tightening of the building regulations' energy requirements took effect on 1 January 2012. Since autumn 2013, a review of these requirements has been under way. In addition, the Board of Housing, Building and Planning's general recommendations on energy performance were incorporated in the regulations on 1 January 2012. With this change, alterations and extensions are also covered by the building regulations, although the requirements normally only apply to the altered part of a building (Swedish Energy Agency 2012f).

Energy performance certificates

Directive 2010/31/EU on the energy performance of buildings has been incorporated into Swedish legislation by, among other enactments, the PBA and the Energy Performance Certificates Act (SFS 2006:985), which first took effect in 2006. Owners of multi-dwelling buildings and commercial and institutional premises are now required by law to obtain an energy performance certificate, setting out the energy use of their building and certain parameters regarding the indoor environment. The aim is to promote efficient use of energy and a healthy indoor environment, by ensuring that property owners have a better understanding of what measures would cost-effectively improve the energy performance of their buildings. Since energy performance certificates were introduced, over 430,000 buildings have been registered with the Board of Housing, Building and Planning as holding such certificates (Swedish National Board of Housing, Building and Planning 2013). As from 1 July 2012, the provisions have been amended, one change being that a certificate has to be shown and handed over when a property is sold or rented out.

Ecodesign and energy labelling

The Ecodesign Directive (2009/125/EC) has been transposed into Swedish legislation by the Ecodesign Act (SFS 2008:112). Legally binding ecodesign requirements are drawn up in the form of product-specific EU regulations, which have direct application in the member states. This directive results in energy savings by prohibiting the least energy-efficient products. The range of products covered by it is constantly growing, with requirements introduced, for example, for air–air heat pumps and lighting. Requirements for electric, gas- and oil-fired boilers and for other heat pumps have recently been adopted, but not yet taken effect.

Mandatory energy labelling of certain domestic appliances has existed in the EU since 1995, but in 2011 it assumed a new appearance, with the introduction of energy labelling for televisions and an update of labelling of refrigerators, freezers, dishwashers and washing machines. Sweden has an active programme of market surveillance, involving both supervision of dealers and laboratory tests of products. New products to be energy-labelled in 2013 include air–air heat pumps and LED lamps. The Commission estimates that the ecodesign and energy labelling requirements adopted to date could, by 2020, save 484 TWh of electricity per year across the EU. In addition, there will be savings from boilers and water heaters of 653 TWh of primary energy, comprising electricity, oil and gas (Swedish Energy Agency 2013i). For Sweden, the ecodesign and energy labelling requirements could bring savings of over 30 TWh by 2020 (Informant 2, Swedish Energy Agency, 2013).

Technology procurement and network initiatives

Technology procurement is an instrument designed to initiate a market transition and disseminate new, efficient technology – new products, systems or processes. Network-based procurement of technology is an approach that encompasses the entire decision-making process, from pre-study and purchaser group to specification of requirements and the spread and further development of new, energy-efficient technology. It is being used, for example, in the areas of heating and control, ventilation and lighting (Swedish Energy Agency 2013j). Purchaser groups exist for housing (BeBo), commercial and institutional premises (BeLok) and food distribution (BeLivs). There is also a network

for public sector bodies that rent premises, HyLok (Swedish Energy Agency 2013f). The existing network projects for housing and premises are estimated to have yielded accumulated energy efficiency improvements of 2 and 117 GWh, respectively. The large difference in the measured impacts is mainly due to the types of projects involved and degree of follow-up of network activities (Swedish Energy Agency 2013k).

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

Emissions from industrial combustion in 2011 were around 9.5 Mt CO_2 eq, some 21% lower than in 1990 (12.1 Mt CO_2 eq). The principal reductions have occurred in the paper and pulp industry.

Industrial process emissions in 2011 amounted to approx. 6.7 Mt CO_2 eq, an increase of about 5% on 1990. Process emissions vary widely from one year to another, partly depending on the economic situation.

Policies and measures in the industrial sector

The instruments primarily affecting combustion emissions from industry are the EU Emissions Trading System, energy and carbon dioxide taxes, the electricity certificates system, the Programme for Energy Efficiency in Energy-Intensive Industry (PFE) and the Environmental Code.

Industrial process emissions have come almost entirely within the scope of the EU ETS since its expansion for the third trading period (2013–20). They are regulated above all by the Environmental Code's requirement to use the 'best possible technology'.

Emissions of fluorinated greenhouse gases are also partly governed by an EU regulation and directive covering certain emissions of fluorinated gases.

Estimate of aggregate effects of economic instruments in the industrial sector

According to estimates made using the MARKAL-NORDIC modelling tool, the effect of economic instruments on combustion-related emissions in this sector would have been somewhat greater, or at least as great, if 1990 policy instruments had been retained. The difference in emissions between the 1990 and current instruments scenarios is consistently small.

The estimates suggest that, looking beyond 2020, the effect of current instruments will be greater than if 1990 instruments had been retained, provided that EU ETS allowance prices are considerably higher than at present (€40 in 2030). The differences, though, are very small. If the allowance price were only to rise to €10 by 2030, the effect would be comparable to that of 1990 instruments. Emission reductions could be achieved compared with the 1990 case if the price increases to €40 by 2030, whereas there will be no reduction with a lower price of €10.

The Energy Efficiency Programme (PFE) and the F-gas Regulation are not included in the MARKAL-NORDIC model.

Increased carbon dioxide tax for non-EU ETS industry, and energy tax on fossil fuels for heating in industry

Taxation of fossil fuels used in sections of industry outside the EU ETS was raised on 1 January 2011 from 21% to 30% of the standard rate of carbon dioxide tax. There will be a further increase in 2015, to 60% of the standard rate. No carbon dioxide tax is payable on fossil fuels used in industrial plants included in the trading system.

Since 1 January 2011, energy tax on fossil heating fuels has been levied according to their energy content, significantly increasing the tax on LPG, natural gas, coal and coke. On fuels used in industrial manufacturing processes, inside and outside the trading system, 30% of the standard energy tax is paid.

When these tax increases were decided, it was estimated that they would result in overall emission reductions of 0.4 Mt CO_2 eq in 2015 and 2020, beyond those projected. This assessment covered the use of fuels for heating both in non-EU ETS industry and in agriculture, forestry and pisciculture.

Programme for Energy Efficiency in Energy-Intensive Industry

An instrument designed to improve industrial energy efficiency is the Programme for Energy Efficiency in Energy-Intensive Industry (PFE). This five-year programme offered companies an exemption from the energy tax on the electricity used in manufacturing processes, in exchange for a commitment, in the first two years, to introduce an energy management system and carry out an energy survey to analyse the company's potential to take energy efficiency measures. Firms also undertook to implement, during the programme period, measures to improve electricity efficiency with a payback time of less than three years.

The first period of the programme ran from 2004 to 2009, and the end result was that the hundred energy-intensive industrial companies participating achieved electricity savings of 1.45 TWh per year (Swedish Energy Agency 2013l). It is difficult to distinguish the exact effect of PFE, as the economic benefits of the measures taken were enhanced by the sharp rise in industrial electricity prices since the beginning of the 2000s.

The PFE Act, which established the programme, ceased to have effect at the end of 2012, as the 2008 EU guidelines on state aid for environmental protection mean that there is no basis for commencing new programme periods after that date. However, the repealed Act continues to apply to companies approved as participants before the end of 2012. At present, 94 companies, together accounting for 72% of industrial energy use, are still taking part. Participating firms are allowed to complete the programme period running from 2013 to 2017. In practice, however, some 90% of them, and an even higher proportion of their total energy use, will exit the programme in June 2014, when the companies involved from the outset complete their programme period (Informant 4, Swedish Energy Agency). Work is in progress to find policy instruments that will continue to encourage energy-intensive industry to improve its electricity efficiency (Ministry of Enterprise, Energy and Communications 2013).

Energy survey grants for SMEs and an expansion of energy advice

Support for energy surveys of small and medium-sized enterprises and farms was introduced in 2010 and will continue at least until the end of 2014. Grants cover 50% of the cost of a survey, up to a maximum of SEK 30,000, and are available to businesses using more than 500 MWh of energy a year. Farms with at least 100 livestock units are eligible even if they use less energy.

The last few years have seen an expansion of active networking initiatives relating to energy use, targeted at businesses both large and small, partly with the aim of maximising the impact of instruments such as PFE and energy survey grants.

EU F-gas Regulation and the Environmental Code

Emissions of fluorinated greenhouse gases (F-gases) have risen sharply since 1990. The biggest increase is due to the replacement of ozone-depleting refrigerants with hydrofluorocarbons (HFCs), which do not harm the ozone layer but are very powerful greenhouse gases.

Emissions of F-gases in Sweden in 2011 totalled around 1.1 Mt CO_2 eq, an increase of 0.6 Mt CO_2 eq compared with 1990 and a decrease of 0.2 Mt CO_2 eq from 2007 levels.

In industry, F-gases are emitted both from processes (mainly in the aluminium industry) and from use of refrigerants. Emissions of process-related F-gases fell from 0.5 to 0.2 Mt CO_2 eq between 1990 and 2011, partly as a result of the Environmental Code's requirement to use the best technology. At the end of 2013, the EU is expected to adopt a BREF (Best Available Techniques reference document) for the non-ferrous metals industry. The performance requirements set out there are to be met within four years and could halve emissions from aluminium production.

Since 2006, the use of certain F-gases has been controlled by EU Regulation No 842/2006, which primarily applies to the use of F-gases in refrigeration, air conditioning and heat pump equipment, as well as in fire protection systems.

When the EU's F-gas legislation was introduced in Sweden, it was expected to reduce emissions by about 0.7 Mt CO_2 eq/year by 2020, compared with if it had not been introduced. To date, total F-gas emissions have admittedly fallen, but most of the reduction has occurred in industry and not in the applications covered by the F-gas Regulation.

In autumn 2012, the European Commission proposed a tightening of the regulation, aimed at cutting emissions by two-thirds from present levels by 2030. The proposal also includes a ban on the use of F-gases in certain types of equipment for which climate-friendly alternatives are available. A decision is expected in 2014.

4.2.6 Transport

Emissions of greenhouse gases from the Swedish transport sector in 2011 made up 33% of the country's aggregate reported greenhouse gas emissions, with road transport as the dominant source, accounting for over 90% of the total for the sector. Emissions from domestic transport have increased since 1990, reaching a peak in 2006–07, when they were 12–13% higher than in 1990. Since then, emissions have declined, especially from cars, and in 2012 they were just 2% up on 1990 levels. Between 2009 and 2012, road transport emissions fell by 5.6% (Swedish Environmental Protection Agency official statistics). Over the same period, the share of renewable energy rose from 5.4% (Swedish Energy Agency 2010b) to 8.1% (Swedish Energy Agency 2013m).

The decrease in emissions since 2006 can be attributed to a number of policy instruments introduced both nationally and at EU level, which have resulted in more energy-efficient vehicles and an increased share of renewable energy. Without the growth in traffic that has occurred, emissions would have been 15% lower than in 1990. According to the latest projection (Chapter 5), transport sector emissions will continue to decline up to 2020 and 2030, but not enough to achieve the Government's priority of a vehicle fleet independent of fossil fuels by 2030, thereby risking the fulfilment of the vision for 2050 (Swedish Transport Administration 2012b). Partly for this reason, the Government has set up an inquiry to define its priority of a fossil-independent vehicle fleet by 2030 and to identify ways of realising it. The inquiry presented its final report at the end of 2013.

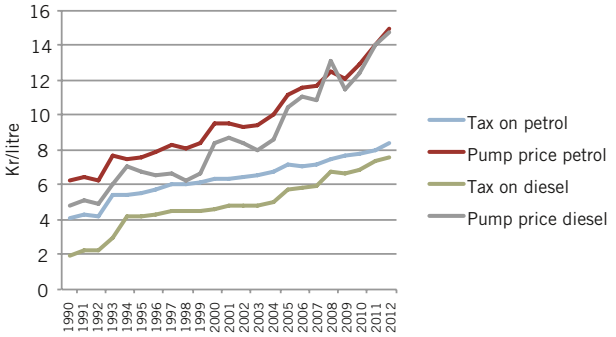


Figure 4.4 **Retail prices and total taxes (energy tax, carbon dioxide tax and VAT) for diesel and 95 octane petrol (annual averages). Current prices. Source: Collation of data from Swedish Petroleum and Biofuels Institute (SPBI 2013).**

General policy instruments: Vehicle fuel taxes

Petrol and diesel are subject to both an energy tax and a carbon dioxide tax. In addition, value added tax (VAT) is charged on the sales value. The carbon dioxide tax on vehicle fuels was introduced in 1991 and has since been raised in several stages. The introduction of and increase in this tax, however, have been partly offset by a simultaneous reduction of energy tax on vehicle fuels. Overall, the tax on these fuels has gone up, but in 2007 and 2008 increases in the total tax were overshadowed by rising pre-tax prices for petrol and diesel, due to higher crude oil prices (see Fig. 4.4). The increase in the pre-tax prices of petrol and diesel has slowed growth in transport, encouraged more energy-efficient vehicles and facilitated the introduction of transport biofuels. In accordance with the climate policy decision of 2009, the energy tax on diesel has been raised in two stages, in 2011 and 2013, by a total of SEK 0.40/litre. In addition, there is the annual index-linking of rates of energy and carbon dioxide tax on fuels and electricity.

Support for research and demonstration

Support for research, development and demonstration is an important complement to pricing instruments. In recent years, some SEK 240m annually has been made available for research, demonstration and piloting of transport biofuels. In 2012, SEK 1,240m was allocated for the period 2013–16, a priority area being initiatives to promote a fossil-independent vehicle fleet, including increased funding for technology verification and demonstration. In the next few years, targeted research support for automotive technology, with a focus on developing electric- and hybrid-vehicle technology within the Swedish vehicle cluster and on transport biofuels etc., will amount to some SEK 400m a year. (Informant 3, Swedish Energy Agency, 2013.)

[2] Fatty acid methyl ester, a form of biodiesel.

Targeted instruments: Renewable transport fuels

Low blends of ethanol in petrol and FAME[2] in diesel have long been used in Sweden. Under the EU's Fuel Quality Directive, fuel specifications now permit 10% ethanol in petrol and 7% FAME in diesel. With effect from 1 February 2013, to promote renewable energy in the road transport sector, sustainable biofuels in petrol and diesel, in blends of up to 5% by volume, are exempt from the whole of the carbon dioxide tax and most of the energy tax (89% for biofuels in petrol and 84% for biofuels in diesel). E85 and other sustainable high-blend biofuels and biofuels with no fossil content are entirely exempt from carbon dioxide and energy tax on their biomass-based component. In the case of sustainable hydrotreated vegetable and animal oils and fats (HVO), exemption from these taxes applies to up to 15% by volume of HVO in diesel fuel, with effect from 1 January 2012. The system will shortly be changing, as the Government intends to introduce a quota obligation on 1 May 2014, which will increase the quantities of ethanol and FAME blended with petrol and diesel. Biofuels will be required to make up a total of at least 9.5% by volume of the volume of diesel fuel subject to the obligation, with at least 3.5% by volume to consist of 'specially designated' biofuels. The proportion of biofuels in petrol is to be at least 4.8% by volume of the volume covered by the quota obligation, rising to at least 7% by volume no later than 1 May 2015. When the quota obligation is introduced, moreover, energy tax on sustainable transport biofuels included in petrol or diesel is intended to be levied at rates corresponding to the energy tax on comparable fossil fuels, calculated on an energy content basis.

The quota obligation system is a market-based support scheme, aimed at ensuring that a certain quantity of transport biofuels is available on the market. High-blend biofuels such as E85, and biogas, will remain exempt from the energy as well as the carbon dioxide tax.

Under the Renewable Fuels Act introduced in 2006, all filling stations with sales above a certain level have to supply at least one renewable fuel. Just under two-thirds of all stations are subject to this requirement.

These targeted instruments to promote renewable transport fuels will help to realise the Government's long-term priority of a vehicle fleet independent of fossil fuels, thereby reducing the climate impact of the transport sector.

Targeted instruments: Composition of the vehicle fleet

Sweden uses vehicle taxation as an instrument for reducing carbon dioxide emissions from light-duty vehicles.

In 2006, a carbon dioxide-based annual vehicle tax

was introduced for passenger cars from the year 2006 and later. This tax also applies to electric and hybrid cars and to other passenger cars meeting certain emission requirements (Euro 4). As from 1 January 2011, the carbon dioxide-based vehicle tax applies, in addition, to motorhomes, light goods vehicles and light buses.

The annual vehicle tax on diesel-powered light-duty vehicles is in general higher, owing to the lower tax on diesel fuel compared with petrol. The higher tax on these vehicles is calculated using a fuel factor. On top of this, an environmental surcharge is added, to reflect the higher nitrogen oxide and particulate emissions from diesel vehicles.

As from 1 July 2009, new vehicles with lower emissions of carbon dioxide (green vehicles according to the old green vehicle definition) are exempt from annual vehicle tax for the first five years. On 1 January 2013, more stringent criteria for the five-year exemption, involving weight-based carbon dioxide emission requirements, were introduced. The tax exemption was also extended to include motorhomes, light goods vehicles and light buses. This means that passenger cars, motorhomes, light goods vehicles and light buses brought into use in Sweden for the first time on or after 1 January 2013 are exempt from annual vehicle tax for the first five years, provided that their carbon dioxide emissions (according to data in the Road Traffic Registry) do not exceed a maximum level calculated in relation to the vehicle's weight (green vehicles according to the new definition). Heavier vehicles that are energy-efficient may therefore also qualify for the exemption. On 1 August 2007 a financial incentive was introduced in the form of a grant towards the purchase cost of passenger cars causing less damage to the environment. This green vehicle rebate was discontinued on 1 July 2009. At the beginning of 2012, a super-green vehicle rebate of up to SEK 40,000 was introduced for new vehicles emitting a maximum of 50 g CO_2/km (super-green vehicles).

Roughly two-thirds of all cars sold in Sweden are bought by legal entities (Swedish Transport Administration 2013a). Many of them are company cars that are used privately, a benefit on which tax is payable. The 'benefit in kind' value on which private individuals are taxed for this has been reduced for company vehicles that are equipped with a gas engine or a hybrid or fully electric motor, to increase the incentive to choose such vehicles. There may also be a number of local advantages to buying a green car, such as free parking in certain municipalities. In addition to Swedish policy instruments, manufacturers selling vehicles in the EU are subject to EU Regulations Nos 443/2009 and 510/2011 setting emission performance standards for new passenger cars and new vans as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles. Under these regulations, new passenger cars should not emit an average of more than 130 g and new vans not more than 175 g CO_2/km by 2015 and 2017, respectively.

Effects of policy instruments in the transport sector

Since 2007, the upward trend in transport sector emissions in Sweden has been reversed. Fig. 4.5 shows actual emissions from 1990 to 2011 and a projection up to 2020, as well as an estimate of what the emissions trend would have been and could be up to 2020 without the fuel tax increases implemented since 1990. The effects of these tax increases have been estimated on the basis of the nominal tax level, as a decision was taken in 1994 to adjust the taxes for inflation. The overall effect of the tax increases on diesel and petrol since 1990 is estimated to be around 2 Mt CO_2/year lower emissions in 2010 and 2 Mt CO_2/year lower emissions in both 2015 and 2020, compared with if the 1990 nominal level of taxation had been retained. The actual reduction from 2007 to the present can mainly be attributed to other factors than fuel taxes, such as a recession, rising crude oil prices and the introduction of other policy instruments.

Transport is a complex sector, with a range of different stakeholders influencing transport demand, modes of transport used, vehicle and fuel characteristics and, ultimately, emission levels. As indicated, Sweden uses a significant number of policy instruments that are intended to address the various market imperfections, barriers and obstacles to a transition to low emissions in the sector. In many cases, it is not possible to determine the exact effect of each of these instruments.

The energy efficiency of the Swedish car fleet has improved substantially in recent years. As a result, av-

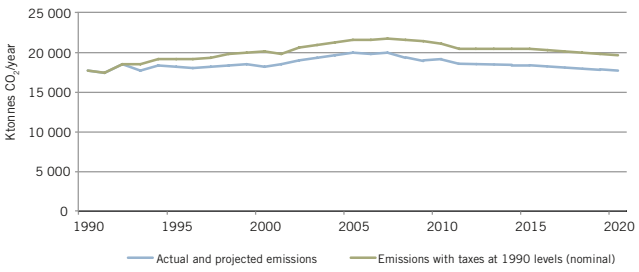


Figure 4.5 **Greenhouse gas emissions from road transport 1990–2011 and projection to 2020 with fuel taxes decided (nominal prices), compared with estimated emissions if fuel taxes had been kept at 1990 levels.[3] (SPBI 2013 and Swedish Tax Agency 2013e.)**

[3] Estimate with sliding elasticities from 0.3 to 0.7 for private transport and from 0.1 to 0.2 for commercial transport. A simplified method has been used, which probably slightly overestimates the tax effect.

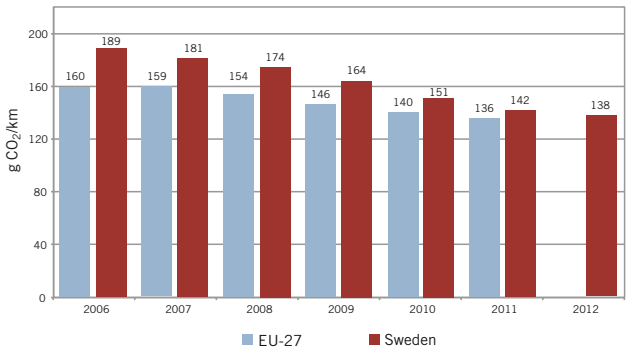


Figure 4.6 **Trends in carbon dioxide emissions (g/km) from newly registered cars in the EU-27 (for 2006, EU-24) and in Sweden, 2006–12.**

Source: Swedish Transport Administration 2013b.

erage emissions from new cars in Sweden were 138 g CO_2/km in 2012, with an average for the entire vehicle fleet of 178 g CO_2/km (see Fig. 4.6). This is partly due to a sharp rise in the proportion of diesel cars, which are more energy-efficient than petrol-engine vehicles.

The main instrument behind this trend is the EU's carbon dioxide standards for passenger cars, but Swedish instruments such as the carbon-differentiated vehicle tax and tax exemption for green vehicles (including fuel-efficient diesels) are also of significance. Other vehicle-specific instruments, such as reduced 'benefit in kind' values for electric and flexible-fuel company cars, and local instruments like parking subsidies, have mainly encouraged flexible-fuel vehicles, rather than energy efficiency.

Green vehicles previously consisted mainly of those run on E85, but sales have increasingly shifted towards fuel-efficient vehicles (see Fig. 4.7). This is an effect not only of policy instruments, but also to a large extent of factors such as prevailing norms in society. Demand for E85 (and E85 vehicles), for instance, has fluctuated sharply, influenced partly by how the media have chosen to describe the fuel.

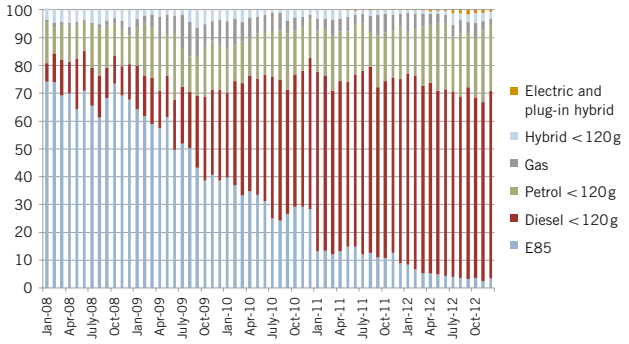


Figure 4.7 **Distribution of new green cars by type.**

Source: Johansson 2013.

The existence of instruments to promote transport biofuels is crucial to their use, since they still cost more to produce than fossil fuels. In all, the use of transport biofuels verified as sustainable achieved emission reductions in 2011 of about 0.94 Mt CO_2 (Swedish Energy Agency 2012g).

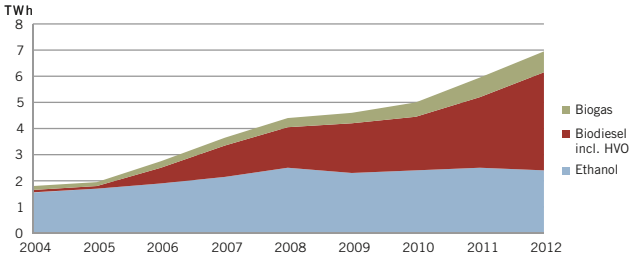


Figure 4.8 **Use of transport biofuels in Sweden from 2004 to 2012.**

Source: Swedish Energy Agency 2013.

The share of renewable energy in the transport sector (calculated using the method prescribed in the Renewables Directive, and including, for example, electricity for railways) was 11.8% in 2012, an increase of 3.9 percentage points compared with 2010. The share of transport biofuels (on an energy content basis) was 8.1%, 2.4 percentage points up on 2010. Use of ethanol increased somewhat, from 400,000 m^3 to 407,000 m^3, between 2010 and 2012. Biodiesel use rose very sharply, from 225,000 m^3 to 404,000 m^3, over the same period, while biogas increased from 59 to 83 million m^3. (Swedish Energy Agency 2013m.)

The relevant stakeholders in Sweden have endeavoured to build up the production of transport biofuels with major climate benefits, since such benefits have been the primary driver of investments in these fuels in the country. Half of all transport biofuel use in Sweden now meets the emission reduction requirement that will apply from 2017 (Swedish Energy Agency 2012g).

Consideration of climate in long-term infrastructure planning

Long-term planning of infrastructure includes operation and maintenance measures, investments in new infrastructure, research, targeted environmental measures affecting existing infrastructure, and minor alterations such as public transport lanes. Problems and shortcomings are identified and remedied according to the 'four-step principle'. This is a step-by-step process for addressing problems and deficiencies in the transport system, while using resources in a sustainable way.

Box 4.6 – The four-step principle

- **Rethink**
  The first step is to consider measures that could influence transport and travel needs and choices of transport mode.
- **Optimise**
  The second step is to implement measures that will enable more efficient use to be made of existing infrastructure.
- **Rebuild**
  The third step involves limited reconstruction.
- **Build new**
  The fourth step involves new investment and/or major reconstruction work.

The Swedish Transport Administration is responsible for long-term planning of all modes of transport. This creates a basis for intermodal measures and coordination benefits. An intermodal approach is central to long-term planning and, among other things, offers greater scope to consider the environment when choosing solutions. Planning is undertaken in dialogue with local and regional planning bodies. Under the Planning and Building Act (SFS 2010:900), too, there is a clear requirement to take environmental and climate issues into account in planning.

4.2.7 Waste

Methane emissions from landfill sites were around 1.3 Mt CO_2 eq in 2011, an estimated reduction of some 57% since 1990. Landfill emissions are expected to continue falling sharply over the next ten years (see Chapter 5). The factors behind this decline are an expansion of methane recovery from landfills and reduced landfill disposal of organic material, combined with increases in recovery of materials and waste incineration with energy recovery. These measures are a consequence of a series of policy instruments at both national and EU level.

Policies and measures in the waste sector

Landfill tax, bans on landfill disposal, and municipal waste planning

In 2000 a tax was imposed on waste disposed of to landfill (SFS 1999:673), and since then bans have been introduced on landfilling of separated combustible material (2002) and of organic material (2005) (SFS 2001:512). Certain exemptions from these prohibitions have been granted, but they are very limited in scale compared with the overall quantities of waste. In 2011, less than 1% of all household waste produced was sent to landfill. The remainder went either to incineration with energy recovery (51%) or to materials recovery, including biological treatment (48%). Most organic industrial waste was incinerated for energy recovery. The municipal waste planning requirement (NFS 2006:6), introduced in 1991, has also contributed to the emission reductions achieved.

Aggregate effect of policies and measures in the waste sector

Sweden's Third National Communication (2001) presented the results of an analysis of the combined effect of policy instruments influencing methane emissions from landfills. The assessment covered instruments introduced in the 1990s and those planned at the time for the early 2000s (and subsequently introduced). It showed that, in a scenario based on policy instruments decided on at that time, emissions would end up around 1.4 Mt CO_2 eq lower in 2010 than in a scenario based on 1990 instruments. By 2020, the difference was projected to be 1.9 Mt CO_2 eq. This is still deemed a reasonable estimate.

Overall, the landfill bans are judged to have had the greatest impact in terms of reducing landfill of organic material, which will result in lower emissions of methane in the future. Demand for district heating has also strongly encouraged diversion from landfill to incineration.

While landfill emissions have decreased, waste incineration in centralised plants for district heating and power generation has increased. Incinerated household waste generates some emissions of greenhouse gases, since it consists partly of material of fossil origin, mainly plastics. However, incineration of waste for the production of heat and electricity results in additional greenhouse gas emission reductions, beyond the decrease in methane from landfills, if it is assumed that it replaces electricity and district heating that would otherwise have been produced using fuels with a higher fossil carbon content, such as coal and oil. In 2011, 13.5 TWh of heat and 2 TWh of electricity were generated from the incineration of household and similar waste in efficient plants with stringent air pollution controls. The effect of the growth in waste incineration in Sweden since 1990 is included in the estimate of aggregate effects of economic instruments in the energy supply sector, presented in 4.2.3.

4.2.8 Agriculture and forestry

Agricultural production gives rise to greenhouse gas emissions from land use, livestock (in particular ruminants such as cattle and sheep), and management of fertilisers and manure, as well as from the use of fossil fuels.

Emissions of methane and nitrous oxide from farming make up over 10% of total greenhouse gas emis-

sions in Sweden. Nitrous oxide emissions, especially, have fallen since 1990, but those of methane are also declining. Overall, emissions of greenhouse gases from Swedish agriculture decreased by about 14% over the period 1990–2011.

Nitrous oxide emissions are linked to the use of mineral fertilisers and animal manure. They result from conversion in the soil of nitrogen from those sources, and the fall in emissions can be attributed to reduced use of both fertilisers and manure. Use of manure is chiefly influenced by the number of dairy cattle, which has declined. Action programmes introduced to curb nitrogen losses to water and air in agriculture have also contributed to the trend, as has a shift to slurry systems for manure management. Yet another explanation for the decrease in total use of fertilisers and manure is a contraction of the arable area.

Emissions of methane have fallen as a result of the declining dairy herd, despite a rise in emissions per head of cattle over the period. While numbers of cattle (chiefly dairy) in Swedish agriculture have decreased, however, consumption and imports of beef have increased.

The land use, land-use change and forestry (LULUCF) sector represented a large net sink for carbon dioxide over the period 1990–2011. In 2011, the sector as a whole was responsible for a net removal of some 35 Mt CO_2. By far the dominant category in this sector is forest land, accounting for a net uptake of 39 Mt CO_2. Cropland generated emissions of about 1.3 Mt CO_2, while the change in the carbon stock in grassland was small, 0.001 Mt CO_2. Throughout the period since 1990, forest growth has exceeded forest felling. The total standing volume of timber has increased by about 20%. Net removals of carbon dioxide resulting from LULUCF are determined largely by changes in carbon stocks in living biomass. These changes are a result of annual forest growth (uptake of carbon dioxide) and losses due to felling and mortality (emissions of carbon dioxide). Removals vary quite widely from year to year, largely because felling varies according to the demand for timber products. Analogously with these fluctuations in living biomass, carbon stock changes in dead organic matter also vary, as increased felling produces more stumps. Gross forest growth and felling both show an upward trend. At present, annual growth and harvesting stand at around 120 and 90 million m^3 standing volume, respectively. The trend in net uptake by living biomass is declining, primarily because felling increased more than growth throughout the reported period 1990–2011.

Energy use in agriculture, forestry and fisheries consists primarily of the use of diesel for farm and forest machinery. This use has shown a slight rise since 1990, while the increase in volumes of production in both agriculture and forestry has been larger. Consumption of fuel oil for greenhouses and to heat other buildings in these sectors is decreasing, partly owing to its replacement with biofuels.

Policies and measures in the agricultural sector

As yet, there are relatively few policy instruments directly targeted at limiting greenhouse gas emissions from Swedish agriculture. Interest in mitigating the sector's climate impact has grown, however, and the Government has taken a number of initiatives recently to reduce fossil fuel use in farming, and to increase awareness and encourage the use of measures that will curb emissions of greenhouse gases from manure and fertiliser management and from land use.

At the Government's request, the Swedish Board of Agriculture drew up and, in spring 2010, presented proposals for an action programme to reduce nutrient losses and greenhouse gas emissions from agriculture. No decision was taken by the Government to implement the programme in its entirety, but it did result in further assignments to the Board from the Government, as well as an increased commitment, for example, to climate and energy advice to farm enterprises. Over the period 2011–16, the Board of Agriculture judges that production and use of renewable energy are the measures that will have the greatest effect. Measures to reduce the climate impact of agricultural production more substantially in the longer term could include more efficient use of input materials, an expansion of anaerobic digestion of animal manure, reconversion of farmland with a high organic content to wetlands, reduced use of fossil energy, and increased sequestration of carbon in agricultural soils.

EU Common Agricultural Policy

The EU's Common Agricultural Policy (CAP) significantly affects the extent, direction and profitability of agriculture in Sweden. In 2003, an agreement was reached to reform the policy, referred to as the Mid-Term Review (MTR). The biggest change was that most direct support, which is one element of the CAP, was decoupled from production. Sweden did, however, retain some production-related aid until as recently as 2012, when the last coupled support scheme, the special beef premium, was withdrawn.

The Swedish Rural Development Programme (RDP) for the period 2007–13 is funded in equal shares by the EU and the Swedish state. It comprises support for rural development, environmental improvements, and

greater competitiveness in agriculture, forestry, horticulture, reindeer herding and food processing. Each county administrative board has developed an implementation strategy for the RDP at county level and sets regional priorities, for instance, for the investment and project support components of the programme.

Agri-environment payments have been designed to achieve environmental objectives concerned with preserving an open agricultural landscape, conserving biodiversity, and reducing nutrient losses to water, partly through the re-creation of wetlands. Measures introduced to curb nutrient losses may in certain cases also cut emissions of nitrous oxide, particularly those that reduce the amount of available nitrogen in soil and water. Nitrous oxide emissions may in addition be mitigated by certain manure and fertiliser management options, but there are also measures that can limit nitrogen losses and benefit biodiversity, yet increase releases of nitrous oxide. Regeneration of wetlands on drained peatland can reduce greenhouse gas emissions.

In 2008 the Government decided to introduce, as part of the RDP, investment support for biogas production, with total funding of SEK 200m for 2009–13. In all, SEK 159m of this sum has been disbursed for biogas investments. As a result, 30 new biogas production plants are in operation and another 20 are at the planning and design stage. In its Budget Bill for 2014, the Government proposes that SEK 240m be made available for a 'dual environmental benefit' support scheme to promote the production of renewable energy over the period 2014–23. This is a pilot project that will encourage anaerobic digestion of animal manure by means of a payment of around SEK 0.20 per kWh of raw methane produced. Increased digestion of manure offers a dual environmental benefit, reducing both emissions of greenhouse gases and eutrophication of fresh and marine waters. In addition, the biogas can be used to generate electricity or heat, or as a vehicle fuel.

Investment support is also provided for the growing of perennial energy crops, which help to reduce greenhouse gas emissions in other sectors, as well as increasing the stock of carbon in the soil. There are currently some 13,000 ha of short-rotation coppice willow, the perennial energy crop grown on the largest scale.

Grants may in addition be available from the RDP to promote a shift to renewable energy and more efficient energy use in greenhouses and agricultural buildings.

In 2007, the European Commission carried out a review of implementation of the MTR, known as the 'Health Check'. As a result of the review, additional rural development measures were introduced to meet challenges in the areas of climate, water management and preservation of biodiversity, and in the dairy sector. Funds from Pillar 1 (direct support) were transferred to the rural development budget to address these priority areas. In the Swedish RDP, a further SEK 500m was made available for climate and energy initiatives over the period 2010–13. The Swedish Board of Agriculture has estimated that the effect of this funding will be to reduce Sweden's annual greenhouse gas emissions by 0.5 Mt CO_2 eq, primarily through switching from fossil energy to renewable energy from agriculture and through greater energy efficiency.

Changes to the energy and carbon dioxide taxes on fuels used in agriculture, forestry and pisciculture

The carbon dioxide tax on fuels used for heating in industry outside the EU ETS and in agriculture, forestry and pisciculture was raised on 1 January 2011 from 21% to 30% of the standard rate. There will be a further increase in 2015, to 60% of the standard rate.

In addition to the general relief on the carbon dioxide tax, enterprises can currently claim a further reduction under what is known as the 1.2% rule. This tax relief primarily takes effect for enterprises in the greenhouse horticulture sector. The Riksdag has decided that it is to end in 2015.

Previously, SEK 2.38 of the carbon dioxide tax on diesel used in agricultural machinery was refunded, but this refund is being scaled back. It was lowered to SEK 2.10 in 2011, and to SEK 1.70 in 2013. In 2015 it will be cut to SEK 0.90.

The energy tax on diesel has been raised in two stages in recent years, by SEK 0.20 in 2011 and a further SEK 0.20 in 2013.

Policies and measures in forestry

Measures in forestry that can contribute to a reduced impact on climate include:

- Increasing biomass growth through forestry methods such as improved propagating material, intensified reforestation practices and continued afforestation, as well as enhancing the carbon stock in forest soils by methods such as changes in silvicultural systems and setting aside of land in reserves and the like.
- Avoiding forestry methods which increase greenhouse gas emissions from forest soils, and in other respects adapting forestry to reduce the risk of future emissions as the climate changes.
- Increasing the amount of carbon stored in harvested wood products.

- Replacing fossil energy with bioenergy, including from harvesting residues.
- Replacing energy-intensive materials with forest raw materials.

The first two types of measures are the ones that will primarily affect carbon sequestration in the LULUCF sector, while the last three could help to reduce emissions in other sectors. The effects of forestry measures on sequestration of carbon are presented as part of the background analysis commissioned by the Government for its 'roadmap towards a Sweden with no net climate emissions by 2050' (Swedish Environmental Protection Agency 2012a).

Policy, legislation and forest certification schemes

Forest policy

Swedish forest policy has two overarching, coequal objectives, relating to production and the environment. The environmental objective is as follows: The natural productive capacity of forest land should be preserved. Biodiversity and genetic variation in forests should be secured. Forests should be managed in a manner that enables plant and animal species occurring there naturally to survive in natural conditions and in viable populations. Threatened species and habitats should be protected. The cultural heritage assets of forests and their aesthetic and social values should be safeguarded. The production objective is: Forests and forest lands should be used effectively and responsibly so that they produce high, sustainable yields. The direction of forestry production should be towards giving a free hand with regard to what forests produce. Emphasis is placed in forest policy on the significance of forests for climate, including the need for increased forest growth.

Government initiatives

As part of the 'Forest Kingdom' initiative, central government advice to the forestry sector has been stepped up, with a view to promoting effective and functional consideration for the environment and improved forest management. To implement this initiative, funding is being increased by SEK 10m per year over the period 2012–15 (Ministry of Finance 2011). The Swedish Forest Agency has mounted information campaigns on forestry and climate change with support from the Rural Development Programme: 'Forestry in a changed climate' and 'Forest owners and climate' (Swedish Forest Agency 2013a and 2013b). In addition, it is running a forest bioenergy project, also funded by the RDP (Swedish Forest Agency 2013c). This project aims to provide forest owners and professionals with knowledge that will enable greater use to be made of forests for bioenergy purposes.

Another strand to the Forest Kingdom initiative is a three-year programme to help achieve its goal of creating conditions for more jobs in the Swedish countryside. The programme seeks to support the development of sustainable forestry methods that will increase production, based on a systematic, iterative approach of active learning. These methods are to be developed in combination with effective and functional consideration for the environment. Examples of measures that may be analysed are tree species selection, use of improved planting material and genetic variation, thinning regimes, shortened rotation times, silvicultural systems other than even-aged management, and fertilisation based on actual needs. In developing methods, the social values of forests are to be taken into account. To implement the programme, funding will be increased by a total of SEK 60m over the period 2013–15.

Legislation

The methods used in forestry are chiefly regulated by provisions in the Forestry Act and the Environmental Code. At present, there are no rules specifically designed to promote increased uptake of carbon dioxide. On the other hand, existing provisions do affect trends in carbon dioxide removals in various ways, in particular:

- Provisions on forest management etc. in the Forestry Act. Under this Act, new forest is required to be established after felling, for example, and abandoned farmland is to be afforested no later than the third year after it is taken out of production. These requirements are designed to ensure that full use is made of the timber-producing capacity of land, which is beneficial from a climate point of view as it promotes uptake of carbon dioxide by forest biomass and production of biomass as a substitute for fossil fuels and energy-intensive materials.

- Provisions on land drainage in the Environmental Code. In central parts of the southern Swedish highlands and north of the *limes norrlandicus* (the biogeographical boundary of northern Sweden), land drainage – defined as drainage with the aim of permanently increasing the suitability of a property for a certain purpose – may only be undertaken with a permit. In the rest of the country and on sites specially protected under the Ramsar

Convention, such schemes are prohibited. Permit applications are considered by county administrative boards. Land drainage has declined since the early 1990s and now occurs on a very small scale.

- Conservation work (site protection, nature conservation agreements and voluntary set-aside of land). Such measures not only preserve biodiversity, but also mean that carbon stocks in forest biomass and soil carbon are maintained or continue to increase. Swedish forests used primarily for timber – timber production forests – have a relatively low average age and hence a large capacity to store carbon, even long after a conservation measure (such as nature reserve or habitat protection area designation, or a nature conservation agreement) has been implemented. Section 2.12 of this National Communication includes information on forest land that has been set aside for biodiversity conservation. In addition, there are proposals to set aside further areas of forest, as mentioned above. There are also targets for the conservation and protection of areas containing both wetlands and forest land. Since such areas are usually excluded from felling, their stocks of carbon in biomass and soil will in most cases be larger than those of production forests. On the other hand, the possibility of producing timber and biomass as a substitute for other materials and as a source of biofuels – the substitution potential – will be lost.

The Government has previously emphasised that it is important now to analyse the scope for regulatory and other policy instruments that could be considered with a view to further enhancing the contribution of forestry to the cost-effective achievement of Swedish climate policy objectives. It was proposed that this analysis should include studies of possible incentives to increase sequestration of carbon in sinks, where appropriate, and to minimise greenhouse gas emissions from land. The measures contemplated were not to conflict with the production and environmental objectives of Swedish forestry. The Government is currently considering how this analysis should be undertaken. There are other instruments, too, which indirectly – by influencing demand for forest raw materials for energy supply and material substitution purposes – affect forestry practice and hence fluxes of greenhouse gases. Exempting biofuels from carbon dioxide and energy taxes has increased the profitability of biomass fuels from forests and been a major factor behind the emission reductions achieved, for example in the district heating sector. The electricity certificates system has rapidly increased the amount of renewable energy available, including forest biofuels for electricity generation (see section 4.2.3).

Sectoral responsibility

Since the early 1990s, forest policy has built on landowners having considerable freedom to make their own decisions about the aims of their forestry and the operations they wish to undertake, at the same time as they have an important part to play in achieving forest policy objectives in the framework of their sectoral responsibility.

One component of this sectoral responsibility is the voluntary third-party certification schemes which most of Sweden's forest owners have joined. There are two such schemes, that of the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). Both are based on landowners undertaking to follow guidelines on sustainable forestry in managing their land. Swedish legislation sets a common standard for all productive forest land regarding consideration for the environment. Certification is designed to raise the bar even higher as regards the ecological, economic and social aspects of forestry, and includes provisions for the voluntary set-aside of forest land. Since many forest managers have signed up to certification schemes, the areas being set aside have also increased. As a rule, this land is set aside from any form of management, or managed with the primary purpose of promoting biodiversity.

As a result of sectoral responsibility, more than 1 million ha of land has been set aside voluntarily by the forestry sector – without compensation from the state. These set-aside areas may also represent a contribution to increasing uptake of carbon dioxide.

Swedish environmental objectives

In 2011, the Government decided to give the All Party Committee on Environmental Objectives an additional remit to propose a strategy for long-term sustainable land use, aimed at achieving the generational goal for the environment and the environmental quality objectives (Terms of reference 2011:91). An interim report was submitted in June 2013, concerning protection and management of sites and an enhanced level of environmental consideration in forestry. A final report is to be presented in June 2014. The interim report includes proposals on setting aside additional areas with biodiversity conservation as their primary purpose, and on ways of developing consideration for

the environment in forestry. These proposals have been the subject of consultation and are currently being considered in the Government Offices.

Implementation of Articles 3.3 and 3.4 of the Kyoto Protocol

For the first commitment period of the Kyoto Protocol (2008–12), Sweden has decided that, in addition to mandatory accounting for greenhouse gas emissions and removals under Article 3.3, it will make use of forest management under Article 3.4 in calculating emissions and removals from LULUCF. Sweden follows the criteria for forest land deriving from the FAO definition and the IPCC's good practice guidance. The methodology and database used to calculate changes in carbon stocks are developed on an ongoing basis. Efforts in this area were for example reported by Sweden in its Fourth National Communication (Swedish Environmental Protection Agency 2006).

Under the Kyoto Protocol, the National Communication is to include information on national legislative or administrative procedures to ensure that implementation of Articles 3.3 and 3.4 also contributes to the conservation of biodiversity and sustainable use of natural resources. Sweden's current forest policy puts great emphasis on using forests sustainably as a natural resource and on conserving biodiversity. Under the Forestry Act, forests are to be managed and harvested in such a way as to contribute to sustainable forestry. The provisions of environmental legislation on nature reserves and habitat protection areas provide long-term formal protection for forest areas of high biological value, and the Forestry Act stipulates that forests must be managed using measures that meet good environmental standards. There has therefore been no need for supplementary legislation to conserve biodiversity and ensure sustainable use of natural resources as a consequence of implementation of Articles 3.3 and 3.4. Every year since 1990, Sweden has reported a net sink from land use (LULUCF) markedly in excess of the maximum net removal of 2.13 Mt that Sweden is allowed to claim credit for in the first commitment period of the Kyoto Protocol.

For the second commitment period of the Kyoto Protocol (2013–20), the rules on accounting for LULUCF removals and emissions have changed. During this period, accounting for forest management and changes in carbon stocks in harvested wood products will be mandatory, while certain other activities will be voluntary. The new rules on forest management also mean that changes in net emissions are to be accounted for against a reference level based on a business-as-usual projection, with Sweden allowed to claim a maximum credit of 2.5 Mt CO_2 per year in the second commitment period of the Protocol. Sweden has not decided whether additional voluntary activities under Article 3.4 will be included in its accounting for the second period.

4.2.9 Shipping and aviation, including international bunkers in Sweden

Emissions from domestic shipping and aviation are declining in Sweden, and together made up only 5% (around 1 Mt CO_2 eq) of total emissions from domestic transport in 2011. International shipping and aviation refuelling in Sweden are responsible for larger emissions than their domestic counterparts, with a total of about 8.3 Mt CO_2 eq in 2011 (6 Mt from shipping and 2.3 Mt from aviation). These emissions show a slight downward trend since Sweden's last National Communication. However, over a longer period, from 1990 – when emissions from international marine and aviation bunkers stood at 3.61 Mt CO_2 eq – there has been a substantial rise. Marine bunkers show the steepest increase. Under the Kyoto Protocol, each party is to report on how it is working within the International Civil Aviation Organisation (ICAO) and International Maritime Organisation (IMO) to help achieve and/or implement decisions in those organisations to limit greenhouse gas emissions.

As from 1 January 2012, aviation is included in the EU ETS. The trading system covers flights and flight operators landing at or taking off from airports in the EU, regardless of the country of departure or final destination. In November 2012 the EU Commission decided to temporarily exempt flights to and from Europe, pending proposals from the ICAO for a global market-based measure to limit the climate impact of aviation. The suspension will only apply until the end of 2013 at the latest, however.

Within the ICAO, Sweden and the EU have been pressing for action to limit greenhouse gas emissions from aviation. At its session in September 2013, the ICAO Assembly decided to develop a global market-based measure, which is to be adopted in 2016 and take effect in 2020. Drafting of proposals on the design and operation of this measure will continue up to 2016 when the decision is taken.

Early in 2013, the ICAO's Committee on Aviation Environmental Protection (CAEP) agreed a metric system and measurement methodology to compare carbon dioxide emissions from different aircraft and to set emission limits. The CAEP has also adopted a new document setting out a carbon dioxide certification requirement for aircraft, drawn up under the joint leadership of the Swedish Transport Agency and

the US Federal Aviation Administration. A new standard in Annex 16 of the Chicago Convention, which will also include limits on carbon dioxide emissions from new aircraft, is expected to be adopted by the CAEP at the beginning of 2016, with entry into force proposed for 31 December 2017.

In the IMO, Sweden has been one of the countries driving forward efforts to develop a number of technical and operational measures aimed at reducing greenhouse gas emissions. In 2011, several important decisions were taken in this area. An Energy Efficiency Design Index (EEDI) – a standardised way of describing the energy efficiency of ships – was made mandatory from 2013 for most (some 85% of) newly built vessels. The EEDI attained by a ship can be compared with a reference level based on an average for existing vessels, and ships for which contracts are placed after 2013 have to be at least as energy-efficient as this level. A mandatory Ship Energy Efficiency Management Plan (SEEMP) has also been introduced. This is to be used in ships' management systems, to improve the energy efficiency of both existing and new ships. In addition, a voluntary Energy Efficiency Operational Indicator (EEOI) has been introduced as a tool and benchmark. This can be used by existing ships. Sweden is also taking a lead in discussions within the IMO on the introduction of other mechanisms, market-based or operational, to reduce greenhouse gas emissions from international shipping. The country gives priority, moreover, to IMO efforts to limit nitrogen oxide and sulphur emissions. Such measures also have benefits from a climate point of view.

4.2.10 Efforts to avoid adverse effects of policies and measures introduced as part of the country's climate strategy

Article 2 of the Kyoto Protocol requires every party with quantified commitments under the Protocol to implement policies and measures to bring about the emission reductions it is committed to achieving. The measures taken must be compatible with overarching goals of sustainable development. Emphasis is placed on measures capable of reducing all the greenhouse gases regulated by the Protocol, and covering all sectors of society. Parties are to strive to implement policies and measures in such a way as to minimise adverse effects. These include the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other parties, especially developing countries.

Under Sweden's policy for global development (PGD), all policy areas are to interact in a coherent way so that the country can make an effective contribution to equitable and sustainable global development. When decisions in a given policy area are judged to affect this goal of equitable and sustainable global development, an impact assessment has to be carried out. The policy's two perspectives – a rights perspective and the perspective of poor people on development – are to serve as a guide. In the framework of the PGD, coordination and collaboration take place, for example, through a reference group on trade policy at the Ministry for Foreign Affairs. Regular meetings of this group, which includes representatives of business, the Swedish International Development Cooperation Agency (Sida) and civil society organisations, have created a basis for broad consultation on trade policy. A variety of capacity-building activities are also undertaken, among them a conference co-hosted in 2009 by the Swedish Government and the EU Commission, looking at ways of reducing the climate impact of the food sector without impinging on the goal of free and open trade. (Swedish Government 2010.)

In connection with decision making on policies and measures in Sweden and at EU level, impact assessments are carried out, including environmental impact assessments. As far as possible, one element in such an assessment is an appraisal of the risk of adverse effects in other countries.

To promote sustainable global development, new knowledge needs to be developed. Several interdisciplinary research initiatives are therefore under way that are seeking to advance our understanding of the global impacts (social, economic and ecological) of large-scale introduction of measures to reduce greenhouse gas emissions. The emphasis in Sweden on increasing the use of bioenergy has made that area a particular priority in systems science research in the country.

Research results have, moreover, already influenced policy development, and will continue to do so. The special sustainability criteria developed for transport biofuels under the EU's Renewables Directive (Directive 2009/28/EC) are a case in point.

Both beneficial and adverse effects need to be taken into account. Sweden is helping to implement a range of measures that could have beneficial effects on the capacity of developing countries to adapt to climate change and take action of their own to reduce their greenhouse gas emissions. Chapter 7 gives an account of such activities in the areas of technology transfer, capacity building and support for adaptation measures.

Finally, Sweden would emphasise that its broad-ranging climate strategy, encompassing many different

types of measures and covering most sectors (both inside and outside the country) and all the greenhouse gases regulated by the Kyoto Protocol, has a design which fundamentally seeks to minimise the risk of adverse effects.

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

Sweden has an active programme to implement the project-based mechanisms of the Kyoto Protocol, the Clean Development Mechanism (CDM) and Joint Implementation (JI). The role of the Swedish CDM and JI programme has been to help develop the CDM, JI and other similar market-based mechanisms as effective climate policy instruments, to contribute to cost-effective greenhouse gas reductions, and to promote sustainable development in host countries. The programme has involved participation in both individual projects and multilateral CDM and JI funds. The individual projects are chiefly in the areas of renewable energy and energy efficiency. Funds have been chosen based on the project types they target, their contribution to a geographical distribution of projects, and Sweden's scope to influence their activities. Up to and including the 2013 budget year, the Riksdag has approved appropriations[4] for international climate initiatives under the CDM and JI totalling, on an accumulated basis, some SEK 2.5bn for the period up to 2022. Sweden has currently signed contracts for 67 individual CDM projects and 2 JI projects. All the CDM projects are being carried out in developing countries, and priority is being given to projects in least developed countries (LDCs), small island developing states (SIDS) and in Africa. Fig. 4.9 shows a breakdown, by host country, of the contracted volume of carbon credits – certified emission reductions (CERs) or emission reduction units (ERUs) – from individual projects.

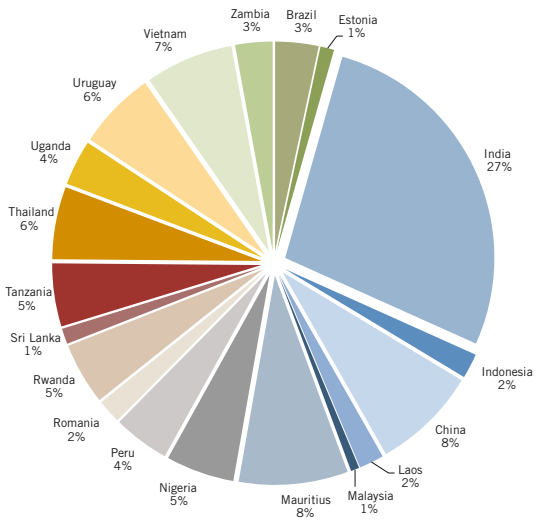


Figure 4.9 **Individual projects – breakdown of carbon credits by country.**

As can be seen from Fig. 4.9, 9% of individual projects are being undertaken in least developed countries and 3% in small island developing states. This can be compared with the CDM market as a whole, in which only 1.1% of projects are based in LDCs and just 0.5% in SIDS. The contracted quantity of carbon credits from Africa makes up 30% of the total volume of contracted credits from individual projects. This percentage can be compared with the CDM market as a whole, where only about 4% of total credits come from Africa.

Sweden participating in seven multinational funds

Participation in multilateral CDM and JI funds offers an opportunity to be involved in projects across several regions and project categories. Five of the seven CDM and JI funds Sweden is participating in (the Prototype Carbon Fund, Asia Pacific Carbon Fund, Future Carbon Fund, Multilateral Carbon Credit Fund and Testing Ground Facility) are described in detail in Sweden's Fifth National Communication on Climate Change. Since 2009, Sweden has joined another two funds: the Umbrella Carbon Facility Tranche 2 (UCF T2) and the Carbon Partnership Facility (CPF).

UCF T2 is a World Bank-administered CDM fund that will be acquiring CERs from the period after 2012. It was opened for contributions in June 2010 and was fully subscribed by February 2011, when a capitalisation of €105m was achieved, of which Sweden has contributed €10m. The fund has targeted projects in the areas of energy efficiency, renewable energy, and methane recovery and destruction. Four of its projects are to be implemented as programmatic CDM, a relatively new project form under this mechanism. This involves larger-scale programmes made up of several small CDM projects across different geographical regions.

The CPF is an innovative CDM fund for post-2012 projects. Sweden and Norway jointly entered the facility in 2010, each contributing €20m to its total capital of €72m. The focus here is on large-scale action programmes and investments, involving programmatic and sector-based approaches, which can achieve major emission reductions in an efficient way. The facility may come to benefit from other new climate collaborations, such as the Partnership for Market Readiness (PMR), a World Bank initiative with a focus on capacity building. Practical experience from CPF activities

[4] Approved appropriations up to and including the authorisation framework for the period 2014–22.

will subsequently be able to feed back into the international climate negotiations and the development of new flexible mechanisms.

Projects and funds under contract up to and including 2012 are expected, under the agreements signed, to generate emission reductions of around 19 Mt CO_2 eq. The Riksdag's aim is to achieve reductions of at least 40 Mt CO_2 eq through international climate initiatives under the CDM and JI programme, as a contribution to meeting Sweden's national target for 2020. Total funding appropriated by the Riksdag, including the authorisation framework for the period up to and including 2013, is expected to be sufficient to acquire credits corresponding to around 27–29 Mt CO_2 eq.

4.4 Cost-effectiveness of policies and measures in Sweden's climate strategy

4.4.1 Cost-effectiveness of policy instruments

The concept of cost-effectiveness refers in this context to achieving a given objective at the lowest possible cost. To be able to assess the cost-effectiveness of different policies and measures, there thus needs to be an objective and an estimate of the costs of the instruments concerned. In the case of a national target for greenhouse gas emissions, the relevant costs are those to the national economy, i.e. the change in households' scope for consumption (in a wide sense) to which the instruments give rise. To arrive at an overall assessment, effects on future generations should also be taken into account.

A given instrument may be intended to achieve a number of objectives, and it may therefore be difficult to correctly allocate the costs arising from it. An instrument may for example – as is commonly the case in Sweden's climate strategy – be designed to be of significance for several environmental objectives at once, but also to help meet broader energy, waste and employment policy goals.

By and large, general, cross-cutting policy instruments, such as a carbon dioxide tax or emissions trading, which impose the same marginal costs for emissions on companies and households, can be said to have a good potential to be highly cost-effective, since they offer flexibility in the choice of measures, resulting in low-cost measures being taken. Efficient use can be made of the information which private stakeholders have regarding their own specific opportunities to cut emissions. An emissions trading system also has the advantage of involving several countries, allowing emission reductions to be secured at a lower overall cost than if the same reductions had been achieved by national measures alone.

It can be argued that there are two main reasons for supplementing general instruments with more targeted ones (Swedish Environmental Protection Agency 2012b). The first has to do with the existence of other market failures than the actual emission of greenhouse gases. These include, for example, knowledge leakage from R&D investments, other obstacles to new technology and infrastructure, and various information failures.

The second reason is that there are sometimes factors restricting the implementation of an effective policy. This may mean that, instead of introducing a single, well-targeted instrument, the second-best solution may be to introduce several blunter ones. This may be because the well-targeted instrument is not judged politically feasible, or involves very high transaction costs.

There is thus a risk that, because of conflicts with other goals, general systems cannot be designed in a theoretically desirable way. Targeted instruments can then help to increase awareness of the options for action available. This means that, in certain cases, it may be cost-effective to combine general and targeted instruments. To limit atmospheric greenhouse gas levels in a cost-effective way, there is also a need for international cooperation, both short- and long-term. Measures to cut emissions and disseminate technology can then be undertaken to the greatest possible extent where the cost is lower. Examples of international cooperation of this kind are the flexible mechanisms of the Kyoto Protocol and the EU ETS.

Sweden's climate strategy includes both emissions trading and a carbon dioxide tax, but these do not cover every sector of society, nor are they uniformly designed. In the case of the energy tax system, rates of tax have been differentiated between sectors, to reflect the exposure of some industries to international competition and to allow for tax increases for other sectors of society. Such differentiation involves the risk of a less cost-effective system, in that different parties face differing costs for their emissions. In a world where not all countries are subject to emission restrictions, tax differentials may nevertheless, taking into account the effects on the overall economy, be justified from a cost-effectiveness point of view. To achieve long-term climate objectives, pressure for change needs to be created, leading to structural change and the development of new technology. Such a development is necessary to secure sustainable long-

term growth. Sweden has chosen to balance these two goals by pursuing a national climate policy including, on the one hand, instruments that result in emission reduction measures being implemented at home and, on the other, cooperation in the framework of Kyoto Protocol flexible mechanisms and the EU ETS.

4.4.2 Costs of measures implemented as a consequence of Swedish climate policy instruments

Several of the instruments that help to reduce greenhouse gas emissions are also designed to achieve other policy objectives. When, in addition, they interact in a given sector or area of use, distinguishing their individual effects is a complex task. Uncertainty also arises when we attempt to separate the effects of an instrument from other external changes that influence developments, such as energy prices and spontaneous technological advances, and to put prices on the transaction costs to stakeholders and the overall impact of instruments on the national economy.

A rough indication of the cost-effectiveness of the policy instruments concerned and the overall climate strategy can nevertheless be obtained by estimating the effects and costs of the technical measures implemented as a consequence of the instruments or packages of instruments introduced.

Fig. 4.10 shows estimates of the costs of a selection of conversion and new investment measures in the electricity and heat supply sector, undertaken in Sweden over the period 1990–2010. For each measure, an assessment has been made of the total annual emission reduction it resulted in over the period. The height of the bar representing a given measure shows its estimated cost on the y-axis, while the width of the bar shows, on the x-axis, the estimated annual emission reduction it achieved. The costs of measures have been calculated without policy instruments such as taxes and grants and using a cost of capital of 4%, which reflects a macroeconomic perspective, rather than that of an investor. The costs shown in the diagram thus do not tally with the actual costs to the households or companies implementing the measures.

The results depend to a large extent on what fuel costs and hence what price differences between fuels are assumed over the period. The fuel costs assumed in the calculations are close to the average for 1990–2010. Over the period, fuel price differences (relative prices) varied most between biofuels and oil, while they were fairly stable between coal and biofuels (apart from one year). As a result, the costs of measures involving a switch from coal varied relatively little over the period, while those of measures to replace oil fell sharply as oil prices rose, even to negative values (making the measures profitable for society), as biofuel prices did not rise to the same extent. For measures relating to electricity production, the alternative investment has been assumed to be coal-fired condensing plant in Sweden (see section 4.2.3). If, instead, coal-fired CHP was assumed as the alternative, the effect of the measures would be reduced by 20% and the costs per kg CO_2 thus increased.

The diagram shows estimated historical costs of measures and does not represent an assessment of future costs. Sources of error and limitations exist in

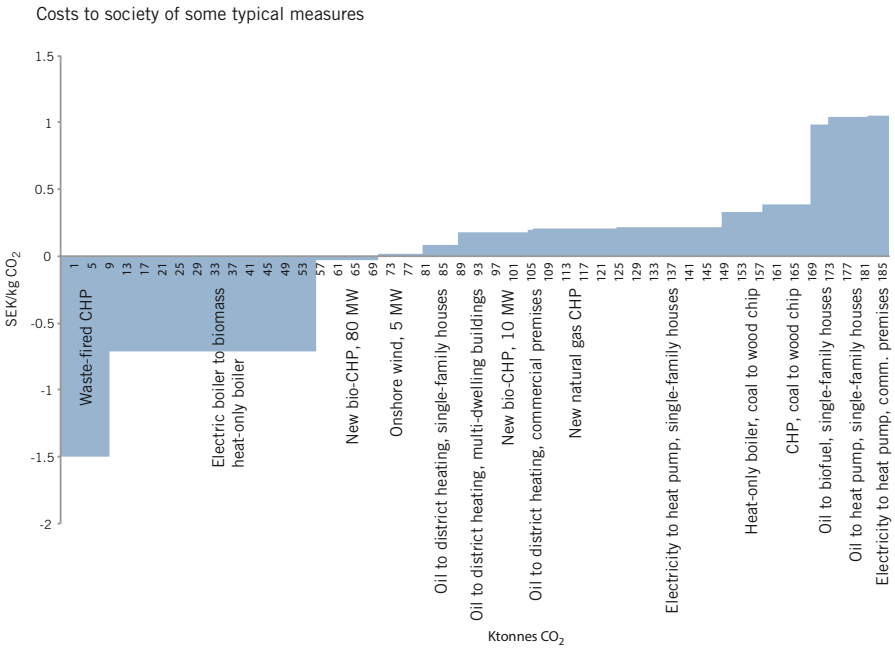


Figure 4.10 **Estimated costs to society and annual emission reductions for typical measures in the area of electricity and heat supply, implemented in Sweden 1990–2010 (weather corrected).**

the method and the underlying data. The effects of fuel switching may be overestimated, as no account is taken of the fact that energy efficiency measures were also undertaken, reducing energy use overall. On the other hand, there are additional conversion measures which could not be estimated, owing to limitations in the statistics. In the calculations, an average energy price has been assumed for the whole period, but measures may very well not have been implemented until electricity and fossil fuel prices were higher than the average, or until the price ratio between fossil and renewable fuels was at its most favourable. A large proportion of switching from oil in the residential sector, for example, was carried out in the 2000s, when oil prices were high. It should be noted that, in most cases, the costs of measures are well below the level of carbon dioxide tax that applied in Sweden in the 2000s. The tax was thus at such a level that it was able to offset by a good margin:

- the larger return on investments required by households and companies (compared with central government)
- transaction costs
- other market barriers.

The cost of waste-fired CHP is particularly low in the estimates, owing to the fact that waste incineration plants generate revenue, in that they can levy a special treatment charge.

Which policy instruments or combinations of instruments were of significance in bringing about the measures undertaken is difficult to determine precisely, beyond the information provided in earlier sections about the instruments targeted at specific sectors. Measures involving the building of new renewable electricity-generating capacity (wind power, bio-CHP), for example, were probably promoted by the electricity certificates system, as certificate prices increased over the period, although the EU ETS may also have contributed by raising the price of electricity somewhat. Special grants were provided for offshore wind power, but we have no cost estimates for this type of measure. The very low cost of new waste CHP can probably be attributed to the bans on landfill and the high costs of alternative treatments of waste, resulting in waste incinerators being able to charge for receiving combustible waste. The energy and carbon dioxide taxes are judged to have been significant in reducing fossil fuel use in the residential sector, offering powerful incentives to switch to non-fossil fuels.

4.4.3 Policy instrument changes that have improved cost-effectiveness

As proposed in Government Bill 2009/10:41 (Ministry of Finance 2009), the Riksdag has decided to reduce, in two stages, the relief on the standard rate of carbon dioxide tax given to industry outside the EU ETS and to agriculture, forestry and pisciculture. The Government made the assessment in 2009 that the carbon dioxide tax could be raised for these sectors, without it resulting to any significant degree in carbon dioxide and other greenhouse gas emissions moving in such a way that global emissions would not be reduced. This assessment was based on the fact that energy generally accounts for a small share of total costs for non-EU ETS enterprises, with the principal exception of greenhouse horticulture. The change introduced will improve the cost-effectiveness of climate policy, in that the same price will apply across a wider range of emissions. The National Institute of Economic Research (2012) notes in its analysis that, in the long term, the change will make for a more cost-effective tax system.

4.5 Policies and measures no longer in place

Compared with the account given in Sweden's Fifth National Communication, four policy instruments are no longer in place (see Table 4.4).

Table 4.4 **Policy instruments withdrawn from use since the Fifth National Communication**

Instrument	Primarily replaced by
Delegation for Sustainable Cities	–
Support for solar heating	Property renovation (ROT) deduction
PFE Act	–
Green vehicle rebate	Exemption from annual vehicle tax for new green vehicles

4.6 Summary of policies and measures

Name of policy/ measure	Primary objective	Green-house gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt CO_2 eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Cross-sectoral instruments									
Delegation for Sustainable Cities	Transition to ecological sustainability at local level	All	Economic	Concluded (2009–12)	Swedish National Board of Housing, Building and Planning	NE	NE	NE	NE
Environmental Code	Ecologically sustainable development	All	Legislation	Ongoing (1999–)	Swedish Environmental Protection Agency	NE	NE	NE	NE
New Planning and Building Act	Promote sustainable development of society	All	Legislation	Ongoing (2011–)	Swedish National Board of Housing, Building and Planning	NE	NE	NE	NE
Climate and energy advice	Greater awareness of possible measures	All	Information	Ongoing (1998–)	Swedish Energy Agency	NE	NE	NE	NE
Research and development	Development of technology with very low climate impact	All	Economic	Ongoing (1990–)	Swedish Energy Agency (mainly)	NE	NE	NE	NE
Production of electricity and district heating									
Energy tax	Fiscal, and to improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (1957–)	Swedish Tax Agency	14	16	16	15
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (1991–)	Swedish Tax Agency				
Electricity certificates system	Increase supply of electricity from renewable energy sources	Carbon dioxide	Economic	Ongoing (2003–)	Swedish Energy Agency and Svenska Kraftnät (Swedish National Grid)				
EU Emissions Trading System (EU ETS)	Reduce use of fossil fuels in trading sector	Carbon dioxide	Economic	Ongoing (2005–)	Swedish Environmental Protection Agency and Swedish Energy Agency				
Special support for wind power	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (2007–)	Swedish Energy Agency	NE	NE	NE	NE
Guarantees of Origin of Electricity Act	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (2010–)	Swedish Energy Agency and Svenska Kraftnät	NE	NE	NE	NE
Central government support for installa-tion of solar cells	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (2009–)	Swedish Energy Agency	NE	NE	NE	NE

Name of policy/ measure	Primary objective	Green-house gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt CO_2 eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Residential and commercial/institutional sector									
Energy tax	Fiscal, and to improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (1957–)	Swedish Tax Agency	1.3	0.3	0.5	0.7
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (1991–)	Swedish Tax Agency				
Building regulations – energy efficiency standards	More efficient energy use	Carbon dioxide	Legislation	Ongoing	Swedish National Board of Housing, Building and Planning				
Energy performance certificates	More efficient energy use	Carbon dioxide	Legislation and infor-mation	Ongoing (2009–)	Swedish National Board of Housing, Building and Planning				
Ecodesign Act	More efficient energy use	Carbon dioxide	Legislation	Ongoing (2010–)	Swedish Energy Agency				
Mandatory energy labelling	More efficient energy use	Carbon dioxide	Information	Ongoing (1995–)	Swedish Energy Agency				
Technology procurement	More efficient energy use and increased use of renewable energy	Carbon dioxide	Economic	Ongoing	Swedish Energy Agency	NE	NE	NE	NE
Support for solar heating	Increased use of renewable energy	Carbon dioxide	Economic	Concluded (2009–11)	Swedish National Board of Housing, Building and Planning	NE	NE	NE	NE
Industrial emissions from fuel combustion and processes (incl. emissions of fluorinated greenhouse gases)									
Energy tax	Fiscal, and to improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (1957–)	Swedish Tax Agency	–0.8	0	0.2	0.4
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (1991–)	Swedish Tax Agency				
Electricity certificates system	Increase supply of electricity from renewable energy sources	Carbon dioxide	Economic	Ongoing (2003–)	Swedish Energy Agency and Svenska Kraftnät				
EU Emissions Trading System (EU ETS)	Reduce use of fossil fuels in trading sector	Carbon dioxide	Economic	Ongoing (2005–)	Swedish Environmental Protection Agency and Swedish Energy Agency				
Reduced carbon dioxide tax relief for industry outside EU ETS, and energy tax on fossil fuels for heating in industry	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (2011–)	Swedish Tax Agency	–	0.4	0.4	–
Programme for Energy Efficiency in Energy-Intensive Industry (PFE)	Reduce use of electricity	Carbon dioxide	Voluntary/ negotiated agreement	Concluded (2005–12)	Swedish Energy Agency	NE	NE	NE	NE
Environmental Code	Ecologically sustainable development	All	Legislation	Ongoing (1999–)	Swedish Environmental Protection Agency	NE	NE	NE	NE
F-gas Regulation and Mobile Air Conditioning Directive		HFCs	Legislation	Ongoing		0.2	0.5	0.7	NE

Name of policy/ measure	Primary objective	Green-house gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt CO_2 eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Transport									
Emission standards for new vehicles	Reduce carbon di-oxide emissions from light-duty vehicles	Carbon dioxide	Legislation	Ongoing (2015 and 2017)	Swedish Transport Agency	NE	NE	NE	NE
Support for research and demonstration	Develop technol-ogy for sustainable growth and reduced fossil fuel depend-ence	Carbon dioxide	Economic	Ongoing	VINNOVA and Swedish Energy Agency (mainly)	NE	NE	NE	NE
Vehicle fuel taxes (energy and carbon dioxide taxes)	Internalise external effects of road trans-port, incl. green-house gas emissions	Carbon dioxide	Economic	Ongoing	Swedish Tax Agency	2	2	2	NE
Increased energy tax on diesel	Internalise external effects of road trans-port, incl. green-house gas emissions	Carbon dioxide	Economic	Ongoing (2011 and 2013)	Swedish Tax Agency	NE	NE	NE	NE
Targeted instruments to promote introduc-tion of renewable transport fuels	Increase use of renewable transport fuels	Carbon dioxide	Economic	Ongoing	Swedish Tax Agency (mainly)	1.8	2.6	3	NE
Waste									
Rules on municipal waste planning and on producer respon-sibility for certain products, landfill tax (2000), bans on landfill of separated combustible waste (2002) and of organic waste (2005)	Increase recycling and reduce total quantities of waste	Methane	Legislation and fiscal instruments	Ongoing	Swedish Environmental Protection Agency	1.4	1.7	1.9	NE
Agriculture									
Targeted agri-environ-ment payments under Rural Development Programme	Reduced Climate Impact, A Varied Agricultural Landscape and Zero Eutrophication	Nitrous oxide and methane	Economic	Ongoing (2007–13)	Swedish Board of Agriculture	0.5	NE	NE	NE
Land use, land-use change and forestry (LULUCF)									
Provisions of Forestry Act on forest manage-ment etc.	Achieve environ-mental and produc-tion objectives for forests	Carbon dioxide	Legislation	Ongoing	Swedish Forest Agency	NE	NE	NE	NE
Provisions of Environ-mental Code on land drainage	Biodiversity	Carbon dioxide and methane	Legislation	Ongoing	County administra-tive boards	NE	NE	NE	NE
Provisions on nature reserves and habitat protection areas in Environmental Code, and nature conserva-tion agreements	Biodiversity	Carbon dioxide	Legislation	Ongoing	Swedish Environ-mental Protection Agency and county administrative boards	NE	NE	NE	NE

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5 Projections and the total effect of policies and measures

The projection of emissions and removals of greenhouse gases described in this chapter has been developed for the present National Communication and for Sweden's reporting to the EU (Ministry of the Environment 2013) in accordance with the requirements of the EU decision on monitoring of greenhouse gases.[1] The projection's reference scenario is based on the policies and measures currently adopted by the EU and the Riksdag (the Swedish Parliament)[2] and on an assessment of future economic trends. It builds on a series of assumptions, all of which are subject to uncertainty, and can primarily be seen as an impact assessment of the assumptions made. The results should be interpreted with this in mind.

The method used to calculate the projection is primarily designed with a medium- or long-term projection in mind, which means that no account is taken of shorter-term variations. For calculation assumptions and the methodology employed, see Annex 5. In addition to the 'with measures' projection, two sensitivity alternatives have been calculated, as well as a 'with additional measures' projection that includes planned policies and measures as well as those already adopted.

5.1 Projection of total emissions

Total greenhouse gas emissions in Sweden in 2011 were 61.4 million tonnes of carbon dioxide equivalent (Mt CO_2 eq), excluding emissions and removals from the land use, land-use change and forestry (LULUCF) sector. The results of the projection (see Fig. 5.1 and Table 5.1) point to a gradual decline in total emissions of greenhouse gases (excl. LULUCF) over the projection period. By 2020, aggregate emissions are projected to be 19% lower than in 1990, and by 2030 there is expected to be a further reduction, to 21% below 1990 levels.

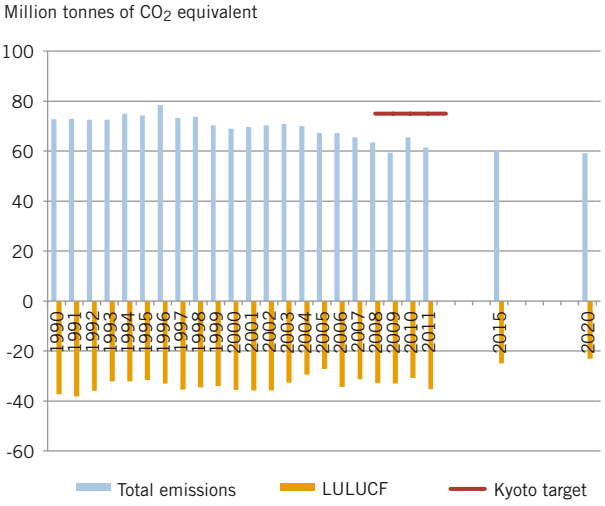

Figure 5.1 **Historic and projected total greenhouse gas emissions and Sweden's Kyoto target.**

The LULUCF sector represented a net sink for Sweden

Table 5.1 **Historic and projected emissions and removals of greenhouse gases, by sector (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Energy	53.7	45.0	44.8	44.3	43.6	42.8	–17%	–20%
Industrial processes	6.3	6.7	6.3	6.2	6.2	6.2	–2%	–2%
Solvent use	0.3	0.3	0.3	0.3	0.3	0.3	–6%	–11%
Agriculture	9.0	7.8	7.5	7.3	7.3	7.2	–19%	–20%
Waste	3.4	1.7	1.3	1.1	0.9	0.8	–69%	–77%
Total emissions	**72.8**	**61.5**	**60.3**	**59.2**	**58.2**	**57.3**	**–19%**	**–21%**
Land use (LULUCF)	–37.2	–35.2	–24.9	–23.0	–21.9	–23.9	–38%	–36%

[1] Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (this decision was repealed and replaced in 2013 by EU Regulation No 525/2013).

[2] Up to the end of 2011.

over the period 1990–2011 and is projected to continue to do so up to 2030.

5.2 Projections by gas

In 2011, carbon dioxide made up around 80% of total emissions, with nitrous oxide accounting for 11%, methane for 8% and fluorinated greenhouse gases for just under 2%. Between 2011 and 2030, emissions of all gases are projected to decrease. The mix of greenhouse gases emitted is expected to change over the projection period, with a slight increase in carbon dioxide's share of the total. Historic and projected emissions, broken down by gas, are shown in Table 5.2.

5.3 Projections by sector

The emissions projection is based on many different assumptions, and trends in greenhouse gas emissions differ between sectors. Drivers of emission trends in some sectors include economic growth, prices, population growth and policy instruments. Over the period 2011–30, emissions from domestic transport, for example, are expected to decrease, while those from the energy industries remain unchanged. Emissions from industrial combustion are projected to rise somewhat up to 2020, before showing a modest fall. Emissions in the remaining sectors decrease slightly over the period of the projection (see Fig. 5.2).

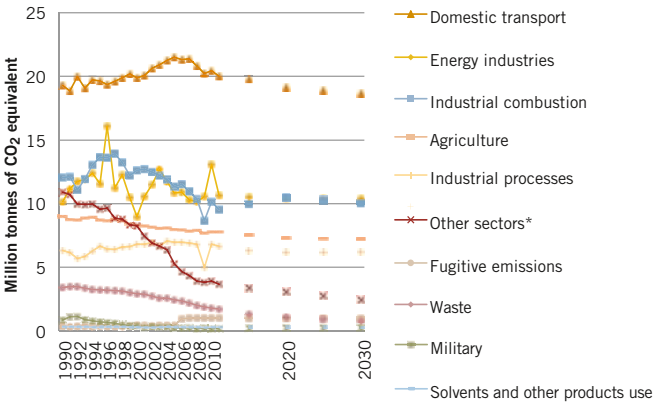

Figure 5.2 **Historic and projected greenhouse gas emissions from different sectors.**

* i.e. fuel combustion in the commercial/institutional, residential and agriculture/forestry/fisheries sectors.

5.3.1 Energy industries

Emissions from the energy industries, i.e. production of electricity and district heating, refineries and the manufacture of solid fuels, are projected to show differing trends in each of the subsectors, but to remain at the same level overall throughout the projection period. This is due to a slight decrease in emissions from electricity generation and district heating, combined with a significant rise in refinery emissions. Emissions from the manufacture of solid fuels remain at roughly the same level over the projection horizon. The biggest increase is expected in emissions of methane (see Table 5.3).

Production of electricity and district heating

Greenhouse gas emissions from the generation of electricity and district heating are projected to fall slightly from 2011 to 2030 (see Table 5.4). This is despite an increase early in the projection period in the production of electricity in particular, but also of district heat. The reduction in emissions, despite higher production, is due to a partial change in the fuel mix. Increased use of natural gas, fuels from the iron and steel industry and, to some extent, waste will add to emissions, but this will be offset by greater use of biofuels and wind power and a decline in the use of oil, coal and peat. Biofuel use is expected to rise above all at combined heat and power plants, a trend favoured by both the electricity certificates scheme and the EU Emissions Trading System. Between 2012 and 2020, production of electricity is assumed to grow more than consumption, resulting in a projected net export of around 23 TWh by 2020.

Table 5.2 **Historic and projected total greenhouse gas emissions, excl. LULUCF, by gas (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	57.0	48.7	48.6	48.3	47.6	47.0	–15%	–18%
Methane	6.9	5.6	4.4	4.0	3.8	3.7	–42%	–47%
Nitrous oxide	8.4	6.7	6.5	6.4	6.3	6.3	–24%	–24%
Fluorinated greenhouse gases	0.5	1.1	0.7	0.5	0.4	0.3	–2%	–35%
Total emissions (excl. LULUCF)	**72.8**	**61.5**	**60.3**	**59.2**	**58.2**	**57.3**	**–19%**	**–21%**

Table 5.3 **Historic and projected greenhouse gas emissions from the energy industries (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	9.8	10.1	10.0	9.9	9.9	9.9	1%	1%
Methane	0.02	0.09	0.10	0.08	0.08	0.09	271%	286%
Nitrous oxide	0.3	0.4	0.4	0.4	0.4	0.4	24%	27%
Total emissions	**10.1**	**10.7**	**10.5**	**10.4**	**10.4**	**10.4**	**2%**	**3%**

Refineries

Refinery emissions are expected to rise appreciably throughout the projection period (see Table 5.5). This is due partly to assumed growth in production, and partly to increased emissions from refining of products meeting higher quality standards. Emissions from refineries are also reported in the fugitive emissions sector.

Manufacture of solid fuels

Greenhouse gas emissions from the manufacture of solid fuels are projected to remain at the same level as in the last few years, around 0.3 Mt CO_2 eq, up to 2030.

5.3.2 Industrial emissions

To cover industrial emissions, account needs to be taken of both process emissions and emissions from fuel combustion in industry, which according to UNFCCC guidelines are to be reported under separate CRF (Common Reporting Format) categories. Greenhouse gas emissions from industrial processes originate from the materials used in the processes, and make up 30–40% of total emissions from industry. Emissions from industrial combustion of fossil fuels account for the remainder.

Combustion emissions from industry vary from year to year, chiefly depending on production volumes and fluctuations in the economy. A small number of energy-intensive industries are responsible for a large share of emissions in this sector. Iron and steel, pulp and paper and chemicals together account for almost half the sector's emissions.

Total energy use in industry is expected to rise between 2011 and 2030, mainly as a result of assumed growth in production. Industrial combustion emissions, on the other hand, are projected to fall (see Table 5.6). This assessment is based above all on an expected reduction in emissions from the pulp and paper industry, driven by a shift from fossil fuels to greater use of biofuels. Emissions from the chemicals, non-ferrous metals, engineering, mineral products and food industries are also expected to show a slight decline. Mining and iron and steel industry emissions, by contrast, are projected to increase somewhat.

Table 5.4 **Historic and projected greenhouse gas emissions from production of electricity and district heating (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	7.7	7.8	7.5	7.2	7.1	7.0	–5%	–17%
Methane	0.02	0.09	0.08	0.07	0.07	0.07	–7%	–19%
Nitrous oxide	0.3	0.4	0.4	0.4	0.4	0.4	232%	195%
Total emissions	**8.0**	**8.3**	**8.0**	**7.6**	**7.5**	**7.4**	**–5%**	**–17%**
Electricity production (TWh)	142	147	160	174	175	175	23%	23%
District heating production (TWh)	41	56	57	59	58	57	42%	38%

Table 5.5 **Historic and projected greenhouse gas emissions from refineries (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	1.8	2.0	2.2	2.4	2.5	2.6	34%	45%
Methane	0.001	0.001	0.001	0.001	0.001	0.001	29%	39%
Nitrous oxide	0.02	0.02	0.02	0.03	0.03	0.03	25%	35%
Total emissions	**1.8**	**2.0**	**2.2**	**2.4**	**2.5**	**2.6**	**34%**	**45%**

Table 5.6 **Historic and projected greenhouse gas emissions from industrial combustion (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	11.5	9.0	9.4	10.0	9.7	9.5	–13%	–17%
Methane	0.05	0.05	0.05	0.04	0.04	0.05	–5%	–1%
Nitrous oxide	0.5	0.5	0.5	0.5	0.5	0.5	–4%	–6%
Total emissions	**12.1**	**9.5**	**10.0**	**10.5**	**10.3**	**10.0**	**–13%**	**–17%**
Energy use (TWh)	140	144	158	171	175	178	22%	27%

Table 5.7 **Historic and projected emissions from industrial processes (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	4.9	5.5	5.4	5.6	5.6	5.7	13%	16%
Methane	0.01	0.01	0.02	0.02	0.02	0.02	19%	25%
Nitrous oxide	0.9	0.1	0.1	0.1	0.1	0.2	–84%	–83%
Fluorinated greenhouse gases	0.5	1.1	0.7	0.5	0.4	0.3	–2%	–35%
Total emissions	**6.3**	**6.7**	**6.3**	**6.2**	**6.2**	**6.2**	**–2%**	**–2%**

Process-related emissions of carbon dioxide, methane and nitrous oxide are expected to increase somewhat over the projection horizon. Emissions of fluorinated greenhouse gases showed a rising trend over the period 1990–2008, but have since fallen, a decline that is expected to continue from 2011 to 2020 and 2030. This decrease is due above all to the bans that will progressively come into effect in the EU for several areas of use of fluorinated greenhouse gases. The net effect on process emissions from industry is a slight decline up to 2030 (see Table 5.7).

5.3.3 Other sectors

Emissions from 'Other sectors', i.e. fuel combustion in the commercial and institutional, residential, and agriculture, forestry and fisheries sectors, fell sharply from 1990 to 2011 and are expected to continue to decrease somewhat up to 2020 and 2030 (see Table 5.8). The decline is primarily due to heat pumps, biofuels and district heating replacing the use of oil for space and water heating in homes and premises.

Emissions from energy use in agriculture are projected to fall between 2011 and 2020, owing to reduced consumption of diesel for mobile machinery and of oil for greenhouses and other agricultural buildings. Emissions from forestry machinery are expected to remain level over the projection period.

5.3.4 Military

Emissions from military transport decreased between 1990 and 2011. Over the projection period, they are expected to remain at roughly the same level as in the last few years, between 0.2 and 0.3 Mt CO_2 eq (see Table 5.9).

5.3.5 Fugitive emissions

The majority of emissions in this sector originate from refineries. Fugitive emissions are expected to remain at roughly the same level over the projection horizon, i.e. around 1.0 Mt CO_2 eq (see Table 5.10).

5.3.6 Transport

Emissions in the transport sector had increased in 2011 compared with 1990. Since 2005, however, there has been a slight downward trend. This decline is expected to slow down, but according to the projection will continue up to 2030 (see Tables 5.11 and 5.12).

The majority of emissions come from cars and heavy-duty vehicles. The projected decline in emissions between 2011 and 2020 is due chiefly to reduced use of

Table 5.8 **Historic and projected emissions from 'Other sectors'* (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	10.4	3.1	2.9	2.6	2.3	2.1	–75%	–80%
Methane	0.24	0.31	0.25	0.25	0.22	0.21	2%	–15%
Nitrous oxide	0.29	0.27	0.24	0.23	0.22	0.21	–20%	–27%
Total emissions	**10.9**	**3.7**	**3.3**	**3.1**	**2.8**	**2.5**	**–72%**	**–77%**

* i.e. fuel combustion in the commercial/institutional, residential and agriculture/forestry/fisheries sectors

Table 5.9 **Historic and projected greenhouse gas emissions from military transport (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	0.8	0.2	0.2	0.2	0.2	0.2	–71%	–71%
Methane	0.001	0.00004	0.0002	0.0002	0.0002	0.0002	–81%	–81%
Nitrous oxide	0.02	0.002	0.005	0.005	0.005	0.005	–68%	–68%
Total emissions	**0.9**	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**–71%**	**–71%**

Table 5.10 **Historic and projected fugitive emissions of greenhouse gases (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	0.3	0.9	0.9	0.9	0.9	0.9	189%	189%
Methane	0.08	0.1	0.1	0.1	0.1	0.1	25%	25%
Nitrous oxide	0.001	0.004	0.004	0.004	0.004	0.004	192%	192%
Total emissions	**0.4**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**157%**	**157%**

Table 5.11 **Historic and projected emissions from domestic transport (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	18.9	19.8	19.6	18.9	18.7	18.4	0.1%	–3%
Methane	0.2	0.05	0.03	0.02	0.02	0.01	–90%	–90%
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	–7%	9%
Total emissions	**19.3**	**20.0**	**19.8**	**19.1**	**18.9**	**18.7**	**–1%**	**–3%**
Petrol (TWh)	49.8	34.5	30.3	23.2	20.2	17.2	–53%	–65%
Diesel (TWh)	16.5	36.2	39.6	43.7	45.8	47.9	165%	191%

petrol and switching to diesel and to more energy-efficient vehicles. A modest shift to biofuels will also contribute to the downward trend.

Emissions from domestic aviation have fallen in recent years, with a growing proportion of passengers switching from shorter-haul flights to rail. This trend is expected to continue, resulting in lower emissions in 2020 and 2030. Emissions from domestic shipping are likewise projected to decline up to 2020 and 2030. Rail traffic is expected to increase up to 2020 and 2030, but emissions are not projected to rise as most rail services are electrified.

5.3.7 Solvent and other product use

Greenhouse gas emissions from the use of solvents and other products fell somewhat between 1990 and 2011. Up to 2020 and 2030, emissions are projected to remain at roughly the same level as in the last few years, just under 0.3 Mt CO_2 eq (see Table 5.13).

5.3.8 Waste

Emissions of methane from landfill sites have fallen since 1990 owing to a decrease in the quantities of waste going to landfill, driven in part by the bans on landfill disposal, municipal waste plans and the waste tax. A further reduction in emissions has been achieved by methane recovery. The downward trend is projected to continue up to 2020 and 2030 (see Table 5.14), thanks to recovery of methane and a further decline in the amount of waste sent to landfill.

Emissions of carbon dioxide from incineration of hazardous waste and of nitrous oxide from wastewater treatment are low and are expected to remain at the same level as in 2011 over the projection horizon.

5.3.9 Agriculture

Emissions from the agricultural sector have fallen since 1990, and the decline is projected to continue up to 2020 (see Table 5.15). Nitrous oxide accounts for a somewhat larger percentage reduction than methane, but also for a greater share of emissions.

The decrease is largely due to reduced numbers of cattle, leading to lower emissions of methane from enteric fermentation and of methane and nitrous oxide from animal manure. Nitrous oxide emissions are also expected to fall as a consequence of a smaller area under cereals, declining use of mineral fertilisers, reduced leaching of nitrogen, and a shift to slurry systems for manure management (see Table 5.16).

A smaller dairy herd and continued decline in the

Table 5.12 **Historic and projected greenhouse gas emissions from different modes of transport (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Road	17.6	18.6	18.4	17.7	17.4	17.2	0%	–2%
Aviation	0.7	0.5	0.6	0.6	0.6	0.6	–8%	–13%
Shipping	0.6	0.5	0.5	0.5	0.5	0.5	–18%	–18%
Rail	0.1	0.07	0.07	0.07	0.07	0.07	–35%	–35%
Other*	0.3	0.3	0.3	0.3	0.3	0.3	8%	8%

* includes mobile machinery not used in industry, agriculture, forestry or households

Table 5.13 **Historic and projected greenhouse gas emissions from solvent and other product use (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	0.24	0.16	0.16	0.16	0.15	0.15	–35%	–38%
Nitrous oxide	0.09	0.13	0.13	0.13	0.13	0.13	39%	39%
Total emissions	**0.33**	**0.29**	**0.29**	**0.28**	**0.28**	**0.28**	**–15%**	**–17%**

Table 5.14 **Historic and projected greenhouse gas emissions from the waste sector (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Carbon dioxide	0.04	0.06	0.05	0.05	0.05	0.05	25%	25%
Methane	3.2	1.5	1.1	0.8	0.7	0.6	–74%	–82%
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	–22%	–22%
Total emissions	**3.4**	**1.7**	**1.3**	**1.1**	**0.9**	**0.8**	**–69%**	**–77%**

Table 5.15 **Historic and projected emissions from the agricultural sector (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Methane	3.2	2.9	2.8	2.7	2.7	2.7	–15%	–15%
Nitrous oxide	5.8	4.9	4.7	4.6	4.6	4.5	–21%	–22%
Total emissions	**9.0**	**7.8**	**7.5**	**7.3**	**7.3**	**7.2**	**–19%**	**–20%**

cereal area up to 2020 and 2030 will be a result of increased productivity, with production maintained at the same level in 2030 as today. The scenario also takes account of trends in agricultural prices and further adjustment to the latest reform of EU farm policy from 2005, with its decoupling of support from production.

5.3.10 Land use, land-use change and forestry

From 1990 to 2011, the land use, land-use change and forestry (LULUCF) sector represented an annual net sink for Sweden. The size of this sink varied over the period, but the trend indicates a slight decline in removals attributable to the sector.

Net removals from LULUCF are primarily dependent on the uptake of carbon dioxide in living forest biomass, which is in turn affected by felling and forest growth. The projection is based on a long-term sustainable scenario with maximum annual felling in relation to annual growth, i.e. with no overfelling. In addition, harvesting of forest residues is assumed to increase in response to growing demand for bioenergy. Annual growth is assumed to rise by 2% from 2010 to 2020 and by 4% from 2020 to 2030, as a result of assumed changes in climate. With these scenario assumptions, the projection shows a decrease in the net sink up to 2025, followed by an increase up to 2030 (see Table 5.17).

5.3.11 International bunkers

Total greenhouse gas emissions from international shipping and aviation – international bunkers – increased between 1990 and 2011 and are projected to go on rising up to 2020, though not at the same rate as before (see Table 5.18). The increase in emissions up to 2020 is primarily due to rising emissions from international shipping, driven by growth in exports of goods.

Greenhouse gas emissions from international aviation are also projected to increase up to 2020. This can be attributed to an expected rise in private consumption, which will be accompanied by increased travel.

5.4 Sensitivity analysis

Two sensitivity alternatives have been developed for the energy sector, one involving lower emissions (higher fossil fuel prices) and the other higher emissions (higher economic growth) (see Table 5.19). In the lower emissions alternative, fossil fuel prices are roughly 30% higher than in the main alternative. The price of electricity is also assumed to be higher. Other assumptions are identical to those underlying the reference scenario (see Annex 5). The higher emissions alternative assumes higher growth in GDP and hence higher industrial growth and increased transport activity.

As expected, the alternative with higher fossil fuel prices results in lower emissions in 2030 than in the reference scenario. With prices for fossil fuels roughly 30% higher, emissions are projected to be further reduced by 2020, to 58.7 Mt CO_2 eq, which is some 19% lower than in 1990. By 2030, they fall to 22% below 1990 levels. The higher prices increase the incentive to replace fossil fuels and improve energy efficiency. The pace of investments to phase out these fuels in industry, and to enhance energy efficiency, is therefore

Table 5.16 **Historic and projected emissions from the agricultural sector, broken down into enteric fermentation, manure management and agricultural soils (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020
Enteric fermentation	3.0	2.6	2.5	2.4	2.4	2.4	–18%
Manure management	1.0	0.7	0.7	0.7	0.7	0.7	–27%
Agricultural soils	5.1	4.4	4.3	4.2	4.1	4.1	–18%
Total emissions	**9.0**	**7.8**	**7.5**	**7.3**	**7.3**	**7.2**	**–19%**

Table 5.17 **Historic and projected emissions and removals from LULUCF (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990-2020	1990–2030
Forest land	–40.5	–39.3	–29.5	–27.4	–26.3	–28.3	–32%	–30%
Cropland	2.4	1.3	2.0	1.8	1.8	1.8	–28%	–28%
Grassland	–0.3	0.001	–0.07	–0.06	–0.06	–0.06	–80%	–81%
Wetlands	0.04	0.05	0.05	0.05	0.05	0.05	37%	37%
Settlements	1.2	2.7	2.6	2.6	2.6	2.6	122%	122%
Total emissions	**–37.2**	**–35.2**	**–24.9**	**–23.0**	**–21.9**	**–23.9**	**–38%**	**–36%**

Table 5.18 **Historic and projected emissions from international bunkers (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990-2020	1990–2030
Shipping	2.3	6.0	7.6	7.8	7.8	7.8	242%	245%
Aviation	1.4	2.3	2.3	2.4	2.5	2.6	76%	93%
Total emissions	**3.6**	**8.3**	**9.9**	**10.1**	**10.3**	**10.4**	**180%**	**188%**

expected to be stepped up. In 'Other sectors' (commercial/institutional, residential and agriculture/forestry/fisheries), the use of all sources of heating except biofuels and district heating is projected to decline. Switching from fuel oil to other alternatives in these sectors will be accelerated. A higher oil price is expected to slow growth in passenger transport, and for freight the pace of efficiency improvements will increase, driven by both enhanced technology and more efficient logistics. In this scenario, higher fossil fuel prices will push up electricity prices, benefiting wind power.

The scenario based on higher economic growth in the energy and transport sector results in higher emissions than the reference scenario. It produces a reduction of 18% by 2020, rather than 19% as in the reference scenario. By 2030, emissions are projected to fall by 19%. Stronger economic growth means increased production in industry, leading to greater use of energy and hence higher emissions. It also boosts imports and exports and demand for both freight and passenger transport.

5.5 Projection with additional measures

National measures to reduce greenhouse gas emissions are continuously reviewed and updated, or new ones introduced. A 'with additional measures' projection has been developed to demonstrate the effect on emissions of planned policies and measures. Continued use of biofuels is considered important in meeting the milestone target for 2020 under Sweden's *Reduced Climate Impact* objective, but is also seen as a key component of energy and climate policy in the longer term and in working towards the Government's priority of a vehicle fleet independent of fossil fuels.

With effect from 1 February 2013, to promote renewable energy in the road transport sector, sustainable biofuels in petrol and diesel, in blends of up to 5% by volume, are exempt from the whole of the carbon dioxide tax and most of the energy tax. E85 and other sustainable high-blend biofuels and biofuels with no fossil content are entirely exempt from carbon dioxide and energy tax on their biomass-based component. In the case of sustainable hydrotreated vegetable and animal oils and fats (HVO), exemption from these taxes has applied to up to 15% by volume of HVO in diesel fuel since 1 January 2012. From 1 May 2014, the Government intends to introduce a quota obligation system for low-blend biofuels (Govt. Bill 2011/12:100).

The calculations show that the quota obligation scheme will reduce emissions by 0.4–0.6 Mt CO_2 eq by 2020 and 2030 (see Table 5.20).

5.6 Comparison with the Fifth National Communication

The projection presented in Sweden's Fifth National Communication on Climate Change (NC5, Ministry of the Environment 2010) showed reductions in total greenhouse gas emissions of 10% between 1990 and 2010 and 12% between 1990 and 2020. The projection set out here, in the Sixth National Communication (NC6), uses partly different assumptions and assessments, based on trends over the last few years (see Table 5.21). The new projection shows a decrease in aggregate greenhouse gas emissions of 19% between 1990 and 2020 and of 21% between 1990 and 2030. A comparison of percentage changes in emissions between 1990 and 2020, overall and by sector, is shown in Fig. 5.3. The projection presented here for the energy sector, excluding transport, indicates a larger reduction of emissions by 2020 compared with that in NC5. The difference is mainly due to differing assumptions, for instance regarding fossil fuel prices and electricity certificates.

Table 5.19 **Historic and projected greenhouse gas emissions for different sensitivity alternatives, excl. LULUCF (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Reference scenario	72.8	61.4	60.3	59.2	58.2	57.3	–19%	–21%
Lower emissions alternative	72.8	61.4	60.1	58.7	57.7	56.8	–19%	–22%
Higher emissions alternative	72.8	61.4	60.7	60.0	59.5	59.1	–18%	–19%

Table 5.20 **Historic and projected total greenhouse gas emissions in the reference scenario and with additional measures, excl. LULUCF (million tonnes of CO_2 equivalent)**

	1990	2011	2015	2020	2025	2030	1990–2020	1990–2030
Reference scenario	72.8	61.4	60.3	59.2	58.2	57.3	–19%	–21%
With additional measures	72.8	61.4	60.1	58.7	57.8	57.0	–19%	–22%

For transport, the new projection shows a small decrease in emissions up to 2020, compared with a relatively large increase as projected in NC5. The difference between the two projections is above all a result of assumptions of greater improvements in energy efficiency and higher fossil fuel prices in NC6 than in NC5.

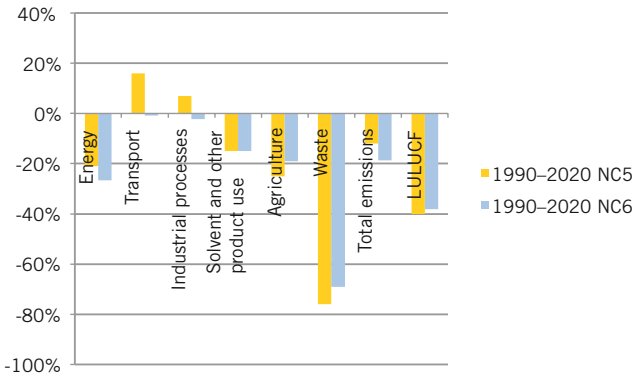

Figure 5.3 **Percentage changes in emissions between 1990 and 2020 as projected in NC5 and NC6, overall and by sector.**

Table 5.21 **Key assumptions for projections in the Fifth and Sixth National Communications (NC5 and NC6)**

	NC5		NC6	
	2005 –2010	2010 –2020	2010 –2020	2020 –2030
GDP (annual change, %)	2.6	2.1	2.4	1.9
	2010	**2020**	**2020**	**2030**
Price of crude oil (US$/barrel)	90	90	112	128
Price of coal (US$/tonne)	96	96	104	110
Price of natural gas (US$/MBtu)	9.2	9.2	10	12
Emissions trading (€/ tonne CO_2)	30	30	16.5	36
Electricity certificates (new renewable electricity)	17 TWh by 2016		25 TWh by 2020	
Nuclear power (economic life)	60 years		60 years	

The projection for industrial processes shows a fall in emissions by 2020, compared with a rise in NC5. The difference is partly due to different assumptions and assessments in the new projection, based on developments in recent years.

For agriculture, the projection indicates a smaller reduction of emissions up to 2020. This is because a new projection has been developed, with new assumptions regarding trends in production, productivity and other factors.

For the waste sector, a somewhat smaller decline in emissions is projected for 2020. The difference is due to a new projection having been developed, based on new assumptions.

Emissions from solvent and other product use decrease to the same extent in the projection for NC6 as in that for NC5.

The projection for the land use, land-use change and forestry sector shows a somewhat smaller net sink compared with NC5. The difference is partly attributable to a revision of the time series of greenhouse gas emissions and removals and the development of a new projection.

5.7 Assessment of aggregate effects of policies and measures

This section describes the overall effects of the economic instruments introduced since 1990 and reported and quantified in Chapter 4. Table 5.22 presents the aggregate effects of the instruments implemented for which estimates have been made.

Table 5.22 **Estimated effects of economic instruments implemented, by sector (million tonnes of CO_2 equivalent/ year) (summary of account in Chapter 4)**

Sector	2015	2020
Electricity and district heating	16	16
Residential and commercial/ institutional	0.3	0.5
Industry	0	0.2
Transport	4.6	5
Waste	1.7	1.9
Total	**22.6**	**23.6**

Fig. 5.4 shows an estimated emissions trajectory without measures, together with a graph of historic and projected emissions in Sweden up to 2020. Historic and projected emissions include the effects of policies and measures implemented since 1990, and of existing and planned measures from 2012. In addition to the effects of the policies and measures presented in Chapter 4, the 'without measures' estimate takes account of the effects of the cross-sectoral instruments LIP (local investment programmes for ecologically sustainable development) and KLIMP (local climate investment programmes), which have been discontinued. The 'with measures' projection encompasses policies and measures adopted up to 2012, while the 'with additional measures' projection also includes the planned instruments presented in section 5.5.

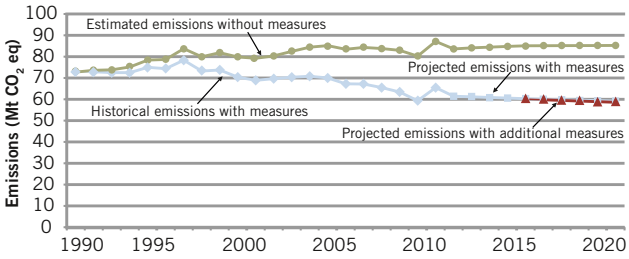

Figure 5.4 **Estimated emissions without measures and with additional measures, compared with historic and projected emissions with existing measures.**

5.8 Progress towards meeting Sweden's commitment for the first commitment period of the Kyoto Protocol

Under Sweden's commitment for the first commitment period of the Kyoto Protocol (2008–12) and EU burden sharing, greenhouse gas emissions in Sweden, excluding LULUCF, are not to exceed the country's assigned amount, which was 104% of base-year emissions as an average for the years 2008–12 when assigned amount units (AAUs) were allocated. The base year is 1990 for all emissions except fluorinated greenhouse gases, for which it is 1995. Base-year emissions, when the assigned amount was determined, were 72.2 Mt CO_2 eq. This means that Sweden's assigned amount of emissions was set at 75 Mt CO_2 eq per year, as an average for 2008–12, taking no account of flexibilities. Of this amount, around 22.4 Mt CO_2 eq has been allocated to the EU Emissions Trading System (EU ETS). The limit on emissions not included in the trading system is thus 52.6 Mt CO_2 eq as an average for 2008–12.

Sweden's total greenhouse gas emissions for 2008–11, i.e. the first four years of the first commitment period of Kyoto, have been reported. For 2012, there are provisional emissions data that can be used to make a preliminary assessment of progress towards the target for the first commitment period. For emissions covered by the EU ETS, reported figures are available for the whole of the first period. Preliminary average emissions outside the EU ETS for the period 2008–12 come to 41.5 Mt CO_2 eq. A gap analysis has been performed in relation to the target of 52.6 Mt CO_2 eq for non-EU ETS emissions. The preliminary analysis shows that emissions are 11.1 Mt CO_2 eq below this target.

In addition, Sweden can claim credit for a carbon sink of 2.13 Mt CO_2 eq under Articles 3.3 and 3.4 of the Kyoto Protocol. This means that Sweden's emissions are permitted to amount to a maximum of 77.13 Mt CO_2 eq on average for 2008–12, not allowing for transactions in AAUs, certified emission reductions (CERs) etc. The preliminary figure for average total emissions is 61.7 Mt CO_2 eq, which means that, on average, emissions are 13.3 Mt CO_2 eq below the target, taking into account the effect of the EU ETS.

Table 5.23 **Progress towards the Kyoto target (million tonnes of CO_2 equivalent)**

Kyoto base-year emissions	72.2 Mt
Kyoto target, base year to first commitment period (2008–12)	4%
Kyoto target for 2008–12, per year	75 Mt
EU ETS allocation (2008–12)	22.4 Mt
Preliminary non-EU ETS emissions (2008–12)	41.5 Mt
EU ETS allocation + preliminary non-EU ETS emissions, per year	63.9 Mt
Carbon sink under Articles 3.3 and 3.4	2.13 Mt
Emissions 2008–12 per year, incl. carbon sink	61.7 Mt
Average surplus of AAUs, per year	13.3 Mt
Emissions 2008–12 incl. carbon sink, relative to base-year emissions	–18%

Over the period 1990–2011, LULUCF represented an annual net sink in Sweden, varying in size between 27 and 38 Mt CO_2 eq. Only part of this carbon sink can be counted towards meeting the country's Kyoto commitment. Accounting under Article 3.3 of the Kyoto Protocol is mandatory, whereas countries can choose whether they wish to account for activities under Article 3.4. Sweden has elected to account for forest management under Article 3.4.

Article 3.3 of the Kyoto Protocol is expected to result in a net emission for Sweden over the commitment period, as emissions from deforestation exceed removals resulting from afforestation and reforestation. An estimate indicates an emission of 0.6 Mt CO_2 eq per year, but this figure is very uncertain. Under Article 3.4, Sweden is expected to have a total net sink from LULUCF that is greater than the net source under Article 3.3. This means that the country can offset its emissions under Article 3.3 and then claim credit for a carbon sink of a maximum of 2.13 Mt CO_2 eq. Table 5.23 shows that Sweden's Kyoto target can be met with national measures alone, even with no allowance made for the carbon sink.

5.9 Progress towards targets under the EU Climate and Energy Package

Under the EU Climate and Energy Package, greenhouse gas emissions from the Union are to be reduced by 20% compared with 1990 by 2020. Emissions from installations included in the EU Emissions Trading

Table 5.24 **Historic and projected emissions from non-EU ETS sectors in Sweden and ESD target trajectory for 2013–2020, million tonnes of CO_2 equivalent (based on Swedish Environmental Protection Agency 2013 and EU ETS scope for 2013–2020)**

	2005	2013	2014	2015	2016	2017	2018	2019	2020
Projection for non-EU ETS emissions	45.5			37.2					35.4
ESD target trajectory (2013–2020)		40.8	40.2	39.6	38.9	38.3	37.7	37.1	36.4

System (EU ETS) are to fall by 21% between 2005 and 2020 for the EU as a whole. Emissions not covered by the trading system are to be reduced in line with the Effort Sharing Decision (ESD, Decision No 406/2009/EC). For Sweden, this decision means that emissions are to be cut by 17% between 2005 and 2020, in line with a target emissions trajectory (see Table 5.24).

In 2005, emissions from Swedish installations included in the EU ETS totalled 19.4 Mt CO_2 eq. If estimated emissions from additional installations during the second trading period (2008–12) and emissions from domestic aviation are added, emissions within the EU ETS in 2005 can be estimated at 21.8 Mt CO_2 eq. In the projection, emission allowance prices of €17 per tonne in 2020 and €38 per tonne in 2030 (at constant 2007 prices) have been assumed. In the models used, these prices – along with other prices and policy instruments – affect the sectors covered by the EU ETS. With the assumptions made, the projection estimates emissions from EU ETS installations at 23.8 Mt CO_2 eq in 2020 and 23.7 Mt CO_2 eq in 2030 (EU ETS scope for the third trading period, including aviation emissions).

Sweden's EU ETS allocation for the period 2008–12 has, to date, been 22.4 Mt CO_2 eq per year. A further 0.2 Mt CO_2 eq can be allocated for new entrants. The allocation for Swedish installations up to 2020 has yet to be decided. Since emission reductions arising from the trading system may be implemented either in Sweden or in other member states, it is not possible to estimate the system's effect on Swedish emissions. Progress towards the target can therefore only be assessed at the EU level.

Emissions from non-trading sectors (based on the scope of the EU ETS for the third trading period) amounted to 45.5 Mt CO_2 eq in 2005 (see Table 5.24). In the 'with measures' projection, these emissions are estimated to decrease to 35.4 Mt CO_2 eq by 2020. According to this projection, Sweden will comfortably meet its ESD target trajectory, with between 1 and 3 Mt CO_2 eq per year to spare. The 'with additional measures' projection includes policy instruments in the transport sector that are estimated to reduce emissions by a further 0.4–0.6 Mt CO_2 eq by 2020.

Under EU rules, Sweden can use carbon credits from international projects towards meeting its commitment. Annually, credits corresponding to 3% of 2005 emissions may be utilised (Swedish Environmental Protection Agency 2013), plus the equivalent of another 1% of 2005 emissions for credits meeting special conditions. Per year, this possible use of credits corresponds to 1.8 Mt CO_2 eq. In addition, up to 5% of annual emission allocations (AEAs) can be transferred between member states. Beyond this, Sweden can, in the event of a shortfall, borrow up to 5% of its AEA from the following year. In the event of a surplus, it can carry over the unused part of the year's AEA to subsequent years.

Under the EU Renewables Directive, the share of renewable energy in Sweden is to increase to 49% by 2020. In the reference scenario, the renewable energy share that year is estimated at 50.6%. In the scenario with higher economic growth, the share is reduced to 50.1%, owing to an increase in energy use. In the scenario based on higher fossil fuel prices, the share is the same as in the reference scenario. High prices for fossil fuels favour the use of renewable energy sources and promote greater energy efficiency, keeping energy use in check.

5.10 Progress towards the milestone target for Sweden's environmental quality objective Reduced Climate Impact

The Swedish milestone target for the environmental quality objective *Reduced Climate Impact*,[3] as defined in the Riksdag's climate policy decision of June 2009 (Govt. Bill 2008/09:162), calls for emissions from activities not included in the EU ETS to be reduced by 40%, or around 20 Mt CO_2 eq, between 1990 and 2020. One-third of this reduction, or roughly 6.7 Mt CO_2 eq, can be achieved by means of investments in emission reductions in other countries.

Preliminary projections indicate that this target will be met. An in-depth evaluation of progress towards it will be undertaken as part of the Checkpoint 2015 appraisal of climate policy.

[3] http://www.government.se/sb/d/5775/a/217993.

5.11 References for Chapter 5

Ministry of the Environment (2010). *Sweden's Fifth National Communication on Climate Change under the United Nations Framework Convention on Climate Change*, Ds 2009:63.

Ministry of the Environment (2013). *Report for Sweden on assessment of projected progress, March 2013. In accordance with article 3.2 under Council Decision No 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for Implementing the Kyoto Protocol.*

Swedish Environmental Protection Agency (2013). *National Inventory Report, Sweden, 2013.*

6 Vulnerability assessment, climate change impacts and adaptation measures

6.1 Introduction

Climate change affects large parts of Swedish society. In its final report (SOU 2007:60), the Swedish Commission on Climate and Vulnerability evaluated climate change impacts and adaptation requirements for various sectors. Since then, adaptation efforts in Sweden have been stepped up by various means, such as the assignments announced in *An Integrated Climate and Energy Policy* (Govt. Bill 2008/09:162). This Bill clarifies the Government's overall policy for climate change adaptation.

In spring 2010, government agencies' adaptation remits and activities were summarised and presented in a report entitled *Climate Adaptation in Sweden: An Overview* (Rydell, Nilsson, Alfredsson & Lind 2010). In autumn 2012 this report was followed up and updated to present the agencies in charge of the respective activities and whether the latter were 'current' or 'completed'. Where feasible, the activities were presented with the associated documentation (SMHI 2013a).

Responsibility for climate change adaptation is divided among several government agencies that, based on their respective sectoral responsibilities, have important roles to play. Some 30 agencies are working to carry out preventive measures, achieve greater skills and knowledge, and foster better preparedness for disruptions in key societal functions.

In 2012 the Swedish Meteorological and Hydrological Institute (SMHI) was tasked with establishing a National Knowledge Centre for Climate Change Adaptation as a hub for knowledge accumulation, development and dissemination to various parts of society. This Centre will, in particular, gather, compile and make available knowledge of climate change adaptation derived regionally, nationally and internationally. Relevant public agencies can assist the proposed Knowledge Centre, as can Sweden's county administrative boards (CABs), which are already responsible for regional coordination of climate change adaptation issues (Govt. Bill 2011/12:1).

Since 2009, CABs have had a Government remit to coordinate adaptation efforts regionally. In doing so they are assisted by the national agencies. The CABs' areas of work include nature conservation and environmental protection, social care, communications, food inspection, animal welfare and general veterinary issues, agriculture, reindeer husbandry (in the counties of Norrbotten, Västerbotten and Jämtland), fishing, gender equality, the cultural environment, regional development, sustainable planning and housing, civil defence, crisis management in peacetime and rescue services. In all these areas, taking the need for climate change adaptation into account may be relevant.

The role of municipalities comprises several important activities to which climate adaptation is of relevance. Municipal responsibilities include ensuring that there are functioning installations for water, sewerage, energy and waste; hospitals and care services; and schools and social care facilities. Municipalities also exercise official authority under various legislative instruments, with responsibility for inspection, supervision and licensing. They are, for example, in charge of environmental protection and nature conservation, and also review and supervision, under the Swedish Environmental Code. Their crisis preparedness and rescue services are key functions for developing risk and vulnerability assessments in climate change adaptation. The municipalities' spheres of responsibility include sectorised work planning, but they also bear overall responsibility for examining and approving physical planning: comprehensive and detailed development plans and building permit applications.

6.2 Sweden's changing climate

To permit more realistic and extensive vulnerability assessments of climate change, numerous new studies of conceivable regional climate changes have been conducted at SMHI's Rossby Centre in the past few years. These have mainly used the Regional Atmospheric Climate Model (RCA). Today, more extensive data are available than were reported in Sweden's Fifth National Communication (NC5). The latest regional climate scenarios use data from nine different global climate models (GCMs), presenting them as an ensemble. A large ensemble of regional climate scenarios facilitates studies of both uncertainties in and robust features of such scenarios.

The new regional climate scenario ensemble is based on a new version of the Swedish regional climate model that uses the IPCC's new scenarios for radiative forcing, especially two Representative Concentration Pathways, RCP4.5 and RCP8.5. All the simulations took input data from the latest generation of GCMs (CMIP5, the fifth phase of the Coupled Model Intercomparison Project). Simulations with several GCMs have been used as boundary data. Since local and regional climatic variations may be large, the regional climate scenario ensemble also contains calculations based on different simulations with a single emission scenario and global model. Table 6.1 lists these regional climate models.

Broadly, the results from the new climate scenario ensemble confirm the findings drawn from the regional scenario data presented in NC5 and in scientific articles based on this material (Kjellström et al. 2011; Nikulin et al. 2011). The results show, in particular, substantial warming and changes in precipitation. Examples are shown in Figs. 6.1 and 6.2, which present ensemble statistics from the nine RCP4.5 simulations for the end of this century.

The largest temperature changes in Sweden are expected in the winter months, especially in the northernmost parts of the country. This will be due, above all, to shrinkage of snow cover, which boosts warming because a smaller quantity of white snow on the ground that reflects solar radiation back into space causes more energy absorption by the land. Moreover, heat conduction from a snow-free substrate is greater than if the ground is covered by an insulating layer of snow.

Corresponding changes in summer precipitation are shown in Fig. 6.2. A clear distinction between an increase in northern Europe and a decrease in southern Europe may be seen. The dividing line between the areas of increase and decrease is close to Scandinavia in the summer and moves south for the rest of the year. Every scenario shows rising precipitation throughout Sweden, but in some cases falls in the far south in summer. The largest increase in precipitation can be expected in the winter.

Figs. 6.1 and 6.2 show clearly that RCA4 largely follows the GCMs in terms of large-scale climate change in Europe. There are also areas where the results diverge. For example, Fig. 6.2 shows a tendency for RCA4, in general, to indicate a higher rise in precipitation in northern Europe. These differences are due to the disparities in process descriptions both among the global models and also between RCA4 and the global models. Accordingly, RCA4 sometimes shows a more similar signal for climate change in the various runs (see, for example, the changes in precipitation in parts of eastern Europe, where the spread is considerably smaller in the RCA4 ensemble compared with the results from the driving GCMs). The regional model has a higher resolution and provides a more detailed picture of the climate change signal, which may mean that the differences among different runs are accentuated in certain areas (see, for example, the changes in precipitation in the Alps, the Scandinavian mountain range and over Iceland).

Table 6.1 **Global climate models from CMIP5 and scenarios for radiative forcing used to develop boundary data for regional climate scenarios with RCA4. The regional scenarios were run with 50-kilometre horizontal resolution. For scenarios marked with an asterisk (*), an additional simulation with 12.5-kilometre resolution is available.**

AOGCM	Modelling centre	Radiative forcing (RCP)
CanESM2	Canadian Centre for Climate Modelling and Analysis	4.5, 8.5
CNRM-CM5	Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique	4.5, 8.5*
EC-EARTH	EC-EARTH consortium	2.6*, 4.5*, 8.5*
GFDL-ESM2M	NOAA Geophysical Fluid Dynamics Laboratory	4.5, 8.5
HadGEM2-ES	Met Office Hadley Centre	4.5*, 8.5*
IPSL-CM5A-MR	Institut Pierre-Simon Laplace	4.5, 8.5*
MIROC5	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	4.5, 8.5
MPI-ESM-LR	Max Planck Institute for Meteorology	4.5, 8.5*
NorESM1-M	Norwegian Climate Centre	4.5, 8.5

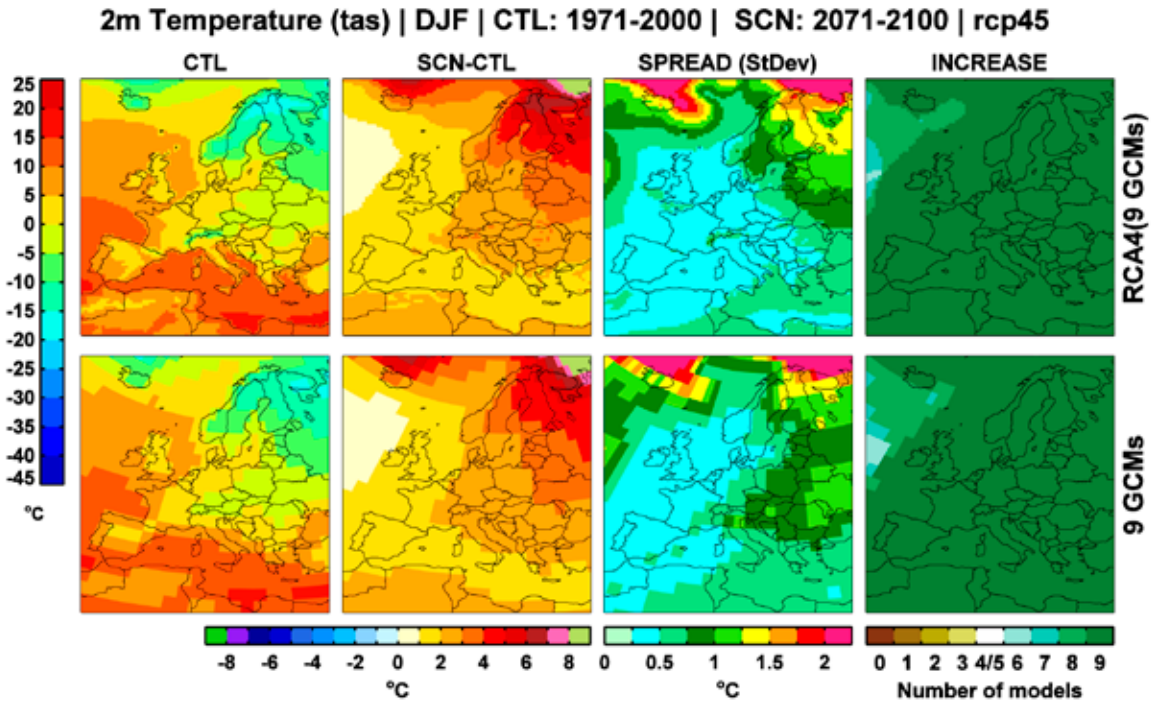

Figure 6.1 **Estimated winter temperature, °C (December, January and February) from 1971 to 2000 (far left) and climate change from 1971–2000 to 2071–2100 (second from left). The two images at the far left correspond to the mean in an ensemble of nine simulations. The third image from the left shows the spread, calculated as a standard deviation, among the nine simulations, while the image at the far right shows how many models indicate temperature rises. The upper images show results from RCA4, the lower ones corresponding results directly derived from the driving global climate models.**

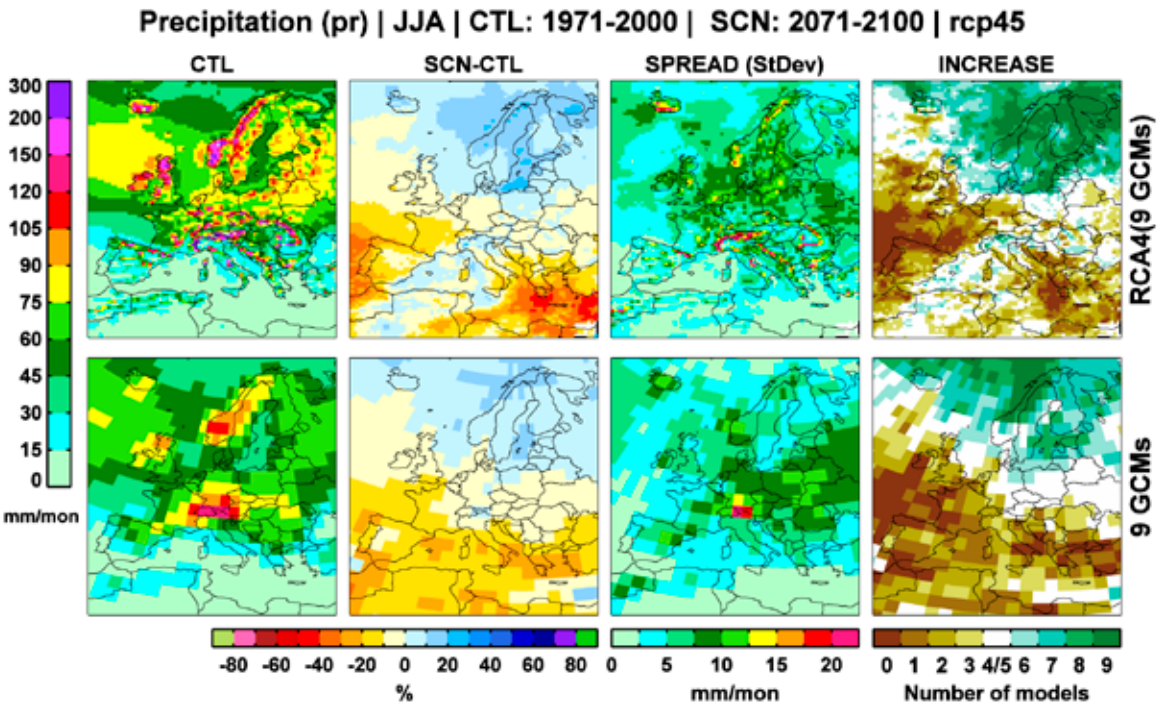

Figure 6.2 **Estimated summer precipitation (millimetres per month in June, July and August) from 1971 to 2000 (far left) and climate change (%) from 1971–2000 to 2071–2100 (second from left). The two images at the far left correspond to the mean in an ensemble of nine simulations. The third image from the left shows the spread, calculated as a standard deviation among the nine simulations, and the image at the far right shows how many models indicate a rise in precipitation. The upper images show results from RCA4, the lower ones corresponding results directly derived from the driving global climate models.**

The extended body of data also clarifies how the choice of global model affects not least the size of changes (Fig. 6.3). Studies based on the data presented in NC5 have previously illustrated the substantial role of natural variability in the short term (Kjellström et al. 2011). In the longer term, the choice of emissions scenario has a dominant influence on the magnitude of climate change.

6.2.1 Measured changes in temperature and precipitation

Noted changes in temperature and precipitation in Sweden over the past few years tie in well with observed global warming and are in line with estimated changes due to anthropogenic impact on the climate. Although we have recently had two relatively cold winters (2009/10 and 2010/11), the overall picture is

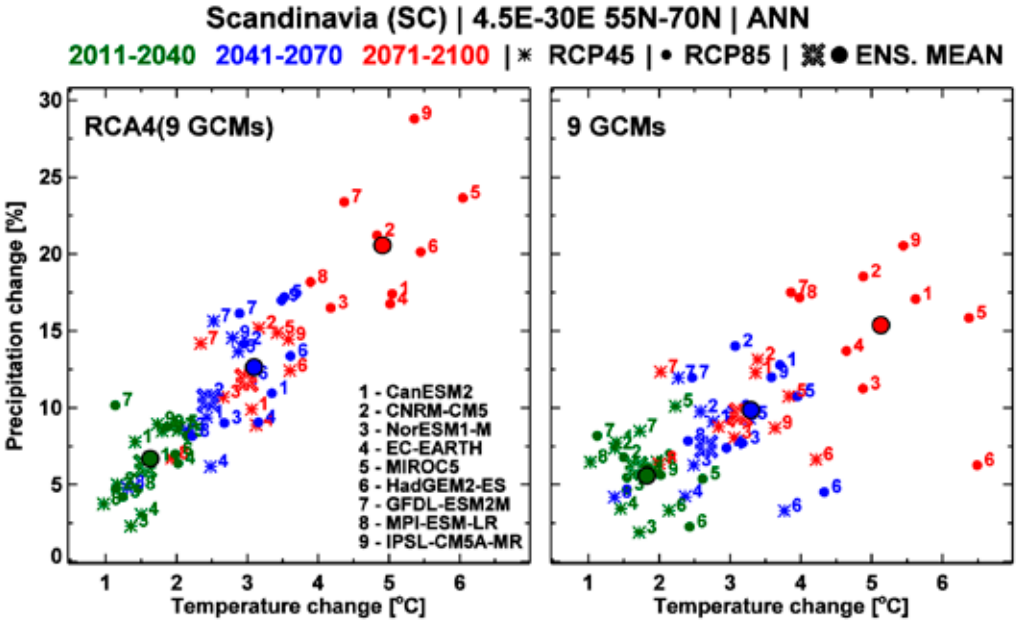

Figure 6.3 **Estimated changes in annual precipitation (%) against estimated changes in annual mean temperature (°C) from 1971–2000 to 2011–2040 (green), 2041–2070 (blue) and 2071–2100 (red) for an area in northern Europe. Results substantiated by the two scenarios, RCP4.5 and 8.5, are represented. The left-hand figure shows the RCA4 ensemble and the right-hand one results based on the nine GCMs.**

that temperatures are remaining higher than in the reference period, 1961–90. Most striking, perhaps, are the continued high precipitation surpluses during the year, especially in the summer. An illustrative analysis of possible climate trends in all the Swedish counties during the 21st century, and of trends up to and including 2012, has been performed using a few scenarios and observations. One example is shown in Fig. 6.4.

The changes in temperature and precipitation that occur when the climate changes affect run-off into watercourses, by influencing both the total quantity of water and its annual distribution. Fig. 6.5 shows how the total supply of water changes according to a few scenarios (SMHI 2013b).

For northern Sweden and the south-western parts of the country, an increased water supply is evident. For Skåne and the south-east, the climate scenarios indicate a reduction in water supply. This picture emerges consistently from the various scenarios. The differences among the estimates are mainly quantitative, i.e. they differ with respect to the size of the change.

6.2.2 Wind

SMHI's climate indicator, 'geostrophic wind', showed no major variations for the period 1951–2012. Future changes in wind conditions are highly uncertain, since global models differ widely in how far large-scale circulation over the North Atlantic and Europe changes. Features common to most scenarios are a decrease in wind speed in the Mediterranean region; a certain increase in the North Sea region; and increased wind speeds over the parts of the Baltic Sea that will become ice-free in a future warmer climate (the Gulf of Finland and Gulf of Bothnia).

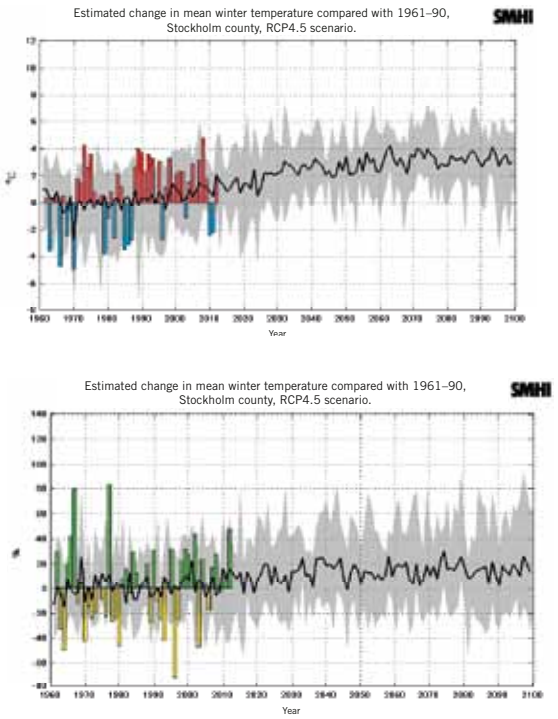

Figure 6.4 **Examples of climate trends for Stockholm county. Estimated change in winter temperature (upper diagram) and winter precipitation (lower diagram) for the years 1961–2100, compared with the mean for 1961–90. The bars show historical data derived from observations: red and green (blue and yellow) bars show, respectively, values above and below the mean for 1961–90. The graphs are taken from nine RCA4 simulations of the RCP4.5 scenario. The thick black line is the mean of all nine simulations and the grey area shows the spread between the highest and lowest values among the various model simulations.**

6.2.3 Variability and extremes

Simulated changes in extremes, such as changes in maximum and minimum temperature, are often more marked than corresponding changes in mean values. This is illustrated for minimum temperature in Fig. 6.6, where the change is almost twice as large as the corresponding change in mean winter temperature in Fig. 6.1.

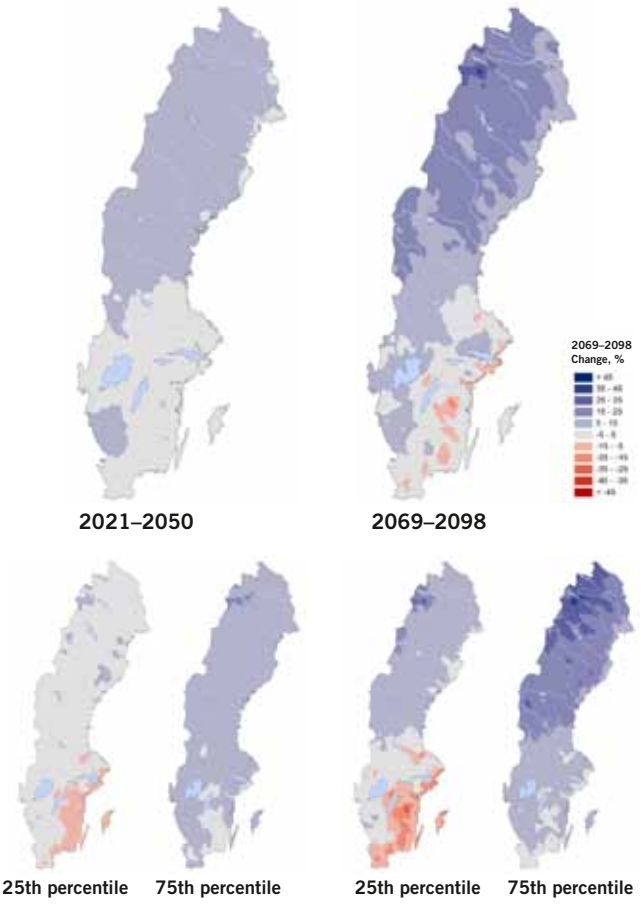

Figure 6.5 **The maps show the percentage change in the aggregate volume of run-off into watercourses during the year. The map at top left shows the change in mean values for the period 2021–50 compared with 1963–92, while the one at top right shows the corresponding values for 2069–98. The small maps below illustrate the spread of the climate simulations (25th and 75th percentiles). This spread may be regarded as a measure of the uncertainty of the analysis. The analysis is based on observations and estimates from SMHI and an ensemble of 16 different climate scenarios from international research (IPCC's Special Report on Emissions Scenarios, SRES). The Swedish HBV hydrological model, applied to 1,001 subareas, has been used to estimate the discharges (river flows) on which the analysis is based.**

Estimated changes in extreme rainfall give a relatively fragmented picture, with major variation from one climate scenario to another. However, the overall picture shows an increase in extreme precipitation in a future warmer climate. This entails an increase in the flood risks associated with stormwater systems and other direct rainwater run-off in, broadly speaking, the whole of Sweden.

6.3 Climate change impacts and vulnerability assessment

Most activities in Sweden will be affected by climate change involving rising temperatures and altered precipitation patterns. Risks of flooding, forest fires, heatwaves, landslides and erosion are expected to increase in many parts of the country. It is therefore important to take action now, already, for buildings, roads, railways, electricity and telecoms networks, and water and sewerage systems. In physical planning, it is important to take climate change into account, to avoid building further risks into society.

6.3.1 Infrastructure

Technical infrastructure, comprising roads, railways, buildings, broadband and water and sewerage systems, is affected by the climate. Infrastructure often consists of systems and installations intended to last for a long time. It is therefore important to consider climate change right from the planning phase, and to include adaptation to climate change as a natural part of planning infrastructural investments.

6.3.1.1 Communications

The expected climate change may bring substantial consequences for Sweden's network of roads, which are often located close to water. The anticipated rise in precipitation and increased flows will entail flooding, with washing-away of roads and embankments, and damage to bridges. High water flows spell an elevated risk of landslides, exacerbating the risk of road damage. The road network will also be affected by the expected rise in temperature and resulting reduction in the depth of frozen ground. The latter causes a decrease in deformation of road superstructure and surfaces. Where frozen

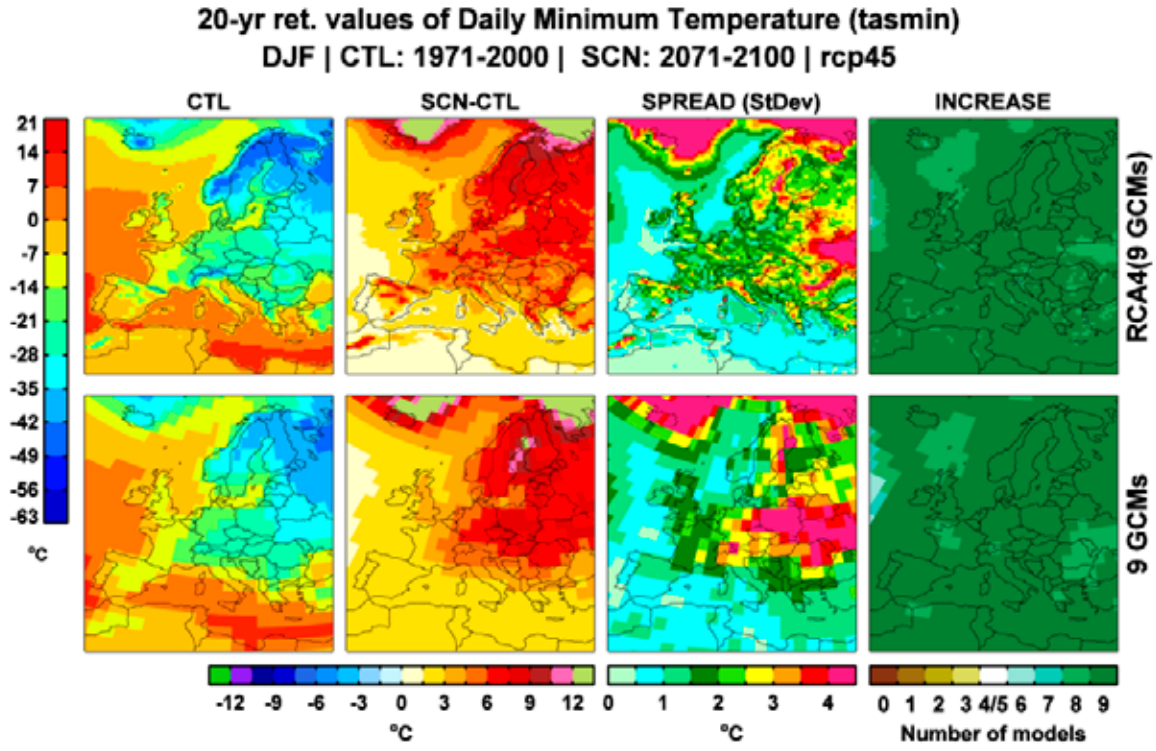

Figure 6.6 **Estimated 20-year extreme minimum temperature (˚C, December, January and February), in 1971–2000 (far left), and scenario results for climate change (˚C) from 1971–2000 to 2071–2100 (second from left). The two images at the far left correspond to the means in an ensemble of nine simulations; the third image from the left shows the spread, estimated as a standard deviation among the nine simulations; and the image at the far right displays how many models show higher minimum temperatures. The upper images show results from RCA4, the lower ones results derived directly from the driving global climate models.**

ground is a foundation for road construction more maintenance may, however, be required. A higher temperature and higher groundwater levels can bring more rutting. Together, these effects mean that the requisite measures to maintain the road network will shift from frost heave-related actions to those concerned with heat and water loads.

The consequences for Sweden's railways will also be substantial. Increased and more intense precipitation will exacerbate such effects as flooding and washing-away of embankment structures, with the associated risk of landslides. The expected rise in temperature during the summer will worsen the risk of railway tracks buckling on hot days. Stronger winds, especially in the south of Sweden, may elevate the risk of forest windthrow and disruption of the power supply for the rail network.

Climate change will probably not affect shipping and aviation to any great extent. However, rising seas may have an adverse effect on ports and harbours, particularly in the southernmost parts of the country. On the other hand, shrinking of sea ice facilitates winter shipping to and from Swedish harbours, especially along the coast of Norrland.

Telecommunications, with overhead lines and masts, will be affected by climate change. The main effect will be a higher risk of windthrow damage owing to reduced extent and duration of frozen ground.

6.3.1.2 Buildings

Settlements have often been sited in areas beside lakes and watercourses, but also close to the coast. Waterfront development, which is already often exposed to flooding today, will be subject to particular risk in a changed climate. Owing to increased precipitation, floods are expected to become more frequent, especially in western and south-western Sweden. Flooding problems caused by heavy downpours are expected to grow throughout the country (Olsson & Foster 2013). Areas not subject to flood risk at present may thus be affected in the future. In the long term, problems caused by the rising sea level may hit coastal towns in southern Sweden (Bergström 2012).

A warmer and damper climate increases the risk of damp and mould in buildings. Buildings of cultural and historic interest may be particularly vulnerable, as they are older and often located in areas close to the coast. Rising temperatures may affect cooling requirements for buildings, causing energy use to rise. Combined with greater humidity, this will necessitate new building technology, materials and locations.

6.3.1.3 Drinking water supply and wastewater management

Climate change will affect the supply of drinking water. Water resources are expected to increase in many places, except in the south-east of Sweden where, instead, there is a risk of water scarcity. In the parts of the country where greater precipitation is expected, the result may be floods that can have repercussions on the water supply. When there is flooding upstream of water sources, contaminants may enter lakes and watercourses, exacerbating the risk of waterborne infection and viruses spreading. The increased risk of floods and landslides may make it possible for pollutants from contaminated soil and old landfills to be dispersed. A higher temperature will lower the quality of raw water in water sources, since it will cause increased leaching of nutrients and humus. This, in turn, will result in brown-coloured water and increased eutrophication. Water pipes may be damaged by downpours that cause landslides. In the southern parts of Sweden a rise in sea level may mean a greater risk of saltwater intrusion into water sources close to the coast.

The expected increase in extreme rains exacerbates the risk of drainage pipes becoming overloaded, leading to a greater risk of back-flowing water and basement flooding. Overloaded drains may also result in large-scale overflows of wastewater in sewage works, thereby elevating environmental and health risks.

6.3.1.4 Supply and use of energy

A climate with milder winters will reduce heating requirements in homes and other premises. This will help to reduce overall heating needs and peak loads on electricity production and networks. In the summer months, greater cooling will be required when temperatures rise. All in all, however, energy requirements are expected to decrease and this will entail cost savings.

Hydropower production will be favoured by increased water inflow and the more even annual rhythm in water flow that is expected. Wind power production may benefit, since the energy content of winds in the Baltic Sea region is expected to rise in the long term. Excessively windy conditions and icing may, however, cause problems for this sector. Bioenergy production is expected to increase as the climate becomes milder and the growing season longer.

Changed climatic conditions may also have an impact on security of supply in the energy sector. In the hydropower industry, heavy rains may cause dam bursts with large-scale repercussions for society.

6.3.2 Agriculture, forestry, fisheries and tourism

The climate change and lengthening of the growing season that are expected may bring production advantages for forestry and farming. Growth in Swedish forests will probably increase owing to a warmer climate in the decades ahead, but this warmth also spells greater risks of damage. Milder winters may permit a higher survival rate among deer and hence heavier browsing pressure on immature pine and deciduous trees. Conditions may improve for many insect pests and some harmful fungi.

A longer growing season may favour root rot, since this spreads best when felling takes place during the growth phase. Windthrow may increase, owing to high waters in winter and an absence of frozen ground. With longer summers, the spruce bark beetle may become more of a problem. Risks of forest fires and spring frosts are expected to increase, and there will be a greater need for forest roads that withstand mild winters.

Attempting to spread risks through greater tree-species diversity than before, and to counteract the 'sprucification' already encouraged by the problem of wildlife browsing, will become more important. Creating mixed forests may enhance security, since most insect pests and several harmful fungi are specific to certain tree species. It will be vital to incorporate more environmental awareness into forest management in various ways.

For agriculture, the positive and negative effects of climate change are expected broadly to cancel each other out. Higher carbon dioxide concentrations are expected to boost yields by some 5%, and improved scope for growing more autumn-sown crops and, for example, maize is expected. Simultaneously, conditions affecting harvests may deteriorate and the risk of drought may increase. Areas that are dry today may be expected to become drier, and those where precipitation is already high may be expected to become wetter.

A warm climate may mean major changes for fisheries. Water temperature has a crucial bearing on living conditions for fish. In Sweden, there are both cold-water and warm-water species.

The expected warming of the Baltic Sea, combined with a decrease in salinity, could mean that species important to the fishing industry, such as Baltic herring, cod and salmon, are eliminated. The extent of the latter changes will depend on the size of the former, expected trends. In freshwater, conditions for cold-water species will worsen while warm-water species are favoured. Impacts on West Coast fishing are less clear.

In reindeer-herding areas, the length of the vegetation period and the volume of summer plant production are expected to increase, while the expected rise in temperature and precipitation may exacerbate insect harassment for the reindeer. Winter conditions will be more unstable, with ice formation and recurrent thaws. Ice accumulation under the snow will make it difficult for the reindeer to find food, making supplementary feeding necessary. The reduced areas of bare mountain may lead to an increase in conflicts of interest between reindeer herding and other livelihoods. If conditions for reindeer herding deteriorate, Sami culture will be threatened as well.

In a changed climate, with warmer summers, conditions for summer tourism will improve. In particular, beach tourism and outdoor recreation close to seas and lakes may benefit. Climate change may cause tourist flows to the Mediterranean region in the hottest summer months to decrease, while those to Scandinavia increase. One key question for the trend in summer tourism will be how climate change affects water quality and algal blooms in Scandinavian lakes and seas. As for winter tourism, the season for many ski resorts in Sweden will become shorter.

6.3.3 The natural environment and biodiversity

Climate change is expected to cause changes in biodiversity and ecosystems, and consequently in the capacity of ecosystems to supply goods and services. It will affect biodiversity both directly, through changed temperature and precipitation, and indirectly through changed land use. Richly biodiverse ecosystems have a greater capacity to withstand disturbances, i.e. are more resilient. This means that ecosystems where biodiversity, as such, has been preserved are better at withstanding disturbances due to climate change.

When the climate becomes warmer, climatic and vegetation zones shift northwards. There are effects on plant and animal reproduction, population distribution and size, and the incidence of pest organisms. Uncommon species may disappear, while new species may become established. Mountain areas are particularly sensitive to climate change. Sweden's bare mountain areas are expected to decrease sharply as the treeline rises. In the 20th century, the treeline rose some 100–150 m in the Swedish mountains. Subalpine birch forest will shrink as the snow cover becomes thinner and less permanent. On the other hand, tree species like pine and spruce will come to predominate across the mountain slopes.

The Baltic Sea will become warmer. The maximum ice cover will decrease, but vary from year to year. Since 2012, SMHI has had a climate indicator that shows annual maximum ice cover (see Fig. 6.7). This

indicator is based on SMHI's daily analyses of the ice situation in the Baltic. The area covered includes the whole Baltic Sea and the Kattegat.

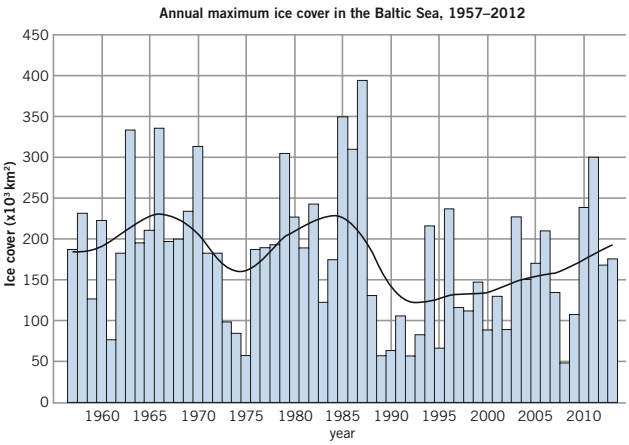

Figure 6.7 **Annual maximum ice cover in the Baltic Sea, 1957–2012 (with preliminary figures for 2012). The black line shows a smoothed trend.**

Globally rising seas will raise the level of the Baltic Sea as well. Owing to land uplift in Sweden, however, this will be most marked in the south. The salinity of the Baltic is expected to change as a result of the increased input of freshwater from precipitation and river run-off and also, to some extent, of changed conditions in terms of wind direction. The extent of the change in salinity will be hard to predict because of the major uncertainties in wind and precipitation scenarios. Changed conditions in the Baltic Sea will bring major changes for biodiversity.

6.3.4 Human health

A changed climate, with extremely high temperatures in the summer months, may have direct repercussions on particularly vulnerable groups. These are, above all, the elderly and people with cardiovascular and lung diseases, who may suffer when heatwaves occur. Swedes, being less accustomed to heatwaves than many other Europeans, are considered to be more sensitive to extreme heat.

With warmer weather, the growing season is lengthened. This affects the duration and intensity of the pollen season and may alter the range of pollen-producing species – changes that may bring an increase in pollen allergies. One positive effect of a milder winter climate is that ailments related to cold weather may be expected to decrease.

Higher summer temperatures may also boost the risk of infections spread with food and water. Flood risk may impact directly on human health, since drinking water is rapidly contaminated when drains overflow or water from polluted ground reaches water sources.

A change in ecosystems and species ranges may cause new diseases, especially vector-borne illnesses, to enter Sweden. Examples are Lyme disease and tick-borne encephalitis (TBE). Today, ticks range virtually throughout Sweden.

6.4 Current and completed climate adaptation activities

Since 2005, Sweden's climate change adaptation has been intensified in various ways. In *An Integrated Climate and Energy Policy* (Govt. Bill 2008/09:162), the Government presented overarching proposals on how further adaptation to climate change should be conducted. At national level, central government agencies are fulfilling their respective sectoral responsibilities to prepare Sweden well for meeting the challenges posed by climate change. A selection of these agencies' activities are given below.

- The Swedish National Board of Housing, Building and Planning has drawn up an online guide for communication and information about the new Planning and Building Act (the 'PBA Knowledge Bank'). The contents of this guide apply primarily to comprehensive and detailed development plans, permits and building, and implementation of plans.
- SMHI collects information about climate change at www.smhi.se. The site includes climate scenarios at national level as well as classified by county, catchment area and meteorological district. There are also continuously updated climate indices and indicators, a knowledge bank of articles and visualisations of climate data. Moreover, the site provides observation data for 150 weather stations for the period 1961–2011.
- During 2012, SMHI launched a new heatwave warning system.
- The National Veterinary Institute, National Board of Health and Welfare, Swedish Institute for Communicable Disease Control, Swedish Board of Agriculture and National Food Agency are working together to achieve greater knowledge, stronger collaboration and organisation among the public agencies in the area of climate and infectious diseases. The aim is to establish and further develop preparedness for climate-related risks of infection spread and diseases affected by climatic conditions.

- The Swedish Civil Contingencies Agency (MSB) has been tasked with supporting municipalities and county administrative boards with overview mapping of stability and flood risks. These maps are an important basis for climate adaptation, spatial planning and risk management.
- The Floods Directive is implemented in Sweden through an ordinance on flood risks (SFS 2009:956). MSB is the agency responsible, and conducts the work in close cooperation with the county administrative boards. The work includes assessments of the impact of climate change on the incidence of flooding.
- In the energy sector, vulnerability to extreme weather events has been analysed, for example with respect to how the safety of hydropower and tailings dams and the risk of flooding are affected by climate change. Since the storms of 2005 and 2007, work to replace overhead power lines with underground cables for electricity distribution has been intensified.
- Risks of landslides, washing-away and flooding in the road and rail networks have been surveyed and measures taken where necessary. For the rail network, an extensive project of tree clearance is also under way, with trees being felled to improve safety in strong winds.
- Knowledge of the effects of climate change and scope for action is conveyed to forest owners and farmers (see section 9.4).
- Since 2012, SMHI has been running the National Knowledge Centre for Climate Change Adaptation on the Government's behalf. This is a resource for everyone in Sweden engaged in adapting society to climate change. The Centre compiles and disseminates knowledge, data to support decisions and tools for climate change adaptation, and is run jointly with other agencies and stakeholders. One of the Centre's tasks is managing the Swedish Portal for Climate Change Adaptation, www.klimatanpassning.se. This portal assembles news of adaptation measures, information about how the climate is changing and what effects this is having, and may come to have, on various parts of society.
- MSB has been tasked by the Government, in cooperation with the agencies and organisations concerned, with running a national platform for work on natural disasters. The purpose is to enhance society's ability to prevent and cope with the adverse consequences of natural events, in line with Sweden's commitments under the Hyogo Declaration and Framework for Action.
- Future climate change may entail flooding around Vänern, Sweden's largest lake, and along the Göta älv river. The Västra Götaland county administrative board has agreed with Vattenfall on a modified water release strategy to eliminate flood risk around Vänern and the risk of landslides along the Göta älv. Using a forecasting model, the release of water is governed by the current water level and estimated inflow.
- The Swedish Geotechnical Institute (SGI) has been charged with proposing means of coordinating implementation of climate change adaptation measures to reduce landslide risk in the Göta älv valley. SGI is also to study possible ways of coordinating adaptation efforts in the Lake Vänern region.

Problems associated with adapting to climate change are attracting ever greater attention in spatial planning. This applies, for example, to the current planning work to boost the capacity for water release from Lake Mälaren in connection with the reconstruction of Slussen in Stockholm. Here, expected climate change may result in flooding of large areas around Mälaren and parts of the inner city of Stockholm, making an ability to regulate the flow of water increasingly necessary.

Most county administrative boards have drawn up reports, analyses and other material concerning climate change adaptation in their own regions. This information is collected on each board's website and serves as a basis for the municipalities' adaptation efforts. To strengthen local and regional work, the Government has tasked county administrative boards with preparing regional action plans for climate adaptation by 30 June 2014.

Responsibility for practical adaptation to climate change is usually located at local, municipal level. Municipalities are responsible for spatial and emergency planning and the rescue services. They, too, are the commissioning authorities for public utilities and other technical services. Many municipalities in Sweden are working to apply measures to reduce their exposure to both current and future climatic conditions. Since May 2011 the new Planning and Building Act, which superseded the previous Planning and Building Act (1987:10) and the Act on Technical Requirements for Construction Works etc. (1994:847), has been in force. Several provisions in the new Act were prompted by climate problems. Municipal plans should play a key role in climate change adaptation, and environmental and climate aspects must be considered in planning and in reviewing other types of applications.

For built-up areas where the risk of natural disasters is particularly high, municipalities can apply for grants from MSB for preventive measures. Here, the aim is to enhance their scope for adapting to the impacts of climate change.

To date, concrete adaptations have been started, above all, in areas hit by extreme weather events. The work has mainly involved measures in physical planning and building. Some municipalities carry out climate and vulnerability assessments when they draw up new comprehensive plans. This kind of analysis entails identifying facilities and functions of importance to the community, transport and utility supply infrastructure, environmentally hazardous activities and contaminated land areas that may be in risk zones for flooding, landslides and erosion. Outline proposals for action are developed for vulnerable areas. Some municipalities have also raised the minimum level for construction, built levees and invested in pump systems to protect against flooding. Some, too, have modified water and sewerage systems to avoid the harmful effects of heavy downpours.

Sweden's municipalities are obliged to carry out risk and vulnerability assessments as a basis for coping with extraordinary events and crises under the Act on municipal and county council measures prior to and during extraordinary events in peacetime and during periods of heightened alert (2006:544). Analyses of risk and vulnerability cover events that will be affected by climate change.

6.5 International work

- In 2013, the European Commission presented a proposal for an adaptation strategy for the EU. How the work will be carried out in Sweden has not yet been determined.
- The European Environment Agency (EEA) and European Commission jointly run the Climate-Adapt portal (www.climate-adapt.eea.europa.eu). Its purpose is to support Europe in its climate change adaptation and provide access to data and information about expected climate change in Europe, vulnerability, strategies and activities, case studies and possible adaptations, and also tools for simplifying planning.
- In the Nordic region, collaboration is under way on the national web portals for climate adaptation and on the development of climate services.
- In the UN, climate change adaptation is being pursued partly through the United Nations Office for Disaster Risk Reduction (UNISDR), and adaptation issues are also dealt with during climate negotiations under the UN Framework Convention on Climate Change (UNFCCC).
- Sweden is active within the scope of the Hyogo Framework for Action, which is intended to reduce the risks and repercussions of natural disasters.
- SMHI and several other Swedish government agencies are taking part both in research projects and in joint agency efforts under the aegis of several international projects aimed primarily at drawing up documentation for vulnerability assessments on which adaptation strategies can be based.
- The Rossby Centre, SMHI's climate modelling unit, studies the processes and behaviour of the climate system. The Centre is active in a number of international research projects, which are listed on its website (SMHI 2013c).
- A macroregional strategy has been drawn up in the Baltic Sea Region Climate Change Adaptation Strategy research project (Baltadapt 2013).
- The CIRCLE-2 European network has three aims. First, it seeks to identify current research on climate change adaptation, effects of climate change and the vulnerability of society. Second, it pinpoints issues where further research is required. Third, it aims to improve dissemination of existing research results, which is covered in the Share subproject (CIRCLE-2 2013).
- Taking part in Mistra-SWECIA (www.mistra-swecia.se), a major Swedish strategic environmental research programme on climate change, its impacts and economic implications, and adaptation, are SMHI, the Stockholm Environment Institute, Stockholm University and Lund University.

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7 Financial resources and transfer of technology

7.1 Introduction

Climate change is a pressing global challenge that requires common action and a wide programme of measures. Sweden has a long history of support for work on climate change issues in developing countries, in an array of sectors and on a long-term basis. A large number of Swedish actors, such as ministries, government agencies, state-owned companies, non-governmental organisations, universities and the private sector, assist in climate change-related cooperative actions and activities such as technology development, research and various forms of capacity development. A number of different modes of cooperation, policy instruments and forms of support exist. Climate finance is provided from both public and private sources.

Tackling climate change in poor countries is, from a Swedish perspective, closely linked to poverty reduction and attaining development objectives such as the Millennium Development Goals (MDGs). In this context, enhancing synergies between the objectives of adaptation, mitigation and poverty reduction is pivotal.

Climate change has the greatest impact on people in poverty, people whose resilience to changes in the climate is very weak. On the basis of principles such as ownership, harmonisation and alignment to a country's systems and processes, Sweden is working towards integrating climate change considerations on a broad basis, for instance in sectors such as energy, water and sanitation, agriculture and forestry, food security, infrastructure, health and education.

It is important to further develop and scale up different tools and financial instruments to address the adverse effects of climate change, and not least its impacts on low-income countries. Climate finance, from different sources – public and private – is crucial in achieving climate-resilient and low-carbon development.

7.2 Governing policies and principles

7.2.1 Sweden's policy for global development

The policy for global development was adopted by the Riksdag (the Swedish Parliament) in 2003. Its adoption was preceded by the work of a parliamentary committee, which was given a broad mandate to examine how such a policy should be designed. The committee concluded that Sweden's contribution to global development and poverty reduction could not be limited to development cooperation alone. The overarching objective of the policy for global development – to contribute to achieving equitable and sustainable global development – therefore applies to all policy areas. Two perspectives permeate all parts of the policy: a rights perspective, based on international human rights conventions, and the perspectives of the poor.

In 2008 a new Government Communication on Sweden's Policy for Global Development was submitted to the Riksdag.[1] In it, the Government identified key challenges in attaining equitable and sustainable global development, where Sweden is in a position to make an effective contribution. Climate change and environmental impact were one of the six key challenges identified.

7.2.2 Policy for environmental and climate issues in development cooperation

In 2010 the Swedish Government adopted a specific policy for environmental and climate issues in development cooperation.[2] This policy establishes fundamental principles and sets out the Government's general position regarding environmental and climate issues within development cooperation. The overarching objective is to achieve a better environment, sustainable use of natural resources, stronger resilience to environmental impact and climate change in developing coun-

[1] Govt. Communication 2007/08:89, cf. www.government.se/sb/d/574/a/113283.
[2] www.government.se/sb/d/574/a/156498.

tries, and limited climate impact. Under the policy, Sweden is to focus its efforts on the following areas in particular:

- Strengthened institutional capacity in public administration
- Improved food security and sustainable use of ecosystem services
- Improved water resources management, greater access to safe water and basic sanitation
- Increased access to sustainable energy sources
- Sustainable urban development

The policy establishes that environmental and climate aspects are a central basis for all development cooperation, and that cooperation is to be based on partner countries' own plans and strategies.

7.2.3 Paris Declaration, Accra Agenda and Busan Partnership

The principles contained in the Paris Declaration of 2005, the Accra Agenda of 2008 and the Busan Partnership of 2011 are of key significance to Swedish development cooperation. National ownership is key to securing long-term sustainability of climate change-related initiatives, and external actors should seek to improve coordination and alignment to the national systems/processes of developing countries, so as to ensure transparency and mutual accountability.

7.2.4 New and additional financial resources

According to the UN Framework Convention on Climate Change, 'The developed country Parties /.../ shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations'. 'New and additional resources' is a term used in many multilateral contexts. There is currently no international agreement on how it should be defined. One common definition, supported by many countries, is that climate financing should be additional to the international development aid goal of 0.7% of gross national income (GNI). Since Sweden's development cooperation has for many years exceeded the 0.7% target (with funding of 1% of GNI), all climate finance provided by Sweden could be viewed as new and additional. Figures for total Swedish ODA are shown in Table 7.1. All exchange rates used in this report are based on the annual average dollar exchange rates for OECD Development Assistance Committee (DAC) members. For Sweden, this means US$ 1 = SEK 7.6322 (2009), SEK 7.2022 (2010), SEK 6.4892 (2011) and SEK 6.7689 (2012).

Table 7.1 **Total Swedish official development assistance in SEK million and US$ million, 2009–2012**

	2009	2010	2011	2012
SEK million	34 713	32 602	36 380	35 483
US$ million	4 548	4 527	5 606	5 242

7.3 The Swedish Government's Special Climate Change Initiative

In 2008 the Swedish Government launched a Special Climate Change Initiative for the period 2009–12, providing a total of SEK 4 billion for multilateral and bilateral climate change initiatives within the framework of development cooperation.

Around two-thirds of funding for the Climate Change Initiative, SEK 2.9 bn, was channelled through multilateral organisations by the Ministry for Foreign Affairs. These efforts focused on both mitigation and adaptation, and the money was disbursed to multilateral climate funds and initiatives such as the Adaptation Fund, the Least Developed Countries Fund (LDCF), the Climate Investment Funds and the United Nations Office for Disaster Risk Reduction (UNISDR).

Around a third of the funding, SEK 1.15bn, was channelled through the Swedish International Development Cooperation Agency (Sida) to bilateral and regional initiatives. Here, the focus was on adaptation measures and on the existing partner countries Burkina Faso, Mali, Bangladesh, Cambodia and Bolivia, which are exposed to a high climate risk combined with high vulnerability. In addition, support was provided for regional cooperation in Africa and Asia. The total funding outcome for the period 2009–12 was SEK 1.12bn, and the remaining amounts were disbursed during 2013.

The Climate Change Initiative formed part of Sweden's contribution to 'fast-start finance', a collective commitment made by developed countries at COP 15 in Copenhagen in 2009. The total Swedish fast-start contribution amounted to more than SEK 8bn for 2010–12, making Sweden one of the largest per capita contributors by far to the fast-start finance initiative.

Examples of contributions under the Special Climate Change Initiative:

- The Adaptation Fund finances projects and programmes to help developing countries adapt to the adverse effects of climate change. Sweden is one of the largest donors and the only country to have contributed an annual US$ 100m since the fund became operational in 2010.
- The LDCF was established to address the special needs of least developed countries by financing the preparation and implementation of National Adaptation Programmes of Action (NAPAs). Sweden is one of the largest donor countries to the fund.
- Support to Mangroves for the Future in several countries in South-East Asia has contributed to the rehabilitation of large areas of mangrove forest. It has also helped to raise awareness about the importance of mangroves and led to improved coastal zone management involving local fishing communities.
- Support to the Water Reservoir Programme in Burkina Faso has reduced the vulnerability of small dams affected by climate change. The programme has contributed to improved food security for more than1,000 people living in poverty by securing 24 million cubic metres of water for food production. Irrigated plots have been distributed and production of vegetables for the local market has started. A guide for climate integration in the construction of dams has also been produced, and awareness among different stakeholders has been raised.
- Support to the African Union has contributed to the establishment of African Risk Capacity, a specialised agency for sovereign disaster risk solutions. It is a first step towards establishing an innovative African insurance solution for natural disasters and weather events, which aims to improve food security in Africa and decrease dependence on international humanitarian assistance.
- Support to Programa de Desarrollo Agropecuario Sustentable in Bolivia has increased farmers' resilience to climate change through soil conservation, more efficient use of water, access to irrigation and new crops. Diversification of production has also increased household incomes.
- In Mali, support to the International Union for Conservation of Nature has reinforced the restoration and sustainable management of natural resources in nine municipalities in the inner delta of the Niger River. The project has increased productive land areas, constructed a database on the hydrological system, and improved women's and communities' capacities to adapt to climate change, including through awareness creation, tree planting and income diversification.

7.4 Multilateral financial support

Nearly half of Swedish development cooperation is allocated to international multilateral development bodies and funds.

Sweden contributes significant amounts of core funding and is actively engaged in a number of other multilateral specialised bodies, international and regional organisations, banks and institutes, with a view to influencing their climate change work in various sectors. Table 7.2 below outlines examples of Swedish contributions to multilateral institutions and programmes. The table presents total contributions, of which a share is devoted to climate change activities. For example, within the World Bank's International Development Association (IDA), an estimated 16% of the budget is used for projects with climate change mitigation and adaptation co-benefits.

Table 7.2 **Examples of financial contributions to multilateral institutions and programmes** [1]

	2009		2010		2011		2012	
	SEK m	US$ m	SEK m	US$ m	SEK m	US$ m	SEK m	US$ m
World Bank – IDA	2 389	313	2 014	280	2 306	355	2 368	350
World Bank – IBRD	80	11	1 079	150	1 057	156	1 104	163
International Finance Corporation	94	12	110	15	40	6.3	47	7
African Development Bank	700	92	644	89	808	125	927	137
Asian Development Bank	136	18	148	20	125	19	150	22
European Bank for Reconstruction and Development	208	27	212	28	280	43	48	7
Inter-American Development Bank	100	13	0	0	11	2	10	2
United Nations Development Programme	1 928	253	1 681	233	1 808	279	2 076	307
United Nations Environment Programme	113	15	81	11	83	13	99	15

[1] Note that some elements of the climate-related contributions are also reported more specifically in bilateral reporting.

Sweden provides climate-specific official development assistance to the financial mechanism of the UN Framework Convention on Climate Change (UNFCCC), as well as through a variety of other multilateral financing channels.

The Global Environment Facility (GEF) is the financial mechanism for a number of important environmental conventions, including the UNFCCC. Table 7.3 shows Sweden's payments to the GEF Trust Fund for the period 2009–12. For the fifth GEF replenishment (2010), Sweden contributed a total of SEK 1,045m. About 30% of total GEF funding is allocated to climate-related projects.

Table 7.3 **Financial contributions to the Global Environment Facility (GEF)**

	2009	2010	2011	2012
US$ million	30.6	47	39.3	30.2

In addition, the Swedish Government contributes to a number of programmes and funds outlined in Table 7.4. Several of these were also covered by the Government's Special Climate Change Initiative 2009–12. During this period, approximately US$ 3bn was channelled through multilateral initiatives designed to support adaptation and mitigation in developing countries.

Sweden contributed SEK 380m to the Least Developed Countries Fund (LDCF), for example, with a focus on adaptation to climate change. Swedish development cooperation has long emphasised the importance of directing official development assistance to least developed countries. Sweden believes that climate-related support to these countries should focus in particular on adaptation to climate change and risk reduction and consequently on reducing poor people's vulnerability. Sweden, furthermore, was the only country that contributed to the Adaptation Fund yearly from 2010 to 2012, providing an annual sum of SEK 100m. The focus of that fund on adaptation activities, in combination with national ownership by developing countries, has been a strong argument for continuing Swedish support.

The establishment of a Green Climate Fund (GCF) was agreed upon at the Climate Change Conference in Copenhagen in 2009. The GCF, which is still under development, is expected to become a central actor in the future climate finance architecture. Sweden has been an active member of the GCF Board and considers it of pivotal importance that the fund's structure becomes effective and efficient, with a focus on results and transparency. In 2012 Sweden provided support for the start-up process of the GCF amounting to SEK 5m, allocated to administrative costs.

Furthermore, Sweden contributed a total of SEK 870m to the World Bank's Climate Investment Funds (CIFs): SEK 600m to the Clean Technology Fund (CTF), SEK 170m to the Scaling Up Renewable Energy Programme (SREP) and SEK 100m to the Forest Investment Programme (FIP). The CIFs are designed to help developing countries pilot low-carbon and climate-resilient development, and are thus involved in both mitigation and adaptation projects.

Other non-conventional channels used in the area of mitigation (in 2012) have been the World Bank's Partnership for Market Readiness, providing finance and technical assistance for capacity building and piloting of market-based tools for GHG emissions reductions, together with the Climate and Clean Air Coalition (CCAC) and its programme on short-lived climate pollutants. These pollutants, which include methane, are short-lived in the atmosphere compared with carbon dioxide, yet responsible for a substantial share of current global warming.

Disaster risk reduction is a key component of climate adaptation, as it aims to reduce the damage caused by natural hazards such as floods, droughts and cyclones. A total of SEK 195m has been allocated through channels focusing on disaster risk management and resilience, such as the United Nations Office for Disaster Risk Reduction (UNISDR) and the Global Facility for Disaster Reduction and Recovery (GFDRR).

Other areas strongly linked to climate adaptation are agriculture and food security. Sweden therefore attaches great importance to cooperation with international research bodies such as the Consultative Group on International Agricultural Research (CGIAR), to which SEK 150m was disbursed. Support is also given to the International Fund for Agricultural Development (IFAD)'s Adaptation for Smallholder Agriculture Programme (ASAP), a programme helping smallholder farmers to increase their resilience.

Sweden also provides assistance to the core budget of the UNFCCC according to the agreed UN scale, with an additional charge for the Kyoto Protocol. Voluntary contributions are in addition made to the Trust Funds for Participation and Supplementary Activities.

Table 7.4 **Financial contributions to multilateral climate institutions**

	2009		2010		2011		2012	
	SEK m	US$ m	SEK m	US$ m	SEK m	US$ m	SEK m	US$ m
UNFCCC Trust Funds	8.7	1	4.5	0.6	5.6	0.9	2.8	0.4
Adaptation Fund	0	0	100	13.9	100	15.4	100	14.8
Least Developed Countries Fund (LDCF)	65	8.5	15	2.1	200	30.8	115	17.0
Global Environment Facility (GEF)[3]	70	9.2	197	27	76	11.7	61	9.1
GEF REDD+[4]	0	0	100	13.9	0	0	0	0
Green Climate Fund	0	0	0	0	0	0	5	0.7
Clean Technology Fund (CTF)	300	39.3	200	27.8	100	15.4	0	0
Forest Investment Programme (FIP)	0	0	0	0	100	15.4	0	0
Scaling Up Renewable Energy Programme (SREP)	0	0	0	0	0	0	170	25.1
IFAD – Adaptation for Smallholder Agriculture Programme (ASAP)	0	0	0	0	0	0	30	4.4
Partnership for Market Readiness (PMR)	0	0	0	0	0	0	50	7.4
World Bank – IDA 15	520	68.1	0	0	185	28.5	0	0
Consultative Group on International Agricultural Research (CGIAR)	50	6.6	50	6.9	50	7.7	0	0
United Nations Office for Disaster Risk Reduction (UNISDR)	25	3.2	5	0.7	0	0	7.5	1.1
World Food Programme (WFP)	0	0	0	0	0	0	44	6.5
Sustainable Energy for All (SE4ALL)	0	0	0	0	0	0	20	3.0
UNDP – Bureau for Crisis Prevention and Recovery	15	2	0	0	0	0	23.5	3.5
Global Facility for Disaster Risk Reduction	0	0	35	5	40	6.2	0	0
UNEP – Climate and Clean Air Coalition	0	0	0	0	0	0	10	1.5
Nordic Development Fund (NDF)	285	37	35	5	122	19	78	11
Other climate-related support	5	0.7	5	0.7	6.1	0.9	1.8	0.3

7.5 Bilateral financial support

Roughly half of Swedish development cooperation is channelled to developing countries and countries with economies in transition as bilateral ODA through Sida. In the area of climate change, Sida supports specific climate change contributions as well as integration at sector level, transfer of technology, capacity building and research cooperation, and in doing so collaborates with many government institutions in developing countries, non-governmental organisations, Swedish authorities and municipalities, the private sector, research institutions etc. ODA channelled through Sida (including 'multi-bi' support[5]) is disbursed at the national, regional and global levels.

In bilateral development cooperation, Sweden's contributions are based on a strategy that takes the developing country's own strategic priorities and poverty reduction strategy as a point of departure. Local ownership is key to ensuring the sustainability of support.

Table 7.5 shows a summary of Swedish climate-related development assistance channelled through Sida for the period 2009–12. Tracking has been performed through follow-up of the specific budget allocation for the Special Climate Change Initiative, and using the 'Rio markers' on climate change mitigation and adaptation. These markers have been developed and defined within the OECD DAC (new methodology since the previous National Communication), and are commonly used by many donor countries to track public climate finance. Each component is marked on a scale of 0–2 by the officer responsible for the contribution, where 2 represents 'primary objective', 1 'significant objective' and 0 'not targeted'. In compiling the figures presented in Table 7.5 and Annex 6, Sweden has included 100% of the funding for contributions under the Special Climate Change Initiative and for other contributions which have mitigation and/or adaptation as a 'primary objective', but only 50% of the fund-

[3] The table includes 30% of the total Swedish contribution to the GEF, since 30% of GEF funding is allocated to climate-related projects, and SEK 100m which was part of the Special Climate Change Initiative.

[4] Reducing Emissions from Deforestation and Forest Degradation.

[5] Bilateral support handled by multilateral organisations.

ing for contributions with mitigation and/or adaptation as a 'significant objective'. The figures presented represent net support *provided*, i.e. *disbursed* according to OECD terminology.

Table 7.5 **Summary of bilateral/regional/global climate finance channelled through Sida to non-Annex I countries and economies in transition**

(US$ m)	Mitigation	Adaptation	Cross-cutting	Total
2009	34	67	114	215
2010	42	104	128	274
2011	51	104	168	324
2012	44	150	164	358

Annex 6 shows this financial support further broken down by country/region/global for the period 2009–12. Only countries/regions where cooperation took place in a given year are included, and the list therefore varies from one year to another. For increased transparency, negative figures are also included; these represent repayments of unspent funds, e.g. when unrest in an area has delayed or prevented implementation of a project or programme, or a project/programme has performed more cost-effectively than budgeted. Sectors are reported according to the OECD DAC Creditor Reporting System (CRS) classification. Important sectors for mitigation are, for example, energy and multisector, such as environmental policy and administrative management. Interventions to improve climate change adaptation also include a great deal of capacity building relating to environmental policy and administrative management, but in addition focus strongly on sectors such as water and sanitation, and agriculture. Most contributions, however, create synergies and/or have cross-cutting benefits for both mitigation and adaptation, particularly under the agriculture and multisector headings; these are therefore reported separately in Table 7.5 and Annex 6. The individual countries that have received the largest share of climate change-related development cooperation include Mozambique, Kenya, Mali, Bolivia and Tanzania, countries that were in focus under the Government's Special Climate Change Initiative and/or where Sweden has been engaged in development cooperation for many years, especially in key sectors such as energy and water/sanitation.

7.5.1 Support through non-governmental organisations

Cooperation with civil society in the area of climate change is important, as these actors often focus on the local level and work directly with the people who are most vulnerable to and suffer most from the impact of climate change. Civil society organisations also have an important role to play when it comes to awareness raising and advocacy regarding climate change. Financial support from Sida is channelled through a number of Swedish organisations, such as the Swedish Society for Nature Conservation, PLAN Sweden, Forum Syd and the Swedish Cooperative Centre, as well as being allocated directly to key organisations in developing countries, including the Pan African Climate Justice Alliance and the Asia Pacific Forum on Women, Law and Development.

Sida has supported the Joint Climate Change Initiative of Capacity Development of Cambodian non-governmental organisations, implemented by Forum Syd and other partners. More than 20 local NGOs have increased their capacity and knowledge relating to climate change and disaster risk reduction. Awareness has increased and climate aspects have now been integrated in the strategic plans and programmes of the NGOs. Women have been key actors in many of the pilot projects, e.g. in cooperating with local authorities to develop disaster management plans, integrating adaptation in local investment plans, and improving livelihoods through climate-resilient fish farming and vegetable cultivation.

Sida has also provided support for the Asia Pacific Forum on Women, Law and Development, a member-based organisation focusing on women's rights and gender equality. Under its Climate Justice programme, the Forum has, for example, conducted research projects documenting climate-related impacts on rural women's rights and livelihoods. The results were presented at COP 17, with rural and indigenous women from Asia Pacific taking part as official delegates of the gender constituency. In 2012 the UNFCCC passed a decision recognising the need for gender balance to improve the participation of women.

Sida also supports global non-governmental organisations and think tanks that are very important actors at the global, regional and national/local levels. Organisations such as the Stockholm Environment Institute, the International Institute for Environment and Development and the World Resources Institute all receive core support from Sida and play an active role in normative efforts, as well as in global policy research, pertaining to climate change.

The Stockholm Environment Institute (SEI) is an independent international research institute. It conducts research, develops tools, and builds capacity. Its work on climate change supports the design, development and implementation of effective and equitable strategies for adaptation and mitigation in developing and developed countries. It offers timely, authoritative and pertinent analysis that informs policymakers and negotiators, finance institutions, civil society, the private sector, and other stakeholders involved in the UNFCCC process. SEI explores both synergies and potential competition between climate policy and development. This is reflected in its work on climate governance

and finance, climate economics, carbon markets, equity, bioenergy, energy efficiency, and vulnerability and adaptation.

7.5.2 Support through Swedish authorities to institutions in developing countries

Sweden channels funding through several Swedish authorities and universities to enable them to run programmes and project activities in developing countries, focusing on their areas of expertise. Key authorities involved in capacity building relating to climate change are, for example, the Swedish Environmental Protection Agency and the Swedish Meteorological and Hydrological Institute.

The Swedish Environmental Protection Agency manages Sweden's contribution to the Nordic Partnership Initiative on Up-scaled Mitigation Action. This is an initiative that aims to (i) build capacity in Peru and Vietnam to enable them to structure and implement 'Nationally Appropriate Mitigation Actions' (NAMAs) in the waste and cement sectors, respectively; (ii) explore ways to attract national and international climate finance; (iii) provide an input of lessons learnt to the international climate negotiations; and (iv) encourage other parties to take similar actions. The initiative was launched in 2011 and the two programmes will continue until 2015.

The Swedish Meteorological and Hydrological Institute, together with other partners, has implemented an international training programme focused on climate change mitigation and adaptation. About 450 participants (36% of them women) from 53 countries have been trained and provided with tools to identify vulnerable sectors in their countries and to develop projects there with support from the organisers. The target group has been individuals in leading positions in administration, national or local, NGOs, universities or companies. Evaluations show that participants rate the course highly and that the training has greatly increased their understanding of climate change. A large majority of the participants also thought that the content was of great significance to their ongoing work, and a number of important contacts with various experts were established.

7.5.3 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 both mitigation and adaptation efforts.

Sida cooperates with the private sector through its 'Innovations Against Poverty' programme, which is designed for companies that are based or operate in a poor country. The programme functions as a risk-sharing mechanism for sustainable business ventures (commercial companies or market-oriented organisations) which have a strong potential to reduce poverty. Many of the projects focus on climate-smart solutions.

In Indonesia, India, China, Vietnam, Namibia, Botswana and South Africa, Sida prioritises what is termed 'partner-driven cooperation', which is often undertaken in close cooperation with the private sector. The purpose is to establish sustainable relationships of mutual interest between Swedish and foreign actors. Effectively, this means that an actor in Sweden and an actor in the partner country initiate a partnership that falls within the framework of the strategic goals set for the country. Several of the initiatives focus on climate change issues.

In 2009, Sweden introduced an Ordinance on the Financing of Development Loans and Guarantees for Development Cooperation, and for the period 2009–13 the Swedish Government has a strategy with a special focus on environmental loans. Sida provides a grant as a complement to a loan facility. Market-financed loans are structured and issued by banks or multinational financial institutions. The environmental loans provided are primarily aimed at improved energy efficiency and renewable energy, management of water, sewage and waste, and transportation – all highly relevant from a climate change perspective. The loans can be stand-alone or combined with a guarantee arrangement, in order to play a catalytic role. More information on mobilised private climate finance is provided in Sweden's first Biennial Report.

Most cooperation with the private sector includes an element of technology transfer. Examples are given in Table 7.7.

7.6 Technology development and diffusion

In September 2011 the Swedish Government launched a national environmental technology strategy. Its aim is to facilitate the development of new, sustainable Swedish solutions to meet the challenges of climate change and environmental degradation, while promoting new business and employment. Short- and long-term initiatives – targeting everything from research and innovation to exports – aim to make Sweden a green-tech pioneer. The Government has decided to invest SEK 400m in environmental technology over the period 2011–14.

The environmental technology strategy outlines measures to promote the Swedish environmental technology sector. These include steps to intensify research and innovation, initiatives aimed at facilitating financing and business development at an early commercial stage, support and assistance with market analysis and start-ups in export markets for small and medium-sized businesses, and measures to improve coordina-

tion among government agencies and other actors of relevance to development in the environment sector.

To implement the strategy, a number of government agencies have been tasked with facilitating and improving conditions for the Swedish environmental technology sector to grow. They include the Swedish Energy Agency, the Swedish Agency for Economic and Regional Growth and the Swedish Trade and Invest Council (semi-governmental). The Swedish Trade and Invest Council is working to facilitate exports by Swedish companies, in areas such as waste management, recycling, bioenergy, solar power, wind power and energy efficiency.

The Government has signed cooperation agreements on environmental or energy technology with a number of countries, among them the United States, Brazil, China, Russia and India. In 2011, the Government appointed a special coordinator to be responsible for the coordination and development of bilateral cooperation with China, Russia and India in the field of environmental and energy technologies, including sustainable urban planning. As an example, cooperation between Sweden and India in the energy sector today includes energy efficiency and renewable energy, mainly biogas. Bilateral technological cooperation with China, focused on sustainable urban development, has been in progress since April 2008.

In 2011 the environmental sector exported goods and services adding up to SEK 38.9bn, which corresponds to 2.2% of Sweden's total exports (see Table 7.6).

Table 7.6 **Environmental sector exports, 2009–2011, SEK billion**

	2009	2010	2011
Exports (SEK billion)	39.6	36.8	38.9

The largest individual sector was waste management and recycling, but many of the current environmental technology solutions, such as district heating, biogas, underground waste collection, geothermal heating and geothermal cooling, have existed on a large scale in Sweden for many years.

Sweden considers the private sector to have an important part to play in technology development and diffusion. However, to create the necessary conditions for it to become involved in developing countries, support is often required to reduce the risk, and for this purpose loans and guarantees or risk credit can be used (see 7.5.3 and below).

Through Swedfund, Sweden's development finance institution, Sweden invests in growth companies in developing countries. Swedfund aims to contribute to international development cooperation by helping to enable people living in poverty to improve their lives and, within the context of Sweden's reform cooperation in Eastern Europe, bringing about strengthened democracy, equitable and sustainable development, and alignment with the European Union and its core values. Swedfund seeks to establish sustainable and profitable companies in these markets with a view to contributing to poverty reduction. An important part of its work is ensuring and maintaining excellence with respect to the environmental and social aspects of investments. Since 2009, Swedfund has administered Swedpartnership (previously StartSyd and StartÖst). Swedpartnership offers small and mid-sized enterprises financial support for investments in knowledge transfer and equipment when they are establishing new businesses in developing countries in Africa, Asia, Latin America and Eastern Europe.

From a development point of view, the issue of technology is more than the physical transfer of hardware or software; it is more a matter of building 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 integrated approach is crucial if developing countries are to benefit from, and themselves contribute to, the development of sustainable technological solutions adapted to their specific circumstances. It does, however, make it challenging to track and distinguish specific technology transfer and/or capacity-building contributions.

Table 7.7 **Examples of support involving environmental technology transfer**

Project/programme title: Solar Home Systems

Purpose: Rural electrification through renewable energy.

Recipient country:	Sector:	Sida funding:	Years in operation:
Bangladesh	Energy	SEK 65m	2009–2018

Description: Solar Home Systems is a renewable energy programme that provides people in rural Bangladesh with clean electricity from solar panels. The programme is designed to build a commercially viable system, but subsidies targeted at people living in poverty aim to make the initial investment possible. At least 1.2 million Solar Home Systems have been installed, improving the quality of life of millions of rural inhabitants. The programme has also improved the productivity and profitability of local businesses. It is operated by the World Bank, but financed by several partners (including local micro-finance organisations), and implemented by local companies in partnerships with local NGOs and partner organisations.

Indicate factors which led to project's success:
Innovative financing and local partnerships.

Technology transferred: Solar panels.

Project/programme title: Innovations Against Poverty/Waste 2 Energy

Purpose: Gas produced from waste will provide low-income communities with an alternative, renewable source of fuel.

Recipient country:	Sector:	Sida funding:	Years in operation:
Uganda	Energy	€20,000	2012–2013

Description:
Waste 2 Energy Ltd.'s aim is to develop commercial production of biogas from municipal waste collected in a densely populated urban centre in Kampala. The gas will be conventionally purified and pressurised to provide a safe, affordable and renewable energy source for poor households. Sorted organic waste will be converted and purified into biogas. Subsequently the biogas will be marketed and sold at a price 20–30% lower than competing products. The gas will reach potential customers through a distribution network.

Indicate factors which led to project's success:
Innovative financing and market demand.

Technology transferred: Biogas technology.

Project/programme title: Comprehensive Disaster Management Programme (CDMP).

Purpose: Reduce people's vulnerability to natural disasters.

Recipient country:	Sector:	Sida funding:	Years in operation:
Bangladesh	Multisector/ Communication	SEK 50m	2009–2014

Description: CDMP has helped to reduce people's vulnerability to natural disasters, including adverse effects of climate change. The programme has worked at many different levels to strengthen the legal framework for disaster management, build capacity and strengthen coordination between various ministries, agencies etc. It has also, among other things, contributed to an improved national early warning system for weather-related disasters. Through the use of mobile phones and the mobilisation of tens of thousands of volunteers, more than 50 million people can now be reached by the early warning system.

Indicate factors which led to project's success:
Programmatic approach and local ownership.

Technology transferred: Information and communications technology.

7.7 Capacity building

Capacity development is a critical factor in enabling developing countries to tackle climate change. Sweden considers capacity building a cross-cutting issue, since capacity is required for developing countries to be able 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 are crucial, as is strengthening of institutions so that countries themselves are able to integrate climate change into their long-term planning processes and pursue their own national climate change policies. Sweden has found that the best results are achieved when capacity development is based on countries' own needs and priorities, is owned and operated nationally, and takes place in partnership as a joint learning process. It is therefore important to strengthen national systems instead of creating new ones.

In Cambodia, Sida has teamed up with the EU, Danida and UNDP in a multi-donor initiative to support the Cambodia Climate Change Alliance, a comprehensive approach seeking to systematically address climate change and disaster risk challenges. The overall objective is to strengthen the capacity of the National Climate Change Committee (a Government-mandated coordinating and policy support entity for all aspects of climate change) to fulfil its mandate to address climate change and to enable line ministries and civil society to implement priority climate change actions. The main achievements to date are: the development of a Cambodia Climate Change Strategic Plan (providing the basis for Cambodia's National Adaptation Plan); improved coordination with key line ministries in sectoral climate change plans; approval of 19 government and NGO projects; establishment of a Trust Fund; strengthening of Cambodia's negotiating capacity on climate change matters at the national and international levels; establishment of a web-based climate change knowledge and information platform; and completion of a climate change public expenditure and institutional review, aimed at strengthening governance and delivery of climate finance in line with monitoring, review and verification requirements.

Capacity development is primarily an integral part of the programmes and projects which Sida supports. This 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 view of capacity development in training and research, but also to raise capacity institutionally through various forms of support to cooperation with national and local institutions. In addition, Sweden regards it as crucial to contribute to building capacity among developing countries' climate change negotiators, in order to create a level playing field and facilitate mutual understanding.

Sida contributes funding towards the European Capacity Building Initiative (ecbi) for sustained capacity building in support of international climate change negotiations. The ecbi aims to promote a more level playing field between government delegations to the negotiations, and to facilitate mutual understanding and trust both between European and developing countries and among developing countries. Through trust-building seminars, regional training workshops, policy reports, bursaries for LDC negotiators from Africa and Asia, a website for awareness creation, mentoring and encouragement, ecbi has created an environment for negotiators that is conducive to honest and open discussions on climate change issues. Almost 700 negotiators have participated in its activities, giving them new skills, knowledge and confidence to play a more effective role in the climate change negotiations. The initiative is having a direct impact on the negotiations.

Sida's research cooperation aims to strengthen the research capacity of partner countries and to promote development-oriented research. This includes support

that will help cooperating countries to establish enabling research environments and training of research scientists and to develop methods to plan and prioritise research. Promoting development-oriented research means supporting, both financially and scientifically, opportunities for partner countries to identify new knowledge in areas of significance for their development.

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 Western Indian Ocean Marine Science Association is a regional organisation promoting the educational, scientific and technological development of all aspects of marine sciences, with a view to sustaining the use and conservation of marine resources. As a result of Sida's support to WIOMSA, knowledge about the consequences of climate change for coral reefs and mangroves has been enhanced; climate change has become a priority on the regional agenda for sustainable management of marine and coastal natural resources in the Indian Ocean; a dialogue has been established between researchers and decision makers regarding marine and coastal environments; and new models have increased the capacity to predict climate change among researchers and decision makers concerned with marine and coastal environments in East and Southern Africa.

Sweden often promotes capacity building by engaging with local partners in developing countries, but sometimes also uses combined studies at home and abroad for key groups such as civil servants, researchers, students etc. These approaches have proved successful in enabling course participants to remain in their countries on completing their education, thereby avoiding the capacity being lost through a 'brain drain'.

7.8 References for Chapter 7

Ministry for Foreign Affairs (2008). Govt. Comm. 2007/08:89 Communication on Sweden's policy for global development.

8 Research and systematic observation

8.1 Climate research policy

The Swedish Government's overall ambitions for research and development, expressed in its two most recent research policy bills, are to strengthen Sweden's long-term competitiveness and promote sustainable growth. Human impact on climate is seen as one of the major challenges to humankind that cannot be addressed successfully without new knowledge. The climate issue and preserving biodiversity, the marine environment and a non-toxic environment are the Government's top environmental priorities during the period under review.

8.1.1 New forms of support

New forms of support for strong research environments at higher education institutions ('Linnaeus Grants') were set up by the Government in 2004. These were extended in the Research Policy Bill, *A Boost to Research and Innovation* (Govt. Bill 2008/09:50), for the Sixth National Communication (NC6) reporting period, 2009–12. Besides support for strong research environments, the Government identified 24 strategic research areas, including climate models, effects on natural resources, ecosystem services and biodiversity, and research on the marine environment. These should be juxtaposed with the themes pinpointed earlier – climate and energy, management of natural resources and the environment, urban and rural development, environmental technology and new materials, and human and environmental quality of life – which are all central to sustainable development. Land use in a national and global perspective was added late in the period, and there is now a strategy for research and development for a biobased economy. Objectives include reducing both climate impact and use of fossil raw materials.

8.1.2 Forthcoming initiatives

The Government's latest bill, *Research and Innovation* (Govt. Bill 2012/13:30), applying to 2013–16, contains long-term initiatives in cutting-edge research, a larger volume of basic resources for higher education institutions (HEIs), and major investments in life sciences and in energy systems that are sustainable in the long term. Research initiatives are considered the key to Sweden remaining successful in the lifetimes of future generations. Ways to achieve this are thought to include increased dissemination of research-based knowledge and open access[1]. Research findings are intended to result in new products and services through focused investments in a few areas of particular importance to the business sector and society. The following initiatives are especially identified: first, research on forest raw materials and biomass – new materials and biobased products for a biobased economy – and, second, research on sustainable urban development. The climate is the subject of a separate initiative launched in the 2008 Bill.

8.1.3 Research infrastructure

One important factor in paving the way for outstanding research is research infrastructure, such as the European Spallation Source, the MAX synchrotron, central or distributed research facilities, databases, biobanks or large-scale resources for calculation, analysis and modelling as instruments for research. The Swedish Research Council performs the task of funding national research infrastructure (such as Environment Climate Data Sweden, ECDS) and Sweden's participation in international infrastructure. HEIs are responsible for local infrastructure, such as LifeWatch, and equipment. LifeWatch is an EU project that is expected to provide data on changes in biodiversity and should thereby be able to contribute to knowledge of the impacts of a

[1] Open access is a model for publishing academic information online free of charge to readers.

changed climate, in particular. The Swedish Species Information Centre at the Swedish University of Agricultural Sciences is the coordinator in Sweden. The Integrated Carbon Observation System (ICOS) is a new European research infrastructure for studies of greenhouse gases in Europe and surrounding regions. One aim of ICOS Sweden, which is headed by Lund University, is to collect information about the country's total greenhouse gas budget. The project will strengthen Swedish research related to greenhouse gases. In Sweden, there are to be six field sites to measure exchange between ecosystems and the atmosphere (see Fig. 8.1). The results will form the basis for work on the environment and climate at national and regional level.

Figure 8.1. **ICOS Sweden field sites are located in areas of permafrost (Stordalen), wetland (Degerö), forests of varying age and productivity (Flakaliden, Norunda and Perstorp), and arable land (Lanna). Three of these are also atmospheric stations.**

Platforms for climate research that have long been established and remain important are the *Oden* icebreaker, the research stations in Abisko (where the northernmost ICOS measuring station is located), Tarfala (run by Stockholm University) and the *Odin* satellite (operated by the Swedish National Space Board). In the period under review, the Swedish Polar Research Secretariat was given a new, extended remit that included responsibility for Abisko Scientific Research Station. The Secretariat was already, and remains, in charge of expeditions and research activities in the Arctic and Antarctic.

The Rossby Centre at the Swedish Meteorological and Hydrological Institute (SMHI) is continuing to provide climate scenarios for other researchers and society at large, in the EU and international organisations like the World Climate Research Programme (WCRP), as well as in Sweden. Ways and means of gaining access to a new ocean-going research vessel are being explored. This would permit high-quality research and survey in the area of marine environment and enable Sweden to meet its commitments towards the EU and under international conventions. This will be an important instrument in research on acidification of the seas and oceans.

One example of infrastructure shared by public agencies is a joint archive for satellite data that stores information about vegetation and terrain variables. Coordination of geodata, including a newly created height database, may have a major bearing on forthcoming work on the second commitment phase of the Kyoto Protocol in which, for example, rewetting of wetlands is under discussion. A new National Knowledge Centre for Climate Change Adaptation has been established at SMHI and its remit includes reformulating research results for decision support by 2015.

8.2 Nordic collaboration

The Top-Level Research Initiative launched by the Nordic prime ministers in 2007, focusing on cutting-edge research in the areas of climate, energy and environment, is now in its final phase. Sweden is taking part in several of the projects through, for example, Linköping University, the Stockholm Environment Institute (SEI) and Chalmers University of Technology, in the framework of NORD-STAR (the Nordic Centre of Excellence for Strategic Adaptation Research) and NORDCLAD-net (the Nordic Climate Change Adaptation Research Network). The projects are being coordinated by SEI, which arranged the 2010 and 2012 Nordic Adaptation conferences, each of which had more than 150 delegates.

Swedish researchers are involved in other Nordic initiatives too. For example, the Swedish Defence Research Agency (FOI) has taken part in the Civilclim project, funded by the Norwegian organisation Vestlandsforsking. In this project, the crisis management system has been studied with respect to the progress in climate change adaptation made in three European cities.

8.3 European collaboration

Sweden supports EU cooperation and participates in many different contexts associated with the climate. These include the European Centre for Medium-Range Weather Forecasts' Earth system model (EC-Earth), European Research Area Networks (ERA-NET) and the Joint Programming Initiative (JPI). The primary purposes of these arrangements are to develop joint European research, exchange experience and issue joint funding calls for research proposals. The EC-Earth consortium entails close collaboration among several Swedish universities (Stockholm, Lund, Gothenburg, Chalmers and Linköping). The Earth model is to be developed so that it can be evaluated and compared with other global models within the framework of Coupled Model Intercomparison Project Phase 6 (CMIP6), which is preliminarily scheduled for implementation in 2014–18. EC-Earth, headed by the Rossby Centre, has recently made a contribution to the international CMIP5 project, which is the primary modelling basis for the fifth IPCC assessment. The Rossby Centre also heads a European initiative for future development of high-resolution global climate models in the EU's Seventh Framework Programme for Research and Technological Development (FP7), Phase 2 of Infrastructure for the European Network of Earth System Modelling (IS-ENES2).

There is collaboration between the Joint Research Centre (JRC) and researchers at Swedish government agencies, organisations and HEIs in areas relating to the climate (emissions, land use, forest ecosystems in Europe, renewable energy and technology with low carbon dioxide emissions, for example).

Sweden is taking part in research on the Baltic Sea, notably through the Joint Baltic Sea Research and Development Programme (BONUS), which is funded by the countries around the Baltic in cooperation with the EU. Rather than directly focusing on the climate, BONUS covers both climate change impact and measures to reduce emissions, especially from shipping. Stockholm University, SMHI and the Rossby Centre are also participating in the Baltic Sea Experiment (BALTEX), an EU project focusing on hydrology, climate and water management in the Baltic Sea basin.

8.4 Global collaboration

Sweden and Swedish researchers are engaged in various global scientific research activities with a climate perspective, such as the Intergovernmental Panel on Climate Change (IPCC), World Climate Research Programme (WCRP) and International Geosphere-Biosphere Programme (IGBP). By participating in the International Council for Science (ICSU), Sweden has taken a lead in the endeavour to integrate global change programmes in the international Future Earth initiative, with its focus on integrating research in social and natural sciences as one means of bridging the gap between policy and practice.

To link Swedish research initiatives in global development in a more strategic and powerful way, the joint Swedish Secretariat for Environmental Earth System Sciences (SSEESS) has been set up by several research funders – the Swedish Research Council Formas, Swedish Research Council (VR), Swedish Research Council for Health, Working Life and Welfare (Forte), Swedish Governmental Agency for Innovation Systems (VINNOVA) and also, since 2012, the Swedish International Development Cooperation Agency (Sida) – together with the Royal Swedish Academy of Sciences (KVA). The purpose of SSEESS is to work for greater Swedish involvement in international interdisciplinary research on global environmental and resource issues and simultaneously serve as a reliable information source for Swedish decision makers.

Within the framework of the Arctic Council and the Swedish Chairmanship in 2011–13, the Swedish Environmental Protection Agency and Formas are funding a circum-Arctic project about threshold effects (tipping points), the Arctic Resilience Report (ARR). This joint project involving the Arctic states is headed by SEI.

8.5 Organisation

8.5.1 Research funders

Central government and other parts of the public sector are the largest funders of academic research. Alongside direct appropriations to HEIs, the most important public research funders are research councils and a few other funding agencies. Research foundations and the EU, municipalities and county councils also fund research. With the inclusion of the private sector as well, the business sector is the largest funder of R&D.

8.5.2 Performers

Almost two-thirds of publicly funded research in Sweden is carried out at HEIs. Other public research performers include industrial research institutes and some sectoral agencies.

All the HEIs have their own research resources, which have been strengthened in recent years (see page 108). In addition, there are some central government

institutes and sectoral institutes with close industrial ties that conduct publicly funded research.

8.5.3 Funding

Since research is increasingly required to contribute to sustainable development, integrated interdisciplinary approaches are necessary. This makes it harder to categorise initiatives under the headings called for by the UN Framework Convention on Climate Change (UNFCCC). It also makes it difficult to compare reporting in different years. This was, in particular, reflected in the Swedish National Audit Office's report (Swedish NAO 2012), which concluded that at least SEK 2bn had been spent on climate research in 2010, against the SEK 1.2bn stated in Sweden's Fifth National Communication on Climate Change (NC5). Another important difference is, however, that funds for faculties and basic state funding for universities were not included in NC5, whereas the Swedish NAO's survey included these. Some 25% of state funding of climate research in 2010 consisted of basic grants at HEIs. Support for climate research made up 7% of aggregate state funding for research and development in 2010, and if funding from the EU, municipalities, county councils and private stakeholders is included total funds for climate research amounted to at least SEK 3.6bn in 2010, according to the Swedish NAO's report.

A further source of uncertainty when it comes to determining the scale of climate research is that not all climate research constitutes 'research' or 'development' as defined by the OECD. Some activities, such as those funded by the Swedish Energy Agency from its grant for energy research, are a matter of disseminating information and performing evaluation and standardisation instead. The largest item in the national budget for research and development, according to Statistics Sweden's national budget analysis for 2012, is direct grants for research and research training at HEIs. These grants amounted to SEK 14.5bn in 2012. Of the other grants for research funders, the largest items are for fundamental research through the Swedish Research Council, totalling more than SEK 5.1bn in 2013, energy research through the Swedish Energy Agency, SEK 1.3bn, and the SEK 926m for development research in 2012 through Sida. Here, since the Swedish NAO has recently reviewed roughly the same period as that covered by Sweden's Sixth National Communication on Climate Change (NC6), we use its figures as a starting point. Note, however, that they are not comparable with the figures in NC5.

Table. 8.1 **State support for climate research in 2010 according to the Swedish National Audit Office's questionnaire survey of higher education institutions and private companies, SEK million**

Climate research in 2010	SEK m	Of which, basic grants
Climate processes and models	286	119
Climate change impact, adaptation and vulnerability	272	85
Reduction of greenhouse gases	1 393	296
Total	**1 951**	**500**

8.6 Systematic observation

Climate observations comprise systematic collection of data on meteorology, hydrology and oceanography. In addition, they include monitoring of sources and sinks for greenhouse gases, as well as climate-related effects on ecosystems, such as changes in vegetation and soil.

There are growing demands for measurements related to vegetation and soil conditions. Some government agencies have therefore created a joint archive of satellite data (saccess.lantmateriet.se; see also section 8.1.3 Research infrastructure). Every year, multispectral optical satellite data with a resolution of 10–30 m, covering the whole of Sweden and collected during the vegetation period, are added to the archive. This archive helps users to study changes in the Swedish landscape and the environment over the past three decades and more.

Sweden has a well-developed system of environmental monitoring and Swedish measurement series are, in many cases, of unique length worldwide.

8.6.1 Responsible organisations

The Swedish Meteorological and Hydrological Institute (SMHI) is the administrative agency for meteorology, climatology, hydrology and oceanography. SMHI provides society with data and is responsible for administering and developing infrastructure and thereby collecting and disseminating knowledge of Sweden's meteorological, climatological, hydrological and oceanographic conditions. Under its directives, SMHI represents Sweden in the World Meteorological Organisation (WMO), European Centre for Medium-Range Weather Forecasts (ECMWF) and European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), where climate monitoring is an ever more essential activity. In addition, SMHI collaborates with other Nordic and European weather services on climate-related issues.

SMHI is also the Swedish representative in the user forum, set up by the European Commission, for what used to be Global Monitoring for Environment and

Security (GMES) and is now the European Earth Observation Programme (Copernicus). In 2011, a liaison group coordinated by SMHI was formed. This group is composed of 12 government agencies that use data from Earth observations. Its primary function is to define end-users' needs and demands as the basis for Swedish positions on priorities in GMES/Copernicus regarding the areas of climate, atmosphere, sea, land, natural disasters and safety.

The Swedish Environmental Protection Agency is responsible for coordinating environmental monitoring. This monitoring helps those concerned to follow the effects of climate change in all biogeochemical systems but also, in the long term, involves following trends in how the measures adopted affect ecosystems and society. Government-funded environmental monitoring is divided into ten different programme areas, including air, forest, farmland, mountain areas, landscapes, coordination of toxic substances and health-related environmental monitoring. The new Swedish Agency for Marine and Water Management took over monitoring of coasts and seas, freshwater and wetlands during the period under review.

The Swedish Environmental Protection Agency represents Sweden in the European Environment Agency (EEA), which coordinates European monitoring, and the UN Environment Programme (UNEP).

The Swedish National Space Board (SNSB) represents Sweden in the European Space Agency (ESA); the EU Seventh Framework Programme for Research (FP7), in the thematic area of Space; and GMES/Copernicus. SNSB also works on bilateral and multilateral satellite projects, of which the *Odin* satellite, with its stratospheric ozone monitoring, is one example.

8.7 Programmes and funding of climate-related research, including international cooperation

During the period, the bulk of new resources went to energy research and development of technologies that mitigate the climate impact of the energy and transport sectors. Examples are wind power, second-generation biofuels and hybrid vehicles. Strongly linked to energy issues is sustainable use of natural resources, since an increase in energy raw materials from the farm and forestry sectors is imperative. Below, selected major or more strategically important initiatives in all areas are described.

8.7.1 Climate processes and climate system studies, including palaeoclimate studies

Key projects for climate work in this category concern research and development relating to the exchange of greenhouse gases at a landscape level, and black carbon (soot) and other aerosols – their sources, processes and effects in the climate system, from local to regional and global perspectives. Research on the climate system is under way at several universities. One new institute that has appeared since the Fifth National Communication is the Bolin Centre for Climate Research at Stockholm University (SU), a product of the policy of investing in strong research environments. A hub of inter- and multidisciplinary research in geosciences at SU, the Centre is one of the groups contributing to EC-Earth CMIP5 (the Fifth Coupled Model Intercomparison Project).

8.7.2 Modelling and scenarios (including GCMs)

The Rossby Centre develops regional and global climate models (RCMs and GCMs respectively). As for global climate modelling, the Centre's activities are focused entirely on the EC-Earth model. The Centre is now heading development work on the latest version of EC-Earth, and also bears overall responsibility for the technical and scientific development of this version over the next three to five years. With the new initiatives in strategic areas, 'ModElling the Regional and Global Earth system' (MERGE) was formed. Involving five universities and the Rossby Centre, MERGE is coordinated by Lund University. The group's focus is the connection between vegetation and the land-based ecosystems' interaction with the climate system, including short-lived climate pollutants (SLCPs). The Rossby Centre, the Mistra-SWECIA research programme, the Department of Meteorology at Stockholm University (MISU) and Lund University are jointly working to develop the global EC-Earth climate model. The Mistra-SWECIA programme is addressing such areas as regional climate modelling, with specific topics including high-resolution climate scenarios, climate change impact, risk assessment and climate change adaptation as a societal process, with a focus that is expected to provide vital decision support in forestry.

8.7.3 Impacts of climate change

Research on effects of climate change takes the form of *in situ* studies but is also based on models to a large extent. The research is conducted in several areas, including climate change impacts and air quality; effects on seas and oceans, and hydrological risks; and

the implications of future natural disasters, such as flooding and drought. The research issues are SLCPs; the impact of climate change on future concentrations of air pollutants; and, conversely, the effects of air pollutants on the climate. Since 2011, SMHI's remit has included coordinating SLCP efforts in Sweden. The aims are to involve national stakeholders in this work and initiate efforts to improve emission inventories in terms of black and organic carbon, in consultation with the agencies concerned. SMHI's climate research is also closely connected with work to improve environmental quality; eutrophication in the Baltic Sea, for example, is strongly connected with climate change.

Of the various geographic regions, the Arctic is being studied particularly closely owing to its vulnerable environment, its prominent role in the global climate system and the singularly powerful signal of climate change it provides. Interdisciplinary research is important for studying the ecological and economic implications of climate change. Climate research also relates to forecasting and safety, since the incidence of extreme events, such as high water levels, may change in a future climate. There is now a greater focus on hydrological processes and tipping points, but also on large-scale modelling of local effects, such as urban issues relating to elevated risk of intense precipitation. Modelling of climate-related impacts on water quality for ecosystems and drinking water (with reference to the marine environment, eutrophication, lakes and watercourses, for example) takes place.

In impact research, too, investments in strategic environments are under way. One such initiative is Biodiversity and Ecosystem Services in a Changing Climate (BECC). The research is interdisciplinary: it investigates how different scales are connected and links ecological modelling and empirical studies, on the one hand, with policy and control mechanisms on the other.

The Mistra Future Forests research programme is evaluating the effects of climate change on Swedish forests, based on new climate scenarios and models. The programme is also analysing which strategy is most effective in reducing climate impact – sequestering carbon in forests and forest land or using products from forests to replace fossil-based products.

The Swedish Civil Contingencies Agency funds research by issuing open calls for proposals concerning the effects of natural events on society's security and emergency preparedness, to make it possible to strengthen our capacity to prevent and deal with negative events. The Agency distributes some SEK 120m annually for research projects to enhance society's protection and preparedness.

8.7.4 Socio-economic analysis (including impacts of climate change, adaptation needs and scope for protective measures)

Research to support global negotiations takes place, for instance, in the International Climate Policy research programme, which is funded by the Swedish Energy Agency. Support is given to research projects, synthesis, advanced investigation and global trend analysis for the purpose of providing an evidence base in the area of climate policy. For the current programme period (2011–14), funds have been awarded for research focusing on areas related, for example, to land use: measures for reforestation and for preserving and enhancing carbon sinks in forests and wetlands, and their potential for reducing greenhouse gas emissions. Research is also being conducted on development of models for emission baselines, CO_2 convergence, development of new flexible mechanisms, scope for improving measurements, verification and follow-up of measures intended to reduce greenhouse gas emissions in developing countries, surveys of emission trajectories for short-lived climate pollutants (black carbon) etc. The programme also supports research on countries' National Appropriate Mitigation Actions (NAMAs). One project, 'Orchestrating International Climate Policy', is intended to explore the potential role of the UNFCCC in three key policy areas: climate funding, REDD+[2] and short-lived gases. Others relate to energy and consumption, with a focus on a climate-driven energy transition and energy security.

Several programmes are developing various tools. The Swedish Environmental Protection Agency's research programme Climatools was concluded during the period under review, and the tools developed in cooperation with users at municipal and regional level are now available at the climate adaptation portal (see Chapter 6) for use in local and/or regional and sectoral climate change adaptation. In another project, Mistra Indigo, tools and policy instruments are being devised for more effective action on climate change worldwide. The premise is that this needs to take place from the bottom up, i.e. independently from the international framework of the UNFCCC. Among the matters being investigated are possible ways of linking together trading systems for emissions of CO_2 in various parts of the world. Another issue is the distributional implications of carbon dioxide taxes and other climate policy instruments. The role played and action taken by industry make up a third area included in the programme.

The Mistra Future Forests research programme is developing economic models for risk assessments in

[2] Reducing Emissions from Deforestation and Forest Degradation (REDD) is an initiative to create a financial value for the carbon stored in forests. REDD+ goes beyond deforestation and includes conservation, sustainable management and enhancement of forest carbon stocks.

forestry. Questions such as how climate variables should be managed in a risk perspective, and when it is worth adapting forestry strategies to a future climate, are tackled in the programme. It also includes analyses of how regulations and strategies of climate and forest policy (at national and international, for example EU, level) affect the Swedish forestry sector and how various stakeholders are positioning themselves. Research in Mistra-SWECIA, too, focuses on such objectives as achieving a better understanding of how society's stakeholders regard the risks and opportunities that a changed climate represents and how decisions on adaptation to these changes – with particular emphasis on Swedish forestry and with a focus on small-scale forest owners – come to be taken. Land-use scenarios with new global and regional climate-economic models, which can be used to demonstrate the implications of various policy options, are being devised.

The Mistra Arctic Futures research programme is evaluating how disturbances of various types (such as storms, floods and insect infestation of forests) can affect the northern (Arctic) parts of Sweden. The programme also analyses how policies and crisis preparedness have been developed in response to events that have already taken place, both in Sweden and, for comparison, in other Arctic countries, and how this preparedness can be strengthened.

8.7.5 Mitigation and adaptation technologies

The Swedish Energy Agency supports, on a number of development platforms, research and innovation that will help to bring about the changeover to an energy system that is sustainable in the long term.

Research in the transport sector is concerned with introducing renewable fuels and developing more energy-efficient energy conversion systems and vehicles, especially for road transport. Work to devise fuel-based energy systems and efficient cogeneration technologies based on biofuels is geared towards developing systems with higher steam data and materials for attaining a higher electrical output and increased fuel flexibility. Activities in the thematic area of 'buildings as energy systems' are aimed at developing new knowledge, products and services capable of contributing to more efficient energy use, lower energy costs in buildings and growing use of heating systems based on renewable energy.

In the area of energy-intensive industry, research-oriented activities are fostering efforts to boost energy efficiency in industrial processes in the *Mekmassa* (mechanical pulp) initiative, in which the primary aim is to help to reduce total electrical energy requirements in the making of products containing mechanical and/or chemi-mechanical pulp. Energy-system studies are intended to enhance knowledge of how the energy system functions and prospects for constructing environmentally, economically and socially sustainable energy systems. Analyses clarify how various parts of the system affect one another. Examples of priority areas or activities for analysis are energy, environmental and climate policy aims and instruments, and their consequences, and the functioning and future challenges of the energy markets. Work is being conducted mainly in three programmes: 'General Energy System Studies' (AES), 'North European Power Perspectives' (NEPP) and the co-funded 'Governing transitions towards Low-Carbon Energy and Transport Systems' (LETS).

Behaviour-related energy research and research on urban development issues are also in progress. Priority areas are hydropower, wind power, solar energy, marine energy and developing the future electricity grid, which will include smart networks. The research and development under way in these five development areas are focused on environmentally sound and cost-effective production technology that can, with advantage, be integrated into the power system. In every development area there is cooperation with the business sector and HEIs, which paves the way for needs-driven research and development. This, in turn, helps to bring about skills development in relevant areas for the benefit of the business sector, which enables research results to be put to practical use in commercial products. The research programme on electricity and fuel from the sun deals with technology for direct conversion of solar energy into electricity and fuel.

Other funders contribute to research on carbon capture and storage (CCS), including the Nordic CCS Competence Centre (NORDICCS), a network project in which the scope for large-scale CCS is being evaluated in the Nordic region. The network is user-controlled and will examine obstacles and opportunities, including more knowledge and acceptance of the issues involved. Another project, 'Baltic Sea Storage of CO_2' (BASTOR 2), intends to clarify the scope and requirements for storing carbon dioxide in the Baltic Sea, including the size of areas involved, leakage, legal aspects and so forth.

A carbon-neutral future is being studied in the project known as 'Nordic Energy Road Map 2050 – Strategic Choices towards Carbon Neutrality' (NORSTRAT). Using scenario analysis of an integrated future Nordic power system by 2050, the researchers are studying its implications for electricity, transport and transmission, and management for transformation. The 'Combating

Climate Change' (3C) project has focused on the scope for the private sector to contribute to implementation of climate policy. As part of the CompNat (Comparability of National Climate Policy Initiatives in a Fragmented International Climate Regime) project, experiments were carried out to develop a method that would afford a better understanding of national prospects of implementing the Copenhagen Accord. The emphasis was on political, technical and economic factors as drivers, to provide guidance for a broad international agreement. An important new initiative has been taken in the GOVREP project where, in cooperation with researchers in law and other disciplines, the focus is on management of energy systems. This research grouping is a new and valuable resource.

8.7.6 Support for climate-related research in developing countries

The Swedish International Development Cooperation Agency (Sida) has been the principal funder of research projects conducted in developing countries. Sida mainly funds projects to support capacity building in low-income countries. In 2009 there was a particular focus on food. The Climate Change Initiative (CCI) is receiving SEK 1.15bn in funds for the period 2009–12, primarily for bilateral and regional initiatives for adaptation. Its overarching aims are to boost the accumulation of research capacity and regional exchange of knowledge; ensure that knowledge is applied at all levels of society; and identify opportunities for collaboration. Sida contributed some SEK 1.4bn to UNFCCC-related initiatives and capacity-building programmes concerning the environment and climate.

Sida funds climate-related research in every continent and supports numerous initiatives and networks. This support includes research on forestry, agriculture, fishing, food, ecosystem resilience, vulnerability and adaptation. For example, SMHI is engaged in modelling of water supplies under climate change in the Arctic, Africa, South America, China, India and elsewhere. This includes water supplies not only for food production but also for industry and energy production. The Swedish Defence Research Agency (FOI) heads a joint international project on conflicts related to natural resources and climate change, focusing on the area around the Zambezi River in Southern Africa. The aims are to expand knowledge of how the area is vulnerable to the climate and climate change, and to strengthen early warning systems and the capacity to prevent and resolve conflicts. International collaboration concerning climate change adaptation (the Center for Water Resources Conservation and Development, WARECOD) is under way in Hanoi, Vietnam. This project, funded by Sida, is using and developing Climatools (see section 8.7.4). The Mistra Urban Futures programme is conducting research on sustainable urban development in cooperation with platforms funded by Sida in Manchester, Kisumu, Shanghai and Cape Town.

8.8 Programmes and funding of systematic observation, including international cooperation

The basic elements of systematic observation are measurements in meteorology, hydrology and oceanography. In Sweden, there are monitoring systems with great potential to help bring about systematic, coherent gathering of information concerning changes in terrestrial systems.

Funding is provided in the form of grants to government agencies, which outsource assignments. SMHI and the Swedish University of Agricultural Sciences (SLU) are the principal performers. The Swedish Environmental Protection Agency contributes some SEK 35m and SMHI roughly SEK 240m annually, comprising grants for meteorology (SEK 37m), hydrology (SEK 14m) and oceanography (SEK 186m). Sweden also grants SEK 60m to the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and SMHI contributes SEK 0.9m to European observations through EUMETNET[3], such as Aircraft Meteorological Data Relay (AMDAR), Advanced Satellite Aviation-weather Products (ASAP) and the Surface Marine programme of the Network of European Meteorological Services (SURFMAR).

8.8.1 National plans, programmes and support for ground- and space-based climate monitoring and participation in international cooperation

The principles of systematic monitoring established in the Global Climate Observing System (GCOS) have influenced Swedish systematic observations. Measures have been taken to ensure that unbroken observation series of high quality are maintained, by managing automation with maximum accuracy when manned stations are converted into automated ones.

One vital aspect of the ongoing development of observation systems in Sweden is creation of synergy between meteorology, hydrology, oceanography and

[3] EUMETNET is composed of 29 European national meteorological institutes.

climate and environmental systems. Owing to improved methods of performing reanalyses of different variables, older data have become more important for in-depth understanding of the climate and its variations. Efforts to digitise older data are continuing, but the volume of data means that this will take many years (more than a century at the current rate, for example, for meteorological data) to complete.

8.8.2 Monitoring of changes in carbon balance, biomass and land use

Changes in carbon balance in forested and farmed land are monitored by the Swedish National Inventory of Forests, which comprises the National Forest Inventory (NFI) and the Forest Soil Inventory. The NFI is part of Sweden's official statistics and information dating back to 1923 is available. It covers more than 10,000 sample plots in which inventories are carried out annually, in the snow-free months. Remote sensing has considerably enhanced quality in recent years.

The National Inventory of Landscapes in Sweden (NILS) is part of the Swedish Environmental Protection Agency's national environmental monitoring programme. NILS fills the gaps left by the National Inventory of Forests. In 2009, for example, it started a project aimed at monitoring climate change impact with the focus on the Swedish mountains, in which shifting of the treeline and forest limit is one aspect studied. The primary purpose is to monitor conditions for biodiversity at a landscape level. Monitoring takes place through interpretation of aerial photographs and field inventories, in a network of more than 600 permanent sampling areas 5 kilometres square, covering all types of terrain.

8.8.3 Participation in international cooperation for systematic climate monitoring, including GCOS

Sweden contributes to GCOS through SMHI, with long-term observations and measurements of parameters including temperature, precipitation, wave height, ice formation and glacier variations, i.e. 'essential climate variables' (ECVs). For observations with global, regional and national coverage, measurement from satellite-based systems is also required. Here, Sweden's contributions are made in several international programmes, such as the ESA Climate Change Initiative (CCI), partly to achieve the objectives in the GCOS 'Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC'.

8.8.4 Atmospheric monitoring

SMHI contributes atmospheric information to the WMO's World Weather Watch (WWW) and this is reported to GCOS. In cooperation within EUMETNET, too, Sweden provides data on wind, temperature and other variables collected at various levels through civil aviation, and weather radar contributes information about wind and precipitation. In Nordic cooperation and jointly with EUMETNET, GPS measurements of atmospheric humidity are also carried out in, for example, SWEPOS – the network of reference stations for satellite positioning support run by the National Land Survey of Sweden.

8.8.5 Monitoring of the sea

SMHI hosts the European EuroGOOS[4] secretariat, and is assisting at European level in improving data access and measurement activity. This is done, for example, for the European Marine Observation and Data Network (EMODNET), especially in coastal zones ('Sustained, Efficient Production of Required Information Services', SEPRISE). Similar activities are under way in the Baltic Sea, where the Baltic Operational Oceanographic System (BOOS) is responsible for coordination and buoys have been installed by Sweden and other nations.

8.8.6 Monitoring of land

SMHI reports river discharge data to the Global Terrestrial Observing System (GTOS) and Global Runoff Data Centre (GRDC). Within the framework of the Swedish National Space Board's national remote sensing programme, support is provided for a project for satellite monitoring of protected tropical forests (World Heritage Tropical Forests) and mapping of illegal logging.

8.8.7 Sweden's contributions to satellite data for climate monitoring

Through SMHI, within the scope of EUMETSAT's Satellite Application Facility (SAF) programme, Sweden is helping to develop new satellite products for climate monitoring on various scales. In addition, Sweden is cooperating in two satellite programmes, Jason-2 and Jason-3 (scheduled for launch in 2015), to monitor both world ocean dynamics and sea levels. Negotiations concerning the subsequent satellite, Jason-CS (to be launched in 2019), have begun with funding from EUMETSAT, the European Space Agency (ESA), the European Commission and the National Oceanic

[4] European Global Ocean Observing System.

and Atmospheric Administration (NOAA). The Swedish National Space Board (SNSB) is cooperating with the ESA in developing new generations of weather satellites and other satellites for remote sensing, to study the Earth and its climate systems. One of Sweden's most important research and development contributions is refined mapping of clouds and cloud characteristics (ECVs), obtained from data provided by a combination of operational and research satellites. SNSB is also, jointly with ESA, helping to ensure continued operation of the Swedish-led Odin satellite. Research satellites, including the ENVISAT environmental satellite, have contributed and will contribute further to our understanding of the climate.

Sweden is an active participant in ESA and the European Southern Observatory (ESO), which is helping to increase the supply of monitoring data relevant to the climate. In 2008, Sweden became affiliated to a new ESA programme for global monitoring of essential climate variables, ESA CCI. The purpose of this programme is to utilise old, existing data capable of being used to improve reliability in climate models, for example through reanalyses. A decision on a second phase of ESA CCI, starting in 2014, has now been taken.

Sweden is contributing to the development of new infrastructure for global observation systems and services based on remote sensing in what is now called Copernicus (formerly Global Monitoring for Environment and Security, GMES). As the EU's contribution to the Global Earth Observation System of Systems (GEOSS), GMES/Copernicus is a programme covering objectives both in the implementation plan for GCOS and in an equivalent plan for GEOSS. Accordingly, Sweden also contributes indirectly to the international monitoring system that the UNFCCC requires.

8.9 References for Chapter 8

Govt. Bill 2004/05:80, *Forskning för ett bättre liv.*

Govt. Bill 2008/09:50, *Ett lyft för forskning och innovation.*

Govt. Bill 2012/13:30, *Forskning och innovation.*

Swedish National Audit Office (2012). *Svensk klimatforskning – vad kostar den och vad har den gett?* (RiR 2012:2). (English summary: Swedish Climate Research: What are the Swedish Costs and Effects?)

9 Education, training and public awareness

9.1 Policy for education, training and public awareness

In Sweden, communicating knowledge of climate change and related measures is a key part of efforts to reduce emissions with a climate impact.

Current positions on climate policy in Government Bill 2008/09:162, *An Integrated Climate and Energy Policy*, reflect the view that the climate issue calls for popular participation and commitment. Educating the public about climate change and providing clear, easily accessible information about the environmental performance of products, in the form of labelling, are therefore encouraged. The aim is to give consumers a basis for making well-informed, active choices.

Agencies such as the Swedish Environmental Protection Agency, Swedish Energy Agency and Swedish Transport Administration communicate on climate issues on behalf of the Government in their respective areas of responsibility. All the agencies have many years' experience of using knowledge transfer and information as policy instruments.

Non-profit organisations and other knowledge centres, such as museums and adult education associations, also help to build knowledge and promote dialogue about the problems of climate change and how to solve them. Today, the notions of climate change and its causes and effects are thoroughly familiar to the general public.

9.2 Mass media and climate change

News reporting on climate change in the Swedish media has steadily decreased over the past few years. As Fig. 9.1 below shows, 2007 was a record year in terms of the number of articles published, and climate-related subjects featured prominently in the media right up to the Copenhagen climate talks in 2009. Since then, media interest in climate has declined.

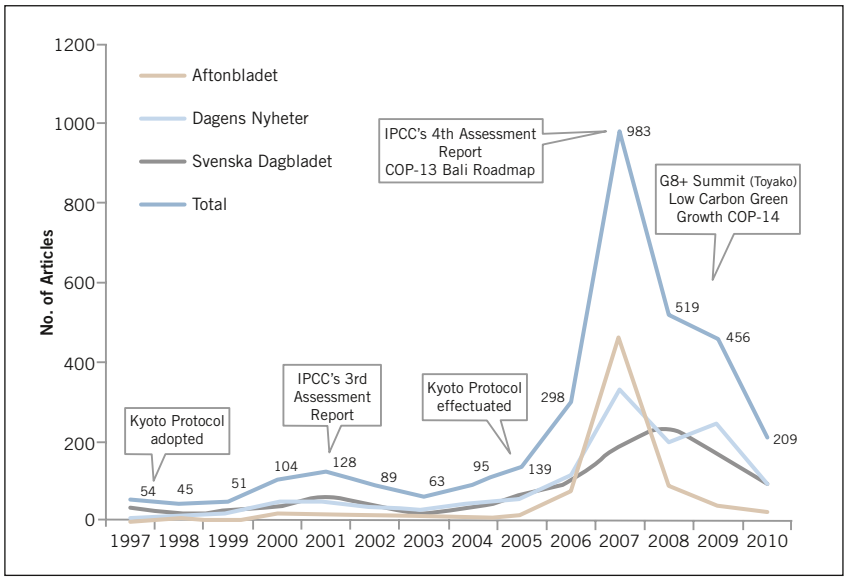

Figure 9.1 **Number of newspaper articles (in *Aftonbladet*, *Dagens Nyheter* and *Svenska Dagbladet*) on climate change.**

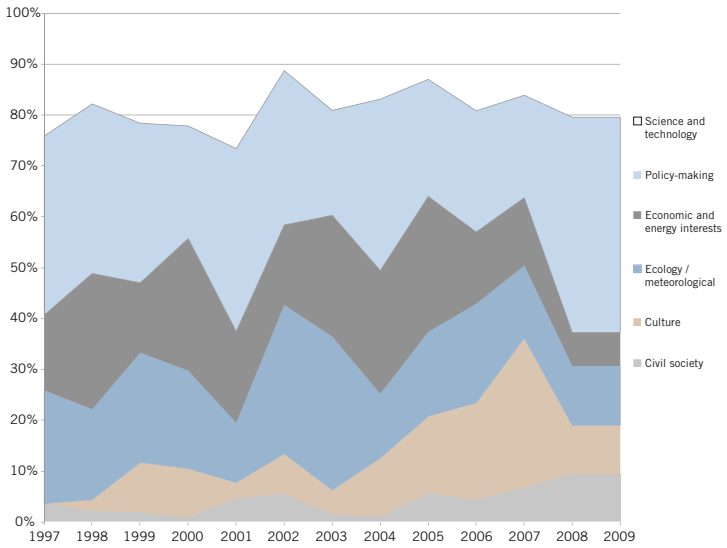

Figure 9.2 **Aggregated distribution (spread) of news, by subject area.**

According to a Stockholm Environment Institute survey (Carson 2012), considerable news value tends to attach to major scientific and/or political events, which thereby attract media attention. The survey also shows that there was a greater focus on the private sector and energy issues before 2007 (Fig. 9.2). One explanation for this may be the far-reaching consensus on the climate issue that arose in 2006–07, partly owing to publication of the *Stern Review on the Economics of Climate Change* and the stir caused by Al Gore's film *An Inconvenient Truth*. Sweden's lack of any national extraction of fossil fuels to defend and the fact that most large companies at the time had already acknowledged climate change as a major challenge brought about a shift in public interest from questions about the causes of the problem ('What...?') to asking about solutions ('How...?').

Another conclusion about media reporting of climate change is that less attention is now being paid to viewpoints and opinions that contradict the conclusions presented in The Physical Science Basis, part of the Fourth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC).

9.3 Public awareness

Between 2002 and 2009, the Swedish Environmental Protection Agency regularly conducted surveys of Swedes' attitudes towards, and understanding of, the climate problem. The purpose was partly to gauge the Swedish people's preparedness and will for change to reduce emissions resulting from their own lifestyle and consumption.

The 2009 survey indicates that Swedes remain highly prepared to reduce their own greenhouse gas emissions, and want more information about how this can be done. There is also growing preparedness to move from words to action.

9.4 Knowledge centres for climate information

Swedish Environmental Protection Agency

This Agency works on behalf of the Swedish Government and is the authority in Sweden with an overview of the state of the environment and progress in environmental management. The Agency also has the function of coordinating, monitoring and evaluating Sweden's progress towards its environmental objectives and, above all, supporting other stakeholders in their environmental efforts, by developing and disseminating knowledge, formulating requirements and aspirations, and engaging in monitoring and evaluation. Since February 2013, the Agency has had a new website (www.naturvardsverket.se) with extensive information about climate change.

Since 2001, the Environmental Protection Agency has also been holding the annual 'Climate Forum', a seminar at which various themes with a bearing on climate change are discussed. The Forum brings together agencies, organisations, municipalities, businesses and politicians.

Swedish Energy Agency

As the central government authority for energy issues, the Swedish Energy Agency is responsible for giving both citizens and businesses information and advice on more efficient energy use. The Agency's website, www.energimyndigheten.se, contains extensive information (mainly in Swedish) about households' energy use and what can be done to reduce it. Along with these energy-saving tips for the public, there is a special website for schools (in Swedish), www.energikunskap.se, addressed to teachers and pupils alike. The Agency's Testlab tests the energy consumption and functioning of various products, and publishes the results on the website.

The Energy Agency arranges, funds and takes part in a range of activities at local or regional level. There are, for example, development programmes like *Sustainable Municipality;* support for information and education projects; and support, in various forms, for municipal advisory services on energy and the climate, and for regional energy offices. Advice on energy and climate change, addressing the public, small and medium-sized enterprises (SMEs) and organisations, is available in most Swedish municipalities.

Swedish Consumer Agency

The Swedish Consumer Agency, the country's central administrative authority for consumer affairs, bears primary responsibility for implementing government consumer policy. The Agency's remit includes integrated responsibility for consumer-related environmental and sustainability issues, and also special responsibility for progress towards environmental objectives within its own sphere of activities. The Agency's website, www.konsumentverket.se, serves as a portal for its own and other authorities' consumer information. Its publicity aimed at the public includes information about climate and environmental labels, such as the Nordic Ecolabel, Good Environmental Choice and the EU Ecolabel.

The Consumer Agency also provides *Bilsvar*, an online service offering an overview of vehicles' fuel consumption, CO_2 emissions, economy and safety.

Swedish Forest Agency

In the years 2009–12, the Swedish Forest Agency received special funds to inform forest owners and forest officers about climate change. Information and advice about the climate have been provided at special seminars or conferences in the various forest districts. The Agency's website, www.skogsstyrelsen.se, and the magazine *Skogseko* ('Forest Echo') have also been important channels.

Swedish Board of Agriculture

Agriculture influences the environment in many different ways. The Swedish Board of Agriculture website, www.jordbruksverket.se, reports both on global aspects of climate change and on matters relating to biodiversity and individual farmers.

Swedish Meteorological and Hydrological Institute

The Swedish Meteorological and Hydrological Institute (SMHI) develops and distributes information about the weather, water and the climate for the purpose of providing knowledge and high-quality decision support for the public and business sectors and for citizens.

The website www.smhi.se contains abundant material (including maps) concerning various climate scenarios for users to download. Information on climate change, in Swedish, has been compiled on the *Klimat i förändring* ('Changing climate') theme page at www.smhi.se/tema/Klimat-i-forandring. Since 2012, SMHI has also run a *National Knowledge Centre for Climate Change Adaptation* to compile, summarise and make available relevant knowledge. In managing the Centre, SMHI collaborates on a broad front with stakeholders involved in climate change adaptation.

The Centre also runs the *Swedish Portal for Climate Change Adaptation*, a collaborative undertaking involving 13 government agencies. This website, www.klimatanpassning.se, serves to support those engaged in adapting society to climate change.

Swedish Transport Administration

The Swedish Transport Administration is a central government agency tasked with ensuring that the systems for road and rail transport, shipping and aviation are of a high standard, economically efficient and universally available.

The Administration is in charge of environmental issues associated with the state road and rail networks. It works to reduce emissions that affect climate, by promoting attractive, accessible towns and cities characterised by reduced car dependence, energy-efficient goods transport chains, more energy-efficient road vehicles and railway rolling stock on a sustainable energy basis, and energy-efficient infrastructure maintenance.

The website www.trafikverket.se contains general information about the environmental impact of road and rail transport, and about how individuals can reduce emissions by, for example, choosing low-emission modes of transport, driving economically and selecting fuel-saving vehicles.

Swedish Defence Research Agency

The Swedish Defence Research Agency (FOI) is a research institute in the area of defence and security that is helping society to adapt to a changing climate by developing methods and tools. The Agency also conducts research with the aim of understanding conditions for adaptation both in Sweden and abroad.

In the *Climatools* research programme, funded by the Swedish Environmental Protection Agency, adaptation tools have been developed in cooperation with stakeholders that include a few municipalities. The intention is for these tools to make it easier for spatial planners and decision makers to adapt society to the repercussions of climate change. Researchers from

FOI, KTH Royal Institute of Technology, the National Institute of Economic Research and Umeå University have taken part in the various projects concerning these tools. Information about Climatools is available at www.climatools.se.

9.5 Complementary knowledge centres

Swedish Museum of Natural History

The 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 hosted *Mission: Climate Earth*, an exhibition designed to impart basic knowledge of climate issues and of what can be done to curb climate change. The exhibition, combining facts and sensory experiences, has been seen by some 1.2 million visitors to date. The Museum also issues study material and a teacher's guide linked to the exhibition, catering for school pupils of all ages. The content of the exhibition was devised in cooperation with Stockholm University, the Swedish Environmental Protection Agency, the World Wide Fund for Nature (WWF) and SMHI.

Adult education associations

The *Study Promotion Association* (Studiefrämjandet) offers nationwide study circles with the goal of enhancing knowledge about 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 wide range of study circles on such subjects as building solar panels and locally adapted courses on sustainable development. The Association has also trained 'climate ambassadors' and 'climate heroes' around Sweden, who offer to lecture or help to start study circles in, for example, energy, consumption, lifestyle and policy.

In several locations in Sweden, the *Workers' Educational Association* (Arbetarnas Bildningsförbund, ABF) runs 'climate courses' that cover the causes of climate change and its effects, globally and in Sweden. Students learn more about the nature of connections between the climate, the environment and health, and learn to make conscious choices to reduce environmental impact.

Other non-governmental organisations

Swedish non-governmental organisations play an active part in public debate on climate change, by creating arenas and meeting places for discussion, debate and action. The Internet is, in this context, an important channel for knowledge transfer and mobilisation of commitment. Relevant organisations include:

- Swedish Society for Nature Conservation (SSNC), 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
- Friends of the Earth Sweden, www.mjv.se
- PUSH Sweden (in Swedish), www.pushsverige.se

9.6 Initiatives and activities

9.6.1 Education: school-oriented activities

In Sweden preschools, schools and adult education have a clear remit to foster socially, economically and ecologically sustainable development. This remit is formulated in national governance documents such as the Education Act, curricula and syllabuses. The National Agency for Education is responsible for initiatives such as the *Education for Sustainable Development* award (started in 2005), which has helped to boost motivation for and interest in working for sustainable development in compulsory school. In-depth teaching on climate issues is common at upper secondary level.

Several higher education institutions offer courses on the scientific basics of the climate and/or climate-related subjects like energy and forestry. There are various networks and centres of competence; at Karlstad University, for example, there is a *Centre for Climate and Safety* that aspires to accumulate knowledge and experience of risks associated with climate change.

Several public agencies and knowledge centres offer online climate information addressing pupils of various ages. With its *Green Flag* award, the Keep Sweden Tidy Foundation assists a growing number of Swedish schools with targets and a structure for their environmental work. The issues of climate change, energy efficiency and resource conservation are dealt with under the overarching objective of sustainable development.

Volunteers from Greenpeace, known as 'Greenspeakers', give talks in schools on request. Interest in these talks has increased, and considerable scope has been given to climate change, which is a key issue for Greenpeace.

Information campaigns targeting schools include the following:

- *Energy around the Baltic Sea* (Swedish Energy Agency), a set of materials for schools that link energy, environment and climate. The materials are available

in Swedish, English, Estonian, Latvian, Lithuanian, Polish and Russian.

- *Active Learning* (Swedish Energy Agency and Swedish schools, 2007–08), an EU project aimed at school pupils and teachers and designed to teach younger children (aged 6–13) to use energy responsibly and sustainably.
- The *Forest in Schools* project (Swedish Forest Agency and Sweden's forest stakeholders), which connects theory and practice with the purpose of enhancing knowledge of and interest in forests and all the values they represent, including their bearing on the climate.
- *KNUT* ('Knowledge Development, Science, Outdoor Education and Technology'), a national school development project at regional level, intended to increase interest in, knowledge of and commitment to energy, climate and resource issues among children and adolescents. This project seeks to help shift society towards sustainability and boost interest in studying science and technology (for information in Swedish, see www.knutprojektet.se).

9.6.2 Training: courses, seminars etc.

Education and knowledge transfer at seminars have a self-evident role in promoting climate awareness at public agencies and companies alike. Training about the environment and the climate is often among the steps taken by companies to achieve environmental certification to international standards (ISO and EMAS). Businesses' involvement in climate issues is reflected, not least, in a rise in the number of networks in which companies jointly hold seminars on climate and environment to promote their own business development. Climate and energy experts from agencies and organisations are often among the lecturers.

The Internet is frequently used for knowledge transfer and exchange of experience among and within agencies and organisations. One example is the Swedish Portal for Climate Change Adaptation, with its facts and guidance on adaptation to a warmer climate. The Portal is managed by the *National Knowledge Centre for Climate Change Adaptation*, which was set up at SMHI on the Government's behalf.

Training courses on how environmental and climate requirements can be imposed in procurement are held by a range of providers at national, regional and local level.

SMHI offers lectures and customised courses on climate change to companies, municipalities and agencies. These explain the science behind climate change, its causes and effects, focusing on the audience's activities.

Several major conferences on climate and energy themes are held in Sweden every year. These include the *Climate Forum*, held annually by the Environmental Protection Agency, and *Nordic Energy Outlook*, arranged by the Swedish Energy Agency. In addition, the magazine *MiljöAktuellt* ('Environmental News') holds an annual seminar on climate change adaptation in Sweden *(Klimatanpassning Sverige)* jointly with various public agencies. These conferences attract audiences of thousands and are popular meeting places for agencies, organisations, businesses and politicians.

9.6.3 Public awareness and activities targeting the public

Several agencies have set out to provide increasing online information, on climate change and what can be done, for households. One discernible trend is that sustainability is being discussed to a larger extent and consumption is increasingly being associated with climate problems. There is rising awareness of how foods for example, but also other products and services, affect the climate. A growing volume of reports and information offering advice and guidance on how people can reduce their own emissions have become available.

9.6.3.1 CAUSES, EFFECTS AND ADAPTATION

Climate change will affect the whole of society and exert effects on various ecosystems and sectors. Ticks are spreading northwards in Sweden; skiing resorts are seeking solutions to ensure sufficient snow; and municipalities are planning to tackle risks of floods and landslides. SMHI's website provides both general information about climate change and analyses on the impact this will have regionally and locally. Users can also download a selection of scenario data or study a set of climate indicators (temperature, precipitation, extreme precipitation and sea level).

For sharing of experience on practical adaptation to climate change, there are frequent seminars where the need for a national strategy for climate change adaptation is discussed. Agencies, municipalities and businesses with activities requiring adaptation measures are the target groups for these seminars.

9.6.3.2 TRANSPORT

Emission checks carried out by the Swedish vehicle inspection company Bilprovningen are its most important contribution to reducing the environmental impact of traffic on Swedish roads. The company also disseminates environmental advice to vehicle owners. Roughly a third of emissions in Sweden come from road transport, and most of these come from passenger cars. Inspections carried out by the company include

several important environmental checks that reveal environment-related defects in nearly 5% of all cars.

Every year, the Swedish Consumer Agency issues its publication 'Vehicles, Fuel Consumption and our Environment' *(Bilar, bränsleförbrukning och vår miljö)*, containing advice on fuel consumption and CO_2 emissions from new cars, and on how to consume less fuel and reduce the environmental impact of vehicles in other ways.

The Swedish Association of Green Motorists promotes development of environmentally sound road transport by, for example, surveying the local presence of green cars. The organisation also provides advice and support to purchasers of green cars, publishes an annual list of the greenest vehicles and, in various ways, highlights climate initiatives in the road transport sector.

9.6.3.3 HEATING AND ENERGY USE

The three-year *Become Energy-Smart* campaign ended in 2009. It included an exhibition, 'The Energy-Smart House', which visited several locations in Sweden. The public were given advice on how to save energy at home, and there was an energy calculator in the information material that estimated costs of investments to reduce energy requirements in single-family dwellings. The campaign was run jointly by the Swedish Energy Agency, Environmental Protection Agency, Consumer Agency and National Board of Housing, Building and Planning.

Municipal energy and climate advisers are an important channel of information to the public. They provide advice and support for households and businesses on many topics, from changing a heating system to insulation and other ways of improving energy efficiency. There are advisers in most Swedish municipalities, and they receive state financial support through the Energy Agency.

Sweden also takes part, through WWF, in the Earth Hour campaign. As part of this campaign, WWF has invited towns and cities in selected countries to present inspiring and credible plans for radically increasing the share of renewable energy used over the next few decades. Twelve Swedish towns signed up for the challenge to show how they are planning to favour climate-smart solutions for housing, transport, food and other sectors.

9.6.3.4 CONSUMPTION AND CLIMATE LABELLING

The Consumer Agency's online Miljömätaren ('Enviro-meter') tool explains a person's impact on the environment in an easily intelligible way. Here, too, estimates of what changed behaviour would mean for energy use are available.

Information about food with a relatively low climate impact and simple ways of saving electricity in the kitchen is disseminated by a range of stakeholders. Joint efforts are being made by the central government and various sectoral bodies to develop climate labelling for food.

IVL Swedish Environmental Research Institute has developed a web-based tool, the 'Climate Account', for individuals to measure their carbon footprint. By providing users with information and a way of estimating their greenhouse gas emissions, the Climate Account can help to reduce climate impact from personal consumption. Basic information on how to reduce one's emissions, and about the impact of policy instruments on society's emissions, is also available.

The Swedish Environmental Management Council offers a method of listing the greenhouse gas emissions from products according to the international Environmental Product Declaration (EPD) system (www.environdec.com). The EPD represents a comprehensive approach to the climate impact of products and can be used by manufacturers, but also by purchasers and consumers wishing to make climate-friendly buying decisions.

9.6.4 Public participation and public access to information: strategies and examples

There is ample scope in Sweden to ask questions and express views on an area of knowledge or a policy proposal, through consultation procedures and open meetings, hearings and seminars. Special initiatives are also taken to increase public participation in climate work. Activities range from answering questions online to engaging in open consultations. Non-profit organisations often establish web-based forums or appeals where the public are urged to express their opinions.

Energy and climate advisers in Sweden's municipalities reply free of charge to questions about heating, energy costs and efficiency, transport, climate, government grants relating to energy and a great deal else. This advisory service caters for the general public, SMEs and organisations.

Authorities and organisations at national level also regularly answer verbal and written questions from the public.

9.6.5 International cooperation and efforts to disseminate Swedish findings abroad

Between 2007 and 2012, in cooperation with the consultancy Sweco, the Stockholm Environment Institute and other organisations, SMHI ran information campaigns within the framework of its international train-

ing programme *Climate Change – Mitigation and Adaptation*. The training, funded by the Swedish International Development Cooperation Agency (Sida), had the overarching aim of boosting knowledge of the causes and effects of climate change in developing countries. The target group was people in leading positions in national or local public administration, non-governmental organisations, universities or companies. During the period, some 440 participants from about 50 countries took part in the project, which is now in a concluding and evaluation phase.

SMHI also takes part in the UN *Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region* (ESCWA RICCAR), which is being funded by Sida from 2011 to 2013. This initiative identifies both the socio-economic and the environmental vulnerability caused by climate change impacts on water availability in the region. The Swedish contribution includes regional climate modelling and simulation of hydrological effects.

In 2007, the Swedish Forest Agency embarked on cooperation with forest authorities in US states in the Mid-West. This cooperation includes activities focused on exchanging experience and knowledge concerning opportunities and problems associated with the role of forests in addressing climate change. Since May 2008, Sweden, through the Forest Agency, has also been heading a development process on bioenergy and climate within the pan-European body for developing forest policy, the *Ministerial Conference on the Protection of Forests in Europe (MCPFE)*.

9.6.6 Networking: networks, in Sweden and abroad, used to disseminate and communicate information about climate change

Sweden has a number of networks focusing on climate issues, each with a distinctive emphasis.

The *National Knowledge Centre for Climate Change Adaptation* runs the Swedish Portal for Climate Change Adaptation. The Portal is a resource for those engaged in adapting society to climate change, and also for other stakeholders.

At local level, networking in programmes or projects is a common form of cooperation. One example is the Swedish Energy Agency's *Sustainable Municipality programme*, covering 37 selected municipalities in Sweden. The idea is that, through joint action, the municipalities should create, develop and disseminate best practice relating to energy in the areas of physical planning and economic policy. They are also intended to develop their general energy and climate work and thereby be models to other municipalities. The programme is now in its third phase. *Municipal climate and energy advisers*, too, form a network and are regularly offered training and information by the Energy Agency.

The *Climate-Neutral Freight Transportation* network is a cooperative project involving the Centre for Environment and Sustainability at Chalmers University of Technology and the University of Gothenburg, together with Preem AB, Schenker AB, Volvo Trucks and the Swedish Transport Administration. The purpose of the work is to reduce CO2 emissions, the target being to halve, by the year 2020, the climate impact of goods transport by road.

For food producers there is the *Food and Environment network* run by the Swedish Institute for Food and Biotechnology (SIK). The purpose of this network is to expand knowledge and understanding of the climate impact of food products, and to strengthen the producers' positions on the market. Participants meet regularly and benefit from one another's experience.

The *Haga Initiative* is a business network that works to reduce emissions from the business sector and raise awareness of climate issues by showing that ambitious climate strategies afford business advantages and greater profitability. The Initiative includes Axfood, Coca-Cola Enterprises Sweden, Fortum Värme, JM, Lantmännen, Löfbergs, McDonald's, Procter & Gamble Sweden, HKScan Sweden, Stena Recycling, Statoil Fuel & Retail Sweden and Vasakronan.

9.7 References for Chapter 9

Carson (2012) *All together now? Climate change in the Swedish mainstream press* (under review).

Annex 1: Acronyms and abbreviations

%	Per cent
€	Euro(s)
°C	Degree(s) Celsius
3C	Combating Climate Change
AAUs	Assigned amount units
ABF	Arbetarnas Bildningsförbund (Workers' Educational Association of Sweden)
ADB	Asian Development Bank
AES	Allmänna energisystemstudier (General Energy System Studies)
AfDB	African Development Bank
AMDAR	Aircraft Meteorological Data Relay
AOGCM	Atmosphere-Ocean General Circulation Model
ARR	Arctic Resilience Report
ASAP	Adaptation for Smallholder Agriculture Programme (Ch. 7)
ASAP	Advanced Satellite Aviation-weather Products (Ch. 8)
Baltadapt	Baltic Sea Region Climate Change Adaptation Strategy
BASTOR 2	Baltic Sea Storage of CO_2
BBR	Building Regulations of the Swedish National Board of Housing, Building and Planning
BECC	Biodiversity and Ecosystem Services in a Changing Climate
bn	Billion (1,000 million)
BONUS	Joint Baltic Sea Research and Development Programme
BOOS	Baltic Operational Oceanographic System
C	Manufacturing (Swedish Standard Industrial Classification SNI 2007)
CAB	County administrative board
CAEP	Committee on Aviation Environmental Protection
CCAC	Climate and Clean Air Coalition
CCI	Climate Change Initiative
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CER	Certified emission reduction
CGIAR	Consultative Group on International Agricultural Research
CH_4	Methane
CHP	Combined heat and power
CIFs	Climate Investment Funds
CMIP5	Coupled Model Intercomparison Project, Phase 5
CMIP6	Coupled Model Intercomparison Project, Phase 6
CO_2	Carbon dioxide
CO_2 eq	Carbon dioxide equivalent
CompNat	Comparability of National Climate Policy Initiatives in a Fragmented International Climate Regime
COP	Conference of the Parties
CPF	Carbon Partnership Facility
CRF	Common Reporting Format
CRS	Creditor Reporting System
CTF	Clean Technology Fund
DAC	Development Assistance Committee of the OECD
E85	Fuel blend of about 85% denatured ethanol and 15% petrol (gasoline) or other hydrocarbon
EBRD	European Bank for Reconstruction and Development
ECDS	Environment Climate Data Sweden
EC-Earth	Earth system model of the European Centre for Medium-Range Weather Forecasts
ECMWF	European Centre for Medium-Range Weather Forecasts
ECVs	Essential climate variables
EEA	European Environment Agency
EEDI	Energy Efficiency Design Index

EEOI	Energy Efficiency Operational Indicator
EIS	Environmental impact statement
EMAS	Eco-Management and Audit Scheme
EMODNET	European Marine Observation and Data Network
ENVISAT	Environmental satellite launched by the European Space Agency
EPD	Environmental Product Declaration
ERA-NET	European Research Area Networks
ERU	Emission reduction unit
ESA	European Space Agency
ESD	Effort Sharing Decision
ESO	European Southern Observatory
EU ETS	European Union Emissions Trading System
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EuroGOOS	European Global Ocean Observing System
F	Construction (Swedish Standard Industrial Classification SNI 2007)
FAME	Fatty acid methyl ester
F-gases	Fluorinated greenhouse gases
FIP	Forest Investment Programme
FOI	Swedish Defence Research Agency
FORTE	Swedish Research Council for Health, Working Life and Welfare
FP7	EU Seventh Framework Programme for Research and Technological Development
FSC	Forest Stewardship Council
GCF	Green Climate Fund
GCM	Global climate model, or general circulation model
GCOS	Global Climate Observing System
GDP	Gross domestic product
GEF	Global Environment Facility
GEOSS	Global Earth Observation System of Systems
GFDRR	Global Facility for Disaster Reduction and Recovery
GMES	Global Monitoring for Environment and Security
GNI	Gross national income
GOVREP	Governance for renewable electricity production
Govt. Bill	Government Bill
GPS	Global Positioning System
GRDC	Global Runoff Data Centre
GTOS	Global Terrestrial Observing System
GWh	Gigawatt-hour(s)
ha	Hectare(s)
HFCs	Hydrofluorocarbons
HVO	Hydrotreated (hydrogenated) vegetable oil(s)
IBRD	International Bank for Reconstruction and Development
ICAO	International Civil Aviation Organisation
ICOS	Integrated Carbon Observation System
ICSU	International Council for Science
IDA	International Development Association
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IGBP	International Geosphere-Biosphere Programme
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
IS-ENES2	Infrastructure for the European Network of Earth System Modelling, Phase 2
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature
IVL	IVL Swedish Environmental Research Institute
JI	Joint Implementation
JPI	Joint Programming Initiative
JRC	Joint Research Centre
KLIMP	Local climate investment programmes
km^2	Square kilometre(s)
KVA	Royal Swedish Academy of Sciences
kWh	Kilowatt-hour(s)
LDCs	Least developed countries
LETS	Governing transitions toward Low-Carbon Energy and Transport Systems
LIP	Local investment programmes for ecologically sustainable development
LPG	Liquefied petroleum gas
LULUCF	Land use, land-use change and forestry
m^2	Square metre(s)
m^3	Cubic metre(s)
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MERGE	ModElling the Regional and Global Earth system
MISU	Department of Meteorology at Stockholm University
mm	Millimetre(s)
MSB	Swedish Civil Contingencies Agency
Mt	Million tonnes
Mt CO_2 eq	Million tonnes of carbon dioxide equivalent
MTR	Mid-Term Review
N_2O	Nitrous oxide
NAMAs	Nationally Appropriate Mitigation Actions
NAPAs	National Adaptation Programmes of Action

NC5	Fifth National Communication on Climate Change
NC6	Sixth National Communication on Climate Change
NDF	Nordic Development Fund
NEPP	North European Power Perspectives
NFI	National Forest Inventory
NILS	National Inventory of Landscapes in Sweden
NOAA	National Oceanic and Atmospheric Administration
NORDCLAD-net	Nordic Climate Change Adaptation Research Network
NORDICCS	Nordic CCS Competence Centre
NORD-STAR	Nordic Centre of Excellence for Strategic Adaptation Research
NORSTRAT	Nordic Energy Road Map 2050 – Strategic Choices towards Carbon Neutrality
OECD	Organisation for Economic Cooperation and Development
PBA	Planning and Building Act
PEFC	Programme for the Endorsement of Forest Certification
PFCs	Perfluorocarbons
PFE	Programme for Energy Efficiency in Energy-Intensive Industry
PGD	Sweden's Policy for Global Development
PMR	Partnership for Market Readiness
ppm	Parts per million
R&D	Research and development
RCA	Regional Atmospheric Climate Model
RCM	Regional climate model
RCP	Representative Concentration Pathway
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SAF	Satellite Application Facility
SE4ALL	Sustainable Energy for All
SEEMP	Ship Energy Efficiency Management Plan
SEI	Stockholm Environment Institute
SEK	Swedish kronor
SEK m	Million Swedish kronor
SEPRISE	Sustained, Efficient Production of Required Information Services
SF_6	Sulphur hexafluoride
SFS	Swedish Code of Statutes
SGI	Swedish Geotechnical Institute
Sida	Swedish International Development Cooperation Agency
SIDS	Small island developing states
SIK	Swedish Institute for Food and Biotechnology
SLCPs	Short-lived climate pollutants
SMHI	Swedish Meteorological and Hydrological Institute
SNI	Swedish Standard Industrial Classification
SREP	Scaling Up Renewable Energy Programme
SSEESS	Swedish Secretariat for Environmental Earth System Sciences
SSNC	Swedish Society for Nature Conservation
SURFMAR	Surface Marine programme of the Network of European Meteorological Services
TBE	Tick-borne encephalitis
TPES	Total primary energy supply
TWh	Terawatt-hour(s)
UCF T2	Umbrella Carbon Facility Tranche 2
UN	United Nations
UN ESCWA RICCAR	Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
US$	US dollars
VAT	Value added tax
VINNOVA	Swedish Governmental Agency for Innovation Systems
WARECOD	Center for Water Resources Conservation and Development
WCRP	World Climate Research Programme
WFP	World Food Programme
WMO	World Meteorological Organisation
WWF	World Wide Fund for Nature
WWW	World Weather Watch

Annex 2:
Summary emissions tables

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1990
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**19 688,47**	**6 939,96**	**8 449,04**	**4,15**	**376,82**	**107,49**	**35 565,93**
1. Energy	**51 741,66**	**574,45**	**1 353,51**				**53 669,62**
A. Fuel Combustion (Sectoral Approach)	51 432,72	499,29	1 352,12				53 284,13
1. Energy Industries	9 794,67	22,13	328,05				10 144,84
2. Manufacturing Industries and Construction	11 510,76	45,85	502,72				12 059,32
3. Transport	18 896,17	187,27	217,63				19 301,08
4. Other Sectors	10 385,02	243,19	287,49				10 915,69
5. Other	846,10	0,85	16,24				863,19
B. Fugitive Emissions from Fuels	308,94	75,15	1,39				385,49
1. Solid Fuels	5,18	0,00	0,07				5,25
2. Oil and Natural Gas	303,76	75,15	1,32				380,23
2. Industrial Processes	**4 926,27**	**13,53**	**901,53**	**4,15**	**376,82**	**107,49**	**6 329,78**
A. Mineral Products	1 721,76	NA	NA				1 721,76
B. Chemical Industry	126,05	7,66	835,30	NA	NA	NA	969,01
C. Metal Production	3 078,46	0,76	NA	NA	376,82	23,90	3 479,93
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 [2]				4,15	NA,NE,NO	83,59	87,74
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**242,27**		**90,22**				**332,49**
4. Agriculture		**3 184,42**	**5 812,80**				**8 997,22**
A. Enteric Fermentation		2 950,61					2 950,61
B. Manure Management		233,82	732,88				966,70
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	5 079,92				5 079,92
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]	**-37 265,58**	**1,72**	**79,39**				**-37 184,46**
A. Forest Land	-40 592,75	1,50	57,58				-40 533,67
B. Cropland	2 407,55	IE,NO	21,79				2 429,34
C. Grassland	-301,91	0,22	0,02				-301,67
D. Wetlands	39,60	NA	NA				39,60
E. Settlements	1 181,94	IE,NE	IE,NE				1 181,94
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**43,85**	**3 165,83**	**211,58**				**3 421,27**
A. Solid Waste Disposal on Land	NO	2 874,22					2 874,22
B. Waste-water Handling		291,60	210,56				502,16
C. Waste Incineration	43,85	0,00	1,03				44,89
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	3 562,81	0,51	53,51				3 616,83
Aviation	1 334,94	0,20	16,93				1 352,07
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	**11 436,56**						**11 436,56**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			72 750,39
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			35 565,93

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1991
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**19 032,17**	**6 927,66**	**8 335,61**	**8,45**	**380,25**	**108,51**	**34 792,65**
1. Energy	**52 240,14**	**593,59**	**1 391,23**				**54 224,97**
A. Fuel Combustion (Sectoral Approach)	51 984,21	518,98	1 390,16				53 893,36
1. Energy Industries	10 761,58	25,75	354,84				11 142,17
2. Manufacturing Industries and Construction	11 541,83	45,08	517,76				12 104,68
3. Transport	18 449,23	195,08	213,18				18 857,49
4. Other Sectors	10 163,39	252,15	284,81				10 700,35
5. Other	1 068,18	0,92	19,57				1 088,67
B. Fugitive Emissions from Fuels	255,93	74,61	1,07				331,61
1. Solid Fuels	5,03	0,00	0,07				5,10
2. Oil and Natural Gas	250,90	74,61	1,00				326,51
2. Industrial Processes	**4 703,45**	**12,46**	**949,04**	**8,45**	**380,25**	**108,51**	**6 162,15**
A. Mineral Products	1 588,44	NA	NA				1 588,44
B. Chemical Industry	129,05	6,28	878,24	NA	NA	NA	1 013,56
C. Metal Production	2 985,96	0,75	NA,NO	NA,NO	379,44	23,90	3 390,04
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 [2]				8,45	0,81	84,61	93,87
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**231,12**		**89,06**				**320,18**
4. Agriculture		**3 110,38**	**5 640,59**				**8 750,97**
A. Enteric Fermentation		2 879,34					2 879,34
B. Manure Management		231,04	712,61				943,65
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 927,98				4 927,98
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]	**-38 194,75**	**1,61**	**60,89**				**-38 132,25**
A. Forest Land	-41 697,05	1,38	33,60				-41 662,07
B. Cropland	2 264,45	IE,NO	27,27				2 291,72
C. Grassland	-83,76	0,22	0,02				-83,51
D. Wetlands	36,60	NA	NA				36,60
E. Settlements	1 285,01	IE,NE	IE,NE				1 285,01
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**52,20**	**3 209,62**	**204,81**				**3 466,64**
A. Solid Waste Disposal on Land	NO	2 918,01					2 918,01
B. Waste-water Handling		291,60	203,62				495,22
C. Waste Incineration	52,20	0,01	1,20				53,41
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	3 727,65	0,53	57,35				3 785,53
Aviation	1 087,92	0,16	14,46				1 102,54
Marine	2 639,73	0,37	42,88				2 682,99
Multilateral Operations	**0,05**	**0,00**	**0,00**				**0,05**
CO_2 Emissions from Biomass	**12 152,54**						**12 152,54**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			**72 924,91**
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			**34 792,65**

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1992
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**21 015,95**	**7 001,20**	**8 186,00**	**10,70**	**252,42**	**108,40**	**36 574,68**
1. Energy	**52 333,37**	**591,28**	**1 382,01**				**54 306,66**
A. Fuel Combustion (Sectoral Approach)	52 039,53	515,99	1 380,76				53 936,28
1. Energy Industries	11 362,93	22,68	363,30				11 748,90
2. Manufacturing Industries and Construction	10 531,08	52,18	496,14				11 079,40
3. Transport	19 578,73	184,04	228,69				19 991,47
4. Other Sectors	9 446,53	256,26	272,86				9 975,65
5. Other	1 120,26	0,84	19,77				1 140,86
B. Fugitive Emissions from Fuels	293,84	75,29	1,25				370,38
1. Solid Fuels	4,43	0,00	0,06				4,49
2. Oil and Natural Gas	289,41	75,28	1,19				365,89
2. Industrial Processes	**4 402,57**	**12,45**	**916,24**	**10,70**	**252,42**	**108,40**	**5 702,78**
A. Mineral Products	1 510,62	NA	NA				1 510,62
B. Chemical Industry	114,77	6,42	845,72	NA	NA	NA	966,91
C. Metal Production	2 777,18	0,62	NA,NO	NA,NO	251,61	23,90	3 053,31
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 [2]				10,70	0,81	84,50	96,01
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**218,72**		**107,57**				**326,29**
4. Agriculture		**3 185,36**	**5 530,06**				**8 715,42**
A. Enteric Fermentation		2 945,57					2 945,57
B. Manure Management		239,78	728,62				968,41
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 801,44				4 801,44
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)	**-35 997,02**	**1,62**	**52,25**				**-35 943,15**
A. Forest Land	-39 486,23	1,40	23,67				-39 461,16
B. Cropland	2 076,13	IE,NO	28,55				2 104,68
C. Grassland	-69,98	0,22	0,02				-69,73
D. Wetlands	39,60	NA	NA				39,60
E. Settlements	1 443,46	IE,NE	IE,NE				1 443,46
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**58,33**	**3 210,49**	**197,88**				**3 466,69**
A. Solid Waste Disposal on Land	NO	2 918,88					2 918,88
B. Waste-water Handling		291,60	196,68				488,28
C. Waste Incineration	58,33	0,01	1,20				59,53
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	3 908,69	0,55	62,14				3 971,38
Aviation	899,49	0,13	13,14				912,76
Marine	3 009,20	0,43	49,00				3 058,63
Multilateral Operations	**0,05**	**0,00**	**0,00**				**0,05**
CO_2 Emissions from Biomass	**13 066,66**						**13 066,66**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			72 517,83
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			36 574,68

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1993
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**24 694,99**	**6 995,62**	**8 249,38**	**33,86**	**290,97**	**96,66**	**40 361,48**
1. Energy	**52 139,56**	**582,26**	**1 402,46**				**54 124,28**
A. Fuel Combustion (Sectoral Approach)	51 823,00	507,36	1 401,17				53 731,53
1. Energy Industries	11 501,10	29,31	357,27				11 887,68
2. Manufacturing Industries and Construction	11 358,94	52,14	516,38				11 927,46
3. Transport	18 678,00	163,24	240,87				19 082,11
4. Other Sectors	9 406,96	262,01	273,25				9 942,23
5. Other	877,99	0,66	13,40				892,05
B. Fugitive Emissions from Fuels	316,56	74,90	1,30				392,76
1. Solid Fuels	4,58	0,00	0,06				4,65
2. Oil and Natural Gas	311,97	74,90	1,23				388,11
2. Industrial Processes	**4 509,09**	**13,65**	**894,68**	**33,86**	**290,97**	**96,66**	**5 838,91**
A. Mineral Products	1 521,89	NA	NA				1 521,89
B. Chemical Industry	118,82	7,37	822,19	NA	NA	NA	948,37
C. Metal Production	2 868,38	0,70	NA,NO	NA,NO	288,41	23,90	3 181,40
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 [2]				33,86	2,56	72,76	109,18
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**207,88**		**107,26**				**315,14**
4. Agriculture		**3 285,82**	**5 592,46**				**8 878,28**
A. Enteric Fermentation		3 030,60					3 030,60
B. Manure Management		255,22	664,14				919,36
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 928,31				4 928,31
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]	**-32 209,55**	**1,67**	**54,69**				**-32 153,19**
A. Forest Land	-36 024,11	1,45	21,02				-36 001,63
B. Cropland	2 222,55	IE,NO	33,64				2 256,19
C. Grassland	-116,06	0,22	0,02				-115,81
D. Wetlands	38,40	NA	NA				38,40
E. Settlements	1 669,66	IE,NE	IE,NE				1 669,66
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**48,02**	**3 112,22**	**197,83**				**3 358,07**
A. Solid Waste Disposal on Land	NO	2 820,61					2 820,61
B. Waste-water Handling		291,60	196,76				488,36
C. Waste Incineration	48,02	0,01	1,07				49,09
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	4 252,15	0,59	65,36				4 318,11
Aviation	1 229,76	0,17	16,23				1 246,16
Marine	3 022,39	0,43	49,13				3 071,95
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**14 206,28**						**14 206,28**
		Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry					72 514,67
		Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry					40 361,48

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1994
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**27 144,26**	**6 917,88**	**8 296,18**	**76,97**	**311,73**	**100,20**	**42 847,22**
1. Energy	**54 196,28**	**589,64**	**1 448,35**				**56 234,27**
A. Fuel Combustion (Sectoral Approach)	53 933,22	514,65	1 447,28				55 895,15
1. Energy Industries	11 983,75	34,45	374,26				12 392,46
2. Manufacturing Industries and Construction	12 434,29	58,28	552,89				13 045,45
3. Transport	19 311,24	168,52	239,97				19 719,73
4. Other Sectors	9 429,31	252,78	269,08				9 951,18
5. Other	774,63	0,62	11,07				786,32
B. Fugitive Emissions from Fuels	263,06	74,99	1,07				339,12
1. Solid Fuels	5,42	0,00	0,08				5,50
2. Oil and Natural Gas	257,64	74,99	1,00				333,62
2. Industrial Processes	**4 914,93**	**14,56**	**867,34**	**76,97**	**311,73**	**100,20**	**6 285,73**
A. Mineral Products	1 604,10	NA	NA				1 604,10
B. Chemical Industry	117,60	8,29	795,49	NA	NA	NA	921,37
C. Metal Production	3 193,23	0,75	NA,NO	NA,NO	308,05	26,29	3 528,32
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 [2]				76,97	3,68	73,91	154,56
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**197,12**		**95,79**				**292,91**
4. Agriculture		**3 316,51**	**5 631,16**				**8 947,67**
A. Enteric Fermentation		3 058,04					3 058,04
B. Manure Management		258,47	673,62				932,09
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 957,55				4 957,55
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]	**-32 213,14**	**1,60**	**55,55**				**-32 155,99**
A. Forest Land	-35 772,67	1,38	18,52				-35 752,76
B. Cropland	2 035,91	IE,NO	37,00				2 072,91
C. Grassland	-269,73	0,22	0,02				-269,49
D. Wetlands	42,00	NA	NA				42,00
E. Settlements	1 751,35	IE,NE	IE,NE				1 751,35
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**49,08**	**2 995,57**	**197,98**				**3 242,64**
A. Solid Waste Disposal on Land	NO	2 703,96					2 703,96
B. Waste-water Handling		291,60	196,83				488,44
C. Waste Incineration	49,08	0,01	1,15				50,24
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	4 910,27	0,68	75,18				4 986,14
Aviation	1 350,46	0,18	17,47				1 368,10
Marine	3 559,82	0,51	57,71				3 618,03
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**15 697,66**						**15 697,66**
		Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry					75 003,22
		Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry					42 847,22

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1995
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**27 232,31**	**6 829,07**	**8 131,58**	**132,12**	**343,43**	**126,68**	**42 795,20**
1. Energy	**53 419,71**	**590,51**	**1 453,30**				**55 463,51**
A. Fuel Combustion (Sectoral Approach)	53 115,13	515,70	1 452,04				55 082,87
1. Energy Industries	11 155,44	37,90	350,07				11 543,40
2. Manufacturing Industries and Construction	13 011,47	56,76	568,17				13 636,39
3. Transport	19 220,22	155,90	258,06				19 634,18
4. Other Sectors	9 024,60	264,57	265,65				9 554,82
5. Other	703,40	0,59	10,10				714,09
B. Fugitive Emissions from Fuels	304,58	74,81	1,25				380,64
1. Solid Fuels	5,99	0,00	0,08				6,08
2. Oil and Natural Gas	298,59	74,80	1,17				374,57
2. Industrial Processes	**5 224,54**	**14,93**	**802,45**	**132,12**	**343,43**	**126,68**	**6 644,15**
A. Mineral Products	1 762,59	NA	NA				1 762,59
B. Chemical Industry	110,36	8,50	730,14	NA	NA	NA	849,01
C. Metal Production	3 351,59	0,86	NA,NO	NA,NO	334,65	26,29	3 713,38
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 [2]				132,12	8,78	100,39	241,29
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**184,86**		**123,69**				**308,55**
4. Agriculture		**3 233,50**	**5 488,12**				**8 721,62**
A. Enteric Fermentation		2 973,58					2 973,58
B. Manure Management		259,92	639,75				899,68
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 848,37				4 848,37
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]	**-31 639,54**	**1,61**	**61,81**				**-31 576,11**
A. Forest Land	-35 555,85	1,39	21,43				-35 533,03
B. Cropland	2 077,79	IE,NO	40,36				2 118,15
C. Grassland	-183,53	0,22	0,02				-183,28
D. Wetlands	46,20	NA	NA				46,20
E. Settlements	1 975,85	IE,NE	IE,NE				1 975,85
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**42,74**	**2 988,52**	**202,22**				**3 233,47**
A. Solid Waste Disposal on Land	NO	2 696,91					2 696,91
B. Waste-water Handling		291,60	201,10				492,70
C. Waste Incineration	42,74	0,01	1,12				43,87
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	4 937,26	0,77	75,16				5 013,19
Aviation	1 436,78	0,27	18,58				1 455,63
Marine	**3 500,49**	**0,50**	**56,58**				**3 557,57**
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**16 495,00**						**16 495,00**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			74 371,31
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			42 795,20

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1996
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**29 643,55**	**6 793,30**	**8 241,19**	**210,53**	**302,91**	**108,40**	**45 299,87**
1. Energy	**57 494,62**	**607,69**	**1 619,48**				**59 721,79**
A. Fuel Combustion (Sectoral Approach)	57 204,62	530,89	1 618,54				59 354,05
1. Energy Industries	15 488,74	52,39	529,25				16 070,38
2. Manufacturing Industries and Construction	12 994,23	54,98	555,30				13 604,51
3. Transport	18 966,13	151,42	255,25				19 372,80
4. Other Sectors	9 109,84	271,61	269,33				9 650,79
5. Other	645,68	0,48	9,40				655,57
B. Fugitive Emissions from Fuels	290,00	76,80	0,94				367,74
1. Solid Fuels	5,90	0,00	0,08				5,98
2. Oil and Natural Gas	284,10	76,80	0,86				361,76
2. Industrial Processes	**5 024,80**	**15,44**	**773,03**	**210,53**	**302,91**	**108,40**	**6 435,11**
A. Mineral Products	1 693,82	NA	NA				1 693,82
B. Chemical Industry	116,68	9,12	701,82	NA	NA	NA	827,63
C. Metal Production	3 214,29	0,83	NA,NO	NA,NO	289,65	31,07	3 535,85
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 [2]				210,53	13,26	77,33	301,12
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**174,48**		**137,33**				**311,81**
4. Agriculture		**3 203,08**	**5 455,48**				**8 658,57**
A. Enteric Fermentation		2 938,59					2 938,59
B. Manure Management		264,50	638,28				902,77
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 817,21				4 817,21
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]	**-33 099,48**	**1,72**	**62,16**				**-33 035,59**
A. Forest Land	-37 645,50	1,50	19,43				-37 624,58
B. Cropland	2 401,37	IE,NO	42,71				2 444,08
C. Grassland	-73,57	0,22	0,02				-73,32
D. Wetlands	40,80	NA	NA				40,80
E. Settlements	2 177,42	IE,NE	IE,NE				2 177,42
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**49,12**	**2 965,37**	**193,70**				**3 208,18**
A. Solid Waste Disposal on Land	NO	2 673,76					2 673,76
B. Waste-water Handling		291,60	192,86				484,46
C. Waste Incineration	49,12	0,00	0,84				49,97
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	5 183,43	0,74	79,60				5 263,77
Aviation	**1 475,28**	**0,21**	**19,38**				**1 494,87**
Marine	3 708,15	0,53	60,22				3 768,90
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**18 057,66**						**18 057,66**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			78 335,46
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			45 299,87

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1997
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**22 148,07**	**6 750,21**	**8 181,34**	**318,46**	**279,69**	**153,10**	**37 830,87**
1. Energy	**52 548,93**	**574,15**	**1 457,40**				**54 580,48**
A. Fuel Combustion (Sectoral Approach)	52 262,97	493,84	1 456,33				54 213,14
1. Energy Industries	10 791,22	43,73	363,79				11 198,74
2. Manufacturing Industries and Construction	13 307,98	53,37	555,84				13 917,20
3. Transport	19 218,34	138,04	265,78				19 622,15
4. Other Sectors	8 359,98	258,20	262,49				8 880,67
5. Other	585,46	0,50	8,42				594,39
B. Fugitive Emissions from Fuels	285,96	80,32	1,07				367,34
1. Solid Fuels	5,72	0,00	0,08				5,79
2. Oil and Natural Gas	280,24	80,31	0,99				361,55
2. Industrial Processes	**4 873,83**	**16,53**	**769,88**	**318,46**	**279,69**	**153,10**	**6 411,50**
A. Mineral Products	1 621,90	NA	NA				1 621,90
B. Chemical Industry	104,36	9,81	693,68	NA	NA	NA	807,85
C. Metal Production	3 147,57	0,86	NA,NO	NA,NO	265,09	40,63	3 454,15
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 [2]				318,46	14,61	112,47	445,53
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**179,20**		**141,67**				**320,87**
4. Agriculture		**3 211,53**	**5 563,98**				**8 775,51**
A. Enteric Fermentation		2 948,03					2 948,03
B. Manure Management		263,51	665,51				929,01
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 898,47				4 898,47
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]	**-35 504,49**	**8,79**	**62,83**				**-35 432,88**
A. Forest Land	-39 288,77	8,43	16,04				-39 264,30
B. Cropland	1 927,71	IE,NO	46,75				1 974,46
C. Grassland	-148,88	0,36	0,04				-148,48
D. Wetlands	48,60	NA	NA				48,60
E. Settlements	1 956,84	IE,NE	IE,NE				1 956,84
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**50,60**	**2 939,20**	**185,59**				**3 175,39**
A. Solid Waste Disposal on Land	NO	2 647,59					2 647,59
B. Waste-water Handling		291,60	184,61				476,22
C. Waste Incineration	50,60	0,00	0,98				51,58
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	**5 908,50**	**0,82**	**91,22**				**6 000,54**
Aviation	1 560,09	0,21	20,58				1 580,87
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	**16 811,49**						**16 811,49**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			73 263,75
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			37 830,87

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1998
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**23 673,47**	**6 580,07**	**8 202,72**	**391,76**	**271,86**	**99,38**	**39 219,26**
1. Energy	**53 077,64**	**546,44**	**1 436,42**				**55 060,50**
A. Fuel Combustion (Sectoral Approach)	52 773,07	463,69	1 435,15				54 671,90
1. Energy Industries	11 852,23	46,29	380,63				12 279,15
2. Manufacturing Industries and Construction	12 634,04	53,20	541,20				13 228,44
3. Transport	19 519,72	129,41	249,92				19 899,04
4. Other Sectors	8 295,01	234,42	256,70				8 786,12
5. Other	472,07	0,38	6,69				479,14
B. Fugitive Emissions from Fuels	304,58	82,75	1,28				388,60
1. Solid Fuels	5,55	0,00	0,07				5,63
2. Oil and Natural Gas	299,03	82,75	1,20				382,97
2. Industrial Processes	**4 965,78**	**16,53**	**853,12**	**391,76**	**271,86**	**99,38**	**6 598,43**
A. Mineral Products	1 740,50	NA	NA				1 740,50
B. Chemical Industry	107,53	9,97	778,36	NA	NA	NA	895,87
C. Metal Production	3 117,76	0,80	NA,NO	NA,NO	258,15	38,24	3 414,95
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 [2]				391,76	13,71	61,14	466,61
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**173,52**		**144,15**				**317,67**
4. Agriculture		**3 120,60**	**5 527,91**				**8 648,51**
A. Enteric Fermentation		2 862,50					2 862,50
B. Manure Management		258,10	651,90				910,00
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 876,01				4 876,01
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]	**-34 592,64**	**0,46**	**63,38**				**-34 528,81**
A. Forest Land	-39 070,02	0,41	15,43				-39 054,18
B. Cropland	2 556,16	IE,NO	47,94				2 604,10
C. Grassland	-344,97	0,05	0,01				-344,92
D. Wetlands	40,20	NA	NA				40,20
E. Settlements	2 225,98	IE,NE	IE,NE				2 225,98
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**49,16**	**2 896,04**	**177,75**				**3 122,95**
A. Solid Waste Disposal on Land	NO	2 604,43					2 604,43
B. Waste-water Handling		291,60	176,76				468,36
C. Waste Incineration	49,16	0,00	0,99				50,16
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	6 690,20	0,95	103,65				6 794,80
Aviation	1 672,90	0,24	22,15				1 695,29
Marine	5 017,30	0,71	81,50				5 099,51
Multilateral Operations	**0,32**	**0,00**	**0,00**				**0,32**
CO_2 Emissions from Biomass	**16 882,22**						**16 882,22**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			73 748,07
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			39 219,26

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 1999
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**21 239,72**	**6 429,20**	**7 837,32**	**494,55**	**291,29**	**101,65**	**36 393,74**
1. Energy	**50 167,05**	**536,71**	**1 368,51**				**52 072,27**
A. Fuel Combustion (Sectoral Approach)	49 862,08	451,15	1 367,32				51 680,55
1. Energy Industries	10 116,71	47,56	346,08				10 510,35
2. Manufacturing Industries and Construction	11 657,19	50,31	499,46				12 206,96
3. Transport	19 819,29	120,36	258,76				20 198,41
4. Other Sectors	7 859,00	232,61	257,28				8 348,89
5. Other	409,89	0,32	5,74				415,95
B. Fugitive Emissions from Fuels	304,96	85,57	1,19				391,72
1. Solid Fuels	5,62	0,00	0,08				5,70
2. Oil and Natural Gas	299,34	85,56	1,11				386,01
2. Industrial Processes	**4 945,51**	**15,08**	**766,32**	**494,55**	**291,29**	**101,65**	**6 614,39**
A. Mineral Products	1 732,87	NA	NA				1 732,87
B. Chemical Industry	107,43	8,41	690,52	NA	NA	NA	806,36
C. Metal Production	3 105,20	0,83	NA,NO	NA,NO	282,97	38,24	3 427,24
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 [2]				494,55	8,32	63,41	566,28
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**164,38**		**134,54**				**298,92**
4. Agriculture		**3 089,92**	**5 329,29**				**8 419,21**
A. Enteric Fermentation		2 838,80					2 838,80
B. Manure Management		251,12	610,57				861,68
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 718,72				4 718,72
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]	**-34 085,41**	**2,96**	**68,31**				**-34 014,14**
A. Forest Land	-38 923,36	2,91	20,37				-38 900,08
B. Cropland	2 619,65	IE,NO	47,94				2 667,59
C. Grassland	-380,93	0,05	0,01				-380,87
D. Wetlands	58,20	NA	NA				58,20
E. Settlements	2 541,02	IE,NE	IE,NE				2 541,02
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**48,20**	**2 784,53**	**170,36**				**3 003,09**
A. Solid Waste Disposal on Land	NO	2 492,93					2 492,93
B. Waste-water Handling		291,60	169,36				460,97
C. Waste Incineration	48,20	0,00	0,99				49,20
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	6 788,09	0,95	103,49				6 892,52
Aviation	1 879,19	0,24	24,66				1 904,08
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	**17 153,73**						**17 153,73**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			70 407,88
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			36 393,74

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2000
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**18 528,71**	**6 254,99**	**7 674,59**	**567,89**	**240,52**	**93,59**	**33 360,28**
1. Energy	**48 794,40**	**522,38**	**1 266,78**				**50 583,57**
A. Fuel Combustion (Sectoral Approach)	48 438,71	431,19	1 264,95				50 134,86
1. Energy Industries	8 619,65	46,00	309,29				8 974,94
2. Manufacturing Industries and Construction	12 082,75	42,20	496,40				12 621,35
3. Transport	19 571,67	109,20	193,84				19 874,71
4. Other Sectors	7 770,47	233,59	259,75				8 263,81
5. Other	394,18	0,20	5,67				400,05
B. Fugitive Emissions from Fuels	355,69	91,19	1,83				448,71
1. Solid Fuels	5,53	0,00	0,07				5,61
2. Oil and Natural Gas	350,15	91,19	1,76				443,10
2. Industrial Processes	**5 151,13**	**17,16**	**741,55**	**567,89**	**240,52**	**93,59**	**6 811,84**
A. Mineral Products	1 879,13	NA	NA				1 879,13
B. Chemical Industry	114,11	9,89	657,16	NA	NA	NA	781,16
C. Metal Production	3 157,89	0,76	NA,NO	NA,NO	232,70	52,58	3 443,93
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 [2]				567,89	7,82	41,01	616,72
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**155,40**		**122,14**				**277,54**
4. Agriculture		**3 006,43**	**5 306,67**				**8 313,10**
A. Enteric Fermentation		2 763,80					2 763,80
B. Manure Management		242,63	598,05				840,68
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 708,62				4 708,62
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]	**-35 616,66**	**2,95**	**72,27**				**-35 541,44**
A. Forest Land	-39 422,26	2,84	20,00				-39 399,41
B. Cropland	1 560,99	IE,NO	52,26				1 613,25
C. Grassland	-190,67	0,10	0,01				-190,55
D. Wetlands	62,40	NA	NA				62,40
E. Settlements	2 372,88	IE,NE	IE,NE				2 372,88
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**44,44**	**2 706,06**	**165,19**				**2 915,69**
A. Solid Waste Disposal on Land	NO	2 414,46					2 414,46
B. Waste-water Handling		291,60	164,23				455,83
C. Waste Incineration	44,44	0,00	0,96				45,40
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	6 696,74	0,90	101,39				6 799,03
Aviation	1 926,23	0,21	25,31				1 951,74
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	**15 728,13**						**15 728,13**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			68 901,73
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			33 360,28

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2001
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**19 332,06**	**6 213,54**	**7 493,28**	**614,70**	**235,61**	**111,49**	**34 000,67**
1. Energy	**49 629,39**	**524,13**	**1 306,90**				**51 460,43**
A. Fuel Combustion (Sectoral Approach)	49 305,13	432,41	1 305,44				51 042,97
1. Energy Industries	10 139,13	56,23	353,47				10 548,84
2. Manufacturing Industries and Construction	12 150,83	54,39	518,97				12 724,18
3. Transport	19 786,74	99,37	180,00				20 066,12
4. Other Sectors	6 957,63	222,28	249,14				7 429,06
5. Other	270,80	0,13	3,85				274,77
B. Fugitive Emissions from Fuels	324,26	91,73	1,46				417,45
1. Solid Fuels	5,93	0,00	0,08				6,01
2. Oil and Natural Gas	318,34	91,73	1,38				411,45
2. Industrial Processes	**5 250,87**	**17,38**	**579,59**	**614,70**	**235,61**	**111,49**	**6 809,64**
A. Mineral Products	1 908,58	NA	NA				1 908,58
B. Chemical Industry	114,77	10,11	496,28	NA	NA	NA	621,16
C. Metal Production	3 227,52	0,84	NA,NO	NA,NO	227,18	55,50	3 511,02
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 [2]				614,70	8,43	55,99	679,12
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**150,13**		**118,42**				**268,55**
4. Agriculture		**3 006,80**	**5 253,28**				**8 260,08**
A. Enteric Fermentation		2 734,78					2 734,78
B. Manure Management		272,02	554,74				826,76
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 698,55				4 698,55
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]	**-35 745,80**	**3,01**	**73,44**				**-35 669,35**
A. Forest Land	-40 639,34	2,88	16,97				-40 619,48
B. Cropland	2 648,12	IE,NO	56,45				2 704,57
C. Grassland	-338,40	0,13	0,01				-338,26
D. Wetlands	63,00	NA	NA				63,00
E. Settlements	2 520,82	IE,NE	IE,NE				2 520,82
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**47,47**	**2 662,22**	**161,65**				**2 871,33**
A. Solid Waste Disposal on Land	NO	2 370,61					2 370,61
B. Waste-water Handling		291,60	160,58				452,19
C. Waste Incineration	47,47	0,01	1,06				48,54
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	6 525,44	0,86	98,43				6 624,74
Aviation	1 870,75	0,18	24,53				1 895,46
Marine	4 654,69	0,68	73,90				4 729,28
Multilateral Operations	**0,76**	**0,00**	**0,01**				**0,77**
CO_2 Emissions from Biomass	**18 861,35**						**18 861,35**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			69 670,03
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			34 000,67

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2002
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**20 246,99**	**6 033,13**	**7 384,88**	**665,82**	**260,91**	**103,85**	**34 695,59**
1. Energy	**50 419,68**	**520,59**	**1 302,16**				**52 242,43**
A. Fuel Combustion (Sectoral Approach)	50 115,52	426,79	1 300,64				51 842,96
1. Energy Industries	11 056,05	59,20	381,00				11 496,25
2. Manufacturing Industries and Construction	11 949,01	47,65	497,92				12 494,59
3. Transport	20 361,38	91,11	170,19				20 622,68
4. Other Sectors	6 429,73	228,69	247,05				6 905,47
5. Other	319,35	0,14	4,48				323,96
B. Fugitive Emissions from Fuels	304,16	93,79	1,52				399,47
1. Solid Fuels	6,12	0,00	0,08				6,20
2. Oil and Natural Gas	298,04	93,79	1,43				393,26
2. Industrial Processes	**5 363,99**	**16,49**	**539,73**	**665,82**	**260,91**	**103,85**	**6 950,80**
A. Mineral Products	1 910,71	NA	NA				1 910,71
B. Chemical Industry	116,05	9,26	457,38	NA	NA	NA	582,69
C. Metal Production	3 337,23	0,85	NA,NO	NA,NO	247,69	65,87	3 651,65
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 (2)				665,82	13,22	37,98	717,02
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**148,45**		**127,14**				**275,59**
4. Agriculture		**2 985,56**	**5 185,28**				**8 170,84**
A. Enteric Fermentation		2 716,21					2 716,21
B. Manure Management		269,35	554,28				823,63
C. Rice Cultivation		NO					NO
D. Agricultural Soils (3)		NO	4 631,00				4 631,00
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)	**-35 745,85**	**4,86**	**70,67**				**-35 670,33**
A. Forest Land	-40 565,11	4,54	11,97				-40 548,60
B. Cropland	2 149,17	IE,NO	58,67				2 207,84
C. Grassland	-30,63	0,32	0,03				-30,28
D. Wetlands	61,20	NA	NA				61,20
E. Settlements	2 639,52	IE,NE	IE,NE				2 639,52
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**60,73**	**2 505,62**	**159,92**				**2 726,27**
A. Solid Waste Disposal on Land	NO	2 214,01					2 214,01
B. Waste-water Handling		291,60	158,80				450,40
C. Waste Incineration	60,73	0,01	1,12				61,85
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: (4)							
International Bunkers	5 715,21	0,74	86,76				5 802,71
Aviation	1 611,26	0,14	21,36				1 632,76
Marine	4 103,95	0,60	65,40				4 169,95
Multilateral Operations	**0,84**	**0,00**	**0,01**				**0,85**
CO_2 Emissions from Biomass	**18 373,57**						**18 373,57**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			70 365,92
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			34 695,59

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
(4) See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2003
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**23 937,66**	**5 888,34**	**7 346,89**	**709,89**	**258,30**	**68,88**	**38 209,95**
1. Energy	**51 315,59**	**532,63**	**1 331,21**				**53 179,43**
A. Fuel Combustion (Sectoral Approach)	50 994,62	435,84	1 329,78				52 760,24
1. Energy Industries	12 176,63	63,67	431,81				12 672,11
2. Manufacturing Industries and Construction	11 702,68	44,24	472,17				12 219,09
3. Transport	20 671,07	83,75	165,51				20 920,33
4. Other Sectors	6 144,28	244,06	256,18				6 644,52
5. Other	299,96	0,12	4,12				304,19
B. Fugitive Emissions from Fuels	320,97	96,80	1,42				419,19
1. Solid Fuels	5,00	0,00	0,07				5,07
2. Oil and Natural Gas	315,97	96,80	1,36				414,13
2. Industrial Processes	**5 091,23**	**17,34**	**533,13**	**709,89**	**258,30**	**68,88**	**6 678,76**
A. Mineral Products	1 829,46	NA	NA				1 829,46
B. Chemical Industry	115,74	9,86	445,73	NA	NA	NA	571,34
C. Metal Production	3 146,02	0,70	NA,NO	NA,NO	248,60	35,06	3 430,38
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 (2)				709,89	9,70	33,82	753,41
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**156,03**		**136,38**				**292,41**
4. Agriculture		**2 952,93**	**5 107,41**				**8 060,33**
A. Enteric Fermentation		2 666,39					2 666,39
B. Manure Management		286,53	523,82				810,35
C. Rice Cultivation		NO					NO
D. Agricultural Soils (3)		NO	4 583,59				4 583,59
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)	**-32 669,93**	**6,05**	**76,75**				**-32 587,13**
A. Forest Land	-37 839,39	5,65	14,22				-37 819,52
B. Cropland	2 160,30	IE,NO	62,49				2 222,79
C. Grassland	289,62	0,40	0,04				290,07
D. Wetlands	56,40	NA	NA				56,40
E. Settlements	2 663,14	IE,NE	IE,NE				2 663,14
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**44,75**	**2 379,39**	**162,01**				**2 586,15**
A. Solid Waste Disposal on Land	NO	2 087,77					2 087,77
B. Waste-water Handling		291,60	158,34				449,94
C. Waste Incineration	44,75	0,02	3,67				48,44
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: (4)							
International Bunkers	7 086,85	0,95	108,28				7 196,07
Aviation	1 566,46	0,13	20,73				1 587,31
Marine	5 520,40	0,81	87,55				5 608,76
Multilateral Operations	**0,76**	**0,00**	**0,01**				**0,77**
CO_2 Emissions from Biomass	**19 099,58**						**19 099,58**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			70 797,08
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			38 209,95

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
(4) See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2004
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**26 272,99**	**5 909,56**	**7 313,86**	**768,99**	**253,98**	**81,21**	**40 600,60**
1. Energy	**50 132,25**	**533,11**	**1 295,11**				**51 960,47**
A. Fuel Combustion (Sectoral Approach)	49 822,46	433,01	1 293,76				51 549,24
1. Energy Industries	11 263,73	65,18	408,74				11 737,66
2. Manufacturing Industries and Construction	11 377,10	44,11	468,32				11 889,53
3. Transport	21 019,95	77,38	158,93				21 256,26
4. Other Sectors	5 882,88	246,24	254,06				6 383,18
5. Other	278,79	0,10	3,71				282,61
B. Fugitive Emissions from Fuels	309,79	100,10	1,35				411,23
1. Solid Fuels	7,30	0,00	0,10				7,41
2. Oil and Natural Gas	302,48	100,09	1,25				403,83
2. Industrial Processes	**5 419,41**	**17,40**	**530,08**	**768,99**	**253,98**	**81,21**	**7 071,08**
A. Mineral Products	1 918,26	NA	NA				1 918,26
B. Chemical Industry	123,04	9,98	444,30	NA	NA	NA	577,32
C. Metal Production	3 378,11	0,77	NA,NO	NA,NO	248,94	40,44	3 668,26
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 [2]				768,99	5,05	40,77	814,81
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**164,85**		**146,18**				**311,03**
4. Agriculture		**2 995,06**	**5 099,41**				**8 094,47**
A. Enteric Fermentation		2 706,52					2 706,52
B. Manure Management		288,55	530,17				818,71
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 569,24				4 569,24
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]	**-29 495,43**	**5,39**	**81,78**				**-29 408,26**
A. Forest Land	-34 230,93	5,29	17,61				-34 208,03
B. Cropland	2 096,30	IE,NO	64,16				2 160,46
C. Grassland	-71,11	0,11	0,01				-70,99
D. Wetlands	48,00	NA	NA				48,00
E. Settlements	2 662,30	IE,NE	IE,NE				2 662,30
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**51,91**	**2 358,59**	**161,30**				**2 571,80**
A. Solid Waste Disposal on Land	NO	2 066,97					2 066,97
B. Waste-water Handling		291,60	157,20				448,80
C. Waste Incineration	51,91	0,02	4,10				56,03
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	8 274,56	1,12	125,38				8 401,06
Aviation	1 771,55	0,15	23,08				1 794,78
Marine	6 503,01	0,97	102,30				6 606,28
Multilateral Operations	**0,76**	**0,00**	**0,01**				**0,77**
CO_2 Emissions from Biomass	**19 233,49**						**19 233,49**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			70 008,86
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			40 600,60

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2005
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**26 043,73**	**5 780,16**	**7 164,67**	**789,50**	**257,15**	**142,48**	**40 177,67**
1. Energy	**47 776,39**	**549,05**	**1 278,56**				**49 604,01**
A. Fuel Combustion (Sectoral Approach)	47 461,58	448,57	1 277,08				49 187,23
1. Energy Industries	10 370,35	71,65	402,04				10 844,05
2. Manufacturing Industries and Construction	10 825,81	43,22	465,58				11 334,61
3. Transport	21 274,74	73,92	158,24				21 506,90
4. Other Sectors	4 767,32	259,67	248,32				5 275,32
5. Other	223,36	0,10	2,90				226,36
B. Fugitive Emissions from Fuels	314,81	100,48	1,48				416,77
1. Solid Fuels	5,33	0,00	0,07				5,40
2. Oil and Natural Gas	309,48	100,48	1,41				411,37
2. Industrial Processes	**5 236,29**	**16,10**	**534,33**	**789,50**	**257,15**	**142,48**	**6 975,84**
A. Mineral Products	2 003,89	NA	NA				2 003,89
B. Chemical Industry	132,68	8,95	448,77	NA	NA	NA	590,40
C. Metal Production	3 099,72	0,51	NA,NO	NA,NO	255,38	99,86	3 455,47
D. Other Production	NE	6,64	85,55				92,20
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6 [2]				789,50	1,76	42,63	833,89
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**166,33**		**136,46**				**302,79**
4. Agriculture		**2 995,77**	**4 958,70**				**7 954,47**
A. Enteric Fermentation		2 679,68					2 679,68
B. Manure Management		316,09	495,20				811,28
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 463,50				4 463,50
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]	**-27 187,48**	**4,99**	**91,90**				**-27 090,60**
A. Forest Land	-31 700,93	4,89	25,84				-31 670,20
B. Cropland	2 020,57	IE,NO	66,05				2 086,62
C. Grassland	-328,12	0,10	0,01				-328,00
D. Wetlands	61,80	NA	NA				61,80
E. Settlements	2 759,19	IE,NE	IE,NE				2 759,19
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**52,20**	**2 214,24**	**164,72**				**2 431,16**
A. Solid Waste Disposal on Land	NO	1 922,62					1 922,62
B. Waste-water Handling		291,60	159,61				451,21
C. Waste Incineration	52,20	0,02	5,11				57,33
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	8 575,38	1,15	130,73				8 707,26
Aviation	1 935,72	0,16	25,14				1 961,02
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	**20 656,23**						**20 656,23**
		Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry					67 268,27
		Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry					40 177,67

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2006
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**18 750,18**	**5 711,05**	**7 191,12**	**817,90**	**245,32**	**111,31**	**32 826,88**
1. Energy	**47 751,90**	**544,20**	**1 311,96**				**49 608,06**
A. Fuel Combustion (Sectoral Approach)	46 900,82	440,09	1 307,45				48 648,35
1. Energy Industries	10 408,87	74,29	417,98				10 901,15
2. Manufacturing Industries and Construction	10 974,23	48,90	493,84				11 516,97
3. Transport	21 086,73	69,33	154,75				21 310,80
4. Other Sectors	4 189,37	247,47	237,56				4 674,40
5. Other	241,62	0,09	3,32				245,03
B. Fugitive Emissions from Fuels	851,08	104,11	4,51				959,70
1. Solid Fuels	5,22	0,00	0,07				5,29
2. Oil and Natural Gas	845,86	104,11	4,44				954,41
2. Industrial Processes	**5 225,88**	**16,64**	**552,40**	**817,90**	**245,32**	**111,31**	**6 969,45**
A. Mineral Products	2 151,60	NA	NA				2 151,60
B. Chemical Industry	116,07	9,60	466,08	NA	NA	NA	591,76
C. Metal Production	2 958,22	0,34	NA,NO	NA,NO	243,51	76,94	3 279,00
D. Other Production	NE	6,70	86,31				93,01
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6 (2)				817,90	1,81	34,37	854,08
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**167,70**		**131,29**				**298,98**
4. Agriculture		**2 997,30**	**4 934,30**				**7 931,60**
A. Enteric Fermentation		2 685,15					2 685,15
B. Manure Management		312,15	494,77				806,92
C. Rice Cultivation		NO					NO
D. Agricultural Soils (3)		NO	4 439,53				4 439,53
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)	**-34 444,20**	**12,21**	**94,86**				**-34 337,12**
A. Forest Land	-38 388,54	12,10	28,43				-38 348,01
B. Cropland	1 344,70	IE,NO	66,42				1 411,12
C. Grassland	-141,17	0,12	0,01				-141,04
D. Wetlands	37,20	NA	NA				37,20
E. Settlements	2 703,61	IE,NE	IE,NE				2 703,61
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**48,90**	**2 140,70**	**166,32**				**2 355,91**
A. Solid Waste Disposal on Land	NO	1 846,70					1 846,70
B. Waste-water Handling		293,97	162,12				456,10
C. Waste Incineration	48,90	0,02	4,19				53,12
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: (4)							
International Bunkers	9 145,86	1,26	139,39				9 286,50
Aviation	2 006,28	0,19	26,10				2 032,57
Marine	7 139,58	1,07	113,29				7 253,93
Multilateral Operations	**2,73**	**0,00**	**0,03**				**2,77**
CO_2 Emissions from Biomass	**21 927,72**						**21 927,72**
		Total CO2 Equivalent Emissions without Land Use, Land-Use Change and Forestry					67 164,00
		Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry					32 826,88

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
(4) See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2007
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**20 609,37**	**5 473,58**	**6 929,72**	**838,35**	**247,60**	**151,49**	**34 250,11**
1. Energy	**46 421,18**	**541,52**	**1 286,66**				**48 249,36**
A. Fuel Combustion (Sectoral Approach)	45 533,88	435,62	1 282,34				47 251,84
1. Energy Industries	9 823,35	74,59	404,35				10 302,28
2. Manufacturing Industries and Construction	10 433,34	46,87	478,16				10 958,37
3. Transport	21 182,00	63,68	152,13				21 397,81
4. Other Sectors	3 846,72	250,42	244,60				4 341,74
5. Other	248,48	0,08	3,10				251,65
B. Fugitive Emissions from Fuels	887,30	105,90	4,32				997,51
1. Solid Fuels	4,60	0,00	0,06				4,66
2. Oil and Natural Gas	882,70	105,89	4,26				992,85
2. Industrial Processes	**5 329,80**	**15,94**	**338,49**	**838,35**	**247,60**	**151,49**	**6 921,67**
A. Mineral Products	2 081,50	NA	NA				2 081,50
B. Chemical Industry	139,98	8,94	252,23	NA	NA	NA	401,14
C. Metal Production	3 108,32	0,31	NA,NO	NA,NO	245,80	113,17	3 467,61
D. Other Production	NE	6,69	86,27				92,96
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6 [2]				838,35	1,80	38,32	878,46
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**166,50**		**114,93**				**281,43**
4. Agriculture		**2 936,44**	**4 919,41**				**7 855,86**
A. Enteric Fermentation		2 631,40					2 631,40
B. Manure Management		305,04	487,55				792,59
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 431,86				4 431,86
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]	**-31 362,31**	**2,40**	**104,41**				**-31 255,50**
A. Forest Land	-35 646,65	2,34	38,44				-35 605,87
B. Cropland	1 819,97	IE,NO	65,96				1 885,93
C. Grassland	-14,90	0,06	0,01				-14,83
D. Wetlands	61,80	NA	NA				61,80
E. Settlements	2 417,47	IE,NE	IE,NE				2 417,47
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**54,21**	**1 977,27**	**165,82**				**2 197,29**
A. Solid Waste Disposal on Land	NO	1 681,60					1 681,60
B. Waste-water Handling		295,65	161,56				457,21
C. Waste Incineration	54,21	0,02	4,25				58,48
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	9 552,30	1,30	144,15				9 697,76
Aviation	2 194,68	0,20	27,68				2 222,56
Marine	7 357,62	1,10	116,47				7 475,19
Multilateral Operations	**1,96**	**0,00**	**0,02**				**1,98**
CO_2 Emissions from Biomass	**22 139,91**						**22 139,91**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			65 505,60
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			34 250,11

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2008
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**17 044,02**	**5 283,10**	**7 077,01**	**866,62**	**225,05**	**83,87**	**30 579,67**
1. Energy	**44 530,61**	**562,53**	**1 307,52**				**46 400,66**
A. Fuel Combustion (Sectoral Approach)	43 638,22	451,87	1 303,52				45 393,61
1. Energy Industries	9 653,30	82,81	417,10				10 153,22
2. Manufacturing Industries and Construction	9 831,02	47,02	478,16				10 356,20
3. Transport	20 609,79	61,31	157,78				20 828,89
4. Other Sectors	3 391,84	260,67	248,52				3 901,04
5. Other	152,27	0,05	1,95				154,27
B. Fugitive Emissions from Fuels	892,39	110,66	4,00				1 007,05
1. Solid Fuels	4,45	0,00	0,06				4,51
2. Oil and Natural Gas	887,94	110,66	3,94				1 002,54
2. Industrial Processes	**5 253,66**	**15,59**	**359,52**	**866,62**	**225,05**	**83,87**	**6 804,30**
A. Mineral Products	2 131,04	NA	NA				2 131,04
B. Chemical Industry	141,55	8,94	275,92	NA	NA	NA	426,41
C. Metal Production	2 981,08	0,15	NA,NO	NA,NO	223,22	47,83	3 252,28
D. Other Production	NE	6,49	83,59				90,09
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				866,62	1,83	36,04	904,49
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**164,73**		**123,04**				**287,76**
4. Agriculture		**2 917,04**	**4 996,62**				**7 913,66**
A. Enteric Fermentation		2 614,34					2 614,34
B. Manure Management		302,70	487,35				790,05
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 509,27				4 509,27
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]	**-32 961,51**	**13,27**	**121,94**				**-32 826,30**
A. Forest Land	-37 517,63	13,16	50,34				-37 454,14
B. Cropland	1 835,40	IE,NO	71,59				1 906,99
C. Grassland	-218,96	0,11	0,01				-218,84
D. Wetlands	54,95	NA	NA				54,95
E. Settlements	2 884,73	IE,NE	IE,NE				2 884,73
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**56,53**	**1 774,67**	**168,38**				**1 999,58**
A. Solid Waste Disposal on Land	NO	1 474,97					1 474,97
B. Waste-water Handling		299,68	162,85				462,52
C. Waste Incineration	56,53	0,02	5,53				62,08
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	9 447,86	1,33	140,85				9 590,05
Aviation	2 456,84	0,28	30,50				2 487,62
Marine	6 991,02	1,05	110,35				7 102,43
Multilateral Operations	**2,55**	**0,00**	**0,03**				**2,58**
CO_2 Emissions from Biomass	**23 832,68**						**23 832,68**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			63 405,97
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			30 579,67

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2009
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**13 508,08**	**5 172,44**	**6 919,38**	**868,52**	**35,33**	**80,53**	**26 584,29**
1. Energy	**42 702,25**	**595,90**	**1 325,17**				**44 623,32**
A. Fuel Combustion (Sectoral Approach)	41 790,14	486,76	1 321,08				43 597,97
1. Energy Industries	10 026,40	88,84	451,87				10 567,11
2. Manufacturing Industries and Construction	8 144,87	46,65	449,10				8 640,62
3. Transport	20 120,37	57,67	157,67				20 335,70
4. Other Sectors	3 257,69	293,54	259,24				3 810,47
5. Other	240,82	0,05	3,20				244,08
B. Fugitive Emissions from Fuels	912,11	109,14	4,09				1 025,35
1. Solid Fuels	14,54	0,01	0,19				14,74
2. Oil and Natural Gas	897,57	109,13	3,90				1 010,60
2. Industrial Processes	**3 596,28**	**12,11**	**392,79**	**868,52**	**35,33**	**80,53**	**4 985,56**
A. Mineral Products	1 809,81	NA	NA				1 809,81
B. Chemical Industry	100,19	5,73	312,04	NA	NA	NA	417,96
C. Metal Production	1 686,27	0,11	NA,NO	NA,NO	33,47	29,22	1 749,07
D. Other Production	NE	6,27	80,75				87,02
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				868,52	1,86	51,31	921,70
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**161,47**		**108,50**				**269,97**
4. Agriculture		**2 891,94**	**4 813,32**				**7 705,26**
A. Enteric Fermentation		2 597,33					2 597,33
B. Manure Management		294,61	454,65				749,26
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 358,67				4 358,67
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]	**-33 010,36**	**2,63**	**116,31**				**-32 891,41**
A. Forest Land	-37 285,75	2,53	45,88				-37 237,33
B. Cropland	1 942,18	IE,NO	70,42				2 012,61
C. Grassland	-146,41	0,10	0,01				-146,30
D. Wetlands	53,79	NA	NA				53,79
E. Settlements	2 425,82	IE,NE	IE,NE				2 425,82
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**58,44**	**1 669,87**	**163,29**				**1 891,59**
A. Solid Waste Disposal on Land	NO	1 372,08					1 372,08
B. Waste-water Handling		297,77	158,14				455,91
C. Waste Incineration	58,44	0,02	5,15				63,60
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	9 369,05	1,35	140,75				9 511,14
Aviation	2 088,05	0,24	26,11				2 114,40
Marine	7 280,99	1,11	114,64				7 396,74
Multilateral Operations	**1,77**	**0,00**	**0,03**				**1,80**
CO_2 Emissions from Biomass	**25 384,00**						**25 384,00**
				Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry			59 475,70
				Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry			26 584,29

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2010
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**21 530,18**	**5 076,91**	**7 167,69**	**845,24**	**158,21**	**72,59**	**34 850,82**
1. Energy	**46 830,98**	**594,90**	**1 445,68**				**48 871,57**
A. Fuel Combustion (Sectoral Approach)	45 944,04	484,41	1 441,69				47 870,14
1. Energy Industries	12 460,27	100,92	529,22				13 090,42
2. Manufacturing Industries and Construction	9 617,31	49,68	487,84				10 154,83
3. Transport	20 307,44	55,80	163,31				20 526,55
4. Other Sectors	3 385,26	277,96	259,07				3 922,29
5. Other	173,76	0,05	2,25				176,05
B. Fugitive Emissions from Fuels	886,94	110,50	3,99				1 001,43
1. Solid Fuels	5,01	0,00	0,07				5,08
2. Oil and Natural Gas	881,93	110,49	3,93				996,35
2. Industrial Processes	**5 317,63**	**15,01**	**401,62**	**845,24**	**158,21**	**72,59**	**6 810,30**
A. Mineral Products	2 050,42	NA	NA				2 050,42
B. Chemical Industry	130,77	8,41	318,95	NA	NA	NA	458,14
C. Metal Production	3 136,43	0,18	NA,NO	NA,NO	156,42	34,26	3 327,29
D. Other Production	NE	6,41	82,67				89,08
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				845,24	1,79	38,32	885,36
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**163,68**		**125,26**				**288,93**
4. Agriculture		**2 884,68**	**4 897,78**				**7 782,46**
A. Enteric Fermentation		2 588,62					2 588,62
B. Manure Management		296,06	460,26				756,33
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 437,52				4 437,52
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]	**-30 838,38**	**0,71**	**137,06**				**-30 700,61**
A. Forest Land	-35 678,93	0,65	65,83				-35 612,45
B. Cropland	2 147,28	IE,NO	71,23				2 218,51
C. Grassland	-70,97	0,06	0,01				-70,90
D. Wetlands	53,79	NA	NA				53,79
E. Settlements	2 710,45	IE,NE	IE,NE				2 710,45
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**56,27**	**1 581,61**	**160,29**				**1 798,17**
A. Solid Waste Disposal on Land	NO	1 282,13					1 282,13
B. Waste-water Handling		299,46	155,61				455,07
C. Waste Incineration	56,27	0,02	4,68				60,97
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	8 820,57	1,23	133,74				8 955,54
Aviation	2 110,19	0,24	26,63				2 137,05
Marine	6 710,38	0,99	107,11				6 818,48
Multilateral Operations	**2,32**	**0,00**	**0,03**				**2,35**
CO_2 Emissions from Biomass	**27 300,34**						**27 300,34**
		Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry					65 551,42
		Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry					34 850,82

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2011
Submission 2013 v2.1
SWEDEN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**13 376,83**	**4 987,02**	**6 795,12**	**813,42**	**182,95**	**60,43**	**26 215,78**
1. Energy	**43 042,21**	**599,75**	**1 372,76**				**45 014,72**
A. Fuel Combustion (Sectoral Approach)	42 157,52	490,78	1 369,07				44 017,36
1. Energy Industries	10 126,60	86,21	449,25				10 662,06
2. Manufacturing Industries and Construction	8 983,26	47,29	483,96				9 514,50
3. Transport	19 786,80	50,51	162,82				20 000,13
4. Other Sectors	3 077,11	306,72	270,63				3 654,46
5. Other	183,75	0,04	2,41				186,20
B. Fugitive Emissions from Fuels	884,70	108,98	3,69				997,36
1. Solid Fuels	5,85	0,00	0,08				5,93
2. Oil and Natural Gas	878,85	108,98	3,61				991,43
2. Industrial Processes	**5 460,12**	**14,31**	**129,33**	**813,42**	**182,95**	**60,43**	**6 660,58**
A. Mineral Products	2 072,27	NA	NA				2 072,27
B. Chemical Industry	136,35	7,88	48,65	NA	NA	NA	192,87
C. Metal Production	3 251,51	0,18	NA,NO	NA,NO	180,50	26,26	3 458,44
D. Other Production	NE	6,26	80,68				86,94
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				813,42	2,46	34,17	850,05
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**163,68**		**125,26**				**288,93**
4. Agriculture		**2 878,81**	**4 891,82**				**7 770,64**
A. Enteric Fermentation		2 577,73					2 577,73
B. Manure Management		301,08	446,39				747,47
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NO	4 445,44				4 445,44
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]	**-35 348,86**	**2,13**	**115,07**				**-35 231,66**
A. Forest Land	-39 301,34	2,06	43,67				-39 255,61
B. Cropland	1 246,74	IE,NO	71,39				1 318,13
C. Grassland	1,21	0,07	0,01				1,29
D. Wetlands	53,79	NA	NA				53,79
E. Settlements	2 650,73	IE,NE	IE,NE				2 650,73
F. Other Land	NA	NA	NA				NA
G. Other	NE	NE	NE				NE
6. Waste	**59,68**	**1 492,01**	**160,89**				**1 712,58**
A. Solid Waste Disposal on Land	NO	1 192,53					1 192,53
B. Waste-water Handling		299,46	155,17				454,63
C. Waste Incineration	59,68	0,02	5,72				65,42
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items: [4]							
International Bunkers	8 152,27	1,13	123,14				8 276,54
Aviation	2 273,83	0,27	28,66				2 302,76
Marine	5 878,44	0,86	94,48				5 973,78
Multilateral Operations	**2,06**	**0,00**	**0,03**				**2,09**
CO_2 Emissions from Biomass	**25 709,10**						**25 709,10**
			Total CO2 Equivalent Emissions without Land Use, Land-Use Change and Forestry				61 447,45
			Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry				26 215,78

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported.
For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).
[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.
[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.
[4] See footnote 8 to table Summary 1.A.

Annex 3: The national system

In accordance with the Kyoto Protocol and the associated Decision 20/CP7[1], as well as EU Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions, Sweden has established a national system for the inventory and reporting of emissions and removals of greenhouse gases. The system came into effect on 1 January 2006 and is described in detail in Sweden's annual National Inventory Report, submitted to the UNFCCC Secretariat. This account of the national system is a summary of the information in sections 1.2–1.3 of the National Inventory Report.

Legal arrangements

The legal basis for Sweden's national system is provided by the Ordinance on Climate Reporting (SFS 2005:626), which describes the roles and responsibilities of the relevant government agencies in this area. The Ordinance ensures that sufficient capacity is available for reporting.

Sweden also has legislation which indirectly supports the work of climate reporting by providing a basis for estimating greenhouse gas emissions and removals. Environmental reports are submitted under the Environmental Code (SFS 1998:808), and the Official Statistics Act (SFS 2001:99) imposes an obligation to submit annual data. In addition, government agencies have to comply with the Secrecy Act (SFS 1980:100) and to archive documents in accordance with the Archives Act (SFS 1990:782).

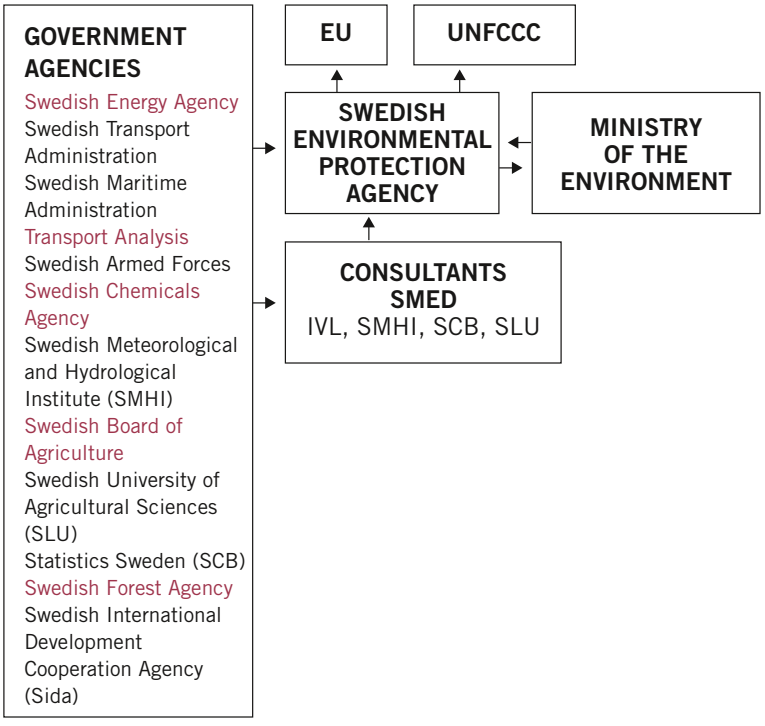

Figure A.3.1 **The Swedish national system.**

[1] UNFCCC 2002. FCCC/CP/2001/13/Add. 3.

Table A.3.1 **Responsibilities of government agencies under the Ordinance on Climate Reporting (SFS 2005:626)**

Sector	Data and documentation	National peer review	Other responsibilities
Energy	Swedish Energy Agency Swedish Transport Administration Swedish Transport Agency Swedish Maritime Administration Swedish Armed Forces	Swedish Energy Agency Transport Analysis	Swedish Energy Agency responsible for documentation of flexible mechanisms, projections and documentation of national registry
Industrial processes	Swedish Chemicals Agency (fluorinated greenhouse gases)	Swedish Environmental Protection Agency Swedish Chemicals Agency	
Solvent and other product use	Swedish Chemicals Agency	Swedish Chemicals Agency	
Agriculture	Swedish Board of Agriculture Statistics Sweden	Swedish Board of Agriculture	
Land use, land-use change and forestry	Swedish University of Agricultural Sciences Statistics Sweden Swedish Forest Agency Swedish Meteorological and Hydrological Institute (SMHI) Swedish Board of Agriculture	Swedish Forest Agency Swedish Board of Agriculture	
Waste		Swedish Environmental Protection Agency	
Reporting of initiatives involving cooperation with developing countries			Swedish International Development Cooperation Agency (Sida) responsible for submitting documentation to Swedish Environmental Protection Agency

Institutional arrangements

To prepare the annual inventory and other reports, cooperation takes place between the Ministry of the Environment, the Swedish Environmental Protection Agency, other government agencies and consultants (see Fig. A.3.1).

The *Ministry of the Environment* is responsible for the national system and for ensuring that Sweden meets international reporting requirements in the area of climate change. The *Swedish Environmental Protection Agency* is responsible, on behalf of the Ministry, for producing data and drafts for the required reporting. The Agency is thus responsible for coordinating Sweden's national system for climate reporting and for maintaining the necessary reporting system. Under contract to the Swedish Environmental Protection Agency, *consultants (SMED[2])* process data and documentation received from the various government agencies, as well as data they have produced themselves, and calculate Swedish greenhouse gas emissions and removals. A range of other *government agencies* participate in the national system (see Fig. A.3.1), with responsibility for different parts of the inventory process (see Table A.3.1).

Contact details of organisation responsible

Ministry of the Environment
Address: SE-103 33 Stockholm, Sweden
Phone: +46 8 405 10 00
Contact: Ms Nilla Thomson
nilla.thomson@regeringskansliet.se

Inventory planning, preparation and management

The Swedish inventory is compiled in accordance with the various reporting guidelines drawn up by the Intergovernmental Panel on Climate Change (IPCC) and the UNFCCC. The national system is designed to ensure the quality of the inventory, i.e. to ensure its transparency, consistency, comparability, completeness and accuracy. The Swedish quality system is based on the structure described in UNFCCC Decision 20/CP7 and applies a PDCA (plan–do–check–act) approach.

[2] SMED = Svenska MiljöEmissionsData (Swedish Environmental Emissions Data), a consortium comprising Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute (SMHI), IVL Swedish Environmental Research Institute and the Swedish University of Agricultural Sciences (SLU).

Planning and development

In any given year, priorities are set on the basis of recommendations received from international and national reviews, the results of key category analysis, uncertainty analysis, ideas for improvements from the Swedish Environmental Protection Agency and SMED, and new requirements, arising for example from international decisions.

Based on these criteria, the Swedish Environmental Protection Agency decides on development projects, which are undertaken by SMED. On completion of these projects, the results are implemented in the inventory.

Preparation

Government agencies supply activity data to SMED, which also gathers activity data from companies and sectoral organisations, and from environmental reports. Emission factors may be plant-specific, developed at a national level, or IPCC default factors. Methods used to estimate emissions comply with current requirements and guidelines.

Quality control and quality assurance

All data are subjected to general inventory quality control (Tier 1), as described in the IPCC Good Practice Guidance (2000), Table 8.1. Certain sources also undergo additional checks (Tier 2). All quality control is documented by SMED in checklists. Data are also validated using the checks built into the CRF Reporter tool.

Quality assurance is carried out in the form of a national peer review by government agencies, as provided in Ordinance 2005:626 (see above). This national review covers choice of methods, emission factors and activity data. The reviewers also identify potential areas for improvement in future reporting. Their findings are documented in review reports.

In addition, reporting is reviewed annually by the EU and UNFCCC.

Finalisation, publication and submission

The Swedish Environmental Protection Agency supplies a draft report to the Ministry of the Environment in mid-December. At the same time, the results are published nationally.[3] The Environmental Protection Agency submits the inventory to the EU on 15 January and to the UNFCCC on 15 April.

Follow-up and improvement

Each year, suggestions for improvements from the national and international reviews, and from SMED and the Swedish Environmental Protection Agency, are compiled into a list. Based on this list, priorities are set and development work is carried out in preparation for next year's reporting. Any suggestions not implemented one year remain on the list for consideration in subsequent years.

The Environmental Protection Agency also undertakes an annual follow-up with government agencies that have supplied input data, to maintain the accuracy of data in subsequent reporting.

Information on changes to the national system

There have been no material changes to the national system since the previous National Communication or Biennial Report. Owing to a national reorganisation of government agencies, certain agencies forming part of the system have been reorganised and changed their names. Their functions in the national system remain the same, however.

[3] www.naturvardsverket.se

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	Fax: +46 (0)16 544 2099
City: Eskilstuna	Email: titti.norlin@energimyndigheten.se

Under the EU Emissions Trading Directive, every member state is required to establish and operate a national registry to ensure the accurate accounting of transactions in emission allowances under the EU Emissions Trading System (EU ETS).

On 16 October 2008, all the registries set up under the EU ETS established a direct connection to the UN's International Transaction Log (ITL). This made possible transfers of international emission units (assigned amount units, AAUs) and reduction units (certified emission reductions, CERs, and emission reduction units, ERUs) between registries operating under the Kyoto Protocol.

Since 20 June 2012, the EU has used a single, consolidated IT platform for the EU ETS, known as the Union Registry. The Swedish Energy Agency, as the national administrator, looks after all administration for users in the Swedish section of the Union Registry. Responsibility for hosting the registry and developing the associated software rests with the EU Commission. All registries are located on a consolidated IT platform that shares the same infrastructure technology. The chosen architecture implements methods to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other. All the national registries within the EU are thus identical in terms of maintenance and basic security standards.

The functions of the registry are governed by a special EU Regulation. The Union Registry conforms to UN and European Commission technical data exchange standards (UNFCCC Data Exchange Standard (DES version 1.1.9) and Commission Regulation (EU) No 389/2013 establishing a Union Registry – the Registry Regulation), and has advanced functions for issuance, external transactions, cancellation and retirement, and for reconciliation of data with the ITL.

Processes are performed by just three authorised officers at the Swedish Energy Agency. Each member state's registry administrator is responsible for the work being carried out correctly, approves activities in the registry and provides support to users of the Union Registry. The registry administrator is also a point of contact with the EU Commission and its helpdesk.

To minimise the risk of inconsistencies in data between the Swedish Energy Agency registry, the ITL and the European Union Transaction Log (EUTL), a transaction is always executed in accordance with the requirements of the DES. A transaction is not completed until all the registries have received confirmation that it is recorded on the servers concerned. If a transaction initiated in the Swedish section of the registry contains a deviation, this will be identified by the ITL or EUTL 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 initiating the transaction. If the registry fails to terminate the transaction, the registry administrator notifies the central administrator of this, with a view to obtaining instructions on any action to be taken. Each member state's registry administrator can make manual corrections on behalf of the central administrator of the ITL or EUTL.

The Swedish registry publishes the information specified in Annex XIV of the EU Registry Regulation at www.utslappshandel.se. The Internet address of the Swedish registry is https://ets-registry.webgate.ec.europa.eu/euregistry/SE/index.xhtml.

Annex 5: Projection methodology and calculation assumptions

Methodology

Different projection methods are used for different sectors. The methodology used to develop the projections in this National Communication is as described here.

Projections of carbon dioxide emissions from the *energy sector* are calculated on the basis of projections of energy use in the sector. Emissions of carbon dioxide are obtained by multiplying the consumption of each fuel by emission factors. Projections of methane and nitrous oxide from combustion installations in the energy sector are based on the energy projections, together with expert assessments of future emission factors.

To make projections of the evolution of the energy system, different models are used for each subsector. For the energy system as a whole, excluding transport, the MARKAL-Nordic model is used. Input data for this model comprise demand in the different subsectors, taxes and other policy instruments, fuel prices, and economic and technological development. MARKAL is a dynamic optimisation model. Most of the methods and models used to project developments in the energy system have a bottom-up approach. An iterative process is applied, whereby model results for different subsectors are cross-checked to arrive at a weighted projection for the energy system as a whole. The process is described in Fig. A.5.1. Expert assessments are an important element at all stages in the process.

An important starting point for work on short- and long-term trends in the energy system is assumptions regarding economic development, in Sweden and internationally. The main variables taken into account in an energy projection are estimates of growth in gross domestic product (GDP), private and public consumption, disposable income, and developments in industry and commerce. For industry, assessments of economic trends in individual sectors are included.

Projections of economic development are prepared by the National Institute of Economic Research, using a general equilibrium model, EMEC (Environmental Medium Term Economic Model). The economic growth generated by EMEC is determined firstly by the supply of factors of production such as labour and capital and secondly by technological development, which are given exogenously in the model. The Swedish Energy Agency's energy price assumptions also serve as input data to EMEC. The advantage with this

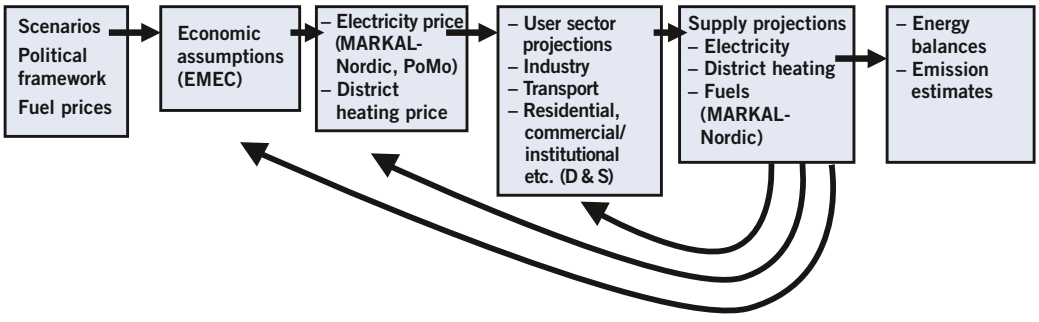

Figure A.5.1 **Projection process for energy sector emissions. Models used are given in brackets.**

type of model is that it encompasses the economy as a whole. It can thus capture repercussions between sectors, for example in the event of a tax change or the introduction of emission caps. The overall impact on the national economy is therefore captured more completely than in partial models.

Another important starting point for projections of the development of the energy system is trends in fuel prices. A model is used to convert international crude oil and coal prices to domestic user prices paid by the final customer, as crude oil has to be refined into finished vehicle and heating fuels before it can be used on the Swedish market. The model generates future domestic prices for fuel oil no. 1 (light fuel oil, domestic heating oil), fuel oil no. 5 (heavy fuel oil), coal, liquefied petroleum gas (LPG), petrol and diesel, for different types of customers. Applicable taxes and VAT are then applied to each fuel and customer category concerned. Future natural gas prices are estimated on the basis of European import prices for natural gas. Biofuel prices are derived from historic cost statistics from 1995 to 2007, together with analyses of future demand for and supply of biofuels based on the other projection assumptions. With the exception of liquid transport biofuels, trends in biofuel prices are assumed to be dependent on demand in the Swedish energy system.

Projections of the fuels used to produce *electricity and district heating* are based on the MARKAL-Nordic model. Future energy demand constitutes exogenous data in the model, which, through its optimisation algorithm, calculates the most cost-effective fuel and energy mix meeting the demand for energy in the stationary energy system as a whole. MARKAL-Nordic includes the other Nordic countries (except Iceland) and permits electricity trading between neighbouring countries. It thus optimises not only the Swedish but also the Nordic energy system.

Projections of energy use in the *residential and commercial/institutional* sectors etc. ('Other sectors') are developed by combining the results of the D&S (Demand and Supply) model, MARKAL-Nordic and assessments by sector experts. D&S is a bottom-up model that produces projections based on assumptions about parameters such as electricity and fuel prices, economic growth, population trends, the potential of different heating systems, investment costs for heating systems, conversion efficiencies and improvements in energy efficiency. Its strength is that, on the basis of very detailed information on energy use in these sectors and on the development of factors with a decisive influence on them, it provides projections of energy use that are consistent with the development of those factors.

Projections of energy use in the *industrial* sector derive from an Excel-based bottom-up model, economic assumptions and assumed energy prices. The results are cross-checked through consultation with energy-intensive companies and sectoral organisations. Account is also taken of results from the MARKAL-Nordic energy system model, which uses the projections of industrial energy use as an input.

Projections of carbon dioxide emissions from the *transport* sector are based on energy use projections for the sector. Emissions of other greenhouse gases are estimated using changes in transport activity, numbers of vehicles of different types (e.g. those fitted with catalytic converters) and emission factors. Transport has been divided into four subsectors: road transport, aviation, rail and shipping. Projections for all modes of transport have been calculated on the basis of present-day energy use.

Petrol consumption has been projected using a bottom-up model that estimates total use of petrol based on an assumption regarding the composition of the car fleet. The Swedish Transport Administration's projections for the vehicle fleet, which estimate new car sales and fuel efficiency for each year of projection, have served as input to this model. The same model has been used to project the fuel use of diesel cars. Projections of other use of diesel have been made using a top-down demand model, which includes assumptions about the price of diesel, trends in various industrial sectors and technological development.

Carbon dioxide emissions from *industrial processes* have been estimated using Excel-based trend analysis of historic emissions and on the basis of the growth projections used in the industrial combustion sector.

For the *waste* sector, emissions from landfills are estimated using a model developed by the IPCC, partially modified to take better account of Swedish conditions. The modelled results are also compared with field measurements. The method is based on data on quantities of landfilled waste from 1952 on, the organic content of the waste, the gas potentials of different types of waste, and emission factors.

To calculate emission projections for the *agricultural* sector, the same method has been used as for historic emissions. Emissions are estimated using specific emission factors and activity data relating to livestock numbers, manure production, livestock housing periods, methods of manure and fertiliser management and annual balances of nitrogen fluxes to and from agricultural soils. Projections for activity data build on results from the Swedish Agricultural Sector Model (SASM), which is based on assumptions regarding productivity and future agricultural policy.

Projections of net removals in the *land use, land-use change and forestry (LULUCF)* sector are produced using the Hugin calculation system, which simulates the future development of forests on the basis of assumptions regarding their management and exploitation over a hundred-year period. In Hugin, sustainable felling is estimated as mean annual values over ten-year periods (2005–14, 2015–24 etc.). Total carbon stocks are calculated for the first year of each such period. Net removals are estimated in the projections as the differences between stocks at different times. Estimates encompass the biomass in living trees on forest land. For other land-use categories and carbon pools, trends are extrapolated.

Assumptions underlying the calculations

CALCULATION ASSUMPTIONS FOR THE ENERGY SECTOR

General assumptions for the energy sector

The general assumptions underlying calculations for the energy and transport sector as a whole are presented below. These are followed by specific assumptions for each subsector.

- Nuclear power stations are assumed to have an economic life of 60 years, which means that no reactors will be decommissioned during the projection period.
- For the EU Emissions Trading System, an emission allowance price of €17 per tonne of carbon dioxide has been assumed for 2020 and a price of €38 per tonne of carbon dioxide for 2030 (at 2007 prices).
- Based on current decisions on the electricity certificates system, it has been assumed that the system will remain in force throughout the projection period and will result in 25 TWh of new renewable electricity production by 2020, compared with 2002. This level is assumed to be maintained through to 2030.
- Other policy instruments and taxes in place in 2012 are assumed to remain until 2030.

National Institute of Economic Research estimates of economic growth

(Growth in %/year)	2010–2020	2020–2030
GDP	2.4	1.9
Private consumption	2.9	2.6
Exports	5.0	3.3
Imports	5.9	3.5

Swedish Energy Agency estimates of trends in fossil fuel prices, at 2007 prices:

	2007	2010	2020	2030
Crude oil (US$/barrel)	79	74	112	128
Coal (US$/tonne)	82	94	104	110
Natural gas (US$/MBtu)	8.3	7	10	12

Swedish Energy Agency estimates of trends in biofuel and waste prices (SEK/MWh, at 2007 prices):

	2007	2020	2030
Forest-industry solid by-products	95–121	155–171	205–221
Forest chips	135–165	182–226	221–266
Short-rotation coppice	190	220	231
Processed wood fuels	244	341	365
Recycled wood	64	93	107
Combustible waste	–150 to –80	–150 to –90	–150 to –103
Peat	112	110	128

These projections are based on normal production, with no account taken of changes due to future impacts of climate change.

CALCULATION ASSUMPTIONS FOR THE ENERGY INDUSTRIES

Swedish area price for electricity in 2007 and for the projection years 2020 and 2030. Annual average, at 2007 prices (SEK/kWh):

Year	2007	2020	2030
Electricity price	0.26	0.49	0.60

Electricity production from hydro (incl. small-scale hydro) and nuclear power is assumed to be (TWh):

	2007	2010	2020	2030
Hydropower	65.7	67.1	68.8	69
Nuclear power	64.3	55.6	72.6	72.6

- Up to 2015, emissions from the refineries sector are assumed to rise in line with the industry's expansion plans. For the period 2015–30, it is assumed that they will increase in line with the National Institute of Economic Research's estimate of economic growth in the petrochemical industry of 1.1% per year.

CALCULATION ASSUMPTIONS FOR INDUSTRIAL COMBUSTION

Projections for fuel combustion in industry are based on assumptions regarding production trends in different sectors, the scale of improvements in energy efficiency, and trends in fuel and energy prices.

Annual percentage changes in value added by individual industries between 2010 and 2020 and between 2020 and 2030, according to National Institute of Economic Research estimates:

	Annual change, % 2010–2020	Annual change, % 2020–2030
Pulp and paper	2.2	1.7
Chemicals	3.1	2.3
Iron and steel	2.7	1.8
Non-metallic mineral products	1.8	1.3
Non-ferrous metals	2.6	2.3
Engineering	3.4	2.5
Mining and quarrying	1.9	1.7

CALCULATION ASSUMPTIONS FOR THE RESIDENTIAL AND COMMERCIAL/ INSTITUTIONAL SECTORS

Projections of energy use in the residential and commercial/institutional sectors are based on assumptions regarding, among other things, temperature, population trends, stocks of housing and non-residential premises, energy prices, investment costs, technological development and economic growth.

Assumptions on numbers of homes and non-residential premises and population trends:

	Unit	2007	2020	2030
Single-family houses		1 760 000	1 877 000	1 967 000
Apartments		2 430 000	2 677 000	2 867 000
Non-residential premises	million m^2	159	162	168
Population	million	9.2	10.0	10.4

- Single-family houses are expected to account for a third of new construction and apartments in multi-dwelling buildings two-thirds. It is assumed that single-family homes will primarily install electric heating, including heat pumps, while multi-dwelling buildings primarily install district heating.
- Projections for the residential and commercial/ institutional sector are weather-corrected, while historic emissions are actual emissions. This means that, because recent years have been warmer than normal, the projections are somewhat high in relation to the historic time series.

CALCULATION ASSUMPTIONS FOR THE TRANSPORT SECTOR

Projections of trends in transport are based on economic growth and the overall development of society. Projections for passenger transport are also based on assumptions about private consumption and vehicle fuel prices. Freight transport projections are primarily affected by the development of industry and commerce and are based on industrial production, exports and imports, broken down by sector.

- Calculations are based on existing decisions on policy instruments, and these instruments are assumed to apply throughout the projection period.
- The assumptions made regarding road transport include assumptions about trends in fuel prices, technological development of vehicles, more efficient use of fuel and the introduction of renewable fuels.
- New car sales over the projection period have been estimated using a model based on fuel prices, historic trends and estimates of the future supply of cars. The main trends over the period are a growing proportion of diesel cars and cars that can run on biofuels in the vehicle fleet, and a declining share of petrol-engine cars.

Fuel prices, SEK/litre, incl. energy and environmental taxes (excl. VAT), at 2007 prices:

Fuel and year	2007	2020	2030
Petrol	8.49	10.83	11.30
Diesel	8.03	11.00	11.74

- The price of ethanol (E85) is assumed to be lower than that of petrol, in terms of litres of petrol equivalent, over most of the projection period.
- Only fuels currently on the market are included in projections.
- During the years covered by projections, it is assumed that 95% of all petrol will contain 5% low-blend ethanol and that 95% of all diesel will contain 5% FAME.
- Some improvement in efficiency in the use of aviation fuel will take place over the projection horizon.
- The share of aviation fuel used for domestic flights was just under 22% in 2007. This share is expected to decline over the projection period, to 17% in 2020.

Annex 6:
Bilateral and regional financial support 2009–2012 related to implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol

USD (exchange rate 1$ = SEK 7.6322		MITIGATION 2009						
Country/Region/Global	TOTAL 2009	Energy	Transport and storage	Forestry	Agricul-ture	Industry	Multisector	Other
Albania	2 622 487	0	0	1 875 651	0	0	0	0
Bangladesh	7 233 072	0	0	0	0	0	0	0
Bolivia	2 000 137	0	0	0	0	0	0	0
Brazil	79 073	0	0	0	0	0	0	0
Burkina Faso	2 447 480	0	0	0	0	0	14 085	0
Cambodia	1 885 423	0	0	0	0	0	0	0
Chile	18 605	0	0	0	0	0	0	0
China	9 630	0	0	0	0	0	0	0
Colombia	68 919	0	0	0	0	0	0	0
Costa Rica	69 770	0	0	0	0	0	0	0
Ecuador	37 211	0	0	0	0	0	0	0
Egypt	25 550	0	0	0	0	0	0	0
Ethiopia	1 716 213	0	0	0	0	0	0	0
Guatemala	30 070	0	0	0	0	0	0	0
Honduras	85 267	0	0	0	0	0	0	0
India	897 330	0	0	0	0	0	444 948	0
Indonesia	199 871	0	0	0	0	0	0	0
Iraq	899 669	0	0	0	0	0	0	0
Kenya	10 813 896	0	0	0	0	0	0	0
Laos	3 140 172	0	0	0	0	0	0	0
Liberia	655 119	0	655 119	0	0	0	0	0
Macedonia	1 411 092	0	0	0	0	0	0	0
Malawi	22 602	0	0	0	0	0	0	0
Malaysia	141 866	0	0	0	0	0	0	0
Mali	13 853 345	0	0	0	0	0	0	0
Moldova	266 269	266 269	0	0	0	0	0	0
Mongolia	108 410	10 142	0	0	0	0	0	0
Mozambique	31 069 110	2 709 483	0	0	0	0	0	733 733
Nicaragua	262 048	0	0	0	0	0	0	0
Pakistan	25 943	0	0	0	0	0	0	0
Paraguay	2 326	0	0	0	0	0	0	0
Peru	44 188	0	0	0	0	0	0	0
Philippines	79 073	0	0	0	0	0	0	0
Senegal	9 303	0	0	0	0	0	0	0
Serbia	1 320 076	0	0	0	0	0	129 088	0
South Africa	102 176	0	0	0	0	0	0	46 360
Sri Lanka	701 699	0	0	0	0	0	0	701 699
Sudan	1 300 536	0	0	0	0	0	0	0
Tanzania	2 396 481	2 361 596	0	0	0	0	0	0
Thailand	102 330	0	0	0	0	0	0	0
Turkey	20 231	0	0	0	0	0	0	0
Uganda	1 309 875	1 219 174	0	0	0	0	0	0
Ukraine	42 833	0	0	0	0	0	0	0
Uruguay	48 839	0	0	0	0	0	0	0
Vietnam	9 143	0	0	0	0	0	0	0
Zambia	2 385 858	729 586	0	0	0	0	0	0
Reg. Africa	19 229 592	0	278 426	0	0	96 630	0	1 146 458
Reg. East Africa	6 156 949	0	0	0	0	0	143 849	0
Reg. Lake Victoria	181 648	0	0	0	0	0	0	0
Reg. West Africa	1 927 540	0	0	393 168	0	0	0	0
Reg. Southern Africa	5 461 293	0	0	0	0	0	0	393 071
Reg. Asia	22 482 018	982 679	0	0	0	0	15 293 614	0
Reg. South Asia	262 048	0	0	0	0	0	0	0
Reg. South-East Asia	5 598 870	0	0	0	0	0	0	0
Reg. Latin America	131 024	0	0	0	0	0	0	0
Reg. Central America	280 653	0	0	0	0	0	0	0
Reg. Middle East	2 122 636	0	0	0	0	0	0	0
Reg. Central & Eastern Europe (non-EU)	336 947	0	0	0	0	0	123 506	0
Global	**58 591 484**	**1 624 111**	**0**	**494 463**	**0**	**0**	**1 035 983**	**0**
Grand Total	**214 733 316**	**9 903 039**	**933 545**	**2 763 282**	**0**	**96 630**	**17 185 072**	**3 021 323**

USD (exchange rate 1$ = SEK 7.6322)	ADAPTATION 2009				
Country/Region/GlobalIt	Water and Sanitation	Agriculture	Government and civil society	Multisector	Other
Albania	0	0	0	0	91 717
Bangladesh	0	0	0	0	5 008 172
Bolivia	128 795	720 631	360 316	0	0
Brazil	0	0	0	0	0
Burkina Faso	404 802	0	383 245	0	1 383 300
Cambodia	0	0	-96 443	0	0
Chile	0	0	0	0	0
China	0	0	0	0	0
Colombia	0	0	0	0	0
Costa Rica	0	0	0	0	0
Ecuador	0	0	0	0	0
Egypt	0	0	0	0	0
Ethiopia	0	0	327 560	0	1 310 238
Guatemala	0	0	0	0	0
Honduras	0	0	0	0	45 730
India	0	0	0	0	0
Indonesia	167 312	0	0	0	0
Iraq	0	0	0	0	0
Kenya	2 504 474	0	0	363 849	0
Laos	0	0	0	0	0
Liberia	0	0	0	0	0
Macedonia	0	1 411 092	0	0	0
Malawi	0	0	0	0	0
Malaysia	0	0	0	0	0
Mali	0	0	1 834 333	0	1 497 687
Moldova	0	0	0	0	0
Mongolia	0	0	0	0	0
Mozambique	0	0	0	0	0
Nicaragua	0	262 048	0	0	0
Pakistan	0	0	0	0	0
Paraguay	0	0	0	0	0
Peru	0	0	0	0	0
Philippines	0	0	0	0	0
Senegal	0	0	0	0	0
Serbia	0	0	0	0	0
South Africa	0	0	0	0	0
Sri Lanka	0	0	0	0	0
Sudan	0	0	982 679	218 288	99 569
Tanzania	0	0	0	0	0
Thailand	0	0	0	0	0
Turkey	0	0	0	0	0
Uganda	0	0	0	0	0
Ukraine	0	0	0	0	0
Uruguay	0	0	0	0	0
Vietnam	0	0	0	0	0
Zambia	0	0	0	0	0
Reg. Africa	3 734 179	1 299 293	0	19 644	3 174 707
Reg. East Africa	804 888	0	0	1 447 813	12 835
Reg. Lake Victoria	181 648	0	0	0	0
Reg. West Africa	214 495	0	0	0	1 319 877
Reg. Southern Africa	2 018 088	0	0	1 410 722	1 613
Reg. Asia	0	0	131 024	3 202 004	131 024
Reg. South Asia	0	0	0	0	0
Reg. South-East Asia	0	0	0	1 480 300	3 819 344
Reg. Latin America	0	0	0	0	0
Reg. Central America	0	0	0	262 048	0
Reg. Middle East	1 256 262	0	0	0	0
Reg. Central & Eastern Europe (non-EU)	0	0	0	0	0
Global	**8 616 105**	**9 192 397**	**0**	**606 430**	**2 851 380**
Grand Total	**20 031 048**	**12 885 460**	**3 922 713**	**9 011 098**	**20 747 194**

USD (exchange rate 1$=SEK 7.6322)	CROSS CUTTING 2009				
Country/Region/Global	Water and sanitation	Agriculture	Government and civil society	Multisector	Other
Albania	0	0	0	0	655 119
Bangladesh	0	0	5 896	0	2 219 004
Bolivia	0	0	0	0	790 396
Brazil	0	0	66 822	0	12 251
Burkina Faso	0	0	0	0	262 048
Cambodia	0	0	0	0	1 981 866
Chile	0	0	15 723	0	2 883
China	0	0	0	0	9 630
Colombia	0	0	39 307	0	29 611
Costa Rica	0	0	58 961	0	10 809
Ecuador	0	0	31 446	0	5 765
Egypt	0	0	0	0	25 550
Ethiopia	0	0	29 480	0	48 935
Guatemala	0	0	0	0	30 070
Honduras	0	0	33 411	0	6 125
India	0	0	49 134	393 939	9 310
Indonesia	0	0	27 515	0	5 044
Iraq	0	0	0	0	899 669
Kenya	0	7 507 092	82 545	340 804	15 133
Laos	0	1 756 816	0	1 184 870	198 486
Liberia	0	0	0	0	0
Macedonia	0	0	0	0	0
Malawi	0	0	0	0	22 602
Malaysia	0	0	119 887	0	21 979
Mali	55 476	0	0	0	10 465 849
Moldova	0	0	0	0	0
Mongolia	0	0	0	98 268	0
Mozambique	0	2 751 500	0	2 111 510	22 762 883
Nicaragua	0	0	0	0	0
Pakistan	0	0	0	0	25 943
Paraguay	0	0	1 965	0	360
Peru	0	0	37 342	0	6 846
Philippines	0	0	66 822	0	12 251
Senegal	0	0	7 861	0	1 441
Serbia	1 190 989	0	0	0	0
South Africa	0	0	47 169	0	8 648
Sri Lanka	0	0	0	0	0
Sudan	0	0	0	0	0
Tanzania	0	0	29 480	0	5 405
Thailand	0	0	86 476	0	15 854
Turkey	0	0	20 231	0	0
Uganda	0	0	76 649	0	14 052
Ukraine	0	0	42 833	0	0
Uruguay	0	0	41 273	0	7 567
Vietnam	0	0	0	0	9 143
Zambia	0	0	0	0	1 656 272
Reg. Africa	0	0	0	1 378 506	8 101 749
Reg. East Africa	0	1 441 262	262 330	2 043 972	0
Reg. Lake Victoria	0	0	0	0	0
Reg. West Africa	0	0	0	0	0
Reg. Southern Africa	1 310 238	0	0	0	327 560
Reg. Asia	0	0	0	1 726 239	1 015 435
Reg. South Asia	0	0	0	262 048	0
Reg. South-East Asia	0	0	0	266 470	32 756
Reg. Latin America	0	0	0	131 024	0
Reg. Central America	0	0	15 723	0	2 883
Reg. Middle East	866 374	0	0	0	0
Reg. Central & Eastern Europe (non-EU)	0	0	76 457	136 984	0
Global	**478 237**	**2 447 854**	**994 471**	**20 847 438**	**9 402 615**
Grand Total	**3 901 314**	**15 904 525**	**2 367 208**	**30 922 071**	**61 137 795**

USD (exchange rate 1$ = SEK 7.2022)		MITIGATION 2010						
Country/Region/Global	Total 2010	Energy generation and supply	Transport and storage	Forestry	Agriculture	Industry	Multisector	Other
Afghanistan	4 234 817	0	0	0	0	0	0	0
Albania	796 274	0	0	41 738	0	0	0	0
Bangladesh	14 522 278	0	0	0	0	0	0	0
Benin	694 232	0	0	0	0	0	0	694 232
Bolivia	6 872 010	0	0	0	0	0	0	0
Bosnia-Herzegovina	1 776 360	0	0	0	0	0	0	0
Botswana	30 907	0	0	0	0	0	0	0
Brazil	92 333	0	0	0	0	0	0	0
Burkina Faso	5 515 820	0	0	0	0	0	13 851	0
Cambodia	1 967 641	0	0	0	0	0	0	0
Chad	1 874 427	0	0	0	0	0	0	485 963
Chile	12 149	0	0	0	0	0	0	0
China	334 485	0	0	0	0	0	0	0
Colombia	233 502	0	0	0	0	0	0	0
Congo, Democratic Republic	826 184	0	0	131 951	0	0	0	0
Costa Rica	84 557	0	0	0	0	0	0	0
Ecuador	43 737	0	0	0	0	0	0	0
Egypt	236 466	0	0	0	0	0	0	0
El Salvador	557 885	0	0	0	0	0	0	0
Ethiopia	3 460 748	0	0	0	0	0	0	0
Georgia	138 846	0	0	0	0	0	0	138 846
Ghana	68 541	0	0	0	0	0	0	0
Guatemala	1 169 281	0	0	0	0	0	0	0
Haiti	1 201 022	0	0	0	0	0	0	0
Honduras	691 339	0	0	0	0	0	0	0
India	1 862 069	20 949	0	0	0	0	315 648	135 106
Indonesia	618 833	0	0	0	0	0	10 195	0
Iraq	948 791	0	0	0	0	0	0	0
Kenya	12 033 152	0	0	0	0	0	0	0
Korea, Democratic People's Rep	23 285	0	0	0	0	0	0	0
Kosovo	25 209	0	0	0	0	0	0	0
Laos	2 009 057	0	0	0	0	0	0	0
Liberia	2 429 813	0	2 429 813	0	0	0	0	0
Macedonia	1 938 820	0	0	0	555 386	0	0	0
Malawi	538 942	0	0	0	0	0	0	0
Malaysia	140 929	0	0	0	0	0	0	0
Mali	13 544 842	0	0	0	0	0	0	0
Moldova	1 683 144	1 626 053	0	0	0	0	0	0
Mongolia	42 378	42 378	0	0	0	0	0	0
Montenegro	7 831	0	0	0	0	0	0	0
Mozambique	29 708 629	357 311	0	0	0	0	0	722 002
Namibia	14 718	0	0	0	0	0	0	0
Nicaragua	456 086	0	0	0	0	0	0	0
Niger	2 603 371	0	0	0	0	0	0	0
Pakistan	238 179	0	0	0	0	0	0	0
Palestinian Administered Areas	656 466	0	0	0	0	0	0	0
Paraguay	589 959	0	0	0	0	0	0	0

ADAPTATION 2010					CROSS CUTTING 2010				
Water and sanitation	Agriculture	Government and civil society	Multisector	Other	Water and sanitation	Agriculture	Government and civil society	Multisector	Other
0	0	0	0	0	0	0	1 855 277	0	2 379 541
0	0	29 549	30 755	0	0	0	0	0	694 232
0	0	0	11 107 717	0	0	0	0	17 009	3 397 552
0	0	0	0	0	0	0	0	0	0
843 492	2 117 409	713 374	572 246	74 702	0	0	0	0	2 550 787
0	0	19 982	20 797	0	1 735 581	0	0	0	0
0	0	0	0	0	0	0	0	30 907	0
0	0	0	0	0	0	0	0	92 333	0
1 247 305	2 082 697	424 870	3 209	347 116	0	0	0	8 308	1 388 465
0	0	627 353	47 434	17 431	0	0	152 503	1 122 921	0
0	0	0	0	694 232	0	0	0	0	694 232
0	0	0	0	0	0	0	0	12 149	0
0	0	0	0	0	0	0	0	334 485	0
0	0	0	0	0	0	0	197 055	36 447	0
0	0	0	0	694 232	0	0	0	0	0
0	0	13 022	20 329	7 470	0	0	0	43 737	0
0	0	0	0	0	0	0	0	43 737	0
0	0	0	0	0	0	0	236 466	0	0
0	0	177 965	277 827	102 093	0	0	0	0	0
0	277 693	381 828	0	2 776 929	0	0	0	24 298	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	68 541	0	0
0	0	121 537	189 735	69 722	0	0	270 736	31 588	485 963
0	0	0	0	1 201 022	0	0	0	0	0
0	0	182 306	270 525	216 639	0	0	0	21 868	0
0	0	0	90 250	0	0	0	0	1 091 846	208 270
228 003	0	0	0	0	4 362	0	0	29 158	347 116
0	0	0	0	0	0	0	312 405	0	636 386
1 149 472	0	230 053	1 324 853	131 974	0	8 844 328	0	352 472	0
0	0	0	0	0	0	0	0	23 285	0
0	0	12 352	12 857	0	0	0	0	0	0
0	0	0	0	0	0	1 282 093	0	666 036	60 929
0	0	0	0	0	0	0	0	0	0
0	342 086	0	1 041 348	0	0	0	0	0	0
0	0	108 515	169 407	62 252	0	0	198 768	0	0
0	0	0	0	0	0	0	0	140 929	0
0	0	0	2 390 957	1 617 561	0	0	208 270	226 544	9 101 511
0	0	27 975	29 116	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	7 831	0
0	808 132	91 153	142 302	52 292	0	2 846 353	0	1 206 850	23 482 237
0	0	0	0	0	0	0	0	4 304	10 413
0	0	134 559	210 064	77 192	0	0	34 270	0	0
0	0	0	0	2 603 371	0	0	0	0	0
0	0	0	0	0	0	0	238 179	0	0
0	0	156 262	243 945	89 643	0	0	0	166 616	0
0	0	186 647	291 379	107 073	0	0	0	4 860	0

USD (exchange rate 1$ = SEK 7.2022)		MITIGATION 2010						
Country/Region/Global	Total 2010	Energy generation and supply	Transport and storage	Forestry	Agriculture	Industry	Multisector	Other
Peru	26 728	0	0	0	0	0	0	0
Philippines	463 122	0	0	0	0	0	0	0
Serbia	1 557 666	0	0	0	0	0	0	18 042
South Africa	249 059	0	0	0	0	0	0	0
Sri Lanka	1 627 824	0	0	0	0	0	0	1 178 795
Sudan	2 378 399	0	0	0	0	0	0	0
Tanzania	6 652 309	4 136 726	0	0	0	0	0	0
Thailand	60 745	0	0	0	0	0	0	0
Turkey	7 146	0	0	0	0	0	0	0
Uganda	3 419 138	52 443	0	0	0	0	0	0
Ukraine	7 869 883	7 773 669	0	0	0	0	0	0
Uruguay	34 017	0	0	0	0	0	0	0
Vietnam	1 792 432	0	0	0	0	0	2 149	0
Zambia	5 608 151	157 898	0	0	0	0	0	0
Zimbabwe	136 070	0	0	0	0	0	0	0
Reg. Africa	9 148 370	0	295 049	0	0	0	1 388 465	506 790
Reg. East Africa	9 989 379	0	0	0	0	0	235 857	284 066
Reg. Lake Victoria	1 646 703	0	0	0	0	0	0	0
Reg. West Africa	2 338 987	0	0	125 693	0	0	0	0
Reg. Southern Africa	4 041 150	0	0	0	0	0	0	208 270
Reg. Asia	5 187 538	1 110 772	0	0	0	0	14 172	0
Reg. South Asia	423 482	0	0	0	0	0	0	0
Reg. South-East Asia	6 419 713	0	0	0	0	0	0	0
Reg. Latin America	138 846	0	0	0	0	0	0	0
Reg. Central America	1 562 603	0	0	0	0	0	0	0
Reg. South America	24 298	0	0	0	0	0	0	0
Reg. Middle East	1 279 587	0	0	0	0	0	0	0
Reg. Central & Eastern Europe (non-EU)	2 162 874	0	0	0	0	0	387 136	0
Global	**78 944 060**	**15 046 112**	**0**	**444 734**	**0**	**0**	**944 741**	**2 506**
Grand Total	**274 740 628**	**30 324 310**	**2 724 862**	**744 116**	**555 386**	**0**	**3 312 214**	**4 374 618**

ADAPTATION 2010					CROSS CUTTING 2010				
Water and sanitation	Agriculture	Government and civil society	Multisector	Other	Water and sanitation	Agriculture	Government and civil society	Multisector	Other
0	0	0	0	0	0	0	0	26 728	0
0	0	134 559	210 064	77 192	0	0	0	41 307	0
0	0	0	0	0	0	0	0	1 539 624	0
0	0	0	0	0	0	0	0	138 846	110 213
0	0	143 240	223 617	82 172	0	0	0	0	0
0	0	1 041 348	422 577	92 201	0	0	822 272	0	0
0	0	138 900	216 840	79 682	0	0	2 055 862	24 298	0
0	0	0	0	0	0	0	0	60 745	0
0	0	0	0	0	0	0	7 146	0	0
0	0	234 393	365 918	134 464	0	0	0	2 228 258	403 661
0	0	7 629	7 941	0	0	0	15 130	65 514	0
0	0	0	0	0	0	0	0	34 017	0
23 604	16 201	95 494	388 350	54 782	0	23 604	278 512	662 970	246 768
0	0	308 184	481 115	176 795	0	0	179 920	0	4 304 240
0	0	43 406	67 763	24 901	0	0	0	0	0
0	1 429 832	13 259	2 582 544	971 925	0	0	13 533	1 395 060	551 915
2 240 912	0	334 228	4 050 613	538 852	0	1 041 348	208 270	1 055 233	0
190 759	0	464 446	725 060	266 438	0	0	0	0	0
407 832	0	0	1 428 841	376 621	0	0	0	0	0
1 450 787	0	303 843	1 712 635	174 305	0	0	0	0	191 310
0	0	0	3 064 982	0	0	0	0	0	997 612
0	0	0	0	0	0	0	0	423 482	0
0	0	144 103	4 797 887	768 934	0	0	0	153 402	555 386
0	0	0	0	0	0	0	0	138 846	0
0	0	447 084	836 802	278 718	0	0	0	0	0
0	0	0	0	0	0	0	0	24 298	0
1 303 052	0	0	0	0	-23 465	0	0	0	0
0	0	23 615	24 579	0	0	0	27 007	1 700 538	0
5 998 763	**9 910 009**	**0**	**77 304**	**9 587 289**	**406 440**	**5 737 830**	**241 217**	**23 294 083**	**7 253 032**
15 083 981	**16 984 058**	**7 517 034**	**40 172 484**	**24 628 218**	**2 122 918**	**19 775 556**	**7 621 338**	**38 747 766**	**60 051 769**

USD (exchange rate 1$ = SEK 6.4892)		MITIGATION 2011						
Country/Region/Global	Total 2011	Energy generation and supply	Transport and storage	Forestry	Agriculture	Industry	Multisector	Other
Afghanistan	8 729 680	0	0	0	0	0	0	0
Albania	1 823 482	0	0	21 569	0	0	0	0
Bangladesh	6 049 978	0	0	0	0	0	0	0
Bolivia	13 157 953	0	0	0	0	0	0	0
Bosnia-Herzegovina	86 578	0	0	0	0	0	0	0
Botswana	329 690	0	19 494	0	0	0	0	0
Brazil	181 029	0	0	0	0	0	0	0
Burkina Faso	12 610 268	0	0	0	0	0	0	0
Burundi	978 549	0	0	0	0	0	0	0
Cambodia	2 964 726	0	0	0	0	0	0	0
Chad	20 804	0	0	0	0	0	0	0
Chile	23 820	0	0	0	0	0	0	0
China	524 236	0	0	0	0	0	52 096	11 295
Colombia	596 870	0	0	0	0	0	0	0
Congo, Democratic Republic	2 900 358	0	0	1 541 022	0	0	0	0
Costa Rica	108 737	0	0	0	0	0	0	0
Ecuador	85 751	0	0	0	0	0	0	0
Egypt	-16 735	0	0	0	0	0	0	0
El Salvador	314 144	0	0	0	0	0	0	0
Ethiopia	1 272 569	0	0	0	0	0	0	0
Georgia	154 102	0	0	0	0	0	0	154 102
Ghana	-4 851	0	0	0	0	0	0	0
Guatemala	2 568 840	0	0	0	0	0	0	1 001 664
Haiti	2 118 905	0	0	0	0	0	0	0
Honduras	434 073	0	0	0	0	0	0	0
India	1 962 868	0	0	0	0	0	67 358	517 843
Indonesia	1 572 695	0	0	0	0	0	154 102	0
Iraq	548 804	0	0	0	0	0	0	0
Kenya	21 549 946	0	0	0	0	0	0	0
Korea, Democratic People's Rep	595 375	0	0	0	0	0	0	0
Kosovo	915 222	0	0	0	0	0	0	0
Laos	785 645	0	0	0	0	0	0	0
Liberia	1 232 818	0	1 232 818	0	0	0	0	0
Macedonia	932 208	0	0	0	847 562	0	0	0
Malawi	177 483	0	0	0	0	0	0	0
Malaysia	276 307	0	0	0	0	0	0	0
Mali	16 065 645	0	0	0	0	0	0	0
Moldova	3 148 676	2 565 160	0	0	0	0	0	0
Mongolia	3 862	3 862	0	0	0	0	0	0
Montenegro	11 135	0	0	0	0	0	0	0
Mozambique	32 733 286	865 025	0	0	0	0	0	625 418
Namibia	159 530	0	0	0	0	0	0	0
Nicaragua	239 079	0	0	0	0	0	5 817	0
Niger	770 511	0	0	0	0	0	0	0

ADAPTATION 2011					CROSS CUTTING 2011				
Water and sanitation	Agriculture	Government and civil society	Multisector	Other	Water and sanitation	Agriculture	Government and civil society	Multisector	Other
0	0	0	0	68 066	0	0	3 216 322	0	5 445 292
0	0	62 735	65 296	0	33 704	0	0	1 640 178	0
0	0	0	1 695 124	0	0	0	0	33 347	4 321 506
2 803 429	4 623 066	460 374	113 160	41 583	0	0	0	0	5 116 342
0	0	42 423	44 155	0	0	0	0	0	0
0	0	0	0	0	193 464	0	0	86 701	30 032
0	0	0	0	0	0	0	0	181 029	0
2 338 957	7 341 706	683 443	462 307	0	0	0	0	62 591	1 721 264
0	0	0	0	978 549	0	0	0	0	0
0	0	1 026 762	26 404	9 703	0	0	-10 793	1 912 650	0
0	0	0	0	20 804	0	0	0	0	0
0	0	0	0	0	0	0	0	23 820	0
0	0	0	0	0	0	0	0	460 846	0
0	0	539 358	0	0	0	0	-13 946	71 459	0
0	0	588 825	0	770 511	0	0	0	0	0
0	0	7 512	11 316	4 158	0	0	0	85 751	0
0	0	0	0	0	0	0	0	85 751	0
0	0	0	0	0	0	0	-16 735	0	0
0	0	102 662	154 652	56 830	0	0	0	0	0
0	426 850	385 256	0	0	0	0	385 256	47 639	27 569
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	-4 851	0	0
0	0	70 111	105 616	38 811	0	0	-19 161	61 931	1 309 869
0	0	0	0	2 118 905	0	0	0	0	0
0	0	105 166	158 424	127 608	0	0	0	42 875	0
0	0	0	100 166	0	0	0	0	1 060 216	217 284
48 879	0	0	0	0	0	0	0	57 167	1 312 547
0	0	0	0	0	0	0	508 537	0	40 267
1 545 066	520 075	132 710	4 371 417	4 234 222	0	8 792 625	0	258 707	1 695 124
0	0	0	0	0	0	0	0	595 375	0
0	0	26 225	27 296	0	0	0	0	861 700	0
0	0	0	0	0	0	772 813	0	12 833	0
0	0	0	0	0	0	0	0	0	0
0	44 116	0	0	0	0	5 316	0	0	35 213
0	0	62 599	94 300	34 652	0	0	-14 067	0	0
0	0	0	0	0	0	0	0	276 307	0
938	0	154 102	1 263 638	900 586	0	0	539 358	1 253 069	11 953 955
0	0	59 393	61 817	0	0	0	0	462 307	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	11 135	0
0	485 456	274 810	79 212	320 929	0	770 511	0	1 855 220	27 456 705
40 067	0	46 231	0	0	0	0	0	15 445	57 788
0	-1 836	77 623	116 932	42 969	0	0	-2 425	0	0
0	0	0	0	0	0	0	0	0	770 511

USD (exchange rate 1$ = SEK 6.4892)		MITIGATION 2011						
Country/Region/Global	Total 2011	Energy generation and supply	Transport and storage	Forestry	Agriculture	Industry	Multisector	Other
Pakistan	-16 857	0	0	0	0	0	0	0
Palestinian Administered Areas	460 756	0	0	0	0	0	0	0
Paraguay	338 995	0	0	0	0	0	0	0
Peru	52 403	0	0	0	0	0	0	0
Philippines	318 510	0	0	0	0	0	0	0
Rwanda	770 511	0	0	0	0	0	0	0
Serbia	708 343	0	0	0	0	0	0	0
Somalia	3 082 044	0	0	0	0	0	0	0
South Africa	445 212	0	0	0	0	0	0	0
Sri Lanka	3 658 801	0	0	0	0	0	0	3 374 422
Sudan	2 364 511	0	0	0	0	0	0	0
Tanzania	11 353 536	7 741 809	0	0	0	0	0	0
Thailand	119 098	0	0	0	0	0	0	0
Uganda	3 170 124	0	0	0	0	0	0	0
Ukraine	12 500 070	8 587 976	0	0	0	0	0	3 698 453
Uruguay	66 695	0	0	0	0	0	0	0
Vietnam	3 192 049	23 583	0	0	0	0	0	0
Zambia	7 285 269	0	0	0	0	0	0	0
Zimbabwe	770 080	0	0	0	0	0	0	0
Reg. Africa	13 339 891	8 840	327 467	0	0	0	1 544 103	770 511
Reg. East Africa	10 749 119	0	0	0	0	0	149 758	184 923
Reg. Lake Victoria	868 109	0	0	0	0	0	0	0
Reg. Southern Africa	2 402 814	0	0	0	0	0	0	230 659
Reg. West Africa	3 113 767	0	0	0	0	0	0	0
Reg. Asia	14 446 879	1 540 204	0	0	0	0	7 705 726	0
Reg. South Asia	585 588	0	0	0	0	0	0	0
Reg. South-East Asia	7 857 196	0	0	0	0	0	0	161 191
Reg. Latin America	167 786	0	0	0	0	0	0	0
Reg. South America	47 639	0	0	0	0	0	0	0
Reg. Central America	788 031	0	0	0	0	0	0	0
Reg. West Indies	-17 264	0	0	0	0	0	-17 264	0
Reg. Middle East	2 496 204	0	0	0	0	0	0	0
Reg. Central & Eastern Europe (non-EU)	2 466 309	369 845	0	0	0	0	599 885	0
Global	**72 830 012**	**2 701 822**	**0**	**1 023 569**	**0**	**0**	**427 459**	**505 205**
Grand Total	**324 476 883**	**24 408 126**	**1 579 779**	**2 586 160**	**847 562**	**0**	**10 689 040**	**11 235 686**

ADAPTATION 2011					CROSS CUTTING 2011				
Water and sanitation	Agriculture	Government and civil society	Multisector	Other	Water and sanitation	Agriculture	Government and civil society	Multisector	Other
0	0	0	0	0	0	0	-16 857	0	0
0	0	90 142	135 792	49 899	0	0	0	184 923	0
0	0	107 670	162 196	59 602	0	0	0	9 528	0
0	0	0	0	0	0	0	0	52 403	0
0	0	77 623	116 932	42 969	0	0	0	80 987	0
0	0	0	0	0	0	0	0	770 511	0
0	0	0	0	0	-91 117	0	0	799 460	0
0	0	0	0	3 082 044	0	0	0	0	0
0	0	0	0	0	0	0	0	195 445	249 768
0	0	82 631	124 476	45 741	31 531	0	0	0	0
0	0	1 155 767	197 210	77 591	0	0	933 944	0	0
0	0	80 127	120 704	44 355	0	0	393 731	2 744 428	228 383
0	0	0	0	0	0	0	0	119 098	0
0	0	135 214	203 687	74 849	0	0	1 155 767	1 262 438	338 170
0	0	16 198	16 859	0	0	0	107 872	72 712	0
0	0	0	0	0	0	0	0	66 695	0
-3 881	0	55 087	319 601	468 150	0	0	233 068	1 668 830	427 610
0	0	177 781	267 811	468 258	0	0	-12 733	161 807	6 222 345
0	0	25 040	37 720	13 861	0	0	693 460	0	0
-35 244	314 158	99 050	4 415 028	1 316 644	0	0	0	2 484 898	2 094 435
2 141 831	0	192 805	3 242 922	1 185 445	0	1 155 767	0	2 495 669	0
48 271	0	267 923	403 603	148 312	0	0	0	0	0
783 213	0	175 277	801 858	97 026	0	0	0	0	314 781
115 736	0	0	1 502 496	1 495 534	0	0	0	0	0
0	0	0	4 468 964	0	0	0	0	269 679	462 307
0	0	0	0	0	0	0	0	585 588	0
0	0	75 119	6 060 054	689 162	0	0	0	503 367	368 304
0	0	0	13 684	0	0	0	0	154 102	0
0	0	0	0	0	0	0	0	47 639	0
0	0	257 907	387 356	142 768	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1 614 677	0	0	0	0	881 526	0	0	0	0
0	0	50 137	52 183	0	0	0	0	1 394 260	0
8 646 294	**1 232 731**	**0**	**64 224**	**9 975 186**	**547 438**	**12 399 063**	**-9 702**	**23 836 388**	**11 480 336**
20 088 232	**14 986 321**	**8 029 815**	**32 066 589**	**29 246 281**	**1 596 547**	**23 896 094**	**8 046 041**	**51 476 904**	**83 697 706**

USD (exchange rate 1$ = SEK 6.7689)		MITIGATION 2012						
Country/Region/Global	Total 2012	Energy generation and supply	Transport and storage	Forestry	Agriculture	Industry	Multisector	Other
Afghanistan	7 680 547	0	0	0	0	0	0	0
Albania	329 592	0	0	-1 034 689	0	0	0	0
Bangladesh	12 470 278	0	0	0	0	0	1 477 345	0
Benin	-869	0	0	0	0	0	0	-869
Bolivia	11 494 525	0	0	0	0	0	0	0
Bosnia-Herzegovina	2 948 996	0	0	0	0	0	0	0
Botswana	1 155 442	0	0	0	0	0	0	0
Brazil	208 007	0	0	0	0	0	0	0
Burkina Faso	4 690 240	0	0	0	0	0	0	0
Burundi	938 114	0	0	0	0	0	0	0
Cambodia	4 830 328	0	0	0	0	0	0	0
Central African Republic	480 403	0	0	0	0	0	0	480 403
Chad	738 746	0	0	0	0	0	0	0
Chile	11 143	0	0	0	0	0	0	0
China	2 157 205	0	0	0	0	0	0	0
Colombia	59 431	0	0	0	0	0	0	0
Congo, Democratic Republic	3 216 529	0	0	1 551 212	0	0	0	480 403
Costa Rica	86 938	0	0	0	0	0	0	0
Ecuador	66 859	0	0	0	0	0	0	0
El Salvador	477 466	0	0	0	0	0	0	0
Ethiopia	4 328 336	0	0	0	0	0	0	0
Georgia	3 528 311	0	0	0	0	0	0	1 903 232
Guatemala	1 086 568	0	0	0	0	0	0	-41 324
Haiti	1 329 610	0	0	0	0	0	0	0
Honduras	520 697	0	0	0	0	0	0	0
India	3 150 385	0	0	0	0	153 891	-21 121	87 281
Indonesia	2 173 485	0	0	0	0	0	0	21 820
Iran	368 760	0	0	0	0	0	0	368 760
Iraq	1 238 507	0	0	0	0	0	0	517 617
Kenya	24 063 019	0	0	0	0	0	0	0
Korea, Democratic People's Rep.	612 838	0	0	0	0	0	0	0
Kosovo	3 002 650	0	0	0	0	0	0	0
Laos	48 214	0	0	0	0	0	0	0
Macedonia	115 409	0	0	0	73 867	0	0	0
Malawi	291 138	0	0	0	0	0	0	0
Malaysia	312 011	0	0	0	0	0	0	0
Mali	9 910 821	0	0	0	0	0	0	0
Moldova	4 010 930	3 678 826	0	0	0	0	0	0
Mozambique	33 609 067	3 596 438	0	0	49 782	0	0	-3 669
Myanmar/Burma	592 046	0	0	0	0	0	0	592 046
Namibia	886 779	0	0	0	0	0	0	0
Nicaragua	361 043	0	0	0	0	0	32	0
Niger	411 041	0	0	0	0	0	0	0
Palestinian Administered Areas	603 907	0	0	0	0	0	0	0
Paraguay	500 757	0	0	0	0	0	0	0
Peru	40 859	0	0	0	0	0	0	0

ADAPTATION 2012					CROSS CUTTING 2012				
Water and sanitation	Agriculture	Government and civil society	Multisectoral	Other	Water and sanitation	Agriculture	Government and civil society	Multisector	Other
0	0	0	0	9 086	0	0	2 343 955	0	5 327 505
0	0	57 193	59 528	0	1 221 955	0	7 294	18 311	0
0	0	0	6 611 118	0	0	0	0	29 715	4 352 100
0	0	0	0	0	0	0	0	0	0
4 722 929	4 432 035	613 335	229 793	57 130	0	0	0	0	1 439 303
0	0	38 676	40 254	0	2 733 088	0	0	25 640	111 338
73 867	0	0	569 530	82 083	164 344	0	0	257 368	8 251
0	0	0	0	0	0	0	0	208 007	0
3 282 536	131 105	369 336	565 386	0	0	0	0	46 408	295 469
0	0	0	0	938 114	0	0	0	0	0
0	0	1 091 612	707 803	13 330	0	0	0	3 017 582	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	738 746	0	0	0	0	0
0	0	0	0	0	0	0	0	11 143	0
0	0	0	877 638	0	155 055	0	0	1 080 192	44 320
0	0	0	0	0	0	0	0	59 431	0
0	0	446 242	0	738 672	0	0	0	0	0
0	0	10 796	18 428	5 713	0	0	0	52 002	0
0	0	0	0	0	0	0	0	66 859	0
0	0	147 544	251 845	78 078	0	0	0	0	0
0	185 374	110 801	0	2 733 679	0	0	1 224 194	74 288	0
0	0	0	0	0	1 625 079	0	0	0	0
0	0	100 762	171 991	53 321	0	0	0	63 145	738 672
0	0	0	0	1 329 610	0	0	0	0	0
0	0	151 143	257 987	59 565	0	0	0	52 002	0
0	0	0	798 243	172 199	147 734	0	77 561	1 245 181	489 414
72 944	0	0	374 683	0	0	0	77 561	1 122 980	503 497
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	720 889	0	0
7 646 443	12 287 927	190 728	1 129 309	1 135 071	0	-397 267	0	815 066	1 255 743
0	0	0	0	442 169	0	0	0	170 668	0
0	0	23 909	24 885	0	0	0	0	2 953 857	0
0	0	0	0	0	0	50 489	0	0	-2 274
0	0	0	0	0	0	18 291	0	0	23 250
0	0	89 966	153 564	47 608	0	0	0	0	0
0	0	0	0	0	0	0	0	312 011	0
0	4 092 245	1 203 223	1 625 079	886 407	0	0	517 071	713 553	873 243
0	0	54 146	56 356	0	0	0	0	221 602	0
0	156 949	380 837	128 994	561 336	0	738 672	0	3 631 562	24 368 166
0	0	0	0	0	0	0	0	0	0
265 922	0	217 431	301 317	0	0	0	0	6 082	96 027
0	0	111 558	190 419	59 034	0	0	0	0	0
0	0	0	0	411 041	0	0	0	0	0
0	0	129 551	221 132	68 556	0	0	0	184 668	0
0	0	154 742	264 130	81 886	0	0	0	0	0
0	0	0	0	0	0	0	0	40 859	0

USD (exchange rate 1$ = SEK 6.7689)		MITIGATION 2012						
Country/Region/Global	Total 2012	Energy generation and supply	Transport and storage	Forestry	Agriculture	Industry	Multisector	Other
Philippines	439 014	0	0	0	0	0	0	0
Rwanda	59 094	0	0	0	0	0	0	0
Senegal	-3 714	0	0	0	0	0	0	0
Serbia	731 654	0	0	0	0	0	0	0
Somalia	1 181 935	0	0	0	0	0	0	443 189
South Africa	1 036 088	0	0	0	0	73 867	0	0
Sri Lanka	2 314 388	0	0	0	0	0	0	1 890 988
Sudan	-15 244	0	0	0	0	0	0	0
Syrian Arab Republic	1 104 241	0	0	0	0	0	0	219 903
Tanzania	11 088 969	8 893 426	0	0	0	0	0	0
Thailand	141 148	0	0	0	0	0	0	0
Turkey	29 715	0	0	0	0	0	0	0
Uganda	2 758 421	79 509	0	0	0	0	0	0
Ukraine	9 857 698	9 499 728	0	0	0	0	0	0
Uruguay	118 861	0	0	0	0	0	0	0
Vietnam	4 208 893	295 469	0	0	0	0	0	0
Zambia	1 610 830	0	0	0	0	0	0	0
Zimbabwe	895 491	0	0	0	0	0	0	0
Reg. Africa	43 358 583	0	0	0	0	0	1 477 345	0
Reg. East Africa	14 024 621	0	0	0	0	0	0	336 571
Reg. Lake Victoria	1 246 071	0	0	0	0	0	0	0
Reg. Southern Africa	2 168 690	0	0	0	0	0	0	0
Reg. West Africa	858 215	0	0	125 204	0	0	0	0
Reg. Asia	6 729 159	1 108 009	0	0	0	0	0	39 674
Reg. South Asia	103 414	0	0	0	0	0	0	0
Reg. South-East Asia	9 224 185	0	0	0	0	0	0	0
Reg. Latin America	6 822	0	0	0	0	0	0	0
Reg. Central America	1 199 488	0	0	0	0	0	0	0
Reg. South America	59 431	0	0	0	0	0	0	0
Reg. Middle East	2 021 249	0	0	0	0	0	0	0
Reg. North Africa	465 364	0	0	0	0	0	0	0
Reg. Central & Eastern Europe (non-EU)	2 169 886	0	0	0	0	0	452 205	0
Global	**85 765 683**	**1 128 533**	**0**	**160 626**	**0**	**2 866 049**	**279 030**	**745 559**
Grand Total	**358 095 447**	**28 279 938**	**0**	**802 354**	**123 650**	**3 093 808**	**3 664 836**	**8 081 584**

ADAPTATION 2012					CROSS CUTTING 2012				
Water and sanitation	Agriculture	Government and civil society	Multisector	Other	Water and sanitation	Agriculture	Government and civil society	Multisector	Other
0	0	111 558	190 419	59 034	0	0	0	78 003	0
0	0	0	0	0	0	0	0	0	59 094
0	0	0	0	0	0	0	0	-3 714	0
0	0	0	0	0	0	0	0	731 654	0
0	0	0	0	738 746	0	0	0	0	0
0	0	0	218 884	0	0	0	221 602	185 173	336 561
0	0	118 755	202 704	62 843	39 098	0	0	0	0
0	0	0	0	0	0	0	-15 244	0	0
0	0	0	0	884 339	0	0	0	0	0
0	0	115 156	196 562	60 939	0	0	361 211	100 289	1 361 386
0	0	0	0	0	0	0	0	141 148	0
0	0	0	0	0	0	0	0	29 715	0
0	0	194 327	331 698	102 834	0	0	1 108 009	1 944 178	-1 002 133
0	0	14 767	15 370	0	0	0	195 748	132 084	0
0	0	0	0	0	0	0	0	118 861	0
0	0	79 170	725 052	226 853	0	0	0	2 364 538	517 809
0	0	255 503	436 121	135 207	0	0	494 911	192 055	97 033
0	0	35 986	61 425	19 043	0	0	779 036	0	0
25 114 864	50 299	160 232	2 552 418	453 344	4 432 035	0	738 672	5 941 756	2 437 619
4 505 902	0	277 095	6 234 621	2 067 353	0	0	0	12 141	590 938
0	0	385 054	657 253	203 763	0	0	0	0	0
1 353 504	0	251 905	429 978	133 303	0	0	0	0	0
0	0	0	0	733 011	0	0	0	0	0
0	590 938	0	3 893 744	0	0	0	0	1 248 356	-151 562
0	0	0	103 414	0	0	0	0	0	0
0	0	107 959	6 841 141	210 990	0	0	0	1 236 538	827 557
0	0	0	6 822	0	0	0	0	0	0
0	0	370 660	632 683	196 146	0	0	0	0	0
0	0	0	0	0	0	0	0	59 431	0
1 324 350	0	0	0	0	696 898	0	0	0	0
0	0	465 364	0	0	0	0	0	0	0
0	0	45 708	47 573	0	0	0	0	1 624 399	0
6 913 664	**579 571**	**0**	**-27 443**	**6 927 130**	**1 265 510**	**32 423 802**	**0**	**22 221 696**	**10 281 955**
55 276 925	**22 506 443**	**8 682 729**	**39 379 851**	**23 917 315**	**12 480 796**	**32 833 987**	**8 852 469**	**54 838 484**	**55 280 282**

Annex 7: Information in accordance with Article 7.2 of the Kyoto Protocol

Reported information	NC6 section
National system for inventory of emissions	Annex 3
National registry	Annex 4
Supplementarity related to mechanisms under Articles 6, 12 and 17	Section 5.8
Policy instruments implemented to promote sustainable development (Art. 2)	Section 4.2
Initiatives in IMO and ICAO to reduce emissions from international transport (Art. 2)	Section 4.2.9
Minimise adverse effects (Art. 2)	Section 4.2.10
Programmes, legislative arrangements and administrative procedures for implementation of the Kyoto Protocol	Section 4.1
Implementation of Arts. 3.3 and 3.4 and contribution to conservation of biodiversity and of natural resources	Section 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	Sections 4.2, 4.3, 6.1, 6.4
c. activities for technology transfer and capacity building	Sections 7.6, 7.7
d. cooperation in research and systematic observation	Sections 8.2, 8.3, 8.4, 8.7
e. international participation in information and training	Section 9.6.5
Financial resources and capacity building (Art. 11)	Sections 7.2.4, 7.4, 7.5
Implementation of New Delhi programme (Art. 6)	Section 9.5

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