Ds 2001:71

Sweden's third 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

Sweden has prepared the following National Communication in accordance with Article 12 of the Climate Convention. The material on which the communication is the result of an extensive project headed by the Swedish Environmental Protection Agency and involving a further ten Swedish public authorities.

The report was adopted by the government on 22 November 2001. Most of the work on the Third National Communication was carried out between autumn 2000 and summer 2001. The second part of the sixth meeting of the parties (CoP6 bis) was held while this communication was being prepared. An important political agreement was reached at that meeting and, as a result, the parties will be able to begin work on ratifying the Kyoto Protocol. Sweden is taking the steps necessary to ratify the Protocol in 2002.

Since most of the work on this communication was completed in the summer of 2001, events occurring after that time are not fully described here. For example, the forecasts of future Swedish emissions of carbon dioxide take no account of the economic slowdown in summer 2001. Nor has it been possible for these forecasts to take account of the growing uncertainty and the international tensions following the terrorist attacks in New York and Washington in September. However, the forecasts are already intrinsically uncertain because they deal with long or very long-term scenarios. The government does not consider that the relevance of the forecasts has been appreciably affected by near-term events of the kind described above.

Moreover, the Third National Communication does not take into account a number of political decisions that were taken after the summer of 2001 and have a bearing on Swedish climate policy.

In September 2001 the government decided to put a bill before parliament entitled Infrastruktur för ett långsiktigt hållbart transportsystem ("Infrastructure for a sustainable transport system") (Gov. Bill 2001/02:20). This bill represents the largest investment in Swedish infrastructure in modern times. The National Rail Administration and the National Road Administration will be instructed to plan investment in new roads and railways, to develop and modernise transport systems and to take the necessary steps to maintain and safeguard the existing road and rail network. SEK 364 billion will be allocated for this purpose between 2004 and 2015. Some of these resources will be made available earlier, so that work can begin during the period 2002 – 2004.

These major infrastructure investments are needed to promote growth, regional development and a changeover to ecological sustainability in Sweden. Investments of significance in terms of climate change include SEK 150 billion to maintain and safeguard the existing road and rail network, SEK 100 billion to be invested in the railways as part of a strategy to improve the competitiveness of rail as compared with passenger and goods transport by road. SEK 69 billion will be

invested in road projects (most of them already planned), environmental improvements along roads and measures to improve road safety.

The "rush-hour charges" and "kilometre tax" issue will be further examined. SEK 30 billion will also be allocated for regional and local projects, including minor roads, public transport subsidies, municipal airports and harbour facilities. Efforts will also be made to develop new technology and a "transport system for sustainable travel". The government also proposes that a coherent programme for technical development, demonstration and implementation of new solutions be initiated.

The government also proposes a number of measures and projects of relevance to the climate issue in the Finance Bill for 2002 (Gov. Bill 2001/2002:1). A total of SEK 990 million will be used to fund climate investments and information on climate issues over a period of three years. Spending on "General environmental protection and nature conservation" will be substantially increased. The most important change in spending on the climate issue is a new appropriation for climate investment funding. The government proposes that the current funding for local investment programmes (LIPs) be replaced by funding for climate investment programmes as from 2002. This is because the climate issue is becoming more important and the government wants to reduce Swedish greenhouse gas emissions. Municipalities can apply for money for climate investment programmes involving measures to reduce emissions of greenhouse gases, for example, in the energy and transport sectors. The appropriation will be SEK 200 million in 2002, SEK 300 million in 2003 and SEK 400 million in 2004. It is also proposed that the landfill tax be raised by 15 per cent as from 2002. SEK 30 million a year will be allocated for information about climate issues during 2002 – 2004. The Swedish Environmental Protection Agency will be given responsibility for this information. Increased resources will also be devoted to research into biodiversity and sustainable development. Research at FORMAS ("the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning") will receive extra funding of SEK 80 million in 2002 and 2003 and SEK 90 million i n 2004. This is to be used for research into biodiversity and research in support of ecologically sustainable development. The spring budget also provided extra funding of SEK 50 million during 2002 – 2004 for Swedish Research Council research into biodiversity and ecologically sustainable development.

The government has also continued to develop a national climate strategy in 2001. The aim is to put a bill before parliament that will, among other things, define environmental quality objectives for "substances affecting climate", and present a strategy for achieving those objectives. The government intends to put this bill before parliament in autumn 2001.

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Summary –

National conditions having a bearing on emissions and removals of greenhouse gases

Greenhouse gas emissions and removals are influenced by prevailing environmental and social conditions in the country. National conditions also affect a country's ability to act.

Important national conditions include energy requirements for trade and industry, transport, heating and electricity production. Political objectives also play a part, in the form of regional policy and labour market policy objectives. Since Sweden joined the European Union (EU) in 1995, Swedish climate policy and re-lated policy areas have been influenced by the membership.

Climate policy and other political programmes are decided by parliament the Riksdagen on the basis of government proposals, which are generally based on documents produced by government agencies, review commissions and government committees. Sweden has a large number of central agencies, responsible to the government. Their role is to act as the government's expert body in relation to specific issues, and to implement government policy and decisions. These agencies act independently in their role as public authorities. There are also 21 county administrative boards and 289 municipalities in Sweden, dealing with matters of a regional and local nature. Responsibility for climate is shared between central agencies, county administrative boards and municipalities.

The population of Sweden was just under 8.9 million in 1999, having risen by approximately three per cent since 1990. The long-term rate of increase is expected to decline, however. The average age of the population is rising. Sweden has a low population density, with an average of 22 inhabitants per square kilometre. Nearly 85 per cent of the population live in urban areas; 65 per cent live in urban areas with over 10,000 inhabitants.

The three main conurbations (Stockholm, Gothenburg and Malmö) have a combined population of almost three million.

The total surface area of Sweden, including lakes but excluding territorial waters, is 449,964 square kilometres. The country lies at a northerly latitude (55°N to 69°N). Most agriculture is concentrated in the south of the country, owing to the favourable climate and fertile conditions there. Forestry predominates in the north and centre of the country. Sweden has a temperate climate, with a mean annual temperature of about 4°C and mean annual precipitation of approximately 650 mm. The montane region displays tundra conditions, however. Much of Sweden is usually snow-covered in winter.

The Swedish economy is open and the country is heavily dependent on foreign trade.

Exports account for approximately 44 per cent of GDP. The principal export products are iron and steel, engineering and forest products. The trend in Swedish industry is towards a greater proportion of processed products and increasingly sophisticated services. Capital-intensive and labour-intensive industry are declining in significance. However, basic industries still play an important part in Sweden, particularly in terms of the regional balance and as a source of employment around the country. The relatively rapid rise in the importance of sophisticated services is in part due to a rapid increase in demand for products in the telecommunications and pharmaceutical sectors, where the average annual increase has been approximately 20 per cent and 13 per cent, respectively.

Swedish per capita energy consumption is fairly high compared with other industrial nations, whereas per capita emissions of greenhouse gases are fairly low. Swedish carbon dioxide emissions peaked around 1970. Emissions fell by over 40 per cent between 1970 and 1990. This was largely due to a changeover from oil-based energy to electric power and other energy sources, as well as considerable improvements in energy efficiency. Factors making this possible included development of nuclear power. Biomass fuels have also increased at the expense of oil products, from nine per cent of the total supply in 1970 to 15 per cent in 1999.

Transport (goods and passenger) increased by approximately two per cent a year in the 1990s. The structure of society, the way communities are planned, the location of homes and shopping centres, and so on, affect transport requirements and the scope for taking effective action to reduce greenhouse gas emissions. Swedish municipalities have overall responsibility for local planning, although this is coordinated with regional and national plans. Building construction is subject to detailed regulations, which influence heating requirements. Building standards are high in Sweden, relative to other countries.

Over the last 50 years, Swedish agriculture has undergone far-reaching structural changes and rationali-

sation. The area of land under cultivation has decreased, while productivity has risen. Since 1995, the EU Common Agricultural Policy (CAP) has had a major impact on the area under cultivation and agricultural product quotas.

Forests are one of Sweden's most important natural resources and represent a basic supply of raw materials of the pulp and paper industry. This is of great importance to the national economy and as a source of renewable energy. Timber volume has increased by approximately 70 per cent since the 1920s.

Emissions and removals of greenhouse gases

Between 1990 and 1999 total emissions of greenhouse gases (not including the land-use and forestry sectors or international transport) rose by less than 0.1 per cent.

As classified in this report, transport and its emissions are included in the energy sector.

Emissions from transport rose somewhat between 1990 and 1999, whereas those from the housing and service sectors fell slightly. In other sectors, methane emissions from waste and transport fell, while emissions of halocarbons rose.

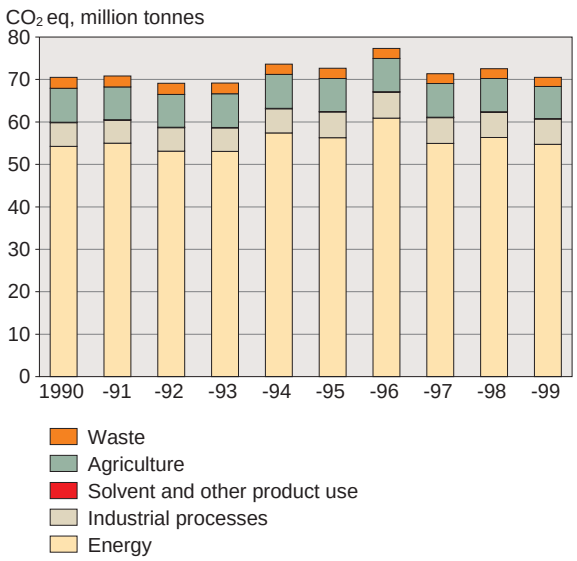
The inventory of emissions has been performed largely along the lines of the standard method formulated by the Intergovernmental Panel on Climate Change (IPCC), but has been refined using national methods in some areas. Emission statistics are largely based on official Swedish statistics. The total impact of various greenhouse gases has been estimated using the guideline weighting (Global Warming Potential) factors for the effect on climate the different gases have over 100 years. The total effect on climate of greenhouse gases is expressed in carbon dioxide equivalent emissions. Some minor revisions and corrections have been made in this national communication as compared with the report submitted under the Climate Convention in April 2001.

The energy sector accounted for 77.4 per cent of the total emissions of greenhouse gases in 1999, of which transport accounted for 29.5. Industrial processes produced 8.6 per cent, solvent use 0.1 per cent, the agricultural sector 10.7 per cent and the waste sector 3.0 per cent of all greenhouse gas emissions. There was some shift in the relative importance of emissions from sub-sectors of the energy sector, although total emissions did not change appreciably.

Less use of fossil fuels in district heating production and connection of homes and commercial premises to district heating networks have particularly reduced emissions in these housing and service sectors.

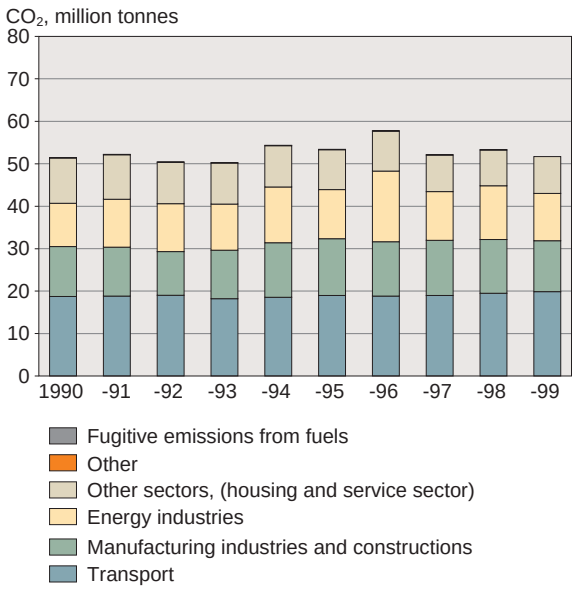
Removals by forest above ground (the change in stored forest biomass) varies over time depending on growth and removal of forest products. Forest above ground accounts for removal of about 23,000 ktonnes carbon dioxide a year, peaking at approx. 30,000 ktonnes carbon dioxide in 1991. Carbon dioxide sinks and emissions from forested land are influenced by a number of factors; it is not possible at present to

Figure 1
Greenhouse gas emissions by sector, not including the land-use and forestry sectors or international transport.



Source: Swedish Environmental Protection Agency

Figure 2
Emissions of carbon dioxide from the energy sector, broken down into sub-sectors.



Note: The sub-sector for combined heating and power plants, oil refineries etc includes emissions from district heating.

Source: Swedish Environmental Protection Agency

make a reliable estimate of the net effect on the carbon dioxide/carbon balance in forest soil. Overall, cultivation of agricultural land results in some loss of carbon dioxide: approx. 3,800 ktonnes a year.

Carbon dioxide is the main greenhouse gas emitted in Sweden, representing just over 80 per cent of all greenhouse gas emissions (expressed as carbon dioxide equivalent emissions) in 1999. Swedish emissions of this gas increased by just under one per cent between 1990 and 1999. Emissions derive mostly from the energy sector, ie, energy supply and use, which accounts for 87 per cent of all carbon dioxide emissions. Domestic transport accounts for some 35 per cent of total carbon dioxide emissions. Industrial processes and certain kinds of agricultural land use also result in carbon dioxide emissions.

Emissions of methane accounted for approximately eight per cent of total greenhouse gas emissions in 1999. The main sources of methane emissions are enteric fermentation (ie, ruminating cattle) and landfill sites. These sources are responsible for just under 90 per cent of all methane emissions. These emissions fell by about nine per cent between 1990 and 1999.

Emissions of nitrous oxide represented just over 10 per cent of all greenhouse gas emissions in 1999. Agricultural fertilisers are the main source, although combustion in the energy sector and industrial processes also contribute. Emissions have remained constant, falling slightly in agriculture and rising somewhat in the energy sector.

Perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) accounted for just over one per cent of all greenhouse gas emissions in 1999. These halocarbons are used and emitted from a limited number of applications (eg, as refrigerants and in certain kinds of fire fighting) and are also released as a pollutant from aluminium production. They all score high in terms of their global warming potential (GWP), ie, greenhouse effect per kg expressed as carbon dioxide equivalent emissions.

Relatively speaking, these emissions increased sharply between 1990 and 1999, mainly owing to the phase-out of ozone depleting substances (including CFCs and HCFCs), governed by the Montreal Protocol.

"Normal-year" correction

Variations in temperature, wind and incoming radiation affect the fossil fuel requirement for heating. Precipitation also affects fossil fuel use because the availability of electric energy from hydropower is dependent on this. To make relevant comparisons between the years, a normal-year correction of carbon dioxide emissions in the energy sector is sometimes performed by calculating the effect of climate variations. The normal-year correction takes account of the annual variation in temperature, incoming radiation and wind, and also the availability of hydropower. However, variations in the economic cycle or temporary shutdowns at nuclear power plants are not included. The normal-year correction in this report differs slightly from that used in previous national reports.

Winters in the 1990s were fairly mild and wet. As a result, all years except 1996 have higher emissions after the normal-year correction. The largest correction was made for 1990, which was a warm and wet year.

Total emissions of greenhouse gases (not including the land-use and forestry sectors or international transport) rose by less than 0.1 per cent between 1990 and 1999. Corresponding normal-year-corrected total emissions of greenhouse gases during this period fell by about 1.6 per cent.

Objectives and measures affecting emissions and removals of greenhouse gases

In 1993 parliament decided that by 2000, emissions of carbon dioxide from fossil sources should have stabilised at 1990 levels and should then fall. This target was confirmed and supplemented in 1999 when parliament laid down the current environmental quality objective termed "Reduced Climate Impact":

> *"Under the UN Framework Convention on Climate, the content of greenhouse gases in the atmosphere must be stabilised at a level at which human activities will not have a harmful effect on climate systems. This objective is to be achieved in a manner and at a rate such that biological diversity is preserved, food production is assured and other sustainable development objectives are not jeopardised. Together with other countries, Sweden is responsible for achieving these objectives."*

Government climate policy is intended to achieve this objective as part of the efforts to achieve an ecologically, economically and socially sustainable society.

Sweden is taking a number of steps and employing various instruments specifically designed to control greenhouse gas emissions, but most measures and instruments affect emissions as a side-effect. Inventories and analysis of the effects of these measures and instruments focus on those that

- are in use or were in use at some time in the 1990s but have now been discontinued or abolished;
- have been decided but will come into force later;
- have come a long way in the planning process, eg, by means of a parliamentary decision in principle or in the form of a government bill.

Measures that primarily have other aims may also help to reduce carbon dioxide.

Sweden is also spending large amounts of money on research and development of new technology, one of whose aims is to reduce environmental impact. Funding for research and development and ecological adjustment of the Swedish energy system totals approximately SEK 10 billion for the period 1998 – 2002.

The policy Sweden has pursued enabled it to keep greenhouse gas emissions in the late 1990s more or less at the same level as in 1990.

International comparison

Compared with other industrialised nations, per capita carbon dioxide emissions in Sweden are relatively low. Emissions of carbon dioxide total some 6 tonnes per person and year, which may be compared with the OECD average, which is approximately 11.5 tonnes per person and year. This is because the proportion of fossil fuels in the Swedish energy system is 40 per cent, compared with an average of 80 per cent in the rest of the OECD. The scope for reducing Swedish emissions therefore differs somewhat from many other countries. The differences are particularly pronounced in relation to electricity generation, where fossil fuels account for a mere 5 per cent or so of total production. Further emission reductions are therefore more costly in Sweden than in many other countries. Sweden's northerly latitude and cool climate and the predominance of energy-intensive basic industries make for relatively high per capital energy consumption compared with other industrialised countries.

Examples of the effectiveness of measures and instruments

Instruments within the tax system

Taxes and charges play a central part as a means of achieving the objectives of energy and climate policy. The tax burden on energy consumption has been raised while that on labour is being eased; there is also a shift in the tax emphasis between energy tax and carbon dioxide tax.

Energy and carbon dioxide taxation changed in the 1990s. Twenty-five per cent VAT on energy use was introduced in 1991. The carbon dioxide tax was introduced the same year.

This was subsequently raised on two occasions in the 1990s. Energy tax has been raised a number of times and the fuels and applications covered by the tax have also been extended. Energy tax was also levied on industrial use in 1990. A shift in the relative levels of energy tax and carbon dioxide tax was made in 2000. State revenues from energy and carbon dioxide taxes totalled about SEK 65 billion in 1999, almost double total revenues from energy taxes in 1990. Changes in Swedish energy and carbon dioxide taxation in the 1990s have had a great effect on carbon dioxide emissions. Estimates using the MARKAL model, which also includes the effect of subsidies for renewable electric energy generation, indicate that emissions of carbon dioxide in 2000 were at least 5,000 ktonnes less than they would have been if no changes had been made in energy and carbon dioxide taxation in the 1990s. This estimate includes the effects of changes in fuel use and some technological changes, but not the inhibitory effect of the taxation on consumption. The effect of these taxation changes on carbon dioxide emissions increases as time goes by. The carbon dioxide tax is one of the main reasons behind the dramatic increase in the use of biomass fuels in the district heating sector.

Other economic instruments such as trade in certificates and use of the flexible mechanisms offered by the Kyoto Protocol are now being prepared as a complement to taxes and charges to achieve clear management by objectives, with a high level of cost effectiveness.

Measures and instruments in the field of energy policy

When parliament laid down energy policy in 1997, new programmes were introduced to increase energy efficiency, reduce electricity consumption for heating and promote renewable electricity production. The programme for adjustment of the energy system is designed to establish a basis for an ecologically sustainable energy system. These measures are necessary to compensate for the loss of electricity generation from nuclear power at the Barsebäck nuclear power plant. The programme runs from 1998 to 2002 and involves funding of approximately SEK 3.5 billion.

To some extent, this was a continuation of the 1991 energy policy programme. Investment grants to increase the use of renewable energy sources such as small-scale hydropower, wind power and biomass power and heating complemented the changes in use brought about by energy taxation, since carbon dioxide tax is not levied on electricity generation.

A special operating grant for small-scale energy generation was introduced in 2000. A special "environmental bonus" for wind power generation was introduced as long ago as 1995.

Another part of the measures, known as "the long-term adjustment programme" is intended to develop new energy technologies and give financial support for the commercial launch of new technology. This support will total some SEK 5 billion between 1998 and 2004.

It is difficult to assess the effects of shutting down

the two nuclear reactors at Barsebäck, since shutdown is being accompanied by wide-ranging measures to replace the electricity shortfall with renewable energy or to reduce energy requirements by greater efficiency.

One of the reactors was shut down in 1999, and, under the Nuclear Power Phase-Out Act, the government must decide when the other reactor is to be decommissioned. The government thinks it will be possible to shut down the second reactor by the end of 2003, at the latest. However, the decision to close down the second reactor involves a proviso that replacement electricity sources and lower consumption must compensate for the shortfall. Another condition is that a shut-down must not create negative effects with regard to electricity prices, electricity supply to industry, the balance between power supply and demand or the environment and climate.

The energy policy decision of 1997 also involved a strategy for Swedish climate policy in the energy field. It was decided that Sweden should adopt a pro-active approach to the use of effective measures and instruments in the energy field, and that it should press for the introduction of a minimum level of energy taxation in the EU. This strategy involves bilateral and multilateral cooperation on joint implementation within the framework of the Climate Convention and also involves efforts to develop new technology for ethanol production from forest biomass.

Measures and instruments in the field of transport policy

Increased traffic has resulted in an increase in total fuel consumption and hence emissions of greenhouse gases, particularly carbon dioxide. An official aim of transport policy since the 1970s has been for all forms of transport to bear their external costs. Among other things, there has been a desire to adjust the taxation of petrol and diesel to reflect the average marginal cost of cars in non-urban traffic. It is estimated that current fuel taxes generally exceed these marginal costs, however.

Sweden is investing to improve rail infrastructure, in particular by removing bottlenecks in our three main cities. Rail traffic largely runs on electric energy generated from renewable fuels.

Efforts to reduce emissions from road traffic include training courses in "Ecodriving" and procurement of ethanol/petrol-driven hybrid vehicles (as part of trade and industry policy).

The Swedish state and vehicle manufacturers are engaged in a joint project to reduce the environmental degradation caused by road traffic and create the potential for a competitive Swedish motor industry in the long term. Up to SEK 1.8 billion is being invested jointly during 2000 – 2005. The government is contributing a maximum of SEK 500 million. The programme covers areas such as advanced combustion technology, hybrid vehicles and fuel cell technology, weight reduction and ensuring that the right skills and know-how are available.

Measures and instruments in the field of housing policy

An express aim of housing policy is a sustainable housing sector and social planning. There are several examples of instruments to promote energy saving and conversion of energy carriers. In international terms, Swedish building standards do much to save energy or reduce energy requirements for heating. Urban and regional planning is a key tool in the long-term reduction of emissions, for example when it comes to siting residential areas and routing public transport systems.

A system of grants for ecological building is available for a three-year period ending 2003.

SEK 635 million has been made available for this.

Measures and instruments in the field of forestry policy

Current Swedish forest policy places commercial production values and environmental assets in forestry on an equal footing. There has been a very long tradition of forest management legislation requiring felled areas to be replanted and forests to be conserved as a natural resource. This has helped to promote removal of carbon dioxide in forest sinks over a long period. Hence, it is difficult to identify instruments introduced in the 1990s, which have, in themselves, had a major impact on climate. Biomass growth in Swedish forests is used for wood, paper and pulp products as well as fer energy. Biomass has increased substantially and carbon sinks have thus grown because the rate of felling was considerably lower than the rate of growth in the 1990s. This growth is expected to continue, albeit at a slower rate. The carbon dioxide tax makes forest fuels relatively cheaper than fossil fuels, particularly for district heating production. This tax is the single greatest reason why Sweden has an efficient, diversified market for biomass fuels, with low prices and a growth in turnover of around 50 per cent in the 1990s. There is considerable potential for further increase in biomass fuel abstraction from Swedish forests.

Measures and instruments in the field of environment policy, including waste policy and local initiatives

The Local Investment Programme (LIP) for sustainable development in Swedish municipalities is the largest single programme and is expected to reduce carbon dioxide emissions in certain sectors, such as district

heating production. Half of the SEK 5.3 billion that has so far been allocated under the programme is considered to have been invested to reduce greenhouse gas emissions. According to the information given in the applications submitted to Swedish municipalities, the overall effect of projects approved under the LIPs may reduce national emissions of carbon dioxide by 1,700 ktonnes a year. The programme has not yet been concluded and further effects may be expected. This estimate is based on advance estimates of the effect by municipalities. In 1999 Swedish environmental legislation was gathered under a unified "umbrella" known as the Environmental Code. The new general appraisal of systems as part of the permit procedure under the Environmental Code offers great scope for reducing greenhouse gas emissions.

Sweden has adopted a rigorous policy on waste over the last few years. This has resulted in a tax on landfill and a ban on landfill of burnable waste from 2002 and organic waste from 2005. The policy is expected to have a major net impact on greenhouse gas emissions.

The potential quantity of methane-generating waste is expected to fall by about 80 per cent by 2010, which is expected to yield an emission reduction of 780 ktonnes carbon dioxide equivalent emissions by 2010, compared with the instruments in place in 1990. Most organic waste is expected to be recycled for energy by incineration in the district heating sector. Municipal Agenda 21 projects and the municipal waste plans required by the Environmental Code should ultimately reduce the amount of waste landfilled.

Measures and instruments in trade and industry policy

Trade and industry policy is focusing on environmental technology as a growth industry of the future. Some support is being given in the form of market analyses of technologies capable of reducing carbon

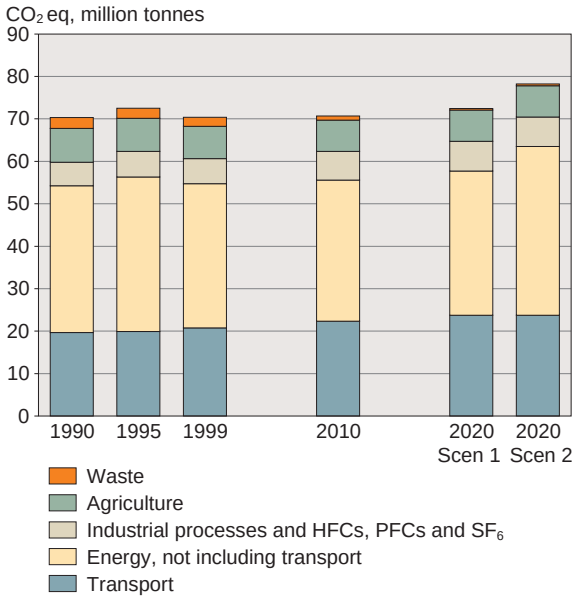
Table 1
Examples of some important measures and instruments and their impact on greenhouse gas emissions and removals.

Name of measure/instrument	Type of instrument[1]	Status of measure[2]	Assessment of effect measured in ktonnes carbon dioxide equivalent equivalent emissions per year[3 4]		
			1995	2000	2005
Energy and carbon dioxide taxes (inc. VAT) on energy	T	O (57-)	1,000	5,000	10,000
Investment subsidy for biomass fuel-based combined power and heating	E	O (98-02)	N.I.U.	490-820	490-820
Investment subsidy for wind power	E	O (98-02)	N.I.U.		
Operating subsidy for small-scale electricity generation	E	O (00-)	N.I.U.	170-414	170-414
Environmental bonus for wind power	T	O (95-)			
Conversion from electric heating to district heating	E	O (98-02)	N.I.U.	88-236	88-236
Conversion of electric heating to other individual heating system	E	O (98-02)	N.I.U.	34-81	34-81
Information, education etc	I	O (98-02)	N.I.U.		
Procurement of new energy technology	E	O (98-02)	N.I.U.	200-400	200-400
Testing, labelling and certification	E	O (98-02)	N.I.U.		
Local Investment programmes for ecological adjustment (LIP)	E	O (98-03)	N.I.U.	1,600	N.C.
Waste policy measures	R, T	O (91-)	N.C.	193	781
64 projects under the climate convention pilot programme for joint implementation (AIJ)	E	O (93-)	N.C.	c. 220	N.C.

1 The guidelines classify instruments as follows: economic (E), tax (T), voluntary or negotiated measures (V/N), regulation (R), information (I), education (Ed), research (R&D) and miscellaneous (M).
2 The following symbol is used to describe the status of instruments: O = ongoing (with the year of introduction and, where applicable, conclusion).
3 N.C. means not calculated and N.I.U. means not in use at the time.
4 The calculations assume that the electricity that is substituted comes from coal-fired condensing or natural gas combination power plants. The interval in the effect calculations depends on whether it is assumed that substituted/saved electricity comes from natural gas combination power plants (the lower figure), or coal-fired condensing power plants (the higher figure).
5 The impact of LIP projects is based solely on applications received by Swedish municipalities.

Note: The figures in the table also include emission reductions in other countries due to reduced import of electricity.

Figure 3
Emissions of greenhouse gases in 1990, 1995 and 1999, and projected emissions of these gases in 2010 and 2020. By sector. (Not including the land-use and forestry sectors or international transport)



Scenario 1 2020 includes the possibility of reinvestment in nuclear power;
Scenario 2 2020 assumes a working life of only 40 years for existing reactors.

Source: Projected emissions of carbon dioxide by the energy sector: National Energy Administration; otherwise Swedish Environmental Protection Agency.

dioxide emissions. Industry has invested in new technology and has thereby been able to make more efficient use of resources in relation to value added.

"Regional Growth Agreements" were drawn up throughout the country in 1998 – 1999.

Various actors in every county came together to analyse industrial potential and development requirements. This resulted in joint proposals for specific measures and their funding. Many of these measures are closely related to development of environmental technology. However, regional administrations also have a number of instruments at their disposal, which, while serving other important purposes, may be assumed to have the opposite effect on emissions of greenhouse gases. Transport subsidies are one example.

Measures and instruments in the field of agricultural policy

Swedish agricultural policy is closely related to the CAP, which, at present, provides no instruments designed to reduce greenhouse gas emissions. Certain forms of agricultural support that have other primary aims may have some positive effects on greenhouse gas emissions.

Examples include various forms of support to reduce nitrogen leaching. There has also been an environmental tax on artificial fertilisers since 1984, which may also have reduced greenhouse gas emissions.

The pilot phase of joint implementation

Sweden is involved in a series of joint projects with actors in the Baltic States to develop systems for sustainable energy supply and more efficient energy use. These projects, which include loans, credits and competence transfer, are being conducted under the Climate Convention pilot programme for activities implemented jointly (AIJ). Seventy projects have so far been initiated by Sweden, of which 64 have been reported to the UN Climate Convention Secretariat.

The total cost of the 64 projects is estimated at SEK 271 million, of which SEK 197 million is being met by the recipient countries and SEK 74 million by Sweden (the donor). The total reduction in carbon dioxide emissions to date is estimated at about 4,000 ktonnes (approx. 220 ktonnes a year).

Most of these projects have been implemented in the district heating sector in the Baltic States and in the St Petersburg and Kaliningrad areas of Russia. A biogas project has been started in Poland. The programme has been continually evaluated by local experts and independent consultants and has attracted attention internationally. The programme has been praised not only for lowering emissions of greenhouse gases, but also for its other positive effects, both in Sweden and in the recipient countries. Table 1 presents a selection of the measures and instruments that have been identified and are considered to impact greenhouse gas emissions or sinks. There is some doubt as to the accuracy of the figures given.

Projections and the combined effects of policy and measures

Projections

A combination of models has been used to estimate future emissions. It must be pointed out that all estimates are unreliable, and the results should therefore be treated with great caution.

Between 1990 and 1999 total emissions of greenhouse gases (not including the land-use and forestry sectors or international transport) rose by less than 0.1 per cent. Total emissions of these gases are expected to rise slightly from their present levels and be about 0.5 per cent higher by 2010 than they were in 1990.

After 2010 greenhouse gas emissions are expected to increase more rapidly. The decisive factor for the size of the increase between 2010 and 2020 is the rate at which nuclear power may be phased out after the two Barsebäck reactors are shut down. If reinvest-

ment in nuclear power is allowed (Scenario 1), it is estimated that total emissions will rise by about 3.0 per cent between 1990 and 2020. If every nuclear power plant is allowed to remain in operation for a maximum of 40 years, the increase in total emissions is expected to be approximately 11 per cent between 1990 and 2020.

The projections assume that the various sectors will change in different ways. The relative emissions of the various greenhouse gases will also change.

- Total emissions of greenhouse gases from the energy sector will increase by approx. 2.4 per cent per year between 1990 and 2010. If reinvestment in nuclear power is allowed (Scenario 1), emissions will rise by about 6.5 per cent between 1990 and 2020, whereas 40 years further operation of every reactor (Scenario 2) will increase emissions by approximately 17 per cent between those years.
- Emissions of carbon dioxide are the most significant emissions from the energy sector. Carbon dioxide emissions are expected to increase by about 20 per cent from the transport sector (not including international transport) and the industrial sector beween 1990 and 2020. Carbon dioxide emissions are expected to decrease in the housing sector (housing and services) by about 15 per cent (scenario 2) and 20 per cent (scenario 1) between 1990 and 2020. Carbon dioxide emissions from district heating production will fall by about 30 per cent, despite an increase of about 20 per cent in energy use in the sector. This is because much greater use of biomass fuels is expected in these sectors.
- Carbon dioxide emissions from electricity generation is expected to fall somewhat by 2010. The same applies up to 2020 in scenario 1. In scenario 2, in which the reactors are shut down after 40 years' operation, emissions of carbon dioxide from electricity generation are expected to double between 1997 (the base year) and 2020. These higher emissions in scenario 2 will arise because a larger proportion of the shortfall of electrical energy from nuclear power will be covered by electricity generation based on natural gas.
- Emissions of greenhouse gases from industrial processes and emissions of halocarbons rose by around
  6 per cent between 1990 and 1999. This trend is expected to continue, in particular because of greater emissions from the iron and steel industry and increased emissions of HFCs. Towards the end of the period, the rate of increase of fluorocarbon emissions will level off somewhat. Emissions are expected to increase by some 25 per cent between 1990 and 2010, and by around 30 per cent between 1990 and 2020.
- Emissions of greenhouse gases from agriculture fell by around 5 per cent between 1990 and 1999. This trend will continue until 2010, mainly because there are expected to be fewer animals producing methane, and because new systems for managing manure are expected, which will reduce nitrous oxide emissions. The trend after 2010 is much less certain, and the figure for 2010 has been used for 2020. Emissions from agriculture are expected to fall by 7 – 8 per cent between 1990 and 2010/2020.
- Emissions of greenhouse gases from waste fell by around 16 per cent between 1990 and 1999. The rapid decrease is expected to continue as a result of existing political decisions, including a ban on landfilling of organic and burnable waste, and the requirement that gas recovery systems be fitted at landfill sites. Emissions are expected to fall by 62 per cent between 1990 and 2010, and by about 84 per cent between 1990 and 2020.
- It is assumed that felling rates will remain largely unchanged over the coming decade, as compared with 1998 – 2000. The rate of sink growth in forest biomass will not have changed by 2010 under this scenario. There is much doubt as to the longer-term trend, and no removal figures have therefore been given for 2020.
- Emissions from international transport rose by approximately 70 per cent between 1990 and 1999. This trend is expected to continue, albeit at a slower rate after 2010. Emissions are expected to increase by 115 per cent between 1990 and 2010, and by 155 per cent between 1990 and 2020.

Evaluation of the combined effects of policy and measures

Economic instruments and effects on the energy system

To analyse the effects of economic instruments on the energy system, model calculations

(MARKAL) have been performed using two sets of economic instruments: "1990 instruments" and "current instruments" (1 January 2001). The calculation based on 1990 instruments assumes that taxes that year will remain constant throughout the period studied. There was no carbon dioxide tax in 1990. Energy tax was also levied on industrial use. Neither VAT on energy use nor the sulphur tax had been introduced, nor was there any operating subsidy for wind power or small-scale power generation. The investment grant for special technologies had not yet been introduced either.

Since the other premises on which the calculations are based are identical in the two scenarios, the differ-

ing effects on the energy system resulting from the differences in the instruments can be identified. One difference between the scenarios concerns the use of fossil fuels, the result being different carbon dioxide emissions. Our analysis assumes that the system of subsidies for renewable energy production will continue. For modelling purposes, it is assumed that the subsidy is SEK 0.15/kWh and covers all types of renewable energy. The current subsidy system is in the range SEK 0.06 - 0.30/kWh, depending on the type of energy. All calculations are uncertain and the results should therefore be treated with great caution.

The combined effect of "current instruments" is that carbon dioxide emissions in 2010 are expected to be about 10,000 ktonnes lower than they would be using "1990 instruments". Even "1990 instruments" clearly act as a curb on the use of fossil fuels.

The conclusion from the evaluation of the effects of economic instruments on the energy system is that

- The use of biomass fuels is being greatly encouraged by "current instruments". Most of the increase is occurring in the district heating sector.
- The use of biomass fuels also increases in the "1990 instruments" scenario, but at a much slower rate. The differences between the scenarios are most evident in district heating production. More than half of district heating production in 2010 will derive from biomass fuel-fired combined heating and power plants under the "current instruments" scenario. Most of the rest will come from biomass fuel-based hot water production.
- Electricity generation from biomass fuel-fired combined heating and power plants, wind power and small-scale hydropower will be greater and will be introduced sooner using current instruments, thanks to the subsidy of SEK 0.15/kWh. Wind power would not be competitive on the basis of 1990 instruments.
- Electric energy for heating and heat pumps will be used more as a result of current instruments.

The "current instruments" scenario improves the scope for use of alternative fuels owing to the increase in the tax on petrol and diesel fuels. However, the instruments are not sufficient to achieve a changeover to alternative fuels.

Measures concerning waste

The evaluation of measures relating to waste has been performed using the spreadsheet model used for the projections. Two scenarios have been produced. One describes developments resulting from instruments decided up to and including 1990, the other developments on the basis of instruments decided to the end of 1999. Some of these measures, such as the ban on landfilling burnable and organic waste, enter into force after this year, but have been decided and have the force of statute. The total effect of decided measures from 1990 and on is arrived at by comparing the two scenarios.

The measures decided in the 1990s did not begin to take effect until 1995. Under the scenario with 1990 instruments, methane emissions would remain approximately at 1995 levels until 2010, ie, around 115 ktonnes a year. Under the scenario based on measures currently decided, emissions will fall more slowly than the quantity of waste landfilled, owing to the time lag before methane is formed. By 2010, methane emissions are expected to be about 50 per cent lower than in 2000, ie, around 46 ktonnes a year. The decrease will then continue, and by 2020 emissions of methane are expected to be about 80 per cent lower than in 2000, ie around 20 ktonnes a year.

Vulnerability analysis, impact on climate and adjustment to climate change

Swedish nature and the various parts of Swedish society, including its infrastructure, are vulnerable under current variability in climatic conditions. Particular pressure and damage occur during violent storms – often in a complex of various effects. Climate change will mean changes in vulnerability and the creation of new threats. In some cases new risks and new forms of vulnerability will arise. Efforts to reduce vulnerability and risks must take account of changes occurring by virtue of changes in society and those expected as a result of climate change.

The global warming trend observed in the twentieth century has also been evident in Sweden. It has become warmer and wetter here over the last 140 years. The temperature rise is most marked in spring. Precipitation has increased at all times of year except summer, which does not display any clear trend. With regard to extremes of weather (cold, heat, heavy precipitation during a single day, storms), there might be said to be a

tendency towards more heat records and fewer cold records in recent decades, although it is difficult to see any other lasting changes.

The vulnerability analysis is based on the SWECLIM research programme climate scenarios, which describe what the climate may be like in a hundred years' time. On average, the Nordic climate is expected to change more than the global climate. It is estimated that a global temperature increase of 2.6°C will raise the annual mean temperature in Sweden by approximately 4°C, with a greater increase in winter than summer.

The relative lengths of the seasons will then change, the result being much shorter winters. The surface temperature of the Baltic Sea is expected to rise by 2 – 3°C. Temperature extremes will also be affected. Extremely high temperatures are expected to rise as much as the mean summer temperature; extremely low temperatures are expected to rise much more than the rise in the mean winter temperature. The hydrological cycle is expected to become more intensive. Precipitation and water supply are expected to increase in many parts of the country: 10 – 20 per cent as an annual mean figure, more in the autumn. The rise in the mean temperature will cause greater evaporation from soil and water. Some parts of southern Sweden will suffer from water shortages, particularly in summer. However, there is much doubt in the climate change scenarios and also about the effects that may arise. In some areas there is a lack of basic knowledge about the significance of climate in terms of effects and risks.

Effects and vulnerability in the natural environment, and in agriculture and forestry:

- There will be marked effects on hydrological cycles. Climate change resulting in higher precipitation and temperatures as shown in the SWECLIM scenarios will increase water flow in the north of the country, but will result in more variable conditions in the south. There will also be a general effect on seasonal distribution, with more water flow in winter and an earlier but less dramatic spring flood than at present. Water flow may be more extreme in autumn than it is today. Control of flow and water levels may mitigate the adverse effects of high flow rates and high water levels.
- Winter snow cover is expected to be less extensive and last for a shorter period. On average, southern Sweden will not have a lasting snow cover. Ice in the Baltic will be less extensive and, on average, will only occur in the Bothnian Bay and parts of the Bothnian Sea.
- It is estimated that climate change according to the SWECLIM scenario will increase forest growth and hence conditions for forestry and agriculture (new crops as well as increased growth). But sensitivity and vulnerability will increase somewhat because many pests and diseases are currently kept in check by our climate.
- The Baltic Sea may be greatly affected, but for much of the region we lack knowledge of the fundamental effects of climatic conditions. Changes in temperature have a direct effect on various species, as well as on ice conditions. Increased precipitation in the Baltic drainage basin is expected to increase the influx of fresh water, which may cause the Baltic to become appreciably less saline. However, the key to the future salinity trend is the magnitude of salt water intrusion from the North Sea. An increase in drainage into the Baltic is also expected to bring with it more nutrients, particularly in connection with autumn rain. These changes might cause freshwater species of fish (perch, pike, pike-perch and carp) to thrive at the expense of marine species such as cod. There is a risk of non-native species spreading into the Baltic. The dynamics governing algal blooms in the Baltic may also be affected.
- Lake fauna is expected to change in favour of species tolerant of higher temperatures (perch, pike, carpinids). Other species typical of colder water (cisco and other salmonids) will suffer and may disappear from shallow lakes and watercourses in southern Sweden.
- It is thought that a change in temperature will allow a number of southern species to become established in terrestrial ecosystems, but there are also a number of obstacles to migration (the Baltic Sea and the agricultural region of southern Sweden). Some resident species of southern origin currently under threat may do better in a warmer climate. Other, more northern species and ecotypes may suffer greatly owing to a combination of warmer climate, increased nitrogen leaching and the current high levels of nitrogen deposition. There is a very great risk in montane regions that arctic-alpine species will lose out to species favoured by warmer, more nitrogenous conditions. Valuable shore biotopes and wetlands are also at risk.
- Endangered, vulnerable and care-demanding terrestrial species are threatened by climate change if the geographical continuity of their habitat (corridors – microenvironments) cannot be maintained because these species have a relict distribution confined to small, sporadically occurring habitats.
- Wetlands play an important part in the global carbon cycle and make up a large proportion of the surface area of Sweden. Their future role in the global eco-cycle is ultimately a question of the hydrological status of these wetlands. However, the tools currently available are not accurate enough to be able to quantify this status with precision. Wetlands over much of Sweden can continue to absorb carbon dioxide from the atmosphere. The effects of climate change on the biodiversity of wetland areas are little known.
- Sudden changes and surprises cannot be ruled out.

Effects and vulnerability in relation to society, infrastructure and health:

- The risk of erosion, land slip and collapse increases with the amount of water in circulation and threatens infrastructure such as roads, embankments, bridges, buildings, dams, sewers and water supply systems.
- Society needs a good capability to take action in emergencies to mitigate the consequences of future extreme weather phenomena. Strong winds, storms and hurricanes, heavy rain, snow, icing and salt coating are the factors causing most damage to infrastructure. Weather of this kind often strikes across large regions, causing a number of effects at the same time. Particularly serious consequences arise when electricity supply is cut off, since society relies on a constant supply of electric power. To some extent, sensitivity and vulnerability can be reduced by strategic development of secure electricity supply and reserve capacity in the event of power cuts.
- Rising lake temperature may have serious effects on drinking water quality in terms of flavour, odour and colour. There will be a greater risk of infectious diseases and toxins spreading if flooding upstream flushes pollutants into lakes and watercourses used for drinking water supply. Water supply infrastructure has a very long life and is sensitive to climate change. The south and south-east of the country are particularly vulnerable.
- Climate change resulting in milder winters and longer spring and autumn seasons may assist the spread of infectious diseases. Carriers of infection such as rats, certain insects and tics are favoured by a milder climate, which will increase the risk of diseases such as TBE (tic-borne encephalitis), borrelia, certain forms of diarrhoea and diseases carried by mosquitoes being spread. A rise in temperature may also lead to an increased risk of infections caught from drinking water. There is expected to be a shift in the seasonal occurrence of pollen allergies and asthma. The severity of attacks may also increase. The lower frequency of periods of extreme cold will result in fewer cold-related illnesses and injuries.

The effects of climate change in the world around us may change conditions and thereby make it more difficult to achieve sustainable use of natural resources, such as agriculture and forestry in other countries. This may also put pressure on Sweden.

Financial support and technology transfer

Swedish development assistance is intended to create the right conditions for sustainable development in recipient countries. This will alleviate poverty in developing countries and help to achieve peace, democracy and sustainable use of natural resources. Compared with other OECD countries, Sweden gives a high
proportion of its gross national income (GNI) in foreign aid. Foreign aid during the period 1997 – 2000 was 0.7 per cent of GNI, a sum totalling almost SEK 52 billion.

Sweden's new and future contributions to aid development in developing countries under the Climate Convention are mainly made via the Global Environment Facility (GEF). The amount committed for the period 1998 to 2001 is SEK 448 million. Additional funding (the Special Environmental Appropriation) totalling approximately SEK 750 million (1997 – 2000) has been earmarked for the promotion of the environmental dimension in foreign aid.

The main aim of Swedish development assistance is to help fight poverty, and the vast majority of "programme countries" are those with low or very low per capita GDP. Many are among the least developed countries in the world and many are particularly vulnerable to climate change. Swedish aid given to the least developed nations in 1998 and 1999 comprised just over 25 per cent of total Swedish aid given for development assistance. Around one third of Swedish foreign aid goes via multilateral organisations. Total payments to multilateral institutions, including the Global Environment Facility, were SEK 13,184 million during the period 1997 – 1999. Important multilateral organisations are the World Bank, the regional development banks and funds and the UN environment programme. Sweden also makes contributions to a number of other organisations, including the World Conservation Union (IUCN), the World Resources Institute (WRI) and the International Institute for Environment and Development (IIED).

Swedish bilateral development work is largely conducted by the Swedish International Development Agency (Sida). Some 120 countries are involved, including cooperation with central and eastern Europe. Most resources are deployed to help the twenty countries with which Sweden is engaged in far-reaching long-term cooperation. Programmes and projects are based on the changes the recipients themselves wish to bring about and are prepared to devote resources to. Development assistance is also carried out by Swedish NGOs.

Environmental issues are an integral component of Swedish foreign aid. Among other things, environmental impact assessments are to be made of all joint projects. Priority areas for foreign aid are sustainable agriculture and forestry and land management, the marine environ-

ment, the urban environment, sustainable energy and water resources. Methods given particular emphasis are skills development and cooperation with NGOs.

All Swedish aid programmes and projects have been classified according to their environmental relevance using the OECD Development Assistance Committee (DAC) system. Programmes and projects in which the environment has been a main or secondary objective account for approximately 50 per cent of total aid.

Sweden funds development assistance in various sectors of significance for the reduction of emissions of greenhouse gases and to increase carbon dioxide sinks. Areas given particular priority are energy, transport, trade and industry, waste management, air pollution, forestry and agriculture. Most of these efforts are not primarily intended to reduce emissions of greenhouse gases, but they do have direct or indirect relevance to the climate issue. Additionally, a portion of foreign aid is allocated to developing skills and administrative competence in recipient countries, often integrated with projects funding "hard technology".

Total bilateral development assistance with some bearing on the Climate Convention was SEK 3.59 billion during 1997 - 2000, including credits of SEK 166 million. Just over 50 per cent is development assistance linked to measures to reduce emissions or increase sinks of greenhouse gases. The other 50 per cent goes on projects involving adjustment, particularly financial support for skills and capacity development.

The Swedish Trade Council, whose task is to promote Swedish exports, has received government funding (SEK 12 million in 1999) to design a special programme for the export of goods and services involving the use of environmental technology of importance to work on the climate change issue in other countries. The Swedish Export Credits Guarantee Board promotes Swedish exports by providing guarantees protecting against the risk of losses on transactions in other countries. Its sphere of operation spans the globe, including many developing countries (non-Annex I-countries). The Board has recently adopted an environmental policy that includes guidelines to ensure that the environmental dimension is taken into account when credits are issued. One requirement, for example, is that an EIA should be performed for major projects.

Research and systematic observation

Sweden accounts for approximately one per cent of global research and development. Almost four per cent of GDP went to fund research in 1999, ie, SEK 75,800 million. Most of this takes place in the private sector, which accounts for about 68 per cent of funding.

Public sector funding amounts to about 26 per cent. The aim of government research policy is for Sweden to be a leading research nation. Substantial efforts and further investment by government and industry alike are needed to achieve this objective.

Research on climate is being carried out in the fields of basic research as well as applied and measures-related research. Swedish research was reorganised 1 January 2001. The purpose was to gather forces in important areas of research, promote cooperation between various fields of research and improve the dissemination of information on research and research findings. The new Swedish way of organising research and development, resulting from the amalgamation of a number of research funding agencies, will help to achieve efficient coordination in the design of research programmes and the allocation of research funding. The newly created research council FORMAS has coordinating responsibility for research on climate. The National Energy Administration is responsible for coordinating measures-related research and development in the energy field.

Government-funded research is mainly conducted at universities and colleges. Some research is conducted by public authorities and independent research institutes, wholly or partially in receipt of government funding.

Distinguishing between climate research and other research is no easy matter. The inventory presented here is based on assessments made by funding bodies as well as scientists. Total government funding of climate-related research in Sweden during the period 1998 – 2001 was approximately SEK 2 billion, of which approx. SEK 1.5 billion was investment in the long-term adjustment programme.

The emphasis and scope of climate-related research during 1998 - 2001 is:

- Climate processes and climate systems, including paleo-climatological studies: SEK 102 million
- Modelling and projections, including general circulation models: SEK 74 million
- Research into the environmental impact of climate change: SEK 209 million
- Socio-economic analyses, including analyses both of effects of climate change and of possible measures: SEK 11 million
- Research and development to reduce emissions and increase sinks of greenhouse gases, and for adjustment (in addition to funds allocated under the long-term adjustment programme for energy): SEK 210 million.

In addition, trade and industry spend a great deal of money on development of technology, eg, treatment technology for burning and use of new fuels.

Responsibility for systematic monitoring and observation is shared by a number of agencies in Sweden. The Swedish Environmental Protection Agency has overall responsibility for environmental monitoring. The main responsibility of the Swedish Meteorological and Hydrological Institute (SMHI) is to supply background material for planning and decision making by those dependent on weather and water. A number of other authorities also have some responsibility for systematic observation of other environmental parameters relating to climate. The Swedish National Space Board is charged with developing satellite systems for systematic observation and research using remote analysis. The National Land Survey is responsible for systematic observation of the land mass.

The Swedish Environmental Protection Agency has overall coordinating responsibility for environmental monitoring in Sweden. This covers national and regional sub-programmes.

Large quantities of data are also generated by municipalities, non-profit-making organisations and other activities at the county administrative level. Only a small proportion of all the environmental monitoring taking place is directly related to climate.

SMHI is charged with the task of supplying the national and international community with meteorological, hydrological and oceanographic data and related products. SMHI also has long-term responsibility for the establishment and operation of the national databases for meteorological, hydrological and oceanographic data, and is the national expert body on climate issues. It produces a great deal of data, products and services, including the gathering and storage of climatic observations at ground level and from satellites. SMHI's climate operations follow the guidelines developed by the World Meteorological Organisation (WMO).

Sweden participates in the Global Climate Observing System (GCOS) and has a long tradition of recording weather, climate and other atmospheric observations, such as visibility and the occurrence of substances affecting climate. Six terrestrial stations have been appointed to record atmospheric observations within GCOS (GSN), and Sweden report metadata and other information from them in accordance with WMO guidelines.

An important part of the WMO World Weather Watch programme is the operational meteorological satellite system. Sweden is one of several European parties involved in the development and operation of meteorological satellites (EUMETSAT).

As well as making meteorological and aerological observations, Sweden takes part in systematic observations of climate-related parameters in the fields of hydrology, oceanography, ground characteristics and land mass. The joint programme for gathering oceanographic data for the Baltic Sea and North Sea operates within the framework of the HELCOM and OSPAR marine conventions.

Sweden only gives limited support for the express purpose of establishing and maintaining monitoring systems for reporting under the Climate Convention. Via Sida, Sweden provides fairly extensive assistance for the development of institutions and administration in the environmental field. This is indirectly relevant to the environment.

Education and public information

Environmental issues have been fairly well to the fore in public debate in Sweden and among Swedes in general since the late 1960s. Since then, Swedish people have learnt more about the environment and become more aware of environmental issues. So nowadays most people are aware of the link between a rise in temperature and climate change. They also think it is necessary to use less fossil fuels than oil and petrol. Public awareness and knowledge about the climate issue have increased as a result of the attention these topics have attracted by way of information campaigns run by various organisations and public authorities and via the press, TV and radio.

Responsibility for raising public awareness and providing information on the climate issue is shared by a large number of agencies such as the Swedish Environmental Protection Agency, SMHI, the National Energy Administration, the National Road Administration, the Swedish Consumer Agency and the National Institute for Ecological Sustainability.

NGOs such as the Swedish Society for Nature Conservation, the World Wildlife Fund (WWF) and Ekocentrum also play an important part in raising public awareness.

The government pursues an active consumer policy in the environmental field with a view to reducing household emissions, energy consumption and waste. Goods, transport, housing and social planning are all involved. Important aims of this work are to improve public awareness of the relationship between consumption and the environment, to give information about the environmental impact and energy consumption of products, and to encourage a change in patterns of behaviour among consumers.

On the government's instructions, the Swedish EPA has drawn up a draft national strategy for the dissemination of information and know-how about Agenda 21 and sustainable development. The aim has been to develop a strategy capable of raising people's awareness about their own lifestyles and thereby to help meet

the aims of Agenda 21. Agenda 21 has met with a very positive response in Sweden. Most municipalities have been, or are, engaged in the process of formulating local Agenda 21 programmes. A study in 1999 revealed that almost all municipalities (97 per cent) had taken concrete action to involve the local inhabitants. Common methods used to get the message across to the public were dissemination of information materials, exhibitions, marketing events and advertising or articles in the local press.

In the field of education, the government decides the national curriculum for schools using clearly defined management by objectives. The environmental dimension is a constantly growing feature of the Swedish compulsory school system. The entire environmental field is covered, the explicit aim being to ensure that everyone understands the environmental perspective and to affect lifestyles. The climate issue is part of this process. Trade and industry also play a part in communicating information about the environment to schools.

The curricula for universities and colleges do not contain the same requirements in relation to general environmental knowledge as do the curricula for compulsory schools. But colleges and universities are included in the extensive efforts being made by government agencies to introduce environmental management systems. These focus on important environmental aspects, such as resource utilisation and energy use. At present, 25 universities and colleges run courses focusing on the environment. The climate issue is a natural feature of these courses, whatever their environmental angle.

Several climate campaigns have been conducted in recent years. The "Klimat.nu" campaign was intended to show that carbon dioxide emissions can be quickly reduced if firm action is taken. The objective is to cut Swedish emissions by two per cent in two years. In autumn 1997 the government appointed the Delegation for Energy Supply in Southern Sweden (DESS), whose task is to develop energy supply in that region. SparKraft Effektivare energianvändning ("Save Power - More Efficient Energy Use") – a DESS initiative, was started in 1999. It is a four-year information project aimed at the industrial, real property and household sectors. Its aim is to spread information and know-how about energy in general, and substitutes for electricity in particular. The idea is to support energy conservation and limit the use of fossil fuels by changing over to renewable energy sources. This is to be achieved by way of various pilot projects, public education and energy information.

Following the climate negotiations in Kyoto, the Federation of Swedish Industry has been running a number of information campaigns aimed at member companies as well as politicians, decision makers, journalists and schools. The Climate Book, published in 1999, describes industry's basic view of the climate issue.

The Swedish Society for Nature Conservation ran a project involving five "challenger" municipalities during 1998 - 2000. Participating municipalities set targets and programmes so that use of fossil fuels will eventually fall to a minimum. Each municipality has adopted reduction targets for carbon dioxide emissions of 50 per cent by 2020 or 25 per cent by 2010, subject to some local variations. The inhabitants of these municipalities have been informed of these commitments in various ways.

Government support for local investment programmes has two aims: (i) to markedly increase the rate at which Sweden is converting to an ecologically sustainable society; and (ii) to help create jobs. Some of this support also takes the form of "supportive measures", including information campaigns on climate.