

3 Objectives, measures and instruments affecting emissions and removals of greenhouse gases

This chapter describes objectives, measures and instruments influencing emissions and removals of greenhouse gases. The principal purpose of some of these objectives, measures and instruments has been to reduce emissions of greenhouse gases. Others, introduced for other reasons, have had a secondary impact on greenhouse gas flows. Since the Climate Convention guidelines for the Third National Communication¹ focus on objectives, measures and instruments decided or used in the 1990s, this report does not contain any proposed new measures except for those considered to be in an advanced planning stage, eg, following a parliamentary decision in principle.

3.1 Swedish climate policy

Swedish climate policy is influenced by the fact that Sweden's scope for reducing its greenhouse emissions differs from that in many other countries. For example, the substantial emission reductions achieved since the early 1970s often make further reductions more expensive in Sweden than elsewhere.

Swedish committees and commissions of enquiry and our widespread use of the consultative process play an important part in preparing reforms and examining the consequences of various political courses of action. The consultative process ensures that government proposals gain broad support throughout society. Examples of public commissions playing an important role in formulating climate policy in the 1990s are

- The Energy Commission.² This was set up in 1994 to examine the ongoing energy policy programmes for adjustment and development of the energy system, and to analyse the need for change and additional measures.
- The Green Tax Commission³ was created in 1994 and was made up of members of parliament, whose task was to analyse the impact of tax legislation on environmental behaviour from a socio-economic perspective, and to use that analysis as a basis for examining the scope for incorporating the environmental dimension in Swedish tax legislation.
- The Committee on Environmental Objectives⁴ was appointed in 1998; it was made up of members of parliament.

- The Government Commission for Measures Against Climate Change⁵ was established in 1998 as a parliamentary commission charged with the task of presenting a proposed Swedish strategy and action programme to control and reduce emissions of carbon dioxide and certain other greenhouse gases.
- The Commission of Enquiry to examine the feasibility of making use of the flexible mechanisms of the Kyoto Protocol in Sweden was set up in 1998 as an expert commission.

The first climate policy objective in Sweden was formulated in 1988⁶, when parliament decided that the government should ascertain the impact of energy consumption on carbon dioxide concentrations in the atmosphere and develop a programme for the emissions nature was capable of withstanding. A subsidiary national objective was that "carbon dioxide emissions should not increase above their present level". Parliament amended the 1988 climate policy objective in 1991. The new objective was that emissions of all greenhouse gases should be limited in all sectors of society.⁷ The 1991 objective involved an action-oriented coherent strategy for reducing impact on climate, based on administrative and economic instruments. It was also stated that national efforts in this area should enable Sweden, together with other west European countries, to assume a pro-active role in the international arena.

The present Swedish climate strategy is largely based on the climate policy decision of 1993⁸ and the energy policy guidelines laid down in 1997.⁹ The 1993 climate policy decision was adopted as a national strategy for complying with the Climate Convention by stabilising emissions of carbon dioxide from the burning of fossil fuels in 2000 at their level in 1990 and then reducing them. A cost-effective Swedish climate policy was also advocated. In this way, economic instruments such as energy and carbon dioxide taxes have come to play an important part in national climate policy.

¹ UNFCCC guidelines on reporting and review, UNFCCC/CP/1999/7, pp 83 – 86.

² Directive 1994:67

³ Directive 1994:11

⁴ Directive 1998:45

⁵ Directive 1998:40

⁶ Gov. Bill 1987/88:85 and 1987/88:90

⁷ Gov. Bill 1990/91:90, p 18, and Gov. Bill 1990/91:88

⁸ Gov. Bill 1992/93:179

⁹ Gov. Bill 1996/97:84

Sweden has also initiated joint projects with the Baltic States, Poland and Russia to promote greater energy efficiency and increased use of renewable energy sources.

An additional emission target was set in 1995, when parliament decided that emissions of HFCs, PFCs and related gases, expressed as carbon dioxide equivalent emissions, should be limited by 2000 to a level representing no more than 2 per cent of Sweden's carbon dioxide emissions in 1990.¹⁰

The 1997 energy policy guidelines contain a strategy for reducing the impact of energy consumption and energy generation on climate. The main features are that efforts to combat the greenhouse effect must be made globally and reflect a long-term approach. It was also said that national emissions of carbon dioxide should be limited as far as possible, taking account of Swedish competitiveness, employment and welfare, and that Sweden should press internationally for emission reductions from heavy industry as well. Emissions should ultimately converge towards a common international target, expressed as emissions per inhabitant.¹¹ A programme was also initiated to develop an ecologically and economically sustainable energy system. The programme has two elements: a long-term component, involving continuing research and technological development, and a short-term component, designed to replace the shortfall of electricity following closure of the Barsebäck nuclear power plant.

Parliament laid down fifteen environmental objectives in 1999.¹² These form the basis for future Swedish environmental policy. One objective, entitled "Reduced climate impact", confirms the climate policy objectives adopted earlier:

"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."

The environmental quality objective, described in the Swedish Environmental Objectives Bill¹³ and confirmed in a new bill in April 2001¹⁴, is to concentrate on taking action to ensure that the concentration of carbon dioxide in the atmosphere stabilises at a level lower than 550 ppm, and that concentrations of other greenhouse gases in the atmosphere do not increase. It has further been established that achievement of this objective is heavily dependent on action taken in

other countries and that responsibility for implementing the necessary measures rests with a number of Swedish agencies at the central, regional and local level. The government intends to present a bill in autumn 2001, which will clarify the strategy, measures and instruments to be used to achieve the objective.

Swedish climate policy is increasingly influenced by developments in the EU. The EU is committed under the Kyoto Protocol to reducing its total emissions by at least 8 per cent between 1990 and 2008 – 2012. The contribution to this reduction to be made by each member state must be established in order for the EU and the member states to ratify the Kyoto Protocol. The respective burdens were decided in the form of "Council Conclusions" at the meeting of EU environment ministers in June 1998. For Sweden's part, an emission level in 2008 – 2012 equivalent to 104 per cent of the level in 1990 was stipulated for the six greenhouse gases governed by the Kyoto Protocol. In addition to this obligation imposed as to Sweden's share of the EU Kyoto commitment, EU common climate policy also influences the form taken by Swedish measures. Important areas are creation of a system for tradable permits, to facilitate the use of renewable energy sources. In the light of this, parliament passed a bill in 2000¹⁵ containing guidelines for a coherent system to promote renewable energy production, intended to come into force in January 2003. The system is to be based on trade in certificates, combined with an obligation when supplying or purchasing electricity to include a certain percentage of renewable energy meeting certain environmental standards.

3.1.1 Description of areas of policy in which there are objectives, measures and instruments capable of influencing emissions or removals of greenhouse gases

Energy policy

Energy policy covers issues relating to supply, distribution and use of energy, energy research, safety and readiness in case of emergencies in the energy field. Energy policy breaks down into two areas: energy market policy and policy for a sustainable energy sys-

¹⁰ Gov. Bill 1993/94:111

¹¹ Gov. Bill 1996/97:84, p 74

¹² Gov. Bill 1997/98:145

¹³ *ibid.*

¹⁴ Gov. Bill 2000/01:130. Swedish environmental objectives – subsidiary objectives and strategies

¹⁵ Gov. Bill 1999/2000:134 on the economic premises for electricity generation from renewable sources

tem. The latter area includes programmes for greater energy efficiency, investments in renewable energy and continued research and development in the energy field. Current energy policy dates from 1997.¹⁶

The aim of Swedish energy policy is to assure a supply of electricity and other forms of energy in the near and long term on terms that are competitive in relation to the world around us. Energy policy is intended to result in efficient use of energy and cost-effective Swedish energy supply, with little effect on health, environment and climate, and to facilitate a changeover to an ecologically sustainable society. The energy policy decision includes a specific strategy for reducing the impact on climate of the energy sector and for efforts in relation to bilateral and multilateral cooperation on joint implementation under the Climate Convention. Energy policy is also intended to create stable conditions for competitive trade and industry, to renew and develop Swedish industry and broader cooperation on energy, environment and climate in the Baltic region.¹⁷ The parliamentary decision of 1997 laid down the guidelines for Swedish energy policy.

To all intents and purposes, the 1997 decision confirmed that in 1991, although an additional feature was the shutdown of the two nuclear reactors at Barsebäck. But 2010 is no longer given as the date by which all reactors are to have been shut down. Instead, the reactors are to be decommissioned at a rate ensuring that adverse effects do not occur in terms of the electricity price, availability of electricity to industry, the balance between output and demand, or the environment and climate. Parliament subsequently enacted a new law on nuclear phase-out.

Energy markets have been gradually deregulated, and trade in electricity in northern Europe occurs over national boundaries in an efficient market. There is now therefore less need to be self-sufficient in electricity. Deregulation also means that national policy cannot differ too much from policies in other countries if market distortions are to be avoided.

Transport policy

Transport policy covers maintenance of roads and railways, road traffic, rail transport, shipping, air traffic and sectoral research.¹⁸ The parliamentary transport decision adopted in the spring of 1998 laid down the present principles and overall aims of transport policy in line with the government transport policy bill.¹⁹ The objectives are framed as a single overall objective with five subsidiary objectives for various areas. The overall objective of transport policy is to assure a socio-economically effective and sustainable supply of transport for private individuals and trade and

industry throughout the country. In addition, there are five long-term subsidiary objectives, as follows (in no particular order):

- An accessible transport system – The transport must be designed to meet the transport needs of private individuals and trade and industry.
- High quality transport – The design and function of the transport system must provide high quality transport for trade and industry.
- Safe traffic – the long-term objective of traffic safety is that no-one should be killed or seriously injured in traffic accidents. The design and function of the traffic system must be adapted to this end.
- A good environment – The design and function of the transport system must be adapted to meet the need for a good quality and healthy environment for everyone, while protecting the natural and the man-made environment from damage. Efficient management of land, water, energy and other natural resources must be promoted.
- Positive regional development – The transport system must promote positive regional development by (i) evening out differences in the potential for development in different parts of the country; and (ii) counteracting the drawbacks of long transport distances.

Interim objectives have been set, particularly under the subsidiary objectives for transport quality, traffic safety and environment. The interim objectives are to be achieved by a certain date and are specified, so it is possible to ascertain whether or not they have been achieved. The "good environment" objective is specified in relation to emissions of greenhouse gases (carbon dioxide) and air pollutants (nitrogen oxides, sulphur dioxide, VOCs), impact of air pollutants on health, noise, adjustment to achieve sustainability, the natural and man-made environment. The interim objective for emissions of greenhouse gases (carbon dioxide) require emissions of carbon dioxide to be stabilised at their 1990 level by 2010. The indications are that the stated interim objective for the impact of transport on climate will not be met unless further steps are taken before 2010.

Housing policy and social planning policy

The construction, use and management of buildings accounts for a substantial proportion of society's overall consumption of resources, eg, energy con-

¹⁶ Gov. Bill 1997/97:84. A Sustainable Energy Supply

¹⁷ *ibid.*

¹⁸ Draft Finance Bill 2001, 2000/01:1

¹⁹ Gov. Bill 1997/98:56. Transport policy for sustainable development

sumption. Housing, building and planning legislation has progressively incorporated requirements reflecting greater concern for the environment. The same applies to other legislation governing activities affecting the use of land, water and other natural resources.

Housing policy covers issues concerning state subsidies for the housing sector, housing supply, social aspects of housing, social planning and housing-related issues concerning ecology and the environment.²⁰ The aim of housing policy is that everyone should be able to live in good quality housing at a reasonable cost and in a stimulating and safe environment within an ecologically sustainable framework. The home environment should help to achieve equal, civilised living conditions and, in particular, offer a good environment in which children and young people can grow up.²¹ Ecological sustainability should form the basis for planning and construction.

Ecologically sustainable development is an important objective of all social planning and all construction. The process of adjustment throughout society to achieve ecological sustainability requires that the construction process, buildings and constructions, the transport system and the rest of the infrastructure are made environmentally compatible and make better use of resources than is currently the case. One of the environmental quality objectives – "a good urban environment" – means that towns, cities, urban areas and other built-up areas should offer a good quality and healthy living environment and help to achieve a good regional and global environment. The objective also covers the indoor environment.²² The government bill entitled "Swedish environmental objectives – subsidiary objectives and strategies"²³ proposes the following subsidiary objective under the "good urban environment" objective: By 2010 spatial planning and infrastructure construction must be founded on programmes and strategies for:

- ways of achieving a varied range of housing forms, workplaces, services and culture so as to reduce car use and increase the scope for environmentally compatible and resource-efficient transport;
- ways of achieving greater energy efficiency, making use of renewable energy resources and promoting development of production facilities for district heating, solar energy and wind power;
- reducing the burden placed on the environment by energy use in homes and commercial/industrial premises, so that it is lower in 2010 than it was in 1995. One way of achieving this is by making overall energy use more efficient so that it will ultimately decrease.

The economic climate varied in the 1990s, moving from a large number of new housing starts in the early 1990s to an unprecedentedly low level in the middle of that decade. The government now has four priority areas within the framework of the overall objective of housing policy:

- Housing supply, particularly removal of obstacles to, and stimulation of, housing construction in expansive regions.
- Development of public housing companies.
- Lower construction and housing costs.
- Increase ecological sustainability in society.

Achievement of the environmental quality objectives will require more joint action on the central government, regional and municipal level to make the national objectives more tangible and ensure that steps are taken to achieve them in regional and local planning.

Trade and industry policy

As well as trade and industry matters, this policy area covers some technical research and development and its infrastructure, competition issues and regional trade and industry policy.²⁴

Knowledge-intensive production of goods and services makes up a growing proportion of total production. For Sweden's part, this means that there is no longer any point in having a separate industry policy.

The aim of trade and industry policy is to promote sustainable economic growth and higher employment provided by a growing number of successful companies.²⁵

Private enterprise is central to Swedish growth and employment. The main emphasis in trade and industry policy is on general measures to provide the right business conditions and incentives. Investment in research and development is crucial to maintain a supply of know-how and competence in the sector.

Taxation policy

The aim of tax policy²⁶ is to ensure that the requisite revenues in the form of tax, customs and charges are collected fairly and cost-effectively, to achieve simplicity

²⁰ Draft Finance Bill 2001, 2000/01:1

²¹ Gov. Bill 1997/98:119, report 1997/98:BoU, rskr, 1997/98:306

²² Government communication 1999/2000:13 Sustainable Sweden – determining the effectiveness of measures to achieve ecologically sustainable development

²³ Gov. Bill 2000/01:130. Swedish environmental objectives – subsidiary objectives and strategies

²⁴ Draft Finance Bill 2001, 2000/01:1

²⁵ *ibid.*

²⁶ The policy area covers the operations of the tax administration (not including its role in relation to general elections), Swedish Customs and the Swedish Enforcement Service.

and prevent crime. The government intends to make a systematic review of the state budget so as to make it more oriented towards ecological sustainability. Environmental accounts, which are intended to create a broader understanding of the link between economics and environment, are central to these efforts.

Taxation of activities detrimental to the environment has long been seen as an effective tool for achieving sustainable development. Selective purchase taxes have long been used as an instrument of Swedish policy. Taxes on electricity and other forms of energy were introduced in the 1950s. These taxes were introduced to strengthen state finances, but were used during the oil crisis of the 1970s to encourage energy consumers to use electric energy instead of oil. Environmental policy objectives entered the scene in the 1980s. For example, petrol taxation was differentiated to favour the use of unleaded petrol over its leaded counterpart.²⁷ The environmental profile of energy taxation was further raised in conjunction with a major tax reform implemented in 1990/91. Carbon dioxide tax, sulphur tax and VAT on energy²⁸ were introduced at that time. The Swedish energy tax system is now a very important factor in limiting carbon dioxide emissions.

The total environmental tax burden is high in Sweden. Major changes were made to the system (eg, in the field of energy and transport taxation) following EU entry in 1995. The "kilometre tax" on diesel vehicles became a diesel oil tax in 1994. Diesel oil tax and petrol tax were replaced by energy tax in 1995.²⁹

The EC Mineral Oils Directive³⁰ sets minimum levels of tax on motor fuels and heating oils. Proposals for broadening the scope of the Mineral Oils Directive were presented in 1997, but the member states have not been able to agree on the issue. A common system of energy taxation in the EU has been discussed, but has not resulted in a decision. Several other EU countries have introduced or announced that they will introduce a national carbon dioxide tax.

Environmental policy, including waste policy and local initiatives

This policy area covers measures and the result of measures in relation to the environmental quality objectives and the overall objectives of policy in this area. Much is also done to further environmental interests in other policy areas.³¹

The aim of environmental policy is to pass on to the next generation a society in which the major problems in Sweden have been solved. Parliament has laid down 15 environmental quality objectives defining the situation to be achieved over a generation.³²

According to the government, Sweden must also set an example when it comes to making the adjustments

necessary to achieve ecologically sustainable development. Efforts to achieve the environmental quality objectives are to be intensified and will permeate all government policy. A greater environmental emphasis in the taxation system attained by shifting the tax emphasis in favour of environmental interests may help to realise the aims of environmental policy.

Waste policy is an integral part of environmental policy. Waste policy covers collection, transport, recycling and disposal of existing waste, including inspection and control of these operations and remediation of landfill sites. This delimitation is supplemented in certain product areas by producer responsibility, which is also intended to bring about the development of more environmentally compatible products. The environmental quality objective entitled "a good urban environment" has a subsidiary objective on waste quantities. The quantity of waste going to landfill, not including mining waste, is to be reduced by 50 per cent between 1994 and 2005, the total quantity of waste generated to remain the same. The government considers that the other steps already taken will suffice to ensure that this objective is attained.³³

Since the Environmental Code³⁴ came into force in 1999, there has been a statutory definition of waste in Sweden. Waste is any object, material or substance that is included in a waste category or that the holder disposes of, intends to dispose of, or is under an obligation to dispose of.³⁵

Sweden employs a waste management "hierarchy".³⁶ Waste management is based on the aim that generation of waste is to be avoided as far as possible and that end-of-life products should, in the first place, be re-used. Failing that, they should be recycled for the materials they contain. The third tier of the hierarchy is recycling for energy extraction; the fourth is landfill. This essentially conforms to the EU waste hierarchy.³⁷

One of the most powerful instruments of sustainable waste management is the incorporation of principles

²⁷ Government report 2000:73. Evaluation of the energy tax model proposed by the Swedish Green Tax Commission.

²⁸ National Energy Administration Report ER 13:2001

²⁹ Miljöskatter och miljöskadliga subventioner ("Environmental taxes and environmentally harmful subsidies"), Environmental Accounts Report 2000:3. Statistics Sweden

³⁰ Council Directive 92/81/EEC of 19 October 1992 on harmonising the structures for sales taxes on mineral oils.

³¹ Draft Finance Bill 2001, 2000/01:1

³² *ibid.*

³³ Gov. Bill 2000/01:130. Swedish environmental objectives – subsidiary objectives and strategies

³⁴ Swedish Code of Statutes 1998:808. Environmental Code. National preparatory works; Gov. Bill 1997/98:45, report 1997/98:JoU20, rskr. 1997/98:278

³⁵ Government communication 1998/99:63

³⁶ *ibid.*

³⁷ EC Waste Directive (75/442/EEC, Art. 3)

on sound management and ecocycles as some of the general "rules of consideration" in the Environmental Code. These rules impose a responsibility for conserving products and energy, and stipulate that the potential for reuse and recycling must always be taken into account. More stringent requirements governing landfill and the introduction of a landfill tax increase the cost of sending waste to landfill and thus encourage reuse and recycling. The EC Waste Incineration Plant Directive imposes additional requirements on these plants with regard to preventive environmental protection measures and control.³⁸

One subsidiary objective of waste policy is that methane emissions from landfill should be reduced by 30 per cent by 2000.³⁹

The government is striving to achieve an environmentally oriented product policy that will create scope for an efficient single market while assuring a high degree of protection for human health and the environment. The EU is in the process of drafting a common Integrated Product Policy. This is intended to give consumers the opportunity and encouragement to act in an environmentally friendly way. Consumer issues will have to be taken into account when systems for sorting waste at source are designed, and when improving information supplied to consumers about the results of their efforts to sort waste.⁴⁰

One central feature of local Agenda 21 projects at municipal level has been information and the use of good examples to achieve a society in which concern for the environment, conservation of natural resources, an ecocycles approach and development of a sustainable society are guiding principles. Some local Agenda 21 projects have involved distributing information to local inhabitants and businesses about waste minimisation, recycling, sorting at source and waste treatment. Agenda 21 at municipal level may ultimately reduce the quantities of waste going to landfill.

Agricultural policy

Agricultural policy is part of food policy, which also includes fisheries policy. The EU Common Agricultural Policy (CAP) falls within this area.⁴¹ The aim of Swedish food policy is to achieve ecologically, economically and socially sustainable food production. Policy should promote a broad and varied range of safe foodstuffs at reasonable prices, sustainable agricultural and food production and contribute to global food safety. Adjustments in line with principles of the market economy are an important means of achieving this objective.⁴²

Since the Second World War, Swedish agricultural policy has largely been governed by three main objectives: the production objective, the income objective,

and the efficiency objective. For a long time, the main thrust of the production objective was to achieve a high degree of self-sufficiency in food supply and was justified for reasons of national security. The income objective was that farmers should be assured a certain level of income; the efficiency objective was to bring about rationalisation of the agricultural sector by means of government subsidies. A general environmental objective was added to these three objectives in the mid-1980s.

The food policy decision of 1990 marked the beginning of the abolition of Swedish farming subsidies. The income objective was abolished as a specific aim. Import restrictions and customs were retained, but the internal regulation system began to be dismantled in 1991. An adjustment programme was intended to give farmers temporary support over a period of five years. Funds were allocated to pay compensation to farmers for landscape conservation. However, there was not time for these measures to be fully implemented, since Sweden applied for EU membership and began to harmonise its agricultural policy prior to joining.

Sweden joined the EU in 1995 and is therefore subject to the CAP. The aims of the CAP are:

- to increase agricultural productivity
- to give farmers a reasonable standard of living
- to stabilise the markets
- to safeguard food supply
- to supply food to consumers at reasonable prices

Forest policy

The forest policy decision of 1993 established that Swedish forests are a national asset, to be managed so as to provide a sustainable high yield and conserve biodiversity.⁴³ These aims remain.⁴⁴

The forest policy established in 1993 is based on the decisions made at the UN Conference on Environment and Development in Rio de Janeiro in 1992, since manifested in "Agenda 21" and "the Forest Principles". One fundamental principle is that forests and forested land should be managed in a

³⁸ Waste Incineration Directive 2000/76/EC

³⁹ Gov. Bill 1992/93:179 on "Measures to prevent impact on climate". Achievement of this objective has not been evaluated.

⁴⁰ Government communication 1999/2000:114

⁴¹ The account does not include measures under Council Directive EC/1257/1999 of 17 May 1999 on support from the European Development and Guarantee Fund for Agriculture for development of rural areas, and on amendments to, and repeal of, certain regulations.

⁴² Draft Finance Bill 2001, 2000/01:1

⁴³ Swedish Code of Statutes 1993:533 Act Amending the Silvicultural Act (Swedish Code of Statutes 1979:429). Gov. Bill 1992/93:226, report 1992/93:JoU15, rskr. 1992/93:252

⁴⁴ Gov. Bill 1997/98:158 Evaluating achievement of forest policy

sustainable way to meet the social, economic, ecological, cultural and spiritual needs of present and future generations.

The production objective for forestry laid down by parliament is that forests and forested land is to be used efficiently and responsibly so as to provide sustainable high yield. Forest production is to be organised so as to allow free choice of the way forest products are used.

The environmental objective of forestry is to conserve the natural productive capacity of forested land. The biological diversity and genetic variation of forests are to be safeguarded. Forests are to be used in such a way that their natural flora and fauna are able to survive under natural conditions and in viable populations. Endangered species and ecotypes are to be protected. Cultural heritage in forested areas, and the aesthetic and social value of forests are to be protected.⁴⁵

3.2 Measures and instruments limiting emissions or increasing removals of greenhouse gases

3.2.1 Measures and instruments relating to energy supply and energy use

This section describes measures and instruments in the policy areas of taxation, energy, transport and housing (including social planning) that significantly influence energy consumption and emissions of greenhouse gases. These four sections together describe the policy impacting on emissions in what Chapter 2 calls "the energy sector". Measures and instruments in other policy areas (eg, forest policy), described later in this chapter, also have some bearing on energy use, although the link is a weaker one.

Responsibility for implementing measures to reduce greenhouse gas emissions rests with a number of agencies and ministries. Moreover, nowadays it is the task of the sectoral authorities to pursue environmental issues. The energy sector cuts across the housing, transport and industrial sectors and climate issues must therefore be regarded as "supra-sectoral", involving the need of a great degree of coordination.

Impact of emission-reducing measures and instruments relating to energy supply and energy use (the energy sector)

The measures implemented by Sweden in the energy sector often have other purposes, such as to assure

energy supply. However, these programmes have also played an important part in limiting carbon dioxide emissions from the energy sector. As a result of the policy it has pursued, Sweden's carbon dioxide emissions in the late 1990s were more or less the same as they were in 1990.⁴⁶ Emissions of greenhouse gases⁴⁷ from the energy sector only increased from 54,269 to 54,727 ktonnes carbon dioxide equivalent emissions between 1990 and 1999 (ie, by just under 1 per cent).

Energy and carbon dioxide taxes are the most effective instruments for reducing and limiting carbon dioxide emissions. These taxes are expected to have reduced carbon dioxide emissions by at least 10,000 ktonnes by 2010.⁴⁸ They have also yielded other environmental benefits, eg, because sulphur emissions to air have decreased as a result of increased use of biomass fuels. A more detailed analysis of the combined effects of the most important instruments is presented in Chapter 4.

In a number of instances, the aim of the measures taken has been to reduce electricity consumption or to increase electricity production from renewable sources. The type of electricity production replaced by action taken under the energy policy programme may be discussed, since the Swedish electricity market is integrated with those in Norway, Finland and Denmark, and direct transfers are possible to Germany, Denmark and Poland. This chapter presents estimates of the size of emission reductions resulting from various measures. Unless otherwise stated, the calculations made in respect of measures that have reduced electricity consumption or increased production of renewable electric energy relate to two different cases. In the first case, it is assumed that electric energy would otherwise have been generated at new gas combination power plants (in Sweden or abroad). In the second case, it is assumed that production would instead have taken place at existing coalfired condensing power plants (outside Sweden). The estimated emission reductions may therefore also relate to countries other than Sweden.

The energy policy programme contains measures to reduce the use of electricity for heating. Grants are available for property conversions and connection to district heating or individual heating. The grants system has recently been revised, since evaluations of measures in the field of energy policy quickly showed that the

⁴⁵ Gov. Bill 1997/87 158 Evaluating achievement of forest policy

⁴⁶ UNFCCC, Article 4.2 a and b

⁴⁷ Revised date, November 2001. See www.environ.se

⁴⁸ The calculation has been made using the MARKAL model. This model optimises the cost of the energy system and has limited capacity for estimating the effect of changes in energy taxes on income.

Table 3.1

Measures of performance for government grants available under the 1997 energy policy programme, measured as kg carbon dioxide per krona of grant

Investment programme

Efficiency measured as kg carbon dioxide per krona of grant (kg/SEK)

Conversion from electric heating to individual heating	0.2
Conversion from electric heating to district heating	0.4
Reduced power requirement	0.1
Investment grants for small-scale hydropower	0.8
Investment grants for wind power	0.7
Investment grants for biomass-fuel based combined power and heating	1.1

Note: The figures have been calculated on the assumption that renewable energy forms and reduced use of electric heating replace electricity generated at natural gas combination power plants.

Source: National Energy Administration

measures would not have achieved the stated objective in their original form.

The energy policy programme also involves action in the field of information and education, eg, in the

form of funding for municipal energy advisory services and information campaigns at regional energy offices, trade associations and the like. Technology procurement is also used as a means of accelerating developments and the launch of new technology on the market, eg, to encourage greater use of more energy-efficient and environmentally friendly products.

The programme of investment grants for biomass fuel-based combined power and heating plants and wind power plants has aided a rapid increase in the output available from these sources. One drawback of support of this kind is that grants paid for a limited period for plants with a long operating life may cause the market to become saturated with plants from that period, thus inhibiting further investment in even better technologies. The system is therefore currently under review. The total effect of decisions taken to date on funding for measures to reduce electricity consumption and increase electricity generated from renewable energy sources is estimated to have reduced the electricity requirement by approximately 0.4 TWh and increased electricity generated from renewable sources by about 1.5 TWh. Converted into reduced carbon dioxide emissions, this gives a reduction of 800 – 1,600 tonnes per year.

The table below shows the efficiency of the invest-

Table 3.2

Some energy and environmental taxes in the 1990s, SEK millions

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Petrol tax ¹	17,169	14,538	14,344	17,554	22,030	1,711	0	0	0	0
Energy tax	15,165	10,489	9,546	7,875	10,239	27,456	30,371	34,212	36,900	37,573
Carbon dioxide tax	-	8,157	9,194	10,641	6,943	11,078	15,053	12,599	12,796	12,811
Sulphur tax		-299	190	190	217	146	212	134	115	104
Special tax on electric power from nuclear power plants	130	139	117	116	137	133	974	1,478	1,537	1,553
Hydropower tax ²	1,018	896	1,030	1,026	817	908	1,423	194	0	0
Special acidification tax	57	73	63	58	63	69	64	58	58	65
Environmental tax on domestic air traffic	27	156	168	190	271	177	128	0	0	0
Tax on pesticides and artificial fertilisers	184	158	153	171	205	277	343	413	371	378
Tax on energy and environment	33,750	34,905	34,805	37,821	40,922	41,955	48,566	49,088	51,777	52,484
Total environmental taxes in Sweden				47,718	48,461	50,640	57,277	56,485	59,638	-
Percentage of Swedish GDP				3.2	3.0	3.0	3.3	3.1	3.2	-
Percentage of GDP in the EU				2.8	2.8	2.8	2.9	2.9	-	-

¹ Petrol tax has been included in energy and environmental taxes since 1996

² The hydropower tax was converted into a raised real property tax on 1 January 1997

Note: VAT on energy is not included in the table, nor are a number of environmental taxes unrelated to energy use.

Source: National Tax Board and Special Tax Office in Ludvika. Total environmental taxes and percentages are taken from Statistics Sweden: Miljöskatter och miljöskadliga subventioner, Miljöräkenskaper ("Environmental taxes and environmentally harmful subsidies, Environmental accounts") Report 2000:3.

ment programmes for whose implementation the National Energy Administration has been responsible.

It is difficult to make quantitative estimates of the efficiency of funding to improve energy efficiency. It is possible to use sales statistics to gain an impression of the impact of technology procurement and labelling on the market for particularly energy-efficient products. If all types of project for more efficient energy use are added together, the reduction is estimated to be 0.4 TWh oil and 0.4 TWh electric energy. Converted into reduced carbon dioxide emissions, this represents a reduction of 100 – 200 ktonnes per year. However, not all this reduction can be attributed to government action for greater energy efficiency; some of it is the result of spontaneous technological developments.

Taxation policy

Energy and carbon dioxide taxes are the most important instruments in Sweden for limiting carbon dioxide emissions. It is estimated that the combined effect of energy and carbon dioxide taxation, as well as efforts to encourage the use of renewable energy sources, is a reduction in carbon dioxide emissions of about 5,000 ktonnes in 2000, rising to about 10,000 ktonnes by 2010.

Energy consumption is taxed to create an incentive for reducing energy use. The taxes also generate revenues. The state's revenues from taxes on energy, carbon dioxide emissions and VAT on energy totalled approximately SEK 60 million in 1999.

When Sweden joined the EU, certain changes were made in the field of energy taxation to finance the membership fee. Other increases in energy taxes have been used to finance a broad range of investments in education, for example. Table 3.2 shows revenues from various environmentally related taxes between 1990 and 1999. In addition to the taxes shown, many users of fossil fuels also bear the burden of an environmental charge on nitrogen oxides.⁴⁹

Energy, carbon dioxide and sulphur tax on fuels⁵⁰

Tax on energy was introduced in 1957 and has since then undergone a number of changes in terms of purpose, rates and those obliged to pay it. Following the tax reform in 1991, environmental protection has become one of the express aims of energy tax. Energy and carbon dioxide taxes are now the most significant instruments in Sweden for limiting carbon dioxide emissions.

Energy tax

State revenues from energy tax totalled approximately SEK 37.5 billion in 1999. Fuels subject to energy tax are petrol, fuel oil, diesel oil, paraffin, LP-gas, coal,

petroleum coke and raw tall oil. In addition to fossil fuels, tax is also levied on other fuels used to drive vehicles (including biomass fuels). Under a scheme known as "pilot project tax relief", the government has lowered the tax on certain alternative motor fuels, mainly ethanol and RME. This relief also applies to natural gas used as a motor fuel. Biomass fuels and peat used for heating are not covered by the energy tax. Diesel and fuel oils used in commercial shipping and aviation fuel are exempt from energy tax. Fuels other than petrol used to run trains and other modes of rail transport are also exempt from energy tax. Energy tax is levied on electric energy delivered to end users. Double taxation is avoided by exempting fuels used to generate electricity from energy tax. The taxpayer is normally the supplier. No energy tax is levied on fuels used in manufacturing processes in industry, agriculture, forestry or aquaculture. However, this exemption does not apply to petrol (regardless of the purpose for which it is used) or other fuels used to operate motorised vehicles. With some minor exceptions, energy tax is not levied on fuels used or produce electricity. Biomass fuels and peat used to produce electricity are also exempt from tax. Electricity consumed by electricity producers themselves is also tax-free. Energy tax is not charged on electric energy produced by wind power plants.⁵¹ Electricity produced by a reserve generator or generated and consumed aboard ships or other modes of transport is not taxable either. Energy tax on fuels is levied at a fixed rate per unit of weight or volume. Tax rates do not differ in proportion to the energy value. The highest rate is levied on oil products; the lowest on LP-gas. This difference originates from the 1970s and the desire at that time to favour other products at the expense of oil. The energy tax rate on certain fuels varies depending on whether the fuel is used to operate motorised vehicles or for heating. Fuels used to operate vehicles are taxed at a higher rate of energy tax.

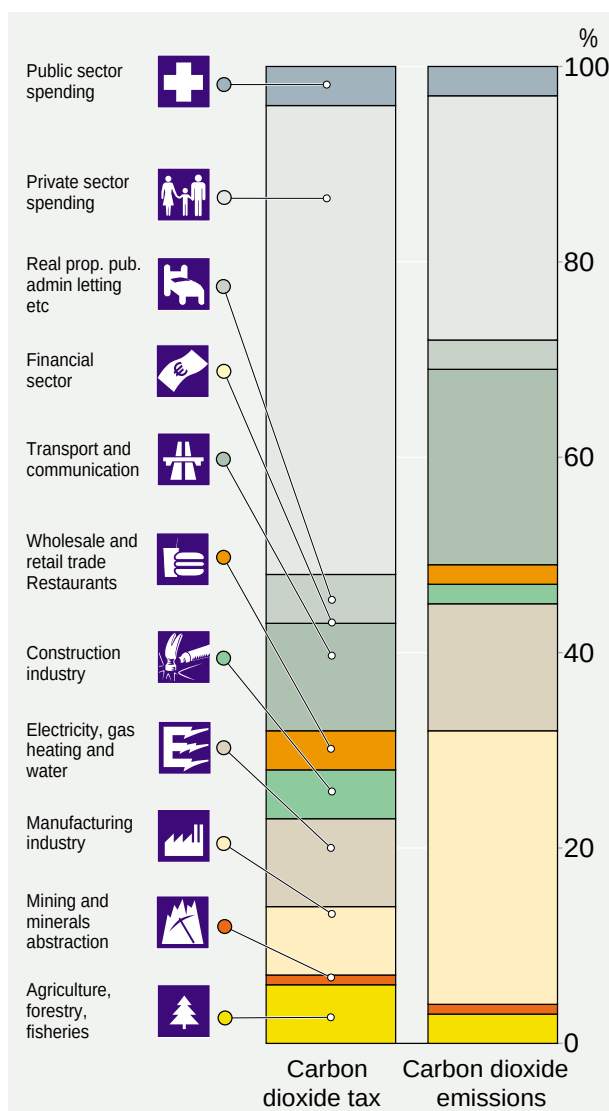
However, the tax on petrol is not related to the purpose for which it is used. LP-gas and natural gas

⁴⁹ Swedish Code of Statutes 1990:613; Gov. Bill 1989/90:141, 1989/90:JoU24, rskr 1989/90:349. For a detailed description of these instruments, see the National Energy Administration NC3 Report ER 13:2001.

⁵⁰ A new Energy Tax Act entered into force when Sweden joined the EU. The act replaced earlier acts on a general energy tax (Swedish Code of Statutes 1994:1776; Gov. Bill 1994/95:54, report 1994/95:SkU4, rskr. 1994/95:152), carbon dioxide tax (Swedish Code of Statutes 1990:582; Gov. Bill 1989/90:111, 1989/90:SkU31, rskr. 1989/90:357) and sulphur tax (Swedish Code of Statutes 1990:587, Sulphur Tax Act. Gov. Bill 1989/90:111, 1989/90:SkU31, Rskr. 1989/90:357). The new act retained the existing terms "carbon dioxide tax" and "sulphur tax", whereas "general energy tax" was replaced by the term "energy tax".

⁵¹ The Finance Bill for 2002 proposes that the link between the "environmental bonus" for wind power plants and energy tax on electricity be removed. It is proposed that the environmental bonus should be fixed at SEK 0.181 per kWh, ie, it will not follow the proposed rise in the tax on electricity.

Figure 3.1 Breakdown of carbon dioxide taxes and emissions into sectors, 1995.



Source: Statistics Sweden: *Miljöskatter och miljöskadliga subventioner, Miljö-räkenskaper* ("Environmental taxes and environmentally harmful subsidies, Environmental accounts") Report 2000:3.

used as motor fuels are exempt from energy tax. In addition, the tax rate on petrol and on oil products used in motorised vehicles is differentiated from other environmental classes.

The energy tax rate on electricity consumption is differentiated, depending on who consumes the electricity and where in Sweden it is consumed. According to the energy policy decision of 1997, the shortfall of electricity consumption arising from the shutdown of the first Barsebäck reactor was mainly to be counter-balanced by reduced electricity consumption at district heating plants. Electric boilers are normally used alongside fuel-fired boilers in district heating systems. The electric boilers are switched off when heating requirements can be met more cheaply using other fuels. Electricity used in electric boilers was tax-exempt between 1984 and 1991, provided that the

boilers were not used when fossil fuels were in use in the Swedish electricity production system. Exemption was abolished in 1991. Taxation is one of the reasons that use of electric energy to operate electric boilers in the district heating system declined throughout the 1990s. The "electric boiler tax" on electric boilers with a power output exceeding 2 MW in winter was raised by SEK 0.023/kWh in 1998. This rise means that electric energy used to operate electric boilers in the district heating system is taxed in the same way as electricity for household use. The expected effect, viz., that the tax rise would reduce electricity consumption by 3 – 4 TWh, was partly based on erroneous grounds; the reduction in 2000 was only 0.3 – 0.5 TWh electric energy.⁵²

Carbon dioxide tax

Carbon dioxide tax has been levied on fossil fuels since 1991.⁵³ Together with the energy tax and VAT on energy, the carbon dioxide tax is the most significant Swedish instrument in terms of climate policy.

Unlike energy tax and VAT on energy, the main reason for introducing carbon dioxide tax was to limit carbon dioxide emissions.

In addition to the fossil fuels mentioned earlier, the tax is also payable on mineral oils used for heating and on all motor fuels (including biomass fuels). Here too, the government is able to grant "pilot project tax relief". Biomass fuels and peat used for heating are not subject to carbon dioxide tax. Diesel and fuel oils used in commercial shipping and aviation fuel are exempt from energy tax. Fuels other than petrol used to run trains and other modes of rail transport are also exempt from the tax. Carbon dioxide tax is not levied on fuels used to produce electric energy. Biomass fuels and peat are exempt whether used for electricity or heat production.

Carbon dioxide emissions are directly related to the consumption of fossil fuels. Even though carbon dioxide tax is a tax on raw materials or end products, it functions very much as a tax on emissions. The tax is computed on the basis of the carbon content of fuels. Coal, for example, has the highest rate of carbon dioxide tax per unit of energy.

Since its inception, the carbon dioxide tax rate has been raised from SEK 0.25/kg carbon dioxide in 1991 to SEK 0.37/kg carbon dioxide in 1996, and subsequently to SEK 0.53/kg carbon dioxide as of 2001. The tax rate is not related to whether or not the fuel is used as a motor fuel or for heating purposes.

For competition reasons, only 35 per cent carbon dioxide tax is levied on fuels used in industrial manufacturing processes or in agriculture, forestry or aquaculture.⁵⁴ The reduced tax rate does not apply to

petrol (regardless of the purpose for which it is used) or other fuels used to operate motorised vehicles. Figure 3.1 shows the proportion of carbon dioxide emissions from various sectors in relation to the amount of carbon dioxide tax each sector pays to the state each year.

In addition to the general tax reduction, companies consuming large amounts of energy may be granted a further reduction of the carbon dioxide tax. If the carbon dioxide tax paid by a company in the manufacturing, agricultural, forestry or aquaculture sectors exceeds 0.8 per cent of its gross sales, the tax will be reduced so that only 24 per cent of the additional tax remains. Carbon dioxide tax on coal and natural gas has been reduced (the "1.2 per cent rule") until 2003. This reduction only applies to the cement, lime, rock and glass industries. The total tax payable by companies in these industries may not exceed 1.2 per cent of their gross sales.⁵⁵

Right from the outset it has been possible to receive a refund of carbon dioxide tax if carbon dioxide emissions from use of the fuel have been reduced. An application may be made to the tax authorities for a refund of carbon dioxide tax in proportion to the amount by which emissions have been reduced.⁵⁶ Some companies engaged in hothouse cultivation have made use of this opportunity.

VAT on energy

VAT has been payable on the purchase of energy since 1990. The tax is computed on energy prices including selective purchase taxes. VAT on energy means that commercial operations such as industrial companies can deduct the VAT they pay on energy in the same way as they can for other products purchased for their business. However, activities not regarded as commercial (mainly households) are not entitled to make any such deduction and must bear the full cost of the tax. The VAT rate on energy is the standard VAT rate, ie, 25 per cent.⁵⁷ State revenues from VAT on energy totalled some SEK 13 billion in 1999.⁵⁸

Green taxes

More and more countries with a heavy tax burden are pursuing green taxation as a way of reducing environment impacts and also of preventing a growing tax burden on trade and industry. A sizeable shift towards green taxation occurred in Sweden in the early 1990s, when VAT was imposed on energy etc simultaneously with a reduction of tax on earned income. This shift in the tax burden was one of the main reasons for the rapid increase in the use of biomass fuels at district heating plants in the 1990s.

Sweden placed further emphasis on green taxation in 2001, raising tax on energy and lowering that on labour. The aim is to heighten the environmental aspect of energy taxation. The shift towards green taxation involved a total of SEK 3.3 billion. Energy taxes were raised, the personal allowance in the income tax system was raised by SEK 1,200 and the employers' social security charges were lowered by 0.1 percentage point.⁵⁹ Green tax changes in 2001 involved a rise of about 40 per cent in the carbon dioxide tax. This rise was partly (25 per cent) offset by an 8 per cent reduction in energy tax. This rendered the tax changes fiscally neutral to some extent. The carbon dioxide tax is now more closely related to the adverse effects of emissions of carbon dioxide than is the energy tax. The shift in the burden from the energy tax to the carbon dioxide tax thereby enhances the environmental impact of these taxes on the choice between various fuels. In addition to the fiscally neutral component, the carbon dioxide tax was also raised by the equivalent of 15 per cent. Raised taxes on carbon dioxide make electric energy cheaper than other forms of energy, so the tax on electricity was raised by SEK 0.018/kWh.⁶⁰

The rises in the tax on carbon dioxide and electricity only affect consumers. Taxes on the transport sector were left largely unchanged. Aside from the rise in the prices index, taxation on petrol has not risen, although there has been a slight rise in the tax on diesel. It was decided to reduce the VAT rate on passenger transport and other commercial transport from 12 to 6 per cent to mitigate any disadvantages arising from increased fuel costs for public transport.

Production taxes on electricity

A number of taxes on electricity production were imposed in the 1990s. These are nuclear power tax⁶¹, hydropower tax, and a charge/tax on storage of radio-

⁵² KM background report to the Ministry of Industry and Trade. Evaluation of the 1997 energy policy programme. Assignment number 77183.

⁵³ Carbon dioxide tax is levied on petrol, heating oil, diesel oil, paraffin, LP-gas, natural gas, coal and petroleum coke. Peat burning for energy purposes is not currently covered by the carbon dioxide tax, although peat is treated as a fossil fuel in international reports.

⁵⁴ Manufacturing industry, commercial greenhouse cultivation and, since 1 July 2000, agriculture, forestry and aquaculture.

⁵⁵ Government report 2000:73. Evaluation of the energy tax model proposed by the Swedish Green Tax Commission

⁵⁶ *ibid.*

⁵⁷ *ibid.*

⁵⁸ Miljöskatter och miljöskadliga subventioner ("Environmental taxes and environmentally harmful subsidies"), Environmental Accounts Report 2000:3. Statistics Sweden

⁵⁹ National Energy Administration NC3 Report ER 13:2001

⁶⁰ National Energy Administration NC3 Report ER 13:2001

⁶¹ Swedish Code of Statutes 2000:466 Tax on Thermal Output of Nuclear Reactors Act; Gov. Bill 1999/2000:105, report 1999/2000:SkU22, rskr. 1999/2000:246

active waste and dismantling of nuclear power plants.⁶² The nuclear power tax was introduced in 1984 and is payable on all electric energy generated at nuclear power plants. The tax was SEK 0.027/kWh in 1999. The tax on nuclear power was altered in 2000, becoming a fixed output tax of SEK 5,514/MW and month, instead of a variable production tax. The purpose of this change was to reduce the risk of distortions in the electricity production system, resulting in less efficient use of resources. There also used to be a production tax on electricity generated at hydropower plants, but this was replaced in 1997 by a higher rate of property tax on the taxable value of land used for hydropower plants. The raised property tax was abolished in 1999.

Some problems with the current system of energy taxation

The Swedish energy tax system gives rise to a number of secondary effects. One effect is that there are differences between the taxation of electric energy and fuels in the industrial and energy sectors. The provisions governing taxation of these sectors have been amended several times over the last few years. This has created substantial doubts about the future in these sectors. This applies both to the special regulations governing combined power and heat production, and the changes in tax rates. Some of the changes in the tax system have created radically new conditions governing the choice of fuels and technology at new plants for combined power and heat production. As a result, some of the tax changes have not fully achieved their purpose. In particular, there has been little incentive to develop and operate combined power and heat facilities.⁶³

Differentiation of energy taxation may provide an incentive to transfer fuels between sectors in a less than efficient manner. However, there is good reason for tax differentiation of energy products, since Swedish companies in the energy-intensive sector operate in an international market in which many of their competitors pay no energy taxes at all.

The imposition of energy tax and the resulting cost difference between fossil fuels (which are taxed) and biomass fuels (which are not) has provided much of the impetus for the growth in the biomass fuel market. But taxation may cause some adverse effects. If production of heat and electric energy occur at the same time (at a combined power and heat plant), the tax legislation may create a situation whereby fossil fuels and biomass fuels are mixed. For tax reasons, the biomass fuel component will be ascribed to heat production and the fossil fuel component to electricity production (which is tax-free). Admixture of coal

increases the content of inert material in ash. This may result in a net input of heavy metals to the environment if the ash is returned to the forest, which is normally desired to maintain the nutrient balance in forest soils.⁶⁴

Reform of the electricity market

The Swedish electricity market was reformed in 1996. Amendments were made to Finnish legislation on electricity at the same time, whereas Norway had opened up its market to competition as long ago as 1991. Thus, Finland, Norway and Sweden have had a common electricity market since 1996. Denmark joined the Nordic electricity market in 2000. The electricity market was reformed for economic reasons. The aim was to improve efficiency and give consumers greater choice.

Prior to the reform of the Nordic electricity markets, power was transferred between the countries by the major producers under a joint arrangement called Nordel. Nowadays, smaller market players, including end-users can participate in cross-border trade in electricity. The common marketplace (Nordpool) has led to more efficient pricing. Border tariffs have been removed between Norway, Sweden and Finland, which has also improved the efficiency of trade. The overall amount of electric energy traded between the Nordic countries has increased.

Electricity prices have varied greatly since the Nordic electricity markets were integrated.

An early evaluation of the common Nordic electricity market, when prices displayed a clear downward trend, suggests that the objectives of the reform of the Swedish market have been achieved. Emissions of carbon dioxide in Sweden have probably not been much affected. The low electricity prices between 1997 and 2000 may have temporarily reduced the profitability of greater energy efficiency and made it less financially advantageous to invest in renewable energy and combined power and heat.

The reform improves the scope for active consumer influence. Eco-labelling of electricity production (eg, Bra Miljöval El – "an environmentally friendly electricity choice") may have a favourable impact on carbon dioxide emissions from electricity generation. However, consumers have not been very active in the market. Up to 2000, approximately 11 per cent of Swedish households had tried to influence their electricity supplier, either by changing supplier or by renegotiating supply agreements.⁶⁵ Thus, it is not possible to make an unequivocal assessment of the effects of the electricity market reform on greenhouse gas emissions.

Taxes on transport

One general purpose of taxes is to finance public spending. Another is that they should be related to environmental issues. These two aims influence the form of taxes and charges in the transport sector. The government bill entitled *Transport för en hållbar utveckling* ("Transport for sustainable development")⁶⁶ proposed that "The taxes and charges that are levied on traffic and are justified for reasons of transport policy are to be based on a well-defined responsibility for costs arising that also takes account of the external impacts caused by traffic."

Among other things, there has been a desire to adjust the taxation of petrol and diesel so that it reflects the average marginal cost incurred as a result of each car on the roads. However, a study has shown that this marginal cost is generally higher than the current taxes on motor fuels, particularly in urban areas, where heavy traffic, noise and air pollution cause major external impacts.⁶⁷

Aside from energy and carbon dioxide tax, taxes on transport are considered to play a marginal role in limiting greenhouse gas emissions. It is true that the tax on vehicle ownership, known as "motor vehicle tax", is differentiated to take account of vehicle weight.

Moreover, cars qualifying under environmental class 1 and newly registered in 2000 and 2001 confer entitlement to reduced motor vehicle tax. However, environmental classification is not specifically related to greenhouse gas emissions. Revenues in the form of motor vehicle tax increased from approximately SEK 4.1 billion in 1993 to about SEK 6.1 billion in 1998, at current prices.

"Pilot project tax relief" on biomass motor fuels

In some cases, the government has lowered the motor vehicle fuel tax rate on alternative biomass motor fuels under the "pilot project tax relief" scheme. Between 1997 and 1999 tax relief was granted on 84,950 cubic metres of RME and 129,005 cubic metres of ethanol. Lowering the energy tax rate is an important way of encouraging the introduction of alternative fuels.

The volume qualifying for relief is much greater

than the quantity sold. One reason for this is that a large ethanol production facility is currently in the start-up phase. It is estimated that the quantity of biomass fuels sold in 2000 replaced 21,000 cubic metres of petrol and 8,000 cubic metres of diesel oil. The gross emission reduction is then about 55 ktonnes carbon dioxide. The actual reduction will be lower because a certain quantity of fossil energy is lost in the manufacture of biomass motor fuels.⁶⁸

Environmental differentiation of shipping and air traffic charges

Shipping charges have been differentiated since 1998. Noise-related air traffic charges have been supplemented by a charge relating to emissions of hydrocarbons and nitrogen oxides.

These charges may be seen as a step towards realising the "polluter pays" principle (PPP).

Landfill tax

Waste going to landfill has been taxed since 2000.⁶⁹ The reduction in quantities of landfilled organic waste will in turn reduce methane formation. The purpose of the tax is to discourage landfilling of waste in favour of more environmentally beneficial disposal methods. Ultimately, the aim is also that waste going to landfill will involve costs such that producers and consumers choose other products and processes that do not generate waste that must be landfilled. The aim of taxation, in combination with other measures in the waste sector, is to halve the quantity of waste

⁶² Swedish Code of Statutes 1981:671

⁶³ Government report 2000:73. Evaluation of the energy tax model proposed by the Swedish Green Tax Commission

⁶⁴ *ibid.*

⁶⁵ *Kunden är lös!* ("Customer on the loose") – consumer behaviour in the deregulated electricity and telecommunications markets. Swedish National Audit Office.

⁶⁶ Gov. Bill 1997/1998:56

⁶⁷ Swedish Institute for Transport and Communication Analysis Report 2000:10

⁶⁸ National Energy Administration Report ER 13:2001

⁶⁹ Swedish Code of Statutes 1999:673; Tax on Waste Act (1999:673). Gov. Bill 1998/99:84, report 1998/99:SkU20, rskr. 1998/99:258

⁷⁰ Draft Finance Bill 2001, 2000/01:1

Table 3.3

Volumes of tax-exempt RME and ethanol sold/used as a motor fuel between 1995 and 2000.

	995	1996	1997	1998	1999	2000
RME (m3)	500	7,500	8,000	7,500	7,000	8,000
Ethanol (m3)	6,000	8,000	12,000	14,000	16,000	21,000

Source: National Energy Administration

going to landfill over a ten-year period.⁷⁰ Tax is payable on waste entering a waste disposal facility at which hazardous waste or other waste exceeding more than 50 tonnes a year is landfilled or kept for longer than three years. The tax is SEK 250 per tonne of waste. Estimated annual revenues from the landfill tax are SEK 1.3 billion.⁷¹

Measures and instruments in the field of energy policy

This section describes measures and instruments in the energy field taken in Sweden as part of the 1997 energy policy programme. The programme includes projects within the scope of the Climate Convention pilot programme for Activities Implemented Jointly (AIJ), which is described separately. Estimates of the impact on carbon dioxide emissions of measures taken under the programme are generally based on the assumption that the electric energy saved or replaced would have been produced at a natural gas combination plant or a coal-fired carbon condensing plant.

In conjunction with the energy policy decision of 1997, the government considered that the role of public authorities in the energy sector should be clarified and reinforced. The new energy policy agreement also entailed new and broader requirements as to the way changes in the energy system are to be implemented. A new central energy agency was therefore established in 1998. The National Energy Administration is responsible for implementing most of the changes in the energy system and coordinating the process of changeover. Another central task for the administration is to monitor developments in the energy markets and energy system and analyse their significance in relation to the environment, technical developments and economic growth. The administration is also responsible for measures taken by the government to promote research and development in the energy field.

Another organisational change was made when the new government took office in 1998. A new Ministry of Industry and Trade was set up and was given overall responsibility for industrial, energy, transport and labour market issues. The ministry is thus responsible for a number of policy areas. The idea of gathering these policy areas under a single "umbrella" is to integrate them and thereby improve the prospects for enhancing welfare, creating jobs and ensuring a good, lasting and sustainable rate of growth throughout the country.

The 1997 energy policy decision also elaborated a strategy for Swedish climate policy in the energy sector. It was expressly stated that Sweden should adopt a pro-active approach to the use of effective measures and instruments in the energy field, and that Sweden should press for the introduction of a minimum level of energy taxation in the EU. The strategy includes

measures to promote bilateral and multilateral cooperation for activities implemented jointly under the Climate Convention. SEK 350 million was allocated for this purpose over a seven-year period, starting in 1997. Some of these funds will be spent on a programme for developing energy systems in eastern Europe, the Baltic States and elsewhere. The strategy also involves efforts to develop new technology for ethanol production from raw materials from forestry. SEK 210 million has been earmarked for this over a seven-year period, starting in 1998. The aim of these research and development projects is to lower the cost of producing ethanol based on raw materials containing cellulose.

Apart from reducing greenhouse gas emissions, the aim of measures and instruments under the energy policy programme has been to

- improve energy efficiency;
- reduce the use of electric energy for heating purposes;
- promote the use of energy from renewable sources;
- increase international cooperation; and
- itake measures in other countries reduce carbon dioxide emissions.

The programme contains a near-term and long-term component. The near-term component involves measures to reduce electricity consumption and subsidising investment in electricity production facilities. These measures are essential to compensate for the 8 TWh shortfall of electricity following shutdown of the Barsebäck 1 nuclear reactor.⁷² The first reactor was shut down in 2000. According to the energy policy decision, the second reactor can only be decommissioned provided that the electricity production shortfall can be compensated for by new energy supply and reduced energy consumption. The long-term component involves measures such as research and development. This component is described later on in this section and in Chapter 7.

The near-term energy system adjustment programme

Approximately SEK 3.5 billion has been allocated for implementation of the near-term programme component. This comprises:

- funding to reduce the use of electricity for heating purposes (SEK 1.65 billion);
- funding to increase the supply of electric energy from renewable sources (SEK 1 billion);
- funding to improve energy efficiency (SEK 450 million);
- measures to develop the supply of electricity and heating in the south of Sweden (SEK 400 million).

Table 3.4
Current subsidies for electricity generated from renewable sources.

Electric energy from	Current subsidy SEK/kWh
Wind	
Investment grant, max 15%	0.04 – 0.05
Environmental bonus 0.181	
Small-scale electricity generation, max. 1,500 kW	
Temporary subsidy	0.09
Small-scale hydropower	
Investment grant, max 15%	0.03 – 0.04
Small-scale electricity generation, max 1,500 kW	
Temporary subsidy	0.09
Biomass fuels	
Investment grant, max 25%	0.05 – 0.07
Note: The above figures have been calculated on the basis of the full depreciation period for the plants.	
Source: National Energy Administration	

Current subsidies expressed as SEK/kWh for investment grants and operating subsidies are shown in Table 3.4 below. As may be seen from the table, wind power receives the highest government subsidies, currently at a rate of just over SEK 0.30/kWh.

Funding to reduce the use of electricity for heating purposes

Some 40 per cent of Swedish houses are heated using electric energy, which is a high proportion seen in an international perspective.

The energy policy programme includes measures designed to reduce the use of electricity in homes and commercial/industrial premises. These take the form of grants for property conversions and connection to district heating, grants for extending the district heating network, grants for conversion to individual heating systems and grants for investment in solar heating. A total of SEK 1.3 billion has been allocated for the period 1998 – 2002.

However, an evaluation of these forms of funding quickly showed that the energy use reduction objective would not be achieved. In its spring 1999 finance bill the government therefore proposed that the grants be discontinued at the end of April that year. Among other things, the cost of converting heat distribution systems had not fallen as expected. The government subsequently examined the form grants should take in the future and reinstated grants (in a revised form) for conversion to district heating systems and to individual heating systems as of 1 June 2001. The aim of these

revised measures is to increase the chances of achieving the parliamentary objective of a 1.5 TWh reduction in energy consumption.

The reinstated conversion grants improve the prospects of achieving the target. The main change is that partial conversions, whereby the household remains partly dependent on electric heating after conversion, now qualify for a grant. Grants have also been lowered so that funds will suffice for more projects.

Grants for conversion to district heating

The aim is to reduce the use of electricity for heating homes and commercial/industrial premises by connecting them to a district heating network. Grants totalling approximately SEK 230 million had been authorised by 30 June 2001. It is estimated that electricity consumption will fall by 0.25 TWh, and that the power output requirement will fall by 140 MW as a result of grants received to date. The grants given for conversion to district heating are expected to reduce carbon dioxide emissions by around 220 ktonnes a year, assuming that the electricity replaced would have come from coal-fired condensing power plants.

Grants for conversion from electric heating to other individual heating systems (not including district heating)

The aim is to reduce the use of electricity for heating homes and commercial/industrial premises by converting them to another individual heating system. Grants totalling approximately SEK 100 million had been authorised by 30 June 2001.

It is estimated that electricity consumption will fall by 0.12 TWh, and that the power output requirement will fall by 50 MW as a result of grants received to date. The grants are expected to yield an annual reduction in carbon dioxide emissions of around 80 ktonnes, assuming that the electricity replaced would have come from coal-fired condensing power plants.

Until 30 April 1999, grants were also available for output-reducing measures, such as the installation of automatic power output regulators and supplementary heating units. Grants totalling around SEK 150 million were paid out. These measures are estimated to have reduced annual electricity consumption by 0.028 TWh and power output requirements by 16 MW. These grants are reduce annual carbon dioxide emissions by around 28 ktonnes, assuming that the electricity replaced would have come from coal-fired condensing power plants.

⁷¹ *ibid.*

⁷² Swedish Code of Statutes 1997:1320. Nuclear Power Phase-Out Act 1996/97:176, report 1997/98:NU5, rskr. 1997/98:132

Solar heating grants

SEK 10 million (2000) and SEK 20 million (2001) has been earmarked for a new solar heating grant as part of the measures being taken to reduce electricity consumption. The grant is paid to facilities for permanent accommodation and premises not used for commercial or industrial purposes. The size of the grant depends on the estimated annual production of the solar panels. SEK 2.50/kWh/year is paid, subject to a maximum of SEK 7,500 for houses, SEK 5,000 for apartments in apartment buildings, and SEK 5,000 for "housing-related facilities". The grant for solar heating units in apartment buildings or housing-related facilities may not exceed 25 per cent of the investment cost. The grant is also limited to a maximum of SEK 250,000 per property. Grants totalling SEK 10.8 million have so far been authorised, which is expected to yield energy savings of 7.5 GWh per year and to reduce carbon dioxide emissions by about 2 ktonnes a year.

Other measures

Grants for extending the district heating network were introduced in January 2000 as part of the measures to reduce electricity consumption. Grants totalling SEK 15 million were authorised for this purpose in 2000. Steps are also being taken to identify ways of reducing the cost of converting houses with direct electric heating.

Grants to increase the supply of electric energy from renewable sources

Investment grants are available as an incentive for developing electricity production based on renewable energy sources.⁷³ The 1997 energy policy programme states the aim of grants for investment in new electricity production from renewable sources to be to add an extra 1.5 TWh of capacity each year over a five-year period. Funds have also been allocated for procurement of new electricity generation technology. A total of SEK 1 billion has been allocated for the period 1997 – 2002 for the creation of new sources of electricity supply.

To some extent, the present system of grants represents a continuation of the 1991 energy policy programme. Investment grants to increase the use of electricity from renewable sources complemented the environmental impact of energy taxation, since no carbon dioxide tax is levied on electricity production. A special operating subsidy for small-scale electricity generation was introduced in 2000. A special "environmental bonus" for wind power production was introduced as long ago as 1995.

Investment grants for biomass fuel-fired combined power and heating plants

A grant of SEK 3,000 per kW of installed electricity generation capacity is available for investment in combined power and heating plants run on biomass fuels. The maximum grant is 25 per cent of the investment cost, however. The aim of these grants is to increase the supply of electric energy produced from biomass fuels by at least 0.75 TWh per year over a five-year period. Ten plants, with a combined capacity of 164 MW, have received grants totalling SEK 445 million. These plants are expected to produce 0.88 TWh of energy a year, which will reduce carbon dioxide emissions by 490 – 820 ktonnes per year. The broad range is because the reduction depends on whether it is assumed that the electric energy derives from natural gas combination plants or coal-fired condensing plants. The grants for new or planned combined power and heating plants are the most cost-effective forms of funding available under the near-term component of the adjustment programme.

The relatively low electricity prices of recent years have not been an obstacle to decisions; all those receiving grants are in fact implementing their projects.

Investment grants for wind power plants and operating subsidies for wind power production

Wind power plants with an electric power output of at least 200 kW qualify for an investment grant not exceeding 15 per cent of the investment cost. The aim of these grants is to increase the supply of electric energy produced using wind power by at least 0.5 TWh per year over a five-year period. The grant represents about SEK 0.06/kWh over the depreciation period of the investment.

The operating subsidy for ongoing wind power production is currently SEK 0.27/kWh. The operating subsidy consists of two elements: the "environmental bonus", equivalent to the energy tax on electric energy, which in 2001 is SEK 0.181/kWh, and a special subsidy for electricity generated at small-scale production facilities.⁷⁴ The special subsidy is available until the end of 2001 and is SEK 0.09/kWh.

The investment grant in combination with the operating subsidy makes investment in wind power plants profitable. Plants with a power output of less than 1,500 kW qualify for the operating subsidy, which may mean that fewer larger units are built. Applications have been received for plants having a potential output of 1,750 kW, which are set not to exceed 1,500 kW, so as to qualify for the operating subsidy.

The appropriation totals SEK 380 million over a five-year period. By the end of 2000, 269 wind power plants had received investment grants totalling SEK

235 million. 167 of these are operational; the remainder are expected to become so by the autumn of 2001.

Electricity production from wind power plants receiving investment grants before the end of 2000 is estimated at 0.444 TWh. The combined electric power output from plants in receipt of grants is 188 MW. The reduction in carbon dioxide emissions is expected to be 170 – 414 ktonnes per year.

Investment grants and operating subsidies for small-scale hydropower plants

Small-scale hydropower plants with a minimum power output of 100 kW and a maximum output of 1,500 kW qualify for an investment grant not exceeding 15 per cent of the development cost. The aim of these grants is to increase the supply of electric energy produced using small-scale hydropower by at least 0.25 TWh per year over a five-year period. The nine hydropower plants so far in receipt of grants are expected to increase electricity production capacity by 12.9 GWh per year. Based on the information given in the applications, the total additional electricity generated by new small-scale hydropower plants may be estimated at 24.8 GWh per year. Again based on successful applications, the reduction in carbon dioxide emissions will be in the range 4 – 12 ktonnes a year. It is not expected that the target of increasing the supply of electric energy from small-scale hydropower plants by 0.25 TWh per year will be achieved. The reason that more small-scale plants of this kind are not being built is that their construction is often difficult to reconcile with other environmental considerations, such as conservation of biological diversity. Like wind power, these small-scale hydropower plants qualify for a temporary operating subsidy of SEK 0.09/kW.

Grants to achieve greater energy efficiency

The 1997 energy policy programme allocated SEK 100 million over a five-year period for procurement of more energy-efficient technology. The aim is to provide an incentive for development and to ensure that more energy-efficient technology comes onto the market by initiating and running projects for procurement of technology.

Funding for procurement of energy-efficient technology was introduced in 1988⁷⁵ in the form of a grant not exceeding 50 per cent of the development costs or a loan with a term not exceeding five years. The idea was to reduce the purchaser's financial and technical risks and thereby to provide an incentive for procuring products and systems that can replace electricity and are energy-efficient. The 1991 energy policy programme extended this form of support to include all

kinds of improvement in energy efficiency. The 1997 energy policy decision revised and redefined the support to cover procurement of more energy-efficient technology. The new ordinance⁷⁶ entered into force on 1 July 1999. The grant covers 50 per cent of the additional cost of the actual procurement of technology and 30 per cent of additional investment costs. On the basis of figures on sales of new products, these grants are estimated to have reduced electricity consumption

by about 0.4 TWh and oil use by 0.4 TWh. These efficiency improvements are expected to reduce carbon dioxide emissions by 200 – 400 ktonnes per year.

Measures to develop the supply of electricity and heating in the south of Sweden

Specific action has been taken in southern Sweden to develop electricity supply and thereby compensate for the production shortfall resulting from the shutdown of the nuclear power plant at Barsebäck. A separate authority under the Ministry of Industry and Trade has been established for this purpose – the Committee for Energy Supply in Southern Sweden (DESS). Its task is to increase the supply of electricity and heating in the south of Sweden in the near term by:

- making a study of the energy situation in the area;
- funding projects;
- instigating action.

DESS funds research, training, information, projects and studies, as well as planning and investment. The authority has been allocated a total of SEK 400 million for 1998 and 1999. These activities are still in progress.

The projects receiving investment grants are expected to add about 0.8 TWh per year to the energy balance in south Sweden. Approximately one quarter of the funds allocated has been used for information, training and advisory services. Carbon dioxide emissions are expected to be reduced by 70 ktonnes a year as a result of the measures taken.⁷⁷

The long-term adjustment programme for energy systems

Climate change is a long-term environmental problem. Measures are now being taken to limit emissions of

⁷⁵ Ordinance on Government Grants for Certain Investments in the Energy Field (1998:22)

⁷⁶ Ordinance on Grants for Small-Scale Electricity Production (2000:614)

⁷⁷ Ordinance on Government Grants for Procurement of Technology (1998:806)

⁷⁸ Ordinance on Government Grants for Procurement of Energy-Efficient Technology and New Energy Technology (1999:344)

⁷⁹ National Energy Administration Report ER 13:2001

greenhouse gases, but further technological development will be required to find a long-term solution to the problems. Research, development and demonstration form the basis of the Swedish strategy for creating sustainable development of the energy system and a limited influence on climate change. An overall aim of Swedish energy research and funding for development of energy technology is to lower the cost of using renewable forms of energy so as to render them economically viable alternatives to nuclear power and fossil fuels. The aim is to dramatically increase the proportion of electric energy and heat production based on renewable energy sources over the next ten to fifteen years. To do this will require development of new technology that is profitable and commercially available.

The government Sustainable Energy Supply Bill⁷⁸ proposed an allocation totalling SEK 5.3 billion over a seven-year period, starting in 1998, for research and development of energy technology. The table below shows the funds allocated to the different areas.

Funds are available to several authorities, although the National Energy Administration has overall responsibility for coordination. The research programmes receive all their funding via government appropriations, whereas funding of the development programmes is supplied jointly with trade and industry. Research areas given particular priority are:

- biomass fuel-based combined power and heat;
- biomass fuel supply and related ash disposal issues;
- new processes for ethanol production based on raw materials containing cellulose;
- alternative fuels;
- new technology for large-scale use of wind power and marine wind power;
- solar cells;
- improving energy efficiency in buildings (described in a later section), the industrial sector and the transport sector (described in a later section).

Research on renewable energy sources for electricity production

Sweden is investing in research and development as regards the use of water, wind and sun as sources of energy. Swedish investment in wind power has recently led to a technical breakthrough in the form of the "Windformer", which is expected to have a major impact. The new technology makes it possible to do without a number of components normally found in conventional wind power systems. The WindformerTM makes it possible to build marine wind power stations with a power output of 6 to 300 MW. According to the manufacturer, the production cost of WindformerTM is less than SEK 0.4/kWh, which is competitive in comparison with conventional gas or oil-fired power plants. A pilot facility with a power output of 3 – 3.5 MW will shortly begin operating at Näsudden off the island of Gotland.

Electricity generated using solar cells may also eventually become competitive. Swedish research into solar power is currently being conducted in the form of two major programmes. SolEl 00-02 is examining the potential for using solar cells in the existing electricity system at a reasonably cost, and is also determining the degree of development necessary to enable solar cells to play a part in Swedish electricity production. Research at the Ångström Solar Center in Uppsala includes projects on thin-film solar cells, nanocrystalline solar cells and "smart windows".

Research on biomass fuel-based electricity and heat production

Biomass fuels have been used in Sweden for a long time, but their use has increased dramatically over the last 20 years or so. There is considerable technically and ecologically available potential in the use of forest fuels at a reasonable cost. This potential has hitherto been unexploited. Realistically, the biomass fuel potential over the next twenty years may be around 130 – 150 TWh⁸⁰, which would represent an increase

Table 3.5
Allocated and estimated funds for research and development under the long-term adjustment programme for energy, 1998 – 2004,

Allocation/item	1998	1999	2000	Est. 2001	Est. 2002	Est. 2003	1998 – 2004	Total 2004
SEK millions								
Energy research total ⁷⁹	320	335	402	431	461	426	2,801	426
Energy technology grants and introduction of new energy technology	250	360	360	360	360	360	2,480	430
Total	570	695	762	791	821	786	5,281	856
<i>Source: National Energy Administration</i>								

of about 50 per cent from current levels. Over the longer term, intensive forest cultivation may yield additional fuel.

The aim of ongoing research is to determine the actual potential of biomass fuels and to improve the entire biomass fuel chain in various ways: from production, ecology, handling, transport and possible processing, to energy conversion and optimum use. Research is also being conducted on the ecological, economic and technical potential for forest fuel production, including ash recycling, energy forest and energy crops. The scope for intensive forest cultivation is also being examined.

The state funds a number of research and development programmes with a view to developing technologies for producing electricity and heat from biomass fuels with increasing conversion efficiency, less environmental impact and at a competitive cost.

Particular efforts are being made to reduce emissions of hazardous substances from small-scale combustion.

Materials and systems are being developed to avoid corrosion in the superheater during the steam turbine process and to achieve higher steam data and conversion efficiencies.

Development of processes using gas turbines are critical for natural gas-based production.

Basic research is being conducted in Sweden into a process for hydrogen production via artificial photosynthesis. The aim is to create a system by which hydrogen is produced from water and sunlight. This Swedish research is at the forefront of international research in this field.

Research into improving energy efficiency in industry

Swedish efforts in this area involve all the country's resources: innovation companies, universities and colleges, research institutions and others all have an important contribution to make to the development of technology to improve energy efficiency. The National Energy Administration is funding a research programme on process integration. The programme is developing methods for designing and modifying industrial processes to reduce their investment and operating costs. Unit processes in industry include strategically important and energy-intensive process stages in various manufacturing processes, such as blast furnace processes in the steel industry and the cooking of kraft pulp in the pulp and paper industry.

The funding of pilot research projects conducted by industrial research institutions is important for technological development in heavy industry. The state contributes to research and development by working together with the Swedish Forestry Technical Research Institute (STFI) and the Foundation for

Metallurgical Research (MEFOS). A new process for manufacturing chloralkali is one example of development in the chemical industry. Another is the development of black liquor vaporisation in kraft pulp manufacture. Other areas in receipt of government funding include a technology for more energy efficient furnaces using high-temperature combustion, which is being tested at the Royal Institute of Technology in Stockholm, and a joint project being conducted by the National Energy Administration and the Association of Swedish Foundries, whose purpose is to improve knowledge of energy-efficient forging methods.

Other measures

Long-term agreements on greater energy efficiency

In addition to legislation, taxes and subsidies, new instruments need to be developed to achieve a balance between environmental concerns and industry's need to remain competitive. In furtherance of this aim, the Ministry of Industry and Trade started a pilot project on long-term agreements in autumn 1998. The idea was to examine the scope for making use of long-term agreements between industry and the state to increase energy efficiency in Sweden. Long-term agreements of this kind are used in several of the countries among Sweden's competitors as a complement to conventional instruments, particularly taxes. The pilot project has shown that long-term agreements between industry and the state may have an important part to play in certain circumstances.

On 31 August 2000 the government decided to appoint a negotiator, charged with the task of producing a basis for, and drafts of, long-term agreements for efficient energy use in the energy-intensive industries and for reduced emissions of greenhouse gases. It is intended that these long-term agreements should encourage industry to take cost-effective steps resulting in lower energy use and reduced greenhouse gas emissions. It is expected to be possible to implement a system of this kind by way of long-term agreements under which the state and the other contractual party make commitments in order to achieve the stated aims.

The negotiator was due to report to the government by 31 October 2001. For obvious reasons, there has been quantification of the emission reductions that can be achieved.

To date, few agreements or accords involving measures designed to reduce greenhouse gas emissions

⁷⁸ Gov. Bill 1996/1997:84

⁷⁹ Approximately 80 per cent of the appropriation is administered by the National Energy Administration. The remainder is administered by Vinnova, FORMAS and the Science Council.

⁸⁰ National Energy Administration background report for Förslag till Svensk Klimatstrategi ("Proposed Swedish Climate Strategy"), Swedish Government Official Report SOU 2000:23

have been drafted. However, it may be noted that the state and the Swedish automobile industry have agreed that carbon dioxide emissions from new cars are to be reduced by 25 per cent by 2008. This has subsequently been overshadowed to some extent by the EU agreement on an emission level for new cars of 0.140 kg carbon dioxide/km.

Information and communication projects on economically and ecologically sustainable energy systems

The energy policy decision of 1997 included an allocation of SEK 350 million for information, advisory services and eco-labelling between 1997 and 2002. The National Energy Administration carries on information and communication projects designed for specific target groups. These help to bring alive the vision of an economically and ecologically sustainable energy system. Other project aims are to encourage a long-term approach. Operations, which received funding of about SEK 200 million during 1997 – 2000, break down as follows:

- general energy information;
- target information about more efficient energy use and renewable energy sources;
- contributions to information projects;
- contributions to municipal energy advisory services;
- information on municipal energy planning;
- the interrelationship between energy, economics and the environment;
- information relating to joint EU activities and the OPET information office.

The nature of these activities is described in greater detail in Chapter 8 – Education, training and public information. The aim of information activities is to increase knowledge.

This knowledge will in turn lead to action that will contribute to more efficient energy use and greater use of renewable energy sources. Follow-up efforts concentrate on ascertaining the extent to which knowledge has improved among target groups, and the extent to which this has led to action. However, follow-up activities of this kind are expensive and measurement of effects has been largely confined to major activities such as campaigns.

Campaigns aimed at the general public about the energy consumed by white goods, low-energy light bulbs and the advantages of waterborne heating systems have had a great impact. Energy savings as a result of these campaigns, estimated on the basis of sales statistics etc, have been in the order of 0.15 TWh/year. Information about newly procured technology is thought to have been a major factor contributing to the introduction of the 17 technologies procured during

1998 – 2000. However, it is not possible to identify separately the effects of information dissemination and the effect of the technology development projects. New heat pump technology has gained particularly wide acceptance; these have replaced both oil-fired and electric heating systems. A very rough estimate of the effects of new heat pumps is 0.4 TWh reduced oil use and 0.13 TWh reduced use of electric heating. These appraisals are based on sales statistics. Other calculation methods might give different results.

It is fairly difficult to assess the efficacy of the contribution to municipal energy advisory services, and to quantify the effects in terms of reduced electricity use or reduced carbon dioxide emissions is virtually impossible. Several evaluations have been made, however.

They indicate that advisory services both increases public awareness of energy consumption and influences people's behaviour, investments and planning for greater energy efficiency, particularly among householders.

Municipal energy planning

In the late 1970s the Municipal Energy Planning Act⁸¹ imposed a duty on Swedish municipalities when planning to promote energy conservation and take steps to ensure a sufficient and reliable supply of energy. Municipal planning must include an examination of the scope for joint action with another municipality or important stakeholder in the energy field (eg, a manufacturing or power company) to resolve issues of importance in relation to energy conservation or supply. The plan must also include an analysis of the impact the activities described in the plan have on the environment, health and conservation of land, water and other resources. No evaluation has been made of the effect of this act on greenhouse gas emissions. The existence of municipal climate objectives, described in the section on local initiatives, may be the indirect result of the production of municipal energy plans.

Measures and instruments in the field of housing policy, including social planning

The importance of adapting municipal spatial planning to achieve better integration of environmental aspects has recently attracted increasing attention. Parliament has adopted a specific environmental objective entitled "a good urban environment", and has stated that energy, water and other natural resources must be used in an efficient and sustainable manner whereby resources are conserved and renewable energy sources used. It has not been possible to quantify the impact of measures and instruments in the field of spatial planning on greenhouse gas emissions. However, their long-term positive effects are considered to be potentially significant.

General municipal planning

Municipalities bear primary responsibility for spatial planning. Spatial planning includes siting and designing traffic facilities and the preparation of general and detailed plans under the Planning, Building and Housing Act.⁸² Spatial planning is one of the most long-term forms of planning in use. This makes it of particular interest from a climate and energy point of view, particularly in the housing, service and transport sectors. There are gains to be made in terms of energy saving and reduced emissions from the burning of fossil fuels by planning so as to save energy. Building design and location in relation to infrastructure, among other things, is of central importance in relation to future climate policy.

The Planning, Building and Housing Act

The Planning, Building and Housing Act⁸³ give municipalities certain powers to decide where various activities can and cannot be located. If there are sufficient grounds, municipalities can limit or prohibit trade in foodstuffs within a detailed planning area.

Regional planning only takes place in exceptional cases in Sweden and is not legally binding. The role of county administrative boards in promoting inter-municipal cooperation gives them certain powers of intervention if there is a difference of opinion between the municipalities concerned with regard to the permissibility or location of a certain activity.

The importance of the Planning, Building and Housing Act in limiting greenhouse emissions has not been quantified, however.

The Environmental Code in relation to the environmental impacts of infrastructure projects

Following the entry into force of the Environmental Code⁸⁴ in 1999, the permissibility of certain kinds of major traffic infrastructure must now be considered by the government.

The code imposes a greater obligation to properly examine the environmental impacts of infrastructure projects at an early stage. This creates more scope for achieving more environmentally compatible overall solutions.⁸⁵ Some major investments in railway infrastructure are described in the section on measures and instruments in the field of transport policy.

Measures and instruments relating to the construction of housing and commercial/industrial premises

It has not been possible to quantify the impact on greenhouse gas emissions of the measures and instruments described below in relation to the construction of housing and commercial/industrial premises. They are considered to have some positive effects.

Investment grants for ecological building etc

The government has allocated SEK 635 million for investment grants for ecological building⁸⁶, which is intended to promote the ecological sustainability of housing construction during 2001 – 2004. The grants will then be evaluated. Grants are available for all forms of ecological building, and enhanced efficiency in the use of energy and natural resources is therefore one criterion. The maximum grant is SEK 2,000 per square metre of heated usable floor area up to a limit of 35 square metres per dwelling. Local Investment Programmes (LIP), are also very much a matter of making environmental improvements in residential properties. Most of the building modifications take the form of energy conversion and improvement of energy efficiency. These are described in the section on environmental policy, however.

Building regulations

Building regulations have been made gradually tightened in relation to the energy needs of new buildings. The energy efficiency requirements laid down in the building legislation for buildings with direct electric heating were extended to include all buildings (no longer only houses). Direct electric heating is only permitted if the building in question uses 40 per cent less energy for heating than buildings heated by other means.⁸⁷ Since 1991 electricity used to run pumps, fans and the like must be included when calculating energy consumption.⁸⁸ Electric energy efficiency, heat recovery and boiler conversion efficiency must also be taken into account.^{89, 90}

⁸¹ Swedish Code of Statutes 1077:439. Municipal Energy Planning Act. Gov. Bill 1976/77:129, CU 1976/77:39, rskr. 1976/77:338

⁸² Swedish Code of Statutes 1987:10 Housing, Building and Planning Act. Gov. Bill 1985/86:1, BoU 1986/87:1, rskr. 1986/87:27

⁸³ Swedish Code of Statutes 1987:10. Preparatory works: Gov. Bill 1985/86:1, BoU 1986/87:1, rskr. 1986/87:27

⁸⁴ Swedish Code of Statutes 1998:808. Environmental Code. National preparatory works; Gov. Bill 1997/98:45, report 1997/98:JoU20, rskr. 1997/98:278

⁸⁵ Government communication 1999/2000:13 Sustainable Sweden – evaluating the effectiveness of measures to achieve ecologically sustainable development

⁸⁶ Swedish Code of Statutes 2000:1389. Ordinance on Government Grants to Promote Ecologically Sustainable Housing Construction, cf Gov. Bill 1997/98:119, 2000/01:26, report 1997/98:BoU10, 2000/01:BoU2, rskr. 1997/98:306, 2000/01:91

⁸⁷ Statutes of the National Board of Housing, Building and Planning 1988:18. De första Nybyggnadsreglerna ("The First Construction Regulations"), entered into force on 1 January 1989

⁸⁸ Statutes of the National Board of Housing, Building and Planning 1990:28

⁸⁹ Statutes of the National Board of Housing, Building and Planning 1993:57

⁹⁰ Statutes of the National Board of Housing, Building and Planning 1993:58 with amendments up to and including 1998:38

The National Board of Housing, Building and Planning has also decided to introduce tougher standards for thermal insulation in new buildings. The result will be to raise the required thermal transmittance (or "U-value") by 10 – 15 per cent. These changes will be implemented as calculation methods in line with European standards are finalised and translated into Swedish standards.

Measures and instruments aimed at building repair and maintenance

Over the last ten years, various grants have been paid out that have influenced building construction as such, and also their energy requirements. As a result, they have indirectly influenced carbon dioxide emissions. These are grants for conversion of electrically heated buildings, various other energy-related grants and solar heating grants.⁹¹ The Interest Subsidies Ordinance also includes grants for energy-saving measures in connection with building alterations.⁹²

It has not been possible to quantify the impact on greenhouse gas emissions of the measures and instruments described below in the area of building repair and maintenance.

Overall, they are considered to have had some positive effects on emissions of greenhouse gases.

Energy declarations for white goods

The Swedish Consumer Agency has introduced energy declarations for white goods. These have raised public awareness of energy efficiency and have to some extent hastened replacement of old fridges and freezers by more energy-efficient units containing refrigerants contributing less to the greenhouse effect.

The "Swan" criteria for oil burners

A common eco-labelling system for oil burners in the Nordic region was introduced in autumn 2000. The Swan labelling criteria for oil and combination burners largely accord with those for the German "Blauer Engel" scheme and the general principles of the ISO 14024 international eco-labelling system. The aim of labelling is to minimise emissions from oil burners and to improve energy efficiency. It is particularly expected that the electricity consumed by circulation pumps will decrease substantially as a result of the eco-labelling rules.⁹³

Energy declarations for apartment buildings

A draft energy declaration has been evaluated as part of a government-instigated National Board of Housing, Building and Planning project on declarations for housing and schools.

The board proposes the introduction of a voluntary system of energy certificates.

Individual metering of, and charging for, heating and hot water

A typical feature of the housing sector is that many actors take place in the decision-making process. These include building contractors, installation firms, building maintenance and repair firms and tenants. One obstacle to greater energy efficiency is the split responsibility for implementation, where the property owner decides on the equipment, but the tenant pays for the energy. The National Board of Housing, Building and Planning has made changes in its regulations governing water and heating meters⁹⁴ in order to reduce the cost and simplify installation of individual meters.

Research on improving energy efficiency in the building sector

The government supports research and development aimed at improving energy efficiency in the building sector, mainly in the form of further development of tried and tested construction and installation technologies, and also development of new materials, components, methods and systems. The small number of housing starts means that measures to improve energy efficiency and conservation in building construction is only having a slight impact. Energy improvements in conjunction with alterations and maintenance are therefore important. The sector offers great potential. By using currently available new technology total energy consumption in new houses of a given size and type may be as little as 8,000 – 12,000 kWh a year, compared with 15,000 – 25,000 kWh a year in older houses.

Long-term funding of research and development on energy consumption in buildings is channelled via FORMAS (the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, formerly the Council for Building Research) and the National Energy Administration. Projects include building construction and installation technology solutions, research into solar heating, district heating, heat pump technologies and small-scale biomass fuel use. Sweden has very considerable know-how in the field of solar heating thanks to long-standing investment in this field. In the field of thermal solar heating, funding is given for research, development and demonstration via an integrated programme involving participants from the scientific community, manufacturing industry and potential customers.

Sweden is at the forefront of international research on heat pump technology and is also a leader when it comes to replacing refrigerants influencing climate with other, mainly natural, refrigerants such as ammonia, propane and carbon dioxide. The National Energy

Administration and some 30 companies are funding an applied research and development programme at two universities. The aim is to develop low-cost efficient systems having little environmental impact.

Since 1998 the National Energy Administration and the Swedish District Heating Association have also been jointly funding a research and development programme in the field of hot water technology, ie, distribution, district heating distribution centres, as well as control and monitoring. The aim is to develop energy-efficient and environmentally compatible district heating systems.

Lighting and ventilation, which accounted for approximately 70 per cent of electricity used for non-heating purposes in the early 1990s, have become more efficient thanks to better light sources and improved operational control and dimensioning. Research into the use of white LED (light-emitting diodes) for lighting purposes is being conducted in two parallel research projects; technological developments and the potential market are among the aspects being examined.

In addition to the above technological projects and investments, the National Energy Administration, FORMAS (formerly the Council for Building Research) and the Electricity Research Council are funding a research programme designed to reduce electricity consumption in buildings and small/medium-sized industrial facilities (ELAN). The object of the programme is to accelerate development in the field of electricity use/electricity applications. A "Smart House" project is also receiving funding.

Measures and instruments in the field of transport policy

The measures and instruments considered to have the greatest impact in the field of transport policy are economic instruments that can be used to influence technological development, transport demand and choice of mode of transport. As mentioned earlier, correct socio-economic pricing of transport is also a fundamental principle of Swedish transport policy. However, the use of economic instruments in the transport sector in the form of taxes and charges has already been dealt with in section 3.2.1.

*Increased investment in railway infrastructure*⁹⁵

The government has allocated funding to a number of projects to improve the potential for an efficient railway network of goods and passenger traffic.⁹⁶

The Mälärbanan and Svealandsbanan line combine to form a ring round Lake Mälaren.

When investment in upgrading has been completed, the total journey time between Stockholm and Örebro will be less than two hours.

The planned Botniabanan line between Kramfors (Nyland) and Luleå will be 190 km long and join the present main line to form a twin-track stretch along this route. This will improve efficiency, enabling goods traffic to go north on the main line and both passenger traffic and express goods trains to go south on the Botniabanan line. Construction of the first phase between Örnsköldsvik and Husum was begun in summer 1999. The five railway reports on other parts of the Botniabanan line have been submitted to the government for its assessment of permissibility under the Environmental Code. Assuming the government grants permission for the Botniabanan line under the code, it will be ready for service in 2006.

The rail network immediately south of Stockholm Central Station is the busiest in Sweden and is a bottleneck impeding through-traffic. The current rail track system, with only two tracks over Årstaviken, is operating virtually at full capacity. Construction of a new railway bridge over Årstaviken has started and alternative measures in central Stockholm to increase rail capacity and the scope for public transport are being examined.

A rail link has been built between Stockholm centre and Arlanda Airport as a consequence of the conditions set forth in the permit granted by the government for expansion of the airport and the addition of a third runway.

The "Gothenburg Agreement" involves the allocation of SEK 4.2 billion for an investment programme for environmental and traffic improvements in the Gothenburg region.

Some SEK 1.9 billion will be spent on public transport improvements in the form of new tram routes and trams, and on environmental and traffic safety improvements to the local road network. Central government funding covers 75 per cent of the Gothenburg Agreement investment programme; the region and municipalities are paying for the rest.

⁹⁵ Swedish Code of Statutes 2000:287 Ordinance on Government Grants for Investment in Solar Heating, cf. Gov. Bill 1999/2000:1 publication area 21, report 1999/2000:NU3, rskr. 1999/2000:115

⁹⁶ Ordinance Amending the Regulations Governing Interest Subsidies for Energy Saving Loans, cf. Gov. Bill 1980/81:63, CU 1980/81:12, rskr. 1980/81:106

⁹⁷ Stiftelsen Miljömerking i Norge (Norwegian Eco-labelling Foundation), 2000, Miljömerking av Oljebrennere og oljebrenner/kjel kombinasjon ("Eco-labelling of oil burners and oil/coal combination burners")

⁹⁸ Statutes of the National Board of Housing, Building and Planning 1994:26

⁹⁹ Government communication 2000/01:38 Sustainable Sweden – determining the effectiveness of measures to achieve ecologically sustainable development

¹⁰⁰ Swedish Institute for Transport and Communication Analysis SAMPLAN, 1999.

Research and development

projects relating to the transport system

Current Swedish know-how on combustion engine technology is considerable, and the Swedish vehicle manufacturing industry is at the forefront of research and development in this field. A key area of new technology is to combine combustion engine technology with electricity technology for use in flexible fuel vehicles.

Vehicles and fuels are in progress as part of the 1997 energy policy programme and are also receiving funding from other programmes. The then Transport and Communications Commission (KFB) concluded a seven-year demonstration programme for electric and flexible fuel vehicles in 2000. A similar programme for biomass fuel vehicles ran between 1991 and 1996. KFB merged with the newly-formed body VINNOVA (the Swedish Agency for Innovation Systems) on 1 January 2001.

Research and development into ethanol production in Sweden is being conducted by ten or so institutions. Biogas is already being used as a fuel (mainly for goods and passenger transport) in central and southern Sweden.⁹⁷ The National Energy Administration has initiated a programme with a view to establishing a pilot plant for vaporisation of raw materials from forestry and biomass motor fuel production.

It has not been possible to quantify the impact of the research projects described above on greenhouse gas emissions. The work being done in this field should be seen as part of the long-term efforts to reduce greenhouse gas emissions.

Quality assurance of transport services

In 2000 the National Road Administration continued to develop the market for safe and environmentally compatible transport. This has been done by funding actors in the market in their efforts to assure transport quality, by way of its own projects or via procurement.

Joint activities have also been commenced with trade and industry, principally companies and trade associations in the retail, food, engineering, steel, mining, forestry and transport sectors. Systems for quality assurance of transport services have so far been introduced by 19 county councils, 108 municipalities, 57 companies and 70 other organisations. In 2000 8 county councils, 49 municipalities and 15 other organisations procured transport services having stipulated specific environmental and safety requirements in the invitation to tender.

Fulfilment of these requirements will impact on carbon dioxide emissions, emissions harmful to health, speed, drink-driving, seat belt use and use of safe vehicles. Environmental standards governing National

Road Administration vehicles have been laid down in all its contracting documentation. Efforts are also being made to assure implementation of administration travel policy.

"Sparsam körning" and Ecodriving

The National Road Administration is running a project called Sparsam körning ("Green Driving"), which intended to make people more aware of how their approach to driving impacts on the environment. Important elements of the project are Ecodriving and Heavy Ecodriving (for truck drivers), which are practical and theoretical training courses on which people learn to drive in an environmentally compatible way. The courses have been developed in cooperation with the National Association of Swedish Driving Schools and the National Energy Administration. Heavy Ecodriving has also involved the participation of the Occupational Health and Safety Board of the Swedish Transport Unions (TYA).

There are at present some 300 Ecodriving instructors and 70 or so Heavy Ecodriving instructors throughout the country. Just over 3,000 people have completed the Ecodriving course and about 400 the Heavy Ecodriving course. A further 1,500 or so people have undergone short practical training courses.⁹⁸

The "Sparsam körning" project, in combination with quality assurance of transport services, is expected to reduce carbon dioxide emissions by almost 100 ktonnes a year by 2005. The cost of the projects is estimated at SEK 30 million per year.

Joint programme for development of more environmentally compatible vehicles

An agreement was concluded between the Swedish state and Swedish vehicle manufacturers in 2000. The agreement concerns a joint programme for developing more environmentally compatible vehicles. The government declaration of 1998 included an invitation to the industry to participate in this programme, which is designed both to reduce environmental harm caused by road traffic, and to enhance the prospects of the Swedish vehicle manufacturing industry remaining competitive over the long term. Up to SEK 1.8 billion is being invested jointly between 2000 and 2005, of which the government's share is a maximum of SEK 500 million. The programme covers areas such as advanced combustion technology, flexible fuel vehicles and fuel cell technology, weight reduction and general development of know-how. Universities and colleges, research institutions and vehicle industry suppliers are also involved.

Procurement of ethanol-petrol flexible fuel cars

The Swedish FFV (Flexible Fuel Vehicle) Buyer Consortium has been created at the instigation of NUTEK (the National Board for Industrial and Technical Development) to promote the manufacture of vehicles capable of running on fuel containing ethanol. The consortium comprises municipalities, companies, private individuals and two government agencies. The purpose is to demonstrate to vehicle and fuel manufacturers that there is a demand for cars capable of running on non-fossil fuels. The consortium invited tenders from sixty car manufacturers, of which one met the procurement requirements. The consortium had received 3,000 enquiries about purchasing flexible fuel vehicles⁹⁹ by August 2001. The number of vehicles to be procured means that the cost per FFV is SEK 5,000 less than the equivalent petrol-driven model. There were about 40 petrol stations in Sweden selling E85 fuel (85 per cent ethanol and 15 per cent petrol) in August 2001.¹⁰⁰

3.2.2 Measures and instruments in the field of trade and industry

This section first describes trade and industry policy and then steps taken by trade and industry to reduce greenhouse gas emissions. The reason these are presented together is that it is difficult to distinguish between them, since policy in this area is pursued in close consultation with trade and industry itself. It has not been possible to quantify the impact of the measures described on greenhouse gas emissions.

Regional trade and industry policy

Growing awareness of the important role played by local and regional conditions in the growth of trade and industry led to a government regional trade and industry policy initiative in 1998, the main tool of implementation being "regional growth agreements".

These agreements were developed throughout the country in 1998 and 1999. Teams of representatives in each county analysed the conditions for trade and industry and its development needs and agreed on proposed specific measures and the way they were to be funded. Many of these measures are closely related to investment in "environmentally driven" growth.

Competitive edge created by future regulation

International agreements on the environment impose obligations on many countries simultaneously. This gives companies able to offer technology, services and system solutions causing less environmental impact a competitive edge. One area very much at the forefront is the climate issue. It gives Swedish enterprise new

opportunities to export technology and services capable of reducing greenhouse gas emissions. Studies have shown that there is great potential for increasing Swedish exports of climate-efficient technology.¹⁰¹ For example, efficient process control offers scope for reducing consumption of energy in the form of fossil fuels and electricity. Replacing pneumatic tools with electric ones is another way of reducing energy consumption. Sweden has come a very long way in terms of information technology (IT) and there should therefore be great potential for using and refining IT-related products and services so as to find more ways of reducing emissions and energy consumption.

Climate measures taken by trade and industry

Total industrial energy consumption only rose by about 6 per cent in the 1990s, whereas the value of production rose by almost 30 per cent. Efficiency improvements were achieved even more rapidly prior to that decade, while industrial energy consumption rose by almost 60 per cent. However, measured by unit of production, electricity consumption remained almost constant between 1970 and 1988.¹⁰²

Examples of measures taken to improve energy efficiency in industry are:

- Integration of pulp and paper industry and municipality. Supply of heat in the form of steam and secondary heating from a number of factories.
- Technical improvements in the pulp and paper industry, eg, presses to make paper drier even before it reaches the drying section of the paper machine, thus reducing energy consumption.
- Lower carbon dioxide emissions from cement manufacture by introducing a drier process.
- At the Rönnskär smelter, which is Sweden's only large smelting works for non-ferrous metals, energy consumption was reduced by 25 per cent between 1985 and 1996, while production virtually doubled.¹⁰³
- One energy-saving measure being pursued by Swedish industry is more efficient recycling of

⁹⁷ See also the section on fuel-based energy generation.

⁹⁸ Swedish transport authorities' joint environmental report 2000

⁹⁹ FFV Buyer Consortium website: <http://www.etanolbil.com>, 16 August 2001.

¹⁰⁰ Swedish transport authorities' joint environmental report 2000

¹⁰¹ MTD (Environmental Technology Commission) Report 2000:1 IT-based solutions with potential for reducing greenhouse gas emissions – an overview, MTD 2000:17 A survey of manufacturing techniques having environmental benefits, and MTD 2000:2 Swedish products that reduce carbon dioxide emissions. http://miljoteknik.nutek.se/rapporter/rapport_1999_5.pdf

¹⁰² Klimatboken. Industrins grundsyn på klimatfrågan ("The Climate Book – Industry's basic view of the climate issue"). Federation of Swedish Industries 1999

¹⁰³ *ibid.*

materials. If steel use can be reduced by one ktonne, this will reduce carbon dioxide emissions during the raw material manufacturing stage by about 2.5 ktonnes. The emission reduction achieved by using 1 ktonne less copper is 6 ktonnes of carbon dioxide.

Swedish trade and industry is actively engaged in the international standardisation process.

Sweden has a fairly large number of environmentally certified companies: 1,484 have received ISO 14000 certification¹⁰⁴ and 211 have gained EMAS approval.

3.2.3 Measures and instruments in the field of agricultural policy

Agricultural policy exercises a strong influence over the market for agricultural products.

There are 50 or so sets of regulations that can be classified either as trade barriers (customs), intra-community market regulation with intervention measures and export subsidies, general support, various forms of environmental and regional development support, as well as quota systems governing agriculture, the food industry and the retail trade.

Even though most instruments exist on the supply side of the agricultural market, it is on the demand side that there is the greatest potential for reducing the sector's impact on climate. Nowadays there is a pronounced tendency for consumption of animal products to rise in line with a rise in disposable income. Livestock farming generally produces larger emissions of greenhouse gases than arable farming.

This area of policy has no instruments designed specifically to reduce greenhouse gas emissions from the sector. Nor is any policy pursued in order to increase carbon dioxide sinks in agricultural soils.

The CAP is central to the extent, emphasis and profitability of agriculture, and naturally also influences its impact on climate.

In addition to market price subsidies, the CAP also uses different forms of specific, targeted environmental support, which are largely adapted to national conditions. In Sweden, these have been designed to maintain an open cultivated landscape, conserve biodiversity and reduce nutrient leaching. These instruments may also indirectly influence emissions of greenhouse gases, although no systematic evaluation of this has yet been performed.

Carbon dioxide emissions from agriculture derive from direct and indirect use of electric energy, fossil fuels and motor fuels used in agricultural operations, as well as from cultivation of the soil itself. General instruments to reduce fossil fuel use are primarily presented under the section on energy, transport and environmental policy. It is possible to reduce emissions

to some extent by modifying farming methods. For instance, reduced mechanical soil cultivation also reduces diesel consumption, although the result may be a rise in quantities of pesticides used.¹⁰⁵ A change-over to organic cultivation or reduced use of artificial fertilisers for conventional cultivation indirectly reduces energy consumption, as well as emissions of nitrous oxide, in the fertiliser industry. However, no study has been made of the other effects of organic production on emissions and removals of greenhouse gases.

Cultivation of organic soils generates significant carbon dioxide emissions as organic matter in the soil decomposes. No instruments have been brought in to reduce these emissions, and there is no reliable information about the extent to which cultivation changed in the 1990s. A changeover from cultivation of root vegetables and grains to seeded grassland and permanent grazing on soils of this kind could potentially reduce emissions substantially. Annual crops are probably grown on about 40 per cent of the area covered by organogenic soils.¹⁰⁶

Cultivation of energy forest in Sweden has remained steady at about 15,000 hectares in recent years, which, in the long term, may produce a yield corresponding to about 0.5 TWh fuel per year. If it is assumed that this fuel will replace fossil fuels, this will reduce carbon dioxide emissions by about 150 ktonnes a year. About 0.1 TWh of energy forest fuel was used at district heating plants in the latter half of the 1990s. Other biomass fuels based on agricultural products amounted to about 0.4 TWh per year. This was mainly straw used on the farm itself and, to a lesser extent, for district heating. Small quantities of biogas, energy grass and RME are also produced. Production of biomass fuels to date has been small in relation to potential agricultural production of this kind.

Methane emissions largely arise from livestock farming and management of farmyard manure. The number of animals, particularly of beef cattle, therefore does much to determine the size of emissions. Dairy cattle numbers fell in the 1990s, from 576,000 in 1990 to 449,000 in 1999. This has reduced methane emissions from dairy cattle by approximately 20 per cent. The number of beef cattle rose prior to EU membership, and total methane emissions from livestock farming remained more or less the same throughout the 1990s.

The steps taken to improve manure management practices are intended to rationalise activities and reduce nitrogen losses. The changeover from solid manure to slurry management, partly with the help of investment grants, tends to increase methane emissions but reduce those of nitrous oxide. It is difficult to determine the overall effect, but greenhouse gas emissions, calculated as carbon dioxide equivalent

emissions, have probably remained virtually unchanged, or have risen slightly.

Emissions of nitrous oxide from manure management and from agricultural land mainly results from the use of farmyard manure and artificial fertilisers, although nitrogen-fixing crops, green fertilisers and cultivation as such also produce emissions. The use of nitrogenous fertilisers varied in the 1990s, but seen over the period as a whole, sales have remained virtually unchanged. This is partly because the environmental tax was levied on artificial fertilisers throughout the period. The overall change in nitrous oxide emissions from fertilisers over the period is therefore very small.

Since it was introduced in 1995 – 1996, large sums have been paid in environmental support for grazing land and an open agricultural landscape. The area of permanent grazing land is estimated to have increased by about 30 per cent in the 1990s.

Increased grazing of nitrogen-poor semi-natural grazing lands tends to reduce emissions of nitrous oxide because the manure falling on such land releases less nitrous oxide than when animals graze on seeded grassland. However, the various forms of environmental support have relatively little impact because only about 20 per cent of manure dropped naturally by cattle falls on natural pastures. During the period 1996 – 1999 environmental support for restoration of wetlands was applied for in respect of approximately 3,000 hectares of wetlands, small lakes and ponds. This may produce a slight rise in emissions of nitrous oxide, but this is not included in the present calculation method. To some extent, it is a matter of redistributing nitrous oxide emissions within aquatic systems, and the net effect is uncertain.

3.2.4 Measures and instruments in the field of forest policy

The forest impact on the Swedish carbon dioxide balance in a number of quantitatively important ways. One is indirectly, when forest fuels and wood-based waste replace fossil fuels. Another is by way of an increase in the carbon sink in biomass and soils. In addition, wood is used as a raw material instead of materials whose manufacture or decomposition gives rise to greenhouse gas emissions or large-scale energy use (plastics, cement, aluminium, other metals).

The current increase in the carbon sink in forest biomass is occurring because the felling rate is not as great as the rate of forest growth. Swedish forests currently fix approximately 7,000 – 8,000 ktonnes of carbon per year (equivalent to 26,000 – 29,000 ktonnes of carbon dioxide). An increasing proportion of forest industry products are used as fuel after use and possible

reuse.¹⁰⁷ Thus, timber felling contributes to higher biomass fuel production and use and hence lower use of fossil fuels. Timber that is not felled adds to the carbon sink.

Because trees grow slowly in the first 10 – 15 years of their life, the current increase in the carbon sink is primarily the result of forestry and regeneration practices in the decades prior to the 1990s (see the section on forests in Chapter 1). If no further regeneration steps had been taken after 1989, this would only reduce sink growth by less than 10 per cent by 2010. However, after the first 10 – 15 years, the growth rate increases and the carbon dioxide removal rate rises rapidly.

A greater proportion of broadleaf trees has been encouraged and approved since 1994 in order to achieve nature conservation objectives and safeguard biodiversity. This will probably reduce forest growth somewhat in the long term, as compared with a continued marked preponderance of coniferous trees. This is because broadleaf trees generally have a lower rate of stemwood growth than the best kind of coniferous trees on various soils.

Swedish EU membership has not had any pronounced effect on Swedish forest policy, since the EU does not have a common forestry policy.

The rules of consideration etc in the Silvicultural Act¹⁰⁸
Those engaged in forest management must also take account of other public interests.

Many of the detailed forest management regulations following from the forest policy adopted in 1979 were abolished in 1994. These include the clearing and thinning obligation. Grants for drainage ditches, construction of forestry vehicle roads and replanting in certain regions were also abolished. Deep cultivation was banned. Broadleaf species are approved for regeneration to a greater extent. Protection of areas in the form of reserves, biotope protection and nature conservation agreements was strengthened in the 1990s, and priority has been given to ensuring that forest owners are aware of natural areas deserving protection. New general guidelines in 1991 introduced tougher restrictions on the use of nitrogenous fertilisers in

¹⁰⁴ ISO – the International Organization for Standardization. ISO 14000 is a series of standards to help companies and organisations to develop and implemented a structured approach to environmental issues. These internationally recognised methods are a way of constantly improving the company or organisation's environmental performance.

¹⁰⁵ Swedish Board of Agriculture Report 2000:21

¹⁰⁶ Statistics Sweden, Fertilisers in agriculture 1996/97, Na 30 SM 9803

¹⁰⁷ Energiläget 2000 ("The energy situation in 2000"). National Energy

Administration (1TWh = 0.1 Mtonnes C = approx. 0.5 million cubic metres)

¹⁰⁸ Swedish Code of Statutes 1993:533 Act Amending the Silvicultural

Act (Swedish Code of Statutes 1979:429). Gov. Bill 1992/93:226,

report 1992/93:JoU15, rskr. 1992/93:252

¹⁰⁹ Swedish Code of Statutes 1991:2, replacing 1984:3

regions with elevated nitrogen deposition.¹⁰⁹ Since 1993 very few permits have been granted for the digging of new drainage ditches in forest soils. This followed from an amendment to the Nature Conservancy Act¹¹⁰, now enshrined in the Environmental Code.

Deep cultivation is no longer practised in Sweden. The area of deep cultivated forest land declined from the mid-1980s up to the ban in 1994. Some 2,500 hectares were still deep cultivated in 1990. The method is considered potentially to increase the amount of carbon released. It is difficult to say what effect the ending of deep cultivation has had on carbon dioxide removals and emissions. A rough estimate is a saving of 200 ktonnes of carbon (equivalent to about 730 ktonnes of carbon dioxide) in soils in the 1990s, as compared with the situation if deep cultivation of 2,500 hectares a year had continued. However, deep cultivation did produce good regeneration and growth, which means that increased forest biomass would in time probably have counterbalanced the decreased carbon content in the soil. In other respects, soil scarification since the 1980s has largely conformed to the area felled, with a time lapse of a few years. In other words, somewhat more scarification took place at the beginning and end of the decade. Since the 1980s the area scarified has increased three to fourfold as compared with the 1950 and 1960s. In the past more use was made of controlled burning as a scarification method. Controlled burning probably causes a greater reduction in the carbon content of the soil than present scarification methods (harrowing and screefing).

National Board of Forestry recommendations for forest fuel extraction

The National Board of Forestry has said that the main contribution made by Swedish forests to the efforts to combat climate change should be the replacement of fossil fuels and raw materials with forest product-based substitutes.¹¹¹ This applies provided that extraction of fuel in the form of logging residues is carried out in a sustainable and environmentally friendly way, taking account of the needs of forest-dwelling species.¹¹² Annual consumption of Swedish forest and wood fuels has increased by approximately 20 – 25 TWh since 1990. If this energy had instead been produced using coal, annual carbon dioxide emissions would have been 6.6 – 8.3 Mtonnes greater. The National Board of Forestry did not advocate any specific measures to increase fixing of carbon dioxide in biomass or soil humus in the 1990s. This would either have only created a temporary sink or it would have created maintenance costs after the incremental effect had ceased. In neither case is it possible to calculate a final cost per kilogram of carbon dioxide kept out of the

atmosphere, and it is therefore difficult to compare the measure with the cost of reducing fossil fuel use.

The single most important factor behind the increased use of forest fuels is the advent of the carbon dioxide tax in 1991. The National Forest Recommendations for forest fuel extraction were revised in the latter part of the 1990s, the result being fewer restrictions on extraction itself, but a recommendation that ash be returned to the forest.¹¹³

Increased extraction of logging residues reduces the amount of litter decomposing on the forest floor. This effect is temporary and will be negligible in the long term. Increased extraction of logging residues reduces the risk of nitrogen leaching in south-western Sweden and hence probably also the risk of nitrous oxide emissions.

Protected areas etc

Between 1990 and 1995 forest reserves totalling some 184,000 hectares of productive forest were created, accompanied by a ban on further commercial forestry. In addition to this there is biotope protection and areas protected under nature conservation agreements.

These totalled approximately 1,700 hectares and 1,800 hectares, respectively, at the end of 1997. Voluntary areas larger than 0.5 hectares demanding care, which are not felled, totalled 230,000 hectares the same year. Areas less than 0.5 hectares demanding care are left standing under the Silvicultural Act or sometimes voluntarily. These areas total 7,000 hectares (Silvicultural Act protection) and 3,000 hectares (voluntary protection) each year, ie, 5 per cent of the total area felled.

Timber volume will probably increase in protected areas, although it will probably also vary, depending on the extent of storm damage, forest fires, insect attacks etc. As long as there is a large surplus of timber production, however, the net sink increase resulting from the creation of reserves will be limited, since felling on other land is expected to increase.

Additional to the above areas are areas of forest in parts of Sweden where regeneration is difficult, where regeneration felling is not allowed, since regeneration cannot be assured.

This area totals some 230,000 hectares. There are an additional 3.4 million hectares of forested non-productive land (eg, mires and areas of outcropping bedrock), where only a few trees may be felled, subject to very restrictive conditions.¹¹⁴

Environmentally-related certification of forestry

Approximately half of Sweden's forests are environmentally certified. At the end of 2000 some 10 million hectares of forest had been certified in accordance with the FSC (Forest Stewardship Council) standard. A further 1.3 million hectares had been certified under the PEFC (Pan-European Forest Certification) scheme. Some of the actions taken within the forest certification framework may result in a somewhat lower rate of forest growth, eg, voluntary protection of forest with restrictions on forest management and an increased proportion of broadleaf trees. Moreover, under current regulations, controlled burning of a certain proportion of the clear-cut area is supposed to take place. This will increase the area undergoing controlled burning, which was about 150 hectares in 1994 and about 1,000 hectares in 1998. According to one estimate, an average of about 8 tonnes of carbon per hectare (equivalent to around 28 tonnes of carbon dioxide) is lost as a result of controlled burning. There are also studies indicating that a certain reduction in growth often occurs after intense controlled burning. However, a considerable number of endangered species may benefit from an increased area of burnt forest.

Tighter restrictions on the use of nitrogenous fertilisers on forest soils

An increased supply of nitrogen increases the quantity of humus and hence the quantity of carbon in the soil. This in turn means a higher growth rate, which increases timber volume as well as biomass fuel potential. Tighter restrictions on the use of nitrogenous fertilisers on forest soils were introduced in 1991. One result is that fertiliser is not normally used on forest soils south of Lake Mälaren. These new restrictions came about as the result of growing awareness of how nitrogen deposition increases the risk of large-scale nitrogen leaching from forest soils. The normal fertiliser dose for forest growing on firm ground is 150 kg N/ha. This dose is sometimes repeated once or twice at intervals of 6 – 8 years, particularly in northern Sweden. The area receiving nitrogenous fertiliser decreased from about 130,000 hectares a year in the mid-1980s to around 70,000 hectares a year in 1990 and about 20,000 – 25,000 hectares a year between 1992 and 1997. Studies have shown that a fertiliser dose of 150 kg N/ha causes a temporary growth of the mor layer in soil of an average of approximately 1.3 tonnes of carbon per hectare (equivalent to 4.8 tonnes of carbon dioxide per year).¹¹⁵ However, the dose must be repeated at regular intervals (perhaps every other decade) if the increased mor layer is to be retained.

Assuming that the area receiving fertiliser in 2000

was as large as that in 1997, the reduction in fertiliser use in the 1990s nonetheless meant that a total of 600 ktonnes of carbon (equivalent to 2,200 ktonnes of carbon dioxide) was not fixed in soils in the 1990s.

3.2.5 Measures and instruments in the field of environmental policy, not including waste policy

Local Investment Programmes for ecological sustainability

Parliament decided in 1997 to provide funding for "Local Investment Programmes for ecological sustainability" (LIPs). The total appropriation for 1998 – 2003 is estimated at SEK 7.2 billion. Funding will be allocated to those municipalities whose LIPs best contribute to ecological adjustment. The stated criteria are that the programmes should:

- reduce the burden on the environment;
- increase the efficiency with which energy and other natural resources are used;
- encourage the use of renewable raw materials;
- increase reuse and recycling;
- help to conserve and enhance biodiversity;
- safeguard our cultural heritage; and
- help to improve the circulation of plant nutrients in an ecocycle.

The programmes should also help to create jobs. In addition, funding is available for municipalities to carry out information and public education campaigns relating to the programme. In total, almost half of all municipalities in Sweden have received funding under the scheme. Climate-related funding up to February 2001 is estimated to account for SEK 2,629 million of the total figure of approximately SEK 5.3 billion granted under the investment scheme. Grants in the climate and energy area have primarily been given for investment in the following:

¹¹⁰ Swedish Code of Statutes 1964:822. Nature Conservancy Act. Gov. Bill 1964:148; 3LU 1964:41, rskr. 1964:371. Statute repealed in 1999.

¹¹¹ Jordbruket och skogsbruket som resurs i klimatarbetet ("Agriculture and forestry as a resource in combating climate change") (1993). National Board of Forestry dnr 601/93 SA 10.04

¹¹² Skogsbränsle, hot eller möjlighet? – vägledning till miljövänligt skogsbränsleuttag ("Forest fuels, a threat or an opportunity? – A guide to environmentally friendly extraction of forest fuels"). National Board of Forestry 2001. ISBN 91-88462-48-x

¹¹³ Rekommendationer vid uttag av skogsbränsle och kompensationsgödsling ("Recommendations for abstraction of forest fuels and compensatory use of fertilisers"). Notice 2-2001, National Board of Forestry

¹¹⁴ Gov. Bill 1997/98:158. Evaluating achievement of forest policy

¹¹⁵ Forest Impact Analyses 1999. National Board of Forestry 2000, ISSN 1100-0295

- Energy saving in residential and other properties.
- Utilisation of surplus heat for use as district heating.
- Expansion of district and local heating, mainly for use of biomass fuels.
- Conversion of oil-fired boilers in individual houses to heating based on renewable energy sources.
- Extraction of methane for heating or as a motor fuel by digestion of sewage sludge or household waste.
- Renewable motor fuels and vehicles for goods and passenger transport.
- Development of cycleway networks.
- Measures in the field of solar energy, wind power and hydropower.

These investments are currently in progress, and final reports have only been presented for a limited number of programmes. However, the application material submitted by municipalities, and responses to a questionnaire sent to them, provide an indication of the extent of the environmental impacts of the grants authorised to date. According to municipal application documentation, a reduction of 1,600 ktonnes carbon dioxide equivalent emissions will be achieved (see Table 3.4).

The programmes include measures to extract or digest waste for biogas and use it for energy purposes or as a motor fuel. Once the measures have been decided, a study is planned into the way the biogas measures break down between collection of methane that would otherwise have leaked from landfill, and methane production. Current data is far too uncertain to use as the basis for a quantitative assessment. Accordingly, the above table does not include the effect of reduced methane emissions.

According to the questionnaire responses given by municipalities, investments completed in 2000 will

Table 3.6
Climate-related projects under local investment programmes (LIPs) for ecological sustainability.

Project	Investment grants SEK millions per year	Estimated emission reduction ktonnes CO ₂ equivalent emissions
Changeover to renewable energy	1,278	951
Measures in the transport sector	507	108
Improving energy efficiency	496	470
Biogas plants and waste management	347	43
Total	2,628	1,572

Source: Ministry of the Environment

reduce carbon dioxide emissions by 700 ktonnes and save 390 GWh of electric energy. If it is assumed that this electric energy will replace gas combination power or coal-fired condensing power, a further carbon dioxide saving of 100 – 300 ktonnes will be achieved. The scheme has not yet been concluded and further carbon dioxide emissions are expected.

Increased consideration of the environmental dimension in public administration

The government has delegated responsibility for integrating concern for the environment in all sectors of society in a number of bills.¹¹⁶ Sectoral responsibility formed part of the basis for environmental policy in the 1990s. This applies both to legislation and to development of instruments used in ecocycle policy, such as producer responsibility.

Specific sectoral responsibility for ecologically sustainable development means that each government agency is responsible for taking steps to achieve this development in its own sector. The agency's responsibility includes identifying its own role and the way activities in that sector influence progress made towards ecological sustainability, producing material in the form of potential sectoral objectives and measures and describing their socio-economic implications, striving to ensure implementation of the measures, continuously monitoring developments in its field of responsibility and working with others and informing them about progress being made in the sector. Production of background material should form a basis for quantifying sectoral objectives, where these are appropriate.¹¹⁷

Environmental management systems are being developed in public administration, both at government agencies and at the Cabinet Office. Environmental management constitutes a systematic approach to the environmental dimension and gives clear guidelines and objectives in the form of central management documents, defined divisions of responsibility, procedures for monitoring progress and reporting of results. Environmental management systems have been shown to be an effective way of integrating environmental considerations in activities or operations. At present, 138 agencies have been instructed by the government to implement environmental management systems. More being so instructed in 2001. It is still difficult to assess the environmental impacts of environmental management systems.¹¹⁸

General rules of consideration in the Environmental Code

The fundamental provisions of the Environmental Code¹¹⁹ essentially apply to all human activities that are potentially harmful to the environment. The general

rules of consideration are most central. They impose a duty to ensure that activities are conducted and measures taken so as to avoid harm to human health or the environment. Sound management of land, water and other must also be promoted. Unless otherwise provided, the provisions of the Environmental Code apply to all operations and measures affecting the environment. The mere risk of harm is sufficient to create an obligation to take precautionary measures.

Since the purpose of the Environmental Code is to promote sustainable development, the scope for imposing conditions, already existing under the Environment Protection Act¹²⁰, has now been substantially widened.

The following general rules of consideration set forth in the Environmental Code are of particular relevance to greenhouse gas emissions.

- The "sound management" principle requires that the potential for reuse and recycling must be exploited, and that use of renewable energy sources is to be given priority. The main aim of the rule is to conserve raw materials and energy.
- The "product choice" (or "substitution") principle imposes an obligation to choose the chemical product or biotechnology organism representing least risk to human health and the environment.
- The "best available technique" (BAT) principle means that commercial operations must use the best available technique or technology to avoid damage. It must be technically and economically feasible to use the technique on an industrial scale in the industry in question.
- The "reasonableness" rule means that the obligations to take measures imposed by the rules of consideration described above apply insofar as it is not unreasonable to meet them. When considering this issue, account must be taken of the benefit of the precautionary measures placed in relation to their cost. Environmental quality standards must not be disregarded when weighing up these factors. It is the operator's duty to show that the cost of a given measure is not environmentally justified, or that it is unreasonably onerous.

The impact of the general rules of consideration on greenhouse emissions has not been quantified. In addition to these general rules of consideration, there are rules governing certain types of operations, such as peat abstraction, agriculture, fuel characteristics, handling of chemical products, waste.

Regulations issued under the Environmental Code may be used to promote achievement of the climate objective. General regulations governing hazardous activities

may be issued, eg, to reduce the impact on climate of an entire sector or to regulate a cross-sectoral issue.

This possibility has not yet been used, however.

Operating permit procedures under various environmental laws

Traditional permit procedures are a tried and tested instrument, which have been found to be effective in reducing other kinds of emission and which now also apply to greenhouse gas emissions.

All industrial operations in Sweden are subject to the Environmental Code, and also to a substantial proportion of EC legislation. The IPPC Directive¹²¹ governs emissions and other environmental impacts caused mainly by large energy and industrial plants (including those already in existence). The directive is also intended to harmonise technical standards within the community and thereby prevent industrial companies from choosing to operate or move to member states where environmental standards are lower. Under the IPPC Directive, emission limit values and other conditions must be set individually by interpreting the overall requirement that BAT be used. The aim of integrated environmental permit procedures is to allow permit decisions reflecting that which is best for the environment as a whole. The IPPC Directive also governs energy use at industrial facilities and lays down efficiency requirements.

As was previously the case¹²², the authority considering the permissibility of hazardous activities can attach conditions to the operating permit. Specific conditions relating to climate are rare, one reason being that there is legislation specifically designed to prevent greenhouse gas emissions. Some permits formerly granted by the National Licensing Board for Environment Protection under the Environment Protection Act reflect a desire to prevent further emissions of greenhouse gases. However, wind power operations, which are advocated as a way of reducing the impact on climate caused by the energy sector, are also classified as a hazardous activity.

¹¹⁶ Gov. Bill 1987/88:85. Environmental policy in the 1990s. Gov. Bill 1990/91:90 A good living environment 117 Gov. Bill 2000/01:130. Swedish environmental objectives – subsidiary objectives and strategies

¹¹⁷ Gov. Bill 2000/01:130. Swedish environmental objectives – subsidiary objectives and strategies

¹¹⁸ Government communication 2000/01:38 Sustainable Sweden – evaluating the effectiveness of measures to achieve ecologically sustainable development

¹¹⁹ Swedish Code of Statutes 1998:808. Environmental Code. National preparatory works; Gov. Bill 1997/98:45, report 1997/98:JoU20, rskr. 1997/98:278

¹²⁰ Swedish Code of Statutes 1969:387. Environment Protection Act. Repealed 1 January 1999. Gov. Bill 1969:28, 3LU 1969:37; rskr. 1969:281

¹²¹ Directive 96/61/EC

¹²² Under the Environment Protection Act 1968:387

There are four instances of permit decisions between 1992 and 1997 in which conditions were stipulated for nitrous oxide emissions. Apart from specific emission conditions, actual emissions were also influenced by other permits granted by the National Licensing Board for Environment Protection. One example was a permit for burning fossil fuels, which was for a limited time and stipulated maximum fossil fuel quantities. The use of peat as a fuel has also been regulated in terms of carbon dioxide emissions. Conditions have also been imposed in relation to collection and burning of landfill gas (methane).¹²³

One example of a permit procedure under the Natural Resources Act¹²⁴ was expansion of Stockholm-Arlanda Airport, involving construction of a third runway. The government permit decision stipulated that the Civil Aviation Administration should take steps to minimise total emissions of carbon dioxide (and other substances) from operation of the airport, as well as terrestrial traffic to and from the airport. As a guide, it was stated that emissions in 2000 ought not to exceed those in 1990. The Civil Aviation Administration was also ordered to submit annual emission reports to Stockholm County Administrative Board.¹²⁵ This permit decision was a factor contributing to the construction of the railway link between Stockholm and Arlanda Airport.

The effects of the Environmental Code (or the Environment Protection Act) in terms of greenhouse gas emissions have not been evaluated. Bearing in mind the limited number of permits to which specific climate-related conditions have been attached, it is considered that the Environmental Code has so far had a limited effect in comparison with other instruments.

The Refrigerants Ordinance

Use of HFCs for certain applications in Sweden is governed by the HFCs Ordinance, by the Swedish EPA regulations governing refrigeration and heat pump units ("the Refrigerants Ordinance"¹²⁶), and by the regulations governing the handling of fire-fighting equipment containing halons etc¹²⁷. Use and emissions of fluorinated greenhouse gases, particularly those governed by the Kyoto Protocol, are on the increase. One reason for this is that Sweden has chosen to quickly replace ozone depleting substances, which has resulted in a rapid increase in the use of HFCs.

Efforts made by the refrigeration industry to reduce leakage from refrigeration units have reduced emissions from 25 – 30 per cent of the installed quantity of refrigerants in the early 1990s to around 3 – 5 per cent. One of the main instruments for reducing and preventing refrigerant emissions is the introduction of compulsory inspection of new and existing refrigeration units containing HCFCs, HFCs or other refrigerants.

Current inspection procedures are as follows:

- Installation inspection when new units become operational.
- Annual site inspections (ie, at least once a year).
- Inspections in conjunction with service and repair of refrigeration systems.
- These inspections may only be performed by refrigeration companies possessing the necessary permit, ie, accredited inspection bodies.

Another important instrument is the duty to report for those operating refrigeration units.

The operator must submit the results of annual inspections and an annual report on relevant refrigerant handling at the same site to the regulatory authority.¹²⁸

The effectiveness of the Refrigerants Ordinance in reducing greenhouse gas emissions has not yet been evaluated.

3.2.6 Measures and instruments in the field of waste policy

Measures and instruments to reduce the quantity of organic waste going to landfill reduce the potential for methane formation. These measures only take effect in the long term, since methane production declines slowly. The estimated combined effects of measures to reduce methane emissions to the atmosphere are presented below. It is difficult to distinguish between the effects of various measures, as they act in concert and sometimes overlap.

Ban on landfilling burnable and organic waste

The most significant instrument for limiting waste going to landfill is the ban in the Public Cleansing Ordinance on landfilling sorted burnable waste.¹²⁹ This ban enters into force in 2002; preparations are already being made. The landfill ban will be extended to cover organic waste as from 2005.¹³⁰ These two instruments are expected to substantially reduce methane emissions by 2010. Methane emissions from landfill sites will eventually fall still further.

The EC Landfill Directive was adopted in April 1999.¹³¹ The directive has now been incorporated in Sweden legislation by the Landfill Ordinance (2001:512), which entered into force in July 2001.¹³² The directive provides a minimum requirement of a 35 per cent reduction in biologically degradable household waste going to landfill as compared with 1995. The preamble of the directive states that measures taken to reduce landfilling of biologically degradable waste should also aim to encourage separate collection of that waste.¹³³ However, the Swedish landfill bans go further than the Landfill Directive.

Municipal public cleansing regulations under the Environmental Code

Under the Environmental Code, every municipality must have public cleansing regulations governing waste management and a waste plan for reducing the quantity of waste and degree of hazard it poses. This planning has done much to help municipalities improve their environmental performance and involve municipal inhabitants in waste sorting and similar activities. A national waste strategy is intended to provide a coherent approach to waste management.¹³⁴

Municipal public cleansing charges

Municipalities are entitled to charge for public cleansing. These charges are levied on households, indirectly via housing companies or directly on householders, and are set in the form of a municipal public cleansing charge. Differential charges, intended to reduce waste quantities, are common. The charge per tonne of household waste, both for larger properties and individual households, is 5 – 6 times higher in the municipality with the highest charges than it is in that with the lowest. Notwithstanding the introduction of the landfill tax in 2000, a number of municipalities made the same charge or lowered the charge between 1999 and 2000.

Installation of gas recovery equipment at landfill sites

The first landfill gas recovery unit began operating in the 1980s; their number rose steadily throughout the following decade. A statutory requirement that methane gas be collected will be introduced when the Landfill Directive becomes law in Sweden. Another way of preventing methane emissions is to cover the landfill surface with a methane oxidising layer. The efficacy of this method varies depending on landfill structure and climate. Some doubts remain as to efficacy and further research is needed.

At present there are no instruments designed to influence net emissions of carbon dioxide in the waste sector. The forthcoming landfill bans will probably increase the total quantity of waste going to incineration. Some waste fractions, particularly plastics, originate from fossil oils and their incineration will therefore generate carbon dioxide. At present there are no reliable figures on the percentage of waste originating from fossil oils.¹³⁵ In 2000 the government appointed an expert to carry out a study into the possibility and appropriacy of introducing an incineration tax on waste as a supplement to the landfill bans.

3.2.7 Local measures to combat climate change

Apart from central government efforts in the field of energy and climate, there are also local and regional initiatives. A description is given below of working being done at a number of "challenger municipalities", the Swedish regional energy offices and as part of the EU renewable energy "Campaign for take-off".

Twelve regional energy offices

Twelve regional energy offices have been set up in Sweden with the help of part-funding from the EU SAVE programme. In most cases, the principals and providers of part-funding are municipalities, the Swedish Association of Local Authorities and/or county administrative boards and county councils. The first offices started operating in 1996. It is estimated that local funding totals at least SEK 14 million. The EU has contributed approximately the same amount. The general task of regional energy offices is to ensure that energy issues are taken into account in the region. Their services include:

- energy supply, including renewable energy;
- recycling energy from waste;
- conservation by local authorities, private enterprise, cooperative societies and individuals;
- small and medium-sized companies, including construction and installation companies;
- creation of regional systems from local resources (firewood, small-scale hydropower and solar energy);
- the public and private service sectors;
- development, city and housing planning;

¹²³ Swedish EPA 2000. Report on carbon dioxide and other greenhouse gases to the EU under Council Decision 1999/296/EC

¹²⁴ Swedish Code of Statutes 1987:12. Conservation of Natural Resources Act. Gov. Bill 1985/86:3, BoU 1986/87:3; rskr. 1986/87:34

¹²⁵ Government decision 15 August 1991

¹²⁶ Code of Statutes of the Swedish EPA 1992:16. Swedish EPA regulations on refrigeration and heat pump units containing CFCs, other CFCs, halons, HCFCs and HFCs ("The Refrigerants Order").

¹²⁷ Code of Statutes of the Swedish EPA 1993:7. Swedish EPA regulations on the handling of fire extinguishers containing halons etc

¹²⁸ Swedish EPA, summary of the 1998 report on the use of CFCs/HCFCs/HFCs as refrigerants in Sweden. September 2000. Also Ordinance on environmental penalty charges, Swedish Code of Statutes 1998:950

¹²⁹ Swedish Code of Statutes 1998:902 Public Cleansing Ordinance. EGTL194/75, p 39; EGTL135/96, p 32

¹³⁰ *ibid.*

¹³¹ Directive 1999/31/EC

¹³² Ordinance 2001:512, decided on 7 July 2001

¹³³ Government instruction to the Swedish EPA, 29 June 2000

¹³⁴ Government communication 1998/99:63

¹³⁵ It should be mentioned that landfilled waste whose carbon content is of biogenic as well as fossil origin may give rise to emissions of methane, and that the Kyoto Protocol stipulates that these emissions must be included in the national emission inventories. If the same waste is instead recycled by incineration for energy extraction, only carbon dioxide emissions from the fraction of the waste of fossil origin is included.

- municipal and regional administrative infrastructure: buildings, public lighting, car and bus fleets, water supply and sewage systems;
- supply of independent energy advice.

The "Challenger Municipalities" project

The Swedish Society for Nature Conservation (SNF) started a project entitled "Challenger Municipalities"

in 1998. Fifteen or so municipalities applied to participate in the project jointly with local branches of SNF in each municipality. Säfte, Övertorneå, Lund, Växjö and Stockholm were selected; Stockholm was replaced by Uppsala following the 1998 general election. The aim of the project is for the municipalities ultimately to stop using fossil fuels. Methods of achieving this include improved energy efficiency, reduced transport

Table 3.7
Action by the "Challenger Municipalities" to reduce carbon dioxide emissions.

Municipality	Base year	Target year	Target
Lund	1995	2005	25% reduction from road traffic
		2050	75% reduction
Säfte	1995	2025	50% reduction
Växjö	1993	2025	50% reduction
Uppsala	1990	2010	25% reduction from traffic
Övertorneå	1990	2020	50% reduction

Source: Swedish Society for Nature Conservation

Table 3.8
Costs and effects of conversion projects under AIJ¹³⁹.

Country	No. of projects	Total cost SEK millions	Accum. reduction of CO ₂ during life of the projects, ktonnes	Cost per reduced tonne CO ₂ (SEK)
Estonia	9	57	1,311	43
Latvia	14	59	1,229	48
Lithuania	8	54	625	87
Russia	8	41	508	81
All	39	211	3,675	57

¹ Total cost = investment costs + transaction costs as described above.

Source: National Energy Administration

Table 3.9
Costs and effects of measures for distribution of district heating under AIJ.

Country	No. of projects	Total cost SEK millions	Accum. reduction of CO ₂ during life of the projects, ktonnes	Cost per reduced tonne CO ₂ (SEK)
Estonia	9	17	190	87
Latvia	5	14	71	203
Lithuania	1	1	4	370
Russia	0	0	0	0
All	14	32	265	122

¹ Total cost = investment costs + transaction costs as described above.

Source: National Energy Administration

requirements and less use of fossil fuels for heating and transport. The idea is that efforts to achieve this should be made on the basis of local conditions and that the municipalities should serve as an example to other municipalities. The project is being partfunded by the National Road Administration. The table below shows the targets each municipality is trying to achieve. The project was concluded in 2001.

Municipal climate objectives

92 of Sweden's 289 municipalities had adopted greenhouse gas emission reduction objectives by early 2000.¹³⁶ 62 of them has set a specific percentage target and year. No analysis has yet been made of the feasibility of these objectives or the measures being taken to achieve them. If the objectives are achieved, it is estimated that the total emission reductions in these municipalities will be about 4,500 ktonnes a year by 2010.¹³⁷

Swedish members of the Renewable Energy Partnership

Seven Swedish municipalities are participating as "Renewable Energy Partners" in the EU Campaign for take-off.¹³⁸ These are the five "Challenger Municipalities", together with Gotland and the part of Malmö municipality included in Bomässan 2001 Housing Exhibition.

3.2.8 The Climate Convention pilot programme for AIJ and other measures taken outside Sweden

Sweden has long had an investment programme to promote energy efficiency and renewable energy in the Baltic States and other parts of eastern Europe. These projects were subsequently incorporated in the Climate Convention pilot programme for activities implemented jointly (AIJ). Total funding of SEK 627

million is being provided for these purposes between 1993 and 2002.

The aim of the programme is to reduce emissions of carbon dioxide and other substances affecting climate, to improve the efficiency of energy systems in the Baltic States, and to introduce renewable sources of energy. To date over 70 projects have been initiated by Swedish authorities, of which 64 have been reported to the UN Climate Convention Secretariat as "pilot projects for activities implemented jointly". The total cost of the 64 projects is put at SEK 271 million, of which SEK 197 million is being provided by recipient countries and SEK 74 million by Sweden. The total reduction in carbon dioxide emissions is estimated at 4,000 ktonnes. The projects have been funded by

¹³⁶ The figure given for the number of municipalities with climate objectives has been taken from a publication entitled Miljöeko, No. 1/2000. The figures are based on that publication's annual questionnaire sent to Swedish municipalities, which is then used to rank the municipalities' environmental performance.

¹³⁷ The calculation has been made by the Swedish Society for Nature Conservation

¹³⁸ The figures given on the number of municipalities is from the EU Commission's website: http://europa.ue.int/comm/energy/en/renewable/idae_site/deploy/tabla_sweden_all_title.html, 18 August 2001

¹³⁹ Also distribution measures in a few cases

Table 3.11
All projects

Country	No. of projects	Accum. reduction of CO ₂ during life of the projects, ktonnes	Cost per reduced tonne CO ₂ (SEK)
Estonia	21	1,531	58
Latvia	22	1,306	61
Lithuania	9	629	88
Russia	12	538	87
All	64	4,004	67

Table 3.10
Costs and effects of measures in buildings to improve efficiency under AIJ.

Country	No. of projects	Total cost SEK millions	Accum. reduction of CO ₂ during life of the projects, ktonnes	Cost per reduced tonne CO ₂ (SEK)
Estonia	4	15	29	527
Latvia	3	6	5	1,170
Lithuania	0	0	0	0
Russia	4	6	29	196
All	11	27	63	428

¹ Total cost = investment costs + transaction costs as described above.

Source: National Energy Administration

favourable loans to the recipient countries; Sweden has also paid for consultancy costs, eg, preliminary studies. Loans to plant owners or the like generally extend over 10 years, with two years of interest-only payments. The aim is that the projects should repay the investment cost more quickly than the loan term.

The projects comprise boiler conversions, ie, change-over to biomass fuels, upgrading of the district heating network, and energy-efficiency improvements in buildings. On average, boiler conversion projects are expected to repay their costs over five years. The repayment period for heat distribution projects varies between 2 and 12 years, depending on the extent to which new pre-insulated district heating pipes are needed. The measures solely intended to improve energy efficiency in buildings repay their costs in 7 – 9 years, whereas renovation work deemed necessary to achieve efficient energy use in buildings takes 16 – 20 years to pay for itself.

The costs are broken down into investment and transaction costs. Investment costs are the investment made by a donor country in the recipient country. (In Sweden's case, this investment is financed by way of loans, which are to be repaid.) Transaction costs consist of consultant support and administrative costs and, in some cases, also forgiveness of loans or unpaid interest. Tables 3.8 – 3.10 show the cost per unit of emission reduction over the lifetime of the projects per country and project category. The projects run for between 10 and 25 years. Costs include investment and transaction costs. These figures are only a rough guide and give an indication of the upper limits of actual reduction costs.

The AIJ projects concluded to date show that it is possible to implement projects meeting the criteria for the flexible mechanisms, ie, that they are cost-effective and that major emission reductions can be achieved with fairly modest means.

Further AIJ pilot phase projects cannot be carried out because new projects must take place as creditable projects under a forthcoming national climate investment programme.

However, the National Energy Administration is completing a few projects decided prior to 1999 but which, for various reasons, could not be started until after that year.

The programme has been continuously evaluated by local experts and independent consultants and has attracted international attention because it has been cost-effective and worked well. The programme has attracted attention not only because of greenhouse gas emission reductions, but also because of other positive effects, both in Sweden and in recipient countries. The programme has had a beneficial effect on attitudes to

environmentally friendly energy supply and use among people involved in, or coming into contact with, the programme in recipient countries. Attitudes have changed and knowledge (eg, about the UN Climate Convention) has improved. Moreover, the programme has had a positive influence on the development of a domestic market for energy products, particularly biomass fuels and biomass fuel-burning boilers. The programme has also helped to establish long-term cooperation between Swedish companies and companies in recipient countries, which includes joint operations in other markets. A further favourable effect of the programme has been to enhance relations between Swedish and Baltic ministries and public authorities.

Other international climate policy programmes

Sweden is working together with the World Bank on two programmes involving measures to protect the climate. In the first, Sweden is supporting the World Bank Prototype Carbon Fund (PCF), providing funding of about SEK 90 million. The PCF aims to produce creditable emissions reductions from projects within the scope of AIJ and the Clean Development Mechanism (CDM), and to heighten public awareness of this. The other programme is CDM-assist, which aims to develop the CDM itself.

Sida is funding energy-related projects as part of the development assistance it supplies to central and eastern Europe. These mainly involve consultancy services, preliminary studies, seminars and the like. For instance, just over SEK 18 million was spent on projects of this kind in the district heating sector in Latvia, Lithuania and Russia in 1998 and 1999. Almost SEK 8 million was spent on improving energy efficiency in Poland, Russia and Ukraine.

Swedish agencies are conducting a number of projects funded out of the "Baltic billion", which was earmarked for helping to develop industry and trade with countries in the Baltic region. The first billion funded energy projects, eg, district heating projects and sulphur removal projects. Parliament allocated a further billion kronor in 1998. This is to be used to develop trade and industry in the Baltic region over a five-year period (1999 – 2003).

These additional funds are to be used to implement the support measures recommended by the Baltic Commission to meet the needs of trade and industry. The government is delegating responsibility for carrying out these measures to government agencies and bodies in receipt of government funding. The programme focuses on seven topic areas, of which environmental technology/environmentally-driven growth is one. The funds are also to be deployed in the energy sector,

among other things to improve the efficiency of heating supply in Riga and Vilnius.

Some of the development assistance provided by Sida takes place in cooperation with the World Bank. These two, together with other Swedish parties, have contributed funding for district heating improvements in Estonia's three largest cities (Tallinn, Tartu and Pärnu), as well as modernisation of small and medium-sized combustion units. The programme required funding of approximately SEK 600 million, of which Sweden provided SEK 100 million in the form of credit and paid for consultancy services and institutional development. These projects formed part of scheduled investments in eastern Europe by the World Bank from 1991 to around 1998.

3.2.9 Forthcoming measures

According to Climate Convention guidelines, countries must specify the measures or instruments they plan to introduce to reduce greenhouse gas emissions. A considerable number of studies have been made in recent years to examine the scope for reducing emissions of greenhouse gases. This section deals with measures the government has decided on in decisions or policy statements. It does not include measures proposed by official commissions, public authorities or NGOs but not yet dealt with by the government.

Tradable permits

At the government's instigation, a special study has been made into the possibility of introducing a system of tradable permits in Sweden.¹⁴⁰ The study also examines issues raised in an EU Commission green paper proposing an EU system of trade in permits for companies producing combined power and heat and for energy-intensive industries. Commission work on an EU system continues. Sweden is supporting this process. The government has recently appointed a parliamentary commission of enquiry to examine outstanding issues concerning tradable permits and other flexible mechanisms.¹⁴¹

Project-based mechanisms under the Kyoto Protocol

The energy policy decision of 1997 included the allocation of funds for climate-related measures in other countries. Funding has so far focused on AII pilot projects. The government is planning to use the remainder for project-based mechanisms under the Kyoto Protocol.

The National Energy Administration is currently drawing up a strategy for implementing the flexible mechanisms. Among other things, the administration will present an analysis of suitable partners with

which to enter into agreements and the potential for cooperation with various countries. The further National Energy Administration programme is named SICIP (Swedish International Climate Investment Programme).

Sweden will be working with the World Bank to prepare investment projects suitable for the Clean Development Mechanism (CDM) under the Kyoto Protocol. The first priority will be to identify a potential CDM project as part of the World Bank's "CDM assist" programme for Africa, which also focuses on measures to develop capacity.

Continuing moves towards green taxation

The Green Tax Commission report¹⁴² considered that there was scope for a further shift towards green taxation over the next fifteen years equal to the shift effected in the 1980s and 1990s. In spring 2000 parliament decided that green taxation changes totalling some SEK 30 billion were to be made between 2000 and 2010.

To continue the move towards green taxation, a number of areas will first have to be further examined. These include tax relief for energy-intensive industry and industries operating in the face of international competition, and also taxation of the transport sector.

Two parallel commissions of enquiry are examining these issues. They are the Swedish Committee on Energy Taxation of the Business Sector¹⁴³, and the Swedish Road Traffic Taxation Commission.¹⁴⁴ As far as the latter area is concerned, the aim is to increase the overall environmental effect of road traffic taxation. The government has also decided that certain aspects of waste taxation are to be examined.¹⁴⁵

Green certificates combined with a quota system to promote renewable electricity production

As may be seen from earlier sections, Sweden has introduced a number of instruments to promote the production of electric energy from renewable sources. The premises on which subsidies in this area are based have changed in a number of respects. Sweden has deregulated its electricity market in line with the principles of market economics so as to improve competition between electricity suppliers. This has also altered the situation in relation to the instruments employed. Electricity prices for end users have fallen

¹⁴⁰ Swedish Government Official Report SOU 2000:45

¹⁴¹ Directive 2001:56. A system and regulations for the flexible mechanisms of the Kyoto Protocol

¹⁴² Swedish Government Official Report SOU 1997:11

¹⁴³ Directive 2001:29

¹⁴⁴ Directive 2001:12

¹⁴⁵ Directive 2001:12

since the electricity market was reformed in 1996. This means lower revenues per kilowatt hour for suppliers and producers. Consequently, the need for financial support for small-scale and often environmentally friendly electricity generation has increased in many instances, notwithstanding the cost reductions that have been made.

The advent of the Kyoto Protocol has brought the spotlight to bear on measures to support renewable energy forms so as to reduce electricity production based on fossil fuels. The EU has started work on drafting a directive giving renewable energy sources access to the single electricity market. The aims of the directive are based on the Commission white paper on renewable energy sources, which sets a target of a 12 per cent market share for these sources within the union as a whole by 2010, compared with the current figure of 6 per cent.

In the light of the above, parliament has decided in 2001 to establish a new system to promote renewable electricity production, scheduled to take effect on 1 January 2003. The system will be based on trade in certificates combined with an obligation to include in the supply or purchase of electricity a certain proportion of renewable energy meeting certain environmental criteria.

Trade in certificates combined with quotas will constitute a system of support financed within the market, which will increase its durability. The model will also create business opportunities for market players and create a market dynamic that will provide scope for cost-effectiveness and technological development without disturbing the workings of the electricity market. The government considers these to be important objectives of a future support system. The aims of the support system should be to:

- promote the creation of new electricity production from renewable energy sources meeting certain environmental criteria;
- encourage technological development and cost-effectiveness;
- create reasonable conditions for existing plants;
- avoid disruption of the operation of the electricity market;
- create a stable regulatory framework, regardless of the state of national finances
- facilitate international harmonisation.

A special study is being made to examine the technical issues and propose necessary legislative amendments.¹⁴⁶

Planning objectives for wind power production

In the finance bill of spring 2000¹⁴⁷, the government pledged that it would present a proposed appropriate planning objective for development of wind power to parliament at a later date. An important part of adjusting the energy system is to create the right economic conditions for renewable electricity production. Wind power has a key role to play in this process and can also help to achieve several of the national environment quality objectives set by parliament in 1999.¹⁴⁸ Being properly prepared for further development of wind power is therefore of strategic importance. The government considers that a planning objective for wind power may serve as a suitable tool for achieving this end.

The government has instructed the National Energy Administration to propose areas on land and out to sea that are particularly suitable for wind power plants, and to propose planning objectives for wind power. The government has also decided to appoint a working group to carry out a study on the general potential for siting wind power plants in marine and mountain areas.

The National Energy Administration has proposed that the planning objective for wind power expansion be set at 10 TWh over a period of 10 – 15 years. A planning objective for wind power is defined as an annual production volume to serve as a target and the basis for necessary planning, to enable large-scale development of wind power in Sweden. The National Energy Administration report has now been referred to various bodies as part of the consultative process. A national planning objective is to be broken down at regional level to serve as an operative basis for the county administrative boards in their planning and in municipal planning for wind power. It is essential that the potential offered by wind power is systematically incorporated in general municipal planning.

Development of terrestrial and coastal wind power stations at sites with the right wind conditions will continue, primarily along the coasts of Sweden. Large wind power stations out to sea will have to be built to achieve sufficient electricity production. Limitations in transmission capacity and other factors mean that large-scale establishment of wind power in the mountains and other parts of northern Sweden will require heavy investment in the grid.

Tools to aid public procurement in the field of energy

Public procurement in Sweden totals some SEK 300 billion a year, of which about SEK 100 billion comprises products and SEK 200 billion services and contracting. One task of the Ecologically Sustainable Procurement Commission¹⁴⁹ is to produce common Internet-based tools for the entire public sector, which are to serve as

models for ecologically sustainable procurement. The following are some of the premises on which the commission is working:

- The tool must serve as an aid/guide when setting environmental standards in public procurement. These standards must be high, and the tool must be designed within the confines of current laws.
- Public organisations themselves decide the environmental standards to be included in the tool, although manufacturers, suppliers and environmental organisations must be given the opportunity to express their opinion of relevant issues and important matters of principle concerning the content of, and alterations to, the tool.
- The environmental standards set by the tool must be high and follow developments in environmental knowledge and know-how. The commission therefore proposes that a scientific council be established for quality assurance of these standards.

A working group has evaluated the effect of introducing energy efficiency requirements in public procurement and has drafted guidelines for procurement of high-energy equipment, taking account of aspects such as quality requirements, occupational health and safety, operation and financial considerations. Procurement information has so far been produced for pumps, fans, lighting, ventilation, refrigeration compressors and compressed air. These guidelines are intended to help purchasers and, among other things, have been based on calculation formulae for life-cycle energy costs. It has been estimated that the effect of setting more stringent energy efficiency standards will reduce the electricity requirement by 2 TWh after 10 years, which may reduce carbon dioxide emissions by 700 – 1,700 ktonnes a year by 2010.

Improved industrial energy efficiency

Over the last decade, it has become increasingly common in Sweden and other countries for companies or trade associations to conclude some form of "environmental agreement" with the state, with a view to limiting the environmental impact caused by trade and industry. These agreements are usually combined with some form of sanction that will be triggered if commitments are not met, eg, legislation in the area, higher environmental taxes or charges. Several projects are currently in progress at a number of public authorities and agencies to examine the scope for using environmental agreements between industry and the state as a means of reducing environmental impact from the private sector.

Dialogue with trade and industry

The task of the Environmental Advisory Council, made up of representatives from parliament, trade and industry and other areas of society, is to formulate strategies for developing ecologically sustainable trade and industry by initiating a dialogue with parts of that sector. The council has chosen to initiate this dialogue with a number of companies in the sectors "Building/Housing" and "Future trade". The aim is that the companies will voluntarily agree to take certain development steps and, where necessary, also present proposals as to how the government can help them to do so.

The results of the dialogue were presented to the government in December 2000.¹⁵⁰ The dialogue contains a joint "vision" for a sustainable construction and property sector, further objectives to be achieved and a strategy for achieving the objectives and realising the vision. The vision is not a forecast of future developments; it is the dialogue team's view of a desirable scenario in 2025. Priority areas are greater efficiency in use of energy and resources, the indoor environment and choice of materials. Proposed objectives include no fossil use in the sector by 2025 and a reduction of at least 30 per cent in energy use. Seven priority areas have been identified by analysing obstacles to, and the potential for, achievement of sustainable development. The seven areas are:

1. Sustainable social development
2. Use of best available techniques and development of new technologies
3. Procurement on the basis of a life-cycle perspective and an holistic approach
4. Coordination of the building and maintenance process
5. Classification of commercial/industry premises and housing
6. Investment in research and development
7. Marketing of environmental solutions

Further efforts in this field will be made by working groups made up of representatives of the parties. The aim is to reach agreement on specific action with representatives from the sector by early 2002.

Energy declarations for housing

A number of energy labelling projects are currently in the initial phase. The National Board of Housing,

¹⁴⁶ Directive 2000:56

¹⁴⁷ Gov. Bill 1999/2000:100

¹⁴⁸ Swedish environmental objectives. Gov. Bill 1998/99:145

¹⁴⁹ Government committee (M 1998:01)

¹⁵⁰ Tänk nytt, tänk hållbart – att bygga och förvalta för framtiden ("New thinking, sustainable thinking – building and administering for the future"). Environmental Advisory Council 2000: <http://www.sou.gov.se/mvb/>

Building and Planning and the National Energy Administration will be examining and submitting proposals for energy labelling of housing and windows, and will also be producing better and more accurate calculation programmes via procurement of technology, for example.

The Malmö City Tunnel and investments in infrastructure

An infrastructure investment bill was put before parliament in September 2001. One of the projects concerned is the Malmö City Tunnel, which will form part of the public transport system in Skåne, in the far south of Sweden. It will link existing county railways to create a coordinated system. Construction will take about five years.

3.2.10 Measures and instruments having a counterproductive effect

The objectives of different policy areas may have conflicting aims. Even when interests are weighed together, the result may be that action is taken in one area, even though it may adversely effect the prospects of achieving objectives in another area.

Some measures and instruments that have been introduced in various policy areas for reasons unconnected with carbon dioxide emissions may thus give rise to higher emissions of greenhouse gases. Two examples of this are given below.

Tax relief on journeys to and from work

Gross tax relief on journeys to and from work totalled SEK 7 billion in 2000. Income tax relief is available on expenses exceeding SEK 7,000 (SEK 6,000 in 1996 and 1997). This tax subsidy helps to create a flexible labour market by cutting the cost to the individual of taking work some distance from his place of residence. Travel costs are thus reduced. This applies particularly to those travelling by car, since the cost of public transport seldom exceeding SEK 7,000 a year. This may then serve as an incentive to travel by road, which causes more carbon dioxide emissions.

Transport subsidy

Since the 1970s a transport subsidy has been paid to companies in certain sectors in sparsely populated rural areas for their transport of semi-finished or fully finished products that have undergone significant processing within the area. The reason for the subsidy is the additional transport costs incurred by companies in certain regions.¹⁵¹ Like tax relief on journeys to and from work, the transport subsidy may act as a stimulus for transport, leading to higher carbon dioxide emissions. The environmental impact of the transport subsidy has not been studied. 99 per cent of this subsidy was paid to the mining, quarrying and manufacturing sectors in 1993 and 1995. The total cost of this subsidy varied between SEK 250 – 400 million in the 1990s.

3.3 Discontinued measures and instruments

Discontinued measures and instruments that limited emissions or increased removals of greenhouse gases. In the 1990s there were a number of traffic-related taxes that had some environmental impact, although they are considered to have had little impact on carbon dioxide emissions.

Environmental tax on domestic air traffic¹⁵²

was introduced on 1 March 1989 and abolished on 31 December 1996 because it was not considered to conform to EC regulations on taxation of mineral oil products.¹⁵³ The tax had been brought in to reduce hydrocarbon (HC) emissions and NO_x emissions from air traffic. It was levied on each flight at a rate of SEK 1/kg of aviation fuel used and SEK 12/kg of hydrocarbons and nitrogen oxides emitted. This tax generated revenues of SEK 196 million in 1993, falling to SEK 186 million in 1995.

¹⁵¹ National Audit Office RRV 1998:6. Impact of subsidies on ecologically sustainable development – three case studies

¹⁵² Swedish Code of Statutes 1998:1567. Environmental Tax on Domestic Air Traffic Act. Gov. Bill 1988/89:39, 1988/89:SkU10, rskr. 1988/89:79

¹⁵³ Council Directive 92/81/EEC of 19 October 1992 on harmonising the structures for sales taxes on mineral oils

Table 3.12
Table summarising measures and instruments affecting emissions of greenhouse gases

Measure/Instrument	Activities affected	Main greenhouse ⁶ gases concerned	Type of instrument ¹	Status of measure ²	Agency responsible	Estimated effect measured in CO ₂ equivalent emissions/year ⁵		
						1995	2000	2005
Energy tax	Affects energy use in all sectors	CO ₂	T	O (57-)	RSV			
Carbon dioxide tax		CO ₂	T	O (91-)	RSV			
VAT on energy		CO ₂	T	O (90-)	RSV	1,000	5,000	ca 8,000
Taxes on electricity production		CO ₂	T	O	RSV			
Energy and environmen- tal tax exemption on biomass fuels, inc. peat		CO ₂	T	O (94-)	RSV			
Exemption from energy tax for use of electricity and fuel by manufactu- ring industry		CO ₂	T	O	RSV			
A number of taxes on electricity production	Affects generation of electricity using certain fuels	CO ₂	T	O				
Reform of the electricity market	Makes the electricity market more a part of the market economy and involves joint egulation of the North European electricity markets	CO ₂	T	O (96-)	STEM ³	N.I.U.	N.C. ⁴	N.C.
Special pilot project exemptions for bio- mass motor fuels	Makes biomass fuels more competitive	CO ₂	T	O	F-dep STEM	N.I.U.	55	N.C.
Environmentally diffe- rentiated charges for shipping and air traffic	N.C.	N.C.	T	O (98-)	N.C.	N.I.U.		
Tax on landfill (descri- bed elsewhere in table as part of waste pro- gramme)	Waste generation and management	CH ₄	T	O (00-)		N.I.U.		
Gradual shifts in tax emphasis	Economic instruments are reviewed to increase the impact of taxation on environmental behaviour	CO ₂	T	O	F-dep	N.C.	N.C.	N.C.

Table 3.12
Table summarising measures and instruments affecting emissions of greenhouse gases

Measure/Instrument	Activities affected	Main greenhouse gases concerned	Type of instrument ¹	Status of measure ²	Agency responsible	Estimated effect measured in ktonnes CO ₂ equivalent emissions/year ^{5,6}		
						1995	2000	2005
Investment grants for biomass fuel-based combined power and heating	Increase renewable electricity generation	CO ₂	T	O (98–02)	STEM	N.I.U.	490–820	490–820
Investment grants for wind power and small-scale hydropower	Increase renewable electricity generation	CO ₂	E	O (98–02)	STEM	N.I.U.	170–414	170–414
Operating subsidies for small-scale electricity generation			E	O (00–)	STEM	N.I.U.		
Environmental bonus for wind power			T	O (95–)	RSV			
Conversion from electric heating to district heating	Reduce electricity consumption	CO ₂	E	O (98–02)	STEM	N.I.U.	88–236	88–236
Conversion of electric heating to other individual heating		CO ₂	E	O (98–02)	LS	N.I.U.	34–81	34–81
Information, education etc	Reduce energy consumption	CO ₂	I	O (98–02)	STEM	N.I.U.	200–400	200–400
Procurement of new energy technology			E	O (98–02)	STEM	N.I.U.		
Testing, labelling and certification			E	O (98–02)	KOV	N.I.U.		
Measures to develop electric heating supply in southern Sweden	Need to compensate for electricity shortfall caused by closure of Barsebäck	CO ₂	E	O (98–01)	DESS	N.I.U.	70	70
Municipal energy planning	Reduce energy consumption etc	CO ₂	R	O (77–)	STEM	N.C.	N.C.	N.C.
Planning, Building and Housing Act	Reduce energy consumption etc	CO ₂	R	O	BoV	N.C.	N.C.	N.C.
Environmental Code in relation to environmental impacts of an infrastructure project	Assess impact on climate	CO ₂	R	O	NV	N.C.	N.C.	N.C.
Standards for energy use in residential and commercial properties, inc. planning permission	Reduced energy consumption	CO ₂	R	O	BoV	N.C.	N.C.	N.C.

Table 3.12
Table summarising measures and instruments affecting emissions of greenhouse gases

Measure/Instrument	Activities affected	Main greenhouse ⁶ gases concerned	Type of instrument ¹	Status of measure ²	Agency responsible	Estimated effect measured in ktonnes CO ₂ equivalent emissions/year ^{5,6}		
						1995	2000	2005
Comprehensive municipal planning	Reduce energy consumption by urban and regional planning	CO ₂	R	O	BoV	N.C.	N.C.	N.C.
64 projects under the climate convention pilot programme for joint implementation (AIJ)	Improve the energy efficiency of the Baltic energy systems and develop the flexible mechanisms	CO ₂	E	O (98-02)	STEM	NC.	220	220
Participation in World Bank Carbon Fund and CDM Assist	Develop the flexible mechanisms under the Kyoto Protocol	CO ₂	E	O	N-dep	N.C.	N.C.	N.C.
Development assistance in neighbouring countries	Improve the energy efficiency of the Baltic energy systems	CO ₂	E	O (98-)	Sida	N.I.U.	N.C.	N.C.
Promotion of growth and employment in the Baltic region in energy and other sectors	Improve the energy efficiency of the Baltic energy systems	CO ₂	E	O (96-)	UD, Sida, STEM	N.I.U.	N.C.	N.C.
Measure-oriented research and development	New fuels, new technology etc	CO ₂	R&D	O (98-04)	STEM, Formas,	N.I.U.	N.C.	N.C.
Local investment programmes for ecological adjustment (LIP)	Municipal adjustment to achieve ecological sustainability	CO ₂	E	O (98-03)	M-dep	N.I.U.	1600	N.C.
Greater consideration of the environmental dimension in public administration	Greater consideration of the environmental dimension in administration and government decision making	CO ₂	M	O	M-dep	N.C.	N.C.	N.C.
General environmental factors to be considered under the Environmental Code	Establish certain fundamental principles governing all activities	CO ₂	R	O (99-)	NV	N.C.	N.C.	N.C.
Permit application procedures under various environmental laws	Integrated consideration of environmental factors in permit application procedures	CO ₂	R	O	NV	N.C.	N.C.	N.C.
The Refrigerants Order	Governs the use of refrigerants, including halocarbons	Halocarbons	R	O	NV	N.C.	N.C.	N.C.

Table 3.12
Table summerising measures and instruments affecting emissions of greenhouse gases

Measure/Instrument	Activities affected	Main greenhouse gases concerned	Type of instrument ¹	Status of measure ²	Agency responsible	Estimated effect measured in ktonnes CO ₂ equivalent emissions/year ^{5,6}		
						1995	2000	2005
Investment programmes for ecological building	Reduce energy consumption	CO ₂	E	O	BoV	N.C.	N.C.	N.C.
Further development of environmental management systems at government agencies	Reduce environmental impact of state activities	E.B.	V/N	O (96-)	Reg.	N.C.	N.C.	N.C.
Sectoral integration	Clarify responsibility for the environment	E.B.	R	O	NV	N.C.	N.C.	N.C.
Collection of landfill gas	Reduce methane evaporation	CH ₄	V/N	O (94-)	Kom, LS			
Ban on landfill of organic waste	More stable landfills and use of waste as a resource	CH ₄	R	PI (05-)	NV			
Ban on landfill of sorted burnable waste	Improvement in disposal of all burnable waste	CH ₄ , CO ₂	R	PI (02-)	NV	0	193	781
Waste Tax Act	Reduce the quantity of landfilled waste	CH ₄	T	O (00-)	NV			
Landfill Directive	Compulsory collection of landfill gas	CH ₄	R	O (01-)	NV			
Environmental Code requirements vis-à-vis municipal waste plans	More efficient waste management	CH ₄	R	O (91-)	NV			
Grants for home solar heating systems	Increase the use of solar energy	CO ₂	E	O (00–01)	LS	N.I.U.	3–5	3–5
Heat insulation of buildings	Clarification of requirements for calculating floor and roof temperature. Tougher requirements for thermal bridges	CO ₂	R	O (99-)	BoV	N.C.	N.C.	N.C.
"Swan" criteria for oil burners	Nordic eco-labelling has produced "Swan" criteria for oil burners with an output of up to 120 kW	CO ₂	R	O	–	N.C.	N.C.	N.C.
Investment grants for ecological building	Reduce energy consumption etc	CO ₂	E	O (01–03)	F-dep BoV	N.I.U.	N.C.	N.C.

Table 3.12
Table summarising measures and instruments affecting emissions of greenhouse gases

Measure/Instrument	Activities affected	Main greenhouse gases concerned	Type of instrument ¹	Status of measure ²	Agency responsible	Estimated effect measured in ktonnes CO ₂ equivalent emissions/year ^{5,6}		
						1995	2000	2005
Start-up grants for energy forests	Cultivation of energy forest	CO ₂	E	O	SJV	150	150	N.C.
Environmental factors to be considered under the Silvicultural Act	Sustainable forestry	CO ₂	R	O	SKS	N.C.	N.C.	N.C.
National Board of Forestry recommendations on forest fuel abstraction	Optimise biomass fuel abstraction	CO ₂	R	O	SKS	N.C.	N.C.	N.C.
Protected areas etc	Protect certain forest ecosystems	CO ₂	R	O	SKS	N.C.	N.C.	N.C.
Environmentally-related forestry certification	Sustainable forestry	CO ₂	M	O	SKS	N.C.	N.C.	N.C.
Tighter restrictions on use of nitrogenous fertilisers on forest soils	Reduce nitrogen leaching from forest soils	N ₂ O	R	O	SKS	N.C.	N.C.	N.C.
Procurement of ethanol-petrol hybrid cars	Increase the scope for using biomass motor fuels	CO ₂	V/N	O (99-)	NUTEK	N.C.	N.C.	N.C.
Promoting development and use of IT and traffic information methods	Reduce fuel consumption etc	CO ₂	R&D	O (95-)	VV	N.C.	N.C.	N.C.
"Green Car", a joint project run by the Swedish state and the automobile industry	Reduce fuel consumption	CO ₂	R&D	O (00–06)	N-dep	N.I.U.	N.C.	N.C.
"Transport Quality Assurance" and "Economical Driving" transport projects	Reduce fuel consumption etc	CO ₂	M	O (00-)	VV	N.I.U.	N.C.	100
Use of renewable energy to run railways	Reduce impact of transport system on climate etc	CO ₂			SJ	N.C.	N.C.	N.C.
Joint programmes for development of more environmentally compatible vehicles	Reduce fuel consumption etc	CO ₂	P	O (00–05)	NUTEK	N.I.U.	N.C.	N.C.
Greater investment in tramway infrastructure	Make trams more competitive	CO ₂	M	O	Banverket	N.C.	N.C.	N.C.

Table 3.12
Table summarising measures and instruments affecting emissions of greenhouse gases

Measure/Instrument	Activities affected	Main greenhouse gases concerned	Type of instrument ¹	Status of measure ²	Agency responsible	Estimated effect measured in ktonnes CO ₂ equivalent emissions/year ^{5,6}		
						1995	2000	2005
Energy declarations for apartment buildings	Better overview of the energy status of Swedish buildings	CO ₂	R	P (01–02)	BoV	N.C.	N.C.	N.C.
Individual metering of heating and hot water	Reduce energy consumption by increasing awareness of individual use of heating and hot water	CO ₂	V/N	P	BoV	N.C.	N.C.	N.C.
Individual metering and charges for heating and hot water	Reduce energy consumption	CO ₂	M	O	BoV	N.C.	N.C.	N.C.
Twelve regional energy offices	Reduce energy consumption etc	CO ₂	I	O	STEM	N.C.	N.C.	N.C.
The "Challenger Municipalities" project	Begin phasing out use of fossil fuels in five municipalities	CO ₂	M	O	VV	N.C.	N.C.	N.C.
Climate objectives set by Swedish municipalities	Reduce impact on climate	CO ₂	M	O	–	N.C.	N.C.	N.C.
Swedish members of the Renewable Energy Partnership	Increase use of renewable fuels	CO ₂	M	O	–	N.C.	N.C.	N.C.
Encouraging the introduction of environmental management systems in small and medium-sized businesses	Some local funding, free telephone advice, seminars and help, eg, in achieving EMAS registration	CO ₂	I	O (96–)	NUTEK	N.I.U.	N.C.	N.C.
Measures no longer in use								
Environmental tax on domestic air traffic	Reduce emissions of HC and NOX from domestic air traffic	CO ₂ CO ₄	T	D/(89–96)		N.I.U.	N.I.U.	N.I.U.

Table 3.12
Table summarising measures and instruments affecting emissions of greenhouse gases

Measure/Instrument	Activities affected	Main greenhouse ⁶ gases concerned	Type of instrument ¹	Status of measure ²	Agency responsible	Estimated effect measured in ktonnes CO ₂ equivalent emissions/year ^{5,6}		
						1995	2000	2005
Measures having the opposite effect								
Tax relief on journeys to and from work	Increase the scope for distance working	CO ₂	E	O				
Regional transport subsidies	Alleviate the impact of cost differences for long-distance transport from companies in regional support areas	CO ₂	E	O		N.C.	N.C.	N.C.
Measures not yet implemented								
Trade in emission rights	Increased use of management by objectives in climate policy	CO ₂	E	P	STEM	N.I.U.	N.I.U.	N.C.
Project-based mechanisms under the Kyoto Protocol	Prepare for the Kyoto Protocol flexible mechanisms	CO ₂	E	P	STEM	N.I.U.	N.I.U.	N.C.
Continuing shifts in the emphasis of taxation	Increase the effects of the tax system on environmental behaviour	CO ₂	T	P (02–10)	F-dep	N.I.U.	N.I.U.	N.C.
Quota-based trade in certificates	Stimulate production of renewable electricity	CO ₂	R	P (03)	STEM	N.I.U.	N.I.U.	N.C.
Planning objectives for wind power production	Improve the scope for a dramatic expansion of wind power use in Sweden	CO ₂	M	P	STEM	N.I.U.	N.I.U.	N.C.
Public procurement in the energy field	Reduced energy consumption	CO ₂	V/N	P	STEM	N.I.U.	N.I.U.	N.C.
Improving energy efficiency in industry	More efficient energy use	CO ₂	V/N	P	STEM	N.I.U.	N.I.U.	N.C.
Dialogue with trade and industry	Adjustments in trade and industry to achieve ecologically sustainable development	CO ₂	V/N	P	Miljövårdsberedningen	N.I.U.	N.I.U.	N.C.
Malmö City Tunnel	Improve railway traffic through Malmö	CO ₂	M	P	Banverket	N.I.U.	N.I.U.	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), Miscellaneous (M).

2 The following symbols are used to describe the status of instruments:
O = ongoing (with the year of introduction and conclusion where possible);
D = measure discontinued (with the year it was discontinued);
PI = measure planned and decided but not yet implemented (with the year it will take effect);
P = measure proposed by the government but with no decision to implement.

3 Joint Nordic deregulation. The National Energy Administration administers the Swedish part.

4 Emissions in the joint Nordic electricity market have increased by up to 8,000 ktonnes carbon dioxide. The environmental impact ought not to be negative in the long term, however.

5 N.C. means not calculated and N.I.U. means not in use at the time.

6 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).

Names and abbreviations used in the fifth column:

RSV = National Tax Board

STEM = National Energy Administration

F-dep = Ministry of Finance

LS = County administrative boards

KOV = Swedish Consumer Agency

DESS = Commission on Energy Supply in South Sweden

BoV = National Board of Housing, Building and Planning

N-Dep = Ministry of Industry and Trade

Sida = Swedish International Development Cooperation Agency

UD = Ministry for Foreign Affairs

M-dep = Ministry of the Environment

NV = Swedish Environmental Protection Agency

Reg. = Swedish government

Kom = Municipalities

SVJ = National Board of Agriculture

SKS = National Board of Forestry

NUTEK = Swedish National Board for Industrial and Technical Development

Miljövårdsberedningen = Environmental Advisory Council

Banverket = National Rail Administration

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