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Report on the in-depth review of the second national communication of Sweden

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I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

1. Sweden ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 23 June 1993. Its first national communication (NC1) was submitted on 21 September 1994 and the second national communication (NC2) was submitted on 5 April 1997. In general, the NC2 was comprehensive and, to a large extent, followed the UNFCCC reporting guidelines.

2. The in-depth review was carried out between February and December 1998 and included a review team visit to Stockholm from 30 March to 3 April. The team consisted of Dr Steven Lennon (South Africa), Ms Riitta Pipatti (Finland), Dr Edward Radwanski (Poland), and Ms Tina Dallman (UNFCCC secretariat, coordinator). During the visit, the team met officials from government ministries and agencies, a member of an environmental non-governmental organization and industry representatives.

3. Sweden is a constitutional monarchy with a parliamentary form of Government. It has 10 ministries mainly concerned with preparing government policies, budget proposals and Parliamentary decisions of either a legally binding nature called Acts or in support of proposed government policies. The ministries also prepare legally binding government ordinances. Practical implementation of national policy decisions is handled by over 100 national authorities and 21 county administrations. The national authorities are autonomous from ministries, but subject to guidelines and laws established by Government.

4. The warm Atlantic Gulf Stream gives Sweden a milder climate than other parts of the world equally far north. The population of 8.8 million predominantly lives in the south, especially around Stockholm, where in summer the average temperature is about 18^{o}C, whilst winter temperatures are slightly below freezing and snowfall is moderate. About 15 per cent live in northern regions which experience long cold winters. Population density is low and there is a high reliance on car transportation.

5. Sweden has rich natural supplies of coniferous forest, which accounts for more than half of all land area, hydroelectric power, iron ore and other minerals, but lacks significant fossil fuel deposits. In 1997, total energy supply, based on data from Statistics Sweden, was 477 TWh, of which crude oil and oil products contributed 205 TWh, nuclear power 204 TWh, biofuels and peat 91 TWh, hydro and wind power 70 TWh, coal and coke 26 TWh, natural gas 9 TWh and heat pumps, *inter alia,* in district heating plants 9 Twh. Gas prices are relatively high in Sweden, compared to neighboring countries, and there is a very limited gas trunk pipeline infrastructure. Most of Sweden's electricity is produced by hydro and nuclear power. As a result, per capita CO_2 emissions are relatively low compared with other industrialized countries although per capita electricity consumption is amongst the highest in the world. Oil-fired and gas-fired plants are mainly used as reserve capacity for years when precipitation and hence hydropower production is low or as peak-load plants during cold weather. In a dry year hydropower production may be 10-15 TWh lower than in a 'normal' year. There are about 300 wind turbines

in Sweden, but their contribution to electricity production is very small (0.1 TWh in 1996). In 1996, a relatively dry year, 136 TWh of electricity was produced domestically of which 52 per cent was nuclear, 38 per cent hydro, 3 per cent oil-fired plant and 7 per cent combined heat and power (CHP). Net imports added another 6.1 TWh to the energy balance. After an advisory referendum in 1980, the parliament decided that nuclear power should be phased out by 2010. The recent Inter-Party Agreement on Energy Policy (February 1997) concluded that two main reactors in Barsebäck are to be decommissioned in 1998 and 2001 respectively. A final year for the total phasing-out of nuclear power has not been determined. Parliament also decided, in 1987, to protect the remaining big unexploited rivers from exploitation.

6. Manufacturing represented 21 per cent of gross domestic product (GDP) in 1996. Pulp and paper products and ferrous metal products account for the largest share of exports, by volume. Industry is dominated by a few large international companies which account for about 60 per cent of manufacturing employment, although small and medium-sized enterprises play an important role, having employed almost 1.4 million people in 1996. About three per cent of the labour force works in the agriculture sector and less than 10 per cent of land area was devoted to farmland in 1995. Sweden suffered from recession in the early 1990s, but the economy began its upturn in 1997. Given both low inflation and long-term interest rates, conditions for growth seem favorable.

7. Sweden is a member of the European Community (EC). As such, it is party to so-called 'internal burden sharing' arrangements, although these have not been formalized for attaining the aim of the UNFCCC up to 2000. As a whole, the EC is on course to reduce CO_2 emissions to 1990 levels by the year 2000, but according to its own forecasts in the NC2, Sweden's CO_2 emissions are likely to be about 8.5 per cent higher.

II. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS

8. The NC2 comprises inventory data for emissions of the direct greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and the indirect greenhouse gases carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs) over the period 1990 to 1995 inclusive. Additional data were provided during the course of the review, but not discussed during the visit. Data for CO_2 removals by sinks and the gases perfluorinated hydrocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) were not available for all years.

9. During the visit, the team formed a favourable impression about the quality of work on inventories, especially in relation to activity data and methodologies employed for energy-related emission estimates. Adequate explanations were provided for various technical issues discussed in detail. Intergovernmental Panel on Climate Change (IPCC) default values were used only sparingly as national emission factors were available for most activities. There were some checks of emission factors with neighbouring countries and expert discussion to explain any differences. Since the NC1, officials noted that coordination between all experts involved in

inventory compilation had improved, knowledge of IPCC methodology had been enhanced, better information was available on emission factors, methodology had improved for calculating emissions from transport and waste and calculation errors in the industrial processes category had been amended.

10. The inventories are reported on the basis of 1996 IPCC guidelines and using standard format tables. They are calculated by the Swedish Environment Protection Agency (SEPA), using primarily official energy, industrial, agricultural and forestry statistics from various national authorities. Energy statistics are based on surveys of all firms with more than 10 employees, annual environmental reports to regulatory authorities, production statistics and additional information from trade associations. Considerable work has been done to improve data and modelling of the transport sector, which also allows for a better disaggregation of emission estimates. Non-CO_2 emissions data from bunkers are provided by the Swedish Maritime Administration and the Civil Aviation Administration. CO_2 emissions from international bunkers are estimated by Statistics Sweden on the basis of fuel consumption statistics. Data on fuel combustion, industrial processes and agriculture are collected annually, whereas data related to solvents, land-use change, forestry and waste disposal are collected every third or fourth year.

11. The emission factors listed in the NC2 are the result of averaging as for each category there are specific emission factors for underlying activities. In some cases, the emission factor was presented as zero when it was a small number because only two decimal places were given. Swedish officials were reluctant to publish the derived emission factors in these cases as it would suggest a degree of accuracy that does not exist.

12. Officials have described the quality of emission estimates in terms of high, medium and low reliability in line with the IPCC Guidelines for indicating the quality of emissions data. CO_2 estimates for energy-related emissions are regarded as high quality, but from industrial processes and solvent use they are rated as medium and from fugitive sources they are considered to be low. All CH_4 estimates are given a medium rating and all N_2O estimates are described as low. NO_x estimates for all categories, except industrial process which are medium, are of a high quality, CO estimates are all of medium quality again apart from industrial process which are low. NMVOC estimates are generally of low quality.

A. Carbon dioxide

13. In 1994, CO_2 accounted for about 84 per cent of Sweden's direct greenhouse gas emissions combined, on a GWP basis. Sweden chose to present both temperature-adjusted and unadjusted CO_2 emission data. Winter temperature affects the demand for heating and, more importantly, the amount of precipitation affects hydroelectricity availability. Only these variations are modelled. 1990 was a wet year, so emissions from fossil fuel generation were lower than normal. Based on unadjusted figures, CO_2 emissions rose 4.9 per cent between 1990 and 1995, compared to 1.6 per cent using adjusted data. Unadjusted data are presented in table 1,

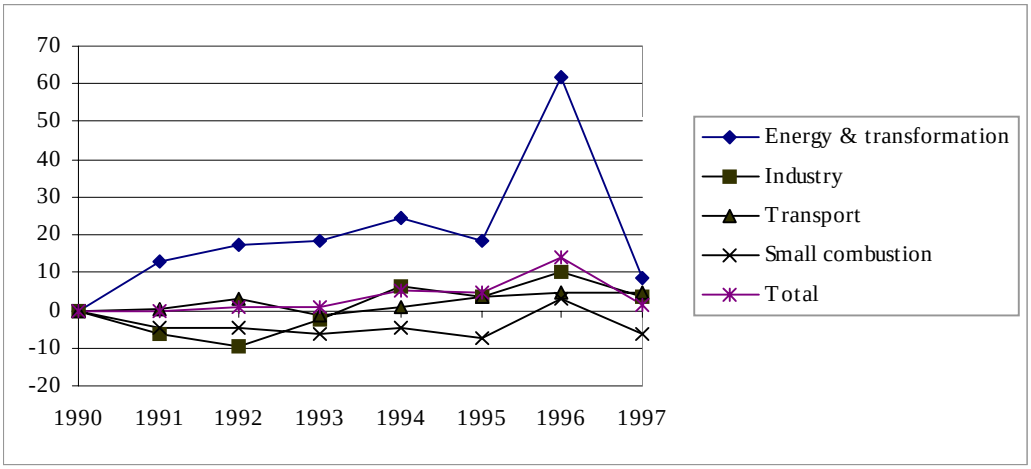
including data obtained during the review for 1996, which was a relatively dry year and provisional data for 1997.

Table 1. Carbon dioxide emissions by source, 1990-1997 (thousand Gg)

	1990	1991	1992	1993	1994	1995	1996	1997*
Energy and transformation	8.8	10	10.4	10.5	11	10.5	14.3	9.6
Industry	13.1	12.2	11.8	12.7	13.9	13.5	14.4	13.5
Transport	18.8	18.7	19.2	18.4	18.8	19.4	19.6	19.5
Small combustion	10.7	10.2	10.2	10.0	10.2	9.9	11.0	10.0
Other	4	4.1	4.4	4.4	4.6	4.8	4.1	3.7
Total	**55.4**	**55.2**	**56.0**	**56.0**	**58.5**	**58.1**	**63.4**	**56.3**
Removals	-34.4	NA[#]	-30	NA	NA	NA	-32.3	NA

* Provisional [#] Not available

Figure 1. Carbon dioxide emissions, percentage change from 1990, by source



14. Between the NC1 and the NC2 the estimate of total CO_2 emissions in 1990 was revised downward from 61.3 million tonnes to 55.4 million tonnes. Most of the reduction was due to a revised estimate for domestic transportation.

15. Forests cover about 27.5 million hectares, but only 22.5 million hectares of managed productive area is covered by the inventories. Most of the annual forest increment is due to forest management practices and if silviculture were to cease the timber volume would return to its natural, lower level. There has been a nationwide annual survey of Swedish forests since 1923. It covers about 8,000 plots of which 30 per cent are permanent and 70 per cent random. The parameters checked include land-use change, timber volume, biomass, tree growth, harvesting, mortality, regeneration, tree vitality, site characteristics, soil chemistry and variables related to biodiversity. The survey's main purposes are to inform forestry and environmental policy decisions, help forest company planning and for research. An estimate of informal cutting by householders for domestic wood-burning stoves is made for the purposes of the emissions

inventory. Biomass (dry weight) is calculated based on a combination of tree characteristics and conversion factors for different tree components. Only biomass above the stump is counted, so roots are not included in the inventory. About 1,600 to 2,800 hectares are lost per annum owing to forest fires and the inventory also includes an adjustment for this. The estimate of Sweden's stock of tree biomass is thought by officials to be fairly accurate, but estimates of increment and removals are a little less certain. There are plans to use satellite data in the future.

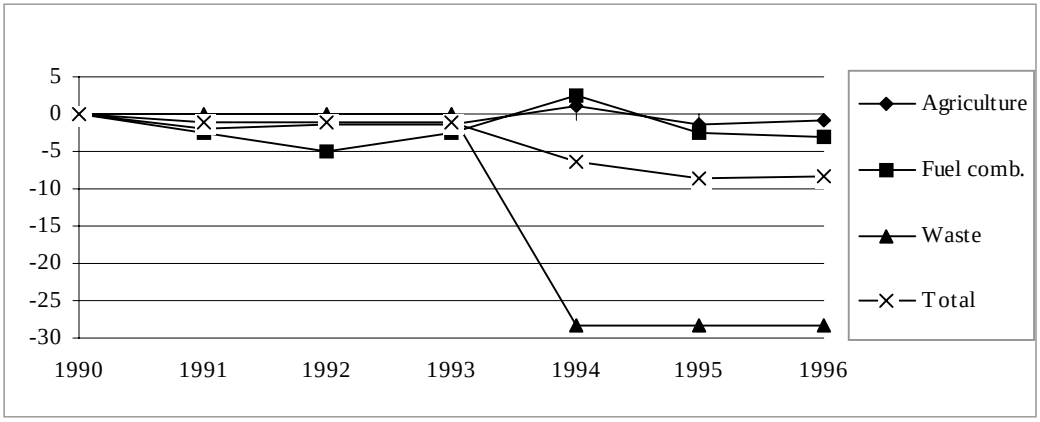
B. Methane

16. Additional data for 1995 and 1996 were given during the review as presented in table 2. The only substantive revision of 1990 figures was in the transport category which was increased from about 17 Gg to 23 Gg between the NC1 and the NC2. Statistics Sweden conducts a general survey and a sample survey of waste, including the treatment of waste. In 1993 there was a separate survey of industrial waste. In table 2, the waste emission estimate for 1990 is also used for the years up to 1993, the emission estimate for 1995 is used from 1994 onward. The emission factor has been reduced over time because of changes in composition of waste**,** changes in waste management practices and an increasing number of landfills with installed gas collection systems.

Table 2. Emissions of methane by source, 1990-1996 (Gg)

	1990	1991	1992	1993	1994	1995	1996
Energy and transformation	1.1	1.2	1.3	1.5	1.7	2.0	2.3
Industry	5.0	5.1	4.9	5.3	5.4	6.0	5.4
Transport	23.0	23.4	22.0	21.0	21.8	20.0	19.0
Small combustion	10.0	10.0	10.0	10.0	11.0	10.0	11.2
Agriculture	200.0	199.7	197.0	197.0	202.0	198.0	198.4
Waste disposal	85.0	85.0	85.0	85.0	61.0	61.0	61.0
Total	**324.0**	**324.4**	**320.3**	**320.0**	**303.0**	**297.0**	**297.3**

Figure 2. Methane emissions, percentage change from 1990 by source



C. Nitrous oxide

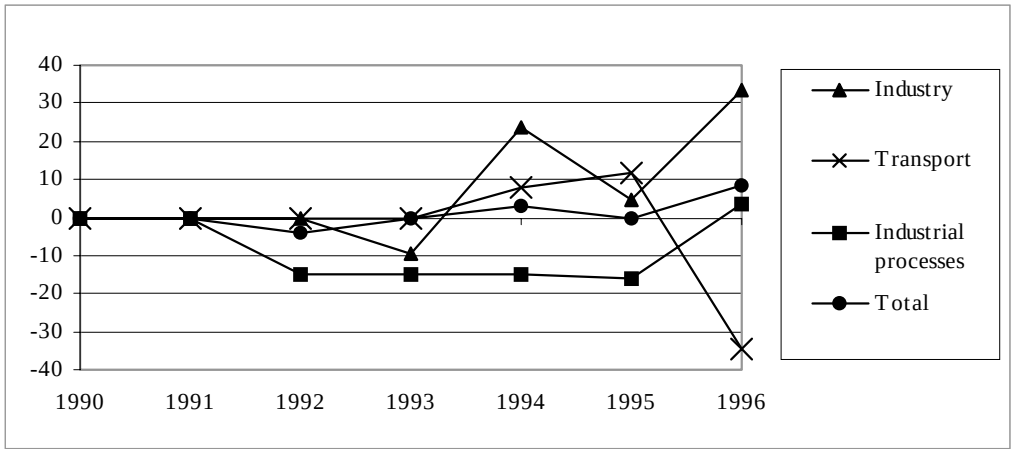
17. The latest data for 1995 and 1996, as shown in table 3, were presented during the review. The most significant emissions of N_2O are from various combustion processes and also from the manufacture of commercial fertilizer.

Table 3. Emissions of nitrous oxide, by source, 1990 - 1996 (Gg)

	1990	1991	1992	1993	1994	1995	1996
Energy and transformation	1.1	1.1	1.1	1.5	1.1	1.2	1.5
Industry	2.1	2.1	2.1	1.9	2.6	2.2	2.8
Transport	2.6	2.6	2.6	2.6	2.8	2.9	1.7
Small combustion	0.5	0.5	0.5	0.7	0.5	0.5	1.1
Industrial processes	2.7	2.7	2.3	2.3	2.3	2.3	2.8
Agriculture	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	**9.2**	**9.2**	**8.8**	**9.2**	**9.5**	**9.2**	**10.1**

18. N_2O emissions from agriculture are considerably lower in the NC2 compared to the NC1. This is attributable to the use of the lowest IPCC emission factor. The team noted that using the default factor in the revised IPCC guidelines would increase this figure by a factor of 25 which illustrates how, in cases where countries do not have their own emission factor, there is a high level of uncertainty. The team suggested that future communications explain the reasoning for such differences in emission estimates.

Figure 3. Nitrous oxide emissions, percentage change from 1990, by source



D. HFCs, PFCs, SF_6

19. In 1994, a consultant produced an inventory of the new gases which excludes part of HFC emissions. It has been presumed that the figures in 1990 were similar as there are few data for that year. Emissions of the new greenhouse gases are reported as potential not actual emissions as data are only available on usage which is assumed to relate directly to emissions. HFCs have been introduced as substitutes for ozone-depleting substances and are mainly used in cooling equipment, including car air-conditioning. PFCs are used in very specific areas such as the electronics industry in plasma etching and vapour-phase soldering and in the textile industry to manufacture waterproof clothing. Emission estimates were given a 30 to 50 per cent range of uncertainty. The 1994 SF_6 estimate is known with accuracy because it was based on import statistics. This gas is used in the manufacture of high-voltage switchgear and deductions are made for the amount of product exported. However, no adjustment is made for SF_6 imported in products and equipment. It is possible that actual emissions of SF_6 from high-voltage switchgear will be low thanks to techniques for gas recovery at the end of products' 20- 30 year lifespan. Officials noted during the visit that the figures in the NC2 contain errors as a deduction was not made for exports. On the basis of revised CO_2 equivalent estimates, HFC rose from zero in 1990 to 0.1 Gg in 1992 and 0.2 Gg in 1994. Emissions of PFCs were around 0.4 Gg in 1990 and 1992 and slightly higher at 0.5 Gg in 1994. Emissions of SF_6 were steady at about 0.5 Gg in these years.

III. POLICIES AND MEASURES

20. Policies and measures were, in general, well described in the NC2, especially those relating to the energy sector. Information was lacking on the costs associated with measures and this was difficult to establish during the review. Sweden's climate change policies are focused on the reduction of fossil fuel and hence CO_2 emissions. Whilst other policies may have an effect in reducing non-energy-related emissions, these are not generally analysed in the context of climate change objectives.

21. Up to 1996 there was an annual appraisal of energy policies, which included the use of non-government experts, resulting in an annual energy report. The Swedish National Board for Industry and Technical Development was entrusted with evaluating energy policy programmes in order to advise on necessary adjustments. The programmes considered comprised all efforts aimed at developing more environmentally acceptable power generation and promoting more efficient energy utilization. Evaluation of investment support measures focused on both measurable effects and assessment of the potential to expand the commercialization of new technologies. The analysis also took account of different demand scenarios and trends in the energy system. The new energy policy programmes decided by the parliament in 1997 will be continuously monitored on an annual basis and also evaluated on a longer term basis.

22. The Government adopted terms of reference for a commission which has the task of presenting a strategy for fulfilling the obligations of the Kyoto Protocol. The commission will present proposals for policies and measures in all sectors, based on a 1993 Decision on climate change whereby the Parliament adopted a strategy stating that Sweden should stabilize its emissions of CO_2 at the 1990 level by the year 2000 and also the Parliamentary Decision of 1997 on Sustainable Energy Supply. The conclusions of the commission should be presented to the Government in 1999, and will provide the basis for a coming parliamentary decision on Swedish ratification of the Kyoto Protocol.

A. Energy policy

23. Current energy policy, in part, is based on Parliamentary Decisions on Energy Policy in 1991 and 1997 and Climate Policy in 1993, which set out a strategy such that Sweden should stabilize its emissions of CO_2 at the 1990 level by the year 2000, after which they should decrease, but the Decisions do not require particular actions if this target is not achieved. These Decisions made funds available for investment to support renewables, energy efficiency programmes, ethanol production and activities implemented jointly (AIJ) in the Baltic States. However, the main emphasis has been on energy and CO_2 taxation.

24. In 1991, subsidies were introduced in order to promote wind turbines, biofuel CHP plants and solar heating. By 1995, renewable energy (excluding hydropower) was made up of burning byproducts from the forest industry (17 TWh), forest fuels, mainly logging residues (23 Twh), waste incineration (4.5 TWh), biogas (1.4 TWh), other biofuels (0.5 TWh), wind power (0.1 TWh) and solar energy (0.05 TWh).

25. In 1990, a 25 per cent value added tax (VAT) was levied on the consumption of electricity and fuels, followed by the introduction of a CO_2 tax on all fossil fuels, in 1991, equal to SKr 250 per tonne. Fuels for electricity production were exempted. The same year energy taxes were halved, but a sulphur tax was also introduced on coal, oil and peat. In 1992, a charge was introduced on nitrogen oxides from certain boilers and turbines. Industry gained concessions in 1993 with exemption from the general energy tax and a reduction of the CO_2 tax to a quarter of the normal level. The 1995 Energy Tax Act brought taxes and duties in line with the EC mineral oils directive. In 1996, the CO_2 tax was raised to SKr 360 per tonne, VAT was raised and special taxes on the production of hydro and nuclear power were also raised. From 1 July 1997 industry was required to pay half of the CO_2 tax, which was expected to increase their tax burden by approximately SKr 500 million per annum.

26. Biofuels have not been subject to the energy, CO_2 or sulphur tax. As a result of this exemption, a number of coal fired CHP and district heating plants have changed to burning solid biomass. Between 1990 and 1995, the amount of biomass fuel used in heating plants doubled, resulting in an increase in generation from 10.2 TWh to 20.4 TWh or from 25 per cent to 42 per cent of total district heating supplied. Biomass fuels dominate new investments. Demand for district heating has increased, whilst the consumption of fossil fuels in this sector remained

broadly constant from 1990 to 1995. If the fossil fuel mix had remained the same over this period then CO_2 emissions would have been 1,500 Gg higher than otherwise in 1995. In part, the tax structure provides conflicting signals as CHP plants have an incentive to use fossil fuels equivalent to their electricity generation and biomass for the heat component. Specific oil consumption in industry declined continuously from 1973 to 1992 and then rose, following the sharp fall in energy taxes on industry. This was mostly due to increased industrial activity and increased consumption in the pulp and paper industry which is able to change between using biomass and oil fairly simply. This could have resulted in an additional 500 Gg of CO_2 in 1995. The housing sector did not appear very sensitive to the CO_2 tax, primarily because of the high costs associated with replacing a heating system. In the transport sector, the CO_2 tax has only been a small proportion of the overall tax burden, but it is assumed to have had some impact in reducing petrol consumption.

27. The Government Commission on Green Taxation presented a report in early 1997 proposing that the tax system be further geared towards environmental considerations, but did not present detailed proposals. Concerns about competitiveness constrain the extent to which further taxes can be placed on industry, especially the manufacturing sector. Sweden has been an advocate of wider European environmental tax harmonization.

28. An agreement between the major political parties in February 1997 stated that two nuclear reactors in Barsebäck are to be taken out of service, the first prior to July 1998 and the second prior to 1 July 2001. Closure of both reactors was subject to legal challenge by the reactors' owners which, at the time of the review, was causing some delay to the Government's original plans. Closure of the second reactor is conditional upon the loss of electricity being compensated for by new electricity production and reduced electricity usage. A new central energy agency was established on 1 January 1998, in part to implement the new sustainable energy policy. By 2001, it aims to have boosted CHP and renewables by 5 to 6 TWh, which represents about 1 per cent of recent annual production levels, and to have reduced electricity consumption by 5 to 6 TWh, which amounts to less than 1 per cent of recent electricity consumption, through energy efficiency improvements.

29. Parliament decided on guidelines for energy policy in the Parliamentary Decision on Energy Policy in June 1997 (based on the Government Proposal 1996/97:84 on a Sustainable Energy Supply). SKr 400 million was allocated to promote the supply of heat and power, SKr 3,100 million to a programme for a sustainable energy system, SKr 5,070 million for technology development, SKr 350 million for international collaboration on climate change and SKr 210 million for the production of ethanol. The funds for a sustainable energy system will be split between actions to reduce electricity consumption, improve energy efficiency and promote renewables. The focus of activity in the short term is to facilitate the decommissioning of the second nuclear reactor at Barsebäck.

30. The electricity market has undergone reform. The main objective was to increase pressure to reduce costs and hence improve efficiency in the production, transmission, distribution and supply of electricity. The national grid is state owned and regulated by the network authority which also sets network tariffs. Since the introduction of competition in the generation and sale of electricity, prices have fallen for most consumers. Statistics have not isolated the impact of this price effect from changes in taxation. Small consumers have been inhibited from changing suppliers as they must pay for their own metering equipment in such circumstances. Both Norway and Sweden, heavily reliant on hydropower, have cooperated in the Nordic electricity pool with Denmark and Finland, where the use of fossil fuel is greater. The Nordic electricity market is based on the decentralised-dispatch of generation. A transparent spot price for electricity is established daily via the Nord Pool electricity exchange. Most of the year the spot price is determined by the marginal production cost of coal condensing generation. Due to higher marginal costs in Sweden, which could, in part, be attributable to higher sulphur emission standards, Danish coal fired plant tends to bid at lower prices than most Swedish plants. So, without government intervention, imports of electricity from Denmark are preferred to domestic renewable energy production. The Nordic electricity market is continuing to develop with the potential to encompass the Baltic States thereby enhancing the scope for cross-border trade.

31. Using funds of SKr 450 million, an expansion of CHP equivalent to 0.75 TWh per annum is aimed for, based on a grant of SKr 3,000 per installed kW of electrical generating capacity, not to exceed more that 25 per cent of total costs. A further SKr 300 million in grants for wind power, amounting to no more than 15 per cent of the total cost, are available with the aim of increasing annual electricity generation by about 0.5 TWh over the period. Small-scale hydropower plants below 1,500 kW can receive grants up to 15 per cent of the investment costs and over SKr 150 million is being spent to increase annual production by 0.25 TWh. A further SKr 100 million is being given for the procurement of new technology for renewables electricity production.

32. State subsidies are available to convert households from electric to other forms of heating including wood stoves in areas without district heating in order to reduce peak electricity demand. At the time of the review, small scale wood burning accounted for about 12 TWh annually and this was predicted to increase. As biomass fuel is a renewable source of energy, this measure could, potentially, reduce fossil fuel emissions, but small scale wood burning accounted for 25 to 30 per cent of volatile organic compound emissions in 1994, which could be exacerbated.

B. Industry

33. Sweden uses a range of mechanisms, including environmental taxation, emission limits and information exchange. Industry is subject to restrictions related to EC air and water quality legislation such as the large combustion plant directive to limit emissions of acidifying substances. During the review, several examples of innovative efficiency improvements by

industry, in cooperation with Government, were presented such as re-use of waste energy from industrial processes in copper and zinc plants.

34. The National Energy Administration has been operating a seven-year programme, begun in 1991, established by parliament, aimed at improving the efficiency of energy use, with particular attention to electricity. Much of the work involves technology procurement, which typically involves a competition for manufacturers to create more effective products. For certain products, technology procurement resulted in improved energy efficiency. The 1997 guidelines on energy policy allocated SKr 400 million for technology procurement, labeling, information and education.

C. Transport

35. The team formed the impression that more emphasis has been placed on reducing emissions from the energy sector through improved energy efficiency than reducing emissions from transport, despite the fact that transport accounted for about a third of CO_2 emissions in 1995. Although there were no specific climate change related policies, in the period before the review the effect of the recession and introduction of higher fuel taxes somewhat limited emissions growth.

36. From 1993 onward, automobiles, trucks and buses were divided into three environmental classes, based on emissions including CO and NO_x. The pre-existing sales tax was then differentiated in favour of low-emission vehicles to reflect the additional costs associated with manufacture. It has been difficult to evaluate the effects of this measure, but an initial assessment suggested that there has been an acceleration in the introduction of vehicles with better environmental performance. It was noted by officials that current EC regulations limit Sweden's ability to levy differential sales taxes on vehicles.

37. An important development, since publication of the NC2, has been the formulation of a new comprehensive transport policy, set out in the Transport Policy Proposal for Sustainable Development adopted by the parliament in June 1998. It sets out a number of long-term objects relating to accessibility, quality, safety and the environment. It also quantifies intermediate objectives. Related to climate change, CO_2 emissions should have stabilized at 1990 levels by 2010, although officials noted this target may change, depending on the outcome of EC burden-sharing negotiations. Based on 1995 levels, NO_x emissions should be reduced by at least 40 per cent by 2005, sulphur emissions by at least 15 per cent and volatile organic compounds by at least 60 per cent. The Government will also report annually to parliament on how transport policy objectives have been achieved. It proposes that certain general principles should guide transport policy, including the greater use of economic instruments to incorporate the 'external costs' of noise and pollution etc into the price paid by users. The Road Tax Commission has been assigned to review road taxation and make proposed changes for environmental benefit. Public opinion against higher taxes may limit the Government's willingness to raise fuel taxes.

38. The Government intends to establish a special Goods Transport Delegation to facilitate cooperation between different modes and design a national goods transport strategy. Officials noted, however, that in many industries, rail is not an alternative to road because most goods are transported over distances of less than 100 kilometres. It is also proposed to establish a National Transport Agency to assist in the provision of long-distance, non-commercial passenger transport with a maximum annual budget of SKr 875 million. The Swedish Transport and Communications Research Board is to be given an additional SKr 20 million per annum to permit continued research efforts with, *inter alia*, so-called 'environmentally adapted' transport. The Government initiated a project in the spring of 1998 to promote regional efforts with biogas as an alternative fuel. The rail network will continue, on the whole, to be State financed, but some services may be provided by the private sector. A new track charging system will be introduced. Charges will be dependent upon traffic and computed on the basis of the socio-economic marginal cost of railway transport. The new track charging system should reduce rail costs for operators by almost SKr 700 million. The State is planning to take over responsibility for terminal and rail links which should reduce railway company expenditure by about SKr 90 million and reduce rail costs for freight users.

39. Sweden's two car manufacturers have recently announced that they will voluntarily achieve a 25 per cent reduction in average fuel consumption by 2005 compared to 1990 levels, in line with the target level the European Commission is trying to agree with manufacturers.

40. Initiatives to introduce so-called 'intelligent transport systems' by including global positioning satellite equipment in lorries should reduce journey distances and have a small effect on reducing emissions. Such systems can also be used to inform waiting passengers when the next tube train or bus is coming and hence make public transport more attractive.

41. There were plans to introduce road pricing in Sweden's two major cities, Stockholm and Göteborg, but owing to a lack of public support, they were dropped. In 1996, over 280 buses were run on ethanol, with the largest fleet in Stockholm. About 180 buses used natural gas and almost 50 biogas. There were a further 20 buses with mixed fuel capabilities complemented by over 300 electric cars and 200 mixed fuel vehicles. As the cost of producing alternative fuels is higher than for petrol or diesel, no large-scale introduction is expected in the near future.

D. Agriculture

42. There is little in the NC2 about agriculture because there are no policies specifically targeted at reducing greenhouse gas emissions. Nevertheless, some measures in this sector have this effect such as regulations relating to animal density and manure spreading and a tax on nitrogen-based fertilizers. The environmental tax on nitrogen accounted for approximately 20 per cent of the price of fertilizer in 1996. The estimated use of nitrogen fertilizer fell by about 15 per cent between 1986 and 1996.

43. The NC1 reported a significant potential to reduce N_2O emissions from nutrient leakage, but this was found to be overly optimistic, so the estimate is now thought to be quite small. Subsidies are available to grow biomass crops such as salix, commonly known as willow. Incentives are provided by Government to promote organic farming, which now accounts for eight per cent of arable land, this reduces the use of fertilizers and increases the use of nitrogen-fixing crops.

E. Waste

44. Of total CH_4 emissions, approximately 20 per cent came from waste (landfills) in 1995**.** The NC2 contains little information about waste policy yet it was clear to the team that a number of measures will be taken to reduce the CH_4 emissions. Parliament adopted a number of overall goals in the waste management field in 1975, including minimization of waste quantities at both the production and consumption levels, maximization of waste recycling and stiff environmental requirements for disposal of waste that cannot be recycled. The Parliamentary Climate Change Policy Decision of 1993 set a 30 per cent reduction target for CH_4 emissions from landfills by 2000, to be achieved principally through the installation of landfill gas recovery systems. Swedish estimates show that this reduction target should be achieved. In 1994, there were at least 56 sanitary landfills with gas recovery and 21 incineration facilities operating in Sweden The energy from these facilities was mainly utilized for heat production with an annual thermal output of approximately 4 Twh. Between 1980 and 1994 the quantity of waste incinerated doubled and energy production almost quadrupled.

45. The EC waste programme encourages waste reduction, incineration and recycling, but it is not legally binding. There is an EC voluntary eco-management system which requires firms to adopt environmental policies in order to join. A number of new policy instruments were adopted by the parliament in November 1997 to broaden producer responsibility for waste, to produce guidelines for environmentally sound procurement, produce environmental product declarations based on life-cycle analysis and introduce a landfill tax. Producers are responsible for collecting and disposing of waste paper packaging, tyres and cars. By the year 2002 a new regulation on sorting should be introduced. Hazardous waste and waste encompassed by producer responsibility should be separated out, to the extent possible, in the waste stream. Waste should be separated into a combustible fraction and a landfill residue, the combustible fraction consisting of waste for incineration and for biological treatment. When biological treatment is available the combustible part should undergo further separation. There are already demonstration projects for biological treatment plants, both biogas facilities and large-scale composting plants. In 2005, there will be a ban on all organic waste going to landfill. At the time of the review, a proposed landfill tax of SKr 250 per tonne was awaiting EC approval.

46. Since 1991, each municipality has been obliged to have a waste management plan which must include measures to reduce waste quantities. As landfill licences come up for renewal the operator may be required to install gas recovery systems, depending on the amount of gas being produced. Even though landfilling of organic waste will be banned in 2005, collection of landfill

gas will be required in most landfills where organic waste has been landfilled, since gas will be generated for a long time. It is recognized by officials that the new measures will entail a significant increase in costs.

F. Local initiatives

47. Swedish local municipalities have an important role to play in energy policy, especially as many have their own energy companies. Since 1977, they have been legally obliged to promote the efficient use of energy in their planning, according to the Municipal Energy Planning Act. An amendment to the Act, in 1991, required that all plans for the supply of energy to households must include an environmental impact study.

48. The Swedish parliament has allocated SKr 5.4 billion for the period 1998 to 2000 for investment grants to municipalities that apply an integrated approach to ecologically sustainable development. Grants will be given for measures that reduce environmental impact, make energy utilization more efficient, promote the use of renewables and increase recycling etc. Funds may also be used in the transport sector to operate hybrid diesel/ ethanol buses, improve cycle lanes and promote park-and-ride schemes etc.

49. Stockholm, along with Göteborg, Linköping, Laholm and Växjö, is a member of the International Council for Local Environment Initiatives, which encourages its members to reduce CO_2 emissions by 20 per cent by the year 2005. Some cities, including Stockholm, Eskilstuna and Växjö, are members of the Climate Alliance of European Cities with Indigenous Rainforest People which has adopted the goal of halving CO_2 emissions by 2010.

G. Forestry and land-use change

50. The potential to increase forest coverage is limited and there are no specific climate change related policies in this sector. The standing volume of trees has been increasing this century, but timber felling has been on a slightly upward trend since 1980. In 1996, timber stocks grew by about 100 million m^3, whilst fellings and natural mortality resulted in a 70 million m^3 reduction. About 87 per cent of forests are privately owned and over 90 per cent of fellings go to sawmills or the pulp and paper industry. The forestry industry is important for Sweden with a turnover of about SKr 200 billion per annum and a workforce exceeding 100,000 people.

51. Under existing policy, about four per cent of the managed forest is protected by law for conservation or recreational use. In 1993/4, changes in the Forestry Act reflected the increasing importance of biodiversity and the preservation of species as environmental and production goals were given equal priority. Consequently, there is less regulation on forest owners, but greater responsibility to fulfil policy goals and penalties in the event of failure to comply. Publicly funded campaigns are run to make foresters more environmentally aware. To promote silviculture, each of the 11 county forestry boards is required to draw up action plans with

specific goals involving improvements in forestry practices. Officials noted that it is too early to evaluate the effects of policy change on CO_2 emissions.

52. Since 1980 recycling activities have increased. Approximately one million tonnes of paper was recovered in 1994, mostly newspaper and corrugated containers, and used in the production of a variety of products.

H. New gases

53. The Refrigerants Order contains general rules of good housekeeping covering the life cycle of refrigeration equipment, to minimize losses. A common industry standard called the Swedish Refrigeration Code provides instructions for the installation and servicing of equipment in line with the Order. There is also an ordinance requiring good housekeeping in the use of HFCs as fire extinguishers. A voluntary agreement between the SEPA and Swedish primary aluminum smelters should lead to a reduction in PFC emissions from this source.

I. Policies which conflict with greenhouse gas reductions

54. The proposed phase-out of the nuclear power programme could result in increased electricity production from fossil fuel sources, although, in part, this is likely to be in neighbouring countries as the amount of electricity imported may increase. According to Swedish officials, unless environmental legislation is harmonized, this could be exacerbated by the increasing integration in the Nordic electricity market. Four of the largest rivers in northern Sweden have been protected from hydropower development for environmental reasons, which limits the potential for this energy source.

IV. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

55. During the review, the team noted that projections are based on robust procedures involving good modelling practices and expert knowledge. The Swedish Environment Protection Agency produces projections of greenhouse gas emissions on a three-yearly basis. Underlying this work, the National Energy Administration produces projections of energy use. Projections are based on policies which are either already implemented or fully committed to; no prospective easures are included. The NC2 provides a comprehensive set of figures for projected emissions, a wealth of detailed information about assumed prices, GDP growth rates and various breakdowns of energy use by sector. Given this, the review concentrated on how the projections were produced.

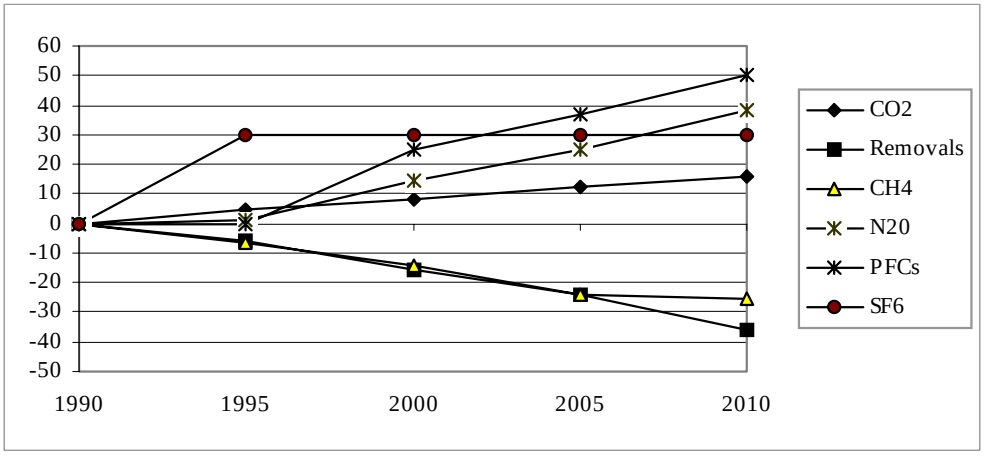
56. The energy projections are the result of interactions of several models, combined with expert knowledge. Over one hundred variables were taken into account. Several Swedish authorities are involved in the provision and checking of basic assumptions about economic development. A bottom-up industry model is used to estimate demand growth for different commodities in various sectors. Projected industrial demand patterns are checked against the

results of econometric work, based on historic demand elasticities. These results are fed into the ELFIN power sector model which consists of several components covering, for example, the electricity supply industry, boilers, CHP capacity etc. This calculates the fuel balance and market price. Separate forecasts for the growth in different types of transport are taken into account and translated into energy requirements. Existing plant is ranked in order of running costs, from hydro, nuclear, district and industrial CHP and oil condensing to combined cycle gas turbines at the top end. In terms of new build, coal is the cheapest fuel of choice, but the model is constrained not to build such plant, given current CO_2 policy. Only known generating technologies are included in the model; there are no assumptions about future so-called 'breakthrough' technologies. The overall power balance model relates only to Sweden. Some consideration has been given to the creation of a Nordic electricity market and it is predicted that 14,000 MW of capacity that would otherwise be required, will not be built.

57. In the NC2, as compared to the NC1, up to 2005, forecast emissions of CO_2 were revised downwards and projections of CH_4 and N_2O are also slightly lower. Projections of the indirect gases are broadly unchanged as are expectations for PFCs and SF_6, but the forecast for HFCs is considerably higher.

58. Emissions of five of the six direct greenhouse gases are forecast to grow, compared to 1990 levels, the exception being CH_4. CO_2 emissions are expected to be nine per cent above the 1990 level by 2000 and 16 per cent higher by 2010. N_2O emissions are expected to be about 14 per cent above the 1990 level by 2000 and 38 per cent higher by 2010. By 2000, CH_4 emissions are expected to decrease by 12 per cent and by 19 per cent in 2010. HFC emissions are not shown in figure 4 as they are expected to increase from a base of zero in 1990 to approximately 0.67 Gg in 2010. Indirect greenhouse gases NO_x, CO and NMVOCs are expected to decrease substantially by the year 2010, but this, to a large extent, is dependent upon assumed improvements in transport technology. Recent changes in taxation policy, since the publication of the NC2, are not thought to have significant impacts on any of the projections.

Figure 4. Projected percentage change in emissions from 1990



59. After a protracted recession, there is now confidence in a strong economic recovery, especially in the exported goods sector. In 1995, industry accounted for about 31 per cent of total energy use. Even though energy efficiency is expected to improve, the economic recovery is likely to result in a 12.5 per cent industrial sector energy use growth between 1995 and 2010. In the residential, commercial and institutional sectors, which accounted for 34 per cent of Sweden's energy use in 1995, only a very weak increase is expected up to 2005 with a slight decline therafter. Underlying this, electricity use is projected to increase whilst oil use declines, mainly due to the conversion of boilers in single owner-occupier homes, and more district heating is expected, along with a greater use of natural gas. An assumed increase in the size of heated areas in buildings is almost entirely offset by presumed technology developments and energy efficiency improvement. The transport sector accounted for approximately 21 per cent of energy use in 1995. Given current policy instruments, alternative fuels are expected to have a minimal market share in future. Transport activity is projected to increase by an average of 1.6 per cent per annum between 1990 and 2010 with passenger car traffic accounting for the greatest portion.

60. Separate consideration was given to analysis of the electricity sector. As a result of EC moves to improve third party access and of the trend toward a Nordic electricity market, the modellers assumed enhanced competition in the production and supply of electricity, although electricity prices for all types of customer are assumed to rise. Electricity use is projected to increase by a total of 11 TWh between 1990 and 2010, equivalent to a rise of 0.4 per cent per annum resulting in the need for a small amount of additional generation capacity beyond the CHP which is assumed to be added to the district heating system, and hence increased fuel use. Only small variations in the overall fuel mix are predicted.

61. The projections were produced before the energy agreement was concluded calling for the shutdown of two nuclear power reactors in Barsebäck, the first in July 1998 and the second before July 2001. It was assumed that an average-sized reactor of 835 MW would be closed before 2000 and that all other nuclear plants would operate until the end of their useful working life of 40 years. Compared to the assumed nuclear electricity production of 67.0 TWh in 2000 it is now assumed to be 67.8 TWh, falling to 64.0 TWh in 2005 and 2010. The closure of the first reactor could result in CO_2 emissions increasing by 0.2 million tonnes of carbon, based on the average 1995 electricity generation mix, but up to 2.1 million tonnes of carbon if the electricity is, instead generated by coal. It should be noted that Swedish energy policy requires a reduced use of electricity for heating, increased utilization of existing CHP, new district heating networks and additional renewables capacity before the second reactor at Barsebäck is closed.

62. Uncertainties about the nuclear phase-out programme, what fuels substitute nuclear power, future development of the Nordic electricity market and alternative paths for industrial development create uncertainties in emission projections. An increase in Swedish imports would reduce future projections of CO_2, but emissions in neighbouring countries would then increase.

63. Transport emission estimates are worked out by the SEPA based on energy use estimates by several agencies. The main transport models covering rail, road and the sea, are run by the

transport agency, SIKA, although the basic economic assumptions are supplied by the Ministry of Finance. Many separate models cover personal traffic, car ownership by region, regional trips, road freight, rail etc. These models include detailed information about demographics, behaviour, the transport fleet, road and rail networks and economic information related to growth in different sectors, including patterns of international trade. Detailed cost data including loading and unloading costs are also included. Some data date back to the 1980s and are in the process of being updated. Assumptions are made about saturation effects, market penetration rates for air-conditioning and technology improvements etc. One key use of the models is to predict infrastructure investment requirements. Consideration of different road/ rail options shows very little impact on the growth of road transport. A policy, under consideration, proposing increased investment in the railways could increase rail travel by 96 per cent between 1993 and 2010 compared to a six per cent increase that is otherwise predicted and car travel could increase by 17 per cent, instead of 19 per cent, over the same period. However, the impact on CO_2 is described as minimal because rail has a very low starting point, in terms of its share of miles travelled.

64. Projections of non-energy-related emissions are based on expert analysis of trends, activity data and assumptions about the effects of measures. The uncertainty associated with these figures is greater. Both CH_4 and N_2O emissions from agriculture are expected to decrease due to declining animal numbers. CH_4 emissions from the waste sector are predicted to decrease substantially, following implementation of the new waste management policy. In the longer term CH_4 emissions from waste are expected to be insignificant. HFC emissions are estimated to grow as a result of continued substitution of ozone-depleting substances. Aluminium production and high-voltage switchgear manufacture should remain stable, so emissions of PFCs and SF_6 are unlikely to grow significantly.

65. Swedish forests are assumed to continue growing at the current annual rate of about 100 million m^3. As global demand for paper is expected to grow at about 2.8 per cent per annum until 2010 and as demand for biomass in energy production grows, logging rates are expected to increase. By 2020 annual fellings are expected to exceed 80 million m^3, compared to current levels of about 66 million m^3, based on a five-year average. Overall, the carbon sink is expected to decline over time but still be significant during the coming 20 to 30 years.

66. A modified MARKAL/ MACRO model is only used to predict the combined effect of tax measures although the forecasts from this approach are in line with the official projections. It combines an energy sector model with a model of the economy and judges all investments on the same basis, assuming perfect knowledge about the future. It incorporates average data for the description of different technologies and it chooses between them in a strictly cost-minimizing fashion. Two scenarios were considered. The 'without measures' scenario assumes that taxes remain at their 1990 level throughout the forecast period whilst the 'with measures' scenario applies taxes in existence up to 1996 and certain subsidies, mainly in support of renewables and CHP. Sulphur and NO_x emission fees are also included. The results show a large increase in biomass use especially for district heating and biomass CHP instead of coal-based CHP. But,

overall, CHP production becomes somewhat less attractive. Wind power and solar heating are advantaged, but there is only a small impact on capacity. There is somewhat less energy efficiency improvement and less use of biomass by industry, which benefits from tax exemptions compared to the 1990 situation. Overall, energy demand is lower due to higher prices. This type of optimization model cannot accurately reflect developments in the energy market because non-price factors are not incorporated. The model results show that GDP growth is somewhat lower than otherwise, but the taxes are recycled in a lump sum fashion and the effect would be lessened if, instead, it is assumed that other distortionary taxes are reduced. The modellers believe that there is too much uncertainty associated with the costs of policies to quote any figures.

67. Non-tax measures have been estimated without the use of a model. The effects of research and development activities are not quantified. Overall, the results are as shown in table 5.

Table 5. Difference in CO_2 emissions between 1996 and 1990 policy instruments, (million tonnes of CO_2 per annum)

	2000	2005	2010
Investment support	-0.7	-0.7	-0.7
Programme for more efficient energy use	-0.2	-0.2	-0.2
CO_2 and energy tax	-3.4	-3.9	-4.3
Other tax	-13.2	-16.7	-18.5
Total	**-17.5**	**-21.5**	**-23.7**

V. TRANSFER OF TECHNOLOGY

68. Technology transfer is not addressed in the NC2. No government department has overall responsibility and there are no specific programmes. Industrial technology transfer by Swedish companies is extremely widespread, but it is part of normal business activities and not regarded as 'additional'. Some overseas development assistance projects involve technology transfer, but they are seldom related to climate change. It was explained to the team that technology transfer primarily occurs as a result of cooperative AIJ activities. For example, in Latvia, local capacity to manufacture efficient boilers was developed, based upon Swedish designs, and numerous energy handbooks have been produced in the multiple languages of the Baltic States to facilitate information transfer. Surveys have shown how Swedish firms that win tenders for boiler conversion and distribution projects in the Baltic States have, in general, also won other business outside the framework of the AIJ programme. Other initiatives which could be regarded as technology transfer include participation in GREENTIE and IEA implementing agreements.

VI. EXPECTED IMPACTS AND ADAPTATION

69. Existing climate models are not sufficient for decision making in Sweden as they take no account of how the Scandinavian mountain range will affect precipitation. The Foundation for Strategic Environmental Research (MISTRA) together with the Swedish Meteorological and Hydrological Institute (SMHI) are developing climate models to generate more detailed scenarios. The NC2 contains a thorough discussion of possible impacts resulting from climate change. Sweden's subarctic ecosystem and mountain regions could be particularly vulnerable. The Baltic Sea area could also be adversely affected through sea level rise, warmer water temperature and reduced salinity. Increased air temperature and precipitation could lead to faster growth of forests, however some trees are adapted to cold winters and forests are assumed to be more vulnerable to damage by insects and disease.

70. Particular emphasis in the NC2 is given to impacts on technical systems. This did not involve any research but instead was based on a study which examined a 'what if' type scenario of rising temperatures and sea level on hydrological systems, infrastructure and the energy sector. On the whole, there appear to be many potential negative impacts with increased risks of flooding, landslides, damage to roads and bridges through corrosion in a milder, damper climate, reductions in water quality through evaporation etc. The risks of power failure would also be increased due to more heavy wet snow-falls. There would be countervailing positive aspects, with reduced expenditure on winter heating and reductions in the cost of winter road upkeep. However, most impacts will not be noticed before 2030. Additional research is being conducted to assist town planning in areas at risk of floods from rivers. At present there are no policies specifically related to adaptation.

VII. FINANCIAL ASSISTANCE

71. During the review, Sweden very helpfully provided a great deal of additional data about financial assistance, using the tables provided in the UNFCCC reporting guidelines. Over the period 1994 to 1997, SKr 450 million was provided to the Global Environment Facility. In 1996, about SKr 4,382 million was given to multilateral institutions and more than SKr 80 million to to multilateral scientific, technology and training programmes. Of new and additional bilateral financial contributions related to implementation of the Convention to 22 developing countries, in 1996, about SKr 1,030 million related to energy projects, SKr 6 million was for transport activities, SKr 3.8 million for industry and SKr 1.7 million for mitigation in agriculture. A further SKr 27.1 million went on adaptation measures. To economies in transition, about SKr 15.5 million was given for energy measures and a further SKr 0.7 million for transport emission mitigation activities. Mitigation measures have, *inter alia*, encompassed energy efficiency, hydropower, renewables, alternative fuels, improved railway systems, sustainable agriculture practices and tree planting. Adaptation measures have mostly related to soil and water conservation in arid and semiarid areas. For many years, Sweden has fulfilled the United Nations goal of 0.7 per cent of GNP for official development assistance and it intends to further increase that assistance.

VIII. EDUCATION, TRAINING AND PUBLIC AWARENESS

72. In 1993, the parliament voted to allocate funds for climate-related information and education. The team formed the opinion that a comprehensive and sophisticated programme has been established, primarily for the youth audience. It includes a study kit on the risks associated with climate change. An evaluation, in 1996, showed excellent results in raising the awareness of young people about the world environment. To assist local Agenda 21 work, the SEPA has given support to municipalities. A book has been produced to highlight examples of good local campaigns to reduce CO_2 emissions. Many municipalities have developed their own climate plans and targets for local application. There are plans to create a dialogue between Government, industry and households about the future of energy supply in Sweden, based on current studies in this area. This will involve seminars for representatives of various groups.

IX. ACTIVITIES IMPLEMENTED JOINTLY

73. The main thrust of Sweden's AIJ programme is in the Baltic region and Eastern Europe. Some 70 projects were completed or under way by early 1998, of which 33 are mentioned in the NC2. The team was given updated information on the Environmentally Adapted Energy System programme, begun in 1993 and mainly relating to converting fossil-fuel heating boilers to wood and other biofuels, renovation of district heating networks and energy efficiency improvements in buildings. The goals are to reduce CO_2 and other emissions, improve energy efficiency, promote environmental awareness and further economic development. Officials noted that a great deal of progress has been made in overcoming technical barriers to the application of new technologies. Ten year loans are given to participants for projects with a payback period of no more than five years. Thus far, loans are generally being repaid on time or, in some cases, early. The projects involve local management with grant-funded support from Swedish consultants. Equipment is procured on the basis of open competitions. Assistance is also given via workshops, training and follow-up activities. Success is attributed to the partnership approach involving direct contacts at the local level. The total programme budget for 1993 to 1997 was SKr 295 million of which SKr 230 million was in the form of loans and the remainder was for technical assistance. In the 1997 Parliamentary Decision on Sustainable Energy Supply, SKr 350 million was allocated to international energy policy related climate change mitigation measures.

X. RESEARCH AND SYSTEMATIC OBSERVATION

74. Sweden has put a lot of funds and effort into research and provides a good description of its activities in the NC2. The only difficulty in reporting is trying to distinguish the climate-related funding in cases where projects address several issues. In 1993/94 SKr 43 million was spent on natural science, SKr 180 million on energy, SKr 52 million on transport and about SKr 10 million on socio-economic research. State funding has subsequently been reduced by about 10 per cent per annum. In relation to forestry, several special projects relating to whole tree physiology are of relevance to climate change.

75. Funds are available from a variety of government departments, from the EC and the Nordic Environment Research Council for both national and international projects. Sweden is involved in the International Geosphere-Biosphere Programme, mainly related to biological and chemical processes, the World Climate Research Programme, which covers physical processes, EC framework programmes and OECD/IEA activities. Swedish researchers are also involved in other international projections and various collaborative efforts with researchers from other Nordic and Baltic countries.

76. The team was informed that Sweden will focus more on climate-related research in future although less will be available for consideration of impacts and adaptation. Priorities for future research have recently been decided during preparations for the 1997 Research Decision. Within scientific climate research, priority is being given to basic research, particularly related to fundamental physical processes. This information will assist in better understanding the effects of climate change on ecosystems and socio-economic sectors, especially agriculture, forestry and fishing. Overall, the weight of research has been shifted more toward technology advancement and socio-economic work related to GHG mitigation**.** Extensive research programmes related to energy and transportation were begun in 1998, following the 1997 Parliamentary Decision on Sustainable Energy Supply, covering improved utilization of biomass and alternative fuels for transportation, in particular.

XI. CONCLUSIONS

77. Overall, the review team formed the impression that a good system is in place to collect activity data, estimate national emission factors and employ the relevant methodologies for the calculation of national inventories. Furthermore, it is evident that there is a reasonable degree of coordination between all of the government agencies involved. In areas where data are incomplete or out of date or where IPCC default emission factors are used, there is evidence of work on improvement.

78. In general, Sweden appears to have a comprehensive set of policies and measures to mitigate greenhouse gas emissions. Whilst some have been designed primarily to improve air quality or for other environmental goals, many are focused on climate change. However, these policies do not seem sufficient for Sweden to achieve its goal of stabilizing CO_2 emissions at the 1990 level by the year 2000 as, based on its official projections, CO_2 emissions are expected to increase by about nine per cent. Furthermore, N_2O emissions are expected to be 14 per cent higher in 2000 than 1990, whilst those of CH_4 may be 12 per cent lower. The NC2 does not describe any additional policies which will allow this goal to be achieved nor do new developments since its publication appear, to the team, sufficient to achieve this goal. In the waste sector, the technical potential to reduce CH_4 emissions should be well exploited if measures are fully enacted. In the transport sector, there are limited opportunities, so emissions growth may be constrained, but is unlikely to be reversed. Sweden already has relatively high levels of taxation and increases are now somewhat limited by concerns about competitiveness. To a large extent, the future path of emissions will be determined by the decision to phase out nuclear power

along with complementary measures to increase renewable electricity production and improve energy efficiency.

79. There is no overall monitoring mechanism to assess the effectiveness of various policies and measures related to climate change. To date, policies in the energy sector have been rigorously analysed on an annual basis. From 1998 onward, it was intended that monitoring and evaluation of short-term and long-term energy policy measures should be intensified in order to improve annual analysis and assessment on a longer term basis, including methodology development. The Government has proposed increasing monitoring efforts in the transport sector through annual reporting to the parliament on transport policy goals.

80. The level of public awareness about environmental issues in Sweden is high. The Government's information campaigns have been particularly targeted at the younger generation and appear, on the basis of evaluation surveys, to have raised awareness in this section of society.

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