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

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Under Articles 4 and 12 of the Convention, Parties are required to prepare national communications on their implementation of the Convention. Guidelines for the preparation of national communications and the process for their review were agreed on by the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change, by its decisions 9/2 and 10/1, and by the Conference of the Parties, at its first session, by its decisions 2/CP.1 and 3/CP.1 (see FCCC/CP/1995/7/Add.1). In accordance with these decisions, a compilation and synthesis of the first 15 national communications from Annex I Parties was prepared (A/AC.237/81).

When reviewing the implementation of the Convention by Parties, the subsidiary bodies and the Conference of the Parties will have this report available to them in English as well as the summary of the report in the six official languages of the United Nations. (These bodies will also have before them the executive summary of the first national communication of Sweden and country-specific information drawn from a compilation and synthesis report covering all countries that have submitted national communications.)

Summary[1]

1. The in-depth review of the national communication was carried out from March to July 1995 and included a visit by the team from 13 to 17 March 1995. The team included experts from Brazil, Bulgaria and the United States of America. Since the communication was submitted, Sweden has changed Government and joined the European Union. These changes are not in themselves expected to have any major impacts on its climate change policy.

2. The team concluded that the communication generally followed the format set out in the guidelines. In some areas, such as the methodologies for assessing carbon sinks and for estimating effects of measures, the reported approaches were particularly innovative and/or advanced. In other areas, additional material or information provided during the visit supplemented and clarified the communication.

3. Particularly important national circumstances are that 95 per cent of the electricity production is currently based on hydro and nuclear power. In addition, Sweden has a relatively high proportion of biofuels and district heating in the energy system, and high taxes (and prices) applied on fossil fuels for most users. This results in lower per capita emissions of carbon dioxide (CO_2) (7 tons) than other member countries of the Organisation for Economic Co-operation and Development (OECD), which have approximately 12 tons on average. Also important is the openness of the economy, which interlinks domestic and international markets for energy and industrial goods. The decision to phase out nuclear power by 2010 as a result of a referendum in 1980 and limitations to further hydro power development are other crucial framework conditions.

4. CO_2 emissions were reduced by 40 per cent between 1970 and 1990 owing to the development of nuclear and hydro power and improvements in energy efficiency. At present, the biggest source of CO_2 emissions is transport, which accounted for 38 per cent of total emissions in 1990.

5. The goal set by the Riksdag (parliament) is that emissions of CO_2 from fossil fuels in the year 2000 shall be stabilized at the 1990 level and shall decline after that. Furthermore, emissions of methane from landfills shall be reduced by 30 per cent between 1990 and 2000. The team concluded that Sweden has a comprehensive approach to climate change, including efforts to address all sources and sinks in inventories, projections, and policies and measures. A number of policies and measures have been implemented, most notably the CO_2 tax introduced in 1991 and now covering approximately 75 per cent of these emissions, which, together with other tax measures, is expected to account for 70 per cent of the estimated effects of measures in 2000. The team also concluded that climate change concerns have been integrated in major sectoral decisions (such as energy, finance/taxation, development

[1] In accordance with decision 2/CP.1, the full draft of this report was communicated to the Swedish Government, which had no further comments.

programmes, waste, agriculture and forestry), although Sweden recognizes that efforts are needed to improve the situation in some areas.

6. The team noted that the effects of the measures in place are already considerable and are expected to reduce CO_2 emissions in 2000 by 14 per cent (10 400 Gigagrams (Ggs)) compared with the level projected on the basis of the policies and measures in place in 1990. This effect will be achieved mainly through taxation measures. However, existing measures are not expected to be sufficient to fully stabilize emissions of CO_2 (which show 4 per cent growth in the projections) or of all greenhouse gases (which show 5 per cent growth) in 2000 at 1990 levels. The growth in CO_2 is due to increasing emissions from the transport sector (16 per cent), which is the largest source of emissions, and a return to average emissions from the energy and transformation sector, reflecting the fact that 1990 was an unusually mild year with high precipitation, causing low heat demand and high electricity production. The emissions may increase further by 2005 (11 per cent for CO_2 and 9 per cent for all gases) if additional measures are not introduced. Such measures, including a wider application of the CO_2 tax, would, according to Sweden, often require international coordination. If Sweden pursues the decision to phase out nuclear power by 2010, it is likely to result in a sharp increase in CO_2 emissions.

7. Swedish forests constitute a large carbon reservoir. However, even though at present the sink capacity is considerable in comparison to the CO_2 emissions, the net sequestration is expected to level off in a few decades. Keeping the level of carbon stored in the forest will demand a continued sustainable forestry policy.

8. The team found that Sweden, being a country adapted to a high natural climate variability, has not implemented specific adaptation measures as a response to climate change. Nevertheless, studies are being carried out and it is recognized that this issue, including the vulnerability of relevant sectors of the economy, needs to be examined further. Sealevel rise is not of great concern because the rate of uplift is greater than projected changes in sealevel.

9. Sweden has contributed its share to the Global Environment Facility (GEF) both in the pilot phase and the replenishment (1994-1997). Additional resources are being transferred to projects aimed at reducing greenhouse gases in Eastern Europe. Official development assistance is, and has been, well above 0.7 per cent of gross national product (GNP) for a number of years, even though it recently declined because of the economic recession. In 1993 it corresponded to 0.98 per cent of GDP according to OECD, Development Assistance Committee (DAC) statistics.

10. The team noted that further development of Swedish policy on climate change must be seen as a continuous process where conclusions from the parliamentary commissions on energy policy, ecological tax reform and transport issues working at the time of the review visit might entail some changes.

I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

11. Sweden ratified the Convention on 23 June 1993. Its national communication was received by the secretariat on 21 September 1994.

12. The in-depth review of the national communication was carried out between March and July 1995 and included a visit by a review team to Stockholm from 13 to 17 March 1995. The team consisted of Mr. José Domingos Gonzalez Miguez (Brazil), Ms. Katya Simeonova (Bulgaria), Mr. William Hohenstein (United States), Ms. Carmen Schlosser (UNFCCC secretariat) and Mr. Peer Stiansen (UNFCCC secretariat, Coordinator). In the course of the visit, the team met representatives of the ministries concerned and of public agencies and members of the scientific and academic community, as well as representatives of non-governmental organizations.

13. Since the submission of its communication, Sweden has changed Government and become a member of the European Union. These developments do not appear to have caused major shifts in Swedish climate change policy, which has wide support in the parliament. Sweden is contributing to the efforts of the European Community to combat climate change.

14. CO_2 emissions dropped by 40 per cent between 1970 and 1990 and are among the lowest per capita (7 tons) among Annex I countries. The main factors behind this are a shift in the electricity supply (95 per cent of which is now based on nuclear and hydro power), increased energy efficiency and an increasing use of biofuels. This has met new demand and also substituted use of fossil fuels for electricity and heating. Other major factors contributing to the decrease are the relatively high prices resulting from taxation on fossil fuels and structural change away from heavy industry. Total final energy use has been stable for 25 years despite the growth of gross domestic product (GDP) and population. However, Sweden still expects a growth in demand for energy services through 2000.

15. Sweden, although a small and open economy, in 1991 unilaterally implemented carbon taxes now covering approximately 75 per cent of their CO_2 emissions. Prices are high for the bulk of fossil fuel use, and for some users this is in particular the result of the carbon tax; however, in the case of petrol, high taxes have been in place for years and the carbon tax is a relatively small fraction of the total taxes. Fossil fuels for electricity production (which are used mainly for peak-load production), are exempted, mainly to avoid double taxation; some other uses have been exempted from the CO_2 tax in order to maintain the competitiveness of the manufacturing industry.

16. General energy efficiency in Sweden appears to be relatively high, in particular in the residential sector, due account being taken of the climatic conditions which result in extensive heating requirements. The use of district heating is considerable and opportunities for expansion are narrowing as a result of the scattered location of detached houses. In the transport sector, the existing fleet of private vehicles has a relatively high proportion of

heavy cars, and both the number of vehicles and the demand for transport services are

expected to grow.

17. The proportion of electricity used in the Swedish energy mix is very high (approximately one third of the total energy supply, compared to an 18 per cent average in OECD countries). This is partly due to the relatively low prices which reflect the situation on the supply side in the Swedish, and in recent years, in the Nordic electricity market. However, the supply of electricity, especially from hydro power, fluctuates considerably, as do imports and exports. This has implications for emissions, since the domestic alternative to nuclear and hydro power is electricity from oil-fired power plants. Also the demand for heating fluctuates considerably from year to year.

18. The repercussions of the decision to phase out nuclear power by 2010 taken after a referendum in 1980 are the major source of uncertainty regarding emissions in the medium and long term. This is the focus of the Energy Commission, which is expected to submit its report in December 1995. Further development of watercourses for hydro power is very limited by environmental restrictions and biofuels are already used to a large extent, although there is still scope for expansion. Contributions from other renewable sources are encouraged, but are not seen as a major short- or medium-term option. Improvements in energy efficiency, although they could yet be considerable, are seen as being far from sufficient to counterbalance the phasing out of nuclear power and the increased demand for energy services. This may not influence CO_2 emissions before 2005, but projections contained in additional material to the national communication indicate that replacement of the nuclear capacity and increased electricity production based on fossil fuels could well increase emissions by 50 to 100 per cent by 2015.

19. Sweden is in the process of carrying out an electricity reform which will probably allow further integration in a competitive Nordic, and possibly later, European, electricity market. Such integration appears beneficial from an environmental perspective and could certainly work well together with programmes to limit greenhouse gas (GHG) emissions, but it could also put greater restrictions on unilateral actions. Furthermore, if this integration leads to more net imports and exports of electricity, it will mean that emissions from electricity production could occur to a greater extent in countries other than where the electricity is consumed.

20. In the 1990s Sweden has faced a recession with rising unemployment, major budget deficits and in 1992 and 1993 even negative growth in the GDP. However, the economic situation seems to have improved to a certain extent since the communication was written.

21. Most of Sweden is covered with forest, and the carbon stock stored there is considerable despite the intensive utilization of this resource. At present, the forest sink absorbs the equivalent of about half of Sweden's annual CO_2 emissions. However, the forest may in a few decades reach a state where the stock is unlikely to be increased further (and stay larger) and where the net sequestration will be zero.

22. Sweden set up an inter-ministerial group to address the various aspects of climate

change at the end of the 1980s. Policies and measures motivated by climate change, including a CO_2 tax, have been introduced gradually with the preliminary target of stabilizing emissions. The present target to stabilize CO_2 emissions from energy use at the 1990 level in 2000 was established in 1993.

23. The development of proposals to the parliament, including those relevant to climate change, involves relevant stakeholders outside the ministries. Time limitations did not permit active participation by non-governmental organizations in developing this national communication. Contacts with non-governmental organizations and the public sector are carried out on an ad hoc basis, but nevertheless there appears to be considerable interaction. The review team had the impression that a considerable national consensus existed between non-governmental organizations and ministries as to how to address climate change, although different views on levels of ambition in pursuing the target were noticed.

24. For gases other than CO_2, implementation of measures to limit emissions is often left to the regional and municipal levels of government, which are responsible for emission permits. The policy to limit CO_2 emissions is mainly based on measures taken at the national level (carbon tax), leaving no explicit responsibilities to the counties or municipalities. The municipalities, however, play a role in arranging for the utilization of local energy sources and some have established GHG targets on their own initiative. Inventories are submitted from these levels of administration to the Environmental Protection Agency.

25. Climate change policy has been and still is under continuous development in Sweden, as understanding increases and economic, technical and political conditions change. There are a number of parliamentary ad hoc committees working on issues relevant to climate change, and it is expected that the report of the Energy Commission (which is to be submitted in December 1995) may have the most important implications for climate change policies since it addresses both the nuclear phase-out and reforms in the electricity market. Further, two commissions on transport and one on an ecological tax reform are seen as particularly important in this respect. The commissions are also mandated to investigate the implications of their suggestions with regard to climate change.

II. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS

26. The communication provided standard and summary inventories of anthropogenic sources and sinks of greenhouse gases. These are updated annually by the Environmental Protection Agency. The minimum data tables were reported in the communication in accordance with the Intergovernmental Panel on Climate Change (IPCC) Guidelines.

27. Of concern to the review team was the lack of documentation in the communication itself on methods used in making estimates of emissions by sources and removals by sinks, where the methods diverged from the IPCC default methodologies. Sources of information used in developing the inventory were not cited in the communication. Contrary to what was specified in the national communication, in many instances the methods used were more

sophisticated and specific to Swedish conditions than the IPCC default methods. These methods were adequately described to the in-depth review team and supplementary materials were provided that make the estimates transparent. The availability of data from which to derive emissions is generally good, both for major sources and sinks.

28. Swedish experts are working on improving the inventory methodology, and they expect that revisions for some sources will have implications for the figures for the base year 1990, where the uncertainties of estimates are medium to high. Work undertaken between submission of the communication and the team visit did not lead to revisions of the actual numbers in the communication.

29. Emissions from **energy** sources were estimated using the CORINAIR[2] methodologies. Larger facilities were monitored, smaller facilities sampled and emissions estimates from them extrapolated from the samples. Emissions from the transportation sector were based on fuel consumption, vehicle miles travelled, data on the composition and age of the Swedish vehicle fleet, and emission factors specific to Sweden (that reflect for the higher amount of "cold starts" compared to the European average). There is a high degree of confidence in the CO_2 estimates from fossil fuels. Other emissions from fossil fuels are less certain. Emissions from bunker fuels were reported separately. The carbon stored in fossil fuel feedstocks was not considered to be a significant issue for Sweden since the energy emissions are developed using the bottom-up CORINAIR methodology and feedstock use is a minor component of Swedish industry.

30. For the **land use change and forestry** sector, Sweden relies on periodic comprehensive inventories of the forest sector to arrive at estimates of forest carbon storage. A "change in stock" approach was used based on **decadal** inventories of the forest sector of 30,000 permanent plots. The estimates reflect the differences in total storage between two time periods. This is supplemented with information on annual growth from yield data that is generated as part of the inventory. Sweden also developed estimates of carbon sink by peat, carbon emissions from peat extraction, and carbon sequestration by sediment in lakes, streams, and the Baltic Sea. However, these sources are not included in the national communication. The communication included CO_2 emissions from waste in the totals, which is excluded in the guidelines.

31. Emissions from **industrial** sources were estimated primarily using CORINAIR methodologies (with Swedish specific factors). Documentation on methods of estimation and sources of emissions of hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulphur hexafluoride (SF_6) were provided to the review team.

32. In the **agricultural** sector, the team was provided with documentation on the methods

[2] CORINAIR is the component dealing with air emissions inventories of the European Economic Community CORINE (Coordination d'Information Environnementale).

used in developing emission factors for methane emissions from ruminant animals specific to conditions in Sweden. CO_2 emissions from animals were removed from the inventory based on comments received as a result of the initial compilation and synthesis of national communications. The level of N_2O emissions from agriculture was regarded as highly uncertain.

33. Emission factors for **waste** were based on measurements and reflect current levels of methane capture.

III. POLICIES AND MEASURES

34. The team concluded that Sweden has adopted a comprehensive approach in carrying out its climate change policy, with great emphasis on cost-effectiveness and use of economic instruments (taxes). In developing policies and measures, Sweden has taken into account all gases from all sources and sinks. Specific measures are introduced for most of the major sources, while some are only affected by policies and measures not specific to climate change. The total effects of the measures introduced so far compared to those in place in 1990 are expected to reduce CO_2 emissions by 10 400 Ggs (14 per cent) in 2000 and thus limit their growth to 1 63 800 Ggs, compared to the projected level reflecting the policies and measures of 1990. Besides climate change concerns, a strong motivation behind many of these policies is the decision of the parliament to phase out nuclear power by 2010. The team has chosen to highlight some of the policies and measures directed towards CO_2 since this accounts for 80 per cent of GHG emissions in Sweden, which has had some years' experience with particular policies and measures.

35. The basic instrument in Sweden for limiting **carbon dioxide (CO_2)** emissions is carbon taxes. The unilateral introduction of substantial carbon taxes from 1991, as well as other reforms in the tax structure, are responsible for 70 per cent of the estimated effects of measures in 2000. Adverse effects of the tax were not pointed out to the team. However, other policies and measures introduced for multiple purposes are also of significance. Despite the weaknesses (exemptions, lower rates for manufacturing industry) of this unilaterally introduced tax, the estimated effects are considerable and much more significant than the effects of other measures to enhance energy efficiency and thereby limit CO_2 emissions.

36. Review of the design and effects of the **tax structure** was a focus of the team's discussion with the main stakeholders. The incentives to limit CO_2 emissions from fossil fuels are equally dependent on the tax system on all energy products. In addition to the CO_2 tax, the value added tax (25 per cent), the sulphur tax and especially the energy tax play important roles in that respect. Since 1991, the tax system has been revised several times. The changes have so far, for example, resulted in higher taxes for the residential sector, and lower taxes for the manufacturing industry. The sum of the changes in the tax system is expected to lower the total emissions significantly compared to the previous structure, despite the fact that industry is increasing its emissions. These estimates coincide with actual development so far in this decade.

37. The general rate of CO_2 tax is 322.8 SKr/ton CO_2 (approximately US$45/ton CO_2). Manufacturing industry pays 25 per cent of this rate, SKr 83.2/ton CO_2. Fossil fuels used for electricity generation are exempted, as is peat, which is also regarded as a non-renewable fuel generating CO_2 emissions. At present, emissions from these sources are a small proportion of the total, but this could grow substantially when the demand for electricity grows and nuclear power is phased out. There are also some other tax exemptions, including exemptions for coke and coal used in industrial processes, fuels for aircraft and commercial ships. There has been special tax relief for energy-intensive industries but this is being phased out.

38. For liquid fossil fuels for transport, which account for more than one third of the emissions, the energy tax is substantially higher than, and additional to the CO_2 tax. The energy tax for fossil fuels for other use (natural gas, fuel oil, coal) is substantially lower than the CO_2 tax, and peat is also exempted from this tax. Manufacturing industry is exempted from the energy tax. The sulphur tax is a considerable tax element for high-sulphur fuels. There is a separate electricity tax which is levied on consumption of electricity outside the manufacturing industry.

39. The team found that the most notable effect of the tax scheme is the substitution of fossil fuels by biofuels and peat, mainly in district heating and combined heat and power (CHP) production, since neither CO_2 nor energy taxes apply to these fuels. From 1990 to 1994 the biofuel component of district heating increased from 3.5 to approximately 8 TWh. This substitution in CHP is slowed by the low demand for increased electricity production capacity. To stimulate the development of an energy system built on renewables, a special subsidy system for cogeneration based on biomass has been established.

40. The team noted that, owing to the tax changes on transport, effects are expected to be significant also in this sector -- almost 10 per cent less emissions in 2000 than with the old tax system, primarily due to less growth in mileage driven and more efficient cars. Nevertheless, emissions from this sector are expected to rise. Sweden has also applied a system of CO_2 taxes on domestic air transport, a sector which is usually exempted in other countries on the assumption that otherwise airlines would buy their fuel elsewhere.

41. Although other new, renewable sources are also favoured by the tax, as is wind power through some relief in the electricity tax, the use of these is still minor, since they are still relatively expensive for most applications.

42. Ideally the CO_2 tax should be equal for all emissions, but in Sweden's view that would require broad international cooperation for a tax at this level. The main reason for exemptions and variations in the rates of the CO_2 tax was basically competitiveness, since most other countries do not have a CO_2 element in their tax system. The energy tax is fixed at specific levels for each fuel and based on a series of considerations.

43. Regarding the exemption of fossil fuels used for electricity production, the team recognized that if Sweden had introduced a CO_2 tax in this sector, it could lead to increased

importing of coal-based electricity instead of stimulating, for example, domestic use of CHP, and consequently result in higher global emissions without some sort of border adjustment. However, the present tax structure treats electricity generated with and without CO_2 emissions produced in Sweden or abroad equally. In the longer term, when expansion of the production and replacement of existing capacity is needed, the tax incentives could be crucial for the choice of fuel and technology and thus have much higher impacts on emissions than today.

44. Manufacturing industry is also exempted from the electricity tax to protect its competitiveness, this exemption being seen as especially important for the energy-intensive industry. A potential shift from electricity to CO_2 taxation could raise the costs of electricity production and thus also affect competitiveness.

45. The exemptions in the tax scheme mean that the exempted sectors, notably the industries that only pay 25 per cent of the general CO_2 tax rate and are exempted from energy/electricity taxes, will not have the incentives to take measures that are cheaper than those which will be taken in other sectors. Similarly, the incentives to make energy-efficient investments are weaker than in other sectors.

46. If combined CO_2 and energy taxes are adopted at the European Community level, the recent Swedish membership may imply changes in the structure of the CO_2 tax. It is not clear whether this could result in a more or less uniform tax system for all sectors.

47. Programmes to stimulate energy efficiency and the use of renewable energy sources are expected to contribute 30 per cent of the total estimated effects of measures in 2000 (compared to 70 per cent from tax changes). The team held extensive discussions with the institutions responsible for financing and implementing these programmes.

48. In **general**, the team concluded that these programmes are being implemented as described in the communication: that is, the funding has not been curtailed during the recent economic recession in spite of general reductions in public spending. Although the estimated effects are highly uncertain, the actual development so far seems to be following the lines given in the calculations. The investment programmes support development of CHP production based on biofuels, wind power, solar and district heating. There are demonstration programmes on new technology, biofuel technology, transport technology and more efficient use of energy.

49. The team recognized the **energy efficiency programme** , which is conducted mainly by NUTEK (Swedish Technical Board on Industrial and Technological Development), as an innovative approach. It is based on technology procurement (also known as a "golden carrot" programme), framework agreements and programme requirements. This works together with standards to improve the performance of new products and eliminate the least energy-efficient ones from the market. The team noted the positive interest from industry despite the limited size of the Swedish market, and one among several successful examples was presented in detail, namely that of refrigerators. Attention was also drawn to activities undertaken by Sweden to improve legislation on energy-efficiency in new buildings. Considerable support

for research, development and demonstration has also been given for a number of years.

50. The issue of **demand side management** was raised, and the team noted that some applications have been tried in Sweden. However, only a few utilities find them relevant in Sweden's emerging competitive market for electricity. Incentives to realize profitable savings in energy use should be in place for consumers and third party financiers under the present market conditions. Furthermore, since almost all electricity, and a considerable proportion of heat, is derived from non-fossil fuels, the short-term effects on GHG emissions will depend on the possibilities for substitution between electricity and fossil fuels. Utilization of local energy sources (such as biomass, waste, waste heat) is a major issue for energy planning and is stimulated by the Government. Also, improving energy efficiency at the consumer end is targeted in national programmes.

51. In the **transport sector**, the CO_2 tax and other elements of the tax system combined with some research, development and demonstration projects, are the instruments currently in place to limit CO_2 emissions. This approach is generally expected to continue. However, the team noted the considerable supply of public transport by rail and road. It also noted that impacts on CO_2 emissions have been an issue in infrastructure decisions such as that concerning the building of a bridge connecting Sweden and Denmark. The team noted that the present tax system favours company cars and that the Swedish car fleet consequently has a higher proportion of large and medium-sized cars for passenger transport than other countries. This increases the emissions from transport compared to a more "neutral" system.

52. The team noted the work of a parliamentary committee, ongoing at the time of the visit, to investigate ways and means of reducing emissions from transport . The Committee considers measures such as efficiency standards, purchase taxes for cars determined by energy efficiency, public transport and toll-roads to limit traffic and thus GHG emissions. Sweden has tried lowered speed limits for reasons other than climate change and this had some effect on CO_2 emissions.

53. **Permits** have only been used once to limit GHG emissions, when Arlanda airport was requested to stabilize CO_2 emissions resulting from airport activities (including transport to and from the airport) at 1990 levels in 2000.

54. The team recognized the efforts to make use of the major **biofuel resources** in Sweden and the progress made during several years to reach the present proportion of approximately 17-18 per cent of the energy balance (including black liquor from the pulp industry). Policies to promote the use of biofuels include favourable tax conditions under the current carbon and energy taxes, subsidies to encourage district heating from biomass, and research and development of biomass technologies. Electricity generation and liquid fuel production from biomass are not expected to be competitive until after the year 2000. Forest residues, agricultural residues, and wastes are the primary short-term sources of biomass feedstocks. Rotation-intensive culture is not anticipated in the short term for economic reasons. The CO_2 reductions from the biofuels programme have not been calculated separately from the overall carbon reductions resulting from the changes in tax structure.

55. Sweden has a target for reducing **methane (CH_4)** emissions from the waste sector by 30 per cent in 2000 from the 1990 level and expects to achieve this. The measures that have either been implemented or are being implemented include reduction of the total amount of organic waste being landfilled, the long-term aim being to eliminate it totally. Meanwhile, methane from larger landfills is drained, and preferably used for energy purposes. Smaller landfills are in limited use, and emissions from these will be eliminated naturally in one to two decades.

56. The volume of methane emissions from agriculture, which represent almost two thirds of the 1990 emissions, depends largely on the number of ruminants and will therefore follow the structural development of Swedish livestock farming. Possible measures have been investigated, but generally do not seem to be feasible.

57. The main source of **nitrous oxide (N_2O)** is in agriculture. Measures taken to reduce nitrogenous fertilizer use and changes in agricultural practices in order to lower runoff of nitrogen to lakes and the sea, will also lower nitrous oxide emissions. Emissions from other smaller sources such as transport, may increase slightly as a result of increased use of catalytic converters used to tackle other environmental problems. There are technical potentials for further reductions in emissions from industrial sources, one policy option being the use of a permit system.

58. The Government is working on the need to regulate **PFCs**, **HFCs** and **SF_6**, and these gases are monitored closely. It is possible to limit these emissions through direct regulations. However, existing law already requires companies to use the most environmentally friendly technology available, if the economic consequences are "reasonable". This means that the HFCs with the lowest global warming potential (GWP) could be preferred as refrigerants as CFCs are phased out. Industry, in particular the multinational companies, has shown great interest in these issues. The main source of PFCs is one aluminium plant. A change of process that would reduce emissions by 90 per cent is under discussion.

59. Sweden is a Party to the United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution, and it has taken measures to comply with the commitments to stabilize nitrogen oxide (**NOx**) emissions and reduce volatile organic compound (**VOC**) emissions which will also limit carbon monoxide (**CO**) emissions.

60. Policies to promote **carbon sequestration in forest sinks** include reducing soil scarification, reducing land drainage, and increasing the use of natural regeneration and shelter-belt systems. In addition to the *Nature Conservation Act* to reduce land drainage, (mentioned in the national communication), Sweden uses information and outreach to change the behaviour of the landowners and promote management shifts. Also there are restrictions to the general level of logging, provisions for replanting and measures to prevent forestfires. The analysis conducted by Sweden indicates that the general forestry policy will stimulate growth in the sequestration of carbon, but that this growth will level off in a few decades.

IV. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

61. The emission projections assume that the policies and measures implemented when the communication was submitted will be continued, except for some changes in energy taxes which were introduced in July 1994. The restrictions to further development of hydro power (and in the longer term the decision to phase out nuclear power by 2010), are crucial. The introduction of a competitive domestic electricity market and further integration in the Nordic electricity market could also have impacts on emission patterns.

62. Sweden does not expect its package of policies and measures to be sufficient to fully stabilize GHG emissions (5 per cent growth) or CO_2 (4 per cent growth) in 2000. The growth is mainly due to increasing emissions from the transport sector and a return to average emissions from the energy and transformation sector, reflecting the fact that 1990 was an unusually mild year with high precipitation. The emissions may grow further to 2005 (9 per cent for all greenhouse gases and 11 per cent for CO_2) if additional measures are not introduced. New measures (for example, a wider application of the CO_2 tax), are often seen to require international coordination. It should also be noted that in the projections, Sweden shifted from an exporter to an importer position regarding electricity during the 1990s, and meeting the demand domestically instead could further increase the emissions.

63. If Sweden pursues the decision to phase out nuclear power by 2010, it is expected to result in a sharp increase in CO_2 emissions from 2005, possibly by 50-100 per cent if the capacity is replaced with fossil fuel based power plants. This could happen in a scenario with an increasing demand for energy, reasonable assumptions for improvements in energy efficiency, (environmental) restrictions on new hydro power developments, and limited scope for expanding district heating and use of biofuels.

64. Sweden gave projections for all GHG (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) and precursors (NO_x, non-methane VOC (NMVOC) and CO). The projections for CO_2 emissions are based on sectoral model approaches incorporating economic and technical information, similar to approaches used in many countries. Other gases are projected using simpler techniques, but assumptions on sectoral development are consistent with the CO_2 projections. Calculations of effects of measures are made using the MARKAL energy sector model and presented separately.

65. The team concluded that the assumptions were reasonable and projections for emissions were well documented in the communication. However, given the nature of projections, the team found its understanding substantially improved after discussions on model approaches and sectoral development. In particular, the team noted considerable short-term uncertainty of emissions stemming from variations in hydro power availability and temperature (leading to heating requirements). Also, it noted that a major uncertainty is the growth in GDP, while the sensitivity of emissions to prices of fossil fuels on the world market is relatively low compared to other countries, due to the high tax proportion in consumer prices.

66. The team found the use of the MARKAL model to calculate most of the expected

effects of measures to be an innovative approach. This is an internationally well known and often applied model, and the approach could therefore be applicable to other countries. Calculations showed that CO_2 emissions in 2000 would be 10 400 Ggs, or 14 per cent lower for the 1994 package of measures compared to that for 1990. The results are presented sector by sector including district heating, industry, residential, commercial, transport and others, and measure by measure including energy and environmental taxation, investment support for biofuel use in CHP and the programme for energy efficiency.

67. Currently forests sequester approximately34 000 Ggs of carbon dioxide, equivalent to more than half of the total gross emissions of carbon dioxide. The forest situation in Sweden provides only limited opportunities to sequester more carbon. Current projections indicate that the forests could be in equilibrium with regard to carbon in 2010-2020. At that point, forest carbon sequestration will be offset by harvesting and other losses. For this reason, as well as concern over measurement and verification, the Swedish position is that their target to stabilize emissions of carbon dioxide excludes forest sinks. While net forest carbon sequestration will not continue past 2010, Sweden expects the total amount of carbon stored in forests at that point to be higher than pre-industrial times due to improved management and fire suppression. The extensive use of biofuels is taken into account in these projections.

V. EXPECTED IMPACTS OF CLIMATE CHANGE

68. The national communication contained a thorough discussion on the vulnerability to climate change. Additional information was provided on the organization of related work. The team found that although efforts are made to assess vulnerability, no comprehensive programme has been set up in Sweden.

69. The lack of suitable regional climate models was highlighted as a limiting factor to better assessing Sweden's vulnerability to climate change and as an explanation of the limited amount of information available, in particular on the socio-economic impacts. Moreover, factors complicating the appreciation of climate change-related impacts and the detection of climate change were presented, including geographical specificity, high natural climate variability and other environmental stresses such as acid rain. General conclusions on the three most sensitive areas, namely, forests, the Baltic Sea and mountain ecosystems, were reiterated.

VI. ADAPTATION MEASURES

70. The team concluded that Swedish society is already adapted to a high degree to natural climate variability, which may explain why adaptation measures are not seen as an urgent concern. Areas where specific adaptation measures might be needed are mentioned in the national communication. However, research efforts on adaptation are limited, except within the forest industry. Owing to present changes monitored in tree species in the southern parts

of the country (the causes of which are as yet undetermined), Sweden is already responding to new conditions by introducing other species.

VII. FINANCIAL ASSISTANCE AND TECHNOLOGY TRANSFER

71. Sweden has made contributions to the Global Environment Facility (GEF) for both the pilot and the first phase, and envisages that this will grow as the GEF grows. Its official development assistance has been and is still well above 0.7 per cent of its GDP (0.98 per cent in 1993 according to OECD/ DAC statistics), even though this level has been reduced owing to the recent economic recession. The national communication described actions to implement Article 4.3, 4.4 and 4.5 and provided corresponding funding figures.

72. Several technical and development cooperation activities, including the principles guiding them and their management and operation, some of which were not mentioned in the communication, were described to the team. The team was also made aware of independent initiatives by industry in the field of technology cooperation and capacity building, in addition to information reported in the communication.

73. The team noted that many agencies and institutions are involved in the implementation of activities in the area of technical cooperation and capacity building, research and training, and that climate change concerns are being incorporated in the general aid programmes.

74. The team examined a special technical cooperation programme aimed at enhancing energy efficiency and increasing the utilization of renewable energy sources in Eastern Europe and particularly the Baltic States. Sweden provides expert advice and capital that can be borrowed on commercial terms for smaller projects (3-10 MW). This was presented as a joint activity which would offer valuable experience in the context of a possible future scheme **of activities implemented jointly** . The team noted the rapid implementation of these projects, and the strong interest and economic commitment at the receivers' end.

VIII. RESEARCH AND SYSTEMATIC OBSERVATION

75. The various aspects of Swedish climate-related research programmes, including funding levels and participation in international programmes, are thoroughly described in the national communication, but more detailed documentation was also given. Additional information was provided on the role of the Swedish Commission on Climate Change, which is coordinating and giving advice on all aspects of climate change-related research and development, participation in the work of IPCC and organization of funding for research. The establishment of a comprehensive climate change research programme is under discussion.

76. Efforts to ensure an interface between research and applications were mentioned. However, limited cooperation with industry was noted. Improvements in international cooperation on mitigation aspects were called for, especially in the transport and energy

sectors.

77. A cross-cutting issue was government-funded research and development for improvements in technology and management. In addition to what was reported in the communication, the team learned of considerable efforts carried out by the private sector.

IX. EDUCATION, TRAINING AND PUBLIC AWARENESS

78. Activities on education, training and public awareness are described in the national communication. Educational tools, including videos especially targeted towards young people, are produced by the Swedish Environmental Protection Agency. The time constraints under which the national communication was prepared did not allow for public participation in that particular process. However, the mechanism for a rather broad and institutionalized public participation in the preparation of political decisions regarding this type of issue in Sweden was described by ministries as well as by non-governmental organizations.

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