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

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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 33 national communications from Annex I Parties was prepared (FCCC/CP/1996/12 and Add.1 and 2).

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 Finland 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 was carried out during the period January to September 1996 and included a visit to Helsinki from 29 January to 2 February of that year. The team included experts from Thailand, the United Kingdom of Great Britain and Northern Ireland and the Russian Federation. Finland ratified the Convention on 31 May 1994 and submitted its first national communication under the Convention in January 1995. Additional information was made available to the team during the country visit.

2. Finland has a cold climate with corresponding heating needs. The considerable energy-intensive industry is largely based on the forest, which covers more than two thirds of the country. Nuclear and hydro power is used for 50-60 per cent of the electricity generation. A biomass utilization constituting 15 per cent of the energy balance is the highest among countries of the Organisation for Economic Co-operation and Development (OECD) and non-fossil fuels in total represent about 35 per cent of the energy balance. Finland's regular electricity import peaked in 1990 at 17 per cent of consumption. Scattered population and long distances to the export markets generate considerable transport needs. Carbon dioxide (CO_2) emissions per capita (11-12 tonnes) were around the OECD average in 1990, which is high in a Western European context. In the first half of the 1990s, Finland experienced one of the most severe recessions in the OECD countries.

3. The team found the inventories to be transparent, and considered that Finland had used the Intergovernmental Panel on Climate Change (IPCC) methodology in a way appropriate to Finnish conditions. The few deviations due to statistical shortcomings were appropriately described. Finland provided inventories for the three main greenhouse gases as well as the indirect ones. CO_2 represented 82 per cent of 1990 emissions, methane (CH_4) about 8 per cent and nitrous oxide (N_2O) about 10 per cent. Hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride were not covered in the communication, but these were estimated for 1994 in the inventories for 1992-1994 submitted in spring 1996, showing zero or very small emissions. There have also been some revisions in methodologies for CH_4 and N_2O compared to the communication. The land-use change and forestry sector makes a relatively large contribution, with net carbon sequestration in forests estimated as equivalent to more than half of the 1990 CO_2 emissions, and considerable net CO_2 emissions coming from cultivated peatlands and non-viable drainage areas as well. The team noted that, despite the history of relatively detailed assessment of the emissions and removals in that sector, the uncertainties are still considerable.

4. Finland has successfully introduced energy efficient technologies such as district heating, which covers 45 per cent of the heat supply, and combined heat and power (CHP),

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[1] In accordance with decision 2/CP.1 of the Conference of the Parties, (see FCCC/CP/1995/7/Add.1), the full draft of this report was communicated to the Finnish Government, which had no further comments.

which currently supplies 30 per cent of the electricity. Because of the climatic conditions, measures such as strict insulation standards for walls and windows (triple glazing) have been in place for a long time. In 1990, Finland was the first country to apply a CO_2 tax, currently (1996) equivalent to about US$ 8.5 per tonne of CO_2. It has the most complete coverage of sources among those countries applying such an instrument, while the rate is lower than in some of them. As a consequence of joining the European Union and the fact that other countries do not have a similar tax structure, it will be changed in 1997, in particular for electricity, to become more indirect and will thus also be potentially less environmentally effective. Finland also has a number of programmes on energy efficiency and renewables, in particular biomass, that are described in the communication. In general, the budget situation has affected the funding of these programmes negatively.

5. The CO_2 projections in the communication were under revision at the time of the team's visit, to reflect, *inter alia*, historic economic developments and recent developments in the energy sector. The emissions are likely to grow considerably, but less than the 30 per cent suggested in the "with measures" projection in the communication, owing to continued imports of electricity and lower economic growth. Prospects for extending the use of district heating, CHP and hydropower are limited, while biomass could still offer some economic potential. In the longer term, self-sufficiency in electricity, the future of nuclear power (in which connection the parliament has rejected a proposal to build a fifth plant), the availability of natural gas, as well as the growth and choice of technologies in the forest-related industry remain crucial determinants. An additional uncertainty in both directions is related to the effects of deregulation of the electricity market. After a downturn caused by the recession, CO_2 emissions were 8 per cent higher in 1994 than in 1990, but for 1995 they were at the 1990 level. Forests are expected to remain a net carbon sink for decades, but the magnitude will depend on the degree of wood use, as illustrated in the communication. A significant drop in methane emissions of about 20 per cent, mainly thanks to measures in the waste sector, is expected between 1990 and 2000, but will have to be achieved in the last part of the decade. Nitrous oxide emissions are expected to grow, mainly owing to the application of catalytic converters to reduce local and regional pollution.

6. Finland has already adapted to major climate variability. Assessments of the impacts of climate change have been made, in particular for the economically important forest sector. A considerable amount of research has been carried out through a comprehensive programme specifically devoted to climate change between 1990 and 1996. The team noted the extensive documentation that had been produced on the programme for an international audience. This programme was seen as a targeted effort limited in time, and climate change related research is now funded through traditional channels. There has also been considerable research and development on technological mitigation options, in particular for the energy sector, as described in the communication. Finland cooperates in international research and development, which is particularly useful for a small country. Such activities in the European Union are seen as increasingly important. There are also initiatives related to education, training and public awareness.

7. Finland contributed US$ 20.6 million to the Global Environment Facility (GEF) in its pilot phase and is contributing US$ 21.7 million to the first replenishment. This is in addition to the country's official development assistance (ODA), which dropped from 0.7 per cent of gross domestic product (GDP) in 1991 to 0.4 per cent in 1995, because of the financial situation. The Government is, however, committed to restoring the previous level when the recession is considered over. Finland is also funding a considerable number of projects in countries with economies in transition. At the time of the team's visit, there were no projects for consideration as activities implemented jointly under the pilot phase.

I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

8. Finland ratified the Convention on 31 May 1994 and its first national communication was received by the secretariat 31 January 1995. The in-depth review was carried out during the period January to September 1996 and included a visit to Helsinki from 29 January to 2 February of that year. The team met officials from the most relevant ministries, as well as representatives from the scientific community, business organizations and municipalities, which all provided additional background information. The team comprised Mr. Vute Wangwacharakul (Thailand), Mr. James M. Penman (United Kingdom of Great Britain and Northern Ireland), Mr. Alexei Kokorin (Russian Federation) and Mr. Peer Stiansen (UNFCCC secretariat, Coordinator).

9. Finland's cold climate creates a considerable need for heating. It has a high share of trade in its gross domestic product (GDP), a main source of exports being products from the energy-intensive industry based on forest resources; forest and other woodlands cover more than two thirds of the country's area. It has a low population density, with one fifth of the population concentrated around Helsinki. The fact that Finland is far from export markets combined with the fact that industry is export-oriented leads to an extra demand for freight transport (industrial transport costs are estimated to be 2.5 times the average of countries in the European Union). Historically, Finland's location at the doorstep to Eastern Europe has also led to a significant eastwards orientation in trade.

10. Finland's recession in the first half of the 1990s was the most severe among countries then members of the Organisation for Economic Co-operation and Development (OECD), with a drop of more than 10 per cent in GDP. There were several reasons for this, such as the aftermath of the strong overheating in the economy in the late 1980 following the liberalization of the financial markets, and the collapse in the economies of some of its major trading partners in Eastern Europe. Unemployment climbed to 20 per cent and the public debt rose from 10 to over 60 per cent of the GDP level. There has been a recovery since 1993 with steady growth, although the GDP had not fully reached the 1990 level at the time of the visit. Following the recession and mirroring trends in many developed countries, Finland is going through a period of economic deregulation and, with regard to the emissions, developments in the electricity sector with the establishment of a free Nordic market, is seen as particularly relevant.

11. Finland has a high energy use per capita: 5.7 tonnes of oil equivalent compared to an average of around 4 tonnes in OECD countries in 1990. It also has a very high utilization of biofuels, which account for around 15 per cent of the energy balance and are mainly used in industry, as well as a considerable utilization of hydro and nuclear power (which together represent 50-60 per cent of the electricity supply and have recently fluctuated between 25 and 30 per cent of the energy balance). Despite this high proportion of non-fossil fuels in the energy system, carbon dioxide (CO_2) emissions per capita are high (11-12 tonnes) on a European scale (average 8-9 tonnes), although the level is similar to the OECD average. Finland has been a net importer of electricity for years; in 1990, which was a peak year, net imports made up 17 per cent of the total electricity supply. These imports come from the other countries participating in the Nordic market, as well as from the Russian Federation, and are mainly based on nuclear and hydropower, although some could be based on fossil fuels. Finland has around 5 per cent peat in its energy balance. Natural gas is available in the southern region (around 10 per cent of the energy supply), coming through a pipeline from the Russian Federation. Coal constitutes around 15 per cent of the energy supply, while oil accounts for 30-35 per cent, mainly for transportation.

12. Two distinct features of the energy system contribute to a high energy efficiency, namely, the use of district heating, which covers 45 per cent of the heat supply, and the use of combined heat and power (CHP) plants, which currently supply around 30 per cent of the electricity, a higher percentage than in any other country. A further factor contributing towards energy efficiency is the fact that Finland has imposed strict building standards relating, for example, to the insulation of walls and windows (triple glazing).

13. There are limitations to further expansion of hydropower for environmental reasons. The Finnish parliament also recently rejected a proposal to authorize the building of a fifth nuclear power plant. At present there are no new applications to build such a plant. In district heating also the possibilities for expansion are limited by the fact that many of the houses that are not connected at present are not easily accessible. Opportunities for expanding and diversifying natural gas supplies are limited by the size of the Finnish market and therefore depend partly on developments in neighbouring countries. It is unlikely that major expansion in the use of natural gas will take place before 2000.

14. Finland has had a new government since the communication was submitted. This does not imply any major change in the policies affecting greenhouse gas (GHG) emissions, although some adjustments could be made. On 1 January 1995 it became a member of the European Union (EU), which is already having effects on the way Finland can respond to climate change. The response strategies have been developed through in an inter-ministerial effort coordinated by the Ministry of the Environment since the late 1980s, and specific climate-change policies and measures have been in place since 1990. Each ministry has the responsibility of carrying out policies and measures in its own sector. A number of operational tasks are carried out by agencies such as the Finnish Environment Agency and regional environment centres.

II. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS

15. The GHG emissions inventory estimates for 1990 in the communication cover anthropogenic CO_2, including separate estimates for the land-use change and forestry sector, methane (CH_4), nitrous oxide (N_2O) and the precursors carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs), and they are believed to be substantially complete. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) were not covered. Based on the values adopted in 1994 by the Intergovernmental Panel on Climate Change (IPCC) for global warming potentials (GWPs) and the figures in the communication, CO_2 represented about 82 per cent, CH_4 about 8 per cent and N_2O 10 per cent of the 1990 emissions. The net sequestration of carbon in total wood biomass in managed forests was estimated at 31 million tonnes (Mt) of CO_2, equivalent to more than half the emissions from other sectors, while the communication also contains estimates of emissions from cultivated peatlands (3-10 Mt CO_2) and non-viable drainage areas (1-5 milllion tonnes CO_2).

16. The team found the Finnish inventory to be transparent and commended the publication of papers related to the inventory in the peer-reviewed academic literature. The inventory data in the communication are for 1990 only. Finland submitted figures for 1992, 1993 and 1994 during the first half of 1996 based on a revised approach, and these figures, together with documentation on the revisions, were also assessed by the team. Specific 1991 data were not produced. Finland has used the IPCC methodology in a way appropriate to Finnish conditions and has explained this in supporting documentation and literature references.

17. The communication does not itself present inventory data using the IPCC summary tables, but gives inventory data in conjunction with the description of activities in the various sectors. However, the background material for the 1990 inventory presents IPCC 1993 source categories for energy and industrial emissions. Emissions related to marine and aviation bunkers, amounting to 2,800 Gg CO_2 or 5.3 per cent of the total emissions, were not included in the total. The corresponding 1994 figure was 2,120 Gg. The 1994 inventories were submitted in accordance with the latest (1995) IPCC Guidelines, and the quality of the data has also been assessed. Some uncertainties have been quantified in the communication and the supporting material. There are still some deviations from the IPCC categories due to statistical shortcomings, but these are clearly described. The 1992, 1993 and 1994 inventories do not include revised data on CO_2 emissions or removals from land-use change and forestry. There is no single document giving 1990 data on a uniform basis with subsequent years and this makes it more difficult to be sure that comparisons between years are on a consistent basis.

18. Although the communication does report summary data on emissions, the detailed data for 1990 were spread between several sources. This was recognized as a problem by the Government, and Finland has given the responsibility of coordinating and presenting subsequent inventories to one body, Statistics Finland. One result of this has been that the reporting under the Convention is done by means of a single inventory document. Annual inventories will also help in the monitoring of policies and measures, and reduce uncertainties

as time series accumulate. The team noted that Statistics Finland with other institutions has had considerable work carried out so as to be able to produce relatively detailed information on emissions by economic sector, which should help with the development and monitoring of policies.

19. In 1990, energy and transformation industries were the source of 37 per cent of the energy-related CO_2 emissions. Industry was the second largest source with 26 per cent, transport next with 22 per cent followed by the residential, commercial and institutional sector with 11 per cent. CO_2 emissions from peat burning were included in the inventory. Specific 1991 data were not produced, but based on the energy statistics, CO_2 emissions were estimated roughly to have been at the same level as in 1990. They then dropped in 1992 and 1993 mainly because of the recession, before increasing to 8 per cent above the 1990 level in 1994, which was a cold year with less hydropower availability in the Nordic market, and the economy had in addition started to recover.

20. In the 1990 inventory reflected in the communication, waste accounted for 55 and agriculture for 37 per cent of methane emissions. Annual animal census data are available, and ruminant feed characteristics were estimated for Finnish conditions. The quantity of waste landfilled in 1990 was known approximately, although the historical time series had to be estimated from proxy statistics on gross national product and population. The choice of an upper limit for methane emissions from landfill was somewhat arbitrary. Data on landfill should improve as the new waste management policies are applied. The assessment of methane emissions from the waste sector has become more detailed with considerable revisions to the data in subcategories in the 1996 submission, while the total figures are only slightly higher. There has been a slight upwards trend. In the agricultural sector the revisions are less significant, and the trend slightly downwards, making the total relatively stable from 1990 to 1994.

21. In the inventory reflected in the communication, agriculture represented 52 per cent of the nitrous oxide emissions, energy 33 per cent and industrial processes 14 per cent. The revised estimates based on "medium" emission factors from agriculture are approximately half those presented in the communication, mainly because emissions from unfertilized land are treated as background rather than anthropogenic, in accordance with the IPCC methodology. The trend for emissions related to nitrogen fertilizer input was downwards. Also the estimate for emissions from fuel production and use appears to have fallen from about 8 kt in 1990 to about 5 kt in 1994, but it is not clear from the additional documentation whether this reflects an actual decline in emissions, or whether it is the methodology for emissions estimations that has changed.

22. Data for CO, NO_x and NMVOC were also given, and it can be noted that the age structure and technical characteristics of the vehicle fleet are known and were used in estimating vehicle-related emissions. As in the 1994 inventory, figures for HFCs, PFCs and SF_6 are given, based on replies to questions sent out by the Ministry of the Environment.

23. Forests and other woodlands cover more than two thirds of the country. Almost all forests are managed, usually to a high extent. Natural forests with near-zero carbon balance occupy only a few per cent of the forested area - protected areas constitute around 8 per cent of the land. The total forested area is quite stable, with a slight increase.

24. As a result of intensive management, the age distribution is moving towards young and middle-aged stands, especially in the southern part of the country. Dry standing stems, which are usually an important secondary carbon reservoir in boreal forests, are almost completely absent in Finland due to selective thinning, which causes low natural mortality. However, substantial amounts of crown mass and unmerchantable stemwood are left in the forest. There is no routine anthropogenic biomass burning in the forests and natural fires are very limited thanks to fire prevention measures and intensive thinning.

25. Forest inventories were started in 1917 and up to now eight inventories have been carried out. The last complete inventory dates from the period 1985-1989, but material from the years 1990 to 1994 was also utilized in the preparation of the national communication. For financial reasons there is not yet a plan and schedule for the next inventory. The carbon balance calculations were made on the basis of about 70,000 plots with approximately one million trees. The amount of carbon stored in Finnish forest ecosystems was estimated at about 2,700 Mt. The inventory includes the total biomass with roots and branches. The correspondent coefficients were developed at Joensuu University for pine, spruce and non-coniferous species as a whole. Finland's forests are thought to be a significant net sink of carbon, estimated at 8.3 Mt C/yr or 30.6 Mt CO_2/yr for 1990. The inventories for years subsequent to 1990 did not include figures for this sector, although work is going on and the results will be included in later inventories.

26. Finnish marshland is estimated to store 6,300 Mt of carbon, but the fluxes are considerably less in volume than from the forest. Peat is a domestic fuel source but can hardly be regarded as renewable, as regeneration takes hundreds or thousands of years. The peatland area has decreased significantly over the present century because of drainage and afforestation. Two thirds of the peat extracted is used as fuel and one-third in industry. Finnish experts recognize the uncertainties and the probability of high temperature dependence associated with carbon accumulation or loss by peat drained for afforestation. No allowance is made for carbon loss from peat drained for afforestation. Cultivated peatlands appear to emit large amounts of carbon dioxide as drainage and tillage accelerate the decomposition of peat, significantly changing its characteristics. However, numerical estimates were not yet available.

27. For the documentation submitted following the team visit, Finland has completed the IPCC reference methodology for CO_2 emissions from energy sources and international bunker fuels. The total emissions agree very closely with the detailed technology-based calculation made in 1994.

III. POLICIES AND MEASURES

28. The bulk of policies and measures described in the communication are aimed at reducing CO_2 emissions primarily through improving energy efficiency and increasing the use of renewable energy sources. The communication also describes policies and measures that will influence methane and nitrous oxide emissions, including those from the agriculture and waste sectors, and enhancing sinks, as well as efforts to reduce precursors. The description in the communication was relatively brief, but considerable additional information was given to the team during the visit. At the time of the visit, Finland had not introduced policies and measures to limit HFCs, PFCs and SF_6. For some of the measures, for example the use of taxes, the design and levels depend highly on international developments. Also, membership of the European Union implies that some measures are developed on a Union-wide basis rather than on a national level. It affects in particular the future of the carbon/energy tax which Finland has implemented.

29. Finland has stated a preference for using economic instruments, mainly taxes, in mitigating climate change. The main policies and measures applied by the Government include energy and carbon taxation, energy conservation, bioenergy promotion, energy-related research, development and demonstration and the promotion of efficient and environmentally friendly traffic. In general, the programmes appeared well structured with specific targets in terms of improvements of energy efficiency, increased use of bioenergy etc, and discussions with officials showed that consideration had been given to the need to monitor the effect of measures. The communication itself provided limited information on that particular issue. The team also noted initiatives at local and regional levels of the administration, as well as by energy companies, to reduce emissions within their jurisdiction. Some demand-side management (DSM) initiatives have been taken by utilities. The future is however uncertain in a competitive electricity market.

30. The communication also includes illustrations of the effects of individual measures or groups of measures, although these overlap to some extent. However, the methodological description and basis of scenario derivation are lacking. A discussion of the methodology or approach in deriving policies or measures would substantially help the reader to understand the process and the basis of such conclusions. Recent studies on effects of measures, monitoring and evaluation of various programmes and measures to reduce CO_2 emissions should be incorporated in the next communication, including a summary table.

31. The team felt that monitoring and evaluation of the programmes was important, in order to assess the effects and compare actual developments with the expected scenarios. Such assessments were being conducted but results were not yet available at the time of the team's visit. Communicating progress results, even preliminary indications, as well as the basis or methodology used in making such assessments, would be helpful for future reviews of climate change policies.

32. Finland was the first country to introduce a CO_2 tax, in 1990. Economic instruments, and in particular taxes, are seen as the best incentives to increase energy efficiency and

promote more environmentally friendly fuels. The taxes are expected to have a significant effect, especially over time as the capital stock changes. Using heavy oil as a reference, taxes are levied at 75 per cent on the CO_2 and 25 per cent on energy content. The tax rates were gradually increased until 1995, when the levels (Fmk 38.3/tonne CO_2 and Fmk 3.5/MWh) were equivalent to US$ 8.5 per tonne of CO_2 and US$ 0.8 per MWh.. The tax is applied at the same rate for all emissions, including those from fuels used in electricity generation, and there are very few exemptions compared to other countries where there are such taxes, which have often also applied different rates for different users. The exemptions are primarily for peat, for which only the energy content is taxed, and energy commodities used in industrial processes (non-energy use). The CO_2 tax covers commodities causing 95 per cent of the CO_2 emissions.

33. The rate is lower than the rates for CO_2 taxes in some neighbouring countries, but as there are fewer exemptions and more fossil fuels in the energy balance, the environmental effects may still be significant, as may the tax-related costs for some groups, for example industry. For transport fuels, the environmental levy is only a small proportion of the total tax, while for some other commodities, it is the main tax element and thus carries relatively more weight in determining the end-user price. A tax is also levied on imported electricity, the rate corresponding to the average tax rate of domestic electricity generation. Imported electricity could be generated from sources such as nuclear fuel and coal, that are tax exempt in the country of origin but taxed in Finland, and these duties make imported electricity less competitive, although it may still be less taxed than some domestically produced electricity. Still, the import duty also applies to electricity generated by hydropower stations.

34. Given the structure and expected trends in the Finnish economy, it is believed that the levels of CO_2 taxes would have to be raised many-fold in order to return emissions to 1990 levels by 2000 by this measure alone, and keep them there in the next decade. However, in the course of the review it became clear that there would be difficulties in increasing the rates further and even in keeping the present tax structure, as long as only a few countries have applied this type of instrument. The reasons lie in the increasingly competitive markets, which are vulnerable to cost increases in general. The establishment of an open Nordic electricity market means that foreign producers that do not impose CO_2 taxes on input fuels have an advantage over domestic producers. In some situations this could even lead to imports causing more emissions than if the electricity had been produced at home. Compensating for such situations by taxing imported electricity as such is not seen as being in conformity with European legislation, and a similar taxation system for imported and domestically produced electricity will have to be found from 1996. In the absence of regionally applied taxes on fuels for electricity generation, this implies that a revised tax is likely not to reflect the carbon content in the fuels on an equal footing, thus considerably impairing efficiency in mitigating climate change.

35. Because of the increased integration with international markets, and the different development in those from what had previously been anticipated, a change in the existing energy tax structure in Finland has been under consideration. In November 1996, the Government submitted a bill to the parliament concerning this issue. The charge for fuels

used for heating will still be based on the carbon content of the fuels, while those charges that are at present affecting the electricity will be replaced by a charge applied directly on electricity regardless of which fuel sources are used CHP will be favoured by assuming a high (95 per cent) efficiency coefficient in the case of heat generation. The experience of Finland highlights the importance of multilateral action as a condition for applying certain policies and measures to mitigate climate change. As a result of these policy revisions, the achievement of CO_2 emission reductions compared to a baseline is now more uncertain. The team notes that in some sectors other taxes, such as fiscally motivated duties on transport fuels and value added tax (VAT) (the standard rate of which is 22 per cent), can be more important than environmental taxes for end-user prices and can thus provide incentives to use energy efficiently.

36. Finland has long been promoting energy efficiency through measures other than taxes as well, and it has achieved a high level of performance. Continuing to promote energy conservation through several programmes that are running, is seen as a main element in the strategy to mitigate climate change, the aim being to improve energy efficiency by 10 to 15 per cent overall in the period 1990-2005, with specified targets for sectors. The already high level of energy efficiency means that a number of measures that are still under consideration in other countries, such as triple glazing and certain levels of wall insulation standards, are already implemented in Finland. Moreover, around 30 per of electricity is generated by CHPs and 45 per cent of buildings are connected to district heating systems. Thus there are fewer cost-effective options left. Consequently, limitations or reductions of CO_2 emissions may require more stringency in Finland than in several other countries.

37. Voluntary agreements of a general character between business associations and the Government to conserve energy were signed in 1992, and were under review at the time of the team's visit. New building codes were expected to be enforced in 1996, and were estimated to result in a 10 per cent improvement in energy efficiency by 2020.

38. In line with efforts to reduce the budget deficit and public debt, the budgets of energy conservation programmes in Finland have also been reduced. Moreover, as stated in the communication, the tax policy also has an influence on the achievements of the conservation programmes, and the revision of energy tax policy could thus reduce their effectiveness.

39. The team considered the utilization of bioenergy in Finland impressive. Following an active promotion policy, combined with favourable market conditions, the share of bioenergy in the energy balance has become one of the highest in the developed world - approximately 15 per cent, with peat contributing an additional 5 per cent. The bulk of the bioenergy is used by the industry. Finland aims at achieving an increase of at least 25 per cent in the use of bioenergy and peat from the existing level by 2005, which could reduce CO_2 emissions from the wood component by 3 Mt. Natural conditions for other new and renewable energy sources are less favourable.

40. The remaining bioenergy potential could be relatively less economically competitive with non-renewable energy sources. Competitiveness will depend on the tax structure, which

at present is in favour of bioenergy. Further, to the extent that the expansion of bioenergy will depend on public grants, budget constraints will also handicap biofuels. An additional uncertainty is the development of the electricity market, where the implications for bioenergy are not clear. Even if the expansion of bioenergy is seen as more difficult than before, however, two thirds of the targeted increase seem to have been achieved already and reaching it in full appears feasible.

41. Another important measure is promotion of technological development related to energy production and use through a number of programmes, rooted in the characteristics of the Finnish energy system as well as the strengths of the industry and research community. As a result of considerable industrial participation, typically on a 50/50 basis, the technology programmes for the period 1993 to 1998, with a total budget of Fmk 1,400 million, have been relatively less affected than other measures by cuts in the government budget. The programmes also aim at developing commercially viable technologies for export. The effects of research and development on emissions in Finland will depend on the success of the programmes in terms of producing results that are taken up by the domestic market. This is an important process that works over time, and the team recognized that quantified estimates related to Finnish research and development are difficult to produce, especially since implementation of new technologies is also dependent on what is available and feasible on the international market. The communication anticipates that new technologies could cut emissions by 5-15 Mt CO_2 by 2010.

42. The transport sector contributes around 22 per cent of CO_2 emissions. Because of Finland's geographical situation it has twice as much freight transport as the European average, while the number of kilometres travelled by passenger vehicles is one and a half times as much. Local air quality is generally not regarded as a major constraint on transport policy. The policy of maintaining the population structure spread over the entire country is a constraint on options for reducing transport emissions. Finland is aiming at improving the energy efficiency in this sector by 1 per cent per year, a rate similar to the historical rate. This is to be attained mainly through energy taxing schemes and taxes on cars. Finland has relatively high sales taxes (100 per cent) on cars based on value, with VAT at 22 per cent on top. There are also annual taxes on cars based on the age of the car and, in the case of diesel cars, even on the weight. The taxes on motor fuels were raised by over 10 per cent in 1995, leading to a price increase of 6 per cent. The tax rates are now among the highest applied in Western Europe where prices on motor fuels are on average high internationally. The taxes are believed to have led to a smaller and more energy efficient car fleet than would otherwise have been the case, although in Finland also there has been a trend towards bigger cars causing the emissions per kilometre travelled to be stable.

43. Finland has an extensive system of public transport, which has had quite a stable market share of passenger transport (21 per cent on average) over the past few years. Public transport is encouraged through subsidies and a reduced VAT rate at 6 per cent. Finland has a higher proportion of industrial freight carried by rail (26 per cent) than the European average (9 per cent). The gradual reduction of public transport subsidies is likely to affect the balance

between private and public transport. This could enhance the importance of regulatory approaches such as land-use zoning and fuel consumption standards.

44. The team noted that the Ministry of Transport and Communication has an action plan to reduce the environmental impact of transport, which discusses measures ranging from fiscal measures to land-use planning and improved provision for pedestrians and cyclists. It is, however, too early to say what the effects of this plan may be. There are also technical options for lowering emissions through the wider use of diesel cars as well as the introduction of more efficient gasoline cars. Discussions are under way within the European Union on how to develop and introduce cars having a consumption of 5 litres per 100 kilometres. Some work has been done on vehicles using alternative fuels, but not on a wide scale.

45. Roads are publicly funded and there are no tollroads. The road authority's business has been to build roads, and remains so, although cooperation with the environment ministry has been developing for about the past 10 years and environmental impact assessments have been carried out. Decentralization (out-of-town shopping) is having a negative effect on some urban centres and planning guidance is being developed. A 5 to 15 per cent reduction in transport demand through better land-use practices is seen as theoretically feasible over a period of about 10 years.

46. Two thirds of the forested land is managed by thousands of small private owners (with 430,000 woodlots). The current policy on forest management in Finland is based on sustainable development and on legislation preventing changes in land-use, including deforestation. Current general forestry practices (replanting, fire prevention, thinning etc.) are believed to include the most important measures that will enhance sequestration, and have led to significantly increased carbon storage in the forests over the last two or three decades. The Forest 2000 programme envisages continuing the intensive forest management, which will enhance the CO_2 sink related to shifts in the age distribution of the forests, as well as reducing the decay of wood-based biomass through wider usage of biofuel, especially in the forest-related industry. The Ministry of Agriculture and Forestry and the Ministry of the Environment in 1994 jointly set up a programme which focuses on biodiversity protection, but also pays great attention to CO_2 sequestration and implies that significant amounts of the annual increment will not be harvested.

47. Methane emissions are projected to fall by about 20 per cent from 1990 to 2000, mainly due to policies and measures in the waste sector, which is estimated to account for more than half these emissions in Finland. The elements are the imposition of a landfill tax from 1 September 1996 of Fmk 90 per tonne of waste, which will increase the cost of landfilling from Fmk 60 to 150, and the implementation of the 1994 Waste Act, which requires waste to be recycled or disposed of according to the best economically feasible technique. The number of landfills in 1990 was around 680, which is a drop from the earlier level of around 1000. The requirements of the Waste Act are expected to reduce the number of landfills further to about 200-250 larger sites over 5-10 years, and will lead to the installation of facilities for gas collection and utilization or flaring. At the time of the visit

there was only one incineration plant in operation and a handful of sites where landfill gas was recovered and utilized.

48. Emissions of methane from the agricultural sector are mainly a function of the number of livestock. This in turn depends on general agricultural policy, where the adoption of the common agricultural policy of the European Union is considered the most important element. This may lead to bigger units, which could then make it easier to handle manure in a way that causes fewer emissions.

49. Nitrous oxide emissions are projected to rise by about 20 per cent between 1990 and 2000, due to increased numbers of cars with catalytic converters, greater use of fluidized bed combustion, and greater industrial production. No changes in rates of fertilizer application are envisaged in the projections given in the communication, although it suggests that the membership of the European Union may promote the more efficient use of chemical fertilizers through the development of an agri-environment programme. The change in treatment in the inventory of nitrous oxide emissions from cultivated but unfertilized land may have an impact on projected nitrous oxide emissions.

50. With respect to the indirect greenhouse gases, Finland is a Party to the United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution, and is taking measures aimed at reducing the precursor gases CO, NO_x and NMVOC significantly.

IV. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

51. The CO_2 projections in the communication were based on an economic scenario drawn up in 1990 which did not anticipate the severe recession of the 1990s. A number of other changes were foreseen only after the communication was published. The Finnish Government was therefore working on a new set of projections at the time of the visit. The issues that are accentuated in the projections presented have not changed in broad terms, however, and the decisions relating to those issues will largely define future emission patterns. The team thus noted the major uncertainties as to how CO_2 emissions will develop in Finland, related to energy supply in particular.

52. The communication presents a "with measures" scenario where CO_2 emissions rise from 54.2 to about 70 Mt in 1990, while under a "business as usual" scenario they could rise to about 78 Mt CO_2. The team was given some preliminary results of the new projections, where the figure comparable to the "business as usual" scenario was adjusted downwards to about 62 Mt, a difference of 16 Mt, of which about 11 Mt would be due to assuming continued electricity imports rather than self-sufficiency in electricity supply. Actual emissions in 1994 were some 58.3 Mt, considerably below the projections published in the communication, largely owing to the effects of the recession. The changes in the carbon-based energy tax will have an impact.

53. Projections are made using a spreadsheet. The new projections have increased econometric representation and involve a fairly detailed bottom-up alternative approach. The projections are carried out by the ministries themselves using results from researchers outside the Government. Outcomes are sensitive to energy price and a high price scenario from the International Energy Agency has been used, with economic growth at about 2 per cent per annum to 2030.

54. *Finnish Energy Economy to 2000* does give fairly detailed results derived from earlier projections, although the data in this report are not completely consistent with the baseline scenario in the communication, and little methodological detail is provided. Publishing more detailed information on projection methodologies as well as results would help clarify the assumptions which have been made, and assist in the development of monitoring procedures to show the effects of the measures implemented.A table summarizing measures included in the Finnish national programme, and their expected impact by the target date, would be a great help.

55. Up to 2000, growth in emissions will depend on the extent to which fossil fuel, most likely coal, is developed for electricity generation and used to reduce the dependence on imports. Even with only three to four years to go, industrial autogeneration in particular represents an uncertainty, although CHP expansion may have reached a level near its economic limits outside industry. Significant further expansion of district heating is not foreseen because of the location of the houses that are not connected at present. The developments in the Nordic market for electricity, which has only been in place for a limited period, and which includes import and export contracts, will also be crucial. The evolution of the tax structure, including the environmental taxes, and funding for climate-related programmes constitute uncertainties.

56. In the longer term, the limitations to further expansion of hydropower and the political reluctance to build new nuclear power stations limit the non-fossil-fuel options on the supply side. Another milestone will be reached when decisions are made on how to replace the existing plants. The pulp and paper industry is already large and expected to grow. Wider use of bioenergy in this sector will depend on the choice of processes: chemical plants produce residues that can make them self-sufficient in biofuels, while mechanical plants convert all of the biomass into end-products and thus require a high external energy input. In the transport sector, the recession brought about lower emissions in the early 1990s, but they are picking up as the economy recovers and particularly freight traffic grows. The number of vehicle-kilometres is projected to increase by about 35 per cent by 2020, though CO_2 emissions would only increase by about 20 per cent if the rate of efficiency improvement of about 1 per cent per annum for all vehicle classes is maintained, and the trend towards larger vehicles comes to an end. There are technical options that would lower emissions, such as the introduction of cars that consume only 5 litres of fuel per 100 kilometres, as discussed in the European Union, but firmer policies would then probably be needed.

57. After the turn of the century further expansion of natural gas use could be possible, and would constitute an alternative to coal as well as to non-fossil fuels. At the time of the

review, the situation regarding natural gas was not clear, either in terms of choice of suppliers, areas that would be supplied or volumes.

58. According to all scenarios presented to the team, Finland's forests will remain a net carbon sink until 2010. However, the size of this sink depends crucially on the volume of fellings. Two scenarios are presented in the national communication. The first assumes invariable cuttings at a constant level of 50 Mm^3, while the second assumes linear growth of cuttings by 1.0 Mm^3 over the period 1990-2010. According to both scenarios, the amount of carbon stored in the forest will grow, probably by a third by the year 2030, but the net-sink dynamics will be very different: in the first scenario there is an increase in the net sink, while in the second there is a decrease by a quarter before 2000 followed by a constant sink.

59. However, bearing in mind economic growth and the investments in the forest industry, the increase in fellings could be even faster. Some possible scenarios made by the University of Joensuu suggest a very modest sink falling to zero by the year 2010. The present projections do not take possible changes in growth rates as a result of climate changes into account. An additional uncertainty relates to the import of timber, paper and other wood products, which could replace domestic fellings.

60. The waste sector produces the bulk of methane emissions. The communication and background material project emissions from landfills to fall by 44 per cent by 2000. This assumes that the policy target of reducing the amount of waste landfilled from 2.5 Mt/year in 1990 to 1.4 Mt/year in 2000 is met. This in turn depends on imposition of a landfill tax and enforcement of the 1994 Waste Act. The Waste Act is expected to reduce the number of landfills from about 2000 to about 200 larger sites, and will require installation of facilities for gas collection and utilisation or flaring. The communication assumes that the amount of methane derived from waste water disposal will remain constant to 2010. Emissions from agriculture will largely follow livestock trends, about which there is considerable uncertainty, even in the short and medium term. The communication assumes a stable level. Overall a significant reduction in methane emissions is expected (19 per cent between 1990 and 2000 according to the communication), although a reduction can not be traced in the 1990 to 1994 inventories.

61. In the nitrous oxide projections reflected in the communication, the 55 per cent growth in energy-related emissions from fluidized bed combustion and the introduction of catalytic converters in cars are the dominant factors in an overall growth of 22 per cent. This outcome is sensitive to the use of emission factors, which the team was told reflected the mix of technologies present in Finland. For agricultural N_2O there is a projected decrease of about 8 per cent, due to a shift from arable to grassland.

62. These projections seek to take account of adjustments to agriculture brought about by Finland's accession to the European Union, although they seem to make no specific allowance for emissions mitigation consequent on the Union's agri-environment support programme, or indeed the 1992 Finnish Rural Environment Programme. The communication recognizes the overall uncertainties in the projections.

63. Regarding the effects of measures, the team found that the communication does not clearly distinguish between what *might* be achieved by a particular date through implementing a measure, and what the measures currently in place are *actually expected* to achieve. A table summarizing measures contained in the Finnish national programme and their expected results by the target date and the means proposed to monitor their effects, would be a great help in subsequent communications, and would do more justice to the sound pragmatic analyses revealed by discussions with the officials responsible.

V. EXPECTED IMPACTS OF CLIMATE CHANGE

64. Finland is already subject to major climate variability. Possible changes have been assessed, e.g. for forest, agriculture, water resources and sea ice regime, and the communication briefly outlines the results. The sensitivity of forests (and peatlands) to climate change is of vital importance to Finland given their important economical role. Substantial efforts are being carried out to assess this sensitivity and to determine in advance possible negative effects. Given the long rotation period, it appears reasonable to take into account the influence of climate changes in planning forestry activities; main factors could be increased CO_2 and nitrogen fertilization and higher temperatures, the latter especially in the north. Sea level rise is not considered a problem, as the land is still rising after the last ice age.

65. The longer-term effects of climate change in Finland may be more positive than negative. The greatest problems could be indirect effects of climate changes in other parts of the world, leading to changes in trade patterns as well as migration, although the impact of a change in the pattern of circulation in the Atlantic could be very serious.

VI. ADAPTATION MEASURES

66. Finland is already adapted to major climate variability. Given the uncertainty in the nature and magnitude of possible impacts of climate change, Finland does at present not see any need for the implementation of specific adaptation measures.

VII. FINANCIAL ASSISTANCE AND TECHNOLOGY TRANSFER.

67. Finland provided Fmk 105 million (US$ 20.6 million) to the Global Environment Facility (GEF) in the pilot phase and is committed to paying Fmk 124 million (US$ 21.7 million US$) for the replenishment (please note that different exchange rates were used - figures in US$ are from the GEF secretariat). The team noted that the contributions are additional to the country's official development assistance (ODA) and were in fact increased despite the economic situation.

68. ODA fell from 0.7 per cent of GDP in 1991 to 0.4 per cent in 1995 because of budget cuts entailed by the recession and the need to control the escalating public debt. Both the

present and the previous governments have committed themselves to reaching the 0.7 per cent level when the recession is considered over.

69. The ODA portfolio has always contained a substantial proportion of projects relevant to climate change mitigation, e.g. in the energy (15 per cent of total) and forestry (14 per cent) sectors, while some projects, e.g. in water supply (15 per cent), could also be relevant to adaptation. Environmental impact assessments have been made for the ODA projects in place since the late 1980. Finland also works actively through multilateral channels to ensure that its practices are in accordance with the various international environment conventions, including the UNFCCC. Capacity building is a strong concern when giving aid, for example by dealing with pricing principles when funding investments in the electricity sector, but also through strengthening the capability of meteorological services in developing countries, particularly their ability to monitor variables relevant to climate change. In the latter areas, the Finnish Meteorological Service is actively involved, in collaboration with the World Meteorological Organization.

70. The team also noted the Finnish contributions to a significant number of projects in countries with economies in transition, in the energy (efficiency, renewables) and forestry sectors for example, on a bi- or multilateral basis. These activities build on Finland's traditional close contacts with countries in the Baltic area. An indicator of technology transfer from the private sector could be that Finland currently exports to 140 countries. Finnish industry is particularly strong in energy and forestry-related business.

71. The team noted that there are currently no projects for consideration as activities implemented jointly (AIJ) under the FCCC. The industry has expressed strong interest in the issue, but a condition for involvement would be "to get something back", for example in the form of credits. The industry could build on existing cooperation to provide AIJ projects for the pilot phase, if funding is provided.

VIII. RESEARCH AND SYSTEMATIC OBSERVATION

72. Finland has a long history of making detailed observations of the physical and chemical state of the atmosphere. Several long time series from anthropogenically undisturbed areas have been carried out, and the team noted the importance of the northern stations in that respect. A specific point of interest has been the influence of climate changes on forest growth and peatland ecosystems. On the scientific side, comprehensive interdisciplinary work has been done since around 1990 under the SILMU programme (Finnish Research Programme on Climate Change). This was funded through the Academy of Science, with relevant ministries involved in the steering group. In addition to funding research and development projects, SILMU organized a number of international conferences and workshops, and these are well documented for the international academic community. There was a bimonthly newsletter and other modes of information. There has also been other funding of research and development, especially of more applied research and development by users such as ministries and industry.

73. Considered to have accomplished its targets, the programme was terminated according to the plan in 1995 with final documentation issued in spring 1996. Projects within the areas that SILMU used to fund will now have to compete for other funding through, for example from research councils, which have already committed some funds. The team noted that funding through the European Union is seen as increasingly more important.

74. A considerable number of technological research and development programmes are carried out, covering energy production, conversion and consumption. The programmes appeared well organized to the team, with clear and ambitious strategies. The team noted that these programmes have substantial involvement of the users in industry, including considerable private funding, as well as a direct orientation towards the world market. A major part of the work was concentrated on various aspects of biofuel use.

75. Being a small country, Finland has to draw heavily on international research. The team noted that an important feature has also been the incorporation of Finnish research and development and its results into international programmes, and the dissemination of information to the international scientific community as a whole. Still, given the amount and quality of work that has been carried out, the team noted that even more could be done in this respect, for example through IPCC.

IX. EDUCATION, TRAINING AND PUBLIC AWARENESS

76. While education and training issues are not explicitly considered in the national communication, Finland traditionally has a very high level of public environmental education and indeed of general education.

77. According to *Finnish Action for Sustainable Development*, environmental education in the form of programmes and teaching materials for children and adults is of great importance. There are extensive information programmes on energy use, for example, MOTIVA. Schools will be encouraged to participate in regional, national and international projects in environmental education with the focus on use of biofuels.

78. The publication and dissemination of results, as well as the climate changes issues related to these results, are an essential feature of all research and development programmes. In this connection, the team noted in particular the documentation of the SILMU programme. There are also a number of initiatives by some municipalities and non-governmental organizations in the field of education and public awareness. In general, the level of public awareness appeared high.

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