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

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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 Iceland 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 September to December 1996, and included a country visit by the team from 9 to 12 September 1996. The team included experts from Eritrea, Estonia and the United States of America. Iceland ratified the Convention on 16 June 1993, and the national communication was due on 21 September 1994. It was only received by the secretariat on 4 March 1996. Additional background material was made available to the team.

2. Iceland's economy is heavily dependent on fishing but some energy-intensive industries based on the relatively abundant supply of hydropower are also important. Energy consumption is high, two thirds of it based on hydro and geothermal sources, including practically all electricity. Carbon dioxide ($CO_2$) emissions amounted to about 8.5 tonnes per capita in 1990, lower than the average of about 12 tonnes for countries of the Organisation for Economic Co-operation and Development (OECD). Two thirds of these emissions are almost equally divided between traditional transport and fishing vessels. Iceland has only about 270,000 inhabitants and a small administration which has to prioritize domestic and international tasks. Climate change is given high priority, and responses have been organized as an interministerial effort since 1991, with various working groups. Iceland has a target of stabilizing its emissions of greenhouse gases (GHGs) in 2000 at the 1990 level. Further developments of the export-oriented energy-intensive industry will be exempted from this target. Continued degradation of vegetation and soil erosion at present constitute the most serious environmental problem in Iceland.

3. The relative importance of greenhouse gas emissions in 1990 based on the Intergovernmental Panel on Climate Change (IPCC) 1994 global warming potentials (GWPs) was as follows: $CO_2$ 67 per cent, $CH_4$ 18 per cent, $N_2O$ 6 per cent and other gases (perfluorocarbons (PFCs) from industrial processes) about 9 per cent. The share of process emissions from industry ($CO_2$ and PFCs) is particularly high. The team was given revised 1990 figures as well as data for 1990-1995. These are based on the IPCC guidelines and presented in a transparent manner with emphasis on areas where improvement is needed. The situation in the land-use change and forestry sector was not sufficiently clear to determine whether this is a net sink or a source, or to give figures. Only about one per cent of the land is presently covered with forest. Emissions of non-$CO_2$ gases are relatively uncertain, and the team concluded that the estimate of nitrous oxide is still likely to be revised significantly downwards. The estimates of methane emissions for more recent years than 1990 have less uncertainty thanks to the better knowledge of landfill conditions. The team also noted that Iceland has made efforts to develop a methodology for calculating $CO_2$ emissions related to the utilization of geothermal sources.

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

4. The Government approved an action plan on climate change in October 1995. The national communication often described planned rather than implemented actions, and the team noted that progress had been made both in terms of the institutional framework and implementation of some concrete measures. This builds on activities carried out over many years, and the team in particular noted the efforts to utilize renewables. The team noted that, because of the relatively high proportion of renewables in the energy supply, many measures applied in other countries to reduce energy use would not have much impact on $CO_2$ emissions in Iceland. There is still some technical scope for reducing $CO_2$ emissions from stationary energy use, where special measures are taken to make substitution with electricity possible for industry and fishing vessels in harbours. In transport, there are some initiatives on land-use planning and public transport at the local government level. General carbon taxes are under consideration, and a shift towards taxing the use rather than the purchase of cars is foreseen. A working group on emissions from the fisheries sector was established in September 1996.

5. The Government is preparing a master plan for land use with the primary aim of bringing soil erosion under control. There is a programme to sequester 100,000 tons of carbon annually through revegetation and reforestation, although additional efforts will be needed to fulfil the goal in 2000. Also voluntary activities are important in this sector. The Government intends to reduce the waste stream by 50 per cent, and the waste management practices in the Reykjavik area have already been improved during the present decade. Since late 1996 biogas from the biggest landfill has been collected, a measure which alone is expected to reduce national methane emissions by 10-15 per cent. The team in particular noted the efforts made by the aluminium industry, which has reduced emissions of PFCs by 80 per cent since 1990, and the partial use of waste wood instead of coal in the ferrosilicon industry. An estimate of the overall effects of measures could not be provided.

6. The communication contains projections for all direct and indirect GHGs, except for the land-use change and forestry sector, and the team found the methodologies and assumptions reasonable. The projections had been revised before the team's visit. $CO_2$ emissions actually grew by 6 per cent between 1990 and 1995, and could grow by 14 per cent by 2000, based on decisions taken and measures implemented, the main factor being transport, including fisheries. Additional industrial developments could further increase this substantially, but such developments would not be counted against the national target as the origin of such emissions is not considered to be "domestic consumption". Methane emissions decreased by 9 per cent and could decrease further mainly as a result of developments in the waste sector. Nitrous oxide will remain a small component of Icelandic emissions. Even if aluminium production increases, PFC emissions are expected to remain significantly lower than in 1990. Hydrofluorocarbon (HFC) emissions could, however, represent 3-4 per cent or more of total GHG emissions in 2000, depending on the speed at which the use of chlorofluorocarbons (CFCs) is phased out in the fishing fleet. With the current measures, emissions of all GHGs could increase by 6 per cent by 2000 without further growth in the energy-intensive industry. Thus, achievement of stabilization would most likely require a rapid and effective implementation of additional measures.

7. The impacts of climate change on Iceland are very uncertain, as the nature of such change is itself uncertain. Even a cooling is not an unlikely possibility. Iceland's economy is very vulnerable to changes in the conditions for the fisheries, which could be brought about by marginal climatic changes. Agriculture is also seen as vulnerable. There are no specific adaptation measures, but the country is adapted to a considerable natural variability. Given its limited resources, Iceland relies heavily on and participates actively in international research and development. Spending for this purpose as a percentage of gross national product (GNP) has been relatively low. The country has a well developed meteorological service and network of monitoring stations.

8. Iceland has not participated in the Global Environment Facility (GEF). Official development assistance in 1994 was about 0.1 per cent of GNP, and there are some bilateral projects relevant to the Convention, in particular on the utilization of geothermal energy. The team also noted the host role and funding of the United Nations programme on geothermal energy. Some efforts have been made on education, training and public awareness, through the media and by making information available for schools. Cooperation with non governmental organisations is also seen as contributing to raising public awareness.

## I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

9. Iceland ratified the Convention on 16 June 1993. Its national communication was due on 21 September 1994, but it was only received by the secretariat on 4 March 1996, more than 17 months late. The in-depth review was carried out during the period September to December 1996 and included a country visit by the team from 9 to 12 September 1996. The members of the review team were Mr. Naigzy Gebremedhin (Eritrea), Mr. Jaan-Mati Punning (Estonia), Ms. Clare Breidenich (United States of America) and Mr Peer Stiansen (UNFCCC secretariat, Coordinator). The team met with governmental officials and representatives from the academic community as well as business and environmental non-governmental organizations, and additional background material was also made available.

10. Iceland is located in the North Atlantic Ocean and has only about 270,000 inhabitants, two thirds living in the capital area and the rest spread around the island. It has a relatively cold climate with heating requirements almost all year round. The geographical location generates considerable needs for imports and transport of goods over long distances. It has no railways or inland waterways. Because of the location and the sparse population, many environmental problems are less noticeable than in continental Europe or North America. However, since settlement in the ninth century, the percentage of the county that is vegetated has been reduced from an estimated 65 to about 25, and forests now covers only 1 per cent of the area compared to 25 per cent. This largely manmade situation, where livestock grazing is a key element, has led to serious soil erosion. Continued degradation of vegetation and soil erosion at present constitute the most serious environmental problem in Iceland, and is also an important factor in the overall carbon balance and thus climate change.

11. Iceland is among the richest countries in the world measured on a gross domestic product (GDP) per capita basis. The most important economic sector is the fishing, which accounts for 50 per cent of Iceland's foreign exchange earnings and approximately 75 per cent of Iceland's merchandise exports. Iceland also has some heavy industry that is the source of a considerable proportion of emissions of greenhouse gases (GHG). The economy tends to follow fluctuations in the fishing sector, rather than short-term international economic fluctuations. Longer-term economic trends, however, are relatively stable. Unemployment, inflation and public debt are low. The population is currently growing at a rate of just over 1 per cent annually, faster than the average of about 0.7 per cent, in countries of the Organisation for Economic Co-operation and Development (OECD).

12. Iceland has a relatively high energy consumption per capita, about 8 tonnes of oil equivalent (toe) compared to around 4 toe on average for OECD countries in 1990. Carbon dioxide ($CO_2$) emissions per capita were 8.5 tonnes in 1990, which is close to the Western European average but lower than the OECD average of about 12 tonnes. Two thirds of the energy supply is renewable. The electricity supply is around 4-5 Twh. Iceland enjoys a relatively abundant and low-cost supply of hydropower, from which about 94 per cent of the electricity is generated, and which represents 17 per cent of the energy balance. About 6 per cent of the electricity is generated from geothermal sources, which could be expanded. Particularly over the last two decades, geothermal heating has been developed to supply most of the population. Geothermal heating constitutes 48 per cent of the energy balance. Fossil fuels are mainly used for transport, with the fishing fleet using more than 60 per cent of the diesel oil, although some is used in industry and only 2 per cent still for heating, particularly in areas where geothermal sources are not available. Iceland has no railways.

13. Iceland has relatively high taxes and prices in the case of transport fuels, while the prices of oils for heating and industry are lower than the OECD average. Because of the geographical location, there is a very high use of international bunker fuels compared with domestic use, which makes up around 25 per cent of oil use. Like other countries, Iceland is considering some reforms in the energy sector, where the production and distribution entities are largely publicly-owned monopolies. However, given the country's size and location, the developments towards deregulation observed in particular elsewhere in Europe may not necessarily be feasible in Iceland. Further, given the domestic sources of supply, such developments may not necessarily affect emissions of greenhouse gases to any great extent.

14. Iceland has had a separate ministry for the environment since 1990. This ministry coordinates policy on climate change, which has been formulated by an interministerial group since 1991 also involving various agencies. An action programme on combating climate change (CC-programme) was adopted by the Government in October 1995. Within the CC programme there are several subgroups working on different aspects of climate change. Implementation of the programme is now the responsibility of the relevant ministries. Background work is carried out in particular by the environment and energy agencies. There is also a group comprising personal advisers to the ministers, which was established to oversee the implementation of the programme. Iceland drew up a national environmental strategy in 1993, and a Programme of Action for Sustainable Development was approved by a

special Environmental Assembly in November 1996. This programme is expected to be adopted by the Government in early 1997. The policies and measures in the CC programme are an integral part of the Programme of Action for Sustainable Development. The ministries have regular contacts with business and some environmental non-governmental organizations. Most measures are decided and implemented by the Government, and so far the parliament has had relatively little direct involvement in climate change policies, except through the annual budget process.

15. Iceland is a member of the European Economic Area, which implies that some responses to climate change, including policies and measures, are decided upon in concert with other members of that grouping. Some responsibilities for policies and measures, in particular those related to land-use and waste, are left to the local communities. Given the limited number of people working in central government, Iceland has to establish priorities regarding which activities it wants to carry out domestically, and in which detail, and to what extent it can participate in the international processes. Given the importance of potential impacts for Iceland, the Government has given priority to the climate change process and negotiations related to marine pollution.

16. During the UNFCCC process, Iceland has emphasized the importance of different national circumstances and starting points among the Annex I countries, drawing attention to its own predominantly renewables-based stationary energy consumption. In particular, Iceland views the commitments in Article 4.2 as a collective commitment of Annex I Parties, and that differences in starting points and approaches, economic structure and resource base should be taken into account for commitments by individual states. The communication states that obligations to limit emissions of GHGs should not prevent new development of heavy industries in the country, since these industries would normally be much more carbon-intensive if located elsewhere. Iceland's national goal is consequently to stabilize emissions of greenhouse gases from traditional industries and economic activities, such as transport and the fishing fleet, and emissions caused by enlargements of the energy intensive industry, powered by clean energy sources, should thus not be counted against this goal since the location of these activities in Iceland is considered to minimize the global effect.

## II. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS

17. Iceland's communication includes summary tables for emissions of $CO_2$, methane ($CH_4$), nitrous oxide ($N_2O$), nitrogen oxides ($NO_x$), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), perfluorocarbons (PFC) and hydrofluorocarbons (HFC) for the years 1990, 1991, 1992, 1993. The team was given revised and new data for 1990-1993 and 1994-1995, respectively, as well as the background information necessary to be able to reproduce the figures. The team concluded that the Icelandic greenhouse gas inventory data given in the communication were reported in the accordance with the Intergovernmental Panel on Climate Change (IPCC) Guidelines. During the in-depth review, new improved data were presented, which slightly differ from those given in the communication. It became clear also that for some gases and sources further revisions could be expected.

18. $CO_2$ emissions account for about 67 per cent of total emissions of GHGs, based on IPCC 1994 global warming potential (GWP) values. The actual figure for $CO_2$ has been revised slightly from 2,172 to 2,147 Gg. Transport accounts for 64 per cent of these emissions, and the share of process emissions from industry, 18 per cent, is high compared to other countries owing to the use of renewables in other sectors. Nearly half of the transport emissions were attributed to fishing vessels. Iceland collects data on fuels for the fishing fleet bought abroad: However, in accordance with IPCC guidelines, emissions from this are not included in the estimate. Iceland has worked out methods, based on measurements, for estimating emissions of $CO_2$ from the geothermal waters used in energy production. This source represented 4 per cent of total $CO_2$ emissions in 1990. The emission data in the energy and industry sectors have a high level of reliability. Emissions from international bunker fuels were estimated separately and not included in the total figure. They equalled 15 per cent of $CO_2$ emissions, this high figure being explained by Iceland's location and its, travel and trade patterns. $CO_2$ emissions grew by about 6 per cent between 1990 and 1995.

19. $CH_4$ emissions were estimated at 23 Gg, which represents about 18 per cent of total GHG emissions, based on IPCC 1994 GWP values. The total figure for 1990 was not revised, and the two principal sources were the agriculture and waste sectors, each of which were responsible for around half of these emissions. These estimates are relatively uncertain. For the waste sector, the statistics for activity data in 1990 were rough. Further, knowledge of the conditions in a number of the landfills and dump sites was not sufficient to determine whether these actually generate methane or not. Since 1990, there has been a change in waste practices, in particular in Reykjavik, and in parallel an improvement in the statistics, which reduces the uncertainties. In the agricultural sector, it is not known to what extent the high emission factor taken from the IPCC accurately reflects Icelandic conditions for enteric fermentation. Overall methane emissions fell by about 9 per cent between 1990 and 1995, most of the reduction stemming from the waste sector.

20. $N_2O$ emissions were estimated at 0.5 Gg, representing 6 per cent of total GHG emissions, based on IPCC 1994 GWP values, whereas a figure of 0.6 was given in the communication. The main source was agriculture. The figure from agriculture appears to be a considerable overestimate, as it implies that all nitrogen contained in the fertilizers was emitted and none fixed in plants. A significant downward revision may thus be expected. However, emissions from fertilizer production was not included, but efforts are under way to estimate these.

21. Other gases account for a relatively high share of Iceland's GHG emissions, about 9 per cent, based on IPCC 1994 GWP values, owing to emissions of PFCs from aluminium production. These emissions were reduced by more than 80 per cent between 1990 and 1995. Using an alternative method of estimation, the PFC emission level was twice as high, which illustrates the uncertainty still connected with this source. Since 1990, Iceland has started to use HFCs as replacements for substances controlled by the Montreal Protocol. The use of these was estimated at 0.10 Gg in 1995, based on sales quantities. Iceland also monitors the indirect GHGs, recording a slight growth in $NO_x$ emissions together with a slight decline in CO and NMVOC emissions between 1990 and 1995.

22. The situation in the land-use change and forestry sector was not sufficiently clear to give estimates of emissions and removals. These could be considerable, but it was not even possible to assess the direction of the net contribution from the sector arising from the sum of soil erosion, peatland deterioration, afforestation, etc. The team noted that it is conceptually difficult to define what is natural and what is anthropogenic in this sector, as the present situation is the consequence of settlement more than 1100 years ago. Still, for example, regeneration of vegetation/forest and wetlands is also highly dependent on current practices.

## III. POLICIES AND MEASURES

23. The team concluded that Iceland has introduced a number of policies and measures that mitigate climate change both prior to and after the coming into force of the Convention. A more specific action was the establishment of a carbon dioxide committee and various working groups. The visit confirmed that a number of working groups are active or have been formed to assess mitigation options in various sectors. The communication refers broadly to a wide range of measures covering the industrial, transport, forestry, land management and agricultural sectors, as well as fisheries and waste disposal, but it gives limited details on each of them. Further, it does not always describe the status: whether the policies and measures are proposed, planned or implemented. Often the communication merely outlines the areas where measures should be assessed and signals the will to do so. Consequently, the team found that the country visit greatly improved the quality of information on policies and measures across all sectors.

24. The team noted that the national environmental strategy from 1993 provides an overall framework for climate change response in Iceland, with emphasis on sustainable development, pollution prevention, renewable energy and land reclamation. An action plan on climate change was adopted by the Government in October 1995. Iceland possesses environmental legislation, including an act on environmental impacts assessment, which could in principle be applied to emissions of GHGs from certain sources, although this has not been done so far.

25. The team noted in particular the utilization of renewable energy sources, which have been developed significantly over the last two decades. These sources now cover two thirds of all energy use and 95 per cent of stationary energy use. Emissions from mobile sources, which constitutes 65 per cent of $CO_2$ emissions, represent the biggest challenge for Iceland. Given that stationary energy use is largely based on renewables, the team recognized that the options for further reducing carbon dioxide emissions are more limited than in countries with systems more dependent on fossil fuels. Generally, the team found that in areas where Iceland has significant options to control greenhouse gas emissions, a wide range of measures are being considered. Several measures are already having effects and the team noted in particular the considerable reductions achieved in reducing PFC emissions.

26. The team noted some policies that could be assessed in the light of Article 4.2.(e)(ii) of the Convention, which states that each of these Parties shall "identify and periodically review its own policies and practices which encourage activities that lead to greater levels of

anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol than would otherwise occur". The fuel tax has one component which is earmarked for road building, and the team felt that it could be worth assessing whether this way of financing leads to more roads being built, and the impacts that would have on traffic and the corresponding emissions. The team noted that such an assessment has been carried out for the policies related to further developing energy-intensive industry, which is likely to increase Icelandic emissions.

## A. Carbon dioxide

27. Several economic policies and measures are under consideration or being implemented. Some parts of the tax system are under evaluation, in particular those related to vehicles and fuels. Unlike the other Nordic countries, Iceland has not introduced any $CO_2$ taxes, but this is being considered. If such taxes had the same structure as in other countries, with exemptions for process emissions, the fishing fleet and possibly some other industrial sources, the team note that the pattern of emissions in Iceland is such that most of the emissions would be exempted. The effects on emissions of higher prices for fossil fuels may not be very great, especially in the short run, as there may be limited possibilities for substitution. Changes in the tax structure on fossil fuels were seen as unlikely to be implemented before 1998 at the earliest.

28. The team noted that Iceland still has large technical potential to develop hydro and geothermal energy, although the options are likely to have increasing costs and, particularly in the case of hydro, also increasing degrees of conflict with nature conservation interests. Still, increased demands for heat and electricity are expected to be met by renewables. There are, however, limits to how much of the little remaining stationary use of fossil fuels can be substituted. The team noted that some utilities apply demand-side management to incite consumers to use less heat and electricity. The effects of such efforts depend on the possibilities for substitution in the market; the more fossil fuel users are able to switch between, in particular, electricity and of oil, the more effective these efforts will be in reducing $CO_2$ emissions.

29. The team noted that the Icelandic Government is endeavouring to increase the flexibility of switching to electricity for those that still depend on fossil fuels for stationary combustion. Together with the electricity utilities and producers, it has devised an option for fish meal plants (of which there were 28 at the time of the team's visit) and other users to buy so-called "occasional power" for partly replacing their use of oil for steam production. The price is low because, for example, the supply may be interrupted should the supply of power for this market be reduced. The National Power Company has signed contracts with 10 users which have made the necessary and often significant investments to be able to use electricity. These investments can often be paid back in a few years. The transmission grid is sometimes an obstacle. The communication refers to a potential for $CO_2$ reductions from this measure of 70,000 tonnes.

30. A similar effort to replace fossil fuels with electricity, that is aimed at the fishing fleet was considered by the team, to be innovative. Fishing vessels are the biggest contributor to $CO_2$ emissions, and the Government encourages them to use electricity instead of fuel when they are in harbour. A total of 30 MWh/year could be used if all vessels used electricity in harbour. At present, a special tariff for electricity supplied to vessels in harbour has led to the use of about 14 MWh, or about 50 per cent of the potential.

31. A working group that will assess options for reducing emissions from the fisheries and that is mentioned in the communication, was to be convened for the first time days after the team's visit. The team noted that one feature of the general fishing policy of Iceland is the use of individually transferable quotas (ITQs). This leads to fewer boats being used to obtain the same catch, and correspondingly less use of energy. However, it may also lead to more boats being available for deep-sea fishing, which could be more energy-consuming.

32. With regard to onshore transportation, which generates 35 per cent of carbon dioxide emissions, the team noted that the central and local governments are making several efforts. As already mentioned, the taxation of vehicles and fuels is under review. At present, vehicle tax rates are 30 to 65 per cent of the value, depending on engine capacity, plus a 25 per cent value added tax and an annual tax based on weight. Assuming that revenues should not be dramatically changed, it is expected that fuel taxes will rise and vehicle taxes fall. It will take some time to develop and implement the changes; for example, changes in diesel taxation have been postponed until 1 January 1998. The possibility of having a sizeable share of the vehicle fleet based on alternative fuels or electricity is not considered feasible in the near or medium term, although the team notes that there could technical scope for electrical trolleybuses in the capital area.

33. The Government intends to launch a comprehensive master plan for land use, the main aim of which will be to bring soil erosion under control. It will also include several aspects of climate change, however, including public transport, the main transport system and future patterns of industrial development, land reclamation, soil conservation, afforestation and even the location and scope of future power projects. The plan is to be drafted under the auspices of the Ministry of the Environment and other ministries. The Ministry of Transport will establish a special working group, in consultation with the Ministry of Environment and the Ministry of Trade, to lay the groundwork for the overall organization of transport in Iceland with regard to environment and energy questions. Local governments have a responsibility for public transport and for implementing physical planning measures, and the team was shown examples of town planning which take into account the needs of cyclists and pedestrians in Reykjavik. Especially outside the Reykjavik area there is limited scope for economic public transport.

## B. Methane

34. The national Government has taken several measures in the waste sector which are expected to reduce methane emissions significantly. It aims at achieving a 50 per cent reduction in waste disposal by 2000 by reducing the amount of packaging, and increasing

recycling and composting. Here the major challenge is likely to be in promoting public awareness and participation, and both central and local governments are active in this connection. The recycling programme emphasizes source separation, and recovered materials will be recycled or composted. In Reykjavik, where over half of Iceland's population lives, these measures are expected to bring about a sharp fall in methane emissions. As discussed in the inventory section, there are considerable uncertainties regarding the monitoring of this activity, given the incomplete information on the generation, collection, transport and disposal of waste around 1990 and earlier. Both the quantitative target (of a 50 per cent reduction in waste disposal) and the qualitative targets of improved collection and recycling should, of course, be kept under review. There has also been progress on two other measures mentioned in the communication; as of 1996, open incineration of wastes is banned (only one small site being left), and equipment to capture methane was installed at Reykjavik's Alfsnes landfill in late 96. The latter measure is expected to reduce the emissions by 3000 tonnes. The team also noted that the ferrosilicon plant utilizes waste wood in partial replacement of coal, which reduces both methane and $CO_2$ emissions.

35. For the most part Iceland's livestock - largely sheep, cattle and horses - are free-ranging. Opportunities to directly control methane emissions, both from livestock waste and from enteric fermentation, are thus limited. However, under the land reclamation programme, Iceland is beginning to change its livestock management patterns. The Ministry of Agriculture is implementing a policy to reduce subsidization of livestock farming. This policy, combined with outreach efforts to alert farmers to the dangers of overgrazing, has the potential to both reduce the number of livestock on the Island and alter grazing patterns. The potential to reduce emissions from livestock may be greater in the future because of increased pressure on grazing activities as a result of national concerns about soil erosion.

### C. Nitrous oxide

36. The primary sources of $N_2O$ emissions are fertilizers and automobiles. Measures aimed at reducing $CO_2$ emissions from the transportation sector will also control $N_2O$ emissions. These include fuel and vehicle taxes and efforts to increase the use of public transport.

### D. Other greenhouse gases

37. The team took note of the reductions that have been achieved in PFC emissions as a result of measures taken at the aluminium plant since 1990. The Ministry of the Environment continues to work closely with the aluminum plant to ensure that the production of fluorocarbons during the smelting process is reduced to the technical minimum. It noted that, consideration is being given to including conditions concerning emissions of such gases when permits for new plants are being granted, primarily to ensure that new plants would have similar performance. This would not be necessary, however, if this level of performance is reached on a voluntary basis. The ministry has also introduced a new regulation to control and limit the projected growth in HFCs, PFCs and sulphur hexafluoride $SF_6$ as replacements for substances controlled by the Montreal Protocol. If passed, the regulation would limit the importation of HFCs to coolants, while fluorocarbon use (and import, for example, for fire

extinguishers) would be prohibited. $SF_6$ use would be limited to electrical equipment for which no alternative gases are available. The Ministry plans to use direct regulations to implement and enforce these regulations.

## E. Precursors

38. Iceland is a Party to the United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution, but it is not a Party to the $NO_x$ and sulphur protocols. Because of its location and low population, Iceland does not have problems with regional transboundary air pollution and contributes only marginally to it; local pollution is also limited. The primary sources of $NO_x$, CO and NMVOC emissions are fossil fuel combustion in the transport and, in particular, the fishing sectors. Iceland has implemented several mitigating measures in the transport sector. Since 1992, all new vehicles sold in the country must be equipped with catalytic converters. In conjunction with this new law, an annual vehicle emissions testing programme was implemented. Efforts made by the City of Reykjavik to encourage people to use public transport will also reduce emissions. Reduction measures for $NO_x$ emissions will be considered by the working group established to investigate options in the fishing sector. The Ministry of Transport has initiated the use of alternatives to turpentine as a solvent on roadways and is seeking ways to reduce the volume of solvent applied annually. Plastic spray paint instead of paint with large amounts of solvents is also used. Measures that reduce the use of fossil fuels in the fishing fleet will also reduce the precursor emissions.

## F. Land-use change and forestry

39. Land reclamation is a high priority for Iceland and the measures taken have significant potential to enhance carbon sequestration over time. The Government has introduced measures that will increase the sequestration of carbon dioxide in biomass. The plan envisages sequestering 100,000 tonnes tons of carbon dioxide per year by the year 2000. The measures include planting lupins, planting grass and spreading fertilizer, as well as reforestation aimed at commercial forestry. The total area affected by these measures between 1991 and 1996 was 16,300 ha, which were estimated to sequester 46,700 tonnes of carbon dioxide per annum at present, including accumulation in low organic matter soils. If the current rate of reclamation and reforestation is continued, it is estimated that 77,000 tonnes would be sequestered in the year 2000. Further action is therefore planned for the period 1997-2000, as sequestration of an additional 22,200 tonnes would be needed to fulfil the target. The Government has recently approved to fund additional measures for fulfilling this target.

40. The team noted that a new soil conservation strategy and special reclamation and afforestation plan is under preparation and will be issued early in 1997. The plan is being prepared by the Ministry of Agriculture in close collaboration with the Ministry of the Environment. Important features are seen as being education and public outreach to educate farmers and the public about the nature, extent and control of land degradation. This emphasizes both land reclamation techniques and grazing management. The team saw fencing

as an effective measure in this respect. The team noted that a reduction of livestock subsidies is expected to result in a change in land-use towards more commercial forestry. The team also noted the important voluntary actions, by farmers and non-governmental organizations, for example, to fight soil erosion and enhance reforestation.

## IV. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

41. Iceland's communication included projections of the greenhouse gases $CO_2$, $CH_4$, $N_2O$, PFCs and HFCs as well as the precursors CO, $NO_x$ and NMVOCs. Owing to the lack of quantitative information, projections for the land-use change and forestry sector were not made. The projections are given according to the IPCC categories and are consistent with the inventories, and the scenarios for the various gases are also internally consistent, even if different methodologies had to be used to carry them out. They are also consistent with expected economic development in the near term. During the visit, revised data were given for most gases, taking into account recent developments.

42. The projections of GHG emissions are based on materials produced by the Energy Forecast Committee. This is an expert group made up of various interested parties (including stakeholders) which uses a comprehensive technical approach to project the development of energy demand and supply. The team found the approach reasonable, especially given the size and characteristics of the Icelandic energy system. The projections given in the communication, as well as the updated ones, do not include the effects of those parts of the action plan that had not been implemented at the time the projections were made.

43. The projections in the communication show an increase in $CO_2$ emissions of about 5 per cent in 2000 compared to 1990. The revised data increased this estimate to about 14.4 per cent. The main source of this growth is the transport sector, including fisheries. The team noted that implementation of some additional measures could reduce this growth. A 60,000 tonne increase in the production capacity of the existing aluminium smelter (which was 87, 000 tonnes in 1990) is under way and is included in the projections. However, these do not include additional emissions from other industrial developments that were under consideration at the time of the team's visit. It is expected that investors will decide in 1997 whether or not to construct another aluminium plant. The plant in question would initially have a capacity of 60,000 tonnes and could be built before the turn of the century. The production capacity of ferrosilicon could also be increased by 100,000 tonnes (from an actual production level of 62,000 tonnes in 1990). All of this could more than double the smelting capacity and thus the amount of emissions generated by industrial processes alone. It could increase national emissions by 10-20 per cent. The team noted that the Government would not count such developments as emissions of greenhouse gases from traditional industries and economic activities and thus not relate them to the achievement of the aim of ensuring that total emissions greenhouse gases in the year 2000 will not exceed the 1990 total.

44. Such industrial developments would need to be supplied by electric power. Until new generating capacity is added, this could mean that less interruptable (or occasional) power will be available, including interruptable power for fishmeal factories. This could increase the

use of oil by those consumers who have the choice, and hence further increase emissions. The projection of traffic emissions assumes the same vehicle fleet structure as today. A further uncertainty is the development of the deep-sea fisheries, which currently employ part of the fishing fleet. If this fleet is employed in local waters, emissions could be reduced. In the longer term, emissions will also depend on the use of factory trawlers, which freeze fish using energy from oil, rather than delivering the catch to onshore factories that may use electricity generated from renewable sources.

45. Methane emissions are projected to decrease by 8 per cent between 1990 and 2000, to a level already achieved in 1995. The most significant factor in this reduction is recent changes in waste management practices, primarily in the Reykjavik area, given that this is where the majority of waste is generated. There is still some uncertainty relating to the extent of these effects, because of the limited knowledge of the composition of the waste stream and conditions in the landfills, in addition to the uncertainties created by the voluntary nature of the Government's waste programme, which aims to reduce the waste stream by 50 per cent by 2000. In addition, there could be a further reduction in emissions as a consequence of the capture and utilization of landfill gas. Equipment was installed at the biggest landfill near Reykjavik shortly after the team's visit and this alone could reduce total methane emissions by 10-20 per cent. Emissions from agriculture, where a small decrease is projected, will largely follow the number of livestock. Cattle and sheep populations have already decreased; the number of cattle is now expected to remain stable while the number of sheep could drop further. It is unclear how the relatively big horse population will develop. The team noted that ongoing efforts to reclaim wetlands will likely increase methane emissions, but also increase $CO_2$ sequestration, although no estimates were provided.

46. Based on revised figures, emissions of nitrous oxide are projected to remain virtually stable to 2000 but they may be boosted by the fact that since 1992 new automobiles have had required to be equipped with catalytic converters. The emissions from agriculture are expected to remain relatively stable, although an increase in fertilizer application is also expected in conjunction with Iceland's comprehensive land reclamation plan. As explained in the inventory section of this report, both historical and projected emissions from the agricultural sector are probably overestimated. Thus emissions from transport, which represent 10 per cent of total $N_20$ emissions in the current 1990 inventory, would become relatively more important. Overall, nitrous oxide emissions will remain a small proportion of Iceland's GHG emissions.

47. Emissions of PFCs, which represented around 9 per cent of GHG emissions (0.045 Gg) in 1990, were reduced to 0.008 Gg by 1995, which is the figure given for 2000 in the communication. This is seen as been close to the technical minimum. Revised projections estimate the emissions for 2000 at 0.013 Gg, reflecting the increased capacity being added to the existing aluminium smelter. Possible further increases in aluminium production are not included, but even with such developments these emissions are expected to remain well below 1990 levels. Implementing the Montreal Protocol, Iceland is phasing out the use of CFCs and replacing them with HFCs. Revised projections for 2000 show HFC use at 0.040 Gg, twice the figure quoted in the communication and representing 3.5 per cent of national emissions.

However, as fishing vessels can continue to use CFCs for some years, there is still considerable room for reduction, possibly up to 0.12 Gg, as these vessels will start to use replacement substances around 2000. More shipboard freezing could lead to even higher growth in HFC emissions in future years.

48. While the figures reported in the communication imply an aggregate reduction of 4 per cent of all emissions outside the land-use change and forestry sector, the revised projections indicate a 6 per cent growth. The team realizes that the uncertainties go in both directions, but feels that some developments that would increase emissions further could be dominant. Consequently, stabilization could depend the effective implementation of additional measures. The team also notes that a better understanding of emissions of $CH_4$, $N_2O$ and PFCs may lead to revisions that could significantly change the overall emission picture.

### A. Carbon dioxide sequestration in biomass

49. No projections were given for carbon sequestration in biomass. The team notes that a main determinant in carbon sequestration is the grazing practices. However, existing programmes administered by the Ministry of Agriculture aim to increase carbon sequestration by biomass to 100,000 tonnes by the year 2000. It is estimated that current efforts and current rates of afforestation and land reclamation will yield a net increase in carbon sequestration of 77,800 tonnes by 2000. The Government has decided to devote additional resources to the land reclamation project over the next four years to meet the projected gap of 22,200 tonnes. Achievement of this aim would imply that stabilization could be closer on a net basis, adding sources and sinks.

### B. Precursors

50. According to the communication, both $NO_x$ and CO emissions are projected to fall, while NMVOCs are projected to remain stable. In the revised projections, $NO_x$ emissions are now projected to grow by 13 per cent between 1990 and 2000, primarily because of a projected increase in the number and activity of fishing vessels. Catalytic converters and other measures significantly reduce emissions from the onshore transport sector, although this is partly offset by increased transportation. CO emissions are projected to decrease by over 26 per cent. Most of this reduction is expected to come from improved vehicle emission control measures. However, it could be offset by increased CO emissions from fishing vessels. NMVOCS are projected to approximately stabilize. However, expansion and improvement of roadways may increase the application of solvents and lead to a corresponding increase in NMVOC emissions, depending on the technical solutions chosen.

### C. Effects of measures

51. The communication does not contain a specific estimate of the effects of measures, but only a general assessment of some measures or packages of measures. During the visit, information on this issue was given in qualitative rather than quantitative terms. The

projections provided incorporated the projected effects of policies and measures which the Government has taken since 1990, while a pure "without measures" scenarios had not been carried out.

## V. EXPECTED IMPACTS OF CLIMATE CHANGE AND ADAPTATION MEASURES

52. Iceland has a high degree of climate variability, which the society is adapted to. Still the economy is very dependent on natural resources, first and foremost fish stocks, so conditions in the sea are crucial to development. Sea currents and temperature determine breeding and the availability of nutrients, and even small changes in the longer-term patterns could have significant impacts on the size, composition and availability of the fish stocks. Agriculture, where some crops are farmed under marginal conditions, could also be considerably affected by limited changes. Some types of possible developments would also affect the conditions for transport, in particular by air. The need for a wider understanding of possible impacts was acknowledged.

53. The effects of an enhanced greenhouse effect in the North Atlantic area are highly uncertain, and in a general scenario of global warming both warming and cooling could be possible, as well as other effects. Given the general uncertainty, the impact of global warming on the fish population is still poorly understood, what makes an assessment of adaptation measures difficult. As an example, in cold years, the continental shelf north of Iceland is less productive, and there is a strong correlation between the influence of Atlantic water and the weight of capelin. Together with the other Nordic countries, Iceland has made an assessment of the possible effects on hydrology and thus the availability of economically important hydropower. Still, in particular given that the uncertainties go in different directions, no specific adaptation measures have been undertaken.

54. If Iceland wants to arrive at a more detailed assessment of possible impacts, the team felt it could be useful to develop scenarios to assess the possible changes in crop production, bioproduction and weather conditions, based on paleoclimatic reconstructions using existing models as well as using historical and paleogeographical data.

## VI. RESEARCH AND SYSTEMATIC OBSERVATION

55. The communication focuses on monitoring and contributions from the natural sciences. The team noted that there has been more monitoring of physical, chemical and biological processes in the Northern Atlantic Sea as well as the Arctic Area. Monitoring and understanding ocean currents, food chains etc. is vital for understanding the basis of the Icelandic economy and of possible impacts of climate change. International efforts are financed and carried out by countries on both sides of the Atlantic, with active participation by Iceland. The Ministry of Agriculture has embarked on collecting the necessary information to combat land degradation, *inter alia*, through the compilation of a map of soil erosion using satellite imagery (scale 1:100,000). Given Iceland's limited size and financial resources,

international cooperation is crucial and Iceland is taking an increasingly active part in the relevant forums. In this respect, participation in the research programmes of the European Union, which are open also to countries of the European Free Trade Area, is seen as increasingly important. Iceland is also involved in Nordic research cooperation, for example on the air-sea flux of $CO_2$ in the Nordic seas.

56. Due to its geographical characteristics, Iceland has a large meteorology service relative to the population size, with about 130 observation posts some of which have provided long time series. Over the last decades, atmospheric chemistry has also been monitored, as well as changes in Iceland's terrestrial ecosystems, including vegetation and soil erosion.

57. Compared to other countries, Iceland has historically spent relatively little on research and development as a percentage of GDP. Over the last decade, expenditure has rapidly increased, however, as has the involvement of industry. The research system has also been reorganized, and there is now one research council funding both basic and applied research. Funding of applied projects is allocated according to economic sectors whereas basic research funding is allocated according to discipline; in both cases, projects relating to climate change must compete on these conditions. Energy research focuses almost exclusively on hydro and geothermal sources; there is a long tradition of such research, which has enjoyed an increase in funding in recent years.

## VII. FINANCIAL ASSISTANCE AND TECHNOLOGY TRANSFER

58. Iceland has not contributed to the Global Environment Facility (GEF), either in the pilot phase or in the first replenishment. The team was not made aware of any concrete action to change this situation. Official development assistance (ODA) was about 0.1 per cent of GDP in 1994. The Government has stated that it intends to increase ODA to between 0.3 and 0.4 per cent of GDP. However, in the light of recent across-the-board budget cuts, such an increase was not seen as likely to materialize in the near future.

59. There are some projects in the energy sector that are of relevance to UNFCCC. In particular, Iceland is the host and finances 80 per cent of the United Nations University Geothermal Training Programme. Further, Iceland's unique expertise in using geothermal energy is applied in bilateral projects in Eastern Europe (e.g. Slovakia, Baltic countries) and Asia (e.g. China).

60. Iceland is developing concepts for activities implemented jointly (AIJ) through the Nordic Council of Ministers, but it does not participate in any pilot projects.

## IX. EDUCATION, TRAINING AND PUBLIC AWARENESS

61. The communication is brief on the issue of education, training and public awareness, and stresses on the need to do more. A government poll on awareness of climate change conducted in 1993, revealed that a majority of the respondents had some knowledge of the subject. In 1994, the Ministry of the Environment produced a pamphlet for use in schools. It

is up to the school authorities and teachers to integrate any information relevant to climate change in basic education, but an increasing demand is recognized and a textbook on environmental issues for the secondary level was made available in Iceland this year. In 1996, a pamphlet aimed at informing households was issued. The Ministry also uses the press to spread information.

62. The team noted that an advantage of having a small government administration appears to be that knowledge of climate change issues is not the reserve of specialists. Rather, all levels of the relevant parts of the administration need to have a good understanding of climate change, its impacts and the mitigation options related to the sector.

63. The Ministry has also supported development of information by environmental non-governmental organizations. In particular regarding the regeneration of vegetation, there are considerable activities, although these are not primarily aimed at carbon sequestration, which is more of a byproduct. The team also notes that the close interaction with business associations in developing policy, through for example hearings, also contributes to spreading awareness in these circles. There is also interaction between some environmental organizations and relevant ministries.

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