

STATUS REPORT FOR ICELAND

pursuant to the United Nations
Framework Convention on Climate Change

1997

MINISTRY FOR THE ENVIRONMENT

FOREWORD BY THE MINISTER FOR THE ENVIRONMENT

Climate change is a vast and risky experiment, which could drastically affect our environment - and that of our children and grandchildren. Few countries are as sensitive to climate shifts as Iceland, which lies on the edge of the Arctic circle, at the junction of warm and cold ocean currents. Relatively small changes in temperature and weather patterns have often caused hardship and famines throughout Icelandic history. A change in climate and ocean currents in the next century could well have a serious effect on our rich fishing grounds and our livelihood.

Iceland is committed to meet the objectives of the UN Framework Convention on Climate Change. Indeed, so far we have been able to take steps to reduce emissions of greenhouse gases, so that they were actually lower in 1996 than in 1990. The government adopted an ambitious programme to combat climate change in 1995, which is being implemented.

Iceland's circumstances are in many ways unique. On one hand, life in Iceland is unusually energy intensive, resulting from a relatively large fishing fleet, long distances for transport in a sparsely populated country, and a great demand for space heating in a cool and windy climate. On the other hand, Iceland has an abundance of clean and renewable energy sources, in the form of geothermal and hydroelectric power. Two-thirds of the country's energy needs are met by renewable sources, by far the highest proportion of any OECD country. A push to develop geothermal energy resulted in almost all houses in Iceland being heated by natural hot water before 1990. Currently, about 95% of stationary energy production comes from renewable sources.

We are proud of this achievement, yet it puts constraints on economically feasible ways to further reduce greenhouse gas emissions. Current technology makes it difficult to power cars and fishing vessels with clean domestic energy sources. One way the government is combating climate change is by substantially increasing the planting of trees and other vegetation, thus combining efforts to slow down global warming with actions and to reverse the severe soil erosion Iceland has suffered.

Iceland could help combat climate change on a global scale by further utilizing its clean energy sources for industry that otherwise would be powered by fossil fuels. For this reason, the government has exempted emissions from industrial processes in new energy-intensive industrial plants set up in the country, from its overall target to limit emissions in the year 2000 to 1990 numbers.

Combating climate change is a difficult and complex task. The countries of the world must do their utmost to increase energy-efficiency, reduce pollution, further utilize clean and renewable energy sources and increase sequestration of carbon dioxide in vegetation. The government of Iceland is taking decisive measures on all those counts and will continue to do so.

Guomundur Bjarnason

Summary

- In 1995, Iceland's emissions of CO₂ were 2,281 thousand tons, and total emissions of greenhouse gases were 2,640 thousand tons (measured in CO₂ equivalents, or Global Warming Potential (GWP)). This was about 0.01% of the world's total emissions. Per capita emissions of CO₂ in Iceland in 1990 and in 1995 were 8.5 tons, compared to about 12 tons average in the countries of OECD.

- The share of individual gases in total emissions (measured in global warming potential (GWP) values) in 1995 are as follows:

- Carbon dioxide - 86 per cent

- Methane - 6 per cent

- Nitrous oxide - 5 per cent

- Other gases - 3 per cent

- The share of individual sectors in carbon dioxide emissions in 1995 were as follows:

- Fishing vessels - 33 per cent

- Other transport - 32 per cent

- Industry emissions - 18 per cent

- Geothermal energy production - 3 per cent

- Other stationary sources - 14 per cent

The most notable aspects of Iceland's CO₂-emissions are the high share of emissions from mobile sources, especially from the fishing fleet and the low share of stationary sources. About two-thirds of Iceland's total energy and over 95% of stationary energy comes from clean and renewable sources.

- Iceland's total greenhouse emissions declined about 3.5% in the period 1990-1995. The main reason for this was reduced emissions of fluorocarbons from the aluminium smelter in Straumsvík. The emissions of carbon dioxide in this period increased about 6%.

- Emissions of greenhouse gases are expected to increase in the near future. Total emissions are forecasted to rise about 16% to the year 2000, about 26% to the year 2010 and about 35% to the year 2020, compared to the year 1990.

- The expected local effects of climate change on Iceland are difficult to assess. Most computer models predict some warming in Iceland and

nearby areas, although smaller than the average increase at that latitude. Of great concern to Iceland is the possible effect of climate change on ocean currents, which could cause drastic change in climate and fisheries.

- The government of Iceland aims to limit emissions of carbon dioxide and other greenhouse gases at the end of this century to the same levels as in 1990. The main policy instrument for curbing greenhouse gas emissions in Iceland is the National Climate Change Action Programme (NCCAP), adopted in 1995. The plan is overseen by a committee composed by special assistants of Ministers in 7 ministries, and more detailed proposals are examined by working groups in individual ministries and sectors.

- Iceland's main problem in curbing emissions of greenhouse gases is the apparent dearth of economically feasible ways to do so. A push to develop geothermal energy for space heating resulted in most houses being heated with renewable energy sources before 1990. It is very difficult to reduce the already low emissions from stationary sources, and a change in technology is needed for a sizeable reduction in emissions from mobile sources.

- One of the most feasible way for Iceland to combat global warming is perhaps to increase carbon sequestration in vegetation, thus combining efforts in climate change and in reversing soil erosion. Iceland is committed to bind about 100.000 tons of carbon dioxide in vegetation annually, or about 4-5% of its emissions of that gas.

- In the field of technology transfer, Iceland can continue to make a significant contribution to combat climate change by assisting with the development of geothermal power, especially in developing countries and in economies in transition.

- Iceland is posed with a dilemma in the development of energy-intensive industry. Emissions from industrial processes will significantly increase total emissions in Iceland. On a global scale, however, it can be argued that industry placed in Iceland, utilizing the country's abundant clean energy sources, emits far less carbon dioxide (in some cases, over 90% less, compared to plants using fossil fuels for energy) than industry using other energy sources, so that energy-intensive industry placed in Iceland guarantees the lowest possible emissions on a global scale. The government is of the opinion that obligations to limit emissions of greenhouse gases should not prevent new energy-intensive industrial development in the country, which would take advantage of the country's clean energy sources. A precondition for such development is

that the best available technology be used in any new heavy industrial plants in Iceland, so that emissions as a result of industrial processes will be as low as technologically feasible.

1. Emission inventories

1.1. INTRODUCTION

This chapter explains the main conclusions of emissions of anthropogenic greenhouse gases inventory in Iceland in 1990-1995, using methods of calculation based on the guidelines of the IPCC (1995).

Emphasis was placed on types of greenhouse gases, i.e. carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC) and fluorocarbons (PFC). Gases causing an indirect greenhouse effect, such as nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO), are included in a similar manner, to the point these are covered by IPCC methods. Similarly, sulphur oxides (SO_x) are included. Sulphur hexafluoride (SF₆) exists as an insulator in electrical equipment and is quantified in this report.

Sources of greenhouse gases are grouped under the following six categories in accordance with the guidelines of the IPCC: energy, industrial processes, solvents, agriculture, forestry and land use change, waste and waste water. These main categories are further divided into sub-categories. One category has been added to the classification system of IPCC—emissions from geothermal energy production—as geothermal energy production increases the emissions of geothermal steam and of the gases present therein.

Emissions from feed stocks are in the industrial processes source category of the inventory. For the production of iron and steel (ferrosilicon) the usage of carbon electrodes and coal have been considered feed stocks and accordingly included under the industrial processes category. For the production of aluminium the feed stocks are alumina, cryolite and carbon electrodes which emissions are handled similarly. The inventory includes estimates for emissions of carbon dioxide, fluorocarbons and sulphur oxides. The carbon dioxide figure includes carbon emitted as fluorocarbons. A separate inventory is also provided for fluorocarbons in their emitted form, causing double counting when reported twice.

For non-metal mineral production the main feed stocks causing emissions is the use of calcium carbonate from mollusc shell sand, in cement production.

Carbon dioxide released by decay and combustion of vegetal residues and other biomass is reported for information purposes, but not included in the figures for the total emissions, as a balance is assumed to exist between

growth and decay. On the other hand the release of other greenhouse gases from decomposition of biomass is included. The fossil-fuel based content of the waste is not known at present.

The release of greenhouse gases resulting from international transport, including all emissions from international ocean and air transport on the bases of fuel sold, is not included in figures for the total emissions from the country. Data for these emissions is provided in a separate category.

1.2. EMISSIONS OF MAIN GREENHOUSE GASES

1.2.1. Emissions of carbon dioxide

Emissions of anthropogenic carbon dioxide in Iceland in 1990 amounted to 2.147 thousand tons, if emissions from biomass and international transport are excepted. The main portion was the result of fuel combustion, some 78% of the total, and another 18% from industrial processes. Other significant emissions include carbon dioxide released by geothermal energy production, some 4%. Fishing vessels account for the greatest single portion of emissions or just over 30%, followed closely by vehicles and machinery with some 29% of the total. Industry contributed 11%, accounted for primarily by fish oil and meal processing plants and a cement plant. It is noteworthy that mobile sources (transport and fishing) account for 64% of the total carbon dioxide emissions, leaving 36% to stationary sources.

In 1995 the anthropogenic emissions of carbon dioxide in Iceland had increased by 6% compared to emissions in 1990, and amounted to 2.282 thousand tons. This corresponds to an almost 18% increase in emissions from the fishing fleet, 8% increase in emissions from vehicles and 9% from industrial processes, with increased aluminium and ferrosilicon production.

1.2.2. Emissions of methane

Total emissions of methane were estimated at 14 thousand tons in 1990. The largest single contributor is agriculture with some 85%. Thereof some 78% is emitted by enteric fermentation in domestic animals and the other 7% from animal waste. Other sources are refuse disposal, with landfills contributing over 13%, and fuel combustion with some 2% of the total methane emissions.

In 1995 emissions of methane were less than 14 thousand tons, slightly lower than in 1990. The primary reason for this reduction is a decrease in the number of livestock, especially sheep.

1.2.3. Emissions of nitrous oxide

Emissions estimates of nitrous oxide in 1990 amounted to 410 tons. Chemical fertilizer and animal wastes were estimated to contribute approximately 52% of those emissions, but there is a high degree of uncertainty. Fertilizer production is believed to contribute over 38%, the fishing fleet over 4%, vehicles over 4% and other mobile sources for the remainder.

In 1995 emissions of nitrous oxide amounted to 390 tons. Compared with the 1990 figures, total emissions are somewhat lower, but a noteworthy change occurred in the contributors, with emissions from vehicles now contributing over 10% of the total, a result of the increased use of catalytic converters.

1.2.4. Emissions of hydrofluorocarbons

Emissions of hydrofluorocarbons are based on figures from imports. Before 1992 there were no imports of HFCs but since then, imports have increased rapidly. In 1995, such imports (HFC-125, HFC-134a, HFC-143a and HFC-152a) amounted to 10.5 tons in total.

1.2.5. Emissions of fluorocarbons

Aluminium production is the only anthropogenic source of emissions of fluorocarbons: tetrafluorocarbon and hexafluorocarbons. In 1990 it was estimated that 45 tons were emitted, but this figure is subject to a high degree of uncertainty. Concerted efforts were made to reduce anode effects, which cause the emissions, and shorten their duration as much as possible. In 1995 it is estimated that emissions of fluorocarbons have been reduced by as much as 80% from 1990 levels as a result of these measures.

1.2.6. Sulphur hexafluoride

Sulphur hexafluoride can be found in electrical equipment. The estimated total quantity in Iceland is 11 tons. Leaks are estimated to have amounted to 200-250 kg per year in 1990-1995.

1.3. EMISSIONS OF INDIRECT GREENHOUSE GASES

1.3.1. Emissions of nitrogen oxides

In 1990 emissions of nitrogen oxides were estimated to be over 26 thousand tons. Of this 61% was attributed to the fishing fleet, 28% to vehicles and machinery and less than 6% to coastal shipping. Other sources included industry, over 2%, and combustion of biomass, 1,5%. Biomass in this connection refers to emissions caused by the calcination of organic remains in diatomaceous deposits.

In 1995 the emissions of nitrogen oxides increased to over 28 thousand tons, which is an 8% increase compared to the 1990 emissions. This increase is due to increased fuel combustion by the fishing fleet, resulting in 18% rise in its emissions since 1990. Emissions from vehicles decreased slightly, however, due to increased number of vehicles equipped with catalytic converters.

1.3.2. Emissions of carbon monoxide

In 1990 the total emissions of carbon monoxide were estimated at 58 thousand tons. By far the largest single contributor was vehicles and machinery, with some 95% of the total. Other sources were the fishing fleet with slightly less than 3% of the total and refuse incineration, with 2%.

In 1995 carbon monoxide emissions fell considerably compared to the 1990 estimates and amounted to some 49 thousand tons. This reduction is primarily due to the growing number of vehicles equipped with catalytic converters and to a lesser extent the decommissioning of open-air incineration sites.

1.3.3. Emissions of non-methane volatile organic compounds

Total emissions of non-methane volatile organic compounds were estimated at nearly 13 thousand tons in 1990. Emissions from vehicles were responsible for 76% of the total, the use of organic solvents 20%, and the fishing fleet contributed nearly 4%.

In 1995 the total emissions were estimated at 12 thousand tons. This reduction from the 1990 figure can be explained by lower emissions from vehicles equipped with catalytic converters.

1.3.4. Emissions of sulphur oxides

Total estimated emissions of sulphur oxides amounted to 24 thousand tons in 1990. It is estimated that two thirds of the total came from harnessed geothermal steam emitted as hydrogen sulphide. For this source in particular it should be noted that both the methods applied to estimate geothermal emissions and to determine to which degree hydrogen sulphide is transformed to sulphur oxides involves a high degree of uncertainty. Other significant sources contributing are industrial processes with some 13% of the total, emissions from fuel combustion in industry, some 11% and the fishing fleet, 7%.

In 1995 the total emissions of sulphur oxides were estimated to be approximately the same as in 1990. Emissions from the fishing fleet increased 50% from 1990 primarily due to increased combustion of heavy fuel oil.

1.4. AGGREGATED EMISSIONS OF GREENHOUSE GASES

In 1990 the total aggregated emissions (GWP-100, direct effect) of the greenhouse gases CO₂, CH₄, N₂O, HFC, PFC and SF₆ amounted to some 2.730 thousand tons (CO₂-equivalents). There were no emissions due to hydrofluorocarbons, as these gases were not imported for use until 1992.

In 1995 the figure was estimated at 2.640 tons, a 3% reduction compared to the 1990 emissions.

1.5. CARBON SEQUESTRATION

Land reclamation and reforestation is a high priority in Iceland and there is significant potential to enhance carbon sequestration over time beyond the present level. The Government has initiated a programme of land reclamation and tree planting to increase the sequestration of carbon dioxide in biomass. This is done within the framework of the National Climate Change Action Programme (NCCAP). The programme involves sequestering additional 100,000 tonnes of carbon dioxide per year by the year 2000. The programme includes planting lupines and grass and spreading fertilizer, as well as reforestation.

The consequences of land use change and forestry for the carbon balance of the whole country have not been analysed. As a first step towards this goal the annual sequestration rate resulting from reforestation and reclamation programmes has been analysed by a panel of experts. (The results are reported in Chapter 3.) They used the carbon stock approach, taking notice of the revised guidelines from IPCC and included the accumulation of organic matter in the top 30 cm of low organic matter soils.

Four types of actions were included in the analysis:

1. Planting lupins on poor soils. This is a commonly used reclamation approach on denuded soils. The nitrogen fixing lupins accumulate significant amount of organic matter and fraction of this enters the soil organic matter pool.
2. Reclamation with grass seeds and fertilisers. This is the most commonly used approach for reclaiming eroded areas in Iceland. This is done both using areal application of seeds and fertilisers and through ground-based approaches. These activities are carried out or co-ordinated by the Soil Conservation Service (a government agency).
3. General reforestation. This involves the planting of seedlings of native birch and some introduced conifers on areas protected from sheep grazing. Most of these areas are established in co-operation with volunteer organisations.
4. Commercial forest plantations. Actions on behalf of farmers to establish commercial forest plantations on their farms have received government subsidy in designated areas. The planning and management of these areas is co-ordinated by the Icelandic Forest Service (a government agency).

An average sequestration rate was assigned to each category taking into account the range of site conditions and management. This estimate is based on forest inventories and analysis of soil carbon content. This is the first approximation and can be expected to change following more thorough analysis and more extensive soil sampling. The total area affected by each of the above types of actions during the period 1990-1996 was recorded and the resulting total annual sequestration estimated.

	Sequestration t CO ₂ /ha/year	New areas 1991-1996 total	Annual sequestration
Lupins on poor soil	3.0	3,000	9,000
Grass and fertilisers	2.5	7,200	18,000
Reforestation	2.0	3,600	7,200
Commercial forestry	5.0	2,500	12,500
Total:		16,300	46,700

The total area affected by reclamation and reforestation programmes 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. Assuming that the current rate of reclamation and reforestation is continued, it is estimated that new areas sequestering 31,000 tonnes will be added bringing the sequestration rate to 77,000 tonnes in the year 2000.

The NCCAP calls for annual sequestration rate of 100,000 tonnes, however. Further action is therefore planned for the period 1997-2000, to sequester additional 22,200 tonnes.

The Government has recently approved a programme aimed at fulfilling this target. 450 million ISK have been allocated and the initiation of reclamation and reforestation projects is under preparation. The carbon sequestration resulting from these actions and earlier efforts will be monitored and documented according to the guidelines of IPCC. A panel of experts will re-evaluate the initial estimates of carbon sequestration rates and suggest additional studies needed to refine the estimates and quantify the sequestration resulting from reclamation and reforestation programmes.

2. Policies and measures

This chapter outlines the policies and measures the Icelandic government is pursuing to curb climate change. The projections of greenhouse gas emissions and assessments of the effects of those measures that have or are being put into effect are discussed in chapter 4.

2.1. POLICY CONTEXT

It is the objective of the government of Iceland, in attempting to halt the increase the greenhouse effect, to limit emissions of carbon dioxide and other greenhouse gases at the end of this century to the levels in 1990, in accordance with the UN Framework Convention on Climate Change. The government places emphasis on achieving these objectives in the most efficient manner possible. Thus, measures which are profitable for the national economy will be prioritised.

Continuing emphasis will be placed on increasing the proportion of hydroelectric and geothermal energy in total energy consumption and thus reducing emissions of greenhouse gases arising from fossil fuel combustion. However, hydropower and geothermal energy have already to a large extent replaced fossil fuels in those areas where it is technically possible and cost-efficient, and these energy sources provide the nation with almost 2/3 of primary energy consumption. Considerable potential exists for the enhancements of sinks for carbon dioxide in Iceland, however. Such actions are also consistent with the current government policy of halting soil erosion, revegetating denuded areas and planting trees.

The government is of the opinion that obligations to limit emissions of greenhouse gases should not prevent new energy-intensive industrial development in the country, which would take advantage of the country's clean energy sources. A precondition for such development is that the best available technology be used in any new heavy industrial plants in Iceland, so that emissions of greenhouse gases as a result of industrial processes will be as low as technologically feasible.

In its action programme, described in the next section, the government places emphasis on four main approaches:

- Incentive measures
- Public education
- Instruments of economic policy
- Compulsory measures

Incentive measures include actions taken by the national government and its institutions to strengthen the work of local authorities, private parties and volunteer groups in order to further limit emissions of greenhouse gases or to increase the sequestration of carbon dioxide.

Public education is an important part of the action programme, which will be directed at the general public, industry and students in the public school system.

The prime emphasis is placed on measures which directly increase efficiency or which contribute towards achieving other goals and ends. Accordingly, the government will emphasise the following measures:

- Fuel conservation, especially in fishing, transport and industry.
- Increased exploitation of non-polluting, domestic energy sources.
- Land reclamation and afforestation in order to halt soil erosion, as well as sequestration of carbon dioxide.

As the largest portion of carbon dioxide emissions in Iceland (64%) is attributable to mobile sources (transport and fishing), the main thrust in the Icelandic action programme is directed towards reducing emissions from automobiles and seafaring vessels. The government is well aware that it will prove difficult to impose compulsory measures on the fisheries sector, which is the main pillar of the nation's economy and accounts for over half of the country's foreign currency earnings. Nor is it considered feasible to reduce emissions of carbon dioxide from industrial processes significantly, since the only method of achieving this would be to limit the production.

There is considerable uncertainty as to the impact of the policies and measures undertaken, partly because most of them are directed at many small sources. Despite this uncertainty, the government feels it important that the action programme be directed at all the main sources of greenhouse emissions in the country. The progress will be closely monitored, for instance by compiling detailed calculations of emissions each year. The government will subsequently review the action programme in the light of the experience gained, and strengthen certain measures as considered necessary.

2.2. NATIONAL ACTION PROGRAMME

In the fall of 1995, the Government of Iceland adopted a National Climate Change Action Programme, which reaffirmed already established policies

on that issue, as well as listing some new measures to be taken. These measures are listed and briefly described below, and are also addressed in the chapter describing policies and actions taken with regard to individual gases and sectors. The Minister for the Environment has appointed a special ministerial co-ordination committee, in consultation with other Ministers involved, to implement the action programme. The committee is to evaluate the progress of the measures and actions of the current programme. In addition, it will make proposals to the Ministries or parties responsible on new or stricter measures or the review of measures, as it considers necessary in order to achieve the objectives of limiting emissions and increasing sequestration of greenhouse gases. The committee is headed by the assistant of the Minister for the Environment. Other members come from the following ministries: Agriculture, Finance, Fisheries, Justice, Industry and Transport. Several of these ministries have established or plan to establish working groups to further elaborate policies within their respective sectors (see Chapter 4).

The action plan of the government is divided into two sections: a) general and economic measures, and b) specific measures, which apply to specific industrial or service sectors in Icelandic society.

2.2.1. General and economic measures

The main general and economic measures in the action programme are:

- **The government intends to review fuel taxation**, so that it will take into account emissions of carbon dioxide and have lead to the reduction of emissions. Plans call for the levying of a special CO₂ tax on fossil fuel for uses other than activities which must compete in the international market. In general, the provisions of the tax will be similar to those which apply to CO₂ tax in countries competing on the same markets as Iceland.
- **Levies on motor vehicles and fuel** will be reviewed by the government with the purpose of encouraging the use of low-fuel-consumption cars. Electric cars and other pollution-free vehicles are likely to be exempted from excise taxes.
- **Use of hydrofluorocarbons** and other powerful and persistent greenhouse gases will be reduced by setting rules aimed at decreasing their use, wherever possible.

- **Research and monitoring** of the effects of climatic changes and responses to them will be systematically strengthened.
- **Monitoring of the implementation of the policies and measures** will be established, for instance, through regular review of the emissions calculations and the preparation of predictions on future developments concerning emissions.
- **Development aid** will be increased during the remaining years of this century with the aim of allocating an amount equal to 0.3-0.4% of GNP in the year 2000.
- **Education and information activities** on the greenhouse effect and on ways to limit emissions of greenhouse gases, will be strengthened, in the mass media, in schools and by other means. To this end the co-operation of local authorities, schools, institutions, associations and private enterprises will be sought as appropriate.

2.2.2. Specific measures

The general rule followed by the Icelandic government is to aim at restricting emissions from every industrial sector to the extent practicable, with the aim of ensuring that total emissions of carbon dioxide from domestic consumption in the year 2000 will not exceed the 1990 total. The attempt will also be made, however, to follow the main rule of keeping the costs to society of reaching this objective at a minimum.

Emissions from fishing vessels

The national government has entrusted the Ministry of Fisheries with the implementation of the following measures for fisheries, in co-operation with the Ministries of the Environment and Industry. Emphasis will be placed on the following aspects:

- **Concerted promotion of energy conservation in fisheries:** The Ministry of Fisheries will support the introduction of measures to promote energy conservation by the fishing fleet in as many areas as possible. A survey of the cost efficiency and fuel consumption of various types of fishing and fishing gear will be undertaken. Efforts will be made to instruct vessel owners, captains and marine engineers on ways to avoid fuel wastage and to reduce fuel consumption in fishing and sailing.

- **Electricity supplies for vessels in port:** Action will be taken to ensure that vessels can obtain electricity ashore in all ports, at rates competitive with electricity produced by generators aboard the ships. If necessary, rules will be set to limit the use of generators in port. Efforts to improve the availability of electricity in ports in recent years have resulted in an estimated reduction of gasoline use of about 1,500 tons, equivalent to an almost 5,000 tons reduction of CO₂ emissions.
- **Working group on environmental and energy issues in fisheries:** The Ministry of Fisheries has appointed a special working group, in consultation with the Ministry of the Environment, to prepare proposals as to how the objectives of reducing emissions of carbon dioxide and other greenhouse gases from the fishing fleet can be achieved.

Emissions from domestic transport

The national government has entrusted the Ministry of Transport and Communications to implement, in co-operation with the Ministries for the Environment and Industry, policies and measures to limit emissions of greenhouse gases from transport. Emphasis will be placed on the following aspects:

- **Strengthening of public transport:** Well-directed and effective co-operation with local authorities will be introduced in order to bolster public transport in urban areas. Special attention is to be given to public transport in municipal planning. The economic feasibility of electrically powered public transport on certain routes will be explored.
- **Improved provision for pedestrians and cyclists:** Pedestrians and cyclists will be provided with more safe and easy routes through towns and villages throughout the country. The co-operation of local authorities and planners will be sought to implement such measures.
- **Obligations of vendors of new motor vehicles to provide data:** Rules will be adopted to oblige vendors of new motor vehicles to provide customers with standardised data on the fuel consumption of new vehicles offered for sale.
- **Limits on the use of solvents in road construction:** To reduce emissions of volatile organic substances the Public Roads

Administration will reduce the use of solvents and the pollution caused by their use in road construction.

- **Overall organisation of transport with regard to environmental and energy questions:** The Ministry of Transport will appoint a special working group, in consultation with the Ministries for the Environment and Industry, to lay the foundation for the overall organisation of transport in Iceland, with regard to environmental and energy questions. The working group will be entrusted with providing increased public education to reduce fuel wastage. It will also conduct a survey on the cost efficiency and fuel consumption of various modes of transport, with the aim of supporting socially efficient, low-polluting, fuel-conserving modes of transport.

Emissions from industry

The Icelandic government has requested that the Ministry of Industry, in consultation with the Ministry for the Environment, implement government policies concerning emissions of greenhouse gases in industry. The main objectives of the government are to increase energy conservation and the use of environmentally clean energy sources instead of fossil fuels, and to restrict emissions of greenhouse gases from industry. It is the opinion of the national government, however, that this objective should not preclude the utilisation of the country's clean energy sources, for example, in new energy-intensive industrial enterprises, even though such enterprise would unavoidably lead to increased emissions of carbon dioxide or other greenhouse gases due to industrial processes. The action programme emphasises the following aspects:

- **Energy conservation campaign in industry:** A fuel and energy conservation campaign will be launched in industrial concerns. Special emphasis will be placed on preventing energy waste and reducing use of fossil fuels.
- **Increasing use of hydropower and geothermal energy:** Efforts are being devoted towards increasing yet further the use of geothermal energy and hydropower instead of fossil fuels as extensively as possible. Further conversion of industrial boilers to electricity will be encouraged. A discount of the price of electricity to boilers in fishmeal factories is estimated to have reduced the burning of crude oil by 11-12 thousand tons of crude oil since 1993, resulting in a reduction of CO₂-emission of about 35,000 tons. Ways will be sought to further

increase the competitiveness of electricity vis-a-vis oil for industrial purposes.

- **Emissions from industrial processes reduced:** Possibilities of reducing emissions of greenhouse gases from industrial processes and the use of raw materials in industry will be reviewed. Possibilities of increasing the use of lumber refuse, wood chips or charcoal as carbon sources in ferrosilicon production will be investigated.

Emissions from refuse disposal

The Icelandic government has entrusted the Ministry for the Environment with the task of implementing its policy in refuse collection and waste disposal and to encourage as much reduction as possible in emissions of greenhouse gases and other pollutants from refuse disposal. Emphasis will be placed on the following aspects:

- **Reduction of refuse:** Concerted efforts are being made to reduce the amount of packaging, increase recycling and increase composting of refuse with the aim of reducing waste disposal by 50% by the end of the century. A special “garbage collection plan” will be drawn up for the entire country, in order to achieve this goal. Special attention is being given to measures to bolster recycling and composting of wastes and reduce the quantity of refuse.
- **Combustion of methane:** Methane gas collection is underway at Iceland's main landfill, for the Reykjavík metropolitan area. This project will be expanded in order to collect and utilise nearly all methane produced by the landfill.
- **Termination of open incineration of refuse:** All open incineration of refuse in Iceland is to be terminated.

Emissions from agriculture

The national government has made the Ministry of Agriculture responsible for producing special land reclamation and afforestation plans in cooperation with the Ministry for the Environment. The prime objective of these proposals is to halt the rapid erosion of soil and ground cover in the country by the end of this century and reclaim as much of the country's lost vegetation as possible. An additional objective is to increase the annual sequestration of carbon dioxide by lupine, forests and other vegetation so

that it will be at least 100 thousand tons more in the year 2000 than it was in 1990. Emphasis will be placed on the following aspects:

- **Plan for land reclamation:** A special land reclamation plan is being prepared for all of Iceland. The main objective of this plan is to halt the rapid erosion of soil and ground cover in the country by the end of this century and reclaim as much of the country's lost vegetation as possible, in accordance with the policy of the national government. Ways will be sought to establish effective co-operation with farmers and other interested parties in this project.
- **Plan for afforestation:** An additional special afforestation plan is being prepared, taking into account the overall land utilisation plan for Iceland referred to earlier, and the plan for land reclamation. By the end of the century, four times as many seedlings will be planted annually as were planted in 1990. Emphasis will be placed on enabling landowners in areas suitable for silviculture to take up this form of agriculture, for instance with grants for planting new forest patches.
- **Projects for the sequestration of carbon dioxide in biomass:** Public institutions in the area of land reclamation and afforestation will be entrusted with the co-ordination and direction of actions in land reclamation and afforestation, together with additional measures as necessary, to increase the annual sequestration of carbon dioxide by vegetation as economically as possible by 100 thousand tons by the end of this century. The objective is to comply with the obligations of the UN Framework Convention on Climate Change by the end of this century and increase the sequestration of carbon dioxide and improve vegetation in the country in the long term. Special emphasis will be placed on economically profitable actions, including the planting of harvestable forests and the termination of land and soil erosion.

New research and monitoring

The Icelandic government intends to strengthen research and monitoring efforts in Iceland to increase knowledge of the effects of climate change in Iceland and to lay the foundation for measures to reduce the detrimental effects of those changes which can be expected. The main areas of research and monitoring which the government will emphasise are: climatological research, monitoring of the atmosphere, marine research, investigation of the effects of sea level rise in Iceland and research in the areas of land reclamation and forestry.

Carbon sequestration

The annual carbon sequestration rate resulting from reforestation and reclamation programmes has been analysed by a panel of experts. They used the carbon stock approach, taking notice of the revised guidelines from IPCC and included the accumulation of organic matter in the top 30 cm of low organic matter soils.

Four types of actions were included in the analysis:

1. Planting lupins on poor soils. This is a commonly used reclamation approach on denuded soils. The nitrogen fixing lupins accumulate significant amount of organic matter and fraction of this enters the soil organic matter pool.
2. Reclamation with grass seeds and fertilisers. This is the most commonly used approach for reclaiming eroded areas in Iceland. This is done both using areal application of seeds and fertilisers and through ground-based approaches. These activities are carried out or co-ordinated by the Soil Conservation Service (a government agency).
3. General reforestation. This involves the planting of seedlings of native birch and some introduced conifers on areas protected from sheep grazing. Most of these areas are established in co-operation with volunteer organisations.
4. Commercial forest plantations. Actions on behalf of farmers to establish commercial forest plantations on their farms have received government subsidy in designated areas. The planning and management of these areas is co-ordinated by the Icelandic Forest Service (a government agency).

An average sequestration rate was assigned to each category taking into account the range of site conditions and management. This estimate is based on forest inventories and analysis of soil carbon content. This is the first approximation and can be expected to change following more thorough analysis and more extensive soil sampling. The total area affected by each of the above types of actions during the period 1990-1996 was recorded and the resulting total annual sequestration estimated.

Sequestration t CO ₂ /ha/year	New areas 1991-1996 total	Annual sequestration
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Lupins on poor soil	3.0	3,000	9,000
Grass and fertilisers	2.5	7,200	18,000
Reforestation	2.0	3,600	7,200
Commercial forestry	5.0	2,500	12,500
Total:		16,300	46,700

The total area affected by reclamation and reforestation programmes 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. Assuming that the current rate of reclamation and reforestation is continued, it is estimated that new areas sequestering 31,000 tonnes will be added bringing the sequestration rate to 77,000 tonnes in the year 2000.

The NCCAP calls for annual sequestration rate of 100,000 tonnes, however. Further action is therefore planned for the period 1997-2000, to sequester additional 22,200 tonnes.

The Government has recently approved a programme aimed at fulfilling this target. 450 million ISK have been allocated and the initiation of reclamation and reforestation projects is under preparation. The carbon sequestration resulting from these actions and earlier efforts will be monitored and documented according to the guidelines of IPCC. A panel of experts will re-evaluate the initial estimates of carbon sequestration rates and suggest additional studies needed to refine the estimates and quantify the sequestration resulting from reclamation and reforestation programmes.

3. Activities implemented jointly

Iceland has participated in a Nordic project studying the possible effects of joint implementation in reducing greenhouse gas emissions. An ad hoc group of energy specialists from the five Nordic countries has studied how exports and imports of energy would affect the countries' individual and combined emissions, as well as how such trade would affect national emission accounts of the countries involved.

The ad hoc group has not completed its mandate, but it is expected to continue its work in 1997 and submit results and recommendations that could be incorporated in a possible proposal of the Nordic countries on Joint Implementation. Early results from the group evaluating ten Nordic projects in Eastern Europe indicate that a Geothermal plant constructed in the Slovak Republic in co-operation with Icelandic companies and NEFCO (Nordic Environmental Financing Corporation), will lead to a 21,000 ton reduction of carbon dioxide emissions annually.

4. Projections and assessment of effects of measures

This chapter outlines the projections of greenhouse gas emissions in the near future and the measures taken to curb those emissions. In most cases, reliable quantitative assessments of the effects of policy measures are lacking. An effort is being made in giving numerical values to such assessments, which should show some results in late 1997.

4.1. CARBON DIOXIDE

In 1990 Iceland emitted 2,147 thousand tons of carbon dioxide into the atmosphere. Emissions of CO₂ are predicted to be 2,697 thousand tons in the year 2000 (an increase of 26% from 1990 levels), 2,893 thousand tons in 2010 (a 35% increase from 1990 levels) and 2,944 thousand tons in 2020 (a 37% increase from 1990 levels).

A significant source of the predicted increase are emissions from industrial processes in new and expanded energy-intensive industry. Considerable increase is also predicted in emissions from mobile sources, both from fishing vessels and other transport. A small decrease in emissions is foreseen from stationary energy sources, but emissions from such sources comprise only a small share of total carbon dioxide emissions in Iceland.

Looking at individual sectors, the predicted increase of CO₂-emissions from fossil fuels is around 12% in the period 1990-2000. Emissions from fishing vessels are expected to increase 22% and emissions from road transport are expected to increase 17%. On the other hand, emissions from domestic air transport, space heating and stationary energy generators are expected to decrease in the period.

Carbon dioxide emissions from industrial processes are expected to increase about 89% in the period 1990-2000. As stated before, these emissions are excluded from Iceland's target of keeping greenhouse gas emissions at the same level in the year 2000 as they were in 1990.

The measures taken to curb emissions of carbon dioxide are the following:

- **Carbon sequestration.** The Government of Iceland in 1996 decided to fund an increased planting of trees and land reclamation so that annual carbon sequestration would be 100.000 tons higher in the year

2000 compared to 1990. For this purpose, the Government funded the project with 450 million Icelandic krónur (around \$6.5 million).

- **Review of fuel taxation.** Proposals for a change in fuel taxation have been discussed by officials in the Ministries of Finance and the Environment. A precondition for an effective CO₂-tax is seen to be a unified and transparent tax collection system for diesel and gasoline due to take effect in the beginning of 1998. No decisions regarding a possible CO₂-tax in the wake of this change have been taken yet, however, by the government
- **Review of fees collected from vehicles.** The Ministry of Finance has been studying proposals to take up taxing the fuel consumption of vehicles rather than collecting a sales or import tax on cars. The special ministerial co-ordination committee has studied the possibility of a tax exemption for electric cars and power-batteries for such cars. An amendment of present tax laws is required for such a measure.
- **Electricity to ships in harbour.** The Ministry of Fisheries has established a working group, which is studying the feasibility and possible effects of further extending electricity (from hydropower) to ships docked in harbour, so that they need not run their generators. Some progress has been achieved in this regard, with the sales of electricity to ships in harbours increasing from 8 GWh in 1992 to 14 GWh in 1995. It is estimated that the total demand is 30 GWh a year.
- **General measures curbing the emissions of the fishing fleet.** The working group of the Ministry of Fisheries is currently drawing up proposals on how to curb emissions of carbon dioxide and other gases from the fishing fleet. Fishing in international and distant waters could be made more efficient and less energy-demanding with the imposition of quotas on fisheries outside the Exclusive Economic Zone (EEZ). Also, more efficient fishing in home waters is expected to decrease emissions per unit of catch. On the other hand, key fish stocks within the EEZ are expected to increase in size as, which could lead to an increase in total catch and fuel-burning by the fleet, while energy-efficiency per unit of catch would improve as a result of the increase in the stocks.
- **General measures curbing emissions from transport.** The Ministry of Transport has established a working group, which is currently studying proposals on increasing the role of public transportation in Iceland, building new paths for pedestrians and cyclists, as well as

drawing up a general plan for transport in Iceland with the specific aim to curb emissions.

- **Saving of energy in industry.** The Ministry of Industry is establishing a working group to organize a campaign for energy savings in industry. The campaign will be organized in co-operation with the Federation of Icelandic Industry and managers of several of the biggest industrial firms in Iceland.
- **An increase in the use of renewable energy sources.** In the last years and decades the government has put great emphasis on increasing the share of hydroelectric and geothermal energy at the cost of fossil fuels. This has been successful, as seen by the fact that currently less than 2% of houses are heated by oil. A 1996 law amendment allows for government funding for research aimed at supplanting fossil fuels by domestic renewable energy. The Ministry of Industry is currently engaged in a campaign to increase energy efficiency in house heating. An effort has been made to increase the share of electricity in fish oil and meal processing plants at the cost of oil. Last year, 111 GWh were sold to factories that had converted from oil to electricity and a further increase in this is seen.
- **A decrease in emissions from industrial processes.** As for carbon dioxide, an effort has been made to shift from coal to less polluting scrap wood in processes at the ferrosilicon plant at Grundartangi.
- **A complete halt to open pit burning.** According to government goals, open pit burning was due to stop in 1996. It is, however, still practised in a few small municipalities which have not yet completed an adequate waste-disposal scheme, but should come to a complete halt in 1997 or 1998.

4.2. METHANE

Iceland's emissions of methane were 14 thousand tons in 1990. Current projections estimate that the emissions will decrease slightly in the coming years and decades, as the number of livestock is not expected to change much, while the generation of waste in landfills is expected to decline with growing recycling.

The measures taken to curb emissions of methane are the following:

- **Collection of methane** at the Reykjavík municipal area landfill at Álfsnes commenced in late 1996. In a few years time it is estimated that this operation will collect 1.500 tons of methane annually, or over 10% of the total current emissions of methane in Iceland. This would mean a reduction of about 16.5 thousand tons of CO₂ equivalent.
- **Increase in recycling** is expected to further reduce the amount of waste to landfills and thus the emission of methane from landfills. In the Reykjavík metropolitan area, the amount of recycled waste has increased from around 8% in 1990 to over 37% in 1996. The government aims for a 50% recycling rate in the year 2000. To realize this goal, efforts will be made to increase further the recycling of paper and of organic waste.

4.3. NITROUS OXIDE

Iceland's emissions of nitrous oxide were 0.4 thousand tons in 1990. Current projections estimate little change in the emissions of nitrous oxide, as the use of nitrogen fertiliser, which is the source of most of the emissions, is expected to stay the same or to increase slightly. No specific measures have been taken to curb those emissions.

4.4. FLUOROCARBONS

Iceland's emissions of fluorocarbons were 0.045 thousand tons in 1990, but had dropped to 0.011 tons in 1995, due to the application of new technology. Current projections estimate an increase of fluorocarbons emissions from the present level, mainly because of an enlargement of the aluminium smelter in Straumsvík, by far the largest source of fluorocarbons emissions in Iceland. Emissions will, however, be much smaller than in 1990. The emissions are expected to be 0.013 thousand tons in the year 2000 (a 60% decrease from 1990), and stay at that level in the years 2010 and 2020.

The measures taken to further curb emissions of fluorocarbons are the following:

- **A regulation on the use and emissions of fluorocarbons** and some other persistent greenhouse gases exists in a draft version in the Ministry for the Environment. It is difficult to assess its possible quantitative effects, but its aim is to further decrease the emissions of these gases.

4.5. HYDROFLUOROCARBONS (HFCs)

There were no emissions of HFCs in 1990, but they are expected to become a growing factor in greenhouse emissions in Iceland. The fishing fleet has been substituting ozone-depleting CFCs with less damaging HCFCs, but in the years 2004-2025 they will have to change from HCFCs, according to the Montreal-protocol. One possibility is to use HFCs as coolants, which would be ozone-friendly and technologically feasible, but would have serious greenhouse effects.

- The working group of the Ministry of Fisheries will focus on the problem of **coolants in fishing vessels**. The group will examine the feasibility to limit or prevent the use of greenhouse-coolants.

4.6. INDIRECT GREENHOUSE GASES

- The Icelandic Road Authority is conducting an experimental project in limiting the use and emissions of NMVOCs during road construction. Results from last year in using less polluting substances were promising and will be taken further this year and in the coming years.
- Emissions of carbon monoxide and NMVOCs are expected to decrease because of the growth in use of catalytic converters.

4.7. CUMULATIVE EMISSIONS OF ALL GREENHOUSE GASES

Iceland's total emissions of all greenhouse gases were 2,730 thousand tons (in carbon dioxide equivalents) in 1990 and 2,640 thousand tons in 1995, a decrease of 3.3%. Emissions in 1996 were estimated at 2,694 thousand tons, which would mean a decrease of 1.3% in 6 years.

Total emissions in the year 2000 are expected to be 3,161 thousand tons GWP, 3,445 thousand tons in 2010, 3,675 thousand tons in 2020 and 3,821 in 2025, based on current trends, not taking into account the effect of measures which are planned but have not yet been implemented.

5. Vulnerability assessment and adaptation measures

The possible effects of climate change in Iceland are very uncertain. Conclusions of recent calculations indicate that warming due to the greenhouse effect in the North Atlantic area, including Iceland, will be on a more modest scale than elsewhere at the same latitude.

Iceland is located at the junction of cold and warm air and ocean currents. Possible changes to the current systems and the most common routes of low pressure zones resulting from global warming could thus have very extensive effects. Existing climate simulations are not sophisticated enough to provide dependable data for individual regions and the uncertainty is relatively large for Iceland and the surrounding oceans. According to the conclusions of a joint Nordic research project, "Climate Change and Energy Production", it is considered possible that the summers in Iceland will become warmer over the next decades by an average of approximately 0.25°C per decade, and the winters by an average of 0.35°C. There is a high degree of uncertainty involved in this assessment. It is considered most likely that there will be some warming of the country in the next century, but it has not been ruled out that cooling could be possible. Of utmost concern to Iceland is the possible effect of climate change on the thermohaline circulation of the oceans and the Gulf stream, which is responsible for the climate in Iceland being considerably milder than can be expected considering its latitude.

Because of the high degree of uncertainty as to possible climatic changes in Iceland, there has been little attempt to formulate specific policies to adapt to climate change. Government policy is at present aimed in particular at increasing research and monitoring, in order to provide a basis for subsequent adaptive measures. Special emphasis is placed on research into the effects of climate change on the ocean surrounding Iceland and on fish stocks.

5.1. FISHERIES

At present it is considered very difficult to predict the effects of the increased greenhouse effect on fish stocks and fisheries around Iceland and in nearby ocean areas. It is clear, however, that variables such as primary productivity (by photosynthesis of algae), distribution of various fish stocks, the routes of fish runs and location of spawning grounds, are dependent upon external conditions, such as the currents and ocean

temperature. This fact has been exemplified by the effect major changes in environmental conditions have had on Icelandic fishing banks during this century.

In the light of the enormous interests at stake for Icelandic fisheries, the national government has decided to increase research on the direct and indirect effects of climate change on the fishing grounds, in order to facilitate adaptation to the changes which may occur.

5.2. SEA LEVEL RISE

Possible sea level change as a result of global warming is of some concern to Icelanders, given the fact that the vast majority of Icelanders live in towns and villages along the coast. A rise in sea level could cause considerable harm due to more frequent sea floods and damages they could cause to roads, harbours and other structures.

Flooding has caused damage to several villages along the south coast and in other areas in the last decades. Some of those villages would probably need special measures to protect them from adverse effects, given even a relatively small increase in sea level. In addition to increased danger of flooding, land erosion by the ocean could increase at certain locations, especially along the south coast.

The government of Iceland has decided to have a special analysis carried out of the danger of flooding and land erosion due to a rise in sea level, and to seek ways to reduce the effects and damages caused by the change.

5.3. AGRICULTURE AND FORESTRY

The climate has a great effect on agriculture in Iceland. Possible effects of climate changes on Icelandic agriculture, with respect to both warming and cooling, was assessed by Icelandic scientists as part of an analysis for UNEP. This investigation indicates that warming of about 1.3°C could result in an increase of 16-19% in Icelandic hay production. The consequences of other climate changes, such as cloud cover, wind or precipitation, were not assessed.

It is to be expected that accompanying an increase in average temperature in Iceland various pests (insects or plant diseases) could become more of a problem than at present, both in agriculture and forestry.

5.4. HYDROELECTRIC POWER PRODUCTION

In connection with the joint Nordic research project “Climate Change and Energy Production” the effects of warming on hydroelectric power production in Iceland in the coming decades was investigated. The effects were considered to be relatively positive, due to increased melting of glaciers and increased flow of glacial rivers.

6. Financial resources and transfer of technology and know-how

Iceland's contribution to development aid has been around 0.1% of GDP in recent years. The government's stated aim is to increase its contribution so that development aid will reach 0.3-0.4% of GDP by the year 2000. According to the government's action programme on climate change, emphasis will be placed, on assistance in the areas of geothermal energy development and soil reclamation in desertified and eroded lands, as well as fisheries.

6.1 GEOTHERMAL TRAINING

The area in which Iceland arguably has the most to offer developing nations with regard to climate change, is by assisting them in harnessing geothermal energy sources. The National Energy Authority of Iceland has hosted the UN Geothermal Training Programme since 1979. In accepting applicants to the programme, priority is given to those from institutions in developing countries where research on geothermal energy and its utilisation is already underway. The operating costs of the UN Geothermal Training Programme are divided between the Icelandic government (80%) and the UN Training Programme (20%). The Geothermal Training Programme can be said to have acquired new importance in recent years in advancing the objectives of the UNFCCC. In developing countries geothermal energy often replaces fossil fuels or firewood, and thus reduces greenhouse gas emissions.

In addition to official assistance through the UN Geothermal Programme, Icelandic scientists and engineers have participated in a number of bilateral projects involving technology transfer and assistance in harnessing geothermal energy. In 1996, such projects were underway in China, Lithuania, Romania and the Slovak Republic, among other places.

6.2. LAND RECLAMATION

Since setting the first law on combating soil erosion in 1907, Icelanders have accumulated extensive knowledge about the problem of soil erosion and ways of halting it. This knowledge could prove of use to countries fighting desertification, even if the processes of soil and vegetation loss, and the methods of land reclamation, are different than in Iceland. According to the government's action plan, the Icelandic International Development Agency will aim to provide Icelandic specialists in the fields

of soil erosion and land reclamation to assist in projects in developing countries.

In September 1997, the Government of Iceland will host an International Workshop on Rangeland Desertification. The workshop will be overview-oriented and aims to bring together knowledge in conservation policy and several fields of science, including agronomy, geography, range ecology and soil science. The goal is to put together a strong multi-disciplinary workshop with emphasis on a critical review of rangeland degradation science, desertification assessment methods and rangeland conservation policy. The discussion will not be limited to any particular climatic conditions, but will attempt to include broad perspectives both from arid warm regions and the more humid and colder parts of the world.

7. Research and systematic observation

The Icelandic Research Council joined IGBP (International Geosphere Biosphere Programme) in 1995 and is in the process of establishing a global change research programme in co-operation with research institutes and ministries. This program will also strengthen the links with WCRP (the World Climate Research Program) and HDP (the Human Dimensions of Global Change).

Below examples are given of research efforts in Iceland in the area of climate change. This is not an exhaustive survey. Several other research programs have direct implications for climate change.

7.1. CLIMATE AND SYSTEMATIC OBSERVATION

7.1.1. Climatological research

The Icelandic Meteorological Office today collects weather information from some 130 locations throughout Iceland, and publishes data on climate and climate change based on this monitoring and research results. The Office has participated in a number of international research projects on climate and climate changes in northern regions, including a joint Nordic project on Climate Change and Hydroelectric Energy Production (in co-operation with the National Energy Authority). Scenarios were drawn up as to the probable changes in climate due to the greenhouse effect and the effects of such changes on power production investigated. The Meteorological Office has also compared the climate simulation of the Max Planck Institute for Meteorology in Hamburg with actual climatic conditions in Iceland.

7.1.3. Atmospheric monitoring

Iceland's position in the mid-North Atlantic means that it is an important measuring location for atmospheric monitoring in a global context. Fairly extensive measurements of ozone have been conducted in the country as well as, in recent years, various measurements of greenhouse gases. Measurements of the total amount of ozone using a Dobson spectrometer have been carried out regularly by the Icelandic Meteorological Office since 1957.

The Meteorological Office has participated in a number of international atmospheric monitoring projects. It has, in co-operation with Aristotle University of Thessaloniki in Greece, carried out measurements of the total

amount of ozone in Reykjavík using a Brewer spectrometer. Additional measurements have been made of the total amount of NO₂ and SO₂ at increasing altitudes in the atmosphere. Measurements of surface ozone levels are made at two Icelandic weather stations in co-operation with the National Oceanic and Atmospheric Administration (NOAA) of the United States. Weekly atmospheric samples have been collected, in co-operation with NOAA, at the weather station at Stórhöfði in the Westman Islands, for the analysis of greenhouse gases CO₂ and CH₄. Monitoring of CO has also been carried out there, in co-operation with the University of Maryland. During the winter, weekly measurements in the troposphere and the lower stratosphere are made in co-operation with INTA (Instituto Nacional de Tecnica Aeroespacial), Madrid, Spain, using a weather balloon sent up from Keflavík international airport.

7.2. PALEOCLIMATE

7.2.1. Drilling on the Greenland Ice-cap, the GRIP and NGRIP projects

Iceland took an active part in the European GRIP (Greenland Icecore Project) drilling on the Greenland ice-cap from 1989 to 1992. The purpose of the drilling was to obtain from the ice cores a variety of information on earlier changes in the earth's environment and climate in order to better understand their nature, and to gain insight into the possible effects of carbon dioxide concentration on the earth's climate. Scientists also hope to achieve a better understanding of climate changes in the northern Atlantic and of the crucial role played by the Gulf Stream in that connection. Specialists of the Science Institute, University of Iceland, work in co-operation with Danish and French researchers on isotope analyses of the cores. By measuring the isotope values along a 3028.8 metre long ice core the climatic history of the North Atlantic area can be read over the past 200 thousand years.

An American drilling program at Summit (GISP II), 30 km east of the GRIP drilling site finished in 1993. Analysis of the GISP and GRIP cores showed that the cores agreed in most cases. However in the lower 300 m, the two cores showed pronounced differences. The depth range includes ice from the Eemian period, the warm period 120,000 years ago. Information from this warm period has direct implications for the climate of our time. With the main objective to provide more information about climate during this period, North GRIP (NGRIP) was established as a multinational drilling program. The operation started in 1996 and will continue to 1998. Specialists from the Science Institute, University of Iceland, will work in

co-operation with Danish and French researchers on isotope analysis of the core.

7.2.2. Paleoclimate as recorded in lake, near shore and shelf sediments in Iceland.

An Iceland/USA PALE initiative was initiated in 1993 in order to construct long paleoclimate records from both lake and near shore sedimentary environments in Iceland. PALE stands for Paleoclimate of Arctic Lakes and Estuaries and is the Arctic research component of Past Global Changes (PAGES), a core project of IGBP. The major goals of PALE are to reconstruct Arctic climatic variations over the past 150,000, 20,000 and 2,000 years and to understand the interactions of these variations with the global climate system.

The main objective of the PALE related research in Iceland is to reconstruct both spatial and temporal environmental changes since the deglaciation of Iceland. This is accomplished by studying numerous sedimentary cores that have been obtained from lakes lying on a transect from south to Northwest of Iceland. With this program a primary attempt is made in Iceland to acquire continuous and high resolution data for this geological time period. Furthermore, a comparison between lacustrine records and results from marine cores collected from W and NW Iceland shelf will significantly increase our understanding of the land-ocean interaction during this period.

7.2.3. Paleoenvironments of the North Iceland Shelf

A research project coined PANIS (PALeoenvironments of the North Iceland Shelf) - focusing on high resolution data in the climatically and oceanographically sensitive area on the North Icelandic shelf was initiated in 1995 with a co-ordinated effort from the universities in Reykjavik, Bergen and Aarhus. The project is motivated by the need for land-sea correlation in the Iceland-Greenland-Scandinavia region, and the need for extending the Icelandic tephrochronology from land to sea. Detailed studies are made of sediment cores from the ocean floor.

7.3. RESEARCH INTO THE EFFECTS OF CLIMATE CHANGE ON THE ICELANDIC ECOSYSTEMS

Integrated studies of the effect of climate change and elevated carbon dioxide on ecosystem function are conducted at the Experimental forest at Gunnarsholt in the south of Iceland. This research facility is operated

jointly by the Agricultural Research Institute, the Forest Research Station and the Soil Conservation Service. The core project on the site focuses on changes in site energy and water balance resulting from tree canopy development of Black cottonwood on this exposed site. The direct effects of elevated carbon dioxide on the carbon balance of the black cottonwood trees has also been studied by growing trees in whole-tree chambers with twice the current carbon dioxide concentration. The effect nutrient level has on the response is also studied. This study is a part of a Nordic research project and contributes to the IGBP/GCTE (Global Change and Terrestrial Ecosystems) Focus 3: Global Change Impact on Agriculture, Forestry and Soils.

The fluxes of carbon dioxide, water vapour and energy from the experimental forest are quantified using the eddy covariance technique. This is done in the context of an EU funded programme EUROFLUX (Long term carbon dioxide and water vapour fluxes of European forests and interactions with the Climate System) and contributes to the IGBP/BAHC (Biospheric aspects of the hydrological cycle) network of carbon dioxide flux sites. The effect of soil temperature on nutrient cycling and carbon dioxide efflux is also studied at the site using the soil warming approach.

Two study sites in Iceland contribute to the ITEX (International Tundra Experiment) network, one in the south of Iceland and one in the central highlands. They are operated by the Agricultural Research Institute in close co-operation with University of Gothenburg.

7.4. LAND RECLAMATION AND AFFORESTATION

The Soil Conservation Service and the Agricultural Research Institute have recently completed the mapping soil erosion throughout Iceland. In addition, the vegetation of 2/3 of the country has been mapped and the Natural History Museum is now continuing this effort. In 1993 the Iceland Geodetic Survey, the Soil Conservation Service and the Agricultural Research Institute jointly published a ground cover map of the entire country based on data processed from the satellite LANSAT.

Extensive research and developmental work is carried out in the areas of land reclamation and afforestation at the Research Station of Iceland Forestry Service, the Agricultural Research Institute and the Soil Conservation Service. Considerable success has been achieved in the growing and processing of seeds of plants important for land reclamation.

7.5. MARINE RESEARCH

Oceanographic conditions around Iceland are monitored by the Marine Research Institute, which collects data on temperature conditions and the distribution of sea types. Investigations of algae and zoological plankton are carried out in spring and summer. The flow of warm sea into the northern banks is assessed by continuous monitoring of currents.

As part of the co-operation of the Marine Research Institute with foreign parties, research on carbon dioxide in the ocean and its air-sea flux has been underway since 1983. In co-operation with Norwegian and Swedish scientists, a three-year research programme on Carbon Cycling and Convection in the Nordic Seas was drawn up in 1992. The objectives of this co-operative project are, among other things: To quantify the rate of sequestering of carbon dioxide in northern seas; to improve understanding of the physical, biological, and geochemical processes relating to carbon dioxide exchange; to improve understanding of the mechanisms involved in deep convection and their relation to carbon dioxide and heat fluxes; and to assess the effects of possible future climate changes on the system.

8. Education, training and public awareness

According to the general programme for the compulsory education level (6-16 year old students), issued by the Ministry of Education, environmental studies should be part of compulsory education in Iceland. Environmental studies are usually integrated into other courses, most often in the natural sciences. There are no specific provisions for the teaching of climate change in this connection, however. The Ministry for the Environment has made some effort to support the publication of suitable material for environmental education in schools. In 1994 the Ministry, in co-operation with the Environment and Food Agency, published a booklet on the subjects of ozone depletion and climate change, which was distributed to most pupils 14-16 years old in Iceland, as well as to other target groups. The booklet was distributed in 20,000 copies, or one for every 13 persons in the country. Another booklet on these issues is due to be published in 1997. As for the gymnasium level (16-20 years old students), there are no official provisions on environmental education. Some schools, however, have taken up courses in environmental issues, and a couple now offer environmental studies as a distinct course of study. Books and other material in Icelandic on environmental studies for this age group have recently become available. At university level, environmental affairs is not offered as a separate course of study, but some departments have begun to offer non-compulsory courses on that subject, including engineering, law and philosophy.

As for educating the general public, the Ministry for the Environment has attempted to provide information on climate change through publishing reports and pamphlets, and through the media. A report on climate change in Icelandic was published in 1992, identical to a report sent to the FCCC. Two general reports on the state of the environment have addressed climate change in the context of Iceland's situation and policies, and this subject is to be highlighted in the next state of the environment report, due to be published in early 1997. A pamphlet published and widely distributed in 1996, in co-operation with the Women's Organization of Iceland, featured, *inter alia*, information on how the general public could assist in combating climate change. The Ministry has also addressed climate change and Iceland's policy in that context, in press releases and the Ministry's newsletter, which is published every two months in printed form and on the World Wide Web.

The Ministry has made some effort to educate key players and interest groups with regard to implementing the UNFCCC. In 1996, the Ministry held a half-day seminar on the UNFCCC and Iceland's policy for representatives of ministries, local governments, industry, fisheries, NGOs etc., which was well attended. The Ministry also sponsored a two-day seminar on the carbon budget of Iceland, featuring scientific and technical lectures on natural and man-made sources and sinks for carbon in Iceland.

The interest of the media in climate change and the UNFCCC has increased markedly in the last year or two, not least in connection with plans for an increase in energy-intensive industry and in reforestation, and the possible effects of these plans on Iceland's goal to stabilise emissions of carbon dioxide and other greenhouse gases.

Public awareness in Iceland about the issue of climate change and the greenhouse effect was last measured in a poll conducted at the request of the Ministry for the Environment in 1993. Almost 56% of respondents claimed to either know what the greenhouse effect was or to have "some idea" about that, while over 44% said they did not know what the greenhouse effect was. It seems likely that the share of those aware of climate change in Iceland has increased since that poll was conducted, as most of the education efforts mentioned above have taken place after that poll, and media coverage of the issue has increased significantly since then.

9. National circumstances

9.1 LOCATION AND GEOGRAPHY

Iceland is the second largest island in Europe, 103,000 km² in area. Its northernmost tip just touches the Arctic Circle. Iceland is a volcanic country situated on top of the Atlantic ridge, with many active volcanoes and extensive geothermal resources. Mean elevation is 500 m above sea level and the highest mountain, Öraefajökull, is 2119 m. Only one-fourth of the country lies below the 200 m elevation line. The landscape is characterised by mountains and glaciers, valleys and a coastline intersected by fjords and inlets, with relatively little lowland area except along the south coast. Located at the junction of warm and cold ocean and atmospheric currents, the biosphere is extremely sensitive to any change in global meteorological and oceanographic systems.

Some 28.5 thousand km² (28%) of the country has extensive or fairly extensive vegetation cover, about two-thirds of it dryland vegetation and one-third wetlands. The remnants of former forests cover less than one thousand km², or about 1% of the country. Some 25 thousand km² of land are considered arable (24%), while only about 1400 km² are under cultivation.

Iceland is surrounded by a 758 thousand km² exclusive economic zone, which supports a rich variety of marine life due to the warming effects of the Gulf Stream and the convergence of warm Atlantic ocean currents with cold seas moving southward from the Arctic Ocean.

9.2. CLIMATE

Iceland has a cold temperate oceanic climate, with relatively mild winters and cool summers. The mean temperature is considerably higher than might be expected at this latitude. In lowland areas along the southern coast, mean January temperature is around 0°C but around -2°C on the northern coast. Areas further inland are somewhat colder. Mean July temperature in most lowland areas is around 10°C, but around 8°C along the northern and eastern coasts. Winds are considerable and precipitation frequent. Mean precipitation ranges from 400 to 4000 mm annually. The annual average in Reykjavík is 805 mm. Because of the low mean temperature interior heating is practically a necessity all year round. Still, emissions of greenhouse gases due to space heating are very low due to the fact that 85% of buildings have geothermal heating, and most of the

remaining one are heated by hydropower-generated electricity. Emissions of carbon dioxide due to space heating in 1990 amounted to less than 3% of the total released in the country and emissions due to thermal energy production less than 4%.

9.3. NATURAL RESOURCES

There are no important minerals found in Iceland and the geographical location and harsh climate makes crop production difficult. Livestock raising is the basis of agriculture. Clean sources of energy (geothermal and hydroelectric) are plentiful and the fishing banks surrounding Iceland are rich. Finally, Iceland's unique nature and landscape can be counted as a natural resource, as 90% of tourists cite the natural surroundings as one of or the prime reason for visiting the country.

The technically harnessable hydropower potential of Icelandic rivers has been estimated at 64 terawatt-hours (TWh) annually, of which 30 TWh could be economically developed. The geothermal potential is considered to be around 200 TWh annually for 100 years and some 20 TWh of electricity could be produced annually using present technology. Less than one-seventh of the hydropower potential which is considered feasible for development has already been developed and only 1% of the geothermal potential.

A wide variety of fish stocks are found in the waters surrounding Iceland, and over 270 different species have been identified within the country's exclusive economic zone. Some 150 of them spawn in the region. These ocean resources are extensively utilised and the total catch in Icelandic waters in 1996 was approximately 2000 thousand tons. This large-scale pursuit results in substantial emissions of greenhouse gases due to the oil consumption of the fishing fleet. About one-third of the total emissions of carbon dioxide in Iceland in 1995 was released by the fishing fleet.

9.4. SOCIETY

The population of Iceland is about 270 thousand. Settlement is primarily along the coast. About 57% of the nation lives in the capital, Reykjavík, and the immediate vicinity. Outside of this area settlement is sparse, with less than one inhabitant per square kilometre. In 1995 emissions of carbon dioxide were estimated to be around 8.5 tons of CO₂ per inhabitant. The sparse settlement of the country results in relatively high emissions of greenhouse gases in Iceland due to transport. Some 64% of total emissions

of carbon dioxide in Iceland in 1990 were from transport (air transport, coastal shipping and road transport).

The living conditions and economic situation in Iceland is comparable to that of other western countries. The general educational level of the population is high and the distribution of wealth and incomes is relatively equal. The standard of public health is high. Life expectancy at birth is among the highest in the world, and infant mortality about the lowest.

9.5. GOVERNMENT

The government in Iceland is a representative parliamentary democracy. The Parliament (*Althingi*) prepares, debates and adopts legislation. The executive branch is divided among 13 ministries. The cabinet ministers exercise executive power in their own ministries on behalf of the government to whom they are responsible. A minister has the power to issue regulations on specific matters on the basis of applicable laws adopted by the *Althingi*. A minister also has control of the public institutions under his jurisdiction on the basis of the relevant laws and regulations. The country is divided into 26 administrative districts (*sýslur*).

At the local level the basic unit is the local authority, which have been slightly reduced in number recently through unification actions, and number at present 171. The local authorities have their own sources of revenue and budgets and are responsible for certain affairs in their own region. Local authorities are responsible for various areas which are important with regard to emissions of greenhouse gases, for example, concerning the planning and operation of public transportation, part of educational affairs and regional planning.

The Ministry for the Environment plays a key role in shaping the NCCAP. Other Ministries which have also made a substantial contribution to policy formation and the implementation of policies and measures include the Ministries of Industry, Transport and Communications, Fisheries, Agriculture and Finance. Public institutions and public enterprises, operating under the auspices of these Ministries which participated directly or indirectly in preparing the NCCAP include: the Environment and Food Agency; Icelandic Meteorological Office; National Energy Authority; National Power Company; Soil Conservation Service; Iceland Forestry Service; Marine Research Institute; and Agricultural Research Institute.

9.6. INDUSTRIES AND ECONOMY

Agriculture, fisheries and energy production have accounted for about one-quarter of GDP for the last two decades. The fisheries sector is the central pillar of the Icelandic economy. Catch quotas have been imposed on vessels pursuing fishing stocks within the exclusive economic zone and as a result fishing outside the EEZ has increased in recent years. The fisheries sector accounts for 15% of gross domestic production and for some 75% of goods exports.

Agriculture in Iceland satisfies domestic demand for dairy and meat products and is thus important to the economy despite the fact that its share of national production is only 3%. Most of the grasslands are used for fodder production or as grazing for sheep, cows and horses, which comprise the major portion of Icelandic livestock. Horticulture and crop production is limited, although considerable quantities of potatoes, turnips, carrots and cabbage are produced. Geothermal water is widely utilised in cultivation of flowers and vegetables in greenhouses.

The travel industry has grown rapidly in recent years and in 1996 it accounted for almost one-fifth of Iceland's foreign currency earnings.

The Icelandic economy is highly dependent upon foreign trade and is structurally similar to that of other western countries. Most Icelanders work in commerce and service industries, while manpower in fisheries and agriculture is steadily decreasing. Per capita production capacity is comparable to that of industrialised nations and the lifestyle is similar. Annual mean growth was 4.6% during the years 1970-90. In early 1990's was a period of contraction in growth and stagnation in domestic production, mainly due to reduced total allowable catch of cod. The economy has since rebounded and is now in its fourth year of growth.

9.7. ENERGY PRODUCTION

Per capita energy consumption in Iceland is among the highest in the world. The total domestic energy consumption in 1993 was approximately 89 petajoules (PJ) or the equivalent of 2119 thousand tons of oil, which corresponds to about 341 gigajoules (GJ) per capita. Consumption of energy from primary sources in Europe in 1991 was about 140 GJ per capita and 320 GJ per capita in North America. The total energy consumption in Iceland includes geothermal heat, which is utilised both for space heating and the production of electricity. Fuel purchased by Icelandic vessels and aircraft abroad is not included (9 PJ). Some 65% of this energy is obtained from environmentally clean domestic energy sources. The comparable figure for OECD countries is 2-3%.

In 1990 Icelanders obtained 93.5% of their electricity from hydropower stations and 6.4% from thermal power plants. Approximately one-half of the electricity is used by power intensive industry.

Iceland's unique situation is reflected in its fuel consumption. The size and pursuit capacity of the fishing fleet together with transportation requirements of sparse settlement explain most of the fuel consumption. Approximately 85% of oil consumption is for fisheries and transportation, where domestic energy sources cannot be utilised, mostly for technical reasons.

9.8. EMISSIONS REDUCTIONS PRIOR TO 1990

From 1970 to 1987 substantial efforts were made in Iceland to establish geothermal heating distribution centres throughout the country in order to reduce oil consumption for space heating purposes. Hydroelectric transmission systems were also extended to reduce oil-powered electricity production. This resulted in a huge reduction in the emission of carbon dioxide (CO₂) from stationary power production in Iceland: from 590 thousand tons in 1973 to only 145 thousand tons in 1990, despite a considerable increase in total energy consumption. This dramatic reduction in emissions, 445 thousand tons, accounts for 20% of the total emissions in the country in 1990.

As mentioned previously, fisheries and industry connected with fisheries are the most important economic sectors in Iceland and the main pillars of the Icelandic economy. Despite the increase in oil consumption up until 1990, much was done to prevent this increase. The fishing fleet was renewed extensively and the technical equipment aboard is among the best in the world. Oil consumption indicators were installed in most trawlers to facilitate fuel conservation and increased emphasis was placed on improving both hull and propeller design of vessels to reduce resistance and improve fuel utilisation.

A system of individual transferable catch quotas was introduced in 1984, in order to prevent overfishing. The quota system has resulted in increased cost-effectiveness in fisheries and has encouraged fuel conservation in fishing vessels.

The aircraft of Icelandic airlines, in both domestic and international services, have been extensively renewed in recent years. This has led to a substantial reduction in their fuel consumption, amounting to almost 40%.

The greater part of the reduction occurred prior to 1990, and extensive additional savings are considered unlikely during the remaining years of this century.

9.9. FUTURE PROSPECTS

Iceland's GDP is expected to grow about 3,5% in 1997 and 3,5-4% a year until 2000, according to recent estimates by the National Economic Institute.

The possibilities for reducing emissions of greenhouse gases in Iceland have to be seen as relatively limited. Renewable energy sources have almost completely replaced oil and coal in stationary power production. Reductions in emissions from mobile sources of greenhouse gases (vehicles, ocean vessels and aircraft) will prove more difficult to obtain, especially with regard to the fishing fleet. Fisheries are of such vital importance for the national economy that it is very difficult to apply restrictions on emissions from fishing vessels. Emissions from the fishing fleet could be reduced, however as a result of downsizing of the fleet and further efficiency gains from improvements of the current fisheries management system. Developments with regard to fisheries outside Iceland's EEZ in the next years are difficult to predict, they could lead either to an increase or decrease of greenhouse gas emissions.

9.10. SPECIAL CIRCUMSTANCES

The unique position of Iceland is characterised by the bountiful supply of environmentally clean energy sources and by the importance of transportation and fisheries for the national economy. Concerted attempts have been made over the last two decades to increase consumption of energy from renewable domestic sources and by so doing reduce the use of fossil fuels. Stationary energy consumption has benefited from these developments, but it has been more difficult to deal with mobile consumption, i.e. in fisheries and transportation.

9.10.1. Industry and energy production

Unlike most OECD countries, economic development in Iceland has been supported to a large extent by the utilisation of energy sources which are both renewable and pollute less than fossil fuels. Highly successful domestic power developments over the past 20 years have substantially reduced atmospheric pollutants and accelerated the decrease in dependency on imported energy sources. The greatest portion of this reduction occurred

prior to 1990. These extensive measures implemented in Iceland prior to 1990 reduce the country's possibility of fulfilling its obligations in the Framework Convention in their current form.

Continuing development of the hydroelectric and geothermal energy potential of the country is proposed, for increasing use industry, in power intensive industry, or even for export via submarine cable. Should plans for additional heavy industrial development, such as proposals for the construction of a new 200 thousand ton aluminium smelter, become a reality, for instance, a substantial increase in the emissions of greenhouse gases can be expected from industrial activities in Iceland. It should be noted that this carbon dioxide comes from the industrial process, not from fuel use.

The position of the national government is that the success which was achieved in Iceland prior to 1990 in reducing the use of fossil fuels and in limiting emissions from stationary sources should be taken into account by international authorities, and recognition made of the limited possibilities at present for reducing emissions of carbon dioxide in the country from mobile sources. Furthermore, the government is of the opinion that it would be in contradiction to the real objectives of the Framework Convention should measures to restrict emissions of greenhouse gases prevent the utilisation of the environmentally clean, practically emission-free energy resources in Iceland. In this connection it should be kept in mind that industrial development in Iceland involves only a fraction of the emissions of greenhouse gases produced by comparable industry in other locations where the energy would be provided by fossil fuels.

9.10.2. Fisheries

Few nations are as dependent upon the prosperity of a single industrial sector as the Icelanders are where fisheries are concerned, as this sector alone brings in over 70% of the country's goods export income. Per capita fishing catch was well over 7 tons in 1988, approximately 185 times the average for OECD countries and more than 16 times the per capita catch of Norway, for instance.

Because of the extreme dependence of the national economy on the production and export of marine products, the authorities have introduced special measures to protect this vital resource. The extension of the limit of fisheries jurisdiction to 200 miles in 1975 brought the nation full jurisdiction over the fishing banks surrounding the country and opened the way for measures to encourage rational exploitation of marine resources.

Fisheries management has been in force for 16 years, to begin with in the form of limits on the number of pursuit days, then with a quota system whereby transferable catch quotas are allocated to individual vessels. Additional technical measures are also applied, including rules on minimum mesh size of nets and temporary closures of specific ocean areas.

The renewal of the fishing fleet has progressed rapidly over the past decade and its pursuit capacity exceeds that which the fishing stocks of the Icelandic banks can sustain. It will require some time to adapt the fishing fleet to catch levels sustainable by the fishing stocks, but efforts aim at this objective, and the management system in use fulfils the requirements necessary to reduce the capacity of the fleet without reducing catches or the amount of fish landed. The fuel consumption of the fishing fleet has, however, increased due to increasing trawling, full processing of catches aboard freezer vessels, larger trawls, increasing fishing efforts on distant banks and an increase in the number of small boats. It is expected that the fleet will be reduced to match the sustainable catch levels of the fishing stocks in coming years, although increased high-sea fishing could affect these developments, at least in the short term.

9.10.3. Transportation

Transportation is a prime factor in determining regional development in Iceland. Improvements to the domestic transportation system are a precondition for economic growth and social development and can make the deciding difference for settlement in many districts of the country. The rugged landscape and harsh climate of the country make efficient transportation throughout the country difficult and the small size of the population and sparse settlement limits the scope for solutions in public passenger and goods transportation. Private automobiles are considered necessary and it is clear that this situation will continue in the future. Domestic transport of goods is primarily carried out by ships and transport vehicles, while buses and small aircraft look after passenger transport. Population growth and an increase in the numbers of foreign tourists is likely to result in increasing emissions from transportation in the coming years.