UMHVERFISRÁÐUNEYTIÐ

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ICELAND

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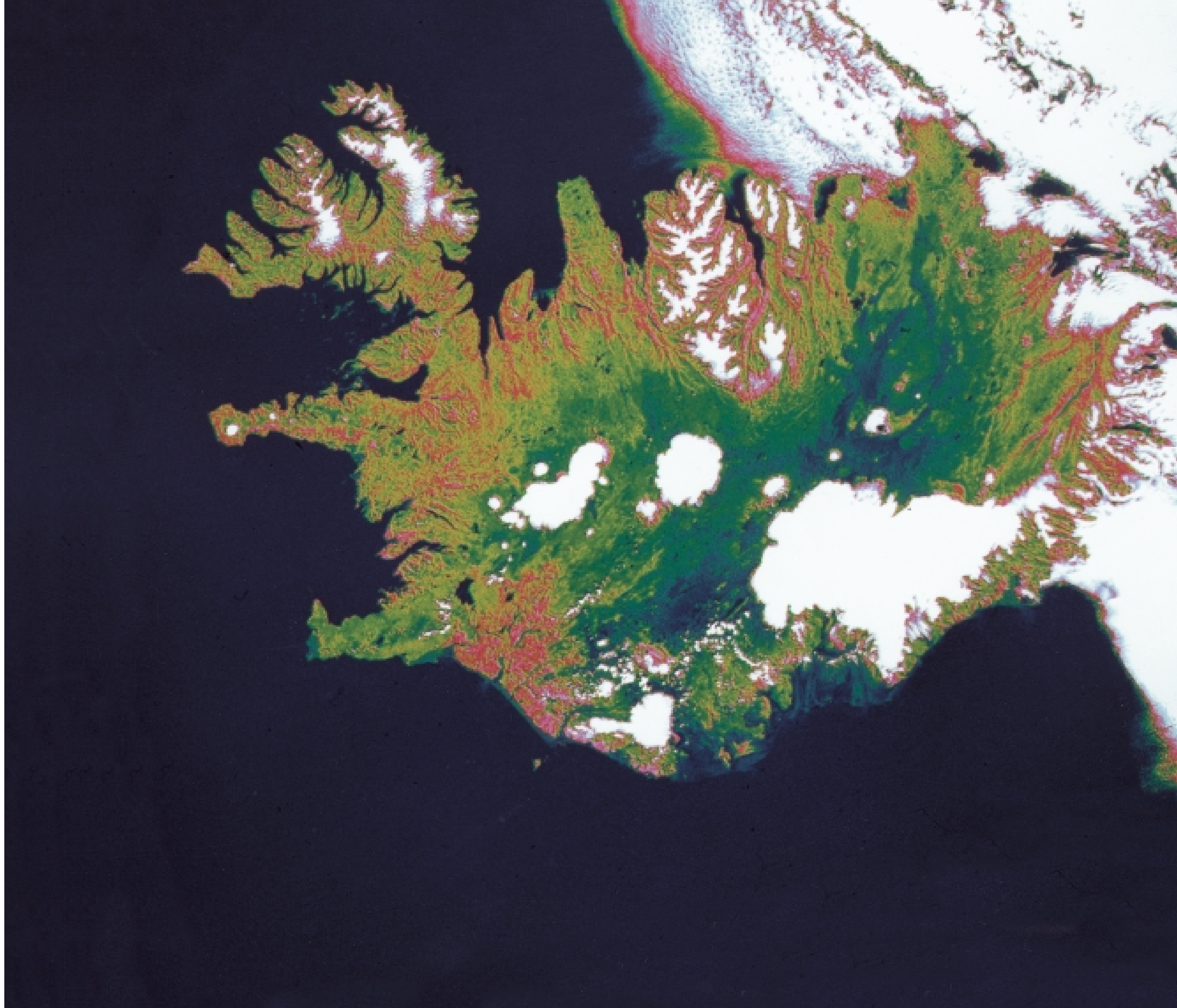

Iceland's Third National Communication under the United Nations Framework Convention on Climate Change

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Executive summary

National circumstances

Iceland is a parliamentary democracy, and Althingi (the Parliament) has 63 members. Most executive power rests with the Government, which is headed by a prime minister. The population of Iceland is 286,000, and settlement is primarily along the coast. About 62% of the nation lives in the capital, Reykjavik, and surrounding areas.

Iceland, which is the second largest island in Europe after Great Britain, has a total area of 103,000 km^2. Glaciers are a distinctive feature of the landscape, and rivers and lakes are numerous. Freshwater supplies are abundant. Soil erosion and desertification is a problem, and more than half of the country's vegetation cover is estimated to have disappeared due to erosion since the settlement period. The country is situated just south of the Arctic Circle but the mean temperature is considerably higher than might be expected at this latitude. Relatively warm winters and cool summers characterize the climate.

Iceland is an industrialized country with a high living standard. The country consistently ranks among the top 10 states in the UNDP Human Development Index. The service sector dominates the economy with a 62.5% share of GDP in 2001, but generation of foreign revenue is highly dependent on natural resources. The fishing industry relies on marine resources, the aluminum and ferrosilicon industry on hydropower and geothermal energy and the tourism industry on nature and natural beauty. In 2001 fishing and fish processing accounted for 40% of total export; the share of tourism was 12.4%, and aluminum and ferrosilicon production accounted for 14.7% of exports. The use of energy is high per capita, but the proportion of domestic renewable energy in the total energy budget is 70%, which is a much larger share than in most other countries. The use of fossil fuels for stationary energy is almost non-existent but fossil fuels are used for transport on land, sea and in air.

Three features stand out that make the Icelandic greenhouse gas emissions profile unusual. First is the high proportion of renewable energy of the total amount of energy used. Second, emissions from the fishing fleet are about one-fourth of total emissions. The third distinctive feature is the fact that individual sources of industrial process emissions have a significant proportional impact on emissions at the national level.

Greenhouse gas inventory information

The Environment and Food Agency compiles and maintains the greenhouse gas inventory. In 1990, the total emissions of the six greenhouse gases covered by the Kyoto Protocol were 2,799 Gg of CO_2 equivalents. In 2000, total emissions were 2,990 Gg, excluding LUCF and emissions falling under Decision 14/CP.7 on the Impact of Single Projects on Emissions in the Commitment Period. This means that total greenhouse gas emissions in Iceland were about 7% above 1990 level in 2000. Over the same period, carbon dioxide emissions increased by 18%; methane emissions fell by 6%; and nitrous oxide emissions fell by 4.5%. Removals of CO_2 from direct human-induced revegetation and reforestation since 1990 are estimated to be 130 Gg in 2000.

Industry, transport and fisheries are the three main sources of GHG emissions, but other sources include agriculture and waste.

Policies and measures

Iceland is a party of the UNFCCC, and Iceland ratified the Kyoto Protocol on May 23, 2002. Earlier that year, the government adopted a new climate change policy that was formulated with close cooperation between several ministries. The aim of the policy is to curb emissions of greenhouse gases so that they will not exceed the limits of Iceland's obligations under the Kyoto Protocol. A second objective is to increase the level of carbon sequestration resulting from reforestation and revegetation programs. The policy will be reviewed in the year 2005.

Key issues in the climate change policy include changes in taxation creating incentives to use small diesel cars and a consultation process with aluminum smelters to ensure that PFC emissions from the aluminum industry will be minimized. Also, the fishing industry will be encouraged to increase energy efficiency, and there will be further reduction of waste disposals. Emphasis will be placed on research and development as well as public education.

Projections and the total effect of measures

The Ministry for the Environment established a working group whose role was to develop projections for GHG emissions until 2020. Two scenarios are provided in the projections. The first scenario assumes no additions to energy-intensive industries other than those enlargements already agreed upon in October 2001 (Scenario 1). The second scenario is based on the assumption that a new aluminum smelter will be built in Reydarfjordur, and that both of the existing aluminum plants will be enlarged (Scenario 2). Expected effects of the key measures of the climate change policy are integrated into the projections, and sensitivity analysis was conducted to estimate the emissions if these expected effects do not materialize.

If emissions are in accord with projections, Iceland will be able to meet its obligations for the first commitment period of the Kyoto Protocol, even with the planned expansion in energy-intensive industries (Scenario 2). However, this assumes that measures included in the Icelandic climate change policy will be successful. Should those assumptions not hold, Iceland could exceed its assigned amount for Scenario 2. This does not take into account carbon sequestration. If plans for increased carbon sequestration are fully implemented, this will help Iceland to stay within its assigned amount.

Impacts and adaptation measures

It is uncertain what impact climate change will have in Iceland. Natural fluctuations in temperature are greater in the North Atlantic than in most other oceanic areas, and the natural fluctuations between decades are substantially more than estimated temperature increases for the next decades due to buildup of greenhouse gases. The impact of the temperature increase due to the greenhouse effect will therefore greatly differ depending on the direction of the short-term natural fluctuation.

An increase in temperature could have some positive effects on marine resources and fish stocks. However, more insects could increase risks of disease in both plants and humans, which would be a negative impact. A worst-case scenario for Iceland would be if climate change would lead to major disruptions in ocean circulation that would have negative impact on fish stocks. The impact climate change could have on human health is likely to be less in Iceland than in many other countries. An increase in temperature should not create discomfort for the population since the current climate is rather cool, but there could be indirect impacts on human health.

Financial assistance and technology transfer

The Icelandic government has been increasing their Official Development Assistance (ODA) in recent years, and in 2002 ODA had reached 0.15% of GDP. Sustainability is a central theme in Icelandic development cooperation. Especially noteworthy in relation to climate change is the UN University's Geothermal Training Program in Iceland.

In addition to ODA, the Icelandic government also provides financial assistance to environmentally related projects in other countries through their participation in various international agreements. Iceland has also made voluntary contributation to the UNFCCC and to the IPCC.

Research and systematic observation

Funds allocated to research and development reached 2.3% of GDP in the year 2000. Environmental change is recognized as an important area in research, and Icelandic scientists are involved in a number of climate-related research projects.

The Icelandic Meteorological Office (IMO) is involved in climate system studies and does some work on modeling and prediction. Paleoclimatological work has mainly taken place within the University of Iceland. Icelandic research institutions are involved in several projects that study the impact of future global climate changes. Two international projects can be mentioned: the Arctic Climate Impact Assessment (ACIA) organized by the Arctic Council, and the Climate, Water and Energy (CWE) program, which the Hydrological Institutes of the Nordic countries are responsible for. Academic research on how climate change could affect socio-economic factors has not been substantial, but some research projects deal with technical mitigation, mainly methods to increase carbon sequestration or technology that make renewable energy a more attractive option as an alternative to fossil fuels.

The two institutions most important in relation to observation of climate change are the IMO and the Marine Research Institute (MRI). The IMO monitors and archives data from close to 200 stations. The MRI maintains a monitoring net of about 100 hydrobiological stations in 12 standard sections (transects) around Iceland.

Education, training and public awareness

Environmental education in schools has increased in the past decade. The University of Iceland now offers a Master's degree in environmental studies, where climate change is an integral subject. Many uppersecondary schools offer courses in the same, or place special emphasis on environmental issues in their curriculum. Studies of environmental issues in primary schools are included in many subjects, especially natural sciences.

There has not been a public information campaign focusing specifically on climate change. However, in the government policy on climate change emphasis is placed on education and a special effort in disseminating information to the public. This effort will be tailored toward possible ways of reducing emissions of GHG from the home due to waste and from transport. It should be noted that since renewable energy is used for both space heating and electrical production, public information campaigns aimed at energy efficiency in the home are not relevant for the purpose of reducing GHG emissions in Iceland.

1. National circumstances

1.1 Government structure

Iceland has a written constitution and is a parliamentary democracy. A president is elected by direct popular vote for a term of four years, with no term limit. Most executive power, however, rests with the Government, which must have majority support of Althingi, the Parliament. Althingi has 63 members, and parliamentary elections are held every four years. The government is headed by a prime minister, and the executive branch is currently divided among 12 ministers. Judicial power lies with the Supreme Court and the district courts, and the judiciary is independent.

The country is divided into 122 municipalities, and local authorities are elected every four years. The largest municipality has around 112,000 inhabitants, but the smallest municipality has only 31 inhabitants. In 1990 the number of municipalities was 204, but in the last decade an attempt has been made to unite small municipalities, and this has resulted in fewer, but more populous, municipalities. This trend is likely to continue since the tasks of local authorities have grown increasingly complex in recent years. The local authorities have their own sources of revenue and budgets and are responsible for various areas that are important with regard to greenhouse gas emissions. This includes physical planning, granting industry licenses and the design and operation of public transport. Municipalities also play an important role in education.

The Ministry for the Environment is responsible for the implementation of the UNFCCC and coordinated national climate change policymaking in close cooperation with the Ministries of Industry and Commerce, Transport and Communications, Fisheries, Finance, Foreign Affairs and the Prime Minister's Office. Several public institutions and public enterprises, operating under the auspices of these ministries, also participated directly or indirectly in preparing the national implementation policy.

1.2 Population

The population of Iceland is 286,000[1]. The population is projected to grow by about 12% over the next two decades, reaching 312,000 in 2020. Settlement is primarily along the coast. About 62% of the nation lives in the capital, Reykjavik, and surrounding areas. In 1990 this same ratio was 57%, demonstrating higher population growth in the capital area than in smaller communities and rural areas. The population density is three inhabitants per square kilometer. Given the large percentage of the population living in and around the capital, the rest of the country is even more sparsely populated, with less than one inhabitant per square km. The dispersed settlement of the country results in relatively high emissions of greenhouse gases due to transport. Emissions from space heating are, however, much lower than what might be expected, keeping in mind the cold temperate climate. This is because the majority of the population relies on renewable energy sources for district heating, as will be explained in more detail in the energy chapter.

1.3 Geography

Iceland is the second largest island in Europe after Great Britain, and has a total area of 103,000 km^2. Geologically Iceland is a very young country, and its formation is still going on. It consists almost exclusively of volcanic rock, lava and sediment and has volcanic and seismic activity. The interior consists of mountains and high plateaus. The average height above sea level is 500 meters; the highest point is 2119 meters. Only one-fourth of the country is under 200 meters elevation.

1 In December 2001 the exact number of the population was 286,250 according to Statistics Iceland (the national statistical bureau of Iceland).

Glaciers are a distinctive feature of Iceland, covering about 11% of the total land area. The largest glacier is Vatnajökull in Southeast Iceland with an area of 8300 km^2. Regular monitoring has shown that all glaciers in Iceland are receding.

Rivers and lakes are numerous in Iceland, covering about 6% of the total land area. Freshwater supplies are abundant, but the rivers flowing from the highlands to the sea also provide major potential for hydropower development. Geothermal energy is another domestic source of energy.

Soil erosion and desertification is a problem in Iceland, and more than half of the country's vegetation cover is estimated to have disappeared because of erosion since the settlement period. This is particularly due to clearing of woodlands and overgrazing, which have accelerated erosion of the sensitive volcanic soil. Remnants of the former woodlands now cover less than 1,200 km^2, or only about 1% of the total surface area. Around 60% of the vegetation cover is dry land vegetation and wetlands. Arable and permanent cropland amounts to approximately 1,300 km^2 (1%). Systematic revegetation began more than a century ago with the establishment of the Soil Conservation Service of Iceland, which is a governmental agency. Reforestation projects have also been numerous in the last decades, and especially noteworthy is the active participation of the public in both soil conservation projects and reforestation projects.

A geographic description is not complete without mentioning the diversity of marine resources in the country's 758,000-km^2 exclusive economic zone. The abundance of marine plants and animals results from the influence of the Gulf Stream and the mixing of the warmer waters of the Atlantic with cold Arctic waters. Approximately 270 fish species have been found within the Icelandic 200-mile exclusive economic zone; about 150 of these are known to spawn in the area.

1.4 Climate

Iceland is situated just south of the Arctic Circle. The mean temperature is considerably higher than might be expected at this latitude. Relatively warm winters and cool summers characterize Iceland's oceanic climate. The average monthly temperature varies from -3 to +3 °C in January and from +8 to +15 °C in July. Storms and rain are frequent, with annual precipitation ranging from 400 to 4000 mm on average annually, depending on location. The annual average in Reykjavik is 805 mm.

The mild climate stems from the Gulf Stream and attendant warm ocean currents from the Gulf of Mexico. The weather is also affected by polar currents from East Greenland that travel southeast towards the coastline of the northern and eastern part of Iceland.

The amount of daylight varies greatly between the seasons. For two to three months in the summer there is almost continuous daylight; early spring and late autumn enjoy long twilight, but from November until the end of January, the daylight is limited to only three or four hours.

1.5 Economy

Iceland is an industrialized country with a high living standard. The GDP per capita in 2001 was USD 26,000, based on current exchange rates, and 30,400, based on purchasing power parities. Iceland consistently ranks among the top 10 states in the UNDP Human Development Index. Economic growth has been high in recent years, averaging 2.7% for the last 10 years.

The service sector dominates the economy with a 62.5% share of GDP in 2001. Industry (including manufacturing and construction), accounted for 23.6%; the share of fisheries was 12.5%, and agriculture contributed 1.4% to GDP. Iceland depends heavily on its natural resources to generate foreign revenue. The fishing industry relies on marine resources, the aluminum and ferrosilicon industry on hydropower and geothermal energy and the tourism industry on nature and natural beauty. Fishing and fish processing accounted for 40% of total exports; the share of tourism was 12,4%, and aluminum and ferrosilicon production accounted for 14.7% of exports in 2001.

1.6 Energy

The energy sector is unique in many ways. In 2000 the per capita energy use was close to 500 MJ, which is high compared with other industrial countries, but the proportion of domestic renewable energy in the total energy budget is 70%, which is a much larger share than in most other countries.
A cool climate and sparse population calls for high energy use for heating and transport. Also, key

Table 1.1

Relative energy use for district heating and production of electricity

	District Heating (%)	*Production of Electricity (%)*
Geothermal energy	89.0	17.2
Hydropower	9.5	82.8
Fossil fuels	1.5	<0.1
Total	100	100

Large-scale industry uses about 64% of the total electricity produced, but the remaining 36% is for public use.

industries, such as fisheries and aluminum production, are energy-intensive. The increase in the use of electricity in the last decade is largely due to an expansion of energy-intensive industry.

Iceland has ample reserves of renewable energy in the form of hydro- and geothermal energy, and these energy sources are used for district heating and production of electricity. As table 1.1 demonstrates, the use of fossil fuels for stationary energy is almost non-existent. Fossil fuel is used for transport on land, sea and air.

In the year 2000 geothermal energy provided about 53% of the total primary energy supply. The share of hydropower was 17%, oil 27%, and coal accounted for about 3% of total energy used. The share of geothermal energy has increased in recent years due to a rise in production of electricity using geothermal energy.

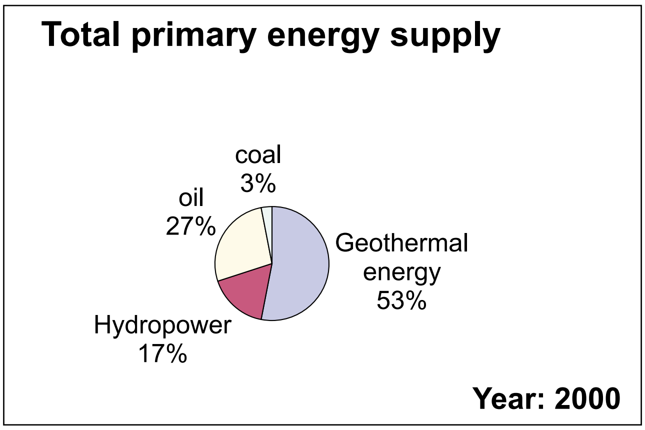

Figure 1.1: Total primary energy supply

Even though the share of domestic renewable energy has been steadily increasing in the last three decades, Iceland still uses only a part of its potential energy sources.

1.7 Transport

In 2000 the transportation sector was responsible for about 30% of total GHG emissions in the country. As previously stated, Iceland is a sparsely populated country. Transport is therefore a major issue for regional development, but the small population also limits the options available. Mountainous landscape and harsh climate further complicate the situation, making the design of an efficient public transport system difficult. Most households consider it necessary to use private automobiles. Population growth and an increase in the number of foreign tourists are likely to lead to an increase in GHG emissions from the transport sector in the near term. The use of new energy carriers, such as hydrogen, if proven technically and economically feasible on a large scale, could reverse the longer-term trend.

1.8 Fisheries

Fisheries are the single most important sector in terms of international trade since fish and fish-related products account for about half of total export. This share was even larger in the past. The total catch of the fishing fleet in Icelandic fishing grounds in 2000 was 1.9 million tons. In spite of its small population, Iceland is the fifteenth largest fisheries nation in the world.

The fishing fleet relies on fossil fuels for energy and accounted for around 26% of total GHG emissions in the year 2000. The total catch is expected to increase slowly in coming years, but this will not necessarily lead to an increase in GHG emissions since new vessels are likely to be more energy-efficient than older ones. Fleet renewal could therefore make it possible to increase the catch without increasing energy use.

1.9 Industry

In 2001 industry accounted for 23.6% of GDP. The largest share, or almost 19%, is from manufactured products and construction. Aluminum and ferrosilicon production only accounted for 1.5% of GDP, but the numbers are very different when one looks at export value. The share of manufactured products in export value was around 21%, with large-scale industries (aluminum and ferrosilicon production) accounting for 62% of this share. Most industries rely on domestic sources of energy that are both renewable and pollute less than fossil fuels.

The use of fossil fuels for energy in manufacturing industries and construction accounted for 11% of total GHG emissions in 2000, but 21% came from industrial process emissions. The share of industry in total emissions therefore added up to 32%. This is exclusive of new, energy-intensive industries falling under the decision on impact of single projects on emissions that is explained in 1.13 (other circumstances).

1.10 Agriculture

Agriculture satisfies domestic demand for dairy and meat products and is thus important to the economy, despite the fact that its share of GNP is only about 2%. Most of the grassland is used for fodder production or as grazing land for sheep, cows and horses. Around 10% of total GHG emissions in 2000 came from agriculture. Methane from livestock explains the largest share of this emission.

1.11 Waste

Just less than 250,000 tons of waste was generated in 1999. Over 60% of that was disposed of in landfills; 30% was recycled for purposes other than energy production, and 7% was incinerated. Per capita waste has steadily increased in the last decade. Growing consumption seems to be the main explanation for this trend. The increase is greater among companies than households.

Waste can explain 2.2% of total GHG emissions in Iceland in the year 2000. Most of this emission is methane from landfills, but carbon dioxide emissions from incineration also contribute. Although the total amount of waste has been increasing, GHG emissions from the waste sector have declined due to more recycling and technological advances in the handling of waste.

1.12 Forestation

The vegetated land area in Iceland, especially woodland, has shrunk considerably since the time of settlement in 874. It is estimated that about 30% of the country was covered by woodland at the time of settlement, but woodland covers at present only about 1.4% of the total area. Thereof, planted forest accounts for about one-sixth of the woodland, but the rest is remnants of the original birch woodlands.

It is government policy to encourage reforestation projects. Regional projects have been established in all parts of the country, funding farmers and other landowners for this purpose.

1.13 Other circumstances

The greenhouse gas emissions profile of Iceland is in many regards unusual as will be described in more detail in Chapter 2. Three features stand out. First, emissions from the generation of electricity are essentially non-existent due to its generation from renewable non-emitting sources. Second, emissions from the fishing fleet are about one-fourth of total emissions. The third distinctive feature is that individual sources of industrial process emissions have a significant proportional impact on emissions at the national level. Most noticeable in this regard is abrupt increases in emissions from aluminum production associated with the expanded production capacity of this industry.

This last aspect of Iceland's emission profile made it difficult to set meaningful targets for Iceland during the Kyoto Protocol negotiations. This fact was acknowledged in Decision 1/CP.3 par. 5 (d), which established a process for considering the issue and taking appropriate action. This process was completed with Decision 14/CP.7 on the Impact of Single Projects on Emissions in the Commitment Period[2].

The problem associated with the significant proportional impact of single projects on emissions is fundamentally a problem of scale. In small economies, single projects can dominate the changes in emissions from year to year. When the impact of such projects becomes several times larger than the combined effects of available greenhouse gas abatement measures, it

2 Decision 14/CP.7 can be found in Appendix B

becomes very difficult for the party involved to adopt quantified emissions limitations.

It does not take a large source to strongly influence the total emissions from Iceland. A single aluminum plant can add more than 15% to the country's total GHG emissions. A plant of the same size would have negligible effect on emissions in most industrialized countries.

Decision 14/CP.7 sets a threshold for significant proportional impact of single projects at 5% of total carbon dioxide emissions of a party in 1990. Projects exceeding this threshold shall be reported separately and carbon dioxide emissions from them not included in national totals to the extent that they would cause the party to exceed its assigned amount. Iceland can therefore not transfer Assigned Amount Units to other Parties through international emissions trading. The total amount that can be reported separately under this decision is set at 1.6 million tons of carbon dioxide.

The scope of Decision 14/CP.7 is explicitly limited to small economies, defined as economies emitting less than 0.05% of total Annex I emissions in 1990. In addition to the criteria above, which relate to the fundamental problem of scale, additional criteria are included that relate to the nature of the project and the emission savings resulting from it. Only projects, where renewable energy is used, and where this use of renewable energy results in a reduction in green-house gas emissions per unit of production, will be eligible. The use of best environmental practice and best available technology is also required. These additional criteria and requirements do not rest on the original mandate from 1/CP.3 but provide the assurance that only projects contributing to the aims of the Kyoto Protocol will fall under the Decision.

It should be underlined that the decision only applies to carbon dioxide emissions from industrial processes. Other emissions, such as energy emissions or process emissions of other gases, such as PFCs, will not be affected. Decision 14/CP.7 is also limited to the first commitment period. It in effect neutralizes the impact of the increased use of renewable energy for energy-intensive industry, such as aluminum production. The use of renewable energy for this purpose reduces global emissions. Energy emissions dominate emissions from aluminum production in countries where fossil fuel energy sources are used to generate the electricity needed for the production. These emissions are avoided if renewable energy is used. Aluminum smelters using coal as the energy source produce approximately seven times more greenhouse gas emissions than smelters using hydropower or other renewable energy sources.

Paragraph 4 of Decision 14/CP.7 requests any Party intending to avail itself of the provisions of that decision to notify the Conference of the Parties, prior to its eighth session, of its intention. The Government of Iceland acceded to the Kyoto Protocol on May 23rd 2002 and with a letter, dated October 17th 2002[3], notified the Conference of the Parties of its intention to avail itself of the provisions of Decision 14/CP.7. Iceland made a statement to this same effect under agenda item 3 of the 17th session of the Subsidiary Body for Implementation in June 2002.

Decision 14/CP.7 further requests any Party with projects meeting the requirements specified in the Decision, to report emission factors, total process emissions from these projects, and an estimate of the emission savings resulting from the use of renewable energy in these projects in their annual inventory submissions. The secretariat is requested to compile information submitted by Parties in accordance with the above request, to provide comparisons with relevant emission factors reported by other Parties, and to report this information to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. Iceland has already initiated preparations for the implementation of these special reporting provisions. One part of these changes in reporting was reflected in the inventory report for the year 2000 submitted in April 2002. This inventory was presented as called for in Decision 14/CP.7. The projections presented in this National Communication are based on the same approach. This was done to facilitate evaluation of the emission trends in Iceland and the policies and measures being implemented or planned. It was considered more consistent with the intent of 14/CP.7 to use this approach to reporting also for the period leading up to the commitment period rather than to introduce an abrupt change in the reporting approach in 2008.

For the year 2000, two projects fell under the single project definition and were therefore reported separately[4]. CO_2 emissions from those projects are not included in total emissions in the inventory from 2000 and are also not included in the discussion about Iceland's emissions in this national commun-ication report unless they are mentioned specifically.

3 The text of this letter can be found in FCCC/CP/2002/MISC.2.
4 Emissions from an expansion of a ferroalloy plant of 150.6 Gg CO_2 and emissions from an expansion of an aluminum plant of 122.2 Gg CO_2.

2. Greenhouse gas inventory information

2.1 Key developments

- The total greenhouse gas emissions in Iceland were about 7% above 1990 levels in 2000. This is excluding CO_2 emissions from two projects falling under Decision 14/CP.7.

- Over the same period, carbon dioxide emissions increased by 18%; methane emission fell by 6%, and nitrous oxide emissions fell by 4.5%.

2.2 National system for preparing the greenhouse gas inventory in Iceland

The Environmental and Food Agency of Iceland compiles and maintains the greenhouse gas inventory. The National Energy Authority provides data on fuel sales; industry provides the data used to estimate industrial process emissions, and the State Road Administration collects data on the imports of solvent used in road surfacing. Data on waste management and wastewater treatment come from the Environment and Food Agency, and agricultural emissions are based on data from industry for artificial fertilizer production and livestock statistics from the Icelandic Association of Farmers and the Agricultural Research Institute's estimates of emission factors. In this Third National Communication, the results for the 1990-2000 period are presented in the form of summary tables in Appendix A.

Two changes were made in the inventory that Iceland submitted for 2000 that are different from earlier reporting. First, emissions from geothermal exploitation were not included, as was the case in earlier submissions. The UNFCCC reporting guidelines do not include guidance on the reporting of emission resulting from geothermal exploitation. In light of this and other factors, it was decided after substantial consideration to exclude geothermal exploitation from the inventory. The reason is primarily the high level of scientific uncertainty when it comes to estimating emissions resulting from geothermal exploitation. The second change is that the inventory for the year 2000 was based on Decision 14/CO.7, as is explained in further detail in 1.13 (Other circumstances). This entails that carbon dioxide emissions from industrial processes in single projects falling under Decision 14/CO.7 are not included in total emissions.

2.3 Greenhouse gas emissions inventory and trends

Carbon dioxide is the most important greenhouse gas, accounting for 74% of the direct global warming potential of emissions in 1990. Methane emissions contributed 10% and nitrous oxide emissions a further 4.5%. The remaining 11% were due to emissions of PFCs, but the emissions level of HFCs and SF6 was very low.
In 1990, the total emissions of the six greenhouse gases covered by the Kyoto Protocol were 2,799 Gg of CO_2 equivalents[5]. In 2000 total emissions were 2,990 Gg, excluding LUCF and emissions falling under 14/CO.7.

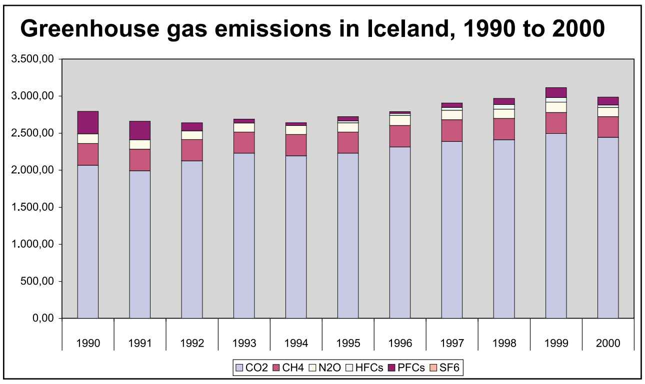

Figure 2.1: Greenhouse gas emissions in Iceland, 1990 to 2000

5 Greenhouse gas emissions are expressed throughout as Gg CO_2 equivalent, unless otherwise specified.

Industry, transport and fisheries are the three main sources of GHG emissions, but other sources include agriculture and waste. The following figure gives an overview of how emissions were divided between sectors in the year 2000.

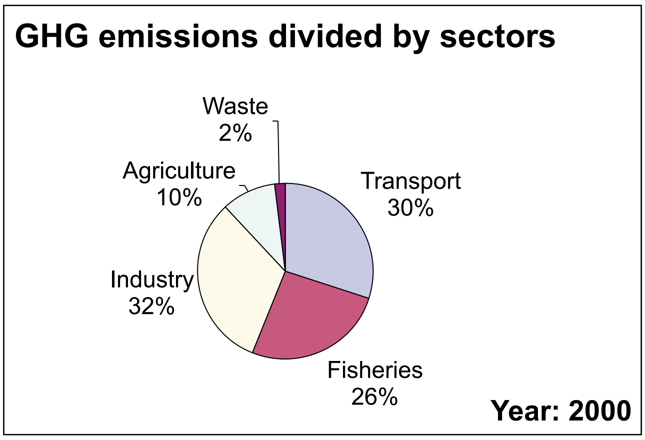

Figure 2.2: GHG emissions divided by sectors

2.4 Carbon dioxide emissions

Carbon dioxide accounted for 74% of the total GHG emissions in 1990, but in 2000 this share was 82%. CO_2 emissions were 2,064 Gg in 1990. They were 2,443 Gg in 2000, or 18% above 1990 levels. If removals of CO_2 from land-use change and forestry are taken into account, the net emission of CO_2 in 2000 would be 2,313 Gg, a 12% increase of CO_2 emissions, compared with 18% when LUCF is not included.

The burning of fossil fuels explains 79% of total CO_2 emissions in 1990; industrial processes were responsible for another 19%, but other sources included waste and agriculture. A closer look at emissions from the energy sector reveals that these emissions are mainly from mobile sources, namely transport and fishing vessels, as CO_2 emissions from stationary energy sources are minimal.

In the year 2000, the burning of fossil fuels remained the main source of CO_2 emissions, with 79% of the total, and industrial processes contributed 20%. Industry[6] (industrial processes and emissions from energy use in manufacturing industries and construction), transport and fisheries were still the three sectors contributing most to CO_2 emissions. The shares of the industry and transport sectors were 34% each, followed by the fisheries sector that was responsible for 30% of total CO_2 emissions in 2000.

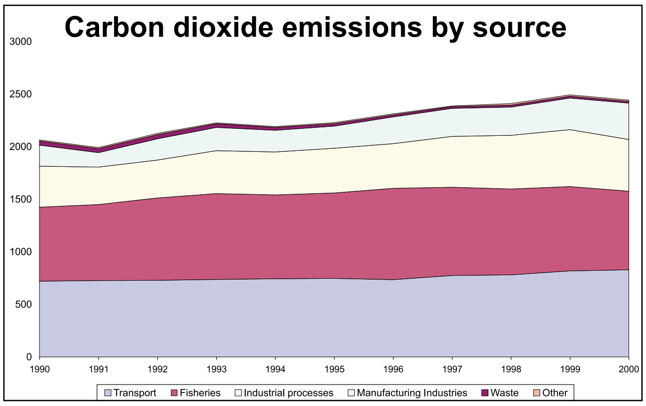

Figure 2.3: Carbon dioxide emissions by source

Removals of CO_2 from direct human-induced revegetation and reforestation since 1990 are estimated to be 130 Gg in 2000. Reforestation projects contributed 30% to this amount, but the rest is estimated to be removals because of revegetation.

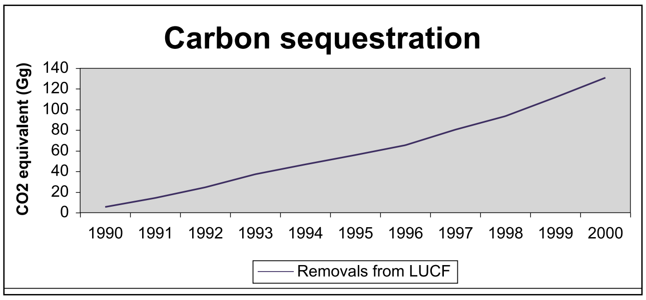

Figure 2.4: Land-use Change and Forestation (LUCF)

2.5 Methane emissions

Methane contributed around 10% of the total emissions of greenhouse gases in 1990, or 294 Gg CO_2 equivalent. The single largest contributor was agriculture with 82% (mostly enteric fermentation), but the remaining emissions mainly came from waste disposal on land.

In 2000 emissions of methane were 277 Gg CO_2 equivalent, or 6% lower than in 1990. The primary reason for this is a decrease in the number of livestock, especially sheep.

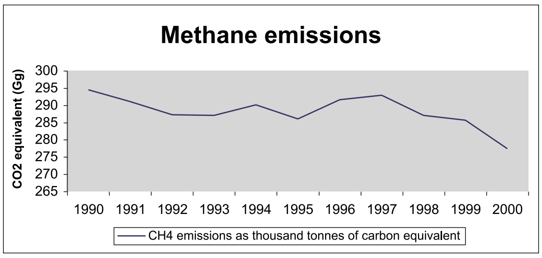

Figure 2.5: Methane emissions

6 Excluding CO2 emissions from industrial processes falling under Decision 14/CP.7)

2.6 Nitrous oxide emissions

Emissions of nitrous oxide in 1990 were 0.42 Gg or equal to 130 Gg CO_2 equivalent. Chemical fertilizer and animal wastes were estimated to contribute approximately 52% of those emissions, but there is a high degree of uncertainty. Fertilizer production was believed to contribute over 38%; the fishing fleet around 5%, and transportation on land another 5%.

In 2000 total emissions of nitrous oxide were 125 Gg CO_2 equivalent, a slight decrease compared with total N_2O emissions in 1990. Although there is not a large change in total emissions, the changes in emissions from individual sources were considerable. One noteworthy change occurred in transport on land, with a significantly higher contribution from vehicles, a result of the increased use of catalytic converters. There was also a decrease in N_2O emissions from industrial processes due to a reduction in the domestic production of fertilizers.

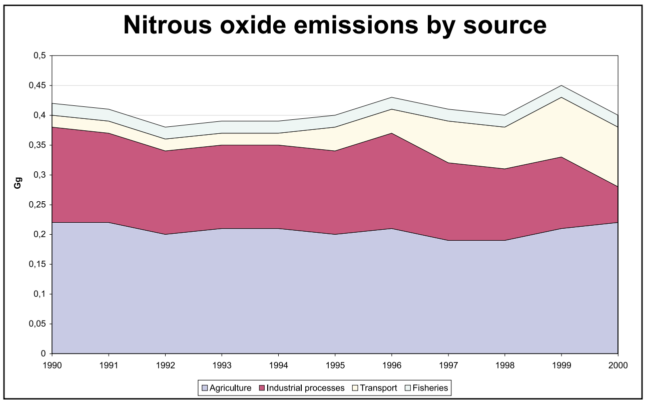

Figure 2.6: Nitrous oxide emissions by source

2.7 Fluorinated gases

Emissions of HFCs are based on figures from imports. Before 1992 there were no imports of HFCs, but since then, imports have increased rapidly in response to the phase-out of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) according to commitments under the Montreal Protocol. Emissions of HFCs from Iceland in 1995 were estimated to be 25 Gg CO_2 equivalent. The consumption of HFCs gradually increased from 1995 to 1998 when emissions were almost 64 Gg CO_2 equivalent, but in 2000 emissions had decreased again and were 32 Gg CO_2 equivalent.

Aluminum production is the only anthropogenic source of emissions of fluorocarbons: tetra fluorcarbon and hex fluorocarbons in Iceland. In 1990 total emissions of PFCs were estimated to be 304 Gg CO_2 equivalent, 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 the estimated emissions of PFCs had been reduced by as much as 80% from 1990 levels as a result of this measure. In 2000 the estimated emissions of PFCs had risen again due to increased aluminum production. The PFC emissions in 2000 were estimated to be 107 Gg CO_2 equivalent, which is still much lower than the 1990 level even though aluminum production has doubled in the same period.

The total use of sulfur hex fluoride has not increased over the past decade. The estimated total quantity is 11 tons, and emissions are equal to 5.38 Gg CO_2 equivalent per year. Sulfur hex fluoride can be found in electrical equipment. Leaks are estimated to have been 200-250 kg per year in 1990-1999.

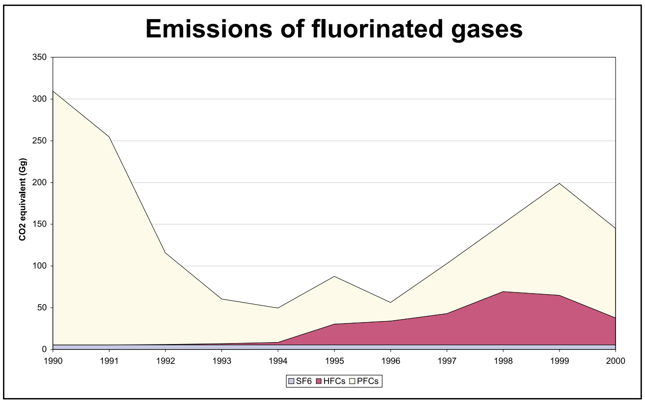

Figure 2.7: Emissions of fluorinated gases

3. Policies and measures

3.1 Key issues

In 1995 the Government of Iceland adopted an implementation strategy based on the commitments in the Framework Convention. The domestic implementation strategy has been revised, based on the commitments in the Kyoto Protocol and the provisions of the Marrakesh Accords. On March 5, 2002, the Government adopted this new strategy. On April 20th, the Icelandic Parliament approved a motion authorizing the government to ratify the Kyoto Protocol. Iceland deposited its instruments of ratification of the Kyoto Protocol on May 23, 2002.

Iceland's obligations according to the Kyoto Protocol are as follows:

- For the first commitment period, from 2008 to 2012, the greenhouse gas emissions shall not increase more than 10% from the level of emissions in 1990.
- For the first commitment period, from 2008 to 2012, the mean annual carbon dioxide emissions falling under decision 14/CP.7 on the "Impact of single project on emissions in the commitment period" shall not exceed 1,600,000 tons.

3.2 Policy development process

The Ministry for the Environment formulated the climate change policy in close collaboration with the ministries of Transport and Communications, Fisheries, Finance, Agriculture, Industry and Commerce, Foreign Affairs and the Prime Minister's Office.

The aim of the policy is to curb emissions of greenhouse gases so that they do not exceed the limits of Iceland's obligations under the Kyoto Protocol. A second objective is to increase the level of carbon sequestration resulting from reforestation and revegetation programs. The policy will be a reviewed in the year 2005.

Box 3.1:

Icelandic climate policy

1. Changes in taxation creating incentives to use small diesel cars.
2. Consultation process with aluminum smelters to ensure that PFC emissions from the aluminum industry will be minimized.
3. The fishing industry will be encouraged to increase energy efficiency.
4. Further reduction of waste disposals, especially in terms of organic waste.
5. Increasing annual carbon sequestration.
6. Increased research and development.
7. Increased emphasis on information and public awareness.

Also relevant is a new strategy for sustainable development, "Welfare for the Future", that the government approved in July 2002.
The strategy provides a framework for sustainable development for the next two decades. Seventeen objectives are discussed, each containing several subgoals, and possible measures for implementation are listed.

Another influential factor is the European Economic Agreement, to which Iceland is party and must therefore implement relevant directions of the EU.

Iceland has two administrative levels, and local authorities work alongside the central government in implementing many of the climate-related policies. In recent years Icelandic municipalities have done considerable work in forming their own sustainable development policy under the label of Local Agenda 21.

The following sections give an overview of the policies and measures in the policy documents listed above, and how they relate to the different sectors of society.

3.3 The energy sector

Measures related to electricity generation and household energy efficiency form the backbone of the climate policy of many industrialized countries. In Iceland the situation is very different, given the fact that the country already relies heavily on renewable energy sources to provide heating and electricity. More than 80% of GHG emissions from energy come from mobile sources (transport on land and fishing vessels) where cuts in emissions are generally considered more difficult to achieve than from stationary energy sources.

The proportion of renewable energy in the total primary energy supply is presently around 70%, but Iceland's newest strategy for sustainable development states the goal of decreasing the share of fossil fuels even further in coming decades. The aim is that transport will use energy from renewable energy resources as soon as it is economically feasible to do so. This policy will be further discussed in the section on transport and the section on research and development.

3.4 The transportation sector

Transportation is one of the fastest growing sources of greenhouse gas emissions in Iceland. In 2000 the transport sector was responsible for 30% of total GHG emissions in the country.

One of the main measures listed in the Icelandic climate change policy is a change in the taxation system that will provide added incentives for the use of small diesel cars. In the current system owners of diesel cars pay a special tax every year, depending on the weight of their vehicle. The owners have a choice of a fixed tax or a milage tax. The proposed change aims at transferring the taxes into user charge tax for using diesel fuel. This change is expected to result in a transfer of around 10% of current gasoline use to the diesel fuel and a corresponding decrease in GHG emission.

Other measures in this sector that are listed in the government policy include:

- Review of import fees for vehicles to determine if changes in fees are a feasible option to increase the share of energy-efficient vehicles;
- Increased coordination of traffic lights;
- Increased emphasis on short travel distances in physical planning of urban areas;
- Improvement of public transportation systems;

The Ministry of Finance will be responsible for implementing this change in taxation, but other policy measures related to the transport sector fall under the Ministry of Transport and Communication.

Box 3.2:

International hydrogen projects

The Icelandic government has offered political support to those interested in developing hydrogen as an energy carrier in the transport sector, which would greatly reduce GHG emissions from mobile sources. In 1997 the Ministry of Industry and Commerce appointed a special committee to explore available options for use of domestic renewable energy resources in relation to hydrogen and methanol. The committee recommended the establishment of a private company whose function was to maintain foreign contacts made by committee members, and to support further research and development. The company, Icelandic New Energy, was formed shortly thereafter and is a joint venture owned by VistOrka hf. (a common platform for most energy companies in Iceland), Daimler Chrysler, Norsk Hydro and Shell Hydrogen. Foreign companies see Iceland as an ideal testing site for hydrogen projects because of the small size of society, the availability of renewable energy and the political commitment of the Icelandic government to the issue. The hydrogen projects are discussed in more detail in chapter 7.

3.4.1 Policies on the local level

Implementation of some of the measures listed above can only be achieved in cooperation with local governments. This is especially relevant to urban planning and improvement of public transportation systems. The participation of Icelandic municipalities in Local Agenda 21 has greatly increased their awareness of environmental issues, including climate change, and many municipalities have integrated measures to cut GHG emissions in the transport sector in their planning.

Reykjavik, the capital of Iceland, is the largest municipality with almost 40% of the population. Reykjavik's environmental policy states the objective of contributing to Iceland's task of fulfilling its obligations under the UNFCCC. The city already participates in two transport-related projects that could help reach this goal:

- Reykjavik takes part in ECTOS, an international hydrogen project, in cooperation with Icelandic New Energy, Daimler-Chrysler and Shell Hydrogen. Experiments with public buses using hydrogen as the energy carrier are to begin in the later half of 2003.
- SORPA, an independent waste management firm owned by Reykjavik and six other municipalities, has been experimenting with using methane from landfills as a vehicle fuel. As of fall 2002, 38 vehicles fuelled by methane were in use in the Reykjavik area.

Another example of a municipality that has integrated measures to curb emissions of GHG in the transport sector is Akureyri, a town of 15,000 inhabitants, located in northern Iceland. In its municipal planning for 1998-2018, the town states its goal of keeping GHG emissions from transport at the same level as in 2000. Several measures are listed to reach this objective, with dates when specific measures are to be implemented.

3.5 The fisheries sector

Fisheries is another sector that is important in terms of GHG emissions in Iceland, and the use of fossil fuels for fishing vessels explains about 26% of total GHG emissions in the year 2000. Use of HFCs in cooling systems onboard fishing vessels also adds to GHG emissions.

As is the case with transport on land, reductions in emissions from fishing vessels are difficult to achieve. Emissions are expected to rise somewhat due to an increase in catch, but the government policy states that a major objective in the fisheries sector is to improve energy efficiency, thereby minimizing the energy needed per ton of fish-catch. Three measures are specifically listed in the policy:
- To educate vessel owners and fishers about the importance of energy saving and options available to increase energy efficiency.
- To encourage the equipping of new vessels entering the fishing fleet with the best available technology in terms of energy efficiency.
- To reduce use of HFC cooling systems. Currently the use of HFCs is banned with the exception of use for cooling systems and in certain medical applications.

The Ministry of Fisheries is responsible for implementation of climate change policies in the fisheries sector.

3.6 Industrial processes

Industrial processes in energy-intensive industries accounted for 21% of total GHG emissions in Iceland in the year 2000. This excludes CO_2 emissions from the two projects falling under Decision 14/CP.7. PFC emissions from energy-intensive industries do not fall under this Decision, and climate-related policies in the industrial sector are primarily focused on limiting PFC emissions.

A voluntary agreement between aluminum smelters and the government has already resulted in lower PFC emissions per production unit, but the aim is to reduce these emissions even further. The goal is to keep PFC emissions from existing smelters at the level of 0.22 tons of CO_2 equivalents per ton of aluminum produced, but for new smelters the target level is 0.14 tons of CO_2 equivalents.

The Ministry for the Environment and the Ministry of Industry and Commerce have initiated a formal consultation process with the aluminum sector in order to achieve these goals.

3.7 The waste sector

GHG emissions from the waste sector were 2.2% of total GHG emissions in 2000. Most of these emissions are methane from landfills. The total amount of waste has been increasing in recent years. Nevertheless, GHG emissions from the sector have declined due to increased recycling and technological advances in the handling of waste. The most important measure is the collection of methane from the largest landfill in the country, serving all of the greater Reykjavík area, which started in 1997.

The government climate change policy adopted in April 2002 states the goal of further reducing waste disposal, especially in terms of organic waste. This goal is also stated in Welfare for the Future, the government strategy for sustainable development. A second objective of the climate change policy is to increase the collection of landfill gas for energy recovery and environmental control.

The Ministry for the Environment is responsible for policies in the waste sector, but in most cases implementation takes place on the local level. Many municipalities have integrated concerns for GHG emissions from waste in their Local Agenda 21. One example of this is SORPA, an independent waste management firm owned by Reykjavik city and six other municipalities, that has been experimenting with using methane from landfills as vehicle fuel (see the section of policies in the transport sector). These experiments will continue.

3.8 Carbon sequestration

Revegetation and reforestation is a high priority in Iceland, and there is significant potential to enhance carbon sequestration beyond the present level. In 1996 the Icelandic government announced its decision to dedicate ISK 450 million for a four-year program of revegetation and tree planting to increase the sequestration of carbon dioxide in the biomass. This program was implemented in 1997-2000. The stated goal was an increase of 22,000 tons in carbon sequestration. Assessment of the results of the program indicates that the total additional sequestration was 27,000 tons.

Although this four-year program is over, efforts to increase the annual carbon sequestration rate resulting from reforestation and revegetation programs will continue in the future. A new strategic plan for soil conservation and revegetation, adopted by the Icelandic Parliament in the spring of 2002, lists carbon sequestration as one of the four main objectives of the strategy. The strategic plan covers the period of 2003 to 2014. The parliament also recently adopted a new five year plan of action for the forestry sector, where attention is given to carbon seqestration.

The Ministry of Agriculture is responsible for implementation is this area.

3.9 Research and development

The government policy on climate change emphasizes the importance of research and development and specifically lists the following actions:

- Emphasis will be put on improving methods to estimate carbon sequestration and to create a reporting system to improve both inventory and projection estimates.
- Research and development whose aim is to increase the use of environmentally friendly energy will be supported.
- More emphasis will be put on exploring ways to curb emissions from the transport sector.
- Experiments with alternative energy that could replace fossil fuels will continue, as well as research on fuel cells and hydrogen as energy carrier.

Implementation of policies related to research and development is a joint responsibility of all ministries. Discussion on research and development is provided in more detail in Chapter 7.

3.10 Information and public awareness

Increased emphasis on information and public awareness is one of the seven main components of the Icelandic climate policy. The government policy stresses the need to inform the public about options available to reduce greenhouse gas emissions on a day-to-day basis by minimizing waste, altering travel habits and increasing fuel efficiency. The government already supports some projects organized by environmental NGOs, whose aim is to encourage environmentally responsible behavior. Information about ways consumers can reduce GHG emissions in their everyday lives is integrated into these projects.

The ministries are jointly responsible for encouraging education and increasing awareness. Further discussion about public education is to be found in Chapter 8.

3.11 Other measures

In addition to measures specifically taken to limit GHG emissions domestically, the Icelandic climate policy discusses other commitments, such as inventory information for carbon sequestration, emissions trading, and financial support to developing countries.

According to the climate policy, a nationwide inventory system on carbon sequestration should be implemented no later than 2007, as called for in the Kyoto Protocol.

The Kyoto Protocol also deals with emissions trading. Iceland’s intention to take advantage of Decision 14/CP.7, which limits its options for participating in emissions trading with other countries. Each country is free to decide whether a domestic system of emissions trading is a feasible option. In the Icelandic case, this is not considered an attractive option for the time being.

The European Union adopted a new directive in November 2002 dealing with permits for the trading of emissions in the European Union. Only CO_2 emissions from industry are included in this directive. As of early 2003, it was not clear if the directive will apply to the European Economic Area and to what degree it will impact Iceland.

Financial support to developing countries is another important aspect of the UNFCCC. So far, Iceland has not made a decision about its participation in the third replenishment of the Global Environmental Fund. Also relevant in this respect is a declaration from a group of states (the EU, Canada, New Zealand, Norway and Iceland) that they would be willing to provide additional support to developing countries equal to USD 410 million no later than 2005. At the end of 2002, no decision had yet been taken about how this amount would be divided among the states participating in the declaration.

Financial assistance will be discussed in more detail in Chapter 6.

4. Projections and the total effect of measures

4.1 Introduction

The Ministry for the Environment formed a working group whose function was to develop projections for GHG emissions until 2020. The group was composed of representatives from various institutions, but the lead agency was the Environmental and Food Agency, which is also responsible for Iceland's GHG emissions inventory. The working group cooperated with the Icelandic Energy Forecast Committee, which was established in 1976 and represents companies, institutions and organizations involved in the energy sector. The projections described in this chapter are based on the energy forecast for fossil fuels that was published in the summer of 2001, as well as assumptions about the future developments of new energy-intensive industries from the Ministry of Industry and Commerce.

4.2 Scenarios and key assumptions

Two scenarios are provided in the projections. The first scenario assumes no additions to energy-intensive industries other than the expansions already agreed upon in October 2001 (Scenario 1). The second scenario is based on the assumption that a new aluminum smelter will be built in Reydarfjordur, and that both of the existing aluminum plants will be enlarged (Scenario 2).

The expected effects of the key measures of the climate change policy are integrated into the projections ("with additional measures" projections). In addition to the two scenarios, the working group, in cooperation with the Energy Forecast Committee, also performed sensitivity analysis to estimate the emissions if these expected effects did not materialize ("with measures" projections).

The Energy Forecast Committee based its forecast for fossil fuels use during the period 2001-2030 on the following main assumptions.

Economic growth during this period is expected to be 2.5% per year, on average. The price of oil is expected to increase slowly, and the forecast assumes there will be no changes in the taxation system other than the proposed change that will affect owners of diesel cars (see explanation in 3.3). Energy use per unit of catch is expected to decrease in the fisheries sector, but the decrease varies depending on the type of vessel. The number of private cars will continue to increase due to changes in the age composition of the nation as well as an increase in the number of households that will buy a second car. However, the average annual use of each car is expected to decrease slightly. The number of utility vehicles is expected to follow growth in GDP. Cars using fossil fuels are expected to be more energy-efficient; the share of small diesel cars is expected to rise, and the forecast also predicts that by the end of the period, in 2030, 15% of the car fleet will use alternative energy sources.

4.3 Projections and aggregate effects of policies and measures

With the additional measures planned as a part of the revised domestic climate change strategy of March 2002, the net emissions from Iceland are expected to be within the assigned amount in the Kyoto Protocol of 3,122 Gg CO_2 equivalent. There is a considerable difference in projections depending on whether plans for new energy-intensive industries materialize or not[7]. In both cases Iceland is expected to stay within its allocated amount under the Kyoto protocol, but if policies and additional measures do not lead to the expected results, Iceland will exceed these limits for Scenario 2. The projections do not take into account carbon sequestration from revegetation and/or reforestation schemes, but possible effects of such measures are discussed separately in section 4.5.

7 Emissions falling under Decision 14/CP.7 are not included in these projections. However, the decision only applies to carbon dioxide emissions from industrial processes and other emissions, such as process emissions of PFCs from energy-intensive industries, which are included in projections. Increases in energy emissions resulting from the construction of the new industry and from increased economic activity are also included.

4.3.1 Scenario 1

This scenario assumes no expansion in energy-intensive industries until 2020, other than because of the projects already granted a license in 2001. If this scenario materializes, the average annual emissions during the first commitment period of the Kyoto protocol will amount to 2,789 Gg CO_2 equivalent, which is well within the 10% increase that Iceland is allocated in the Protocol (which would amount to 3,122 Gg CO_2 equivalent).

Table 4.1

Projections with additional measures of the 6-greenhouse-gas basket, broken down by gas, Gg CO_2 equivalent, based on Scenario 1.

Gas	1990	2000	2005	2010	2015	2020
Carbon dioxide (without LUCF)	2108	2322	2247	2278	2313	2301
Methane	295	278	279	286	279	272
Nitrous oxide	126	121	106	108	108	107
HFCs	0	32	46	65	73	73
PFCs	304	107	54	54	54	54
SF6	5	5	5	5	5	5
Greenhouse gas emissions	2838	2865	2737	2796	2832	2812

Greenhouse gas emissions by source, Gg CO_2 equivalent

Sector	1990	2000	2005	2010	2015	2020
Transport and machinery	730	862	920	954	984	1001
Residential	43	27	20	18	16	14
Industry	986	861	727	713	706	695
Fishing vessels	662	739	700	733	756	738
Other	417	376	370	378	370	364
Total	2838	2865	2737	2796	2832	2812
CO_2 emissions fulfilling 14/CP.7[8]	0	273	394	394	394	394

8 Decision 14/CP.7 calls for separate reporting only after a party has exceeded its assigned amount. For clarity of presentation, all emissions that would fulfill the requirements of 14/CP.7 are listed here.

4.3.2 Scenario 2

This scenario assumes three additional energy-intensive industrial projects. These projects include a further expansion of the two already existing aluminum smelters and the building of a new smelter in Reydarfjordur. The additional projects will lead to a substantial increase in total emissions. Average annual emissions during the first commitment period would reach 3,028 Gg CO_2 equivalent, which is still below the allocated amount in the Kyoto Protocol (3,122 Gg CO_2 equivalent). As in Scenario 1, these numbers do not include emissions falling under Decision 14/CP.7 and do not take into consideration measures to increase carbon sequestration.

Table 4.2

Projections with additional measures of the 6-greenhouse-gas basket, broken down by gas, Gg CO_2 equivalent, based on Scenario 2.

Gas	1990	2000	2005	2010	2015	2020
Carbon dioxide (without LUCF)	2108	2322	2265	2390	2438	2430
Methane	295	278	279	286	279	272
Nitrous oxide	126	121	106	109	109	109
HFCs	0	32	46	65	73	73
PFCs	304	107	79	185	201	201
SF6	5	5	5	5	5	5
Greenhouse gas emissions	2838	2865	2780	3040	3105	3090

Greenhouse gas emissions by source, Gg CO_2 equivalent

Sector	1990	2000	2005	2010	2015	2020
Transport and machinery	730	862	924	979	1016	1041
Residential	43	27	20	18	16	14
Industry	986	861	766	932	947	933
Fishing vessels	662	739	700	733	756	738
Other	417	376	370	378	370	364
Total	2838	2865	2780	3040	3105	3090
CO_2 emissions fulfilling 14/CP.7	0	273	567	1546	1662	1662

4.4 Sensitivity analysis

The effects of the first three key measures included in the government climate policy (see box 3.1) are already integrated into the projections for both scenarios. Sensitivity analysis was undertaken to estimate the emissions if the three additional measures did not have the expected effects. The assumptions were changed as follows:

- *Transport*: The fossil fuel forecast expects a 10% reduction in gasoline use with an equal increase in the use of diesel oil, as a consequence of a change in taxation. How much would the emissions increase if the relative share of gasoline and diesel oil remained unchanged?
- *Industry:* The projections assume that existing aluminum industries will succeed in limiting PFC emissions to 0.22 tons of CO_2 equivalents per each ton of aluminum produced, and that for new aluminum industries, the number will be 0.14 per ton produced. The average emission for the past decade has been 0.4 but has been declining rapidly in recent years. How much would the emissions increase if the average continues to stay at the 0.4 level?
- *Fisheries:* Although total catch is expected to increase, emission per unit of catch is expected to decrease 10-15% (depending on the type of vessel). How much would the emissions increase if emissions per unit of catch stayed the same?

Given these changes in assumptions, annual emissions for the period 2008-2012 would increase by 118 Gg CO_2 equivalent for Scenario 1, bringing the annual average up to 2,908 Gg CO_2 equivalent, which falls within the allocated amount.

For Scenario 2, these changes would result in Iceland exceeding its assigned amount for the first commitment period of the Kyoto Protocol. Total annual emissions would increase by 273 Gg CO_2 equivalent, which means that the annual average would be 3,302 Gg CO_2 equivalent.

4.5 Effects of carbon sequestration on projections

Increased carbon sequestration is listed as one of seven main measures of the government climate change policy. Projections in this area are difficult as revegetation and reforestation efforts are being undertaken by a broad range of actors and the level of ambition depends on a combination of factors. The Government policy is based on the assumption that annual sequestration will be 200 Gg on average during the first commitment period. Removals in the LUCF sector were estimated for the first time in the inventory for 2000. That year, removals of CO_2 were estimated to be 130 Gg. Reforestation projects contributed 30% and revegetation 70%. Iceland is developing a comprehensive inventory system for emissions and removals associated with LULUCF.

4.6 Summary of projections

In short, if projections are accurate, Iceland will be able to meet its obligations for the first commitment period of the Kyoto Protocol, even with the planned expansion in energy-intensive industries (Scenario 2). However, this assumes that measures included in the Icelandic climate change policy will be successful. Should those assumptions not hold, Iceland could exceed its assigned amount for Scenario 2. If plans for increased carbon sequestration are fully implemented, net emissions should stay within the assigned amount for all options explored in this chapter. It should be emphasized that the uncertainty in those projections is considerable.

5. Impacts and adaptation measures

5.1 Impacts on climate and oceanic currents

The third IPCC assessment of climate change concludes that there is increasing evidence that man is affecting the global climate system. The mean global temperature has risen by approximately 0.6°C over the last 100 years, in Europe the mean temperature has risen by about 0.8°C during the same period. The 1990s was the warmest decade on record in Europe.

The global climate change scenarios also indicate major impacts on the hydrological cycle, which are expected to become more intensive. However, regional and local effects on climate may differ considerably from the mean global figures. In some regions the risk of flooding will increase, while in others there will be a greater risk of drought.

It is uncertain what impact climate change will have in Iceland. A scientific committee on climate change turned in a report in October 2000 called Climate Change and its Consequences, in which possible effects of a rise in the average temperature in Iceland are discussed. The information in this chapter is drawn from this report.

A Nordic research team on climate change predicts that a temperature increase in Iceland due to greenhouse effects could be 0.3°C per decade in the next few decades, given certain assumptions about future GHG emissions. The increase is expected to be larger in winter, and precipitation is likely to increase. Natural fluctuations in temperature are greater in the North Atlantic than in most other oceanic areas, and the natural fluctuations between decades are substantially more than the estimated temperature increases for the next decades due to buildup of greenhouse gases. The impact of temperature increase due to the greenhouse effect will therefore greatly differ depending on the direction of the short-term natural fluctuations.

Oceanic currents play an important role in Icelandic climate. The country is located at the junction of cold and warm ocean currents. A worst-case scenario would be if any major changes were to take place in the so called “conveyor belt” that transfers warm currents from southern oceans to the North East Atlantic. Some models indicate that a global rise in temperature will make the conveyor belt less efficient in transferring heat, which could greatly influence the climate around Iceland. There is a high degree of uncertainty on this issue since other models show different results.

The IPCC predicts that the rise in sea level will be 21 cm during the period 1990-2050 (3.5 mm per year), and 29 cm from 2050 to 2100 (5.8 mm per year). There is no reason to believe the rise in sea level will be any different in Iceland.

Climate change will impact glaciers and the flow of rivers. Rising temperature will lead to a reduction in the size of most glaciers. The melting of glaciers could lead to an increase in the flow of rivers, and floods could become more frequent. Some studies predict that the glaciers will almost disappear in the next two centuries.

5.2 Impacts on ecosystems

Changes in temperature impact both terrestrial and marine ecosystems. Ocean currents and temperature are important factors for variables like primary productivity (by photosynthesis of algae), distribution of various fish stocks, the routes of fish runs and location of spawning grounds. For some years the Marine Research Institute has measured the primary productivity in the ocean in spring, and these measurements have provided valuable information about the impact of temperature fluctuations. These measurements demonstrate that primary productivity is very sensitive to environmental factors, such as temperature and currents. An increase in temperature will lead to more productivity, which is likely to have a positive impact on the cod stock and other ground fish species. A decrease in oceanic temperature could have the opposite effect and limit the growth of important fish stocks.

Climatic factors, such as temperature, precipitation and wind, greatly influence plants and vegetation cover. Research on climatic fluctuation in the past has shown that the production increased 11% for each rise in temperature of 1°C. The impact of a temperature increase will be even greater on barley production. Iceland has a short history of growing barley since weather conditions limit the possibility of such production. However, new variations of barley have made it possible to experiment with this kind of agriculture. An increase in temperature would have positive effect on barley production. Negative impacts of climate change on terrestrial ecosystems include increasing risks of plant diseases.

5.3 Impacts on society

In light of the high degree of uncertainty, estimating impacts on society becomes a very difficult task. An increase in temperature could have some positive effects on marine resources and fish stocks. However, more insects could increase the risk of disease in both plants and humans, which would be a negative impact. A worst-case scenario for Iceland would be if climate change led to major disruptions in oceanic circulation that impacted fish stocks negatively.

The impact that climate change could have on human health is likely to be less in Iceland than in many other countries. An increase in temperature should not create discomfort for the population since the current climate is rather cool. An increase in the frequency of severe storms could however result in more casualties due to bad weather. There can also be indirect impact on human health. For example an increase could be expected in the number of incidents involving pollution of drinking water due to E.coli and Giardia lamblia. In general, however, the health impact is not likely to be substantial and should not be a great burden to the healthcare system.

5.4 Adaptation measures

Most climate change measures adopted in Iceland aim at curbing emissions of greenhouse gases, and emphasis on adaptation measures has been minimal. The main reason for this is the high degree of uncertainty about the impacts of climate change. The most important adaptation measures are likely to involve changes in the design of dams, bridges, harbors and other structures that are affected by changes in the flow of rivers and a rise in sea level. Expected sea level rise has already been taken into account in the design of new harbors.

6. Financial assistance and technology transfer

6.1 Development cooperation

The government of Iceland has increased their funding for Official Development Assistance (ODA), both in real terms and as a share of GDP. In 1999 the amount allocated to development cooperation was 0.09% of GDP, but this share was up to 0.15% in 2002. Sustainability is a central theme in the Icelandic development cooperation. Especially noteworthy in relation to climate change is the UN University's Geothermal Training Program in Iceland, where specialists from developing countries receive training in the utilization of geothermal energy. The training program was established in 1979 and during the first twenty years, 245 participants from 35 countries have finished the six-month program.

The table below gives an overview of ODA for the period 1999-2002. The numbers are given in millions of Icelandic kronur.

Table 6.1

Bilateral Assistance	**1999**	**2000**	**2001**	**2002**
ICEIDA[9]	228.4	298.6	479.7	468.5
Multilateral Assistance				
UN Geothermal Training Pr.	44	50.3	51.8	63.0
UN Fisheries Training Pr.	23.2	30.4	36.1	48.9
FAO	7	7.3	10.1	10.4
UNDP	18.3	18.3	21.8	22.4
UNICEF	9.5	9.5	9.5	11.6
UNIFEM	2.5	2.5	2.5	3.1
Other UN bodies	17.4	1.4	22.2	14.2
IMF	19.8	22.1	26.2	27.2
World Bank			13.6	15
Bosnia-Herzegovina	31.7	16.3	1.7	
Peacekeeping missions		110.3	166.9	177.8
Humanitarian aid	39.9	20.2	15.1	79.1
Debt relief (HIPC)		68	68.5	67
Grants to development NGOs	13.4	4.9	19.2	7.2
Other	7	7	30.5	41.5
Total	**462.1**	**667.1**	**975.4**	**1056.9**
Capital Funds	**1999**	**2000**	**2001**	**2002**
IDA[10]	79.7	95.3	95	100
NDF[11]	40.7	35.4	29	40
IFAD[12]	0.4	0.5	0.5	0.5
Total	**120.8**	**131.2**	**124.5**	**140.5**
Total ODA[13]	**582.9**	**798.3**	**1099.9**	**1197.4**

9 Icelandic International Development Agency (ICEIDA) has programs in four African countries: Malawi, Mozambique, Namibia and Uganda.
10 International Development Association
11 Nordic Development Fund
12 International Fund for Agricultural Development
13 The total number includes bilateral assitance, multilateral assistance and capital funds.

Table 6.2

	1998	1999	2000	2001	2002
Int'l Environmental Institutions	10.2	11.7	14.7	14.8	25.0
NEFCO	12.5	12.8	13.2	13.5	12.3
NEDF				5.2	6.4

6.2 Financial assistance to international environmental institutions

In addition to ODA, the Icelandic government also provides financial assistance to environmentally related projects in other countries through participation in various international agreements. Table 6.2 gives an overview of the funds the Ministry for the Environment has allocated for international environmental institutions during the period 1998-2002 (in millions of Icelandic kronur). It also lists financial contributions to two Nordic environmental funds, Nordic Environmental Finance Corporation (NEFCO) and Nordic Environmental Development Fund (NEDF), both of which provide loans and grants for environmental projects in Central and Eastern Europe.

Included in payments to the International Environmental Institution is an annual payment to the UNFCCC Secretariat. In addition to the required amount, Iceland has also paid voluntary contributions to the UNFCCC and the IPCC.

The Nordic Environment Finance Corporation (NEFCO) is a risk capital institution financing environmental projects in Central and Eastern Europe. Its purpose is to facilitate the implementation of environmentally beneficial projects. Many of the projects focus on mitigation measures for climate change. NEFCO is now in the process of setting up a financing facility for projects based on joint implementation, and the Baltic Sea Region will become a Testing Ground for JI.

Iceland has not made a commitment towards the third replenishment of the Global Environment Facility (GEF), but the Government is considering this matter. At the resumed Sixth conference of the Parties in Bonn, the government made a political commitment by participating in a declaration where several donor countries reaffirmed their commitment to climate change funding for developing countries and promised jointly to contribute an additional USD 410 million no later than 2005.

6.3 Technology transfer

The government has emphasized the importance of technology transfer and sharing of knowledge in their development cooperation. This commitment is demonstrated in the participation in the UN Geothermal Training Program. Icelandic companies are involved in geothermal projects in Eastern and Central Europe through NEFCO, and the government has facilitated bilateral cooperation, e.g., between Iceland and China, on the utilization of geothermal energy.

Soil conservation and revegetation is another area where Icelanders have technical knowledge that could benefit other countries and help reach climate-related goals, and this could be an area of cooperation in the future.

7. Research and systematic observation

7.1 General research policy

Research and development (R&D) play an increasingly important part in Icelandic society. Funds allocated to research and development were 1% of GDP in 1990 but had reached 2.3% of GDP in the year 2000. Most of the increase is due to increased investment in research by the private sector, but there has also been some increase from the public sector. New legislation on the organization of science and technology policy and the funding of research and technological development in Iceland, which went into force in January 2003, should further strengthen the R&D sector.

Environmental change is recognized as an important area in R&D, and in 1998 the Icelandic Research Council launched a five-year program with a special fund to support projects in environmental research and research on information technology. Several climate-related projects have received grants from this fund or other funds of the Icelandic Research Council, but Icelandic scientists are also involved in a number of international climate-related projects funded from sources, such as the European Union and the Nordic Council of Ministers. Research on climate and systematic observation is also part of the mandate of some public institutions, such as the Icelandic Meteorological Office (IMO) and the Marine Research Institute (MRI).

7.2 Climatic Research

Most of the climate-related research in Iceland is focused on climate processes and climate system studies and impacts of climate change. Other efforts involve modeling and prediction, and large ongoing projects deal with mitigation measures, but there has been less research on socio-economic analysis.

7.2.1 Climate process and climate system studies

The evaluation of changes and variability of the climate (including sea-ice) during the period of instrumental observations is among the basic tasks of the IMO. Although the research is mainly centered on the climate of Iceland, the IMO has also been active in many multi-national projects focusing on the analysis of climate data.

Icelandic scientists have for many years contributed considerably to paleoclimatological work with their participation in many ice and sediment core projects. Most of this work has taken place within the University of Iceland.

7.2.2 Modeling and prediction

The climate modeling work of the IMO has mostly been restricted to physical downscaling experiments and to the effects of mountains on both local climate and the general circulation in the North Atlantic Region. The IMO takes part in the European High-Resolution-Limited-Area-Model (HIRLAM) cooperation and its development and evolution of high-resolution deterministic weather forecasting models, but the model is not in operational use in Iceland.

The IMO, in cooperation with the University of Iceland, uses the non-hydrostatic, high-resolution 5th generation Mesoscale Model (MM5) for research projects in dynamic meteorology and for the downscaling of climate simulations. Most of the research projects in dynamic meteorology have emphasized interaction between the terrain and the atmosphere on scales ranging from flow around hills up to synoptic systems. Projects on predictability and sensitivity of forecasts to observations are planned in connection to the upcoming WMO-program THORPEX (THe Observation System Research and Predictability EXperiment).

The IMO, the MRI and the University of Akureyri cooperate on a research project with the goal of understanding the natural variations in oceanic circulation surrounding Iceland, and how climate change might affect this. A model describing the mesoscale variability of the ocean circulation is an important component of this project.

7.2.3 Impacts of climate change

Icelandic research institutions are involved in several projects studying the impact of future global climate changes. Two international projects can be mentioned: the Artic Climate Impact Assessment (ACIA) organized by the Arctic Council, and the Climate, Water and Energy (CWE) program, which the Hydrological Institutes of the Nordic countries are responsible for. Both these projects focus on future climate changes in the neighborhood of Iceland.

The goal of ACIA is to evaluate and synthesize knowledge on climate variability, climate change, increased ultraviolet radiation and their consequences. The aim is to provide useful and reliable information to the governments, organzations and people of the Arctic on policy options to meet such changes. The ACIA will examine possible future impacts on the environment and its living resources, on human health, and on buildings, roads and other infrastructure.

The CWE program studies the impact of climate change on the hydrological cycle and hydropower. One component of this study has been the impact of climate change on glaciers, which is of special importance to Iceland. In addition to participating in this Nordic project, several Icelandic institutions have also worked on a related research project that focuses specifically on Icelandic conditions.

7.2.4 Socio-economic analysis

The report “Climate Change and its Consequences”, which was published in October 2000, and which chapter 5 of this report is based on, provides some analysis of the possible social effects of climate change. In the year 2000, a government-appointed committee produced a report estimating the economic consequences for Iceland of participating in the Kyoto Protocol. Academic research on how climate change could affect socio-economic factors has not been substantial, but several research projects deal with technical mitigation issues. These projects focus on either revegetation and reforestation for carbon sequestration or the development of technology making renewable energy a more attractive alternative to fossil fuels.

The Agricultural Research Institute and the National Forestry Institute are both involved in studies focusing on carbon sequestration. They include, e.g., developing methods to estimate how much carbon is being restored with revegetation and reforestation, and research on carbon cycles in Icelandic ecosystems.

Icelandic New Energy, in cooperation with Norsk Hydro, Daimler Chrysler and Shell Hydrogen, runs several research projects aiming at developing technology to make it technologically possible and economically feasible to use hydrogen as an energy carrier in the transport sector and for fishing vessels. The research program of Icelandic New Energy has received considerable international attention. The very ambitious overall goal of the program is to create the world’s first hydrogen economy. This would mean that Iceland would become independent of imported oil since domestic, renewable energy sources can be used to produce hydrogen.

The research program has several phases. The first phase is the ECTOS project. The objective of ECTOS is to implement a demonstration of state-of-the art hydrogen technology by running part of the public transport system in the capital with fuel-cell buses. The energy will be almost free of CO_2 emissions because geothermal energy and hydropower will be used to produce hydrogen by electrolysis. The first hydrogen station will be opened in April 2003, and the first buses are expected to come to the country in late summer 2003. The second phase of the research program is the introduction of hydrogen-based fuel-cell private cars, and the third phase deals with the gradual replacement of fossil fuels in the fishing fleet by fuel-cell-powered vessels.

Although this is a private venture, the projects have received funding from public sources, such as the European Union and the Government of Iceland.

7.3 Systematic observation

The two institutions most important for the observation of climate change are the Icelandic Meteorological Office (IMO) and the Marine Research Institute (MRI).

7.3.1 Atmospheric climate observing systems

The IMO is responsible for atmospheric climate monitoring and observation. The IMO monitors and archives data from close to 200 stations. These stations are either manual (synoptic, climatological and precipitation stations) or automatic. The number of synoptic stations in operation (45) has been relatively constant over the last 40 years. The observations are distributed internationally on the WMO GTS (Global Telecommunication System). The manual precipitation network has been steadily expanding and now consists of about 70 stations measuring precipitation daily in addition to the synoptic stations. The majority of the precipitation stations report daily to the IMO database. The automation of measurements started in Iceland in 1987, and the number of automatic stations has been rapidly growing since then. The IMO now operates about 70 stations and about 35 in addition to this in cooperation with the National Power Company, The Energy Authority and the Maritime Administration. A repository of data from the about 50 stations operated by the Public Roads Administration is also located at the IMO. A majority of automatic stations observe wind and temperature every 10 minutes, a few once per hour, and most transmit data to the central database every hour. Many stations also include humidity, pressure and precipitation observations, and a few observe additional parameters (shortwave radiation and ground temperatures) or observe at more than one level.

For the last 15 years, the observations at the synoptic stations have been subjected to base quality check programs resident in PC computers at the stations. Internet-based software is now replacing this system. The automatic station data are routinely checked for errors, but not in real-time. Procedures are being developed to flag dubious data on reception. The IMO participates in a Nordic project on observation quality checking, where common problems are discussed and standards developed.

Table 7.1 gives an overview of participation in the Global Atmospheric Observing Systems (GAOS):

The GSN stations are among the synoptic stations regularly transmitted on GTS and also transmit monthly climatic summaries (CLIMAT). One upper air station is in operation (Keflavik Airport) making soundings at 00 and 12 UTC. The IMO has participated in the MATCH ozone-sounding program during the winter months since 1990, and the data are reported to the International Ozone Data base at NILU, Norway.

The three GAW stations are: the BAPM at Írafoss and Storhofdi, where tropospheric ozone, carbon dioxide, methane and isotopes of oxygen and carbon are monitored in cooperation with NOAA. Heavy metals and Persistent Organic Pollutants (POPs) in air and precipitation are monitored and reported to AMAP and OSPAR. In Reykjavik, data on global radiation are collected and reported annually to the World Radiation Data Center in St. Petersburg (WRDC).

7.3.2 Ocean climate observing systems

Both the IMO and the Marine Research Institute (MRI) contribute to ocean climate observations. Table 7.2 (see page 30) gives and overview of observation stations operated by the IMO.

Table 7.1

	GSN	GUAN	GAW	Other
How many stations are the responsibility of the party?	4	1	3	
How many are operating now?	4	1	3	
How many of those are operating to GCOS standards?	4	1	2	
How many are expected to be operating in 2005?	4	1	3	
How many are providing data to international centers now?				

Table 7.2

	VOS	SOOP	TIDE Gauges	SFC Drifters	SUB-SFC Floats	Moored buoys	ASAP
For how many platforms is the Party responsible?	13	0					1
How many are providing data to int'l data centers?	9	0					1
How many are expected to be operating in 2005?	10	0					1

The VOSes are merchant ships plying both Europe and the east coast of North America in addition to some coastguard and research vessels operating in Icelandic waters. The IMO operates one ASAP unit on a merchant ship between Iceland and the USA, in cooperation with the Swedish Meteorological and Hydrological Institute. The IMO does not operate any Icelandic drifting or moored buoys, but as members of EGOS (European Group on Ocean Stations), which is an organization operating 50 meteorological drifting buoys and 11 moored buoys in the North-Atlantic at any time, it supports a very important meteorological network.

The Marine Research Institute (MRI) is a member of the International Council of Exploration of the Seas (ICES) and through that membership contributes to the GOOS (Global Oceanic Observing System). The MRI maintains a monitoring net of about 100 hydrobiological stations on 12 standard sections (transects) around Iceland. These stations are monitored four times per year for physical and chemical observations (phosphate, nitrate, silicate) and once a year for biological observations (phytoplankton, zooplankton). Some of these stations have been monitored since around 1950. The zooplankton biomass monitoring has demonstrated fluctuations, which to some extent appear to be linked to climate and circulation changes. The MRI has also monitored carbon dioxide at selected stations for about 20 years and maintains a grid of about 10 continuous sea surface temperature meters at coastal stations all around the country.

8. Education, training and public awareness

8.1 General education policy

A fundamental principle of the Icelandic educational system is that everyone should have equal opportunities to acquire an education, irrespective of sex, economic status, residential location, religion, possible handicap, and cultural or social background. Education has traditionally been organized within the public sector, and there are very few private institutions in the school system. Almost all private schools receive public funding.

The educational system is divided into four levels. The first level is pre-school for children up to 6 years of age. The second level is compulsory (primary and lower-secondary) for children from 6 to 16 years old. The third level is the upper-secondary, where most students are 16 to 20 years old. This level is open to all who have finished compulsory education. The fourth level is higher education (universities).

8.2 Environmental education

Environmental education in schools has increased in the past decade, from pre-school to university. The University of Iceland now offers a Master's degree in environmental studies, where climate change is an integral subject. Many upper-secondary schools offer courses in the same field, or place a special emphasis on environmental issues in their curriculum. Studies of environmental issues in primary schools are included in many subjects, especially natural sciences, but also in subjects like life skills and home economics. In addition, many schools have taken initiative in harmonizing environmental education and general education.

8.3 Public information campaigns

General discussion of environmental issues, including disseminating information to the public through the media and the Internet, has increased considerably in recent years. Non-governmental organizations also play an important role in disseminating information to the public.

There has not been a public information campaign focusing specifically on climate change. However, the governmental policy on climate change emphasizes education and a special effort in disseminating information to the public. This effort will most likely be tailored toward reducing emissions of GHG from the home due to waste and from transport. It should be noted that since renewable energy is used for both space heating and electrical production in Iceland, public information campaigns aimed at energy efficiency in the home are not relevant for the purpose of reducing GHG emissions.

8.4 Resource or information centers

The Environmental and Food Agency has information on climate change on their home page. Information about GHG emissions in Iceland is available, as well as a general explanation of the causes and consequences of climate change.

The Environmental Education Board (EEB), which has representatives from both the environmental and education sector, has initiated a website with links to information in Icelandic about various environmental issues. The Board has also reached an agreement with the University of Iceland to include a special section on the environment on the so-called "Web of Science" (Vísindavefurinn). This is a website where the public can ask questions, and scientists and researchers at the university provide the answers. Answers to several questions relating to climate change have already been provided.

8.5 Involvement of non-governmental organizations

As already stated, environmental NGOs play an important role in disseminating information about environmental issues. Environmental NGOs run several projects that are instrumental in raising environmental awareness.

One project especially relevant to climate change is “Global Action Plan” (GAP). This is an international project that Landvernd, an Icelandic environmental NGO, participates in. GAP is a project where small groups of 5-8 people follow a special eight-week program where five subjects are on the agenda. These subjects are: waste, energy, transport, shopping and water. Each group has a leader who has received special training. The goal of the project is to make people aware of how their actions in daily life influence the environment, and how simple changes can make a difference.

The Ministry for the Environment, the National Power Company (Landsvirkjun), SORPA (an independent waste management firm owned by seven municipalities), Reykjavík Energy (Orkuveita Reykjavíkur), Toyota and one supermarket (Fjarðarkaup) support the project financially.

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Annex A

National greenhouse gas inventory, 1990 - 2000: Summary tables

TABLE 10 EMISSIONS TRENDS (CO_2)
(Sheet 1 of 5)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Gg)											
1. Energy	**0,00**	**1.630,52**	**1.591,83**	**1.721,72**	**1.781,99**	**1.753,00**	**1.777,03**	**1.865,35**	**1.883,93**	**1.876,99**	**1.929,90**	**1.932,51**
A. Fuel Combustion (Sectoral Approach)	0,00	1.630,52	1.591,83	1.721,72	1.781,99	1.753,00	1.777,03	1.865,35	1.883,93	1.876,99	1.929,90	1.932,51
1. Energy Industries		4,13	4,45	4,13	3,18	3,18	3,47	4,03	2,18	4,30	3,31	3,38
2. Manufacturing Industries and Construction		199,70	136,72	202,08	221,33	206,52	211,42	255,45	266,52	269,25	301,23	346,16
3. Transport		720,81	726,57	728,84	738,02	742,86	748,93	734,81	775,83	780,72	819,18	829,98
4. Other Sectors		704,14	722,52	784,42	816,66	798,79	811,11	870,04	838,76	817,10	801,32	748,08
5. Other		1,74	1,57	2,25	2,80	1,65	2,10	1,01	0,63	5,63	4,85	4,91
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels												
2. Oil and Natural Gas												
2. Industrial Processes	**0,00**	**390,46**	**357,33**	**360,58**	**408,17**	**408,79**	**424,97**	**424,04**	**482,50**	**510,05**	**541,25**	**489,89**
A. Mineral Products		50,50	46,99	44,15	38,28	35,88	36,24	40,10	44,67	52,21	59,19	63,13
B. Chemical Industry		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Metal Production		339,96	310,34	316,43	369,89	372,91	388,72	383,94	437,83	457,84	482,06	426,76
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other												
3. Solvent and Other Product Use		**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
4. Agriculture	**0,00**	**4,24**	**4,05**	**4,18**	**4,63**	**4,25**	**4,46**	**4,69**	**5,01**	**5,31**	**4,66**	**4,93**
A. Enteric Fermentation		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Manure Management		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Rice Cultivation												
D. Agricultural Soils [(2)]		4,24	4,05	4,18	4,63	4,25	4,46	4,69	5,01	5,31	4,66	4,93
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues												
G. Other												
5. Land-Use Change and Forestry [(3)]	**0,00**	**-5,41**	**-14,14**	**-24,50**	**-37,16**	**-46,68**	**-55,97**	**-65,57**	**-80,42**	**-93,74**	**-111,96**	**-130,85**
A. Changes in Forest and Other Woody Biomass Stocks		-2,29	-6,06	-10,37	-14,52	-18,04	-21,63	-24,92	-27,74	-31,42	-35,29	-39,18
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands												
D. CO_2 Emissions and Removals from Soil												
E. Other		-3,12	-8,08	-14,13	-22,64	-28,64	-34,34	-40,65	-52,68	-62,32	-76,67	-91,67
6. Waste	**0,00**	**39,58**	**38,77**	**39,62**	**33,60**	**26,86**	**21,89**	**18,69**	**16,78**	**18,23**	**18,37**	**16,52**
A. Solid Waste Disposal on Land		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Waste-water Handling		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Waste Incineration		39,58	38,77	39,62	33,60	26,86	21,89	18,69	16,78	18,23	18,37	16,52
D. Other												
7. Other *(please specify)*	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
Total Emissions/Removals with LUCF [(4)]	**0,00**	**2.059,39**	**1.977,85**	**2.101,60**	**2.191,23**	**2.146,23**	**2.172,38**	**2.247,20**	**2.307,80**	**2.316,84**	**2.382,22**	**2.313,00**
Total Emissions without LUCF[(4)]	**0,00**	**2.064,80**	**1.991,99**	**2.126,10**	**2.228,39**	**2.192,91**	**2.228,35**	**2.312,77**	**2.388,22**	**2.410,58**	**2.494,18**	**2.443,85**
Memo Items:												
International Bunkers	**0,00**	**318,65**	**259,64**	**263,56**	**293,02**	**307,10**	**376,87**	**395,45**	**440,80**	**514,67**	**527,25**	**626,29**
Aviation		219,65	221,99	203,62	195,64	213,62	236,15	271,51	292,12	338,13	363,37	407,74
Marine		99,00	37,65	59,95	97,38	93,49	140,72	123,95	148,68	176,54	163,88	218,55
Multilateral Operations												
CO_2 Emissions from Biomass		**95,26**	**91,46**	**85,85**	**77,08**	**69,69**	**64,40**	**60,14**	**57,62**	**62,77**	**79,85**	**84,45**

(1) Fill in the base year adopted by the Party under the Convention, if different from 1990.
(2) See footnote 4 to Summary 1.A of this common reporting format.
(3) Take the net emissions as reported in Summary 1.A of this common reporting format. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
(4) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.

TABLE 10 EMISSIONS TRENDS (CH_4)
(Sheet 2 of 5)

Iceland
2000
2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Gg)											
Total Emissions	**0,00**	**14,02**	**13,86**	**13,68**	**13,67**	**13,82**	**13,62**	**13,89**	**13,95**	**13,67**	**13,61**	**13,21**
1. Energy	**0,00**	**0,22**	**0,23**	**0,24**	**0,24**	**0,24**	**0,22**	**0,23**	**0,20**	**0,20**	**0,17**	**0,17**
A. Fuel Combustion (Sectoral Approach)	0,00	0,22	0,23	0,24	0,24	0,24	0,22	0,23	0,20	0,20	0,17	0,17
1. Energy Industries		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Manufacturing Industries and Construction		0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,01
3. Transport		0,15	0,16	0,16	0,16	0,16	0,14	0,14	0,12	0,12	0,09	0,09
4. Other Sectors		0,06	0,06	0,07	0,07	0,07	0,07	0,08	0,08	0,07	0,07	0,07
5. Other		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels												
2. Oil and Natural Gas												
2. Industrial Processes	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Mineral Products		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Chemical Industry		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Metal Production		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other												
3. Solvent and Other Product Use		**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
4. Agriculture	**0,00**	**11,90**	**11,74**	**11,41**	**11,31**	**11,36**	**11,08**	**11,18**	**11,29**	**11,40**	**11,27**	**10,79**
A. Enteric Fermentation		10,96	10,80	10,49	10,41	10,45	10,18	10,27	10,38	10,48	10,37	9,93
B. Manure Management		0,94	0,95	0,92	0,91	0,90	0,90	0,91	0,91	0,91	0,90	0,87
C. Rice Cultivation												
D. Agricultural Soils		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues												
G. Other												
5. Land-Use Change and Forestry	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Changes in Forest and Other Woody Biomass Stocks												
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands												
D. CO_2 Emissions and Removals from Soil												
E. Other												
6. Waste	**0,00**	**1,90**	**1,89**	**2,04**	**2,12**	**2,22**	**2,33**	**2,49**	**2,45**	**2,07**	**2,16**	**2,25**
A. Solid Waste Disposal on Land		1,72	1,72	1,86	2,00	2,13	2,27	2,45	2,43	2,04	2,13	2,22
B. Waste-water Handling		0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02
C. Waste Incineration		0,18	0,17	0,18	0,11	0,08	0,05	0,03	0,01	0,01	0,01	0,01
D. Other												
7. Other *(please specify)*	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
Memo Items:												
International Bunkers	**0,00**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,02**	**0,02**	**0,02**	**0,02**
Aviation		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Marine		0,01	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02
Multilateral Operations												
CO_2 Emissions from Biomass												

TABLE 10 EMISSIONS TRENDS (N_2O)
(Sheet 3 of 5)

Iceland
2000
2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Gg)											
Total Emissions	**0,00**	**0,42**	**0,41**	**0,38**	**0,39**	**0,39**	**0,41**	**0,44**	**0,41**	**0,40**	**0,45**	**0,40**
1. Energy	**0,00**	**0,04**	**0,04**	**0,04**	**0,04**	**0,04**	**0,07**	**0,07**	**0,09**	**0,09**	**0,12**	**0,12**
A. Fuel Combustion (Sectoral Approach)	0,00	0,04	0,04	0,04	0,04	0,04	0,07	0,07	0,09	0,09	0,12	0,12
1. Energy Industries		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Manufacturing Industries and Construction		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Transport		0,02	0,02	0,02	0,02	0,02	0,04	0,04	0,07	0,07	0,10	0,10
4. Other Sectors		0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
5. Other												
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels												
2. Oil and Natural Gas												
2. Industrial Processes	**0,00**	**0,16**	**0,15**	**0,14**	**0,14**	**0,14**	**0,14**	**0,16**	**0,13**	**0,12**	**0,12**	**0,06**
A. Mineral Products		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Chemical Industry		0,16	0,15	0,14	0,14	0,14	0,14	0,16	0,13	0,12	0,12	0,06
C. Metal Production		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other												
3. Solvent and Other Product Use		**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
4. Agriculture	**0,00**	**0,22**	**0,22**	**0,20**	**0,21**	**0,21**	**0,20**	**0,21**	**0,19**	**0,19**	**0,21**	**0,22**
A. Enteric Fermentation		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Manure Management		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Rice Cultivation												
D. Agricultural Soils		0,22	0,22	0,20	0,21	0,21	0,20	0,21	0,19	0,19	0,21	0,22
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues												
G. Other												
5. Land-Use Change and Forestry	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Changes in Forest and Other Woody Biomass Stocks												
B. Forest and Grassland Conversion												
C. Abandonment of Managed Lands												
D. CO_2 Emissions and Removals from Soil												
E. Other												
6. Waste	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Solid Waste Disposal on Land		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Waste-water Handling		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Waste Incineration		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other												
7. Other *(please specify)*	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
Memo Items:												
International Bunkers	**0,00**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,02**	**0,02**	**0,02**
Aviation		0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Marine		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Multilateral Operations												
CO_2 Emissions from Biomass												

TABLE 10 EMISSION TRENDS (HFCs, PFCs and SF_6)
(Sheet 4 of 5)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Gg)											
Emissions of HFCs[5] - CO_2 equivalent (Gg)	**0,00**	**0,00**	**0,00**	**0,47**	**1,56**	**3,12**	**25,01**	**28,56**	**37,46**	**63,90**	**59,40**	**32,28**
HFC-23												
HFC-32		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-41												
HFC-43-10mee												
HFC-125		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01
HFC-134												
HFC-134a		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00
HFC-152a		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-143												
HFC-143a		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00
HFC-227ea												
HFC-236fa												
HFC-245ca												
Emissions of PFCs[5] - CO_2 equivalent (Gg)	**0,00**	**303,97**	**249,14**	**109,67**	**53,48**	**41,03**	**57,00**	**22,27**	**59,91**	**81,58**	**134,11**	**107,30**
CF_4		0,04	0,03	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,02	0,01
C_2F_6		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C_3F_8												
C_4F_{10}												
$c\text{-}C_4F_8$												
C_5F_{12}												
C_6F_{14}												
Emissions of SF_6[5] - CO_2 equivalent (Gg)	**0,00**	**5,38**	**5,38**	**5,38**	**5,38**	**5,38**	**5,38**	**5,38**	**5,38**	**5,38**	**5,38**	**5,38**
SF_6		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

TABLE 10 EMISSION TRENDS (SUMMARY)
(Sheet 5 of 5)

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 equivalent (Gg)											
Net CO_2 emissions/removals	0,00	2.059,39	1.977,85	2.101,60	2.191,23	2.146,23	2.172,38	2.247,20	2.307,80	2.316,84	2.382,22	2.313,00
CO_2 emissions (without LUCF) [6]	0,00	2.064,80	1.991,99	2.126,10	2.228,39	2.192,91	2.228,35	2.312,77	2.388,22	2.410,58	2.494,18	2.443,85
CH_4	0,00	294,49	291,13	287,32	287,09	290,13	286,11	291,61	292,92	287,09	285,74	277,42
N_2O	0,00	130,49	127,18	116,29	121,24	121,91	125,69	135,19	127,37	124,57	139,71	124,65
HFCs	0,00	0,00	0,00	0,47	1,56	3,12	25,01	28,56	37,46	63,90	59,40	32,28
PFCs	0,00	303,97	249,14	109,67	53,48	41,03	57,00	22,27	59,91	81,58	134,11	107,30
SF_6	0,00	5,38	5,38	5,38	5,38	5,38	5,38	5,38	5,38	5,38	5,38	5,38
Total (with net CO_2 emissions/removals)	**0,00**	**2.793,72**	**2.650,67**	**2.620,74**	**2.659,98**	**2.607,79**	**2.671,57**	**2.730,21**	**2.830,83**	**2.879,36**	**3.006,56**	**2.860,03**
Total (without CO_2 from LUCF) [6] [8]	**0,00**	**2.799,13**	**2.664,81**	**2.645,24**	**2.697,14**	**2.654,47**	**2.727,54**	**2.795,78**	**2.911,25**	**2.973,10**	**3.118,52**	**2.990,88**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 equivalent (Gg)											
1. Energy	0,00	1.647,60	1.609,23	1.739,88	1.800,48	1.771,43	1.801,99	1.890,95	1.916,08	1.909,56	1.971,32	1.973,32
2. Industrial Processes	0,00	748,17	658,66	517,95	512,61	502,65	554,52	529,54	626,36	696,75	776,32	653,48
3. Solvent and Other Product Use	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4. Agriculture	0,00	323,85	318,41	305,00	306,03	306,93	300,27	304,39	300,55	305,01	307,05	300,35
5. Land-Use Change and Forestry [7]	0,00	-5,41	-14,14	-24,50	-37,16	-46,68	-55,97	-65,57	-80,42	-93,74	-111,96	-130,85
6. Waste	0,00	79,51	78,51	82,40	78,01	73,46	70,77	70,90	68,28	61,78	63,83	63,73
7. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

[6] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.

[7] Net emissions.

[8] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table Summary2 if Parties report non-CO2 emissions from LUCF.

Annex B

Decision 14/CP.7

Impact of single projects on emissions in the commitment period

The Conference of the Parties,

Recalling its decision 1 / CP.3, paragraph 5 (d),

Recalling also, its decision 5 / CP.6, containing the Bonn Agreements on the Implementation of the Buenos Aires Plan of Action,

Having considered the conclusions of the Subsidiary Body for Scientific and Technological Advice at its resumed thirteenth session FCCC / SBSTA / 2000 / 14,

Recognizing the importance of renewable energy in meeting the objective of the Convention,

1. *Decides* that, for the purpose of this decision, a single project is defined as an industrial process facility at a single site that has come into operation since 1990 or an expansion of an industrial process facility at a single site in operation in 1990;

2. *Decides* that, for the first commitment period, industrial process carbon dioxide emissions from a single project which adds in any one year of that period more than 5 per cent to the total carbon dioxide emissions in 1990 of a Party listed in Annex B to the Protocol shall be reported separately and shall not be included in national totals to the extent that it would cause the Party to exceed its assigned amount, provided that:

   (a) The total carbon dioxide emissions of the Party were less than 0.05 per cent of the total carbon dioxide emissions of Annex I Parties in 1990 calculated in accordance with the table contained in the annex to document FCCC / CP / 1997 / 7 / Add.1;

   (b) Renewable energy is used, resulting in a reduction in greenhouse gas emissions per unit of production;

   (c) Best environmental practice is followed and best available technology is used to minimize process emissions;

3. *Decides* that the total industrial process carbon dioxide emissions reported separately by a Party in accordance with paragraph 2 above shall not exceed 1.6 million tonnes carbon dioxide annually on the average during the first commitment period and cannot be transferred by that Party or acquired by another Party under Articles 6 and 17 of the Kyoto Protocol;

4. *Requests* any Party that intends to avail itself of the provisions of this decision to notify the Conference of the Parties, prior to its eighth session, of its intention;

5. *Requests* any Party with projects which meet the requirements specified above, to report emission factors, total process emissions from these projects, and an estimate of the emission savings resulting from the use of renewable energy in these projects in their annual inventory submissions;

6. *Requests* the secretariat to compile the information submitted by Parties in accordance with paragraph 5 above, to provide comparisons with relevant emission factors reported by other Parties, and to report this information to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol.

Annex C

Contact addresses

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