Iceland's
Climate Change Strategy

Ministry for the Environment, February 2007

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I. Introduction

Climate change stemming from human activity is one of the greatest challenges to mankind in the 21st century. Climate change is a global issue, and measures designed to reduce it cannot be successful unless the nations of the world act together in a co-ordinated and harmonious manner. The countries of the world have joined forces under the auspices of the UN Framework Convention on Climate Change, which was ratified in 1992, and the Kyoto Protocol to that Convention, which was ratified in 1997 and took effect in 2005. These nations work within the boundaries of the Framework Convention in order to co-ordinate measures for mitigation and adaptation to climate change. Iceland is a party to the UNFCCC and the Kyoto Protocol.

The current Strategy is the third that the Icelandic government has adopted with respect to climate change issues. It is conceived as a framework for action and government involvement in climate change issues. The Strategy will be reviewed regularly in view of new scientific knowledge, developments in international co-operation to combat climate change, and governmental emphases at any given time.

This Strategy sets forth a long-term vision for the reduction of net emissions of greenhouse gases by 50-75% until the year 2050, using 1990 emissions figures as a baseline. The need to reduce greenhouse gas (GHG) emissions so substantially can be rationalised in two ways: first, scientists are of the opinion that it is necessary to reduce GHG emissions on a global level in coming decades in order to prevent hazardous changes in climate on Earth; and second, developed nations such as Iceland should be in the vanguard in achieving that reduction. Emphasis is placed on reducing net emissions by the most economical means possible, including the introduction of new technology, economic measures, carbon sequestration in vegetation and soil, and financing of measures adopted abroad. Many measures to combat climate change are accompanied by other societal benefits, and emphasis will be placed on these. In this way, it is hoped that Iceland's actions to contain climate change will not have a palpable negative effect on the quality of the average citizen's life; indeed, it is hoped that they will can a positive economic effect as demand for climate-friendly knowledge and technology increases. The primary benefit of a substantial reduction in greenhouse gas emissions from Iceland as a part of a global effort is, however, to avert the worst effects of human-induced climate change, which could have unforeseeable consequences for the environment and living conditions in many parts of the world. Numerous factors indicate that the consequences of unrestrained GHG emissions could prove many times more expensive than measures taken to reduce the concentration of greenhouse gases in the atmosphere.

The Strategy sets forth the Icelandic government's five principal objectives with respect to climate change, which aim toward the realisation of the above-described long-term vision:

- The Icelandic government will fulfil its international obligations according to the UN Framework Convention on Climate Change and the Kyoto Protocol.
- Greenhouse gas emissions will be reduced, with a special emphasis on reducing the use of fossil fuels in favour of renewable energy sources and climate-friendly fuels.
- The government will attempt to increase carbon sequestration from the atmosphere through afforestation, revegetation, wetland reclamation, and changed land use.
- The government will foster research and innovation in fields related to climate change affairs and will promote the exportation of Icelandic expertise in fields related to renewable energy and climate-friendly technology.
- The government will prepare for adaptation to climate change.

The Strategy contains provisions for measures that will be adopted in order to achieve these objectives. It also discusses possible benefits from these measures in addition to the benefits directly connected with climate change. This is of critical importance because many of the

measures that either aim toward the mitigation of climate change or prepare the adaptation to such changes are related to governmental strategies or objectives in other areas, such as economic affairs, energy issues, industry, transport, fisheries, agriculture, development aid, environmental affairs, and other matters. In this way, reduced use of imported fossil fuels can promote savings, as well as increased energy security. Icelandic government agencies have worked toward land reclamation and afforestation for 100 years in an attempt to reverse land erosion, and therefore were engaged in these practises long before the accumulation of carbon dioxide in the atmosphere was acknowledged as a problem. It is possible to argue that most of the measures specified in the Strategy would be positive even if they did not aim at the mitigation of climate change. The implementation of the Strategy will also aim at co-ordinating the Strategy with other environmental objectives, such as the protection of biodiversity and the conservation of nature.

It is necessary to lay a proper foundation for measures combating climate change and to prioritise those measures according to effectiveness and economic efficiency. To that end, two expert work groups will be appointed to assist governmental authorities. One group will have the role of compiling and summarising the best available scientific knowledge of the likely effects of climate change on Iceland and to present proposals on the best possible responses to those effects. The other work group will have the task of assessing the effectiveness and economic efficiency of measures to mitigate climate change. The groups will collaborate closely with employers, interest groups, and non-governmental organisations involved in environmental affairs, both to carry out their assigned tasks and to implement the strategy in other respects.

The Strategy contains statistical indicators that will be updated in the future. These indicators should provide clues to how successfully the Strategy is being enforced and how much progress is being made in reducing greenhouse gas emissions and increasing carbon sequestration.

In many ways, Iceland has a unique position in the battle against climate change. First of all, there is a superabundance of renewable energy resources, as is demonstrated by the fact that over 99% of electricity production and over 70% of total energy production comes from hydropower and geothermal. No other nation uses such a high proportion of renewable energy resources. The utilisation of such resources for domestic consumption and for exportation is positive from a climate change point of view, though it can sometimes conflict with nature conservation aims. The exportation of technology and knowledge in the field of renewable energy is likely the weightiest contribution that Iceland can make to the campaign against climate change.

Another characteristic of Iceland centres on the great potential to use vegetation and soil for sequestration of carbon from the atmosphere. Such sequestration is consistent with Iceland's centuries-old land reclamation endeavours.

There are great possibilities for scientific research related to climate change in Iceland, whether in the form of monitoring — for example, of changes in glaciers and ocean currents — or in the implementation of new climate-friendly technology such as that relating to hydrogen and other climate-friendly fuels, geothermal heat, and carbon sequestration in soil or even in layers of rock.

Iceland's status as a small economy and the consequences of that small size with respect to emissions obligations are recognised in the implementation of the Kyoto Protocol. It is necessary to aim at a situation wherein a new agreement encourages individual sectors and industries to utilise climate-friendly technology and minimise greenhouse gas emissions insofar as is possible, independent of location. This is especially important in view of globalisation, which facilitates the transfer of economic activity between countries and

continents. For this reason, among others, it is necessary that business shoulder increased responsibility in the battle against climate change.

Representatives of the Icelandic government have received awards and formal recognition from organisations that are concerned about matters related to climate change. Among the chief reasons cited for these awards are Iceland's use of renewable energy resources, work in the field of geothermal energy, attempts at afforestation and land reclamation, and research and development projects, especially those concerning the use of hydrogen for fuel. This positive image is very important at a time when climate change and measures to combat it are high on the global agenda. It is important to conserve and cultivate this image, to ensure that it is based on fact, and to aim to keep Iceland in the vanguard in the battle against climate change and its consequences.

II. Iceland's obligations and long-term vision

The Icelandic authorities are responsible for setting goals concerning limitation of net GHG emissions within the country. Many countries have formulated numerical targets concerning the reduction of emissions for the short and the long term, but if such targets are to be binding and effective, they must be part of an international agreement. Otherwise, there is the danger that emissions will be merely relocated, but not limited at at global level. The UN Framework Convention on Climate Change and the Kyoto Protocol require developed nations to take the lead in curbing emissions, based on the accepted principle of common but differentiated responsibilities. This should continue to be the case, but it is evident that some developing nations, especially those where economic growth and emissions are sharply on the rise, must take on obligations of some sort in the future if the ultimate goal the Convention is to be met.

For the short term, the Icelandic authorities must guarantee that they will fulfil the obligations set forth in the Kyoto Protocol. This Climate Change Strategy presents, for the first time, the Icelandic government's long-term vision concerning the necessity for substantial reduction of net GHG emissions until the year 2050. Such a vision does not represent a binding obligation for Iceland, but it does demonstrate the nation's will and desire to be at the forefront in a global campaign against climate change.

The Kyoto Protocol

According to the Kyoto Protocol, Iceland's specific obligations concerning greenhouse gas emissions are twofold:

- ✓ Greenhouse gas emissions from Iceland may not increase more than 10% over and above 1990 levels; that is, they must remain within approximately 3,800 thousand tonnes of CO_2 equivalents per year, on the average, during the period 2008-2012.

- ✓ It is authorised, however, to emit additional CO_2 from new heavy industry originating after 1990, if that industry meets the conditions of Decision 14/CP.7, though the emissions may not exceed 1,600 thousand tonnes per annum, on average, during the period 2008-2012.

According to the Environment and Food Agency's emissions forecasts until the year 2020, it is very likely that Iceland will remain within these limits. There is nonetheless some uncertainty regarding the scope and timing of new energy-intensive industry projects that are planned for the period from the present until 2012. It is necessary to ensure that there is no danger that Iceland will exceed the limits set for the country, even though forecasts indicate that the likelihood of such exceedance is very small. A new adopted by the Parliament in 2007 is intended to ensure that emissions from single sources do not lead to Iceland exceeding its Kyoto obligations, by requiring industry emitting more than 30,000 tons of CO2 to achieve emission credits from a limited government-administered pool of AAUs. Should any company need more credits than is available in this pool, it has to achieve Kyoto-credits through other means, or face a fine.

Aspirational goal for 2050

The Icelandic government has set the following long-term aspirational goal:

- **that net GHG emissions shall drop by 50-75% from net 1990 levels by the year 2050.**

This long-term target is set as an ambitious goal at which Iceland should aim, but one which requires systematic measures over the next few decades in order to reduce net GHG emissions. The objective

is not set based on forecasts of possible developments in energy use, greenhouse gas emissions, or likely technological developments; rather, it is based on the need to reduce GHG emissions significantly on a global scale over the next several decades, which has been clearly laid out by the assessments of the Intergovernmental Panel of Climate Change. To succeed in this, large and rapidly developing countries must take some kind of efforts to limit emissions, and developed countries must reduce their emissions drastically.

There are a large number of uncertainty factors regarding the likely developments in greenhouse gas emissions from Iceland some four decades in the future, which makes it difficult to estimate how realistic it is to suppose that this long-term vision will become a reality. It is difficult to predict technological developments— in, for example, automotive engines, ship engines, or industrial processes — so far in the future. It must be considered likely, however, that climate-friendlier technology will make more decisive inroads in the future; for example, the use of hydrogen, other climate-friendly fuels, or electricity for ships and automobiles; the use of carbon-free carbon anodes in the aluminium industry, etc. It is not inconceivable, actually, that progress in these areas will result in net levels of greenhouse gas emissions (emissions less sequestration) that approach zero or are even negative, especially if actions to mitigate climate change abroad would be counted, in a similar way as the Kyoto Protocol's Clean Development Mechanism and Joint Implementation.

On the other hand, it should be pointed out that greenhouse gas emissions are closely related to nearly all types of economic activity and come such a wide range of sources that it can be considered likely that they will continue to be significant for a long time, even if it is possible to reduce the amount emitted. It is also extremely difficult to affect some causes of GHG emissions — such as emissions from livestock — through improved technology. Furthermore, it is appropriate to examine emissions reduction potentials in Iceland by comparison with other countries, using the same criteria. Several countries have set for themselves long-term goals similar to Iceland's, but most of those countries produce most of their electricity through the use of fossil fuels. In that respect, most other countries have more potential for reducing GHG emissions. Iceland has substantial potential for carbon sequestration, which could help in reaching the 2050 goal. It is clear, however, that this long-term vision will hardly be realised unless the Icelandic government works systematically toward reducing net emissions in the country and with international collaboration.

It is appropriate to re-evaluate 2050 aspirational goal at a later time, based on IPCC assessments of the necessity to limit GHG emissions, an expert appraisal of the technological and economic possibility of reaching the goal, and a comparison of the vision with the long-term goals of other nations, using comparable criteria for analysing mitigation potential.

III. Objectives and measures

A. The Icelandic government will fulfil its international obligations according to the UN Framework Convention on Climate Change and the Kyoto Protocol.

It is important that measures adopted by Iceland to combat climate change take into consideration the provisions of the UN Framework Convention on Climate Change and the Kyoto Protocol, and that those measures aim at reducing climate change on a global level, not merely in Iceland. The Icelandic authorities will aim at ensuring that Iceland remains within the emissions targets set in the Kyoto Protocol. Iceland will participate actively in the negotiation of further international climate agreements, and efforts to disseminate renewable energy and climate-friendly technology.

Measures:

- The Icelandic government will work toward improving the infrastructure to help it fulfil its obligations under the Kyoto Protocol during the first commitment period, 2008-2012. A registry will be set up in order to keep track of Iceland's Kyoto units, and the greenhouse gas emissions and carbon sequestration inventory will be improved.

- The Icelandic government will participate actively in discussions taking place within the domain of the UNFCCC, as well as participating in international collaboration pertaining to climate change issues in other fora, such as in Nordic co-operation and the Arctic Council.

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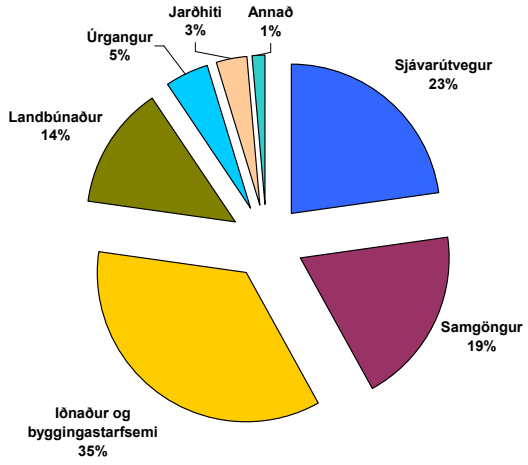
B. Greenhouse gas emissions will be reduced, with a special emphasis on reducing the use of fossil fuels in favour of renewable energy sources and climate-friendly fuels.

Projections by the Environment and Food Agency indicate that, during the period 2008-2012, Iceland will achieve its Kyoto emission limitation commitment, of not increasing its GHG emissions by more than 10% above 1990 levels. The objective regarding GHG emissions is, however, not only to adhere to international obligations, but to seek all economically feasible means to reduce greenhouse gas emissions. Such actions are useful in the campaign against climate change and should be a priority goal for Iceland, which possesses an abundance of renewable energy resources and is a known leader in climate-friendly technology, such as geothermal and hydrogen fuel use. An emphasis is placed on the efficiency and economy of the measures employed.

Iceland enjoys a unique position among Annex-I countries in that there is virtually no GHG emission from stationary energy production, which is almost exclusively carried out using renewable energy sources. Thus it is a matter of high priority to reduce the use of fossil fuels in transport and in fisheries to the maximum extent possible and to use electricity or climate-friendly fuels such as hydrogen, methane, or biodiesel instead. It is difficult to predict what the technological development will be in this respect, but it is worth pointing out that Iceland's 2002 sustainable development strategy, Welfare for the Future, sets forth the aim that Iceland's use of fossil fuels will be insignificant by the year 2030.

Measures aimed at reducing greenhouse gas emissions constitute the most important aspect of the government's climate change strategy. Below are assessments of mitigation potentials for individual sectors and industries, as well as measures pertaining to each.

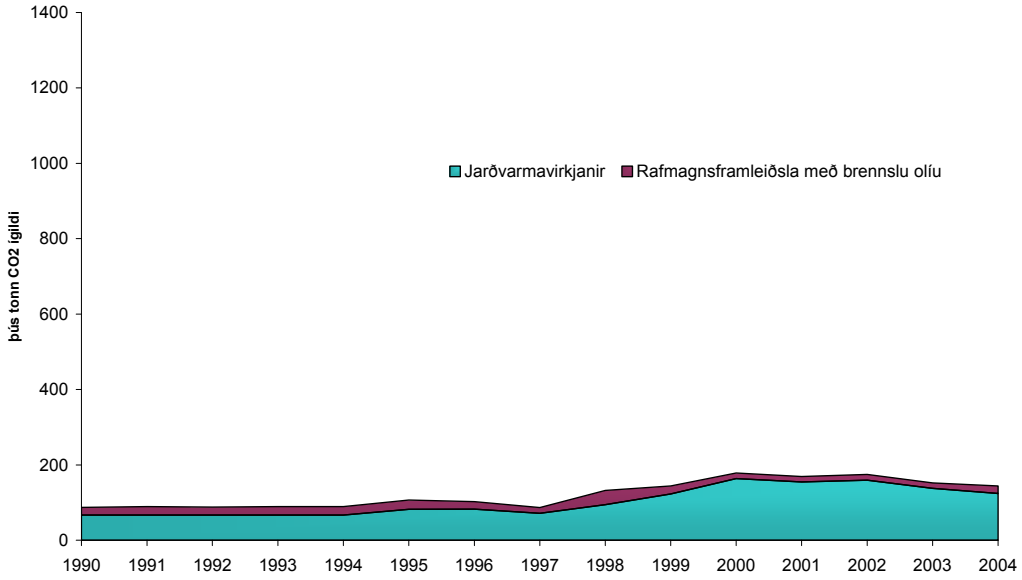
Emissions in 2004, by sector



Energy production

Emissions 1990: 88 Gg = 2.6% of total emissions
Emissions 2004: 144 Gg = 3.9% of total emissions

64% increase since 1990



Emissions reduction potential: Iceland is in a very special situation, in that nearly all of its stationary energy production comes from renewable resources: hydropower and geothermal heat. In most countries fossil fuels are a significant source for electricity production and for space heating, and in most places, this is the sector with the greatest emissions reduction potential. If stationary energy production in Iceland utilised coal or oil, the resulting emissions would probably total approximately 8-10 million tonnes of CO_2 per year. Research indicates that there is some emission of CO_2 from some geothermal plants above the natural emission emission rate from geothermal fields. However, emissions from geothermal power stations are always far less than those resulting from the combustion of fossil fuels. For these reasons, there is very little margin for reduction of the emissions resulting from stationary energy production in Iceland. There is the possibility, however, of pumping CO_2 from geothermal plants back underground, where it is mineralized. An experimental project of this type, the first of its kind in the world, is currently underway in Iceland.

Other benefits: Iceland's primary asset in limiting greenhouse gas emissions is its abundance of renewable energy resources. The utilisation of these resources, whether for public use in Iceland or for export, is positive from the standpoint of climate change issues, through in some instances it could have negative environmental effects on nature conservation. Icelanders' knowledge in this field, especially that relating to the utilisation of geothermal energy, has already been disseminated to many parts of the world, and exportation of that know-how could prove to be Iceland's greatest contribution to the campaign against climate change.

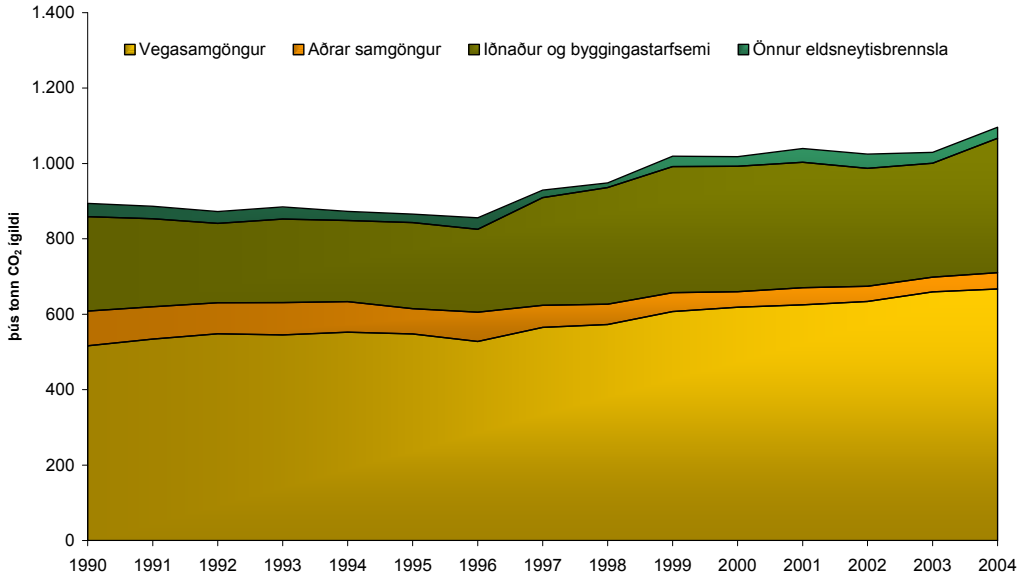
Measures:

- Research will be done on the feasibility of pumping CO_2 from geothermal power plants back into the earth.
- Increased emphasis will be placed on the exportation of technology and know-how in fields related to the utilisation of renewable energy resources.

Transport and fuel

Emissions 1990: 894 Gg = 26.4% of total emissions (transport = 18.1%)
Emissions 2004: 1096 Gg = 29.6% of total emissions (transport = 19.2%)

23% increase since 1990 (17% increase from transport since 1990)



Emission reduction potential: Nowhere are the possibilities for emissions reduction greater than in this sector. There are three reasons for this: emissions are substantial, they have increased, and new climate-friendly technology in the field already exists or will very likely become mory widely available and competitive in the years to come.

Other benefits: Reductions in GHG emissions from fuel use and transport are accompanied by savings in fuel purchases from abroad. The cost of fuel purchases was ISK 27.6 billion in 2005, up from ISK 17.8 billion in the year 2000. The domestic production of fuel or electricity for transport enhances energy security. Both reductions in the use of fuel and the use of most types of climate-friendly fuels will result in reductions in local air pollution.

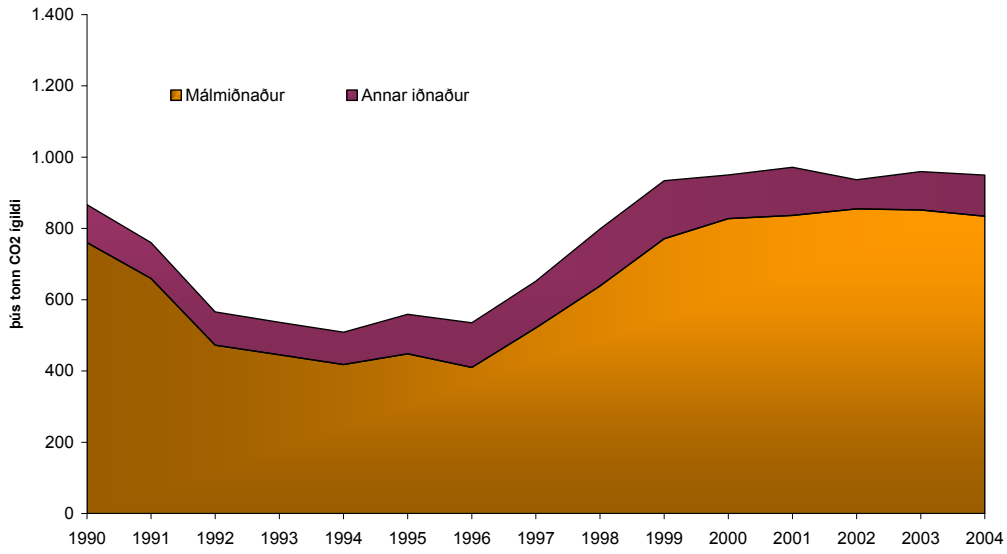
Measures:

- It is necessary to continue to use economic incentives in order to encourage the purchase of climate-friendly motor vehicles and the use of climate-friendly fuels. Existing proposals for such incentive systems will be assessed, including those from the Forum for Environment-Friendly Fuel. The temporary discount on fees for vehicles that use climate-friendly technology (such as hydrogen, methane, electricity, and hybrid technology) will be extended until a comprehensive fee system has been established.
- Government agencies will purchase climate-friendly vehicles for their operations insofar as is possible.
- There will be increased emphasis on educating buyers about CO_2 emissions from motor vehicles and the effects of those emissions on climate.
- The government shall seek further ways to increase the possibilities for bicycling as a feasible transport option.
- The government shall promote public transport as a feasible option for most people.

Industrial processes

Emissions 1990: 867 Gg = 25.8% of total emissions
Emissions 2004: 949 Gg = 25.6% of total emissions

9% increase since 1990



Emission reduction potential: It is possible to control fluorocarbon emissions from aluminium smelters to a substantial degree, and the government's ambitious targets from its previous strategy have been achieved in the two aluminium smelters operating in Iceland. The possibility of limiting CO_2 emissions from aluminium smelters is quite small without changes in technology; however, carbon-free anodes could be developed in the future and would present the option of producing aluminium in a manner accompanied by very little emissions. The aluminium industry in Iceland has the potential to emit a smaller amount of greenhouse gas per tonne of aluminium produced than does comparable industry anywhere else in the world. The possibilities for reducing emissions from other heavy industry are not as well known.

Other benefits: Fluorocarbons generate pollution that can cause harm to human health and to the natural surroundings, as well as generating a greenhouse effect; therefore, reductions in fluorocarbon emissions are generally a positive development.

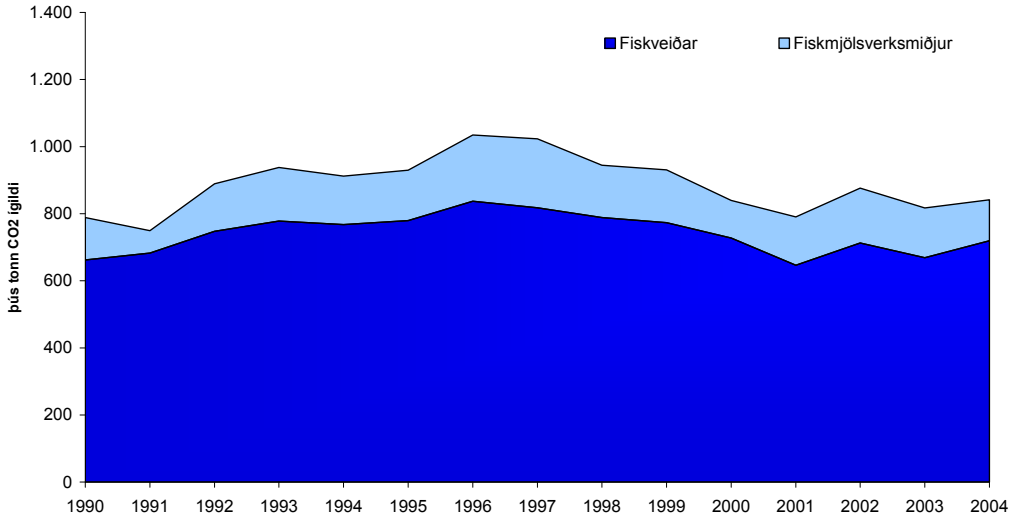
Measures:

- Information showing, among other things, a comparison of greenhouse gas emissions from aluminium smelters in Iceland and elsewhere will be published regularly.
- Rules will be set concerning the assignment of emissions allocations to industrial companies, and the companies will be required to obtain emission reduction units if they exceed allocation limits.
- A study of emissions reduction potentials from industries other than aluminium production shall be made.

The fishing industry

Emissions 1990: 783 Gg = 23.3% of total emissions
Emissions 2004: 834 Gg = 22.5% of total emissions

7% increase since 1990



Emission reduction potential: The potential for reduction of emissions from fishing vessels has been considered limited because the fishing industry derives a clear benefit from saving fuel. The Icelandic fishery industry is not subsidised by the government, but operates in competition with fisheries that, in many other places, are subsidised, which means that the fuel economy and efficiency is greater. It has also been pointed out that the catch quota system provides an incentive to minimise expenses, including fuel use, in order to achieve the set quota. There is a lack of comparison with other countries in this instance, however. Constant work is being done to develop technology that could reduce energy consumption and emissions from fishing vessels, and Icelandic companies are rather advanced in these matters. There is the possibility of substituting ammonia for greenhouse gas refrigerants (HFCs). In recent years, many fishmeal plants have set up equipment in order to use electricity instead of oil for rendering; however, the relatively recent trend has been that some factories have turned back to the use of oil, which is negative from climate considerations.

Other benefits: Reduced emissions from fuel combustion in fishing goes hand-in-hand with savings and increased efficiency of fishing operations.

Measures:

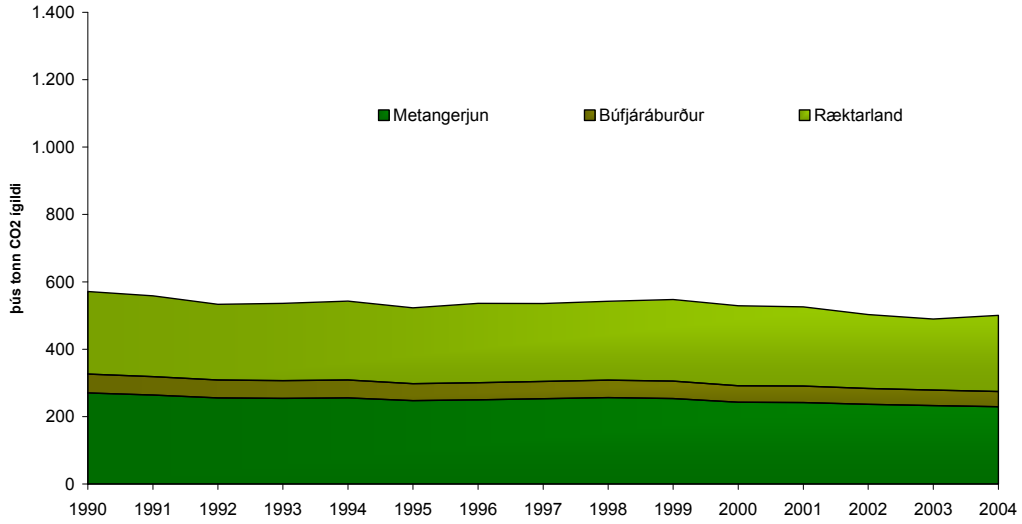
- An agreement will be made with stakeholder groups in the fishing industry concerning fuel use and GHG emissions from fishing and fish processing, and this agreement will form the foundation for regular consultation between the government and the fishing sector. Means will be sought to reduce GHG emissions, both in general and as a proportion of the catch and its value.
- Governmental agencies shall support research and development projects in fields related to fuel savings and the use of climate-friendly energy sources for fishing ships, energy-saving fishing equipment, etc.
- Ships purchased by the government should be furnished with fuel-saving equipment.
- A study shall be made of the possibility of substituting ammonia for HFCs in refrigeration systems.

- The government shall look at ways to get fishmeal plants to use electricity instead of fossil fuels.
- The government shall exert its influence so that harbours will be equipped with electricity that is more efficient than diesel engine use.

Agriculture

Emissions 1990: 571 Gg = 17.0% of total emissions
Emissions 2004: 500 Gg = 13.5% of total emissions

12% decrease since 1990



Emission reduction potential: The possibilities for reduction of emissions from conventional agriculture are uncertain. In general, it is considered very difficult to reduce emissions from livestock and fertiliser except through reductions in agricultural production; however, changes in land use can sometimes result in reduced emissions. Emissions from conventional farming were considered rather low in Iceland until 2004, when a correction in calculation methods revealed that emissions stemming from agriculture were greater than previously believed. It is necessary to review all aspects of emissions from agriculture and then assess the possibilities for reduction.

Other benefits: The chief benefit is related to instituting changes in land use so as to reduce emissions and increase sequestration. This will occur together with enhancement of fertility, which promotes improvements in agricultural operations.

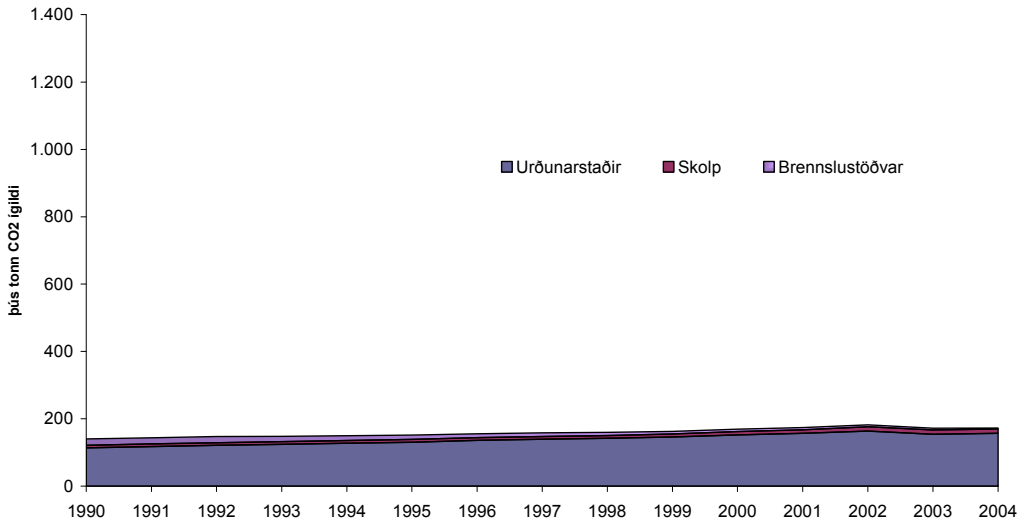
Measures:

- Have an appraisal done of the possibilities for reducing emissions in agriculture.

Waste

Emissions 1990: 141 Gg = 4.2% of total emissions
Emissions 2004: 172 Gg = 4.6% of total emissions

23% increase since 1990



Possibilities for reduction of emissions: It is possible to reduce the volume of organic waste that is sent for landfilling, and it is possible to increase the tapping of methane from landfills.

Other benefits: Organic waste that is now placed in landfills could be utilised as fertiliser for vegetation, among other things. The methane that accumulates could be used as a fuel instead of imported fuel, which would increase energy security.

Measures:

- A national plan for waste handling should be implemented, and the resulting reduction in emissions should be assessed.
- The processing and combustion of methane at Álfsnes landfill should be continued and increased, and attempts should be made to increase the number of methane-driven automobiles through economic measures and/or government purchases of methane vehicles.
- Methane should be processed for fuel use or combustion in more locations in Iceland if possible.

C. The government will attempt to increase carbon sequestration from the atmosphere through afforestation, revegetation, wetland reclamation, and changed land use.

Land and soil erosion are one of Iceland's chief environmental problems. It is believed that more than 95% of the country's forests and over half of its contiguous soil cover have been lost since the time the island was settled. This means not only that the capacity of vegetation and soil to remove carbon from the atmosphere is much less than would otherwise be the case, but also that the soil in Iceland is especially needy of carbon. This means that it is possible to combine the goals of reclaiming vegetation and soil and of combatting climate change through the sequestration of carbon from the atmosphere. Recent research indicates that a there is significant emission of CO_2 from overused land and from drained wetlands. This calls for changes in land use and increased emphasis on wetland reclamation, which would reduce such emissions and even result in net sequestration of carbon from the atmosphere. Wetland reclamation is a new topic of emphasis in the government's policy on climate.

Carbon sequestration through changed land use should take account of biodiversity and human welfare concerns. Care will be taken that revegetation efforts are taken in harmony with nature conservation. The chief premise of measures related to afforestation, land reclamation, and wetland reclamation should be the strengthening of the biosphere, the reclamation of land, the interest of communities, and economic development. The sequestration of carbon from the atmosphere significantly increases the effectiveness of such measures from an environmental point of view and can become an important element in Iceland's endeavours to reduce net emissions of greenhouse gases.

Sequestration of carbon from the atmosphere Sequestration 1990: 8 Gg Sequestration 2004: 254 Gg (-6.9% of total emissions)
Possibilities for increased sequestration: In Iceland there is a great deal of room to increase sequestration of carbon in soil and vegetation, as a result of both the substantial erosion of vegetation and soil throughout the centuries and the drainage of wetlands in recent decades. This has resulted an a loss of carbon stocks, but the trend can be reversed. The sequestration of carbon through afforestation and land reclamation is a recognised means of fulfilling the commitments set forth in the Kyoto Protocol. Recent research indicates that there are significant CO_2 emissions from drained wetlands, which now are less important to agricultural production than they used to be. These emissions can be stopped and even reversed through the reclamation of wetland areas. At present, such sequestration is not assessed for emission reduction units in the Kyoto system, but measures of this type could possibly be included in a registration system for emissions and sequestration of greenhouse gases in the future.
Other benefits: It has long been the policy of the government to stop – and to reverse – the erosion of vegetation and soil, to reclaim vegetated lands through revegetation efforts, and to plant forests for a variety of uses. In recent years, there has also been increased emphasis on the reclamation of ecosystems — such as wetlands and birch forests — independent of production-linked uses.
Measures: • An action plan and cost estimate pertaining to increased sequestration through afforestation, land reclamation, and changed land use will be prepared. An assessment will be made of the various benefits of such an action plan, in addition to the benefits from carbon sequestration. An assessment will be carried out of the various methods based on how quickly they result in increased carbon sequestration. • A plan will be prepared for wetland reclamation, which will, among other things,

analyse its effects of emission and sequestration of greenhouse gases.

- Work will continue on the development of a recently started project related to education on revegetation within the framework of Iceland's developmental collaboration work.
- Iceland will participate actively in new discussions on the connection between land use and carbon sequestration as these relate to climate change issues, with the aim, among other things, of strengthening the scientific foundation of sequestration as a measure to mitigate climate change, and to examine wetland reclamation as a recognised sequestration method in the next commitment period defined in the Kyoto Protocol.

D. The government will foster research and innovation in fields related to climate change affairs and will promote the exportation of Icelandic expertise in fields related to renewable energy and climate-friendly technology.

Measures to reduce greenhouse gas emissions often include costly obligations for companies and the general public. However, the problem also represents opportunity in many cases because it calls for new ways of thinking and new solutions. Climate change caused by human activity requires that the countries of the world rely on climate-friendly technology, not least in the field of energy affairs, because it is necessary that clean and renewable energy sources supplant the use of fossil fuels. Icelanders have significant experience and expertise in the field of climate-friendly technology, which can be communicated to other countries. It is possible that Icelanders can contribute more to the international campaign against climate change through the exportation of such expertise and technology than through any other means. The following are three projects that are important in this context:

- Iceland has been a leader in geothermal heat utilisation and has made significant contributions in the field, both through the operation of the UN University Geothermal Training Programme and through various projects carried out by Icelandic companies abroad. Hundreds of millions of people who now live with a shortage of energy or who use fuels that pollute could utilise geothermal energy for spatial heating or electricity production. Iceland can be at the forefront in pushing for increased geothermal heat utilisation on a global level and could further promote development aid and international expansion by Icelandic companies in this field. Icelanders also possess knowledge of the utilisation of hydropower, which could also prove useful in other countries.
- Icelanders' research and development projects in the field of hydrogen utilization have attracted attention., Work has also been done on utilising other climate-friendly fuels, such as methane. Further R&D efforts regarding climate-friendly fuels should be encouraged, as Iceland can benefit substantially from using domestic energy resources instead of fossil fuels, and because Iceland has a realistic possibility of becoming the first developed country whose energy needs are met almost entirely without the use of fossil fuels.
- Icelandic parties have worked toward the development of technology to reduce fuel use on ships, and this technology has been put into use both in Iceland and abroad.

Measures:

- Research relating to climate change and climate-friendly technology will be promoted, and the possibility will be examined of setting up a co-ordinated research and development plan concerning innovation in climate-related fields.

- An examination will be made of whether Iceland or Icelandic companies can engage in projects under the Kyoto Clean Development Mechanism in introducing geothermal energy or other climate-friendly technology abroad.

E. The government will prepare for adaptation to climate change.

Despite measures to mitigate climate change, it is clear that there will be considerable changes in climate in the decades to come, even if the success of measures designed to reduce GHG emissions and increase carbon sequestration, both in Iceland and on a global level, exceeds expectations. Therefore, it is necessary to study the likely effects of climate change on Iceland's natural environment, economy, and society, and to prepare the way for adaptation to those changes.

Measures:

- A scientific committee shall be established, which is to submit a report on the likely effects of climate change in Iceland in the decades to come. The committee shall also point out issues that should be considered with respect to the potential adaptation to climate changes. The report shall be based, among other things, on the work done on the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It shall also take into account the report entitled Climate Change and its Effects, which was issued in 2001. The committee shall submit its report to the Minister for the Environment before 1 March 2008.

- The prospect of rising sea levels shall be particularly considered in connection with the design of communities and structures on the shore. An assessment of the probability of flooding from the sea shall be carried out with respect to the likely rise in sea level.

- It is necessary to examine both opportunities and threats accompanying the probable increase in ship traffic and the transport of goods, oil, and gas in the Arctic region.

IV. Research

The worries about climate change generated by human activity are rooted in scientific research and knowledge, which tells us that greenhouse gas emissions from human activities cause atmospheric warming, which will very likely result in serious disturbances to climate and quality of life if no mitigating action is taken. All strategies relating to climate change issues must therefore be securely based in the best possible knowledge available at any given time. The importance of research extends not only to scientific knowledge of the nature and extent of climate changes and the various effects of those changes, but also to research and development in the field of new, climate-friendly technology, economic and social research into the most effective and economical responses to climate changes, and studies of possible ways to co-ordinate the battle against climate change with the move toward greater economic and social welfare.

This Strategy contains numerous provisions that promote research in various fields as a part of government measures. There is no reason to summarise those provisions in this section; however, it is appropriate to draw attention to the fact that the field of research related to climate change represents a host of opportunities to foster the Icelandic scientific community and to participate actively in international endeavours to monitor the consequences of climate changes and develop solutions to the problem.

The Ministry for the Environment has compiled a summary of research related to climate change in a report for the Science and Technology Policy Council. That summary makes it clear that numerous research and monitoring projects related to climate change take place in Icelandic research institutions and universities, including the Iceland Meteorological Office, the Marine Research Institute, the Icelandic Institute of Natural History, the Soil Conservation Service of Iceland, the Iceland Forest Service Research Centre at Mógilsá, the University of Iceland, the Agricultural University of Iceland, and the University of Akureyri. Little has been done, however, to link these research projects or to compile a summary of the results, with the exception of the 2002 report by the Scientific Committee on the effects of climate change in Iceland.

It is highly likely that research related to climate changes will increase worldwide in the years to come. In this context, it is appropriate to mention that during the International Polar Year, 2007-2008, there will be a special effort centring on scientific research related to polar regions. It is probable that studies related to climate change will form a salient part of that research.

In the previously mentioned report to the Science and Technology Policy Council, the Ministry for the Environment stated that increased emphasis on studies of climate change is desirable because such research would lend support to measures combating climate change and would be useful to Icelandic scientists in their efforts to participate even more actively in international monitoring and research projects. In many respects, Iceland is an interesting venue for research into climate changes and their effects, as well as the possible measures to mitigate them. This stems in part from the country's geographical position — at the boundary of the Arctic region and in the path of the Gulf Stream — and it also results from the significant emissions from damaged vegetated lands and the corresponding potential for sequestration of carbon from the atmosphere. In addition, Iceland is an interesting subject of research because of the superabundance of renewable energy resources and progressive technology that can aid in both utilising those resources and reducing greenhouse gas emissions in general.

The report mentions several subjects that would be especially interesting to study and monitor:

- The effects of climate change on Iceland;
- The natural emission of greenhouse gases and the sequestration of CO_2;
- Emissions caused by human activities — improvements in greenhouse gas inventory;
- Measures to combat climate change — assessment of mitigation potentials and economic efficiency of measures;
- Climate-friendly technology — innovation and promotion.

It is appropriate that the Science and Technology Policy Council, together with ministries and government institutions involved in climate change research, examine Iceland's possibilities in these and other related fields, and that they seek ways to promote research related to climate change, possibly with a target plan or with other similar methods.

V. Education and public participation

This Strategy addresses primarily the measures that the Icelandic government will adopt in order to combat human-induced climate change and to fulfil Iceland's international obligations. It is clear, however, that such measures will be of limited value if there is no general awareness of the subject and if the general public are not willing to participate in achieving set targets. The government must work with industry and non-governmental organisations in order to mobilise the public so that goals can be achieved.

The government has in the past consulted with industry concerning the implementation of various elements of the Climate Change Strategy of 2002. Chief among those efforts is collaboration with the aluminium industry. Aluminium manufacturers have, in co-operation with the government, made substantial progress in minimising the emissions of fluorocarbons, with the result that PFC emissions in Iceland are among the lowest in the world. In addition, the government has financially supported the work of non-governmental organisations, such as the Landvernd Climate Change project, which has yielded a number of proposals for potential reduction of emissions.

Individuals and households can make a considerable impact on greenhouse gas emissions, though emissions from these sources are much less than those resulting from commercial activities. Emissions generated by individuals in Iceland are also different than in most other countries and are mostly a result of transport rather than domestic energy use. It is necessary to increase general public knowledge of the possibility of reducing greenhouse gas emissions in daily life. Work will be done to prepare educational materials in co-operation with non-governmental organisations and stakeholder organisations so as to inform the public of the greenhouse effect and the measures that can be adopted to reduce it.

VI. Implementation and follow-up

This Strategy provides a framework for the government's policy in climate change issues, which should be reviewed regularly and revised if need be or if premises change in any way; for example, in relation to negotiations concerning new international commitments after the year 2012.

The discussion of climate change, both in the international arena and in Iceland, has become weightier and more serious in light of new and better scientific knowledge; therefore, it is necessary to lend further support to the government's Strategy. In this context, it is appropriate to emphasise four points:

- The first commitment period under the Kyoto Protocol takes effect in 2008, and it will require substantial work to maintain the registry system for Iceland's emissions allocations and to carry out the emissions and sequestration inventory and reporting to the UNFCCC;
- New contractual negotiations concerning the continuation of both the Kyoto Protocol and international co-operation on climate change issues after 2012 began in May 2006. This calls for more active participation by the Icelandic government in international discussions and in examining ways to fulfil future commitments and achieve them in the most cost-effective manner;
- The European Union has set rules designed to reduce CO_2 emissions, which could effect Icelandic companies, including proposals concerning limitations on emissions from air transport; and
- The 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), to be issued in 2007, will include the best available scientific knowledge of the extent and rate of climate change and their expected consequences, which in turn calls both for responses by individual countries on ways to limit net greenhouse gas emissions and for an assessment of the consequences of climate changes in individual countries and geographical regions.

The Inter-Ministerial Advisory Committee on Climate Change will work actively toward enforcing and reviewing the government's Strategy and will follow developments in international climate negotiations. This Strategy also stipulates that two committees be appointed in order to support the government's work on climate change issues:

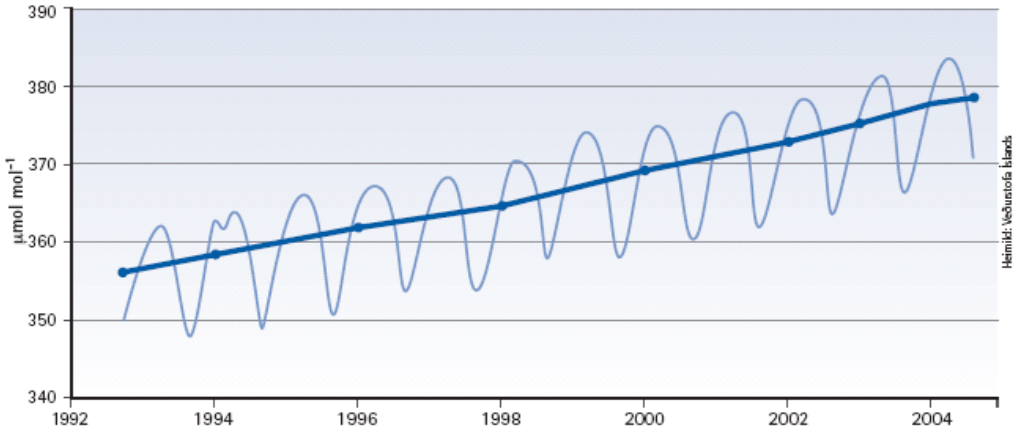
- **An Expert Panel on the Reduction of Net Greenhouse Gas Emissions.** The panel will be assigned the task of preparing an expert assessment of Iceland's possibilities for reducing greenhouse gas emissions and removing carbon from the atmosphere. Special emphasis will be placed on examining the cost of various measures and on assessing their efficiency and economic benefits.
- **A Scientific Committee on Climate Changes.** The committee will be assigned the task of submitting a report on the likely effects of climate change on Iceland in the decades to come, and of pointing out items that should be considered with regard to the potential adaptation to climate change. The report shall be based, among other things, on the work done on the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Both committees will be appointed by the Minister for the Environment, who will stipulate further on the tasks they should carry out, in consultation with the Ministerial Advisory Committee on Climate Change.

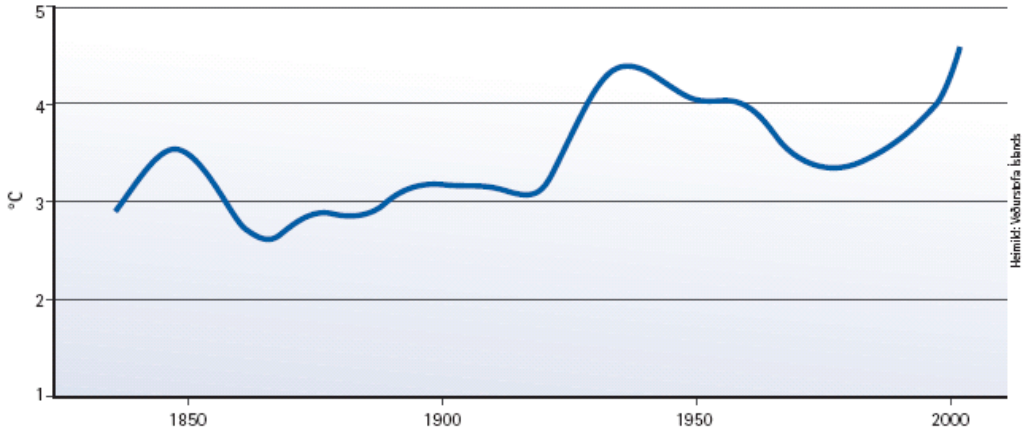
It is reasonable to review the Strategy once the expert committee has completed its work concerning the reduction of net GHG emissions, for at that time it should be possible to re-examine proposals for measures and prioritise them more effectively in terms of economy and efficiency.

VII. Climate change indicators

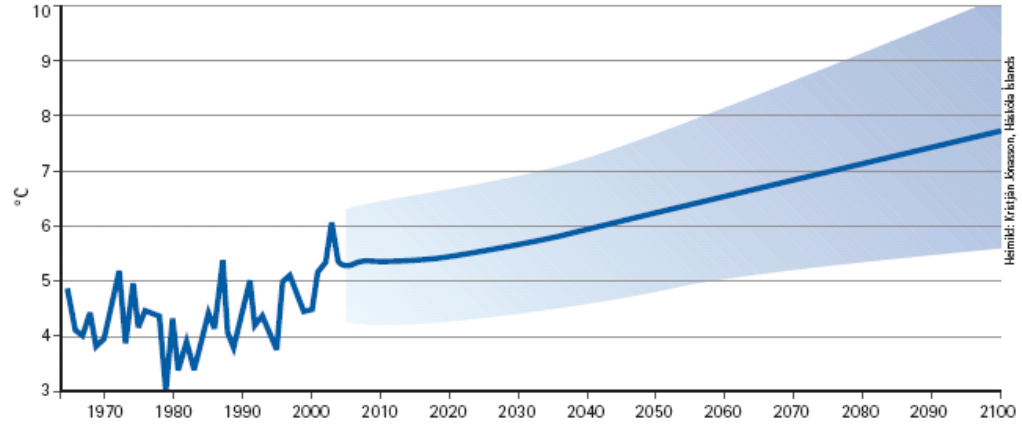
Carbon dioxide concentration in Iceland 1992-2004



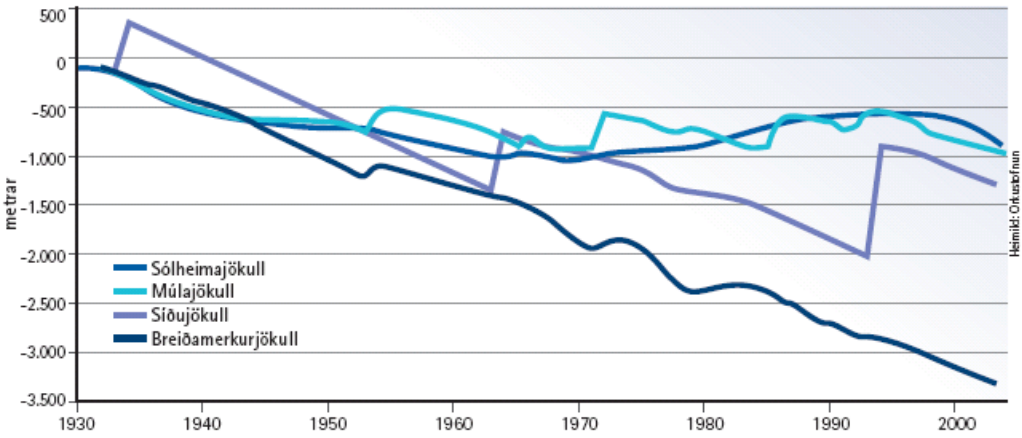
Temperature trends in Stykkishólmur 1820-2004



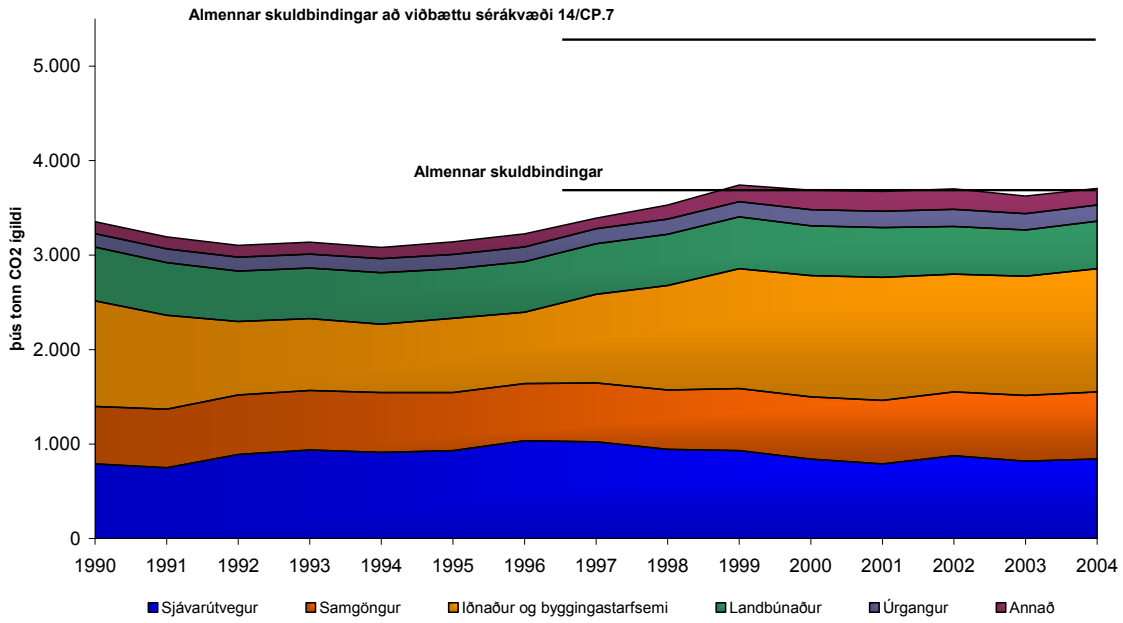
Forecasted temperature developments in Reykjavík until 2100



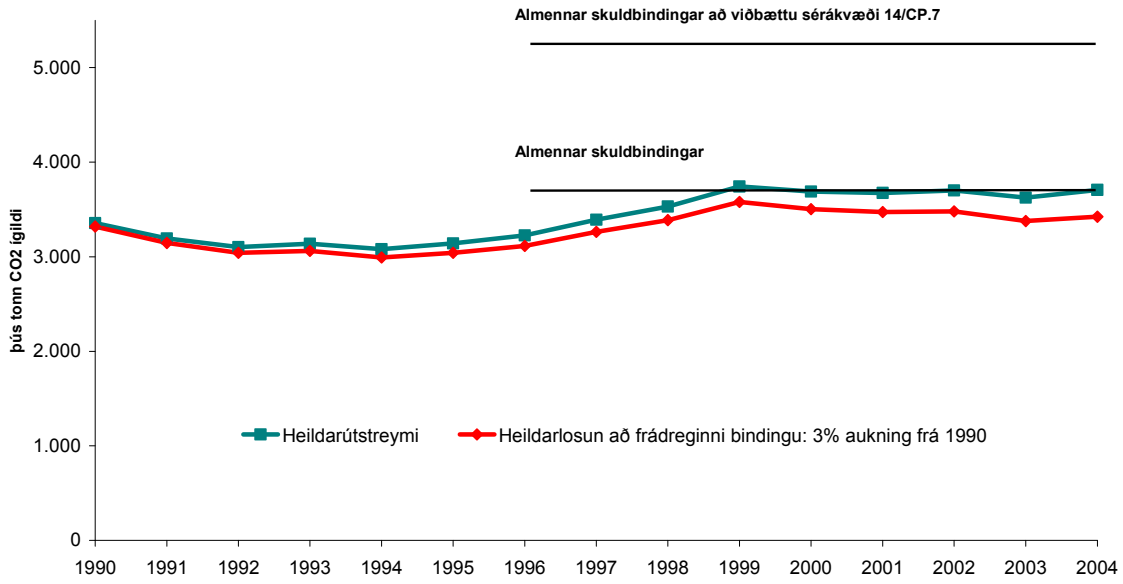
Glacial developments in Iceland 1930-2003



Total emissions of greenhouse gases 1990-2004
11% increase since 1990

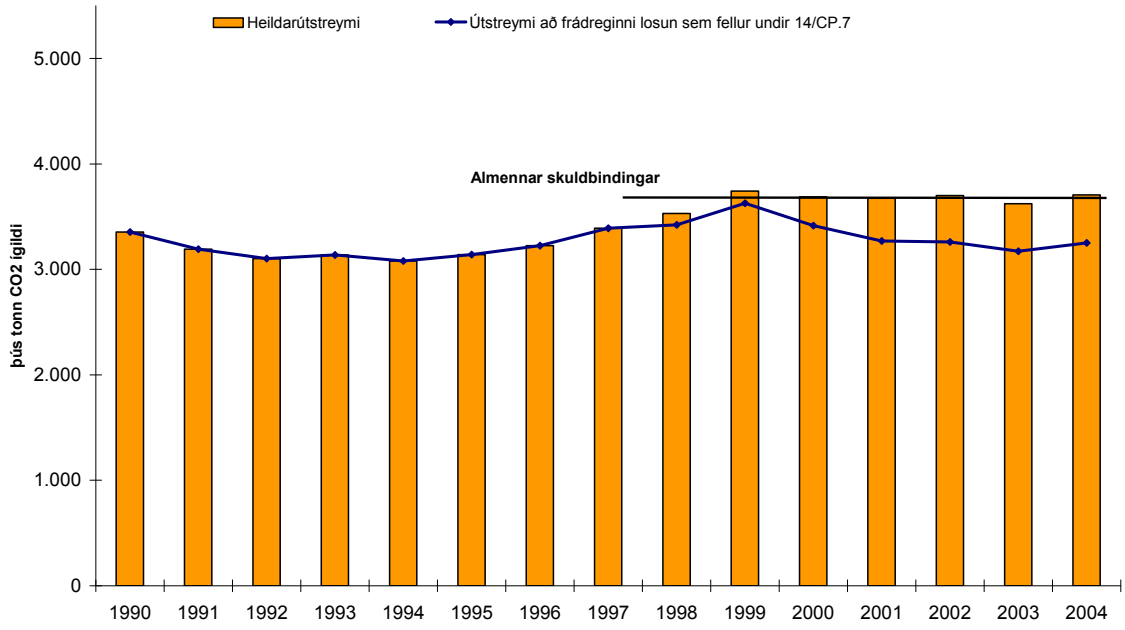


Total emissions of greenhouse gases 1990-2004
3% increase since 1990, with consideration given to sequestration from land reclamation and afforestation.

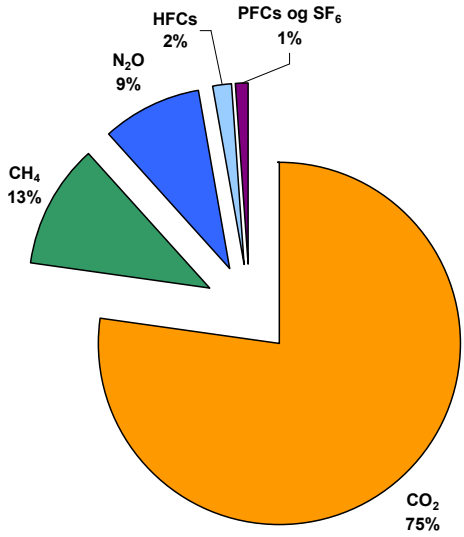


GHG emissions less emissions falling under Decision 14/CP.7

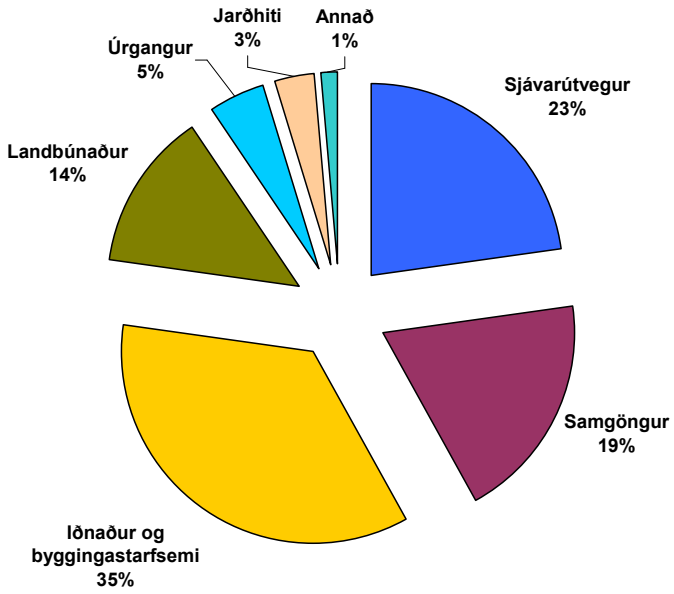
CO_2 falling under the provisions of Decision 14/CP.7 totalled 455 thousand tonnes in 2004.



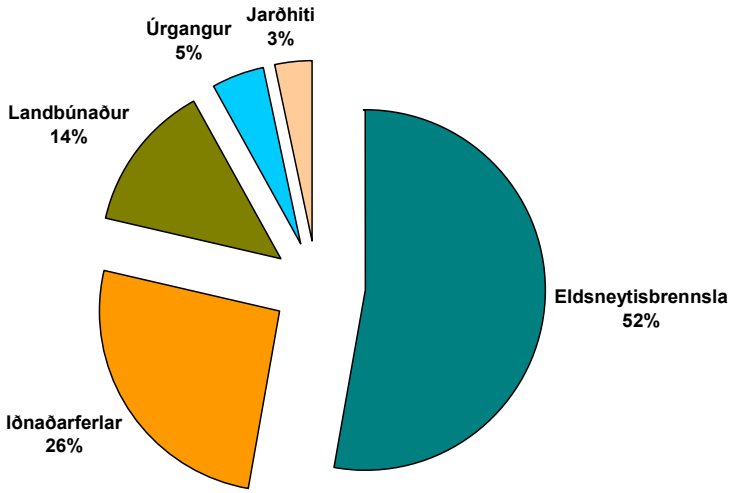
Emissions in 2004, by gas type



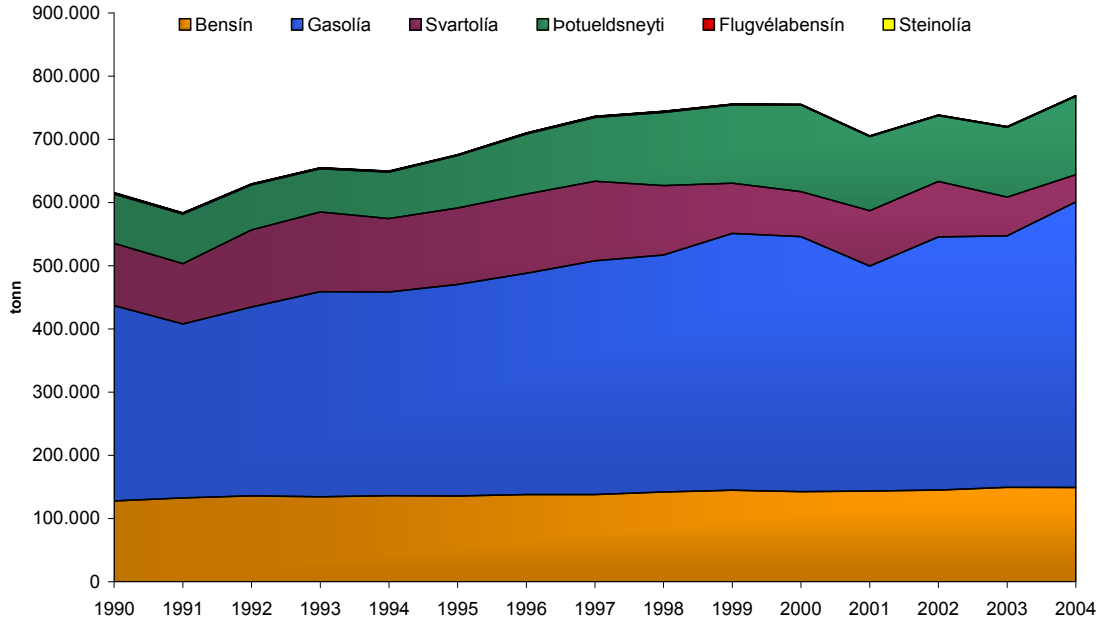
Emissions in 2004, by sector



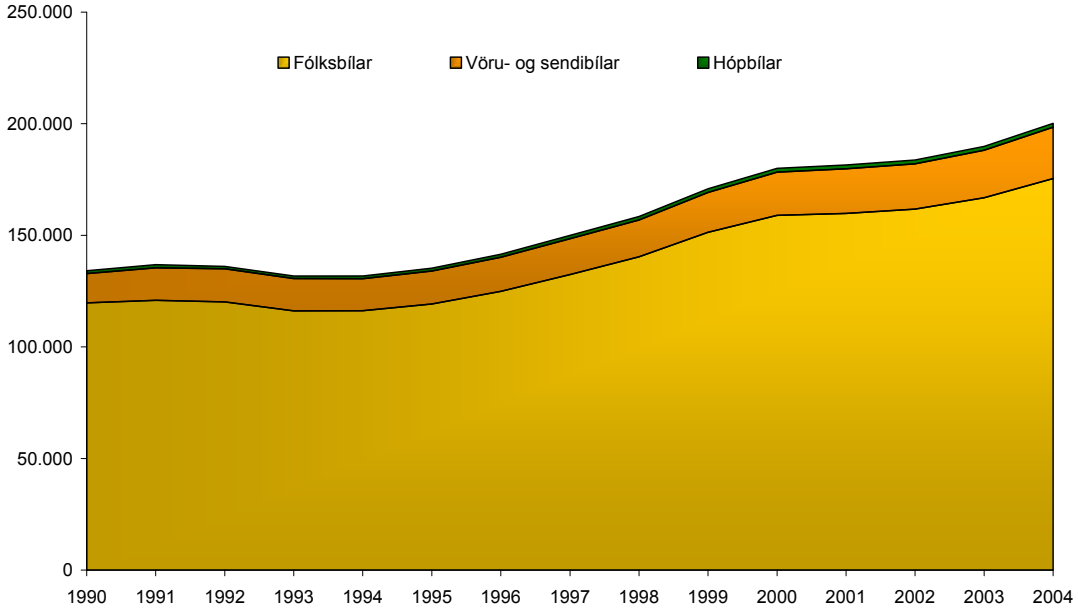
Emissions in 2004, by origin



Fuel sales in Iceland, by fuel type
25% increase since 1990
International use of aviation gasoline, jet fuel, diesel fuel, and fuel oil does not fall under the provisions of the Kyoto Protocol.

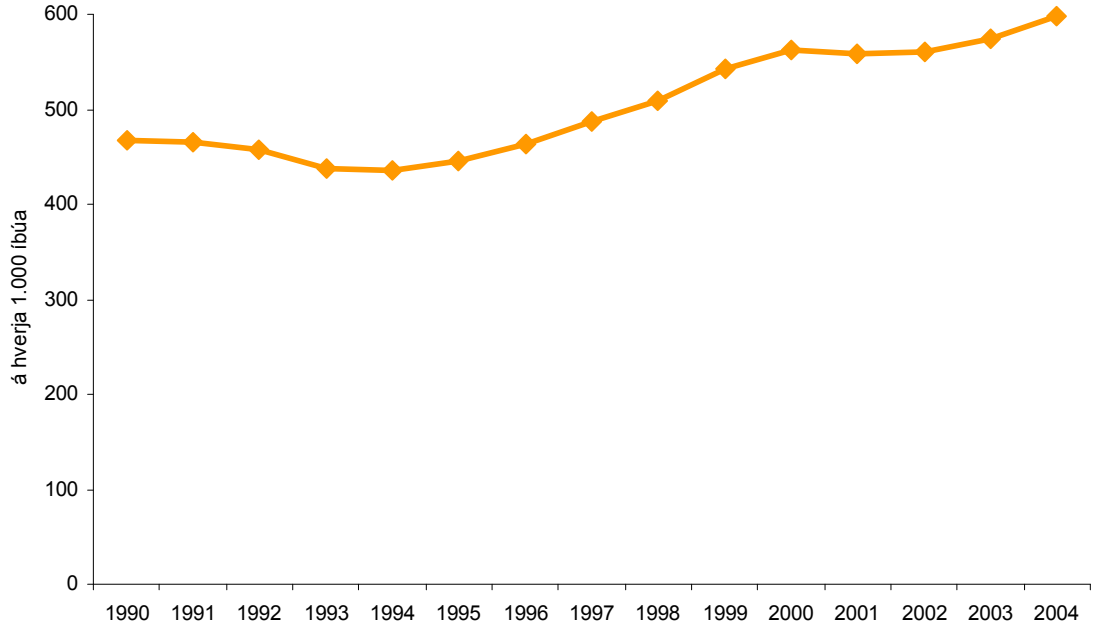


Number of private vehicles, trucks, vans, and group passenger vehicles, 1990-2004
49% increase since 1990



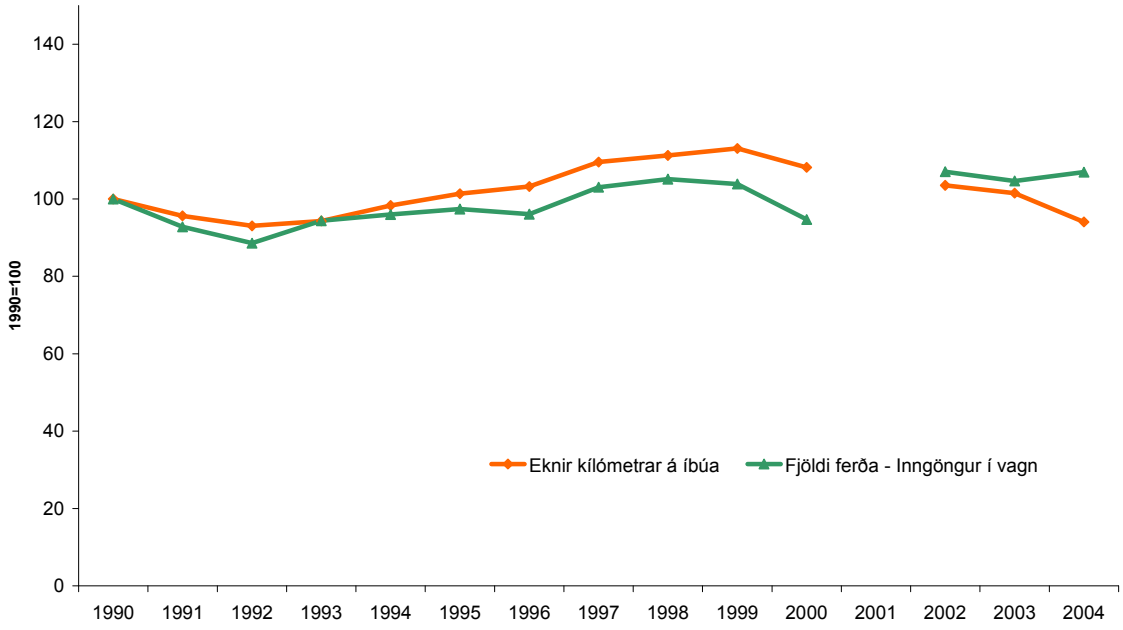
Private vehicles per 1000 inhabitants, 1990-2004

28% increase since 1990

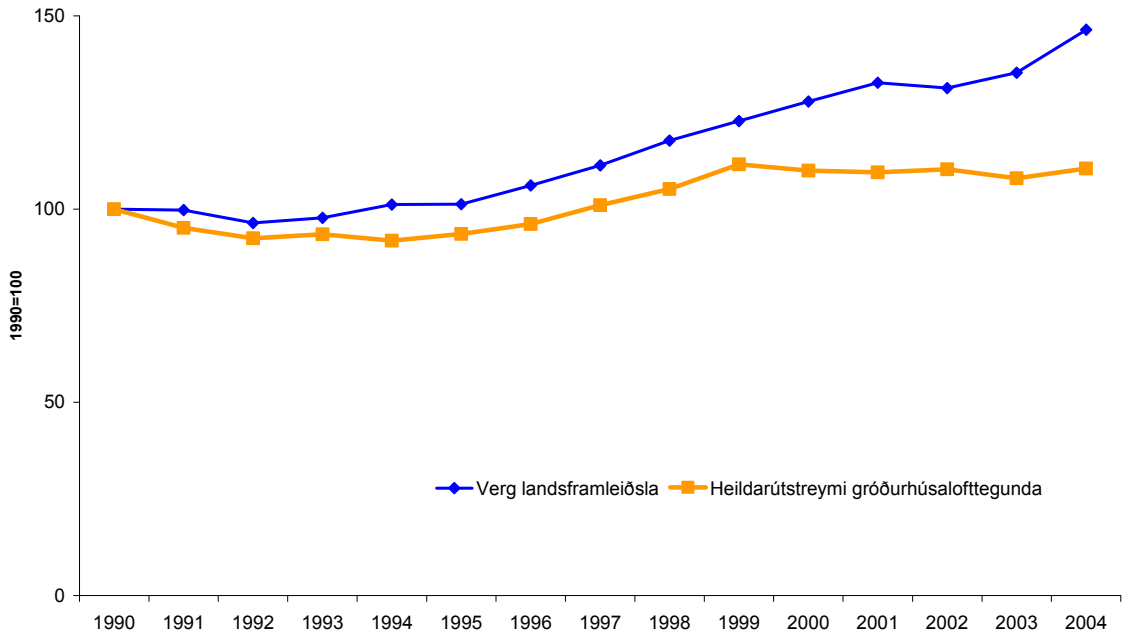


Developments in public bus traffic and number of passengers in the Reykjavík area

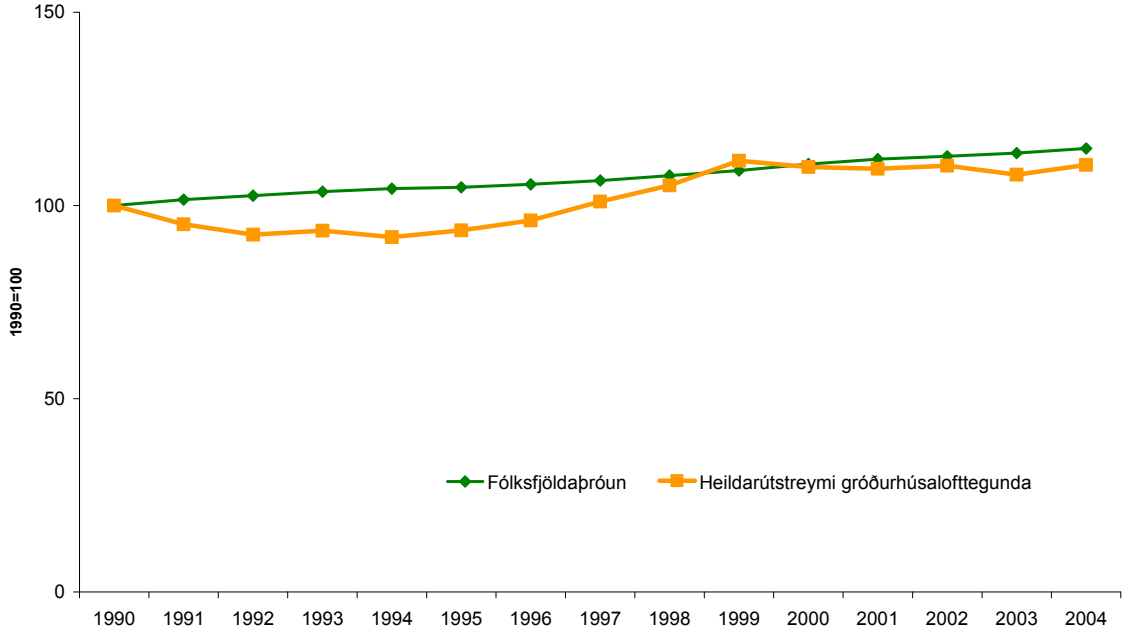
As of mid-2001, the bus company Straetó bs. also serves Hafnarfjördur, Gardabaer, and Bessastadir.



Developments in total GHG emissions and gross domestic product (GDP)



Developments in total GHG emissions and population



Appendix:

Implementation of the Icelandic government's Strategy of 2002 concerning measures for fulfilling the obligations under the UN Framework Convention on Climate Change and the Kyoto Protocol:

The Icelandic government strategy from 2002 contains provisions relating both to government measures for fulfilling Iceland's obligations under the Kyoto Protocol and to the division of ministerial responsibility relating to the implementation of these measures.

According to that division, the Ministry for the Environment bears the overall responsibility for implementing the Framework Convention and the Kyoto Protocol in Iceland. Measures related to transport are the responsibility of the Ministry of Transport, Tourism, and Telecommunications; changes in taxation of diesel vehicles are the responsibility of the Ministry of Finance; energy-saving measures for fishing vessels are the task of the Ministry of Fisheries; the Icelandic provision of the Kyoto Protocol and measures to limit landfills and landfill emissions are handled by the Ministry for the Environment; carbon sequestration through plant and crop cultivation is the responsibility of the Ministry of Agriculture; and research, development, and educational matters are the joint responsibility of all of the ministries.

The Icelandic government's report to the Framework Convention office on visible progress in the implementation of the Kyoto Protocol, which was issued in 2006, describes the implementation of the Strategy. That report states that the primary progress from a statistical standpoint has been in reducing fluorocarbon emissions from aluminium production and in increased carbon sequestration through land reclamation and afforestation. Various other measures have been adopted as well, and though these have yielded less measurable success so far, it is expected that some of them — such as reductions in fees and taxes on climate-friendly motor vehicles — will generate results later on. The report estimates that government measures resulted in a 95,000-tonne reduction in emissions in the year 2005 and a reduction of 200,000 – 226,000 tonnes during the period 2008-2012. If account is also taken of sequestration through afforestation and land reclamation, the total effect of the government measures is considerably greater, or a net reduction of approximately 302,000 in 2005 and of 407,000 – 433,000 tonnes during the period 2008-2012.

The accompanying summary provides more detailed information on measures that have been adopted in order to implement the Strategy from the year 2002 to the present.

Transport

- ✓ A new oil charge system took effect on 1 July 2005. The pertinent legislation changed the taxation structure for diesel fuel, thus simplifying the use of diesel automobiles by charging fees in the same manner as is done for gasoline. This change should result in a gradual increase in the number of smaller diesel vehicles in use, thus reducing greenhouse gas emissions resulting from motor vehicle traffic. For vehicles weighing 10 tonnes or more, a per-kilometre fee is still charged in addition to the oil charge. The abolition of the weight tax and

the adoption of an oil fee instead of the weight tax has resulted in a reduction in fees charged for busses and long-distance coaches. Figures on motor vehicle imports in the year 2006 show that the proportion of diesel automobiles in Iceland has increased.

- ✓ Vehicles that generate virtually no pollution and are powered by unconventional energy sources, such as electricity or hydrogen, have been exempt from excise tax. This exemption includes all motor vehicles that are imported to or manufactured in Iceland and are powered solely by pollution-free energy sources, such as electricity or hydrogen. It does not include vehicles that are powered by both polluting and non-polluting energy sources, such as automobiles with hybrid engines. The exemption will expire at year-end 2008. Vehicles that are powered by electricity and are imported or built for experimental purposes are also exempt from excise tax.

- ✓ Automobiles that are equipped with engines utilising methane or electricity to a substantial degree instead of gasoline or diesel fuel bear an excise tax that is ISK 240,000 less than that on conventional vehicles. This discount has been doubled, and it remains in effect through the year 2006. As a result of the reduced excise tax, hybrid automobiles could become more economical than conventional vehicles in some instances.

- ✓ It is now permissible to cancel or refund value-added tax on hydrogen-powered vehicles and on specialised spare parts that are imported for research purposes. It is also permissible to cancel import duties and/or excise tax on spare parts. This authorisation applies only to hydrogen-powered automobiles that are virtually pollution-free, and it remains in effect through the year 2008.

- ✓ It is also authorised to refund 2/3 of the value-added tax on new group transport vehicles equipped with engines that meet the quality standards for fuel utilisation and environmental impact (EUROIII).

- ✓ The Public Roads Administration has, in collaboration with the City of Reykjavík, tendered out, in the EEA countries, the purchase of computer equipment to guarantee the co-ordination of traffic lights in the Reykjavík area, as well as the related installation and set-up. Now, at year-end 2005, contracts are being negotiated with the lowest bidder. The equipment is supposed to handle the controls for 150 intersections, but 10-15 intersections will be connected at the outset. Thereafter, the aim over the next 2-3 years is to connect as many traffic lights as possible to a centralised control system.

- ✓ In the past few years, a great deal of road construction has been done in order to shorten driving routes; examples include the Fáskrúdsfjördur tunnel, the improved road over Öxi, the bridge over Kolgrafarfjördur, and the new road in Svínahraun. Work is also being done on proposals for changes in road placement in several populated areas, such as Selfoss and Borgarnes, and this could affect driving times.

The fishing fleet

- ✓ There has been significant renewal of the fishing fleet. In general, new ships are more efficient than comparable older ships in terms of fuel consumption; therefore, newer ships can represent substantial benefits for fisheries when fuel prices are high.

- ✓ Various fisheries companies have examined the possibility of equipping their ships with Icelandic energy-saving devices based on information technology and active participation by the ship's captain. Such equipment does not automatically reduce fuel consumption, but it does provide the skipper with constant information and advice concerning fuel savings, allowing him to evaluate the information at any given time. The government has supported experimental projects in this field. The Marine Research Institute has also set up an energy-saving system in the research vessel *Árni Fridriksson*, and the Ministry of Justice and Ecclesiastical Affairs has concluded a contractual agreement related to the installation of such a system in the Coast Guard's new cruiser.

- ✓ The importation and use of HFCs began when they were substituted for so-called HCFCs, which were considered undesirable because of their ozone-depleting properties. It was later revealed that this exchange could be incompatible with targets related to greenhouse gas emissions. It is possible to use ammonia, which neither depletes the ozone layer nor causes GHG emissions, but it is not utterly risk-free either, and it could take time to exchange these substances.

Fluorocarbons in aluminium manufacture

- ✓ The government target presented in the Climate Change Strategy of 2002, specifying that fluorocarbon emissions should not exceed 0.14 tonnes of carbon equivalents per tonne of aluminium produced, has been achieved in both of the aluminium smelters in operation in Iceland. A provision to this effect is included in the operating permit for the Alcan smelter and will be included in the Nordurál and Fjardaál operating permits. Perfluorocarbon emissions dropped by over 300,000 tonnes from 1990 to 2004, despite the fact that aluminium production increased during that period. In Iceland's report on the visible progress in the implementation of the Kyoto Protocol, the assessment of the success rate of measures adopted attempts to present a quantitative evaluation of the success of the measures employed. That report does not assume that PFC emissions per tonne of aluminium produced would have remained the same after 1990 without the adoption of measures to protect the climate, but by assuming such premises, it would be possible to calculate a substantial level of progress. Instead, an examination is made of the difference between the average PFC emissions per tonne of aluminium produced in the world and the emissions demanded in Iceland's Climate Change Strategy, and which have been actually achieved by Alcan and Nordurál. According to such a comparison, the calculated success of measures adopted is approximately 65,000 tonnes of CO_2 equivalents in 2005 and an estimated 161,000 – 187,000 tonnes during the period 2008-2012.

- ✓ There is regular consultation between the Ministry for the Environment and the Ministry of Industry and Commerce, on the one hand, and the companies that produce aluminium in Iceland, on the other, for the purpose of minimising GHG emissions per unit of production.

Waste handling

- ✓ Sorpa collects methane at the landfill in Álfsnes. It is estimated that the gas collected there would suffice for 4,000 – 6,000 methane-powered automobiles per year. Today there are only around 50 methane vehicles in Iceland, so the remainder of the methane is used for electricity production. These measures therefore reduce emissions by 30,000 CO_2 equivalents per year.

- ✓ A national plan for the handling of waste has been approved and launched. The aim is to reduce the burial of organic waste, which will result in a reduction in methane emissions.

Carbon sequestration through land reclamation and afforestation

- ✓ In 1996 the Icelandic government decided to allocate an additional subsidy of ISK 450 million to land reclamation and afforestation projects until the year 2000, in order to increase the sequestration of carbon from the atmosphere and to promote research into the subject. The aim was to increase annual sequestration of CO_2 in vegetation by 100,000 tonnes from its 1990 levels. This target was met, as were other targets in that campaign.

- ✓ A total of 207,000 tonnes of CO_2 were sequestered in 2005, and current forecasts estimate that annual sequestration will be similar in 2008-2012.

Research and development

- ✓ In 2006 the Ministry for the Environment prepared a summary of research into climate change issues and submitted it to the Science and Technology Policy Council. The summary was based, among other things, on answers submitted by the Marine Research Institute, the University of Akureyri, the University of Iceland, the Agricultural University of Iceland, the Institute of Natural History, the Environment and Food Agency, the Iceland Forest Service, and the Iceland Meteorological Office in response to the Ministry's request for information. Those responses make it clear that numerous research studies and monitoring projects on climate change are underway and that work in the field has increased in recent years. In its report to the Science and Technology Policy Council, the Ministry for the Environment states that though there is a certain level of growth in the amount of research done in the field, it is desirable to increase it still further and to increase the co-ordination of monitoring and research connected to climate change. This would lend support to measures for responding to and adapting to climate changes; furthermore, it would better enable Icelandic scientists to participate in international monitoring and research products, which will most likely continue to increase in number and scope in the years to come. For many reasons, Iceland is an

interesting subject for research into climate changes, their effects, and the possible means of mitigating them. Among these reasons are the country's geographical position at the boundary of the Arctic region and in the path of the Gulf Stream, the considerable emissions from damaged vegetation and the corresponding potential to increase carbon sequestration, and — last but not least — the wealth of renewable energy resources and progressive technology to utilise them and to reduce GHG emissions and fossil fuel use through other means. In its report, the Ministry for the Environment mentions five areas that it considers interesting subjects for research:

- The effects of climate changes on Iceland;
- Natural emissions and greenhouse gas sequestration in Iceland;
- Emissions caused by human activities — improvements in climate "bookkeeping";
- Measures to combat climate change — assessment of success and economic efficiency;
- Climate-friendly technology — innovation and promotion.

✓ An assessment of carbon sequestration has been carried out by the Agricultural University of Iceland (and, previously, by the Agricultural Research Institute), the Iceland Forest Service, and Soil Conservation Service of Iceland. Work has been done to improve sequestration accounting, but it is a complex task and must be fostered if it is to prove successful.

✓ Furthermore, a variety of work has been done on matters related to hydrogen, and the Icelandic government has participated either directly or indirectly in those endeavours. The Ministry of Industry and Commerce launched the Forum for Environment-Friendly Fuel, which has submitted two interim reports on how to increase the use and consumption of climate-friendly fuel.

Education and dissemination of information to the public

✓ In recent years, there has been a dramatic increase in the amount of discussion of climate changes, both discussion generated by the government and that deriving from other sources, and it would be a difficult and lengthy task to compile an exhaustive list of it. The national and municipal governments in Iceland have engaged in various efforts, including those pertaining to Transport Week, which is held annually. This is an area that could be improved, however, especially as regards disseminating information to the general public concerning what individuals can do to help and working with non-governmental organisations toward that end.