National Inventory Report

Iceland 2008

Submitted under the United Nations Framework
Convention on Climate Change

UMHVERFISSTOFNUN

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Preface

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and entered into force in 1994. According to Articles 4 and 12 of the Convention, Parties are required to develop and to submit annually to the UNFCCC national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol.

To comply with this requirement, Iceland has prepared a National Inventory Report (NIR) for the year 2008. The NIR together with the associated Common Reporting Format tables (CRF) is Iceland's contribution to this round of reporting under the Convention, and covers emissions and removals in the period 1990 – 2006.

The NIR is written by the Environment Agency of Iceland (EA), with a major contribution by the Agricultural University of Iceland (AUI), under the responsibility of the Ministry for the Environment.

Ministry for the Environment, Reykjavík, May 2008

EXECUTIVE SUMMARY

Kyoto accounting:

For 2006, Iceland's total Annex A greenhouse gas emissions were estimated to be 4.234 Gg CO_2-equivalents. Iceland's total emissions in 2006 were 24,3% above 1990 levels and 8,5% above the 1990 levels when activities under Article 3, paragraph 3 and 4 of the Kyoto Protocol are accounted for. Emissions that could fall under Decision 14/CP.7 amounted to 535,5 Gg in 2006.

Background

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) requires that the Parties report annually on their greenhouse gas emissions by sources and removals by sinks. In response to these requirements, Iceland has prepared the present National Inventory Report (NIR).

The IPCC Good Practice Guidance, the Revised 1996 Guidelines, the 2006 Guidelines and national estimation methods are used in producing the greenhouse gas emissions inventory. The responsibility of producing the emissions data lies with the Environment Agency, which compiles and maintains the greenhouse gas inventory. Emissions and removals from the LULUCF sector are compiled by the Agricultural University of Iceland. The national inventory and reporting system is continually being developed and improved.

Iceland is a party of the UNFCCC and acceded to the Kyoto Protocol on May 23rd, 2002. Earlier that year the government adopted a climate change policy that was formulated in close cooperation between several ministries. The aim of the policy is to curb emissions of greenhouse gases so 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 afforestation and revegetation programs. In February 2007 a new climate change strategy was adopted by the Icelandic government. The 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 Kyoto Protocol commits Annex I Parties to individual, legally binding targets for their greenhouse gas emissions in the commitment period 2008-2012. 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.
- Decision 14/CP.7 on the "Impact of single projects on emissions in the commitment period" allows Iceland to report certain industrial process' carbon dioxide emissions separately and not include them in national totals; to the extent they would cause Iceland to exceed its assigned amount. For the first

commitment period, from 2008 to 2012, the mean annual carbon dioxide emissions falling under decision 14/CP.7 shall not exceed 1.600.000 tonnes.

Trends in emissions and removals
In 1990, the total emissions of greenhouse gases in Iceland were 3.406 Gg of CO_2-equivalents. In 2006 total emissions were 4.234 Gg CO_2-equivalents. This is an increase of 24,3% over the time period. Total emissions show a decrease between 1990 and 1994, with an exception in 1993, and an increase thereafter.

A summary of the Icelandic national emissions for 1990, 2005 and 2006 is presented in Table ES1 (without LULUCF). Empty cells indicate emissions not occurring.

Table ES1. Emissions of greenhouse gases during 1990, 2005 and 2006 in Gg CO_2-eq.

	1990	2005	2006	Changes 90-06	Changes 05-06
CO_2	2160	2854	3035	41%	6,3%
CH_4	456	438	462	2%	5,3%
N_2O	368	308	335	-9%	9%
HFC 32		0,2	0,2		16%
HFC 125		30,1	24,3		-19%
HFC 134a		10,9	10,2		-7%
HFC 143a		35,5	29,4		-17%
HFC 152		0,05	0,02		-51%
CF_4	355	22	282	-21%	1177%
C_2F_6	65	4	51	-21%	1177%
SF_6	5	5	5	0%	0%
Total Emissions	**3406**	**3708**	**4234**	**24,3%**	**14,2%**
CO_2 emissions 'fulfilling' 14/CP.7		440	536		21,7%
Total emissions, excluding CO_2 emissions 'fulfilling' 14/CP.7[1]	**3406**	**3269**	**3699**	**8,5%**	**13,2%**

The largest contributor of greenhouse gas emissions in Iceland is the energy sector, followed by industrial processes, then agriculture, waste and solvent and other product use. From 1990 to 2006 the contribution of the energy sector to the total emissions decreased from 52% to 51%. The contribution of industrial processes decreased from 25% in 1990 to around 17 - 19% in the period 1992 to 1997. The contribution of industrial processes increased again after 1997 and was 32% in 2006.

[1] Decision 14/CP.7 allows Iceland to report certain industrial process carbon dioxide emissions separately and not include them in national totals; to the extent they would cause Iceland to exceed its assigned amount.

Table ES2. Total emissions of greenhouse gases by source 1990, 2005 and 2006, Gg CO_2-eq.

	1990	2005	2006
Energy	1705	1957	2007
Industrial Processes	867	944	1341
Emissions fulfilling 14/CP.7*	-	440	535
Solvent Use	14	16	9
Agriculture	572	479	512
Waste	181	189	207
Geothermal Energy	67	123	156
Total without LULUCF	**3406**	**3708**	**4234**
LULUCF	1476	1154	1127

* Industrial process carbon dioxide emissions that could fall under Decision 14/CP.7 are included in national totals

The distribution of the total greenhouse gas emissions over the UNFCCC sectors (including geothermal energy and excluding LULUCF) in 2006 is shown in Figure ES1. Emissions from the energy sector account for 51% (fuel combustion 47% and geothermal energy 4%) of the national total emissions, industrial processes account for 32% and agriculture for 12%. The waste sector accounts for 5% and solvent and other product use for 0,2%.

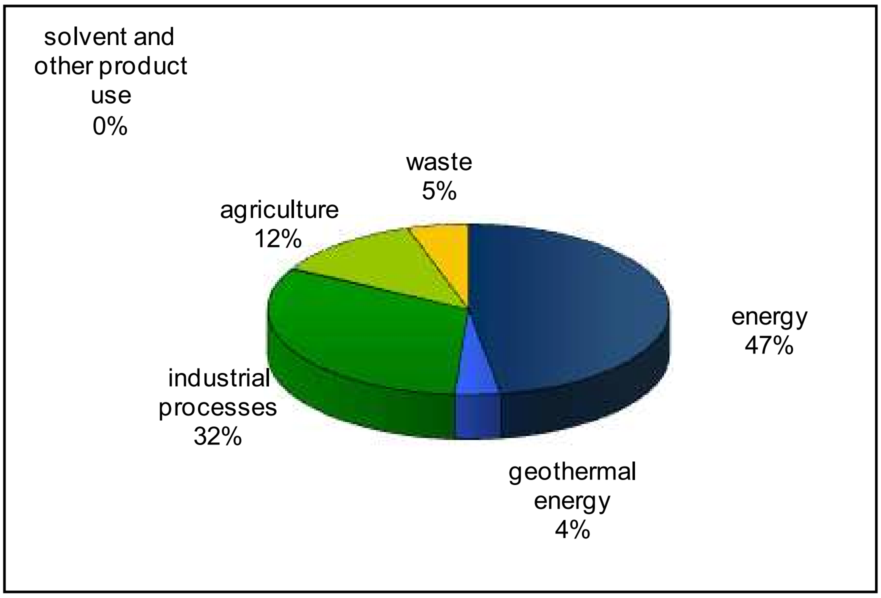

Figure ES1. Emissions of greenhouse gases by UNFCCC sector in 2006

1 INTRODUCTION

1.1 Background information

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) was ratified by Iceland in 1993 and entered into force in 1994. One of the requirements under the Convention is that Parties are to report their national anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using methodologies agreed upon by the Conference of the Parties to the Convention (COP).

In 1995 the Government of Iceland adopted an implementation strategy based on the commitments in the Framework Convention. The domestic implementation strategy was revised in 2002, based on the commitments in the Kyoto Protocol and the provisions of the Marrakech Accords. In February 2007 a new climate change policy was adopted by the Icelandic government. Iceland acceded to the Kyoto Protocol on May 23rd 2002. The Kyoto Protocol commits Annex I Parties to individual, legally binding targets for their greenhouse gas emissions in the commitment period 2008-2012. 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.
- Decision 14/CP.7 on the "Impact of single project on emissions in the commitment period" allows Iceland to report certain industrial process' carbon dioxide emissions separately and not include them in national totals; to the extent they would cause Iceland to exceed its assigned amount. For the first commitment period, from 2008 to 2012, the mean annual carbon dioxide emissions falling under decision 14/CP.7 shall not exceed 1.600.000 tonnes.

A new climate change strategy was adopted by the Icelandic government in February 2007[2]. The Ministry for the Environment formulated the strategy 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 long-term vision of the strategy is to reduce net greenhouse gas emissions in Iceland by 50 – 75% by 2050, compared to 1990 levels. In the shorter term, Iceland aims to ensure that emissions of greenhouse gases will not exceed Iceland's obligations under the Kyoto Protocol in the first commitment period. The strategy contains provision for measures in six sectors in curbing and reducing GHG emissions, as well as provisions to increase carbon sequestration resulting from afforestation and revegetation programs.

The greenhouse gas emissions profile for Iceland is unusual in many respects. Firstly, electricity production and space heating are based on renewable energy sources resulting in very low emissions from these sectors. Secondly, more than 80% of emissions from the energy sector stem from mobile sources (transport, mobile machinery and fishing

[2] http://eng.umhverfisraduneyti.is/media/PDF_skrar/Stefnumorkun_i_loftslagsmalum_en.pdf

vessels). Thirdly, emissions from the LULUCF sector are relatively high. Recent research has indicated that there are significant emissions of carbon dioxide from drained wetlands. These emissions can be attributed to government-sponsored drainage of wetlands in the latter half of the 20th Century, which was largely ceased by 1990. These emissions of CO_2 continue for a long time after drainage. The fourth distinctive feature is that individual sources of industrial process emissions have a significant proportional impact on emissions at the national level. Most noticeable are increased 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 paragraph 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.

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 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 aluminium plant can add more than 15% to the country's total greenhouse gas 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 tonnes 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 carbon dioxide 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 greenhouse gas emissions per unit of production will be eligible. The use of best environmental practice and best available technology is also required. 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.

The Government of Iceland notified the Conference of the Parties with a letter, dated October 17th 2002, of its intention to avail itself of the provisions of Decision 14/CP.7. Since Decision 14/CP.7 only applies for the first commitment period, emissions that are stated in this report as emissions that could fall under Decision 14/CP.7 are not excluded from national totals. On the other hand, they show the scope Iceland has for increased emissions. Annex VI gives an overview of the projects from which emissions could fall under Decision 14/CP.7.

The present report together with the associated Common Reporting Format tables (CRF) is Iceland's contribution to this round of reporting under the Convention, and covers emissions and removals in the period 1990 – 2006. The methodology used in calculating the emissions is according to the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories as set out by the IPCC Good Practice Guidance and Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG -LULUCF)(IPCC 2003), to the extent possible.

The greenhouse gases included in the national inventory are the following: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Emissions of the precursors NOx, NMVOC and CO as well as SO_2 are also included, in compliance with the reporting guidelines.

1.2 Institutional arrangement

The Environment Agency of Iceland (EA), an agency under the Ministry for the Environment, has overall responsibility for the national inventory. EA compiles and maintains the greenhouse gas emission inventory, except LULUCF which is compiled by the Agricultural University of Iceland (AUI). EA reports to the Ministry for the Environment, which reports to the Convention. Figure 1.1 illustrates the flow of information and allocation of responsibilities.

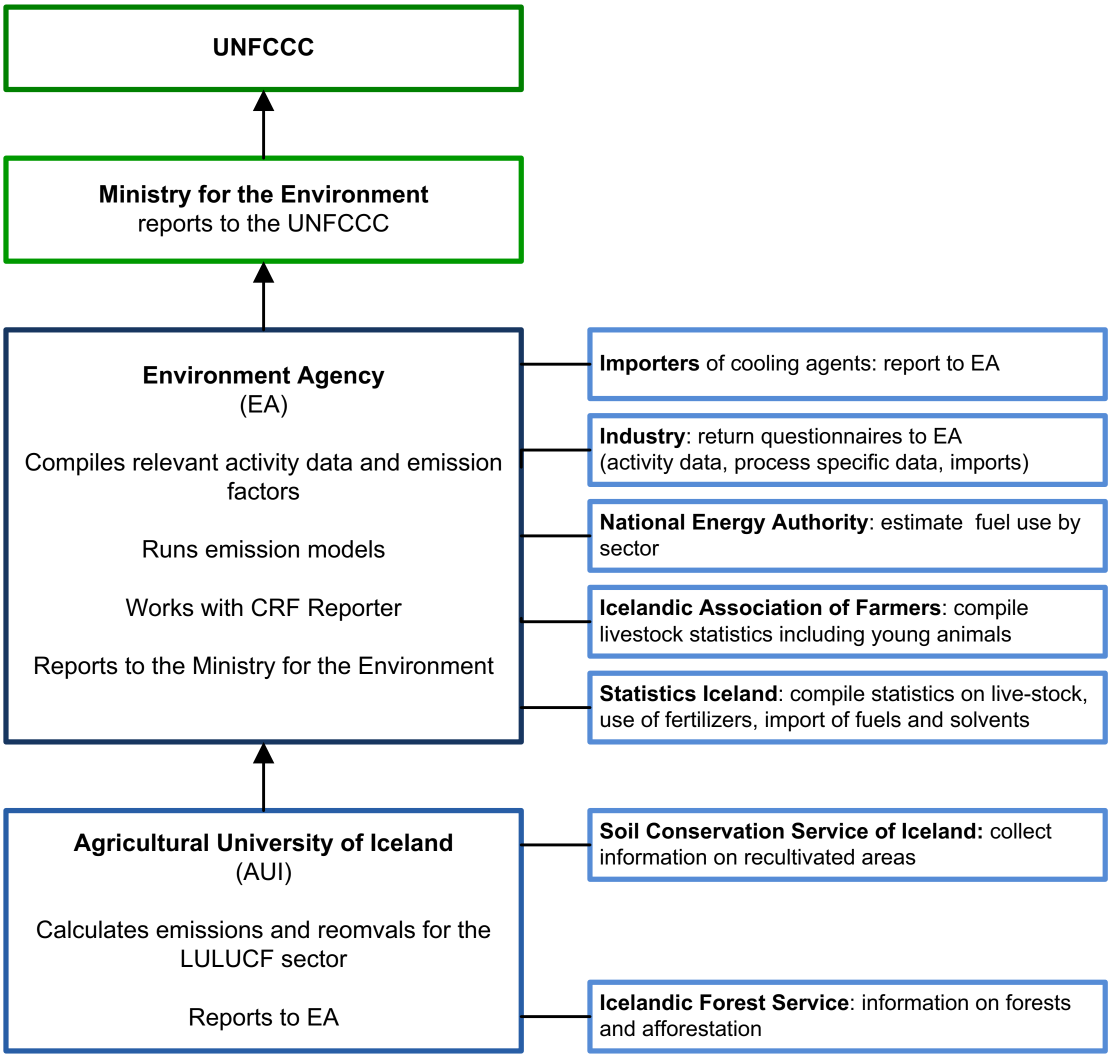

Figure 1.1 Information flow and distribution of responsibilities in the Icelandic emission inventory system for reporting to the UNFCCC

A new law on emissions of greenhouse gases was passed by the Icelandic legislature, Althing, in March 2007. The stated purpose of the law is to create conditions for Icelandic authorities to comply with international obligations in limiting emissions of greenhouse gases. The law covers the national system for the estimation of greenhouse gas emissions and removals by sinks, the establishment of a national registry, emission permits and the duty of companies to report relevant information to the authorities.

The law specifies that the EA is the responsible authority for the national accounting as well as the inventory of emissions and removals of greenhouse gases according to Iceland's international obligations. The EA shall, in accordance with the legislation, produce instructions on the preparation of data and other information for the national inventory. Formal agreements have been made between the EA and the necessary collaborating agencies involved in the preparation of the inventory to cover responsibilities as data collection and methodologies, data delivery timelines and estimation of uncertainty estimates. This involves the National Energy Authority on the one hand and with the Agricultural University of Iceland on the other hand. Further the Agricultural University has made formal agreements with its major data providers, the Soil Conservation Service of Iceland and the Icelandic Forest Service.

1.3 Process of inventory preparation

The EA collects the bulk of data necessary to run the general emission model, i.e. activity data and emission factors. Activity data is collected from various institutions and companies, as well as by EA directly. The National Energy Authority (NEA) collects annual information on fuel sales from the oil companies. This information was until 2008 provided on an informal basis. In 2007 a new legislation nr. 48/2007 went into force, enabling the NEA to obtain sales statistics from the oil companies. The Icelandic Association of Farmers (IAF), on the behalf of the Ministry of Agriculture, is responsible for assessing the size of the animal population each year. On request from the EA, the IAF also accounts for young animals that are mostly excluded from national statistics on animal population. Statistics Iceland provides information on imports of solvents, the use of fertilizers in agriculture and on the import and export of fuels. The EA collects various additional data directly. Annually a questionnaire is sent out to the industry regarding imports, use of feedstock, and production and process specific information. Importers of HFCs submit reports on their annual imports by different types of HFCs to the EA. EA also estimates activity data with regard to waste. Emission factors are mainly taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, since limited information is available from measurements of emissions in Iceland.

AUI receives information on revegetated areas from the Soil Conservation Service of Iceland and information on forests and afforestation from the Icelandic Forest Service. The AUI assesses other land use categories on basis of its own geographical database and available supplementary land use information. AUI then calculates emissions and removals for the LULUCF sector and reports to the EA.

1.4 Methodologies and data sources

The estimation methods of all greenhouse gases are harmonized with the IPCC Guidelines for National Greenhouse Gas Inventories and are in accordance with IPCC's Good Practice Guidance.

The general emission model is based on the equation:

$$\text{Emission (E)} = \text{Activity level (A)} \cdot \text{Emission Factor (EF)}$$

The model includes the greenhouse gases and in addition the precursors and indirect greenhouse gases NOx, SO_2, NMVOC and CO as well as some other pollutants (POPs).

Methodologies and data sources for LULUCF are described in Chapter 7.

1.5 Key source categories

According to the IPCC definition, a key source category is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both. In the Icelandic Emission Inventory key source categories are identified by means of Tier 1 method.

A key source analysis was prepared for this round of reporting. The Table below lists the 1 identified key sources. Tables showing key source analysis (trend and level assessment) can be found in Annex I. The key source analysis shows similar result as last year. PFC emissions from aluminium production are now a key source in level as well as trend, CH_4 emissions from solid waste disposal sites are now only key source in level..

Table 1.1 Key sources

IPCC SOURCE CATEGORIES	Direct GHG	Key source		
		Level '90	Level '06	Trend
ENERGY SECTOR				
Mobile combustion: fishing	CO_2	v	v	v
Mobile combustion: road vehicles	CO_2	v	v	v
Mobile combustion: road vehicles	N_2O			v
Mobile combustion: construction	CO_2	v	v	v
CO_2 emissions from stationary combustion, oil	CO_2	v	v	v
CO_2 emissions from stationary combustion, coal	CO_2	v		v
CO_2 emissions from geothermal energy utilization	CO_2		v	v
INDUSTRIAL PROCESSES				
CO_2 emissions from Ferroalloys	CO_2	v	v	v
CO_2 emissions from cement production	CO_2	v	v	
CO_2 emissions from aluminium production	CO_2	v	v	v
PFC emissions from aluminium production	PFC	v	v	v
Emissions from substitutes for Ozone Depleting Substances	HFC		v	v
AGRICULTURE				
CH_4 emissions from enteric fermentation	CH_4	v	v	v
Direct N_2O emissions from agricultural soils	N_2O	v	v	v
Indirect N_2O emissions from Nitrogen used in agriculture	N_2O	v	v	v
WASTE				
CH_4 emissions from solid waste disposal sites	CH_4	v	v	

1.6 Quality assurance and quality control (QA/QC)

A QA/QC plan has been prepared. It can be found in Annex VII.

1.7 Uncertainty evaluation

For this round of reporting a preliminary estimate of the quantitative uncertainty of the Icelandic emission inventory has been prepared. The uncertainty estimate has revealed that the total uncertainty of the Icelandic inventory (excluding LULUCF) is 7,4%. The results of the uncertainty estimate can be found in Annex II.

1.8 General assessment of the completeness

An assessment of the completeness of the emission inventory should, according to the IPCC's Good Practice Guidance, address the issues of spatial, temporal and sectoral coverage along with all underlying source categories and activities.

In terms of spatial coverage, the emission reported under the UNFCCC covers all activities within Iceland's jurisdiction.

In the case of temporal coverage, CRF tables are reported for the whole time series from 1990 to 2006.

With regard to sectoral coverage the few sources listed in Table 9 of the CRF are not estimated.

The main sources not estimated are:

- Emissions of CO_2 and CH_4 from distribution of oil products (1B2a v)
- Only the potential emissions of HFCs are estimated and SF_6 emissions are not estimated but held constant over the whole time series (2F)
- The emissions/removals of many LULUCF components are not estimated (see chapter 7). Most important are probably the emissions from degraded grassland and emissions due to biomass burning.

The reason for not including the above activities/gases in the present submission is lack of data, and/or that additional work was impossible due to time constraints in the preparation of the emission inventory.

1.9 Planned and implemented improvements

In 2007 the UNFCCC secretariat coordinated an in-country review of the 2006 greenhouse gas inventory submission of Iceland. The review took place from 18th to 23rd of June 2007 in Iceland.

Following the in-country-review revised estimates were provided for CO_2 emissions from solvent and other product use, CH_4 from 4A10 – fur animals, CH_4 and N_2O emissions from 4B10 – fur animals, and N_2O emissions arising from subsequent animal manures and 4D – agricultural soils. These revisions increased the GHG emissions by 0,4%.

Further following the review, to strengthen the national system, EA made formal agreements with the National Energy Authority and the Agricultural University of

Iceland. The Agricultural University further made formal agreements with the Soil Conservation Service of Iceland and the Icelandic Forest Service.

In the near future the following improvements are planned:

- Iceland has until now not prepared a national energy balance. The NEA will start preparing annually a national energy balance, in accordance with the formal agreement between EA and NEA.
- Estimate actual emissions of HFCs and SF6.
- Construction of geographically identifiable land use database covering the whole country started in 2007, including extensive sampling on present and previous land use.
- Ongoing new forest inventory will improve both estimates of Forest land area and Carbon stock changes. Similar effort regarding Revegetation began in 2007.

The following improvements are under consideration:

- Improve methodologies to estimate emissions from road transportation.
- Develop country-specific emission factor for enteric fermentation.
- Revise country-specific N excretion factors.
- Improvements of QA/QC for LULUCF.
- Revision of LULUCF emission/removal factors, emphasizing key sources and aiming at higher tier levels.

2 TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Emission trends for aggregated greenhouse gas emissions

The total amount of greenhouse gases emitted in Iceland during the period 1990 – 2006 is presented in the following tables, expressed in terms of contribution by gases and by sources.

Table 2.1 below presents emission figures for all direct greenhouse gases, expressed in CO_2-equivalents. Table 2.2 presents emission figures along with the percentage change indicated for both the time period 1990 – 2006 and 2005 – 2006.

Table 2.1. Emissions of greenhouse gases in Iceland during the period 1990 – 2006 (without LULUCF). Empty cells indicate emissions not occurring. Units: Gg CO_2-eq

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
CO2	2160	2085	2211	2315	2278	2311	2400	2494	2504
CH4	456	454	450	452	458	453	459	462	464
N2O	368	357	335	345	350	346	366	364	360
HFC			0	2	3	25	29	37	64
PFC	420	348	155	75	45	59	25	82	180
SF6	5	5	5	5	5	5	5	5	5
Total	3409	3249	3157	3194	3139	3199	3283	3445	3578
*									108
**									3471

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
CO2	2708	2758	2762	2854	2835	2905	2854	3035
CH4	463	454	458	444	445	437	438	461
N2O	380	356	349	315	302	300	308	335
HFC	59	32	54	35	69	58	77	64
PFC	173	127	92	73	60	39	26	333
SF6	5	5	5	5	5	5	5	5
Total	3789	3733	3720	3726	3716	3745	3709	4234
*	115	273	404	441	451	455	440	535
**	3674	3460	3316	3285	3266	3291	3269	3699

* CO2 emissions fulfilling 14/CP.7

** Total emissions excluding CO2 emissions fulfilling 14/CP.7

Table 2.2. Emissions of greenhouse gases in Iceland during the period 1990, 2005 and 2006 (without LULUCF). Empty cells indicate emissions not occurring. Units: Gg CO_2-eq

	1990	2005	2006	Changes 90-06	Changes 05-06
CO_2	2160	2854	3035	41%	6,3%
CH_4	456	438	462	2%	5,3%
N_2O	368	308	335	-9%	9%
HFC		77	64		-17%
PFC	420	26	333	-21%	1177%
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Total Emissions	**3406**	**3708**	**4234**	**24,3%**	**14,2%**
CO_2 emissions 'fulfilling' 14/CP.7		440	536		21,7%
Total emissions, excluding CO_2 emissions 'fulfilling' 14/CP.7*	**3406**	**3269**	**3699**	**8,5%**	**13,2%**

*Decision 14/CP.7 allows Iceland to report certain industrial process carbon dioxide emissions separately

As mentioned in Chapter 1.1 industrial process CO_2 emissions that fulfill Decision 14/CP.7 shall be reported separately and shall not be included in national totals, to the extent they would cause a Party to exceed its assigned amount. In this report, emissions that are stated as emissions that could fall under Decision 14/CP.7 show the scope for increased emissions. Since this decision only applies for the first commitment period, they are not excluded from national totals.

In 1990, the total emissions of greenhouse gases (excluding LULUCF) in Iceland were 3.406 Gg of CO_2-equivalents. In 2006 total emissions were 4.234 Gg CO_2-equivalents. This implies an increase of 24,3% over the time period. Total emissions show a decrease between 1990 and 1994, with an exception in 1993, and an increase thereafter. A sudden increase of 14,2% is seen in 2006. The main reason for this is an increase in PFC emissions in 2006.

Iceland has experienced economic growth since 1990, which explains the general growth in emissions. This has resulted in higher emissions from most sources, but in particular from transport and industrial processes.

Since 1990 the number of private cars has been increasing much faster than the population. Also the number of passengers using the public transport system has declined. More traffic is thus not mainly due to population growth, but much rather because a larger share of the population owns and uses private cars for their daily travel.

During the late nineties large-scale industry expanded in Iceland. The existing aluminium plant and the ferroalloys industry experienced enlargement in 1997 and 1999. In 1998 a new aluminium plant was established. In 2006 the new aluminium plant was expanded. The sudden increase seen in PFC emission in 2006 is mainly caused by technical difficulties experienced during the expansion.

Nitrous oxide emissions have decreased since 1990, despite the fact that nitrous oxide emissions from road transport have increased. This is due to a decrease in animal livestock and because fertilizer production in Iceland was terminated in 2001.

Before 1992 there were no imports of HFCs, but since then, imports have increased rapidly in response to the phase-out of CFCs and HCFCs. The potential emissions of HFCs have risen from 0,5 Gg CO_2-equivalent in 1992 to 64,1g CO_2-equivalent in 2006.

The overall increasing trend of greenhouse gas emissions was until 2005 to some extent counteracted by decreased emissions of PFCs, caused by improved technology and process control in the aluminium industry. In 2006 a sudden increase in PFCs from aluminium industry is seen leading to an overall increase in trend of greenhouse gas emission.

2.2 Emission trends by gas

As shown in Figure 2.1, the largest contributor by far to the total GHG emissions is CO_2 (72%), followed by CH_4 (11%) and N_2O (8%) and then by the fluorinated gases PFCs, HFCs and SF_6 (9%). In 1990 the share of CO_2 was lower than in 2006 or (63%), the share of CH_4 and N_2O about the same (13% and 11% respectively) but the share of fluorinated gases was higher (13%).

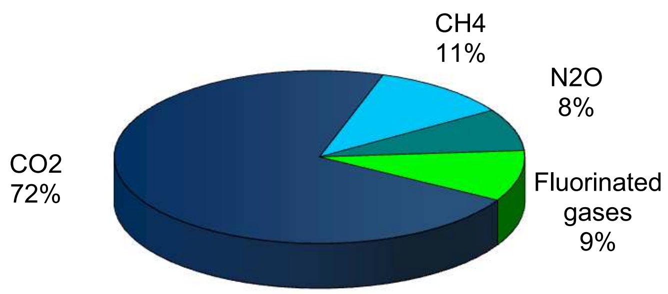

Figure 2.1 Distribution of emissions of greenhouse gases by gas in 2006

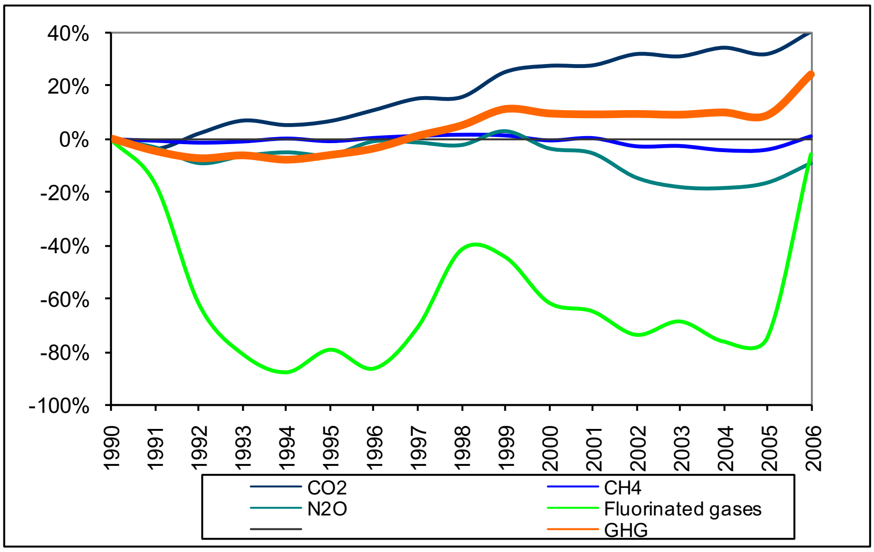

Figure 2.2 Percentage changes in emissions of greenhouse gases by gas 1990 – 2006 compared with 1990

2.2.1 Carbon dioxide (CO_2)

Fisheries, road transport and industrial processes are the three main sources of CO_2 emissions in Iceland. Since emissions from the electricity generation and space heating are very low because they are generated from renewable energy sources, emissions from stationary combustion are dominated by industrial sources. Thereof the fishmeal industry is by far the largest user of fossil fuels. Emissions from mobile sources in the construction industry are also significant. Emissions from geothermal energy exploitation are moderate. 'Other sources' consist mainly of emissions from coal combustion in the cement industry and other transportation than road transportation. Table 2.3 lists CO_2 emissions from each source category for the period 1990 – 2006. Figure 2.3 illustrates the distribution of CO_2 emissions by main source categories, and Figure 2.4 shows the percentage change in emissions of CO_2 by source from 1990 to 2006 compared with 1990.

Table 2.3 Emissions of CO_2 by sector 1990 – 2006, Gg.

	Year								
CO2	1990	1991	1992	1993	1994	1995	1996	1997	1998
Fishing	655	676	740	770	759	772	828	810	781
Road vehicles	509	527	540	537	544	534	514	545	552
Stationary combustion, oil	237	168	241	253	229	219	270	285	261
Industrial processes	393	359	362	410	411	427	426	485	513
Construction	121	115	107	116	118	148	144	174	175
Geothermal Energy	67	67	67	67	67	82	82	71	94
Other	178	173	154	162	150	129	136	125	128
Total	2160	2085	2211	2315	2278	2311	2400	2494	2504

	Year							
CO2	1999	2000	2001	2002	2003	2004	2005	2006
Fishing	765	720	640	705	670	641	626	549
Road vehicles	577	589	595	604	682	718	747	859
Stationary combustion, oil	264	203	245	275	243	226	168	161
Industrial processes	659	766	804	822	824	846	835	938
Construction	192	197	192	180	165	198	215	195
Geothermal Energy	123	163	154	159	138	124	123	156
Other	127	120	132	108	113	152	139	176
Total	2708	2758	2762	2854	2835	2905	2854	3035

In 2006 the total CO_2 emissions in Iceland were 3.035 Gg. This implies an increase of about 6,3% from the preceding year but an increase of about 41% from 1990. Emissions from stationary oil combustion decreased by 4% from 2005 to 2006. This is mainly due to decreased emissions from the fish meal industry. Emissions from construction decreased by 10%. Emissions from road vehicles rose by 15% mainly due to increase in number of cars per capita. Emissions from industrial processes increased by 12% and geothermal energy as well from other sources increased by 27%.

The increase in CO_2 emissions between 1990 and 2006 can be explained by increased emissions from industrial processes (139%), road transport (69%), geothermal energy utilization (135%), and the construction sector (61%). Emission from fishing has declined by 16% in the same period. Since 1990 and in particular after 1995 Iceland has experienced economic growth, which partly explains the general growth in emissions. During the late nineties energy intensive industry expanded. The existing aluminium plant and the ferroalloys industry experienced enlargement in 1997 and 1999, and in 1998 a new aluminium plant was established. This new plant was expanded in 2006. The economic growth and the expansion of energy intensive industry have resulted in higher emissions from most sources, but in particular from the industrial processes sector as well as from the construction sector. Emissions from the construction sector have risen, particularly in recent years, due to increased activity related to the construction of Iceland's largest hydropower plant. Since 1990 the vehicle fleet in Iceland has increased nearly by 70%. This has led to increased emissions from road transportation, a trend that is still ongoing. Furthermore the latest trend has been towards larger passenger cars which consume more fuel. Emissions from fishing rose from 1990 to 1996 because a substantial portion of the fishing fleet was operating in distant fishing grounds. From 1996 the emissions decreased again reaching 1990 levels in 2001. Emissions increased again by 10% between 2001 and 2002, but in 2003 they dropped to 1990 levels. In 2006 emissions were 16% under 1990 levels and. Annual changes in emissions reflect the inherent nature of the fishing industry. Emissions from other sources decreased from 1990 to 2003, but rose again between 2004 and 2006 when they were 1% below the 1990 level. This is mainly due to changes in the cement industry where production had been slowly decreasing since 1990. Due to the construction of a hydropower plant (resulting in more demand of cement) production increased again between 2004 and 2006, though the major part of the cement used in this project is imported. Emissions from both domestic flight and navigation have declined significantly since 1990.

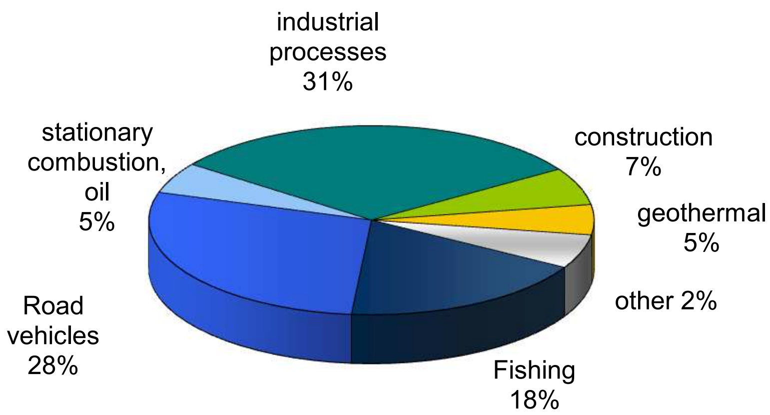

Figure 2.3 Distribution of CO_2 emissions by source in 2006

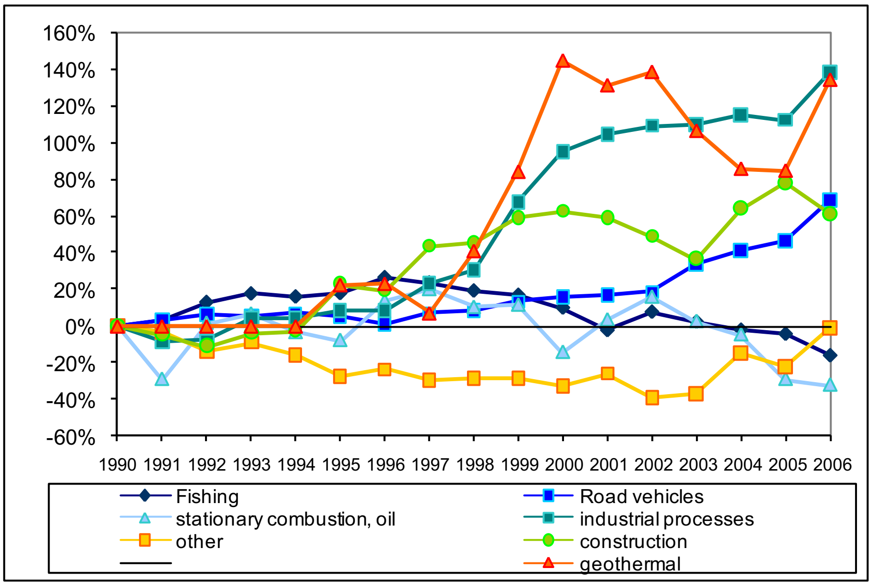

Figure 2.4 Percentage changes in emissions of CO_2 by major sources 1990 – 2006, compared with 1990

2.2.2 Methane (CH_4)

As can be seen from Table 2.4 and Figure 2.5, about 43% and 56% of the emissions of methane in 2006 originated from waste treatment and agriculture respectively. The emissions from agriculture have decreased by 12% since 1990 and waste has increased by 27%. Emissions from waste treatment increased from 1990 to 2001 due to an increased amount of waste generated and increased ratio of landfilled wastes in managed waste disposal sites. The emissions from landfills decreased slightly from 2001 to 2005, due to increased methane recovery. In 2006, emissions from rose by 10%. This increase is mainly due to failure in methane burner but also due to increased amount of landfilled wastes disposed at managed waste disposal sites.

In whole emissions of methane have been relatively stable over the period.

Table 2.4 Emissions of CH_4 by sector 1990 – 2006, Gg

	Year								
CH4	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture	14.0	13.7	13.3	13.2	13.3	12.9	13.0	13.2	13.3
Waste	7.5	7.6	7.9	8.1	8.2	8.4	8.6	8.6	8.6
Other	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2
Total	21.7	21.6	21.4	21.5	21.8	21.6	21.8	22.0	22.1

	Year							
CH4	1999	2000	2001	2002	2003	2004	2005	2006
Agriculture	13.2	12.6	12.6	12.3	12.1	11.9	12.0	12.3
Waste	8.7	8.8	9.0	8.6	8.9	8.7	8.6	9.5
Other	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	22.0	21.6	21.8	21.1	21.2	20.8	20.9	22.0

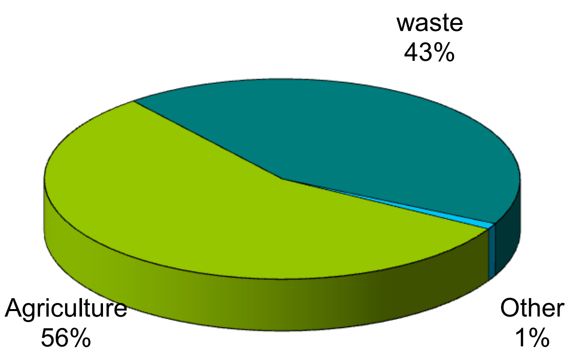

Figure 2.5 Distribution of CH_4 emissions by source in 2006

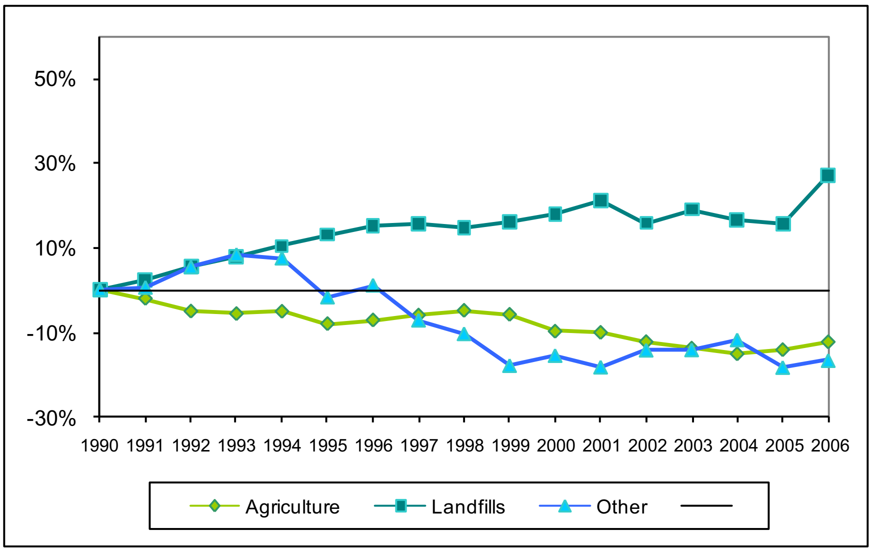

Figure 2.6 Percentage changes in emissions of CH_4 by major sources 1990 – 2006, compared to 1990

2.2.3 Nitrous oxide (N_2O)

As can be seen from Table 2.5 and Figure 2.7 agriculture accounts for around 76% of N_2O emissions in Iceland, with agricultural soils as the most prominent contributor. The second most important source is road transport, which has increased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995.

The overall nitrous oxide emissions decreased by 9% from 1990 to 2006, due to a decrease in the number of animal livestock and because fertilizer production in Iceland was terminated in 2001.

Table 2.5 Emissions of N_2O by sector 1990 – 2006, Gg

	Year								
NO2	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture	0.9	0.9	0.8	0.8	0.9	0.8	0.9	0.8	0.8
Road traffic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Other	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Total	1.2	1.2	1.1	1.1	1.1	1.1	1.2	1.2	1.2

	Year							
NO2	1999	2000	2001	2002	2003	2004	2005	2006
Agriculture	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.8
Road traffic	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Other	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Total	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.1

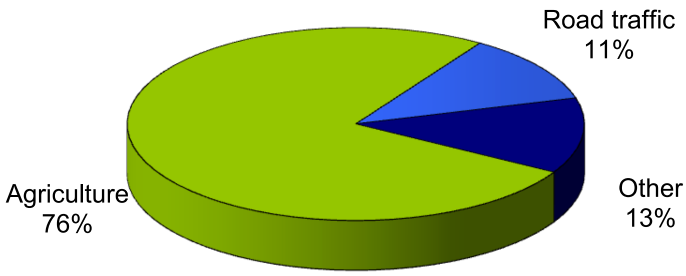

Figure 2.7 Distribution of N_2O emissions by source in 2006

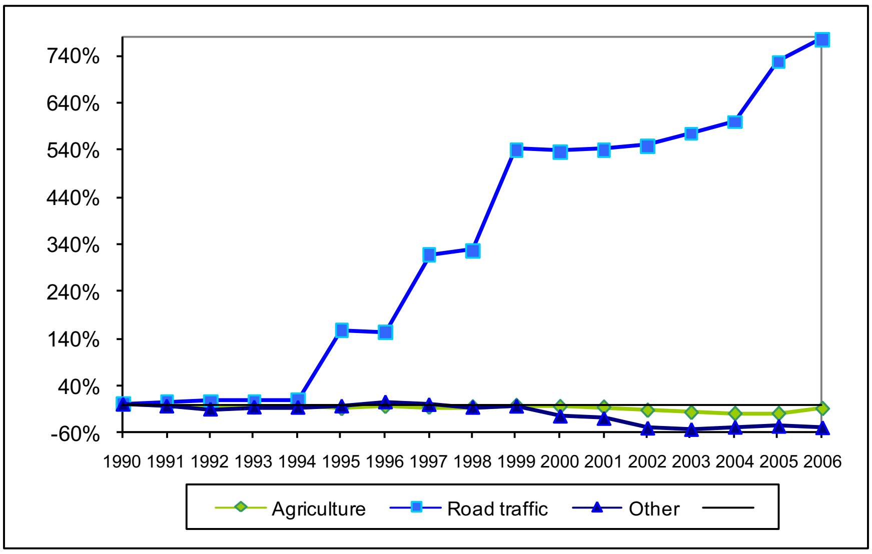

Figure 2.8 Changes in N_2O emission for major sources between 1990 and 2006

2.2.4 **Perfluorcarbons**

The emissions of the perfluorcarbons, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) from the aluminium industry were 281,9 and 51,3 Gg CO_2-equivalents respectively in 2006.

Total PFC emissions decreased by 21% in the period of 1990 – 2006. As can be seen from Figure 2.9 the emissions decreased steadily from 1990 to 1996 with the exception of

1995. In 1997 and 1998 the emissions rose again due to expansion of the single existing aluminium plant in 1997 and the establishment of a new aluminium plant in 1998. Since 1998 the emissions showed a steady downward trend until 2005. The PFC reduction was achieved through improved technology and process control and led to a 98% decrease in the amount of PFC emitted per tonne of aluminium produced during the period of 1990 to 2005. In 2006 the PFC emissions rose significantly due to an expansion of aluminium plant that was established in 1998. The sudden increase was mainly caused by technical difficulties experienced during the expansion.

Table 2.6 Emissions of PFCs by species 1990 – 2006, Gg CO_2-equivalent

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
CF4	355	295	131	63	38	50	21	70	152
C2F6	65	54	24	12	7	9	4	13	28
Total	420	348	155	75	45	59	25	82	180

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
CF4	147	108	78	61	51	33	22	282
C2F6	27	20	14	11	9	6	4	51
Total	173	127	92	73	60	39	26	333

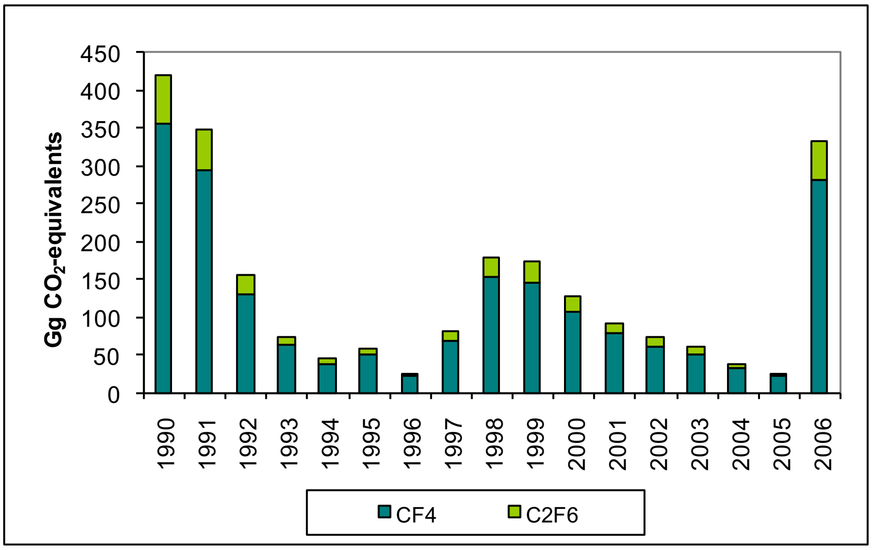

Figure 2.9 Emissions of PFCs from 1990 to 2006, Gg CO_2-equivalent

2.2.5 **Hydrofluorocarbons (HFCs)**

The total potential emissions of HFCs, used as substitutes for ozone depleting substances, amounted to 64,1 CO_2-equivalents in 2006. The import of HFCs started in 1992 and increased until 1998. Since then annual imports have ranged between 30 and 77 Gg CO_2-equivalents. Sufficient data is not yet available to calculate actual emissions. This means that only potential emissions, based on imports, are estimated. The potential method is likely to overstate emissions, since chemicals used e.g. in refrigerators are emitted over a period of several years. The application category refrigeration contributes by far the largest part of HFCs emissions but cooling system in cars is also minor source that is gradually increasing.

Table 2.7 Emissions of HFCs by species 1990 – 2006, Gg CO_2-equivalent

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
HFC 32	-	-	-	-	-	-	-	-	0.0
HFC 125	-	-	-	-	-	10.8	11.7	11.1	27.1
HFC 134a	-	-	0.5	1.6	3.1	4.1	6.5	7.1	8.0
HFC 143a	-	-	-	-	-	10.0	10.3	19.0	28.6
HFC 152a	-	-	-	-	-	0.1	0.1	0.2	0.1
Total	0.0	0.0	0.5	1.6	3.1	25.0	28.6	37.5	63.9

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
HFC 32	0.0	0.1	0.0	0.0	0.1	0.1	0.2	0.2
HFC 125	23.5	14.5	23.2	15.7	26.3	22.4	30.1	24.3
HFC 134a	8.2	6.0	6.8	3.8	13.4	11.5	10.9	10.2
HFC 143a	27.6	11.6	23.8	15.6	29.4	24.3	35.5	29.4
HFC 152a	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0
Total	59.4	32.3	53.8	35.2	69.3	58.4	76.7	64.1

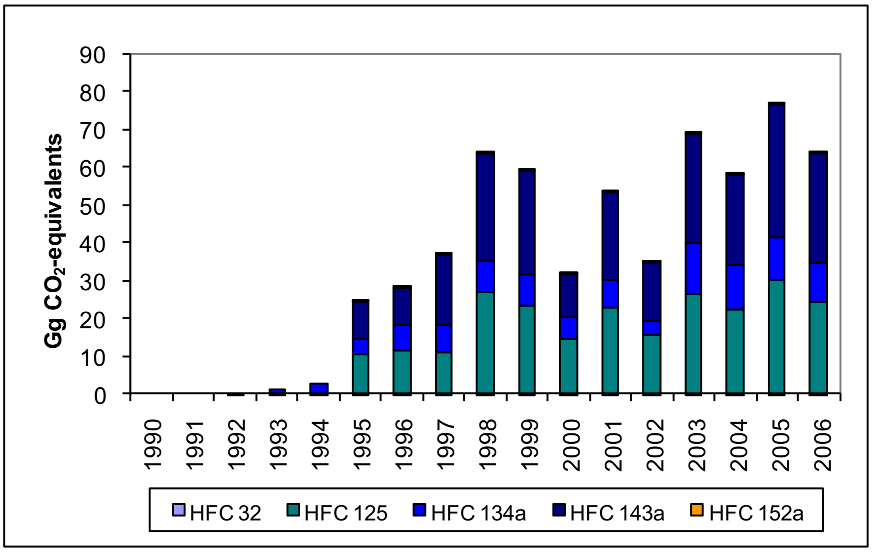

Figure 2.10 Potential emissions of HFCs by species 1990 – 2006, Gg CO_2-eq

2.2.6 **Sulphur hexafluorid (SF_6)**

Sulphur hexafluoride emissions are not estimated but held constant over the whole time series. The largest source of SF_6 emissions is thought to be leakages from electrical equipment.

2.3 Emission trends by source

The largest contributor of greenhouse gas emissions (without LULUCF) in Iceland is the energy sector, followed by industrial processes, agriculture, waste, geothermal energy and solvent and other product use. From 1990 to 2006 the contribution of the energy sector to the total net emissions decreased from 52% to 51% respectively. The contribution of industrial processes was 25% in 1990 and 32% in 2006.

Table 2.8 Total emissions of greenhouse gases by sources (without LULUCF) in Iceland 1990 – 2006, Gg CO_2-equivalents

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Energy									
-Fuel combustion	1705	1659	1784	1846	1809	1822	1914	1971	1933
-Geothermal energy	67	67	67	67	67	82	82	71	94
Industrial processes	867	760	566	536	509	559	535	652	798
Solvent and other product use	14	16	15	13	14	14	14	13	13
Agriculture	573	559	534	539	546	524	539	538	542
Waste	184	187	192	193	195	198	200	200	197
Total	3409	3249	3157	3194	3139	3199	3283	3445	3578

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
Energy								
-Fuel	1974	1875	1847	1919	1923	1993	1957	2008
-Geothermal	123	163	154	159	138	124	123	156
Industrial processes	934	950	971	936	960	949	944	1341
Solvent and other product use	14	15	17	13	10	10	16	9
Agriculture	547	530	526	503	486	476	479	512
Waste	197	200	204	196	200	193	189	207
Total	3789	3733	3720	3726	3716	3745	3709	4234

The distribution of the total greenhouse gas emissions over the UNFCCC sectors (including geothermal energy and excluding LULUCF) in 2006 is shown in Figure 2.11. Emissions from the energy sector account for 51% (fuel combustion 47%, geothermal energy 4%) of the national total emissions, industrial processes account for 32% and agriculture for 12%. The waste sector accounts for 5% and solvent and other product use for 0,2%.

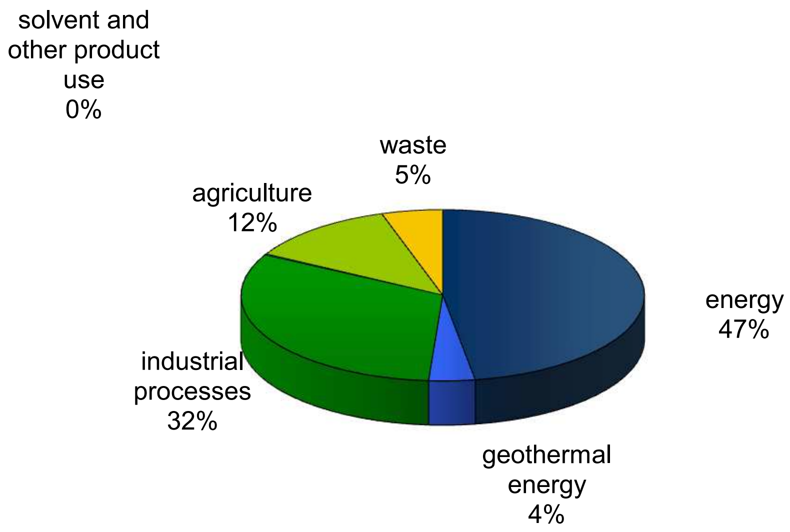

Figure 2.11 Emissions of greenhouse gases by UNFCCC sector in 2006

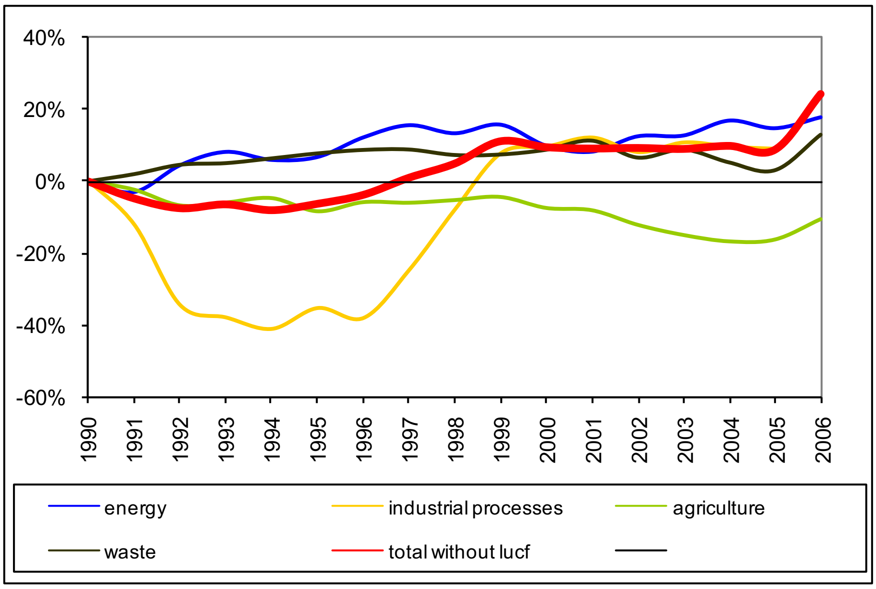

Figure 2.12 Percentage changes in emissions of total greenhouse gas emissions by UNFCCC source categories during the period 1990 – 2006, compared to 1990

2.3.1 Energy

The energy sector in Iceland is unique in many ways. In 2006 the per capita energy use was more than 560 GJ, which is high compared to other industrial countries, but the proportion of domestic renewable energy in the total energy budget is 80%, which is a much higher share than in most other countries. The cool climate and sparse population calls for high energy use for space heating and transport. Iceland relies heavily on geothermal energy for space heating and electricity production and on hydropower for electricity production.

The total emissions of greenhouse gases from the energy sector over the period of 1990 – 2006 are listed in Table 2.9. Figure 2.14 shows the distribution of emissions in 2006 by different source categories. The percentage change in the various source categories in the energy sector between 1990 and 2006, compared with 1990 are illustrated in Figure 2.15.

Table 2.9 Total emissions of greenhouse gases from the energy sector in 1990 – 2006, Gg CO_2-eq.

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Energy industries	21	22	21	24	24	27	23	18	41
Manufacturing ind./constr.	377	301	353	381	360	378	418	491	465
Transport	608	620	630	631	634	615	605	624	627
Other sectors	699	716	780	810	791	803	867	838	801
Fugitive emissions									
Total	1705	1659	1784	1846	1809	1822	1914	1971	1933

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
Energy industries	24	17	18	18	17	21	24	34
Manufacturing ind./constr.	492	445	477	477	443	444	427	408
Transport	657	659	670	674	770	823	834	979
Other sectors	801	753	683	750	693	704	672	587
Fugitive emissions								
Total	1974	1875	1847	1919	1923	1993	1957	2008

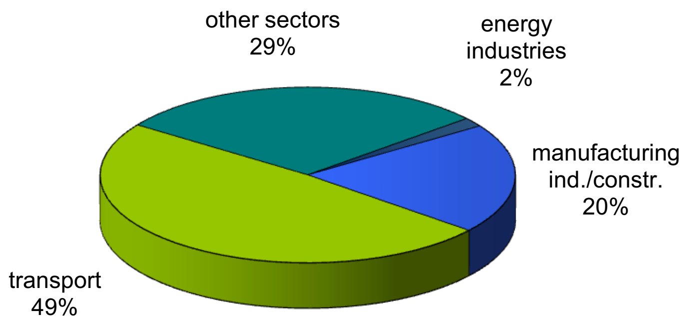

Figure 2.14 Greenhouse gas emissions in the energy sector 2006, distributed by source categories

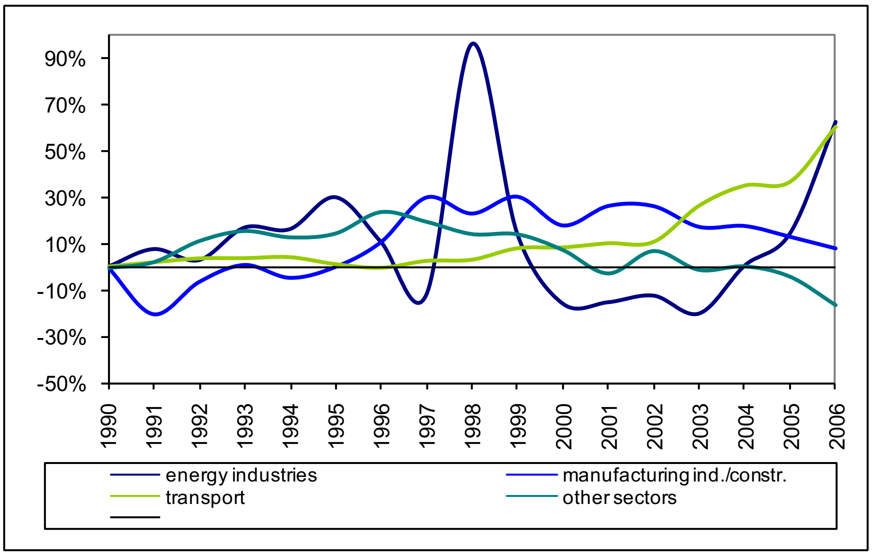

Figure 2.15 Percentage changes in emissions in various source categories in the energy sector during the period 1990 – 2006, compared to 1990

As can been seen from Table 2.9 and Figure 2.15 emissions from all source categories except 'other sectors' have increased during the period. The peak in the energy industries in 1998 was due to unusual weather condition during the winter of 1997/1998, which led to unfavorable water conditions for the hydropower reservoirs. This created a shortage of electricity which was met by burning oil for electricity and heat production. The peak seen in 2006 is due to increased waste incineration with energy recovery.

Increased emissions from the manufacturing industries and construction source category are explained by the increased activity in the construction sector during the period.

The fisheries dominate the 'other sector'. Emissions from fisheries rose from 1990 to 1996 because a substantial portion of the fishing fleet was operating in distant fishing grounds. From 1996, the emissions decreased again reaching 1990 levels in 2001. Emissions increased again by 10% between 2001 and 2002. In 2003 emissions again reached the 1990 level. In 2006 emissions were 22% under the 1990 level. Annual changes are inherent in the nature of fisheries.

Since 1990 the vehicle fleet in Iceland has increased by nearly 70%. This has led to increased emissions from the transport sector. The latest trend has been towards larger passenger cars, which consume more fuel. A decrease in navigation and aviation has however compensated the effect of rising emissions in the transport sector to some extent.

2.3.2 Geothermal energy

Iceland relies heavily on geothermal energy for space heating and for electricity production (27% of the total electricity production). Researches indicate that CO_2 emissions associated with the utilization of geothermal energy in Iceland constitute a net increase in emissions. The emissions are though considerably less extensive than from fossil fuel power plants. Table 2.10 shows the emissions from geothermal energy from 1990 to 2006.

Table 2.10 Emissions from geothermal energy from 1990 – 2006, Gg CO_2-eq.

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total	67	67	67	67	67	82	82	71	94

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
Total	123	163	154	159	138	124	123	156

2.3.3 Industrial processes

Production of raw materials is the main source of industrial process related emissions for both CO_2 and other greenhouse gases such as N_2O and PFCs. The industrial process sector accounts for about 32% of the national greenhouse gas emissions. As can be seen from Figure 2.16 and Table 2.11 emissions decreased from 1990 to 1996, mainly because of decrease in PFC-emissions. During the late nineties large-scale industry expanded in

Iceland. The existing aluminium plant and the ferroalloys industry experienced enlargement in 1997 and 1999, and in 1998 a new aluminium plant was established. This new aluminium plant then experienced enlargement in 2006. This led again to an increase in industrial process emissions.

Table 2.11 Total greenhouse gas emissions from industrial processes 1990 – 2006, Gg CO_2-eq.

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Mineral products	52	49	46	40	37	38	42	47	54
Chemical industry	49	47	42	44	45	43	50	42	36
Metal production	760	659	472	445	417	448	409	520	638
-Ferroalloys	*203*	*171*	*182*	*231*	*225*	*238*	*227*	*249*	*192*
-Aluminium	*556*	*488*	*289*	*214*	*193*	*210*	*182*	*271*	*446*
-Aluminium CO_2	*136*	*139*	*134*	*139*	*148*	*151*	*157*	*189*	*266*
-Aluminium PFC	*420*	*348*	*155*	*75*	*45*	*59*	*25*	*82*	*180*
Other production	NE	NE	NE	NE	NE	NE	NE	NE	NE
Consumption of HFCs and SF6	5	5	6	7	8	30	34	43	69
Total	866	760	565	536	508	559	535	651	798
emissions fulfilling 14/CP.7									108

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
Mineral products	62	66	59	41	33	51	55	62
Chemical industry	37	19	17	0	0	0	0	0
Metal production	770	827	836	854	851	833	806	1209
-Ferroalloys	*250*	*354*	*370*	*389*	*389*	*387*	*371*	*369*
-Aluminium	*520*	*473*	*466*	*465*	*461*	*446*	*435*	*840*
-Aluminium CO_2	*347*	*346*	*374*	*393*	*402*	*407*	*409*	*507*
-Aluminium PFC	*173*	*127*	*92*	*73*	*60*	*39*	*26*	*333*
Other production	NE	NE	NE	NE	NE	NE	NE	NE
Consumption of HFCs and SF6	65	38	59	41	75	64	82	69
Total	933	949	971	935	959	948	943	1340
emissions fulfilling 14/CP.7	115	273	404	441	451	455	440	535

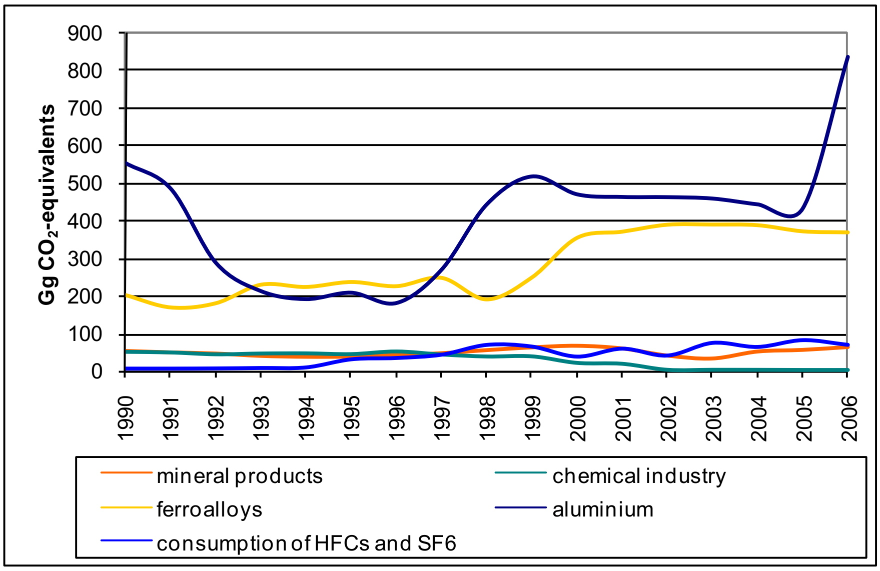

Figure 2.16 Total greenhouse gas emissions in the industrial process sector during the period from 1990 – 2006, Gg CO_2-eq.

The main category within the industrial process sector is metal production, which accounted for 88% of the sector's emissions in 1990 and 90% in 2006. Aluminium production is the main source within the metal production category, accounting for 63% of the total industrial process emissions. The production technology in both existing plants is based on using prebake anode cells. The main energy source is electricity, and industrial process CO_2 is mainly due to the anodes that are consumed during the electrolysis. In addition, the production of aluminium gives rise to emissions of PFCs. From 1990 to 1996 PFC emissions were reduced by 94%. Because of the enlargement of the existing aluminium plant in 1997 and the establishment of a new aluminium plant in 1998, emissions increased again from 1997 to 1999. From 2000 the emissions showed a steady downward trend until 2005. The PFC reduction was achieved through improved technology and process control and led to a 98% decrease in the amount of PFC emitted per tonne of aluminium produced during the period of 1990 to 2005 or from 4,78 tonnes CO_2-equivalents in 1990, to 0,10 tonnes CO_2-equivalents in 2005. In 2006 the PFC emissions rose significantly due to an expansion of aluminium plant that was established in 1998. The sudden increase was mainly caused by technical difficulties experienced during the expansion.

Production of ferroalloys is another major source of emissions, accounting for 37% of the industrial processes emissions in 2006. CO_2 is emitted due to the use of coal and coke as reducing agents and from the consumption of electrodes. In 1998 a power shortage caused a temporary closure of the ferroalloy plant, resulting in exceptionally low emissions that year. In 1999, however, the existing plant was expanded and emissions have therefore increased considerably.

Production of minerals is the sector's second most important category, accounting for 5% of the emissions in 2006. Cement production is the dominant contributor. Cement is produced in one plant in Iceland, emitting CO_2 derived from carbon in the shell sand used as raw material in the process. Emissions from the cement industry reached a peak in 2000 but declined until 2003, partly because imports of cement. In 2004 to 2006 emissions increased again. This can be explained by increased activity related to the construction of Iceland's largest hydropower plant.

Production of fertilizers used to be the main contributor to the process emissions from the chemical industry. The production was terminated in 2001. Silicon production was terminated in 2004 and therefore no chemical industry was operated in Iceland in 2006.

Imports of HFCs started in 1992 and increased until 1998. Since then annual imports have been between 30 and 77 Gg CO_2-equivalents. Sufficient data is not available to calculate actual emissions. This means that only potential emissions, based on imports, are estimated. The potential method is likely to overstate emissions, since the chemicals used, e.g. in refrigerators, are emitted over a period of several years. The application category refrigeration contributes by far the largest part of HFCs, increasing use of air cooling system in cars is also a source.

Sulphur hexafluoride emissions are not estimated but held constant over the whole time series. The largest source of SF_6 emissions is thought to be leakages from electrical equipment.

2.3.4 **Solvent and other product use**

The use of solvents and products containing solvents leads to emissions of non-methane volatile organic compounds (NMVOC), which are regarded as indirect greenhouse gases. The NMVOC emissions will over a period of time oxidize to CO_2 in the atmosphere. This conversion has been estimated. Also included in this sector is are emissions due to use of N_2O, mainly for medical purposes but also to a smaller extent for car racing. Those emissions were 6,3 Gg CO_2-equivalents in 2006 and have declined by 50% since 1990.

2.3.5 **Agriculture**

As can be seen from Table 2.12 and Figure 2.17 the emissions from agriculture decreased from 1990 to 2006. This was mainly due to a decreasing number of livestock.

Table 2.12 Total greenhouse gas emissions from agriculture in 1990 – 2006, Gg CO_2-eq.

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Enteric fermentation	270	264	256	255	256	248	250	254	257
Manure management	58	57	55	55	55	52	54	54	54
Agricultural soils	244	238	223	229	234	224	235	231	232
Total	573	559	534	539	546	524	539	538	542

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
Enteric fermentation	254	243	242	237	233	229	232	236
Manure management	53	51	51	49	48	47	48	49
Agricultural soils	240	236	233	217	205	199	199	226
Total	547	530	526	503	486	476	479	512

Greenhouse gas emissions from agriculture comprise emissions of methane and nitrous oxide. The greenhouse gas emissions from the agricultural sector accounted for 12% of the overall greenhouse gas emissions in 2006. The largest sources for agricultural greenhouse gas emissions are CH_4 from enteric fermentation and N_2O from agricultural soils.

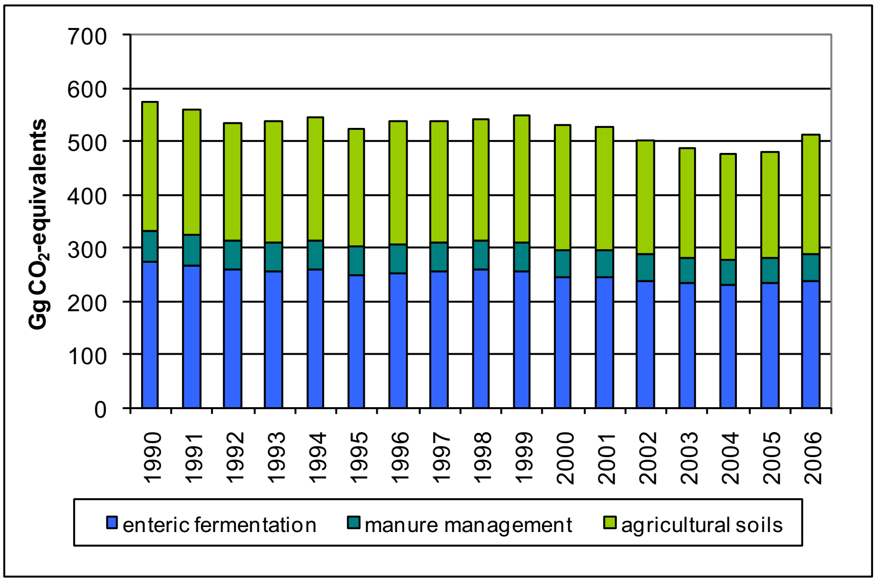

Figure 2.17 Total greenhouse gas emissions from agriculture from 1990 – 2006, Gg CO_2-eq.

2.3.6 **Waste**

As can be seen from Table 2.13 and Figure 2.18 the amount of greenhouse gases (CH_4) from landfills increased steadily from 1990 to 2001. From 2002 to 2005 a minor decrease in emissions occurred. In 2006 emissions increased again. From 1990 to 2006 the emissions rose by 31%. There are two reasons for this, increasing amounts of waste being landfilled and a larger percentage of that waste being landfilled in managed waste disposal sites. The amount of landfilled waste increased by 12% over the period. Methane recovery started at the largest operating landfill site in 1997, and the amount recovered increased steadily until 2006 where methane recovery equipment failed partly due to technical problems.

Emissions from wastewater handling have increased constantly since 1990 because total number of inhabitants connected to wastewater facilities has increased in the time period.

Emissions from waste incineration have decreased constantly since 1990 because total amount of waste being incinerated in Iceland has decreased. A higher percentage of the waste has concurrently been incinerated with energy recovery and is thus reported under 1A1a (public electricity and heat production).

Table 2.13 Emissions from the waste sector from 1990 – 2006, Gg CO_2-eq.

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Landfills	138	142	146	149	152	156	158	159	159
Wastewater handling	20	20	21	22	23	25	26	26	25
Waste incineration	19	19	19	16	15	13	11	11	9
Total	177	181	186	187	190	193	195	196	193

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
Landfills	161	163	169	159	163	162	163	181
Wastewater handling	25	26	26	27	29	27	25	25
Waste incineration	8	7	7	6	5	2	0	0
Total	194	197	201	193	197	191	188	206

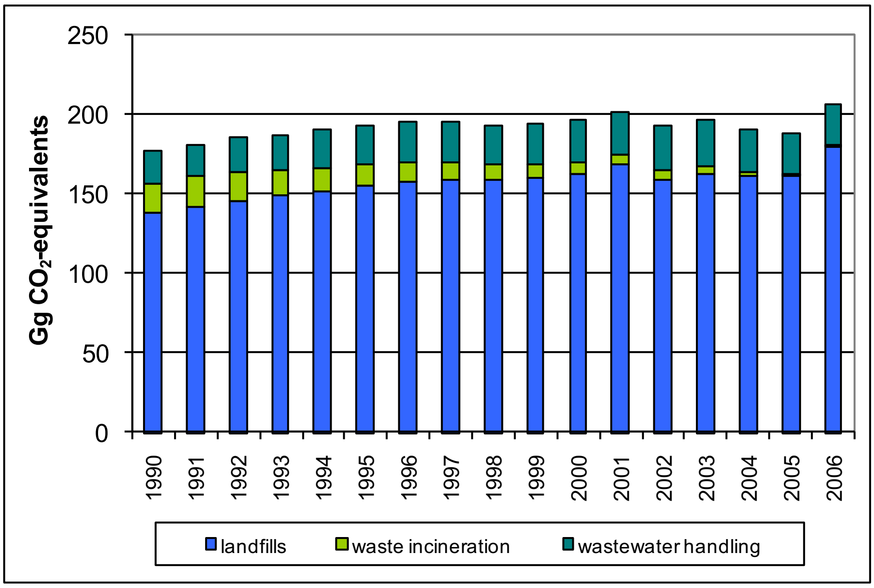

Figure 2.18 Emissions of greenhouse gases in the waste sector 1990 – 2006, Gg CO_2-eq.

2.4 Emission trends for indirect greenhouse gases and SO_2

Nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO) have an indirect effect on climate through their influence on greenhouse gases, especially ozone. Sulphur dioxide (SO_2) affects climate by increasing the level of aerosols that have in turn a cooling effect on the atmosphere.

2.4.1 **Nitrogen oxides (NOx)**

As can be seen in Figure 2.19, the main sources of nitrogen oxides in Iceland are fishing, transport and manufacturing industry and construction. The NOx emissions from fishing rose from 1990 to 1996 when a substantial portion of the fishing fleet was operating in distant fishing grounds. From 1996 emissions decreased, reaching the 1990 levels in 2001. In 2006 emissions were 5% below the 1990 level. Annual changes are inherent in the nature of fisheries. Emissions from transport are dominated by road transport. These emissions have decreased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995. The rise in emissions from the manufacturing industries and construction are dominated by increased activity in the construction sector during the period. Total NOx emissions show, like the emissions from fishing, an increase until 1996 and then a decrease until 2001. Emission rose again between 2002 and 2004 and then decreased in 2005 and 2006. The emissions in 2006 were 5% below the 1990 level.

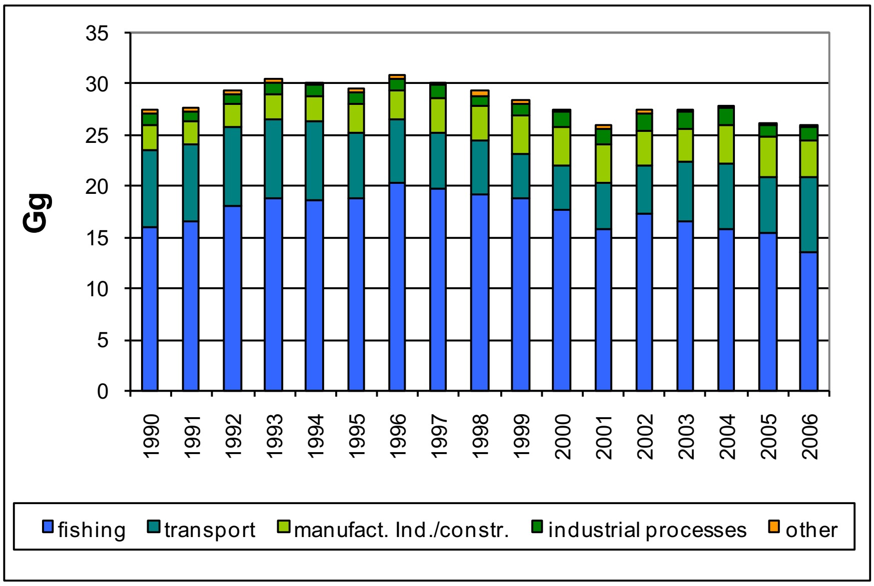

Figure 2.19 Emissions of NOx by sector 1990 – 2006, Gg

2.4.2 Non-methane volatile organic compounds (NMVOC)

As can be seen in Figure 2.20 the main sources of non-methane volatile organic compounds are transport and solvent use. Emissions from transport are dominated by road transport. These emissions have decreased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995. Emissions from solvent use vary between 2 Gg and 4 Gg during the period with no obvious trend. The total emissions show a downward trend from 1994 to 2003 with exception of 2000 and 2001. The emissions in 2006 were 50% below the 1990 level.

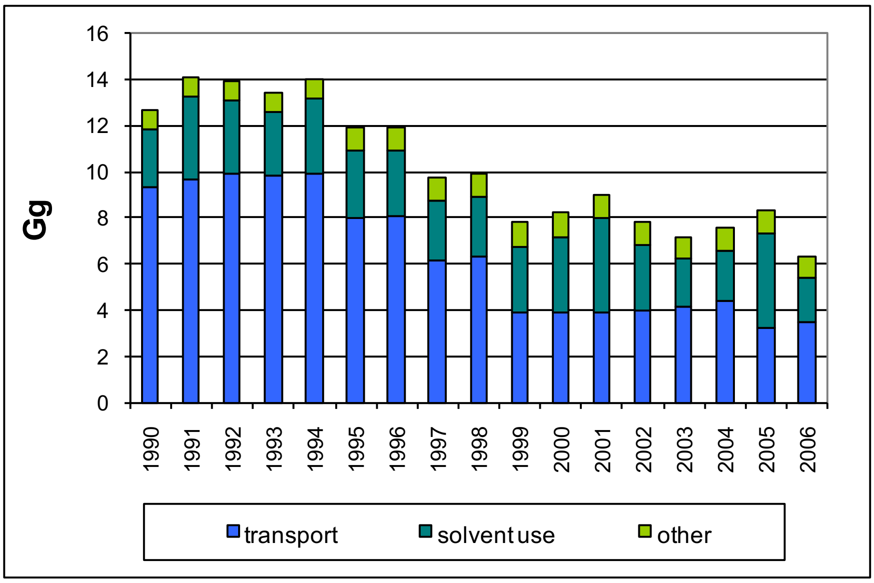

Figure 2.20 Emissions of NMVOC by sector 1990 – 2006, Gg

2.4.3 **Carbon monoxide (CO)**

As can be seen in Figure 2.21, transport is the prominent contributor to CO emissions in Iceland. Emissions from transport are dominated by road transport. These emissions have decreased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995. Total CO emissions show, like the emissions from transport, a rapid decrease after 1990. The emissions in 2006 were 53% below the 1990 level.

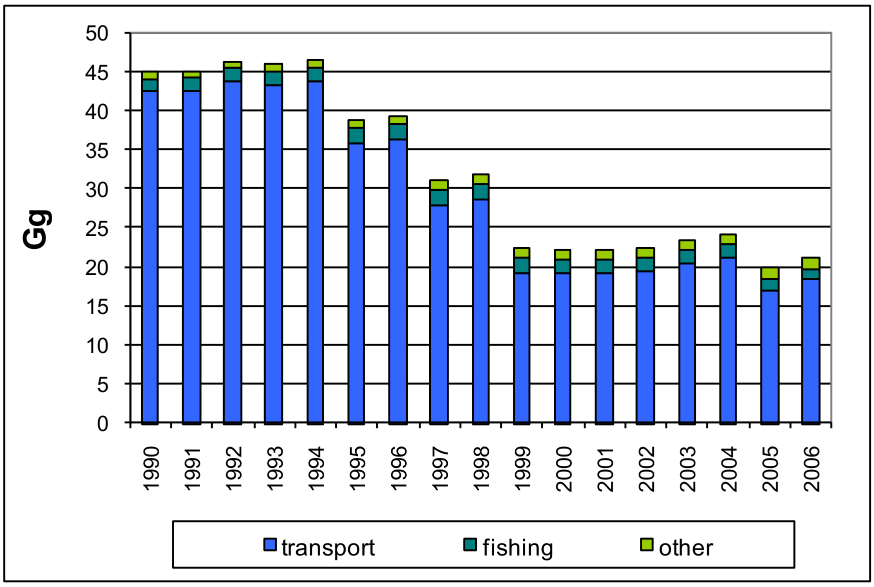

Figure 2.21 Emissions of CO by sector 1990 – 2006, Gg

2.4.4 **Sulphur dioxide (SO_2)**

Geothermal energy exploitation is by far the largest source of sulphur emissions in Iceland and has increased by 179% since 1990 due to increased activity in this field. Other significant sources of sulphur dioxide in Iceland are industrial processes and manufacturing industry and construction, as can be seen in Figure 2.22. Emissions from industrial processes are dominated by metal production. Until 1996 industrial process sulphur dioxide emissions were relatively stable. During the late nineties the metal industry expanded. The existing aluminium plant and the ferroalloys industry experienced enlargement in 1997 and 1999. In 1998 a new aluminium plant was established, this same aluminium plant experienced an enlargement in 2006. This led to increased emissions of sulphur dioxide. The fishmeal industry is the main contributor to sulphur dioxide emissions in the sector 'manufacturing industries and construction'. Emissions from the fishmeal industry increased generally from 1990 to 1997 but have declined since and were 7% below the 1990 level in 2006.

Total SO_2 emissions in 2006 were 122% above the 1990 level.

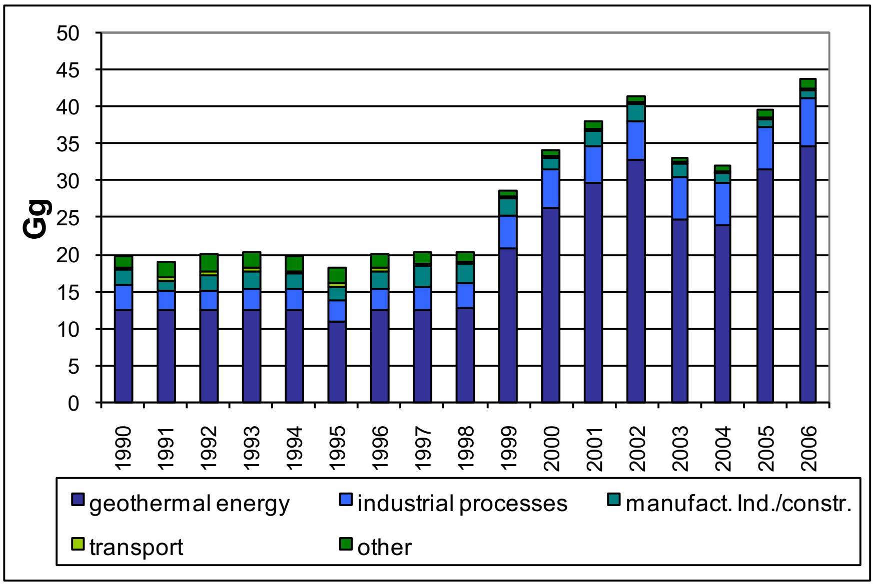

Figure 2.22 Emissions of SO_2 by sector 1990 – 2006, Gg

3 ENERGY

3.1 Overview

The energy sector in Iceland is unique in many ways. In 2006 the per capita energy use was more than 560 GJ, which is high compared to other industrial countries. However, the proportion of domestic renewable energy in the total energy budget is nearly 80%, which is a much higher share than in most other countries. The cool climate and sparse population calls for high energy use for space heating and transport. Also the largest portion of the electricity is used in metal production. Iceland relies heavily on its geothermal energy sources for space heating and electricity production (27%) and on hydropower for electricity production (73%). Emissions from hydropower reservoirs are included in the LULUCF sector.

The energy sector accounts for 51% of the GHG emissions in Iceland. Emissions increased by 22% from 1990 to 2006. From 2005 to 2006 the emissions increased by 4%. Fisheries and road traffic are the sector's largest single contributors. Combustion in the manufacturing industries and construction is also an important source.

3.1.1 **Methodology**

The calculation of greenhouse gas emissions from fuel combustion activities is based on the methodologies suggested by the IPCC Guidelines and the Good Practice Guidance. Fuel combustion activities are divided into two main categories: stationary and mobile combustion. Stationary combustion includes energy industries, manufacturing industries and the other sector (residential and commercial/institutional sector). Mobile combustion includes civil aviation, road transport, navigation, fishing, mobile combustion in construction and international bunkers. The methodology applied for each source category is described below.

The key source analysis performed for 2006 has revealed, as indicated in Table 1.1, that in terms of total level and/or trend uncertainty the key sources in the Energy sector are the following:

- Stationary combustion: oil – CO_2 (1A1, 1A2, 1A4)
- Stationary combustion: coal – CO_2 (1A2f)
- Mobile combustion: construction – CO_2 (1A2f)
- Mobile combustion: road vehicles – CO_2 (1A3b)
- Mobile combustion: road vehicles – N_2O (1A3b)
- Mobile combustion: fishing – CO_2 (1A4c)
- Geothermal energy – CO_2 (1B2d)

3.1.2 **Completeness**

Table 3.1 gives an overview of the IPCC source categories included in this chapter and presents the status of emission estimates from all sub-sources in the energy sector.

Table 3.1 Energy - completeness

Sector	Greenhouse gases						Other gases			
	CO_2	CH_4	N_2O	HFC	PFC	SF_6	Nox	CO	NMVOC	SO_2
Energy industries										
Public electricity and heat production	X	X	X	NA	NA	NA	X	X	X	X
Petroleum refining	NOT OCCURRING									
Manufacture of Solid Fuels and other energy industries	NOT OCCURRING									
Manufacturing Industries and Construction										
Iron and Steel	X	X	X	NA	NA	NA	X	X	X	X
Non-ferrous metals	X	X	X	NA	NA	NA	X	X	X	X
Chemicals	X	X	X	NA	NA	NA	X	X	X	X
Pulp, paper and print	NOT OCCURRING									
Food Processing, Beverages and Tobacco	X	X	X	NA	NA	NA	X	X	X	X
Other	X	X	X	NA	NA	NA	X	X	X	X
Transport										
Civil Aviation	X	X	X	NA	NA	NA	X	X	X	X
Road Transportation	X	X	X	NA	NA	NA	X	X	X	X
Railways	NOT OCCURRING									
Navigation	X	X	X	NA	NA	NA	X	X	X	X
Other Transportation	NOT OCCURRING									
Other Sector										
Commercial/Institutional	X	X	X	NA	NA	NA	X	X	X	X
Residential	X	X	X	NA	NA	NA	X	X	X	X
Agriculture/Forestry/Fisheries	X	X	X	NA	NA	NA	X	X	X	X
Other										
Stationary	X	X	X	NA	NA	NA	X	X	X	X
Mobile	NOT OCCURRING									
Fugitive Emissions from Fuels										
Solid Fuels	NOT OCCURRING									
Oil and Natural Gas	NE	NE	NE	NA	NA	NA	NE	NE	NE	NE
Geothermal Energy	X	NA	NA	NA	NA	NA	NA	NA	NA	X
International Transport										
Aviation	X	X	X	NA	NA	NA	X	X	X	X
Marine	X	X	X	NA	NA	NA	X	X	X	X

X: estimated

3.2 Stationary fuel combustion

3.2.1 Energy industries, manufacturing industries, commercial/institutional and residential fuel combustion

This source refers to emissions of GHG from combustion of fuels in the energy industries, in the manufacturing industries and construction and in the 'other sector' (commercial/institutional and residential fuel combustion activities). The key source analysis shows that CO_2 emissions from stationary oil combustion constitute a key source in level (both in 1990 and 2006) and trend and CO_2 emissions from stationary coal combustion constitute a key source in level 1990 and in trend.

Emissions from fuel combustion are estimated at the sectoral level. They are calculated by multiplying energy use by source and sector with pollutant specific emission factors. Activity data is provided by the National Energy Authority (NEA), which collects data from the oil companies on fuel sales by sector. Since not all oil companies provided sales statistics for the years 2003 to 2005, fuel use by sector was estimated by the NEA. In 2007 a new law nr. 48/2007 went into force enabling the NEA to obtain sales statistics from oil companies. In the beginning of 2008 NEA collected data, including historical data for the years 2003 to 2005 from the oil companies. Since Iceland relies heavily on geothermal energy for space heating and hydropower for electricity production, emissions from those sectors are relatively low. Emissions in this key source originate predominantly from the combustions in the manufacturing industries, and the fishmeal industry in particular. Emissions from waste incineration with energy recovery are reported under ‘energy industries’ and a description of the method is in Chapter 8.

Activity data

Total use of different oil products is based on the NEAs annual sales statistics for fossil fuels. The data is considered reliable since all oil companies report their sales statistics. There is thus a given total, which usage in the different sectors must sum up to. There is not a clear distinction between the energy industries sector and residential sector in fuel sales statistics. The National Energy Authority (NEA) has on request by the Environment Agency (EA) divided the fuel consumption between the two sectors. The EA collects consumption data from all major industry installations and the consumption in the fishmeal industry is from 1990 to 2002 estimated from production statistics, but for 2003 to 2006 they are based on data provided by the industry.

Emission factors

The CO_2 emission factors (EF) used reflect the average carbon content of fossil fuels. They are, with exception of NCV for solid fuels which were obtained from NEA, taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and are presented in Table 3.2. SO_2 emissions are calculated from the S-content of the fuels. Emission factors for other pollutants are taken from Table 1-15 to 1-19 of the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. Where EF were not available the default EF from Tables 1-7 to 1-11 in the Reference Manual were used.

Table 3.2 Emission factors for CO_2 from stationary combustion

	NCV [TJ/kt]	Carbon EF [t C/TJ]	Fraction oxidised	CO_2 EF [t CO_2/t fuel]
Kerosene (heating)	44,75	19,60	0,99	3,18
Gas / Diesel Oil	43,33	20,20	0,99	3,18
Residual fuel oil	40,19	21,10	0,99	3,08
Coking Coal	28,05	25,80	0,98	2,60

Uncertainty

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from stationary oil combustion is 7% and for coal combustion 11%.

Recalculations

Emissions for the years 2003 to 2005 were recalculated since better activity data was obtained by the NEA was explained above. Due to this some changes are observed for these years.

3.3 Mobile combustion

3.3.1 Construction sector

Emissions are calculated by multiplying energy use with a pollutant specific emission factor. Activity data is provided by the NEA, which collects data on fuel sales by sector.

Activity data

Total use of oil products in the construction sector is based on the NEA's annual sales statistics for fossil fuels. The data is considered reliable since all the oil companies have reported their sales statistics. In some instances oil, which is reported to fall under vehicle usage, is actually used for machinery and vice versa. This is, however, very minimal and the deviation is believed to level out.

Emission factors

The CO_2 emission factors used reflect the average carbon content of fossil fuels. The emission factors for other pollutants are taken from Table 1-49 in the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. EF for CO_2 and N_2O are presented in Table 3.3.

Table 3.3 Emission factors for CO_2 and N_2O from combustion in the construction sector

	NCV [TJ/kt]	Carbon EF [t C/TJ]	Fraction oxidised	CO_2 EF [t CO_2/t fuel]	N_2O EF [t N_2O/kt fuel]
Gas / Diesel Oil	43,33	20,20	0,99	3,18	1,3

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from construction is 11%.

Recalculations

Emissions for the years 2003 to 2005 were recalculated since better activity data was obtained by the NEA was explained above. Due to this some changes are observed for these years.

3.3.2 **Road vehicles**

Emissions from road traffic are estimated by multiplying the fuel use by type of fuel and vehicle, and fuel and vehicle pollutant specific emission factors. Activity data is provided by the NEA, which collects data on fuel sales by sector.

Activity data

Total use of diesel oil and gasoline are based on the NEA's annual sales statistics for fossil fuels. The data is considered reliable since all the oil companies have reported sales statistics. The EA estimates how fuel sale is divided between the different types of vehicles, but the method used is considered to be inaccurate.

Emission factors

For CO_2 the standard emission factors based on carbon content of the fuels are used. Emission factors for CH_4 and N_2O depend upon vehicle type and emission control. They are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and are presented in Table 3.4.

Table 3.4 Emission factors for greenhouse gases from European vehicles, g/kg fuel

	CH_4	N_2O	CO_2
Passenger car – gasoline, uncontrolled	0,8	0,06	3070
Passenger car – gasoline, non catalyst control	1,1	0,08	3070
Passenger car – gasoline, three way catalyst	0,3	0,8	3070
Light duty vehicle – gasoline	0,8	0,06	3070
Heavy duty vehicle – gasoline	0,7	0,04	3070
Passenger car – diesel	0,08	0,2	3180
Light duty vehicle – diesel	0,06	0,2	3180
Heavy duty vehicle – diesel	0,2	0,1	3180

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from road vehicles is 11%. For N_2O, both activity data and emission factors are highly uncertain. The uncertainty of N_2O emissions from road vehicles is 206%.

Recalculations

Emissions for the years 2003 to 2005 were recalculated since better activity data was obtained by the NEA was explained above. Due to this some changes are observed for these years.

3.3.3 **Fishing**

Emissions are calculated by multiplying energy use with a pollutant specific emission factor. Activity data is provided by the NEA, which collects data on fuel sales by sector.

Activity data

Total use of residual fuel oil and gas/diesel oil for the fishing is based on the NEA's annual sales statistics for fossil fuels. The data is, with the exception of 2003 and 2004 considered reliable since all oil companies reported their sales statistics.

Emission factors

The emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories for ocean-going ships and are presented in Table 3.5.

Table 3.5 Emission factors for CO_2, CH_4 and N_2O for ocean going ships

	NCV [TJ/kt]	Carbon EF [t C/TJ]	Fraction oxidised	EF CO_2 [t CO_2/t]	EF N_2O [kg N_2O/TJ]	N_2O EF [kg N_2O/t]	EF CH_4 [kg CH_4/TJ]	EF CH_4 [kg CH_4/t]
Gas / Diesel Oil	43,33	20,20	0,99	3,18	2	0,086	7	0,30
Residual fuel oil	40,19	21,10	0,99	3,08	2	0,084	7	0,28

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from fishing is 5%.

Recalculations

Emissions for the years 2003 to 2005 were recalculated since better activity data was obtained by the NEA was explained above. Due to this some changes are observed for these years.

3.3.4 **Civil aviation**

Emissions are calculated by using the Tier 1 method, thus multiplying energy use with a pollutant specific emission factor. Activity data is provided by the NEA, which collects data on fuel sales by sector.

Activity data

Total use of jet kerosene and gasoline is based on the NEA's annual sales statistics for fossil fuels. The data is, with the exception of 2003 to 2005 considered reliable since all the oil companies reported their sales statistics.

Emission factors

The emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and are presented in Table 3.6. Emissions of SO_2 are calculated from S-content in the fuels.

Table 3.6 Emission factors for CO_2 and other pollutants for aviation

	NCV [TJ/kt]	Carbon EF [t C/TJ]	Fraction oxidised	EF CO_2 [t CO_2/t]	NO_x [kg/TJ]	CH_4 [kg/TJ]	NMVOC [kg/TJ]	CO [kg/TJ]	N_2O [kg/TJ]
Jet kerosene	44,59	19,50	0,99	3,16	300	0,5	50	100	2
Gasoline	44,80	18,90	0,99	3,07	300	0,5	50	100	2

Recalculations

Emissions for the years 2003 to 2005 were recalculated since better activity data was obtained by the NEA was explained above. Due to this some changes are observed for these years.

3.3.5 National navigation

Emissions are calculated by multiplying energy use with a pollutant specific emission factor. Activity data is provided by the National Energy Authority (NEA), which collects data on fuel sales by sector.

Activity data

Total use of residual fuel oil and gas/diesel oil for national navigation is based on the NEA's annual sales statistics for fossil fuels. The data is, with the exception of 2003 to 2005 considered reliable since all the oil companies reported their sales statistics.

Emission factors

The emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories for ocean-going ships and are presented in Table 3.5.

3.4 International bunker fuels

Emissions from international aviation and marine bunker fuels are excluded from national totals as required according to the IPCC Guidelines. These emissions are presented separately for informational purposes and can be seen in Table 3.6.

In 2006, greenhouse gas emissions from ships and aircraft in international traffic bunkered in Iceland amounted to a total of 533 Gg CO_2-equivalents, which corresponds to about 13% of the total Icelandic greenhouse gas emissions. Greenhouse gas emissions from marine and aviation bunkers increased by around 85% from 1990 to 2006, and between 2004 and 2005 emissions decreased by 2%.

Looking at these two categories separately, it can be seen that greenhouse gas emissions from international marine bunkers increased by 39% from 1990 to 2006, while emissions from aircrafts increased by 78% during the same period. Between 2005 and 2006 emissions from marine bunkers increased by 24% while emissions from aviation bunkers decreased by 7%.

Table 3.7 Greenhouse gas emissions from international aviation and marine bunkers, Gg CO_2-eq.

	1990	1995	2000	2001	2002	2003	2004	2005	2006
Marine	100	146	221	151	209	145	198	112	139
Aviation	222	238	411	352	313	336	383	425	394
Total	322	384	632	503	522	481	582	537	533

Emissions are calculated by multiplying energy use with pollutant specific emission factors. Activity data is provided by the NEA, which collects data on fuel sales by sector. These data distinguish between national and international usage. The data is considered reliable since all oil companies selling oil products report those statistics. The emission factors for marine bunkers are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories for ocean-going ships and are presented in Table 3.5 above. Emission factors for aviation bunkers are also taken from the IPCC Guidelines and presented in Table 3.6 above.

Recalculations

Emissions for the years 2003 to 2005 were recalculated since better activity data was obtained by the NEA was explained above. Due to this some changes are observed for these years.

3.5 Cross-cutting issues

3.5.1 Sectoral versus reference approach

This section will be completed for the next submission.

3.5.2 Feedstock and non-energy use of fuels

Emissions from the use of feedstocks are according to the Good Practice Guidance accounted for in the industrial processes sector in the Icelandic inventory. This includes all use of petroleum coke, other bituminous coal and coke oven coke.

Iceland uses a carbon storage factor of 1 for bitumen and 0,5 for lubricants for the non-energy use in the Reference Approach, CRF Table 1(A)d.

3.6 Geothermal energy

3.6.1 Overview

Iceland relies heavily on geothermal energy for space heating and to some extent for electricity production (27% of the total electricity production in 2006). Geothermal energy is generally considered to have relatively low environmental impact. Emissions of CO_2 are commonly considered to be among the negative environmental effects of geothermal power production, even though they have been shown to be considerably less extensive than from fossil fuel power plants.

As indicated in Table 1.1, the key source analysis performed for 2006 has revealed that geothermal energy is a key source in terms of both level and trend.

3.6.2 Methodology

Three major geothermal power plants in operation in Iceland are at Krafla, Svartsengi and Nesjavellir. The Svartsengi and Nesjavellir plants produce both electricity and hot water for space heating, whereas the Krafla plant generates electricity only. The total installed capacity of these three power plants is 195 MW and they produce about 17% of the total electricity used in Iceland.

Geothermal systems can be considered as geochemical reservoirs of CO_2. Degassing of mantle-derived magma is the sole source of CO_2 in these systems in Iceland. CO_2 sinks include calcite precipitation, CO_2 discharge to the atmosphere and release of CO_2 to enveloping groundwater systems. The CO_2 concentration in the geothermal steam is site and time-specific, and varies greatly between areas, wells within an area as well as the time of extraction.

Iceland reported greenhouse gas emissions from geothermal energy utilization prior to 2000 when it was decided to not include these emissions in the national emissions, as research in Iceland and some other countries indicated great uncertainty in the estimation of such emissions. At the time it was considered likely that no net emissions were taking place from geothermal power plants, only a relocation of the natural emissions within the wider geothermal area. Recent research, however, indicates that emissions associated with the utilization of geothermal energy in Iceland do constitute a net increase in emissions.

The total emissions estimate is based on direct measurements. The enthalpy and flow of each well are measured and the CO_2 concentration of the steam fraction determined at the wellhead pressure. The steam fraction of the fluid and its CO_2 concentration at the wellhead pressure and the geothermal plant inlet pressure are calculated for each well. Information about the period each well discharged in each year is then used to calculate the annual CO_2 discharge from each well and finally the total CO_2 is found by adding up the CO_2 discharge from individual wells.

The total CO_2 emissions in 2006 were 156,5 Gg and the electricity production amounted to 2620 GWh.

4 INDUSTRIAL PROCESSES

4.1 Overview

Production of raw materials is the main source of industrial process related emissions for CO_2, N_2O and PFCs. Emissions also occur because of use of HFCs as substitutes for ozone depleting substances. The industrial process sector accounted for 32% of the GHG emissions in Iceland in 2006. Emissions decreased from 1990 to 1996, mainly due to reduction in PFC emissions. In 1996 emissions were 38% below the 1990 level. Due to the expansion of energy intensive industry, emissions rose rapidly from 1996 to 1999, when they were 8% above the 1990 level. In 2006 emissions from the industrial processes sector were 55% above the 1990 level. This is mainly due to very high process emissions (PFCs) from one aluminium plant that was expanded in 2006. The main category within the industrial process sector is metal production, which accounted for 90% of the sector's emissions in 2006.

4.1.1 Methodology

The calculation of greenhouse gas emissions from industrial processes is based on the methodologies suggested by the IPCC Guidelines and the Good Practice Guidance.

The key source analysis performed for 2006 has revealed, as indicated in Table 1.1, that in terms of total level and/or trend uncertainty the key sources in the Industrial Processes Sector are the following:

- Emissions from Cement Production – CO_2 (2A1)
- Emissions from Ferroalloys – CO_2 (2C2)
- Emissions from Aluminium Production – CO_2 (2C3)
- Emissions from Aluminium Production – PFCs (2C3)
- Emissions from Substitutes for Ozone Depleting Substances – HFCs (2F)

4.1.2 Completeness

Table 4.1 gives an overview of the IPCC source categories included in this chapter and presents the status of emission estimates from all sub-sources in the industry sector.

Table 4.1 Industrial Processes - Completeness

Sector	Greenhouse gases						Other gases			
	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NOx	CO	NMVOC	SO_2
Mineral Products:										
Cement Production	X	NE	NE	NA	NA	NA	NE	NE	NE	IE
Lime Production	NOT OCCURRING									
Limestone and Dolomite Use	NOT OCCURRING									
Soda Ash Production and Use	NOT OCCURRING									
Asphalt Roofing	NOT OCCURRING									
Road Paving with Asphalt	NE	NE	NE	NA	NA	NA	X	X	X	X
Other (Mineral Wool Production)	X	NE	NE	NA	NA	NA	NE	X	NE	X
Chemical Industry										
Ammonia Production	NOT OCCURRING									
Nitric Acid Production	NOT OCCURRING									
Adipic Acid Production	NOT OCCURRING									
Carbide Production	NOT OCCURRING									
Other (Silicium Production – until 2004)*	X	NE	NE	NA	NA	NA	X	NE	NE	NE
Other (Fertilizer Production – until 2001)*	NA	NE	X	NA	NA	NA	X	NE	NE	NE
Metal Production										
Iron and Steel Production	NOT OCCURRING									
Ferroalloys Production	X	X	NA	NA	NA	NA	X	X	X	X
Aluminium Production	X	NE	NE	NA	X	NA	NE	NE	NE	X
SF_6 used in aluminium/magnesium foundries	NOT OCCURRING									
Other	NOT OCCURRING									
Other Production										
Pulp and Paper	NOT OCCURRING									
Food and Drink	NE	NA	NA	NA	NA	NA	NA	NA	NE	NA
Production of Halocarbons and SF_6	NOT OCCURRING									
Consumption of Halocarbons and SF_6	NA	NA	NA	X	NO	X	NA	NA	NA	NA
Other	NOT OCCURRING									

X: estimated
* Fertilizer production was terminated in 2001 and Silicium production was terminated in 2004

4.2 Mineral Products

4.2.1 Cement Production (2A1)

The single operating cement plant in Iceland produces cement from shell sand and rhyolit in a rotary kiln using a wet process. Emissions of CO_2 originate from the calcination of the raw material calcium carbonate, which comes from shell sand in the production process. The resulting calcium oxide is heated to form clinker and then crushed to form cement. Emissions are calculated according to the Tier 2 method based on clinker production data and data on the CaO content of the clinker. Cement Kiln Dust (CKD) is non-calcined dust produced in the kiln. CKD may be partly or completely recycled to the kiln. Any CKD that is not recycled can be considered lost to the system in terms of CO_2 emissions. Emissions are thus corrected with plant specific cement kiln dust correction factor.

Activity data

Process specific data on clinker production, CaO content of the clinker and non-recycled CKD are collected by the EA directly from the cement production plant. The data is considered reliable. Data on clinker production is only available for the years 2003 to 2006. Historical clinker production data has been calculated as 85% of cement production, which was the average proportion for the year 2003 to 2005.

Table 4.2 Clinker production and CO_2 emissions from cement production from 1990 – 2006.

Year	Clinker production [kt]	CO_2 emissions [kt]
1990	114,100	51,6
1991	106,174	48,0
1992	99,800	45,1
1993	86,419	39,1
1994	80,856	36,5
1995	81,514	36,8
1996	90,325	40,8
1997	100,625	45,5
1998	117,684	53,2
1999	133,647	60,4
2000	142,604	64,4
2001	127,660	57,7
2002	84,684	39,4
2003	75,314	32,1
2004	104,829	49,8
2005	99,170	53,9
2006	112,219	61,0

Emission factors

It has been estimated by the cement production plant that CaO content of the clinker is 63%. The corrected emission factor for CO_2 is thus 0,495. For CKD it is 7,5% for all years except 2005 and 2006 when it is 110%.

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from cement production is 6,5%.

4.2.2 Road paving with asphalt

Asphalt road surfaces are composed of compacted aggregate and asphalt binder. Gases are emitted from the asphalt plant, the road surfacing operations and from the subsequent road surface. Information on the amount of asphalt produced come from Statistics

Iceland. Emission factor for SO_2, NO_x, CO and NMVOC are taken from Table 2-4, IPCC Guidelines, Reference Manual.

4.2.3 **Mineral Wool Production**

Emissions of CO_2 and SO_2 are calculated from the amount of shell sand and electrodes used in the production process. Emissions of CO are based on measurements that were made at the single operating plant in 2000.

4.3 Chemical industry

The only chemical industry that has existed in Iceland is the production of silicium and fertilizer. The fertilizer production plant was closed down in 2001 and the silicium production plant was closed down in 2004.

At the silicium production plant silicium containing sludge is burned to remove organic material. Emissions of CO_2 and NO_x are estimated on the basis of C-content and N-content of the sludge. Emissions also occur from the use of soda ash at the production process and those emissions are reported here.

When the fertilizer production plant was operational it reported its emissions of NO_x and N_2O to the Environment Agency.

4.4 Metal Production

4.4.1 **Ferroalloys**

Ferrosilicon (FeSi, 75% Si) is produced at one plant in Iceland. The raw material is quartz (SiO_2). The quartz is reduced to Si and CO using reducing agents. The waste gas CO and some SiO burns to form CO_2 and silicia dust. In the production raw ore, carbon material and slag forming materials are mixed and heated to high temperatures for reduction and smelting. The carbon materials used are coal, coke and wood. Electric (submerged) arc furnaces with soederberg electrodes are used. The furnaces are semi-covered. Emissions of CO_2 originate from the use of coal and coke as reducing agent, as well as from consumption of electrodes. Emissions are calculated according to the Tier 1 method based on the consumption of reducing agents and electrodes and emission factors from the IPCC Guidelines.

Activity data

The consumption of reducing agents and electrodes are collected by the EA directly from the single operating ferroalloys production plant. The data is thus considered reliable.

Emission factors

For CO_2, the standard emission factors based on carbon content of the reducing agents and electrodes are used. They are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and are presented in Table 4.3. Values for NCV are from NEA. Emission factors for CH_4, NO_x and NMVOC are taken from Tables 1-7, 1-9 and 1-11 in the IPCC Guidelines, Reference Manual. Emissions of SO_2 are calculated from the sulphur content of the reducing agents and electrodes. The emission factor for CO is taken from Table 2-16 in the IPCC Guidelines, Reference Manual.

Table 4.3 Emission factors for CO_2 from production of ferroalloys

	NCV [TJ/kt]	Carbon EF [t C/TJ]	Fraction oxidised	CO_2 EF [t CO_2/t input]
Other Bituminous Coal	28,00	25,80	0,98	2,60
Coke Oven Coke	28,00	29,50	0,98	2,97
Electrodes	28,00	32,14	0,98	3,23

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from ferroalloys production is 11%.

4.4.2 Aluminium Production

Aluminium is produced at 2 plants in Iceland. They both use the prebaked anode method. Primary aluminium production results in emissions of CO_2 and PFCs. CO_2 emissions originate from the consumption of electrodes during the electrolysis process. Emissions are calculated according to the Tier 1 method based on the quantity of electrodes used in the process and the emission factors from the IPCC Guidelines.

PFCs are produced during anode effects (AE) in the prebake cells, when the voltage of the cells increases from the normal 4 – 5 V to 25 – 40 V. Emissions of PFCs are dependent on the number of anode effects and their intensity and duration. Anode effect characteristics are different from plant to plant. Emission factors are calculated according to the Tier 2 Slope Method. Default coefficients are taken from the IPCC Good Practice Guidance for Centre Worked Prebaked Technology. Emission factors are calculated with the following formula:

$$\text{EF (kg } CF_4 \text{ or } C_2F_6 \text{ per tonne of Al)} = \text{Slope} \bullet \text{AE min/cell day}$$

Emissions are then calculated by multiplying the emission factors with the amount of aluminium produced.

Activity data

The EA collects annual process specific data from the two operating aluminium plants. The data is considered reliable.

Emission factors

For CO_2, the standard emission factors based on carbon content of the electrodes are used. They are taken from the revised 1996 IPCC Guidelines for National Greenhouse

Gas Inventories and are presented in Table 4.2. The default coefficients for the calculation of PFC emissions are taken from the IPCC Good Practice Guidance for Centre Worked Prebaked Technology (0,14 for CF_4 and 0,018 for C_2F_6). Measurements that have been performed at both plants seem to indicate that the emissions from the plants fall within the range of this method. The measurements took place in 1997 at the older aluminium plant and in 2001 at the newer one.

Table 4.4 Emission factors CO_2 from aluminium production

	NCV [TJ/kt]	Carbon EF [t C/TJ]	Fraction oxidised	CO_2 EF [t CO_2/t input]
Electrodes	31,35	31,42	0,98	3,54

Table 4.5 Aluminium production, AE, CO_2 and PFC emissions from 1990 – 2006.

Year	Aluminium production [kt]	CO_2 emissions [kt]	AE Andoe Effect [min/cell day]	PFC emissions [kt CO_2-eq]	CO_2 [t/t Al]	PFC [t CO_2-eq per t Al]
1990	87,839	136,5	4,44	419,6	1,55	4,78
1991	89,217	139,3	3,63	348,3	1,56	3,90
1992	90,045	134,2	1,60	155,3	1,49	1,72
1993	94,152	139,0	0,74	74,9	1,48	0,80
1994	98,595	148,0	0,42	44,6	1,50	0,45
1995	100,198	150,7	0,55	58,84	1,50	0,59
1996	103,362	157,0	0,23	25,2	1,52	0,24
1997	123,562	188,9	0,62	82,4	1,53	0,67
1998	173,869	265,5	10,90	180,1	1,53	1,04
1999	222,014	347,2	2,17	173,2	1,56	0,78
2000	226,362	345,5	1,13	127,2	1,53	0,56
2001	244,148	373,9	0,71	91,7	1,53	0,38
2002	264,107	392,6	0,56	72,5	1,49	0,27
2003	266,611	401,6	0,40	59,8	1,51	0,22
2004	271,384	407,3	0,25	38,6	1,50	0,14
2005	272,488	408,7	0,22	26,1	1,50	0,10
2006	326.270	506,9	1,95	333,2	1,55	1,02

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from aluminium production is 11%.

The emission factors for calculating PFC emissions have more uncertainty but still seem to fit well to the measurements that have been performed so far at the aluminium production plants. The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of PFC emissions from aluminium production is 9% for CF_4 and 23% for C_2F_6.

4.5 Emissions from Substitutes for Ozone Depleting Substances – HFCs (2F)

HFCs are used as substitutes for the ozone depleting substances (CFCs and HCFCs) which being phased out by the Montreal Protocol. There is no production of HFCs in Iceland but they are imported for use in stationary and mobile air-conditioning systems and metered dose inhalers. HFC is banned in other aerosols, solvents and fire extinguishers. The HFCs used in significant quantities in Iceland are HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a and HFC-152a.

The import of HFCs started in 1992 and increased until 1998. The annual imports have since stayed between 30 and 77 Gg CO_2-equivalents. Sufficient data are still not available to calculate actual emissions in most applications, meaning that only potential emissions, based on registered imports, are estimated. However, estimates of HFC import in equipment are now being ascertained and will be included in potential emissions next year. In 2006 the potential emissions of HFCs were about 2% of national total greenhouse gas emissions (without LULUCF). This source category is a key source in both level and trend.

Method

Potential emissions of HFCs (sector 2F) are calculated using the Tier 1b methodology which considers the import, export and destruction of chemicals in bulk and in equipment without time lag.

Data on imported and exported bulk are reported directly to the EA each year. The data are considered reliable. There is no destruction of HFCs in Iceland, although small amounts are exported every year for destruction at a facility in Denmark.

Activity data

Information on the import of chemicals in bulk is reported directly to the EA. The importers are required to report on the type and amount of HFC they are importing in order to release the chemicals from the customs agency. At present, there is no registration of HFC in imported refrigeration equipment or vehicles.

Uncertainty

The quantitative uncertainty has not been evaluated. The activity data are considered reliable. Emissions are likely to be overestimated since only potential emissions are calculated.

Planned improvements

Considerable progress has been made towards improving estimations for this source for 2006 estimates. Much has been done already to assess the amount of HFC imported in refrigeration equipment and in mobile air-conditioning systems.

It now is believed that the levels of HFCs imported in mobile air-conditioning systems (MACs) are higher than previously assumed. A voluntary survey of car importers was conducted last year and the resulting data, along with import statistics, will be used to extrapolate data for levels of imports in MACs. According to the survey the import of vehicles with mobile air conditioning (MAC) systems has increased in recent years. Preliminary data suggest that 8,5 Gg of HFC-134a (CO_2-equivalents) were imported in vehicles in 2005 alone. Considering that 77 Gg of HFC (CO_2-equivalents) were imported in bulk in 2005, the amount imported in MAC systems is considerable and will be included in next year's inventory.

Data on HFCs in refrigeration equipment will be estimated from import statistics, based on land of origin and type of refrigerator.

A considerably smaller source is the use of HFCs in aerosols, or metered dose inhalers. Their import is registered by the Icelandic Medicines Control Agency. This category will be moved to Tier 2 by next submission.

5 SOLVENT AND OTHER PRODUCT USE

The use of solvents and products containing solvents leads to emissions of non-methane volatile organic compounds (NMVOC), which are regarded as indirect greenhouse gases. Estimates of NMVOC emissions are based on data on imports of solvents combined, with expert estimates based on surveys. The NMVOC emissions will over a period of time oxidize to CO_2 in the atmosphere. This conversion has been estimated with the following equation:

$$CO_2 \text{ emission} = 0{,}85 \times \text{NMVOC emissions} \times 44/12$$

where 0,85 is the carbon content of the NMVOCs.

Other emissions reported under the sector solvent and other product use are due to use of N_2O, mainly for medical purposes, and also, to a smaller extent, for car racing. Data on sold amounts are collected directly by the Environment Agency.

6 AGRICULTURE

6.1 Overview

Icelanders are self-sufficient in all major livestock products such as meat, milk and eggs. Traditional livestock production is grassland-based and all the native breeds, i.e. of dairy cattle, sheep, horses and goats are of ancient Nordic origin, one of each species. These animals are generally smaller than in Europe. Beef production, however, is partly based on imported breeds. The more intensive agricultural sector, pork and poultry production is based on imported breeds.

6.1.1 Methodology

The calculation of greenhouse gas emissions from agriculture is based on the methodologies suggested by the IPCC Guidelines and the Good Practice Guidance.

As indicated in Table 1.1, the key source analysis performed for 2006 has revealed that in terms of total level and/or trend uncertainty the key sources in the agriculture sector are as follows:

- Emissions from Enteric Fermentation – CH_4 (4A)
- Direct Emissions from Agricultural Soils – N_2O (4D1)
- Indirect Emissions from Agricultural Soils – N_2O (4D2)

6.1.2 Completeness

Table 6.1 gives an overview of the IPCC source categories included in this chapter and presents the status of emission estimates from all sub-sources in the agricultural sector.

Table 6.1 Agriculture - completeness

	Greenhouse gases		
Sector	CO_2	CH_4	N_2O
Enteric Fermentation	NA	X	NA
Manure Management	NA	X	X
Rice Cultivation	Not Occurring		
Agricultural Soils			
Direct emissions	NA	NE	X
Animal Production	NA	NE	X
Indirect emissions	NA	NE	X
Prescribed burning of Savannas	Not Occurring		
Field burning of agricultural residues	Not Occurring		
Other	Not Occurring		

X: estimated

6.2 Enteric Fermentation

The production of CH_4 by enteric fermentation in animals varies with digestive systems and feed intake. Ruminants such as cattle and sheep produce the largest amount of methane. However, enteric fermentation in pseudo-ruminants (e.g. horses) and monogastric animals (e.g. pigs) is also of significance. The methodology for calculating methane from enteric fermentation is in accordance with the Tier 1 method. Both the population levels and emission factors by type of animal are used to calculate the emissions.

Activity data

The Icelandic Association of Farmers (IAF) is in charge of assessing the size of the animal population each year. On request from the EA, the IAF also accounts for young animals, but those are mostly excluded from national statistics on animal population. The data is considered relatively reliable.

Emission factors

Emission factors are taken from the IPCC Guidelines, except for fur animals which were taken from Norway's NIR 2007. They are presented in Table 6.2. The emission factors are likely to be too high, since domestic animals in Iceland are generally smaller (sheep, horses) than in other European countries.

Table 6.2 Emission factors for CH_4 from enteric fermentation

	kg CH_4 per head per year
Dairy cattle	100
Non-dairy cattle	48
Sheep	8
Goats	5
Horses	18
Swine	1,5
Fur animals	0,1*

* Revised National Inventory Report 2007, Norway

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CH_4 emissions from enteric fermentation is 54%.

Planned improvements

Develop country-specific emission factors from feed intake according to the Tier 2 method, in particular for the special Icelandic livestock.

6.3 Manure management

Manure management is responsible for methane and nitrous oxide emissions. Methane is produced during the anaerobic decomposition of the manure, while nitrous oxide is produced during storage and treatment of the manure before it is used as fertilizer.

CH_4 emissions from manure management were estimated according to the IPCC Tier 1 methodology. Population levels for each kind of animal as well as its specific emission factor are used to calculate the emissions. The animal population size is collected, as mentioned before, from the Icelandic Association of Farmers (IAF).

Emission factors are taken from the IPCC Guidelines, except for fur animals which are taken from Norway's NIR 2007. They are presented in Table 6.3, but are likely to be overstated, as domestic animals in Iceland are generally smaller (sheep, horses) than in other European countries.

Table 6.3 Emission factors for CH_4 from manure management

	kg CH_4 per head per year
Dairy cattle	14
Non-dairy cattle	6
Sheep	0,19
Goats	0,12
Horses	1,4
Swine	3
Poultry	0,078
Fur animals – minks	0,405*
Fur animals – foxes	0,65*

* Revised National Inventory Report 2007, Norway

In order to calculate N_2O emissions from manure management, the default IPCC methodology was used, according to the following equation.

$$E = \sum_S \left(\sum_T (N_T \cdot Nex_T \cdot MS_{T,S}) \right) \cdot EF_S$$

where E is N_2O emissions, T is the animal species index, S is the manure management system index, N_T is the livestock population, Nex_T is the annual average N excretion per head of species, $MS_{T,S}$ is the fraction of total annual excretion for each livestock species that is managed in system S and EF_S is the N_2O emission factor for system S.

The emission factors for N excretion are country-specific nitrogen factors. They are presented in Table 6.5. Emission factors for N_2O-N/N are those suggested by the IPCC Guidelines. The treatment of animal manure in different management system per animal species was estimated by the Agricultural University of Iceland. There have been some changes in the manure management practices over the time series. For example the share of liquid systems for cattle is believed to have increased from 46% in 1990 to 53% in 2006. The shares of manure management systems per animal species differ therefore for the period 1990 – 2006. The situation in 2006 is reflected in Table 6.4.

Table 6.4 Manure management systems in 2006

Manure management systems	Liquid system	Solid storage and dry lot	Pasture/range/paddock
Dairy cows	53%	13%	34%
Other cattle	53%	13%	34%
Sheep	17%	41%	42%
Goats	17%	41%	42%
Horse	0%	17%	83%
Swine	100%	0%	0%
Poultry	0%	100%	0%

6.4 Emissions from Agricultural Soils – N_2O (4D)

6.4.1 Description

Three sources of N_2O from agricultural soils are distinguished in the IPCC methodology:

- Direct emissions from agricultural soils (applying for Iceland: use of synthetic fertilizers, applied animal manure, crop residue, cultivation of soils (IE)). This is a key source in both level and trend.
- Direct soil emissions from production of animals
- N_2O emissions indirectly induced by agricultural activities (N losses by volatilization, leaching and runoff). This is key source in level and trend.

6.4.2 Methodological issues

The methodology for calculating N_2O from agricultural soil is in accordance with the Tier 1b method.

Use of synthetic fertilizer

The direct emissions of N_2O from the use of synthetic fertilizers are calculated from data on annual usage of fertilizers and their nitrogen content, collected by Statistics Iceland, multiplied by the IPCC default emission factor. Statistics Iceland collects information on the total annual usage of fertilizers. The amount of synthetic fertilizers used in the forestry and revegetation sectors are subtracted from the total amount to find out the amount used in agriculture. The emissions are corrected for ammonia that volatilizes during application.

Manure applied to soil

It is assumed that all animal excreta that are not deposited during grazing are used as manure. The total amount of nitrogen in manure is estimated from the number of animals and the country-specific nitrogen factors for each kind of animal, presented in Table 6.5. They are taken from Óskarsson, M. and Eggertsson, M. (1991), except for fur animals which are taken from Norway's NIR 2007.

Table 6.5 Nitrogen excretion factors

	kg N per head per year
Dairy cattle	60
Non-dairy cattle	33,6
Sheep	5,76
Goats	5,76*
Horses	28,8
Swine	13,3
Poultry	0,42
Fur animals – minks	4,27**
Fur animals – foxes	9**

* N-excretion from goats are assumed to be the same as by sheep

** Revised National Inventory Report 2007, Norway

Crop residue

This source is negligible, since crops are used as fodder and the crop residue either used as fodder or f.ex. in greenhouses.

Cultivation of organic histosols

This source is not estimated separately but included under emission from organic Grassland soils.

Direct soil emission from animal production

The fraction of the total amount of animal manure produced, which is deposited on pastures during grazing, is set to be 40 - 45% and differs between years. The Agricultural University of Iceland has estimated the proportion of excreted nitrogen from different types of livestock subject to different types of animal waste management systems. The level of animal manure deposited on pastures has been changing slightly due to changes in farming practices.

N losses by volatilization

Atmospheric deposition of nitrogen compounds fertilizes soils and surface waters, and enhances biogenic N_2O formation. Climate and the type of fertilizer influence the ammonia volatilization. The IPCC default values for volatilization are used (10% for synthetic fertilizers and 20% for animal manure).

N_2O from leaching and runoff

A considerable amount of nitrogen from fertilizers is lost from agricultural soils through leaching and runoff. Fertilizer nitrogen in ground water and surface waters enhances biogenic production of N_2O as the nitrogen undergoes nitrification and denitrification. The IPCC default value of 30% is used.

Emission factors

The IPCC default emission factor of 0,0125 kg N_2O-N/kg N has been used for all sources of direct N_2O emissions from agricultural soils, except for the emissions of N_2O from animal production which are calculated using the IPCC default factor of 0,02 kg N_2O-N/kg N.

The IPCC default emission factor of 0,025 kg N_2O-N/kg N is used for leaching and runoff.

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of direct N_2O emissions from agricultural soils is 102% and the uncertainty of indirect emissions from Nitrogen used in agriculture is 102%.

Planned improvements

Revise country-specific N excretion factors.

7 LULUCF

7.1 Overview

This chapter provides estimates of emissions and removals from Land Use, Land-Use Change and Forestry (LULUCF) and documentation of the implementation of guidelines given in "2006 Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry and Other Land Use" (IPCC 2006) hereafter named AFOLU Guidelines. The LULUCF reporting is according to the CRF LULUCF tables. This section was written by the Agricultural University of Iceland.

The CRF for LULUCF was prepared through UNFCCC CRF Reporter program (version 3.2.1). From the submission 2007 there are some development in structure of the information reported. The main changes are; in previous submissions all land except new afforestation of the inventory year has been reported as land remaining in relevant land use category. In this submission some of this land is allocated to land converted to relevant category. Time series for land conversion are provided for some categories although still incomplete. Conversion period used is variable between categories as explained below. Four types of land conversion are reported i.e. Grassland converted to Forest land, Wetland converted to Grassland, Grassland converted to Wetland and Other land converted to Wetland. Reporting on emission of CO_2 from organic soil in Grassland is included in general CRF structure, other emissions from grassland organic soils still needs modification of CRF. As in 2004-2007 submission QA/QC is still only qualitative.

Land use information was obtained through same accumulation and processing of existing data as in the inventories submitted 2007. Two important improvements have been made regarding Land use data. The extent of drainage of peat land has been revised on basis of new estimate for length of ditches. Time series for flooded land due to building of reservoirs has been established and information on type of land flooded obtained.

Land use data is also structured differently compared to previous submissions. For three land use categories part of land previously reported as land remaining in category is now reported as land being converted. This applies to forest plantations up to 20 years old, drained wetlands and flooded land. The processing of land use data is described below.

The reported emission from LULUCF sector has decreased substantially compared the 2007 submission. The total reported emission is now 1.127 Gg CO_2 eq. compared to 1.754 Gg CO_2 eq. in 2007 submission. This decrease (35%) is mainly to revision of the estimate of area of organic soils drained and improved methodology regarding estimation of emission from reservoirs (flooded land).

7.2 Data Sources

The present CRF reporting needs country-wide information on land use and land use changes subdivided to a minimum of six land use categories of AFOLU Guidelines. Additionally the area on organic soil for some categories is needed. The criteria for which land use categories, an estimate for Area on organic soil is requested and which not is not always obvious.

There has not been any country wide land use survey in Iceland. In 2007 AUI launched a project designed to obtain data on land use classification according to the needs of the inventory. Iceland has become formal partner of the European land use classification program CORINE. According to the commitments of the program CORINE CLC-2006 mapping will be delivered in July 2008. On later stages also CLC 2000/2006 changes will be mapped and integrated to give CLC 2000. The National Land Survey of Iceland (NLSI) is responsible for Iceland's participation in the CORINE project. These two projects are carried out in close cooperation between AUI and NLSI. These projects have not yet delivered land use classification applicable for the CRF reporting. The land use data in the present submission is therefore derived from other sources as described below.

Definitions of land use categories still need to be clarified. There is a need to clearly define categories and there are cases of overlapping within categories. Information on land use is also in some cases inconsistent.

For several years Iceland's Agricultural Research Institute, (now merged into the Agricultural University of Iceland) has been compiling a geographical database on vegetation types and grazing land condition on all farmlands. The need to control grazing pressure in accordance with ground tolerance in order to prevent erosion has been the main driver for creating this database. This work has been based on remote sensing by satellite images, existing maps of erosion and vegetation cover and various other sources. Extensive ground-truthing has resulted in a level of approximately 85% scoring in categorisation on less than 0.05 ha resolution.

The present database on farmland condition has made it possible to produce a crude estimate of land use categories needed for CRF_LULUCF. This estimate was done for the 2004 inventory submitted 2006. The same estimate is applied to this year's submission with minor adaptations.

As explained in the following chapters the accuracy of land use information is not high but is expected to improve considerably in coming years. At present information on previous land use is not available. Thus for this submission reported land use for years prior to the year 2006 is corrected backward as on bases of information on afforestation and flooding of land due to hydro power reservoirs. Afforestation is assumed to have been on Grassland remaining grassland and to some extent on wetland converted to grassland (drained organic soil). Flooded land is divided between previous land use categories on basis of information provided by the power companies. Revegetation and is not reported as land use changes but as activity. The below description explains how information on total area of individual land use categories was obtained.

In preparing the inventory several databases and information sources were used to estimate coverage of the main land use categories. These data sources and their compilation are described below.

7.2.1 NYTJALAND- Icelandic farmland database: Geographical database on condition of farming land.

The Agricultural University of Iceland and its predecessor Agricultural Research Institute in cooperation with other institutes has for several years been working on a geographical database on the condition of vegetation on all farms in Iceland.

NYTJALAND Class (Icelandic name in brackets)	Short description	Converted to CRF category
Cultivated land (ræktað land)	All cultivated land including hayfields and cropland.	Cropland
Grassland (Graslendi)	Land with perennial grasses as dominating vegetation including drained peat-land where upland vegetation has become dominating.	Grassland
Richly vegetated heath land (Ríkt mólendi)	Heath land with rich vegetation, good grazing plants common, dwarf shrubs often dominating, and mosses common.	Grassland
Poorly vegetated heath land (Rýrt mólendi)	Heath land with lower grazing values than richly vegetated heath land often dominated by less valuable grazing plants and dwarf shrubs, mosses and lichens apparent.	Grassland
Moss land (Mosi)	Land where moss covers more than 2/3 of the total plant cover. Other vegetation includes grasses and dwarf shrubs.	Grassland
Shrubs and forest (Kjarr og skóglendi)	Land covered to more than 50% of vertical projection with trees or shrubs higher than 50 cm	Grassland
Semi-wetland- wetland upland ecotone- (Hálfdeigja)	Land where vegetation is mixture of upland and wetland species. Carex and Equisetum species common also often dwarf shrubs. Soil is generally wet but without standing water. This category includes drained land where vegetation not yet dominated by upland species.	Wetland
Wetland (votlendi)	Mires and fens. Variability of vegetation is high but mires are dominated by Carex and Equisetum species and often also shrubs.	Wetland
Partly vegetated land (hálf gróið)	Land where vegetation cover is from 20-50% generally infertile areas often on gravel soil. Both areas where the vegetation is retreating and in progress can be included in this class	Other land
Sparsely vegetated land (Lítt gróið)	Many types of surfaces are included in this class with the common criteria of less than 20 % vegetation cover in vertical projection.	Other land
Lakes and rivers	Lakes and rivers	Wetland
Glaciers	Glaciers	Other land

Table 7-1 Land cover classes of NYTJALAND database and their transformation to CRF land use classes

The mapping is now nearly finished and approximately 60% of the country, there of 70% of the lowlands below 400 m a.s.l., has been covered. This geographical database is based on remote sensing using both ***Landsat 7*** and ***Spot 5*** images. The categorization used divides the vegetation cover into ten classes and in addition includes lakes and glaciers as classes. The definitions of categories are not the same as required for CRF LULUCF. The classes used in NYTJALAND are listed in Table 7-1.

The pixel size in this database is 15×15 m and the reference scale is 1:30000. The data was simplified by merging areas of one class covering less than 10 pixels to nearest neighbour area, thus leaving 0.225 ha as minimum mapping unit.

7.2.2 Vegetation maps

To compensate for areas not covered by NYTJALAND database simplified vegetation, maps from Iceland Museum of Natural History were used. The scale of these maps is 1:500000 and vegetation is categorised to 5 classes plus water and glaciers. These maps are of considerably less resolution and accuracy than the NYTJALAND database and their classes are listed in Table 7-2.

Vegetation class	Converted to CRF land use category
Grassland -Heath land	Grassland
Wetland	Wetland
Shrubs and forests	Grassland
Moss land	Grassland
Sparsely vegetated land	Other land
Lakes and rivers	Wetland
Glaciers	Other land

Table 7-2 Categories of 1:500000 vegetation maps from Iceland Museum of Natural History and the conversion of those to CRF_LULUCF categories

7.2.3 Cities, towns and villages

Data on area covered by cities, towns and villages were obtained from IS50 database of National Land Survey of Iceland available in 1:50000 scale. This area was converted to CRF_LULUCF category settlement.

7.2.4 **Unified dataset**

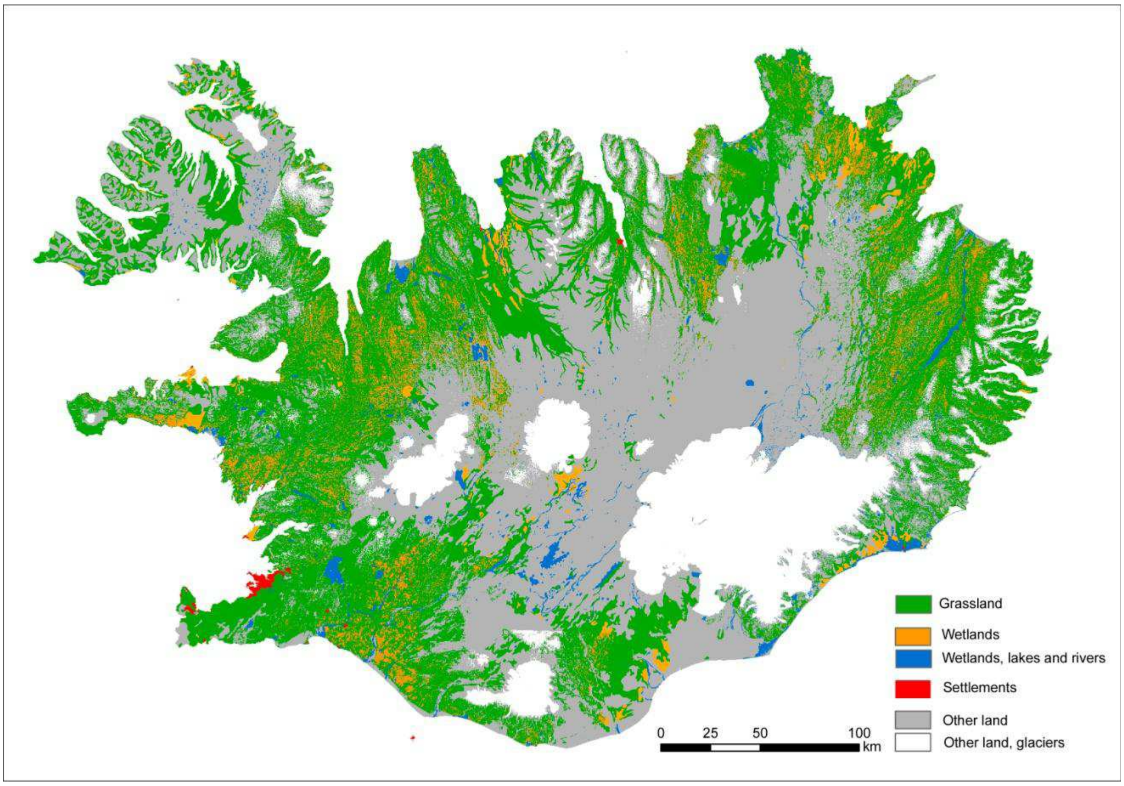

Figure 7.1 First approach to land use map of Iceland

The above described geographical databases were merged into one dataset, providing a first approach to a geographically identifiable land use database covering four of the AFOLU Guidelines suggested land use categories, i.e. grassland, wetland, settlement and other land. Two subcategories, lakes and rivers and glaciers are included. A map of Iceland showing this first approach is in Figure 7.1

Besides lacking two of the main categories suggested in the AFOLU Guidelines there are many uncertainties regarding the definition of categories. Further refinement of this database could therefore result in large areas to be transposed from one category to another. To better meet the requirements of the inventory many of the categories need to be further subdivided, most importantly into managed and unmanaged areas. Geographical identification of organic soil is also very important.

The unified dataset does provide two subcategories in addition to the main categories, i.e. lakes and rivers as ‘wetland’ subcategories and glaciers as a subcategory of ‘other land’.

To improve the quality of the information provided several modifications of the land use categorization were made. Some of these changes are geographically identifiable but others not.

The modifications that were made are:

a) Subdivision of class “Partly vegetated land” of the NYTJALAND database and reclassification of some of these subcategories. Part of this land cover class does better fit to the category ‘grassland’ than ‘other land’. Some of the land in this category has been reclassified as such because it is eroded to a certain stage. All erosion in Iceland was mapped in the years 1993-1995, in a large project which was carried out in cooperation between the Iceland Agricultural Research Institute and the Iceland Soil Conservation (Arnalds et al. 2001) By comparing the category ‘partly vegetated land’ and all erosion classes connected to vegetated land the areas inside this class where vegetation is retreating but still should be classified as grassland can be identified. These areas were added to the ‘grassland’ category and removed from the category ‘other land’. In areas covered by the NYTJALAND database these transformations are geographically identifiable, in other areas not.
b) Lava fields from historic time (from year 875 AC) covered with mosses was moved from category ‘grassland’ to ‘other land’. By comparing the geological maps from the Icelandic Museum of Natural History to land referred to as ‘moss land’ from both the NYTJALAND database as well as vegetation maps, these areas can be identified geographically.
c) Drained wetlands are in this inventory classified as wetland converted to grassland. Part of the drained wetlands is already included under the grassland category but some areas are in the Nytjaland database under the categories ‘semi-wetland’ or ‘wetland’. To correct for this, all ditches with a 100m buffer zone, from the map layer “lakes and rivers” of the National Land Survey of Iceland database were added to the ‘grassland’ category and subsequently removed from the ‘wetland’ category. As the ditches layer of National Land Survey of Iceland database is incomplete only covering 10.000 km length of ditches of which the total length is estimated 32.700 km (Óskarsson 1998) the results of the re-estimate was extrapolated to these 32.700 km of ditches, this additional area estimate was added to the Grassland category and subsequently removed from the ‘wetland’ category. The revised total length of ditches is not taken into account in this transfer between land use categories. This improved categorization is only partly geographically identifiable.
d) Land for roads is not included in the Settlement as it is in IS50 database of National Land Survey of Iceland used in compiling the unified dataset. To correct for that a layer of all roads with a 15 m buffer zone was added to the unified dataset and overlaps to each category in that dataset were added to the Settlement category and subsequently removed from the relevant category.
e) The category Forest land is not in the unified dataset. Information on total area of forests both plantations and native birch shrub- and woodland are available from Icelandic Forest Research. All tree plantations fulfil the country specific definition of forest but only part of the native shrub- and woodland does so. Total area of defined forest was set as total area of Forest land category and

subsequently removed from the grassland category. The area estimate for Forest land is explained in chapter 7.3 .

f) The Cropland category in the NYTJALAND database is incomplete and does only cover part of the country. This information has to be screen digitized to the database and that work is not finished. The area already mapped is subsequently removed from the relevant land use category. To compensate for the incompleteness in mapping the total area of cropland is corrected according to information from Iceland Agricultural Statistics and the difference in area removed from the Grassland category.
g) Revegetated land is not reported as a land use category, although information on some areas is available and calculation is based on the size of land subjected to revegetation. It can be argued that revegetated land should be categorized as separate land use category or subcategories in order to increase transparency and completeness of the land use recording. Thus classification of land subjected to revegetation is still to be decided.

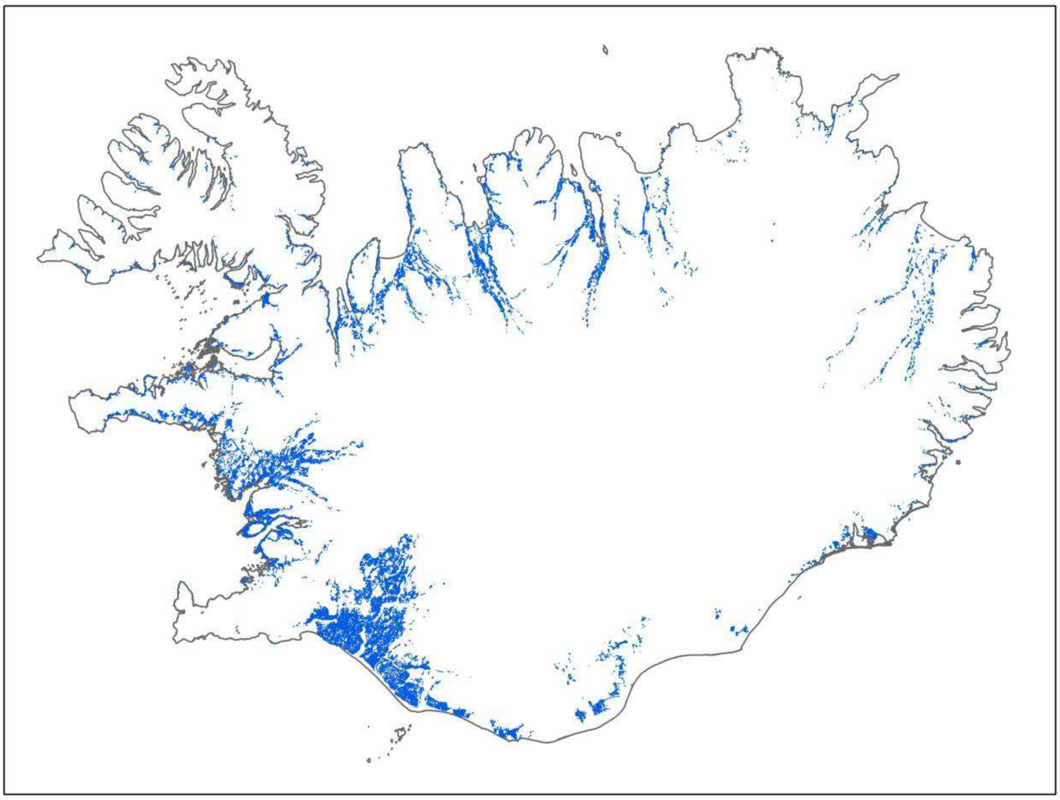

Figure 7-2 Map of Iceland showing all digitized ditches

h) The area of drained peatland has been estimated (Óskarsson 1998). The estimate is based on estimated drainage efficiency and total length of ditches subsided by the government according to the Farmers Association. The total length of ditches subsided was 32.700. The AUI and NLSI recently in a joint effort digitized all ditches from satellite images (SPOT 5) and with support of aerial photographs. This effort produced a map of ditches (Figure 7-2) and revised total length of ditches 27.240 km. This new number is used converted to area drained on bases of average efficiency of drainage (Óskarsson 1998). It is estimated that 98% of the drained areas are with organic soils based on soil samples taken randomly within 100 m from ditches in west Iceland. (AUI unpublished data). All drained areas are reported under wetland converted to grassland except the drained area later converted to forest land. The areas drained are mostly geographically identifiable.

i) The area of flooded land is based on information from companies running the reservoirs used for electrical power plants. The area is subdivided according to the companies information on type of area flooded. Also provided by the power companies are data on year of establishment or enlargement of relevant reservoirs.

The resulting estimate of land use categories is listed in Table 7-3.

Land-Use Category	Sub-division[(1)]	Area[(2)] (kha)	Area of organic soil[(2)] (kha)	Geographically identifiable
Total Forest Land		55,91	4,02	Majority
Forest Land remaining Forest Land		30,58	0,73	
	Native Birch	25,00		Partly
	Plantation older than 20 years	5,58	0,73	Partly
Land converted to Forest Land		25,33	3,29	
Grassland converted to Forest Land		25,33	3,29	
	New Plantations inventory year	1,80	0,23	Majority
	Plantation 1-20 years old	23,53	3,06	Partly
Total Cropland		129,00		
Cropland remaining Cropland		129,00		Partly
Total Grassland		3.842,10	363,62	Majority
Grassland remaining Grassland		3.452,06		Majority
Land converted to Grassland[(12)]		390,04	363,62	
Cropland converted to Grassland		19,00		Not Identifiable
Wetlands converted to Grassland		371,04	363,62	Majority
Total Wetlands		876,49		
Wetlands remaining Wetlands [(7)]		856,63		Majority
	Lakes and rivers	169,74		Identifiable
	Peatland	667,59	667,59	Partly
	Reservoirs	19,30		Identifiable
Land converted to Wetlands [(8)]		19,86		Identifiable
Grassland converted to Wetlands		7,22		Partly
	High SOC	0,99		Partly
	Medium SOC	6,23		Partly
Other Land converted to Wetlands		12,64		Partly
	Low SOC	12,64		Partly
Total Settlements		68,45		Identifiable
Settlements remaining Settlements [(8)]		68,45		Identifiable
Total Other Land		5.310,06		Identifiable
Other Land remaining Other Land [(7)]		5.310,06		Identifiable
	Glaciers	1.324	-	Identifiable
	Other(sparsely or not vegetated)	3.986	-	Identifiable

Table 7-3 Land use classification used in GHG inventory 2006 submitted 2008.

7.2.5 Land use changes

Compared to previous submissions structure of land use data is changed. Part of land previously reported as land remaining in relevant land use category is now reported as land being converted. The only previously reported land use change has been new forest plantations of the inventory year. In this year's submission, plantations 20 years old and younger are reported as land being converted to Forest Land. Twenty years default conversion time is applied for this land use category. All drained wetlands are reported as

Wetland converted to Grassland. Conversion time is not defined but considered much longer than default 20 years as soil carbon remains higher than in mineral soil for much longer time. Part of land reported in previous submission as subcategory Reservoirs under “Wetland remaining wetland” is now reported as “Land converted to wetland”. Lakes that were converted to reservoirs are still reported under subcategory “Wetland remaining wetland- Reservoirs”. Changes in area of Cropland, according to Iceland Agricultural Statistics, are treated as land use conversion. Other land use changes are at present not reported. Time series for the land converted 1990-2006 are provided for these categories.

7.2.6 Land use definitions and the classification system and their correspondence to the LULUCF categories

Definitions of land use categories have not been elaborated. The present status of land use information in Iceland is as described above very fractional and in many ways inconsistent between data sources. The definitions on land use categories used in this inventory are those presented in Table 7-1 with the modifications described. The elaboration of definitions for land use categories is a vital part of building the geographical land use database.

7.2.7 Uncertainties QA/QC

The NYTJALAND database, which is the main source of land use information supporting the land use classification used for the inventory, has the scoring accuracy of 85% on its categorization. The modifications and additions of other data needed for the complete coverage of all land has most likely decreased that accuracy to some level. The amount of that increase in uncertainty has not been quantified. The revision of area drained based on digitization of all ditches is considered to have improved the estimated emission of that category.

7.2.8 Planned improvements regarding land use identification

Land use registration in Iceland is very fragmentary and not based on long term traditions as in many other European countries. Construction of geographically identifiable land use database covering the whole country started 2007. The Government of Iceland has ensured financing of the project. This work is expected to gradually increase the quality of land use information as well as provide data for estimates of ongoing land use changes and to some extent past changes. Important part of data sampling for the land use database is to obtain information on various C-pools in each land use category.

Iceland has become to participate in CORINE land cover mapping of Europe. The CLC 2006 mapping will be completed in July 2008. Next phase involves mapping CLC 2000/2006 changes which will be integrated to give CLC 2000.

The Icelandic mapping effort is based on the NYTJALAND database and other sources available. The construction of Icelandic land use database and CORINE mapping effort are carried out in close cooperation between the relevant institutions (AUI and NLSI).

These two projects are expected to improve the quality of land use information considerably and provide backward estimates of land use changes.

7.2.9 **Completeness and method**

Based on the above described accumulation of land use data and emission factors the emission by source and removal by sinks were calculated.

		CO_2		
Source/sink	**Area kha**	**Methode**	**EF**	**Gg Emission/ Removal (-)**
Forest remaining forest	30,58			
Native Birch	25,00	NE		
Plantation older than 20 years	5,58			-24,14
- Living biomass		T2	CS	-24,56
- Dead organic matter		NE		
- Soils				
Mineral Soil	4,85	NE		
Organic Soils	0,73	T1	D	0,43
Land converted to forest	25,33			
Grassland converted to Forest Land	25,33			-109,53
New Plantations inventory year	1,80			-7,78
- Living biomass		T2	CS	-7,92
- Dead organic matter		NE		
- Soils				
Mineral Soil	1,57	NE		
Organic Soils	0,23	T1	D	0,14
Plantation 1-20 years old	23,53			-101,75
- Living biomass		T2	CS	-103,54
- Dead organic matter		NE		
- Soils				
Mineral Soil	20,47	NE		
Organic Soils	3,06	T1	D	1,79
Cropland remaining cropland	129,00			
- Living biomass		NO		
- Dead organic matter		NE		
- Soils				
Mineral Soil	NE	NE		
Organic Soils	NE	IE		
- Lime application		T2	D,CS	3,54
Grassland remaining grassland	3.452,06	NE		
Land converted to Grassland	390,04			

		CO_2		
Source/sink	**Area kha**	**Methode**	**EF**	**Gg Emission/ Removal (-)**
Cropland converted to Grassland	19,00	NE		
Wetlands converted to Grassland	371,04			
- Soils				
Mineral Soil	7,42	NE		
Organic Soils	363,62	T1	D, CS	1.466,59
Wetlands remaining wetland	856,63			
Lakes and rivers	169,74	NE		
Peatland	667,59	NE		
Reservoirs	19,30	NE		
Land converted to Wetlands	19,86			9,30
Grassland converted to Wetlands	7,22			9,00
High SOC	0,99	T2	CS	2,75
Medium SOC	6,23	T2	CS	6,26
Other Land converted to Wetlands	12,64			0,30
Low SOC	12,64	T2	CS	0,30
Settlements remaining settlements	68,45	NE		
Other land remaining other land	5.310,06	NE		
Other				
Revegetation	NA	T2	CS	-553,74

Table 7-4 Summary of method and emission factors applied on CO_2 emission calculation.
EF = emission factor, D = default (IPCC), CS = country specific, NA = not applicable, NE= not estimated, NO = not occurring, IE=included elsewhere, T1 = Tier 1, T2 = Tier 2 and T3 = Tier 3,

		CH_4			
Source/sink	**Area Kha**	**Methode**	**EF**	**Gg Emission/ Removal (-)**	**CO_2 eq. Gg**
Grassland remaining grassland	3.452,06				
Biomass burned CH4		T1	D	0,0	0,1
Land converted to Grassland	390,04				
Biomass burned CH4		T1	D	0,0	0,2
Wetlands remaining wetland	856,63				
Lakes and rivers	169,74				
Peatland	667,59	NE			
Reservoirs	19,30	NE			
Biomass burned CH4		T1	D	0,1	1,2
Land converted to Wetlands	19,86			9,3	195,3
Grassland converted to Wetlands	7,22			9,0	189,0
High SOC CH4		T2	CS	0,1	2,4
Medium SOC CH4		T2	CS	0,3	5,3
Other Land converted to Wetlands	12,64			0,3	6,3
Low SOC CH4		T2	CS	0,0	0,3

Table 7-5 Summary of method and emission factors applied on CH_4 emission calculations.
EF = emission factor, D = default (IPCC), CS = country specific, NA = not applicable, NE= not estimated, NO = not occurring, IE=included elsewhere, T1 = Tier 1, T2 = Tier 2 and T3 = Tier 3,

		N_2O			CO_2 eq. Gg
Source/sink	**Area Kha**	**Methode**	**EF**	**Gg Emission/ Removal (-)**	
Forest remaining forest	30,58				
Plantation older than 20 years	5,58				
fertilizer		T1	D	0,00	0,0
Organic Soils		T1	D	0,00	0,2
Land converted to forest	25,33				
fertilizer		T1	D	0,00	0,1
Grassland converted to Forest Land	25,33				
New Plantations inventory year	1,80				
Organic Soils		T1	D	0,00	0,1
Plantation 1-20 years old	23,53				
Organic Soils		T1	D	0,00	0,9
Grassland remaining grassland	3.452,06				
Biomass burned		T1	D	0,00	0,0
Land converted to Grassland	390,04				
Biomass burned		T1	D	0,00	0,1
Wetlands converted to Grassland	371,04				
Organic Soils		T1	D	1,03	318,8
Wetlands remaining wetland	856,63				
Biomass burned		T1	D	0,00	0,5
Revegetation fertilizers		T1	D	0,02	5,1

Table 7-6 Summary of method and emission factors applied on N_2O emission calculations.
EF = emission factor, D = default (IPCC), CS = country specific, NA = not applicable, NE= not estimated, NO = not occurring, IE=included elsewhere, T1 = Tier 1, T2 = Tier 2 and T3 = Tier 3,

Summary of method and emission factors used is provided in Table 7-4, Table 7-5 and Table 7-6.

7.2.10 **Key sources/sink and key areas**

Of the sources/sinks as calculated for each subcategory, four were recognized as LULUCF level key source with regard to CO_2 equivalents (Table 7-7). Non-estimated categories can not be excluded as a potential level key source.

Source/sink Subcategories as reported	Direct Gg Emission/ Removal (-)	CO2 equivalent Gg absolute value category	Level %	Cumulative level %	Key source/sink
Wetlands converted to Grassland -Organic Soils CO_2	1466,6	1466,6	58,5	58,5	x
Revegetation Net CO_2	-553,7	553,7	22,1	80,6	x
Wetlands converted to Grassland -Organic Soils N_2O	1,0	318,8	12,7	93,3	x
Grassland converted to Forest Land Plantation 1-20 years old-Living biomass	-103,5	103,5	4,1	97,4	x
Forest remaining forest -Plantation older than 20 years-Living biomass	-24,6	24,6	1,0	98,4	
Grassland converted to Forest Land -New Plantations inventory year - Living biomass	-7,9	7,9	0,3	98,7	
Grassland converted to Wetlands -Medium SOC CO_2	6,3	6,3	0,2	99,0	
Grassland converted to Wetlands -Medium SOC CH_4	0,3	5,3	0,2	99,2	
Revegetation N2O fertilizers	0,0	5,1	0,2	99,4	
Cropland remaining cropland - Lime application	3,5	3,5	0,1	99,5	
Grassland converted to Wetlands -High SOC CO_2	2,7	2,7	0,1	99,7	
Grassland converted to Wetlands -High SOC CH_4	0,1	2,4	0,1	99,8	
Grassland converted to Forest Land Plantation 1-20 years old - Organic Soils CO_2	1,8	1,8	0,1	99,8	
Wetlands remaining wetland - Biomass burned CH_4	0,1	1,2	0,0	99,9	
Grassland converted to Forest Land Plantation 1-20 years old - Organic Soils N_2O	0,0	0,9	0,0	99,9	
Wetlands remaining wetland - Biomass burned N_2O	0,0	0,5	0,0	99,9	
Forest remaining forest - Plantation older than 20 years Organic Soils CO_2	0,4	0,4	0,0	99,9	
Other Land converted to Wetlands -Low SOC CO_2	0,3	0,3	0,0	100,0	
Other Land converted to Wetlands -Low SOC CH_4	0,0	0,3	0,0	100,0	
Forest remaining forest - Plantation older than 20 years Organic Soils N_2O	0,0	0,2	0,0	100,0	
Land converted to Grassland - Biomass burned CH_4	0,0	0,2	0,0	100,0	
Grassland remaining grassland - Biomass burned CH_4	0,0	0,1	0,0	100,0	

Source/sink Subcategories as reported	Direct Gg Emission/ Removal (-)	CO2 equivalent Gg absolute value category	Level %	Cumulative level %	Key source/sink
Land converted to Grassland - Biomass burned N_2O	0,0	0,1	0,0	100,0	
Grassland converted to Forest Land -New Plantations inventory year -Organic Soils N_2O	0,0	0,1	0,0	100,0	
Grassland remaining grassland - Biomass burned N_2O	0,0	0,0	0,0	100,0	
Forest remaining forest - Plantation older than 20 years - N_2O fertilizer	0,0	0,0	0,0	100,0	
		2506,7	**100,0**		

Table 7-7 LULUCF level key source assessment of land use categories, for which emissions/removals were calculated

Too much division of sources can disguise the contribution of land use categories. Therefore the contributions within each main land use category were added and the total contribution assessed Table 7-8. Three main land use categories were recognized as key sources.

		CO2 equivalent Gg			
		Sum of absolute values			
Source/sink	**Area kha**	**main category**	**level%**	**cumulative %**	**key source/sink**
Land converted to Grassland	390,04	1785,69	71,24	71,24	x
Revegetation		558,80	22,29	93,53	x
Land converted to forest	25,33	114,45	4,57	98,09	x
Forest remaining forest	30,58	25,21	1,01	99,10	
Land converted to Wetlands	19,86	17,27	0,69	99,79	
Cropland remaining cropland	129	3,54	0,14	99,93	
Wetlands remaining wetland	856,63	1,68	0,07	100,00	
Grassland remaining grassland	3452,06	0,09	0,00	100,00	

Table 7-8 LULUCF level key source assessment of total absolute values within main land use categories, for which emissions/removals were calculated

Trend key source assessment was not done as land use change data is not available for most of the categories. Considering the present status of land use information the key land use categories were assessed on basis of area. On the land use categories as reported two assessments were performed; the highest resolution area subcategories and on main land use categories (Table 7-9). Including highest area subcategories five were recognised as key area, three of which are by definition unmanaged and no emission reported i.e.; Other land remaining other land, Peatland and Lakes and rivers. No emission is presently estimated for Grassland remaining Grassland. This leaves only one of the categories recognised as key area considering all subcategories, where emission is estimated. Considering only main land use categories four are recognized as key area i.e.; other land remaining other land, Grassland remaining grassland, Wetlands remaining wetland and Land converted to Grassland (Table 7-10). Emission is presently only estimated for one of these categories.

An additional area assessment was carried out, considering only applicable land use categories by adding revegetation as land use category and excluding other land and other categories which as by definition unmanaged and emission/removal calculation not applicable.

Considering only applicable land use categories, (Table 7-11) three additional land use categories i.e. “Revegetation”, “Cropland remaining cropland” and “Settlement remaining settlement” is assessed as key areas.

Assessment of level key area point out the areas which should be emphasized both regarding improved area estimate and due to their relatively large area the emission estimate needs to be improved.

No systematic assessment has been carried out regarding trend in land use changes. Considering only the information presented in this inventory, two land use changes are most important with regard to both area involved and emission or removal reported. These land use changes are conversion of wetland to grassland and revegetation.

Land use category at highest reported resolution	Area kha	Area Level %	Cumulative %	Key area
Other land remaining other land	5.310,06	51,6	51,6	x
Grassland remaining grassland	3.452,06	33,6	85,2	x
Wetlands remaining wetland -Peatland	667,59	6,5	91,7	x
Wetlands converted to Grassland -Organic Soils	363,62	3,5	95,2	x
Wetlands remaining wetland -Lakes and rivers	169,74	1,7	96,9	x
Cropland remaining cropland	129,00	1,3	98,2	
Settlements remaining settlements	68,45	0,7	98,8	
Forest remaining forest-Native Birch	25,00	0,2	99,1	
Grassland converted to Forest Land - Plantation 1-20 years old -Mineral Soil	20,47	0,2	99,3	
Wetlands remaining wetland -Reservoirs	19,30	0,2	99,4	
Cropland converted to Grassland	19,00	0,2	99,6	
Other Land converted to Wetlands -Low SOC	12,64	0,1	99,8	
Wetlands converted to Grassland -Mineral Soil	7,42	0,1	99,8	
Grassland converted to Wetlands -Medium SOC	6,23	0,1	99,9	
Forest remaining forest-Plantation older than 20 years -Mineral Soil	4,85	0,0	99,9	
Grassland converted to Forest Land - Plantation 1-20 years old -Organic Soils	3,06	0,0	100,0	
Grassland converted to Forest Land -New Plantations inventory year -Mineral Soil	1,57	0,0	100,0	
Grassland converted to Wetlands -High SOC	0,99	0,0	100,0	
Forest remaining forest-Plantation older than 20 years -Organic Soils	0,73	0,0	100,0	
Grassland converted to Forest Land -New Plantations inventory year -Organic Soils	0,23	0,0	100,0	
Total	10.282,01			

Table 7-9 LULUCF area level assessment of land use categories for highest area resolution reported

Main land use category	Area kha	Area level %	Cumulative %	Key area
Other land remaining other land	5.310,06	51,6	51,6	x
Grassland remaining grassland	3.452,06	33,6	85,2	x
Wetlands remaining wetland	856,63	8,3	93,5	x
Land converted to Grassland	390,04	3,8	97,3	x
Cropland remaining cropland	129,00	1,3	98,6	
Settlements remaining settlements	68,45	0,7	99,3	
Forest remaining forest total area	30,58	0,3	99,6	
Land converted to forest total area	25,33	0,2	99,8	
Land converted to Wetlands	19,86	0,2	100,0	
Total	10.282,01			

Table 7-10 LULUCF area level assessment of main land use categories

Applicable land use categories	Area kha	Area Level %	Cumulative %	Key area
Grassland remaining grassland	3.452,06	79,6	79,6	X
Wetlands converted to Grassland -Organic Soils	363,62	8,4	88,0	X
Revegetation	201,36	4,6	92,6	X
Cropland remaining cropland	129,00	3,0	95,6	X
Settlements remaining settlements	68,45	1,6	97,2	X
Forest remaining forest-Native Birch	25,00	0,6	97,8	
Grassland converted to Forest Land - Plantation 1-20 years old -Mineral Soil	20,47	0,5	98,2	
Wetlands remaining wetland -Reservoirs	19,30	0,4	98,7	
Cropland converted to Grassland	19,00	0,4	99,1	
Other Land converted to Wetlands -Low SOC	12,64	0,3	99,4	
Wetlands converted to Grassland -Mineral Soil	7,42	0,2	99,6	
Grassland converted to Wetlands -Medium SOC	6,23	0,1	99,7	
Forest remaining forest-Plantation older than 20 years -Mineral Soil	4,85	0,1	99,8	
Grassland converted to Forest Land - Plantation 1-20 years old -Organic Soils	3,06	0,1	99,9	
Grassland converted to Forest Land -New Plantations inventory year -Mineral Soil	1,57	0,0	100,0	
Grassland converted to Wetlands -High SOC	0,99	0,0	100,0	
Forest remaining forest-Plantation older than 20 years -Organic Soils	0,73	0,0	100,0	
Grassland converted to Forest Land -New Plantations inventory year -Organic Soils	0,23	0,0	100,0	
	4.335,98			

Table 7-11 LULUCF area level assessments of land use categories considered relevant as potential source/ sinks and where area was identified

7.3 Forest land

Current calculation of C-stock changes is simple and deficient. The whole process of national forest inventory and aggregation of forestry data is under total revision as described below. Total recalculations of the forest sector are to be expected in the nearest future. In this year's submission the method for C-stock are the same as in previous submissions. The data is on the other hand arranged differently to better comply with AFOLU Guidelines. The default value of 20 years of transition from one land use to another is applied leaving only Natural birch forests and plantations older than 20 years as "Forest land remaining forest land". Younger plantations are reported as land converted to forest land.

Plantations 1-20 years old are recognised as level key source/sink in LULUCF.

7.3.1 Carbon stock changes (5A)

7.3.1.1 Carbon stock changes in living biomass

In accordance to the GPG arising from the Kyoto Protocol a country-specific definition of forest has been adopted. The minimal crown cover of forest is 10%, the minimal height 2 m, minimal area 0.5 ha and minimal width 20 m. This definition is also used for the national forest inventory. Further description of forest definition will be found in methodological report of carbon accounting of forests (Snorrason 2008 personal communication). All forests, both naturally regenerated and planted, are defined as managed as they are affected directly by human activity. The native birch woodlands have been under continuous usage for ages. Until the middle of the last age they where the main source for fuel wood for house heating and cooking in Iceland (Ministry for the Environment 2007). Most of the woodlands were used for grazing and still are although some areas have been protected from grazing.

Natural birch woodlands in Iceland has been inventoried twice in the 20th century, in the periods 1972-1975 and 1987-1991, resulting in area estimates of 125 and 118 kha respectively. Maps and data sampled in the inventories have newly been put to GIS. New SPOT images were used to refine the mapping remotely and the total area of the natural birch woodlands is adjusted to 120 kha (Snorrason et.al. 2007). The Icelandic Forest Research reported in 2006 that 25 kha of the native birch woodland is higher than 2m. Resent mapping effort by the Icelandic Forest Research due to CORINE participation are consistent with these numbers with 115.5 kha and 23.7 kha for birch woodland and birch >2m height respectively (Traustason and Snorrason 2008). The 25 kha areas estimate fore native birch forest is maintained in this year's submission consistent with previous estimate.
Total woody C-stock was from these data estimated at 1300 kt C with average of 11 t C ha^{-1} in 1990. The two inventories are not comparable in methodology and can not be directly compared to show changes in area or woody stock during this period. (Sigurðsson and Snorrason 2000). The C stock of the native birch woodlands is assumed to remain constant with no changes reported.

Afforestation and reforestation started in Iceland 1899. Annual afforestation since 1942 is presented in Figure 7-3. Before 1970 planting of forest was by majority done in natural birch woodlands. The total area of plantations older than 20 years (planted 1985 and earlier) is estimated 5.6 kha in 2006, plantation 1-20 year's old (planted 1986- 2005) are estimated 23.53 kha and new plantations 2006 1.8 kha. The annual change of the woody biomass is estimated the same for all plantations.

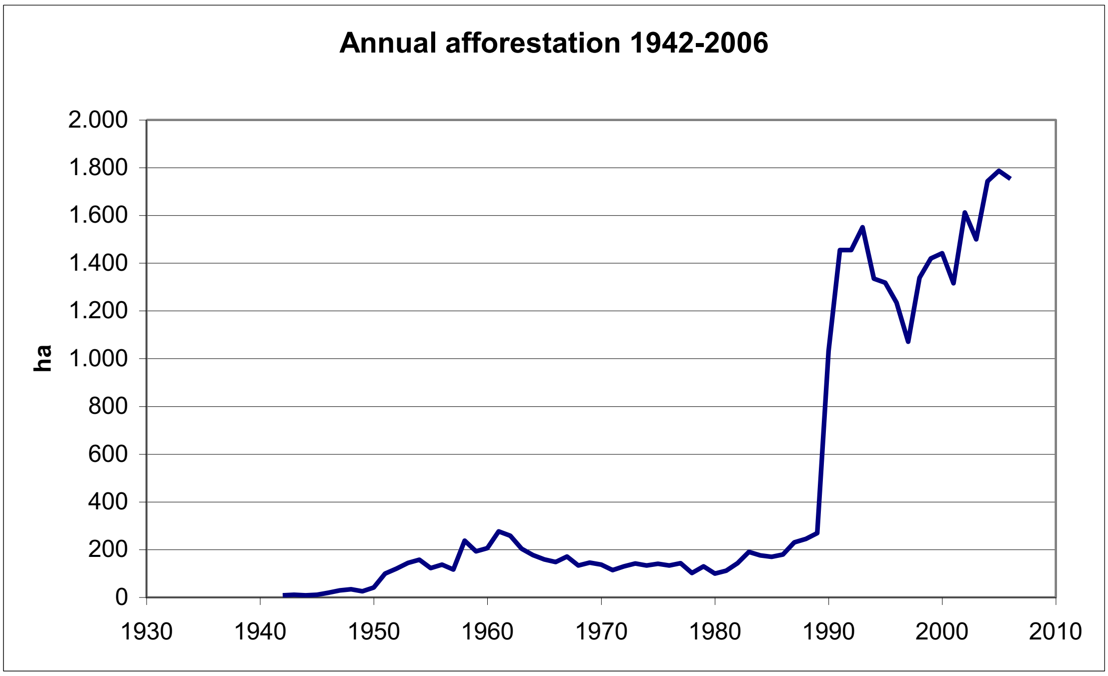

Figure 7-3 Annual afforestation according to number of seedlings delivered from breeding stations, based on information from Icelandic Forest research.

Most afforestation areas in Iceland are relatively young (Figure 7-3) and clear cutting has not started. The only exceptions of deforestation are when natural birch forest and plantations have to give way for road or house building. A preliminary investigation of deforestation has shown that it is rather rare and at a small scale. Neither the deforestation nor the thinning of managed forests has been spatially recorded. On the other hand they are estimated in the ongoing sample based national forest inventory program of the Icelandic Forest Research.

Current C-stock change calculation of living biomass is described in chapter 7.3.3

7.3.1.2 Net carbon stock changes in dead organic matter

No attempt is made to estimate changes in dead organic matter due to lack of data. Tier 1 (AFOLU Guidelines) default assumes no changes in dead wood or litter. Changes in dead organic matter are in AFOLU Guidelines connected with forest management and due to the young age of most Icelandic plantations, this category is not considered important.

7.3.1.3 Net carbon stock change in soils

The Icelandic Forest Research has estimated that 13% of planted forest since 1990 were planted on wetland or drained wetlands. Assuming this ratio applies to all plantations, and these areas represent organic soils in forests, the area of organic soils in forest land is estimated. The area estimated for organic soils in forest land was subsequently subtracted from the aggregated estimate for drained organic soils previously reported under Grassland. Net carbon stock changes in soils are only estimated for the organic soils. Net carbon stock changes in mineral soils are not estimated. The natural forest and the remaining afforested areas are mostly situated on mineral soils which can be highly variable regarding carbon content. Research results do show increase of carbon of soil organic matter (C-SOM) in mineral soils (0.3-0.9 t C $ha^{-1}yr^{-1}$) due to afforestation but high variation of carbon content of soil samples give, in most cases, statistically insignificant results (Snorrason et.al. 2002, Sigurðsson et.al. 2008) Accordingly the Icelandic Forest Research estimate that soil carbon stock in forest land on mineral soil is unchanged in time.

7.3.2 Other emissions (5(I), 5 (II), 5(III))

Direct N_2O emission from use of N fertilisers is reported separately for forest remaining forest and land converted to forest land.

N_2O emission from drainage of organic soils is also reported separately for forest land.

Ploughing is sometimes part of the preparation of new plantations and might therefore cause N_2O emissions comparable to land conversion to cropland. No data is available on amount of afforested land ploughed or emissions caused by such activity reported under 'other' in Table 5(III).

7.3.3 Land converted to forest land.

The AFOLU Guidelines default period of 20 years for conversion of land to forest land is applied. Accordingly all plantations up to 20 years old are reported as land converted to forest land. At present state of information on land use changes all conversion is assumed from grassland to forest land. The average ratio of plantation area on organic soil is estimated from information from the first two year of five of the first NFI on plantations since 1990 and is here assumed to apply for all plantations.
The Icelandic Forest Research records, in the new forest inventory project, previous land use of planted area involved. Information is thus available on more detailed land use conversion than reported (Table 7-12). Due to high uncertainty in area of other land use categories this information is not considered applicable as only source of land use changes.

Land category	% of afforested area
Sparsely vegetated upland (<30% vegetation cover)	16%
Other upland	69%
Wetland	3%
Drained wetland	10%
Cropland	2%
Total	100%

Table 7-12 Former land categories of afforested areas since 1990 as estimated by the Icelandic Forestry Research

7.3.4 Methodological issues

The area of plantations is estimated from number of seedlings delivered from plant breeding stations the relevant year. The estimation of afforested area is based on the following assumptions: On average planting density was 4000 seedlings ha^{-1}, 25% of afforested area is lost to various reasons (Sigurðsson and Snorrason 2000). Since 1990 the seedling density has decreased and new comparison of number of seedling and area of land did show that the number had dropped down to 2350 seedlings per ha (Snorrason and Kjartansson. 2004). First results of the ongoing new national forest inventory (Snorrason 2006 personal communication) are consistent with the total area of forests estimated from number of seedlings planted.

7.3.5 Emission/removal factors

Tier 2 is used to estimate the carbon stock change in living biomass. The annual C removal factor used in the inventory (1,2 t C ha^{-1}) is a precautionary estimate of data from Icelandic Forest Research, (Snorrason 2003) including both above ground biomass of trees and below ground biomass of coarse tree roots.

Tier 1 and default EF = 0,16 [t C ha^{-1} yr^{-1}] (AFOLU Guidelines Table 4.6.) is used to estimate net carbon stock change in forest organic soils. For direct N_2O emission from N fertilization and N_2O emission from drained organic soils, tier 1 and default EF=1,25% [kg N_2O-N/kg N input] (GPG2000) and EF=0,6 [kg N_2O-N $ha^{-1}yr^{-1}$] (AFOLU Guidelines Table 11.1.) were used respectively.

7.3.6 Uncertainties QA/QC

Using the average annual C removal factor overestimates the removal of C by young plantations and underestimates the C-removal of middle-aged forest plantations. The C uptake factor is based on measurements where the biomass of forest plantations of known age was measured. (Snorrason et al 2002, Sigurðsson et al 2008) These measurements have show in results ranging from 0.1-1,2 t C ha^{-1} for young plantation (9-16 years old) to 1.1-3.0 for middle aged plantations (32-54 years old).

How well the used factor represents the actual plantations is thus a source of error which acts both on age of plantation, tree species used and spatial variability. The area estimate is based on indirect data sources calibrated to field data (Snorrason and Kjartansson. 2004).

The new forest inventory project, established by the Icelandic Forest Research, yielded its first unpublished results which were consistent with previous estimates of total forest area. The annual removal factor is based on field measurements (Tier 2). The ongoing improvement in forest inventory will improve the control and verification options.

7.3.7 Recalculations

As described above the division of forest land area between reporting categories has been revised to better meet AFOLU Guidelines. This rearrangement between reporting categories is applied for all years from 1990. This change in structure of the information reported does not change the previously reported emission and removal of Forest land.

7.3.8 Planned improvements regarding Forest land

The methodology for the new national forest inventory is based on systematic sampling consisting of a total amount of nearly 1.000 permanent plots. One fifth of the plots are measured each year and measurements repeated at 5 year intervals. The sample will be used to estimate both the division of area to subcategories and C-stock changes over time (Snorrason and Kjartansson. 2004). Preparation of this work started in 2001 and the measurement on field plot started in 2005. The first inventory will finish in the year of 2009 and in 2010 the second one will start with re-measurements of the plots measured in 2005 together with new plots on afforested land since 2005. One can therefore expect gradually improved estimates of carbon stock and carbon stock changes in both managed and unmanaged woodlands in Iceland. Improvements in forest inventories will also improve uncertainty estimates both on area and stock changes. Soil and litter sampling is included as part of the national forest inventory program and estimates of changes in soil carbon stock is expected in future reporting after the first re-measurement.

Major recalculations of the forest sector are therefore to be expected in the nearest future.

7.4 Cropland

Cropland in Iceland consists mainly of cultivated hayfields, many of which on drained organic soil. A small but increasing part is used for cultivation of barley. Cultivation of potatoes and vegetables also takes place. No information is available on emission/removal regarding different cultivation types and subdivision of areas is not attempted. Cropland is identified as a key area in applicable land use categories.

7.4.1 Carbon stock changes (5B)

7.4.1.1 Carbon stock changes in living biomass

As no perennial woody crops are cultivated in Iceland, no biomass changes need to be reported. Growth of willow in shelterbelts not reaching the definitions of forest land does occur but is very limited. This might be considered as cropland woody biomass. No attempt is made to estimate the increase in this biomass.

7.4.1.2 Net carbon stock changes in dead organic matter

The AFOULU Guidelines Tier 1 methodology assumes no or insignificant changes in DOM in cropland remaining cropland and no emission /removal factors or activity data needed. No data is available to estimate the possible changes in dead organic matter in remaining cropland. The majority of land classified as cropland in Iceland is hayfields with perennial grasses only ploughed or harrowed at decade intervals. A turf layer is formed and depending on the soil horizon definition it can be considered as dead organic matter. This is therefore recognised as a possible sink/source although no data is available. No land converted to cropland is reported at present status of land use information. Emission due to conversion of wetland to cropland is included under category “Wetland converted to grassland”.

7.4.1.3 Net carbon stock change in soils

Net carbon stock changes in mineral cropland soil are not estimated. No data available and no default relative stock change factors recognised as applicable to perennial hayfield.

Emissions from organic cropland soils are reported as an aggregate number along with emission from drained grassland organic soils. Data for partitioning of drained organic soils between cropland and grassland is not available.

7.4.2 Other emissions (5(I), 5 (II), 5(III), 5(IV))

Direct N_2O emission from use of N fertilisers is included under emissions from agricultural soils.

N_2O emissions from drainage of organic soils are reported as an aggregated number under emissions from grassland. Separation of drained organic soil to land use categories is not possible on basis of present land use data.

Carbon emissions from agricultural lime application are estimated. Information on lime application is obtained from distributors. Numbers reported included lime application in the form of shellsand, which contains 90 % $CaCO_3$, dolomite and limestone. Additive limestone or other calcifying agents included in many of the fertilizers imported are also included. Although the ratio of calcifying materials is low in these fertilizers the amount of fertilizers applied make this source relatively large. Numbers on lime application are only available on national level and all of it is assumed to be applied on cropland.

7.4.3 Land converted to cropland

As no data is available on area of land converted to cropland, its emissions are not estimated. Part of the wetlands drained and reported as wetlands converted to grassland were turned to cropland. The size of these areas is at present unknown and all emission reported under wetlands converted to grassland.

7.4.4 Emission factors

The only cropland emission reported is CO_2 emission due to liming. Emissions are calculated by conversion of carbonated carbon to CO_2.

7.4.5 Uncertainty QA/QC

The only reported emission/removal under 'cropland' is emission due to agricultural liming. No quality control or assurance has been undertaken regarding the submitted amounts. The largest uncertainty in cropland emissions/removals is probably the area estimate. Cropland as reported by Iceland Agricultural Statistics is mostly hayfields with perennial grasses where only a small part is used for annual crops. Elaboration of definitions on cropland could shift a large section of 'cropland' to the 'grassland' category. Due to the lack of subdivision of cropland to cultivation categories and soil type, the emissions/removals of cropland are included in aggregated numbers in other categories resulting in relatively substantial uncertainty within the category. The quantity of uncertainty for cropland emissions/removals is not estimated.

7.4.6 **Planned improvements regarding cropland**

Mapping of cropland and subdivision with regard to soil types and cultivation will improve along with the quality of other land use information. One of the objectives by constructing the land use database is to identify relevant subcategories regarding soil types and management.

7.5 Grassland

Grassland is the second largest land use category identified by present land use mapping described above. Only the land use category “other land” which includes glaciers is estimated larger. If glaciers are excluded from ‘other land’ the grassland category is the largest land use category in Iceland. The ‘grassland’ category is very diverse with regards to vegetation, soil type, erosion and management. Included are heathlands with dwarf shrubs, small bushes, grasses and mosses in variable combinations, fertile grasslands, all in highly variable condition regarding erosion. Also included in the category are large areas of drained peatlands. This category as presented in this submission is likely to include areas which could be considered as wetland, cropland or other land depending on definitions of each category. There are large areas suffering from severe erosion where vegetation cover is severely damaged but the Andic soil still has high amounts of carbon. Resent research results in Iceland indicate that the carbon budget of such areas might be negative, resulting in CO_2 emission to the atmosphere. The vegetation cover in many other grassland areas in Iceland is at present increasing both in vigour and continuity (Náttúrufræðistofnun Íslands 2005) (*Icelandic Institute of Natural History Annual Report 2005*). In these areas, the annul carbon budget might be positive at present, meaning C is removed from the atmosphere. The size of these subcategories of grassland is not known at present. Whether these changes in vegetation are due to changes in climate, management or a combination of both is not clear.

Drained wetlands have in previous submissions been reported under Grassland remaining grassland, subcategory grassland on organic soil. In this year’s submission the drained wetlands are reported as wetland converted to grassland. Due to structure of the CFR-Reporter software version 3.2, used in preparing the CRF tables, non CO_2 emission resulting from drainage still needs to be reported under subcategory “Other -Grassland organic soil”.

Numbers are only available on the total area of drained organic soil and not for divisions between land use categories, with the exception of forest plantations. All other drained organic soil is at present assumed to be included under ‘grassland’ as subcategory.

The land use categories ‘Grassland remaining grassland’ total area and “Wetland converted to grassland” (and subsequently the category “Land converted to grassland”) are identified as key areas considering both reported area and applicable area (Table 7-9, Table 7-10 and Table 7-11).

7.5.1 **Carbon stock changes (5C)**

Revision of area drained on basis of digitized mapping of all ditches in Iceland has resulted in considerable decrease in reported emission from this category. The total area drained has decreased from previously reported 450 kha to 374,8 kha, including drained area reported as forest land. Of the drained area 98% are estimated organic soil. This revision of area result in decrease of 18,5 % in reported emission of CO_2 from 1.800,74 Gg CO_2 in submission 2007 to 1.466,59 Gg CO_2 in this year's submission.

7.5.1.1 Carbon stock changes in living biomass

No information is available on overall changes in living biomass although it is known that changes are occurring. Division of grassland to subcategories is not possible with the present status of geographical information. Changes in carbon stock in living biomass are therefore not estimated, as is consistent with the Tier 1 methodology for the category.

7.5.1.2 Net carbon stock changes in dead organic matter

Tier 1 methodology of AFOLU Guidelines assumes no changes in dead organic matter in Grassland remaining grassland and for land converted to grassland tier 1 assumes the stock changes to take place in 1st year of conversion. The reported land use changes are older in all cases. Changes in dead organic matter are thus not requested by the AFOLU Guidelines Tier 1 methodology and the information needed to move up to higher tiers is at present not available for this stock.

7.5.1.3 Net carbon stock change in soils

Changes in carbon stock in mineral grassland soils are not estimated due to lack of data. Tier 1 methodology gives by default no changes if land use, management and input (F_{LU}, F_{MG}, F_I) are unchanged over a period. Information needed to move up to higher tiers is at present not available. This subcategory is therefore at present not estimated.

Extensive drainage of wetland has taken place in Iceland mostly in the period 1940-1985 (Figure 7-4). All ditches recognizable on satellite images (SPOT 5) have recently been digitized (Figure 7-2). Interpretation of ditches to drained area and stratifying according to different soil types and land use is at present a pending assignment at AUI.

Iceland's drained soils include three soil types; Histosol, Histic Andosol and Gleyic Andosol. The two organic soil types are Histic Andosol and Histosol. Although Gleyic Andosol is not classified as organic, it is included here. Organic soils in Iceland generally are with relatively low C/N ratio and are therefore considered nutrient rich.

The area of Wetland converted to grassland is reported as an aggregate number which includes all drained soils except area of organic soil in forest land. The reported area is the estimate of drained areas as described in chapter 0 subtracted by the area of afforested organic soils as estimated on base of information from Icelandic Forestry Research. Some of area may eventually be included under cropland or even managed wetland, depending on the definitions of the land use categories still to be elaborated.

This factor is identified as level key source factor of LULUCF and as a key area both regarding reported area considering highest reported resolution and applicable area.

7.5.2 Other emissions (5(IV))

All CO_2 emission due to liming is reported as aggregate number under land use category “cropland”. N_2O emission from grassland drained organic soil is due to structure of CRF-Reporter software reported under the category “LULUCF Other“(chapter 7.9.2.1).

7.5.3 Emission factors

Emissions of CO_2 from organic soil in Wetland converted to grassland are calculated according to Tier 1 methodology and uses the emission factor EF = 1,1 [t C ha-1 yr-1] (AFOLU Guidelines Table 7.4) considering high N content and aggregation of areas from different categories. Recent researches on upland CO_2 emission indicate a higher emission factor than used. Considering the category being a key source establishing higher tier EF are of high importance. EF for N_2O is discussed in chapter 7.9.2.2.

7.5.4 Land converted to grassland.

Two categories of land converted to grassland are reported in this year’s submission. Wetland drained were in previous submissions reported as Grassland remaining grassland, but are now reported as Wetland converted to grassland. This change is made to better meet the definitions of AFOLU Guidelines regarding land use changes.

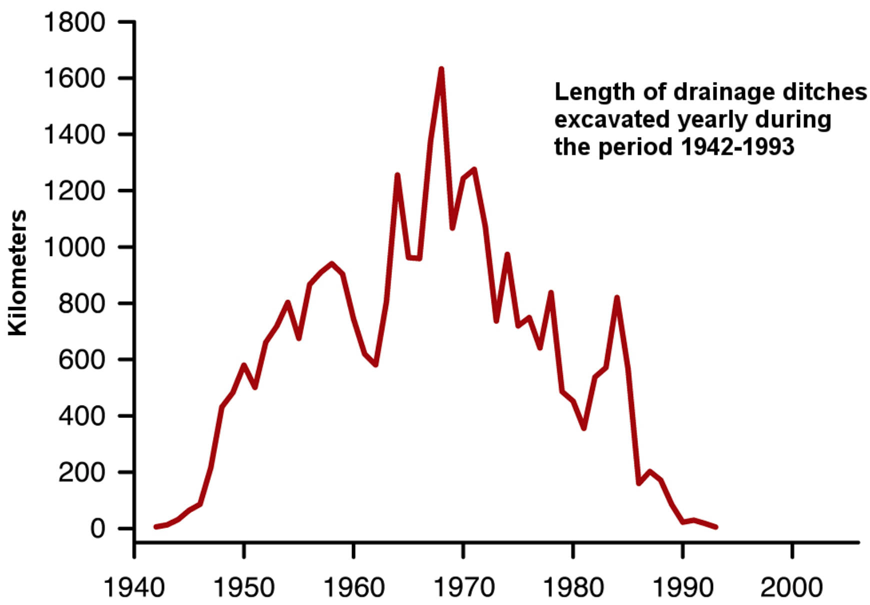

Figure 7-4 Length of ditches subsided in the period 1942-1993 (Based on information from Icelandic Farmers Association)

Applying the AFOLU criteria on length of transition period until reaching stabile soil carbon level of the resulting land use category, all drained land, except fore the area already converted to forest land, is reported as Wetland converted to grassland. The drained areas have generally not reached the same level of soil carbon as grassland mineral soils (AUI unpublished information). The excavation of ditches was mostly finished before 1990 according to subsided ditches Figure 7-4.

Cropland area as reported by Iceland Agricultural Statistics has not been updated since 1999 and 1990-1998 no changes were reported. The decrease of 19 kha in area reported 1998 and 1999 is assumed to have been converted to grassland and is reported as cropland converted to grassland for all subsequent years.

Revegetation in Iceland often involves converting previously unvegetated area (‘other land’) into grassland. In those instances it could be reported as such. Revegetation is reported in this submission as separate activity not involving land use changes. Reporting revegetation also under land converted to grassland would therefore involve double accounting.

7.5.5 **Uncertainty QA/QC**

Uncertainty in reported emission from this category is supposed to be large. Several components contribute to this uncertainty. The CO_2 emission from mineral soils, which is not estimated, is potentially a large source considering the severe erosion in large areas. Counteracting these emissions might be removal in areas where vegetation is recovering from previous degradation.

Uncertainty in reported emissions from drained soil is also substantial. The total area drained is based on the estimate of drainage effectiveness (Óskarsson 1998) and the total length of ditches as recorded by AUI and NLSI mapping. Effectiveness estimates range from 7,3 km/km^2 (Óskarsson 1998) to 20 km/km^2 (Geirsson 1975). Preliminary data from those mapping of ditches indicate effectiveness around 8.4 km/km^2 (unpublished data from Agricultural University of Iceland), which is around 15% larger number than effectiveness used. The uncertainty of total length of ditches is supposed to have decreased compared to previous estimate based on subsided ditches, but the uncertainty still needs to be quantified.

Elaboration on definitions of land use categories might shift large areas into or out of grassland category. Field sampling and remote sensing work are needed to define boundaries of grassland to other land use categories e.g. wetland, other land and cropland.

Emission factors for both CO_2 and N_2O are stated with large uncertainty range in AFOLU Guidelines.

7.5.6 **Planned improvements regarding grassland**

Due to the potential importance of emissions, and removal in case of e.g. changed management, from/to mineral grassland soils, it is recognised as high priority issue to move up to a higher tier level regarding estimate of carbon stock changes in soil for that subcategory.

As severely degraded soils are widespread in Iceland as a reflected by extensive erosion over a long period of time, the changes in carbon stocks of mineral soil are a potentially large source of carbon. The importance of this source is emphasized, since mineral grassland soil in Iceland is almost always Andosol with high C content (Arnalds and Gretarsson 2001). Dividing the area of grassland remaining grassland into subcategories, regarding management considering degradation of soil and vegetation is under preparation as part of the new land use database.

Emissions of both CO_2 and N_2O from Wetland converted to grassland (grassland organic soils) are identified as key sources for LULUCF and improving the resolution in recording land use, soil types and refinement of emission factors is highly important for this category. Improvements in ascertaining the extent of drained organic soils within different land use categories and soil types is a priority issue of the new land use database under construction.

How to incorporate revegetation activities in the geographical land use database and ensure consistent accounting to UNFCCC and KP remains to be solved. The recording of land converted to grassland is closely connected to that question. Solving this is a priority task in construction of the new geographical land use database.

7.5.7 **Recalculation**

The revision of total area drained is applied for all years reported and emissions recalculated consequently, considering drained area afforested. This recalculation involves both emissions of CO_2 and N_2O from drained soils. The latter reported as subcategory “Other- Grassland organic soil”.

The change in structure of reporting involving reporting of drained wetland under subcategory wetland converted to grassland does not involve any recalculation of emission reported.

7.6 Wetland

Compared to previous year’s submission there are considerable changes in both structure of land use information and emission reported from this land use category. Flooded land, which previously was reported as “Wetland remaining wetland” is now divided to “Land converted to wetland” and “Wetland remaining wetland”. New information is now available on EF and area flooded allowing use of higher tier methodology than applied in previous submissions. This improvement in method explains the decrease in emission compared to previous submission. Improved time resolution of land use changes enables reporting time series for land converted to flooded land.

7.6.1 **Carbon stock changes (5D)**

Areas of Wetland remaining wetlands are divided to three subcategories, “lakes and rivers”, “peatlands” and “reservoirs”. Two first categories are considered unmanaged.

Reservoirs, which are classified as wetland remaining wetland, include only lakes turned into reservoirs. In case when the area of the lake was increased only the lake area before is defined as wetland remaining wetland. No emission is assumed from previous lakes turned into reservoirs. Peat extraction is not occurring in Iceland for fuel combustion. The only peat extraction occurring is due to land converted to settlement (chapter 7.7.1.). Some of the lowland peatlands in Iceland could fall under managed land due to livestock grazing and should be reported as such, no information is at present available on area of grazed peatlands. Drained peatlands are reported as wetlands converted to grassland and regarding "Non CO_2 emission" under subcategory "Other- Grassland organic soil". All lakes and rivers are considered unmanaged.

The subcategories 'peatland' and 'lakes and rivers' are identified as key areas with regards to reported land use categories at highest resolution reported .

7.6.1.1 Flooded land:

CO_2 emission from reservoirs is presented for three subcategories:

1. Grassland with high soil organic carbon content (High SOC). SOC higher than 50 kg C m^{-2}.
2. Grassland with medium soil organic content (Medium SOC). SOC 5-50 kg C m^{-2}.
3. Other land with low soil organic content (Low SOC). SOC less than 5 kg C m^{-2}.

The emission from flooded land is estimated either on basis of classification of reservoirs or parts of land flooded to these three categories or on basis of reservoir specific emission factors available (Óskarsson and Guðmundsson 2008). Reservoir classification is based on information from power companies running relevant reservoir on area and type of land flooded.

The emission is calculated from the emission factors available, reservoir area and estimated length of ice-free period. No meteorological data is available on ice-free period of lakes or reservoirs but 215 days assumed as average number of ice-free days, as in previous submissions.

This recalculation has resulted in 93% decrease in CO_2 emission estimate, from 141.4 Gg CO_2 reported in 2007 submission to 9.3 Gg CO_2 now reported.

The estimated area of reservoirs is also improved involving previous lakes and other power companies, resulting in larger area of reservoirs 39.1 kha instead of 25 kha. Area of lakes and rivers was subtracted accordingly. Information on reservoirs area still needs to be improved.

The improved estimate of CO_2 emission explains why the emission of CO_2 from reservoirs is not included as key source as in last year submission.

Area estimates for reservoirs were obtained from the power companies running the relevant reservoir.

7.6.2 Other emissions (5II)

Emission of N_2O from drained peatlands is reported under subcategory "Other- Grassland organic soil".

7.6.2.1 Flooded land

Emission of CH_4 from reservoirs is reported. Emission of CH_4 is estimated by comparative method as for CO_2 emission using either reservoir classification or reservoir specific emission factor for relevant reservoir available (Óskarsson and Guðmundsson 2008). Emission of N_2O is considered not occurring. Tier 1 method of AFOLU Guidelines include no default emission factor for N_2O and zero emission was measured in the recent Icelandic research on which the emission estimate is based(Óskarsson and Guðmundsson 2008).

The refinement in emission estimate of CH_4 resulted in 83% decrease in emission or from 2,34 Gg CH_4 reported in 2007 submission to 0,38 Gg CH_4 now reported

7.6.3 Emission factors

Reservoir specific emission factors are available for one reservoir classified as High SOC, one reservoir classified as Medium SOC and five classified as Low SOC. For those reservoirs, where specific emission factors are not available, the average of emission factors for relevant category is applied for the reservoir or part of the flooded land if information on different SOC content of area flooded available.

Emission factors for reservoirs in Iceland	**Emission factor [kg GHG ha-1 d-1]**			
Reservoir category	**CO_2 ice free**	**CO_2 ice cover**	**CH_4 ice free**	**CH_4 ice cover**
Low SOC				
reservoir specific	0,23	0	0,0092	0
reservoir specific	0,106	0	0,0042	0
reservoir specific	0,076	0	0,003	0
reservoir specific	0	0	0	0
reservoir specific	0,083	0	0,0033	0
average	0,099	0	0,00394	0
Medium SOC				
reservoir specific	4,67	0	0,187	0,004
High SOC				
reservoir specific	12,9	0	0,524	0,012

Table 7-13 Emission factors applied to estimate emission from flooded land (Óskarsson and Guðmundsson 2008)

Emission factors include diffusion from surface and degassing through spillway for both CO_2 and CH_4 and for the latter also bubble emission.

7.6.4 **Land converted to wetland**

Two sources of land converted to wetland are recognized; by flooding due to construction of new hydropower reservoirs and through reclamation of wetland to counteract damaged wetlands due to road building or as recreational area connected to tourism. Land flooded is reported as grassland converted to wetland, (high or medium SOC) or as “Other land converted to wetland” (low SOC) depending on vegetation cover. All flooded land is kept in conversions stage although most of the land was flooded for more than ten years.

7.6.5 **Uncertainty QA/QC**

Main uncertainty is associated with emission factors used and how well they apply for reservoirs of different age. The emission factors for CH_4 are estimated from measurements on freshly flooded soils. The CO_2 emission factors are based on measurements on reservoir flooded 15 years earlier. The information on area of flooded land is not complete some reservoirs are still unaccounted for. This applies for reservoirs in all reported categories. The same number of days in ice-free period is applied for all reservoirs and all years. This is a source of error in the estimated emission.

7.6.6 **Planned improvements regarding Wetland**

The improvement on emission factors expected in NIR 2007 is already implemented. Further improvements regarding information on reservoir area and type of land flooded are planned. Recording and compiling information on ice-free period for individual reservoirs or regions is planned.
Information on changes in emission factors with age of reservoirs are needed but no plan known is at present to obtain those.

The new geographical land use database is expected to improve area data on wetland and its subcategories.

7.7 Settlements

7.7.1 **Carbon stock changes (5E)**

The AFOLU Guidelines are more extensive on reporting emission from settlements and land converted to settlement than the previous GPG for LULUCF where focus was only on stock changes in living tree biomass for this category.

Carbon stock changes are not estimated for any of the carbon pools in settlement area or in land converted to settlement due to lack of data.

Potential sources of emission and removal by sinks involve excavated organic soils as source and growth of trees, shrubs and herbaceous vegetation as sink.

When former wetlands area converted into settlements or areas already included under settlement are prepared for construction of streets or buildings organic soils are sometimes excavated and used in shaping the landscape or other purposes. This excavation of organic soil enhances decomposition of the organic material and emission of both CO_2 and N_2O. This source is not estimated in the inventory. There is no data presently available on the amount extracted.

Newly established quarters are generally with less vegetation both woody and herbaceous than more settled quarters. This increase in biomass is not estimated in the inventory.

7.7.2 **Other emissions (5)**

Burning of biomass in open areas within the category settlement does take place (see chapter 0). No other sources of CH_4 or N_2O have been recognized.

7.7.3 **Land converted to settlement**

At present no official country wise compilation of land converted to settlement is done. Previous land use categories are generally not recorded in municipal area planning.

7.7.4 **Planned improvements regarding Settlement**

The new geographical land use database is expected to improve area data on previous land use of land converted to settlement. Compilation of municipal area mapping is part of the CORINE mapping effort and will be carried out by NLSI. Therefore estimate of area of land use category ‘settlement remaining settlement’ and ‘land converted to settlement’ are expected to improve. In the new geographical database data for the land use category ‘settlement’ will be provided by NLSI.

7.8 Other land (5, 5F)

No emission/removal is reported for “other land remaining other land” in accordance with AFOLU Guidelines. As with most other land use categories information on land use conversion is not available at present.

This land is identified as a key area considering reported land use categories but not as part of applicable land use categories due to its definition as unmanaged.

7.8.1 **Planned improvements regarding other land**

Data on area covered by this category will be collected in connection with construction of the new geographic land use database. Definition of other land as land use category will be elaborated in that contest too.

7.9 Other (5)

Two emission/removal categories are reported under other. Non-CO_2 emission form Grassland organic soil and emission/removal due to Revegetation. Harvested Wood Products are not reported.

7.9.1 **Harvested Wood Products**

No data is available on stock changes in harvested wood products and therefore not estimated. There are no planned improvements regarding recording of this stock.

7.9.2 **Grassland organic soil**

Under this item non-CO_2 emission from grassland are reported. Present structure of Reporter software does not allow reporting this emission under Grassland land use category.

7.9.2.1 Other emissions (5(I), 5(II), 5(III)

Grasslands in Iceland are generally not fertilized. The main exception is as part of revegetation activity. Use of fertilizers in revegetation is reported separately. Direct N_2O emission from eventual use of N fertilisers on grassland is included under emission from agricultural soils.

Emission of N_2O due to drainage of organic soils is reported here as aggregated number under "Other" specified as grassland on drained organic soils consistent with reporting of CO_2 emission from drained soils. This factor is identified as level key source of LULUCF.

7.9.2.2 Emission factors

Emission of N_2O from drained organic soil is calculated according to Tier 1 using emission factor EF = 1,8 [kg N2O-N ha-1 yr-1] (AFOLU Guidelines Table 7.6) for nutrient rich organic soils considering high N content.

7.9.2.3 Planned improvements regarding grassland organic soil

See chapter 7.5.6

7.9.3 **Revegetation**

7.9.3.1 Overview

Since settlement of Iceland large areas of the former vegetated areas have been severely eroded and in large areas the entire soil mantle has been lost. It has recently been estimated that total of 60-250 $*10^3$ kt C has been oxidized and released into the atmosphere in the past millennium (Óskarsson et al. 2004).

The current ongoing loss of SOC due to erosion was in the same study estimated 50-100 kt C yr^{-1} (Óskarsson et al. 2004). No attempt is made to include that estimate in the CRF.

The revegetation of deserted areas sequesters some of the carbon back into the soil.

The Icelandic Soil Conservation was established in 1907. Its main purpose was and still is the prevention of ongoing erosion, the revegetation of eroded areas, restoration of lost ecosystem and ensuring sustainable land use by livestock. From 1907 to 1990 most of the reclamation work was carried out in 170 enclosures, covering about 3% of the total area of the country. The protection from grazing in the soil conservation enclosures and and other means of improved land utilization of land by livestock has sequestrated carbon, which has not been estimated yet. Until 1960 recording of soil conservation and revegetation activities was very limited and consisted only of occasional maps and reports. From 1958 to 1990 most of the activities involved spreading of seeds and/or fertilizer by airplanes and direct seeding of lyme grass and other grasses. These activities are to a large extent recorded. From 1990 the importance of aerial distribution has decreased as other methods have taken over and cooperation with farmers and other parties of interest has increased. At the same time, recording of activities has developed and since 1990 all activities have been recorded by GPS simultaneously and mapped, available both on paper and in a databank.

7.9.3.2 Carbon stock changes

Changes in carbon stock in soil and vegetation due to revegetation are reported under the category 'other'. Preferably, revegetation would be reported as a separate main land use category or subcategory of relevant land use categories, addressing changes in individual pools and other emissions more directly. Due to this reporting format aggregated carbon stock changes (accumulation) is reported as CO_2 removal. In order to increase the transparency of reporting for this category and improve consistency to other land use categories a sectoral background table for revegetation comparable to other CRF prepared by the Reporter software was prepared for this report (Table 7-14). There the reported removal of CO_2 is calculated according to the estimated area revegetated and the emission/removal factor for carbon stock changes in living biomass and soil. The area reported is divided to three periods: pre-1990, 1990 - inventory year, and the area revegetated in the inventory year. The increase in C-stock in areas revegetated before 1990 is estimated 78,75 Gg C, 66,68 Gg C in areas revegetated 1990-2005 and 5,594 Gg C for areas revegetated 2006. Accordingly the CO_2 removal is estimated -288,750 Gg CO_2, -244,493 Gg CO_2 and -20,510 Gg CO_2 for the same periods. Due to CRF- Reporter restrictions only the total removal is reported.

The reported CO_2 removal by revegetation after 1990 is based on area recorded by Icelandic Soil Conservation. The removal by revegetation before 1990 is based on estimate of area provided by the Icelandic Soil Conservation.

This factor is identified as a key source of LULUCF and as a key area considering only applicable land use categories.

TABLE 5.(G) SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY
Revegetated land
(Sheet 1 of 1)

Iceland
2006
2008

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA	IMPLIED EMISSION FACTORS					EMISSIONS/REMOVALS				
Land-Use Category	Sub-division[1]	Total area (kha)	Carbon stock change in living biomass per area [2,3]			Net carbon stock change in dead organic matter per area[3]	Net carbon stock change in soils per area [3]	Carbon stock change in living biomass[2,3]			Net carbon stock change in dead organic matter[3]	Net carbon stock change in soils [3]
			Increase	Decrease	Net change			Increase	Decrease	Net change		
			(Mg C/ha)					(Gg C)				
H. Total Revegetated Land		201,36	0,08	0,00	0,08	0,00	0,68	15,10	0,00	15,10	0,00	135,93
1. Revegetated Land remaining Revegetated Land		193,91	0,08	0,00	0,08	0,00	0,68	14,54	0,00	14,54	0,00	130,89
	after 1990	88,91	0,08	0,00	0,08	0,00	0,68	6,67		6,67		60,01
	before 1990	105,00	0,08	0,00	0,08	0,00	0,68	7,88		7,88		70,88
2. Land converted to Revegetaded Land[4]		7,46	0,08	0,00	0,08	0,00	0,68	0,56	0,00	0,56	0,00	5,03
2.1 Forest converted to Revegetaded Land		0,00						0,00	0,00	0,00	0,00	0,00
										0,00		
2.2 Cropland converted to Revegetaded Land		0,00						0,00	0,00	0,00	0,00	0,00
										0,00		
2.3 Grassland converted to Revegetaded Land		0,00						0,00	0,00	0,00	0,00	0,00
										0,00		
2.4 Wetlands converted to Revegetadedt Land		0,00						0,00	0,00	0,00	0,00	0,00
										0,00		
2.5 Settlements converted to Revegetaded Land		0,00						0,00	0,00	0,00	0,00	0,00
										0,00		
2.6 Other Land converted to Revegetaded Land		7,46	0,08	0,00	0,08	0,00	0,68	0,56	0,00	0,56	0,00	5,03
		7,46	0,08	0,00	0,08	0,00	0,68	0,56		0,56		5,03

(1) Land categories may be further divided according to climate zone, management system, soil type, vegetation type, tree species, ecological zones or national land classification.

(2) CO_2 emissions and removals (carbon stock increase and decrease) should be listed separately except where, due to the methods used, it is technically impossible to separate information on increases and decreases.

(3) The signs for estimates of increases in carbon stocks are positive (+) and of decreases in carbon stocks are negative (-).

(4) A Party may report aggregate estimates for all conversions of land to forest land when data are not available to report them separately. A Party should specify in the documentation box which types of land conversion are included. Separate estimates for grassland conversion should be provided in table 5 as an information item.

Documentation box:
Parties should provide detailed explanations on the Land Use, Land-Use Change and Forestry sector in Chapter 7: Land Use, Land-Use Change and Forestry (CRF sector 5) of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and/or further details are needed to understand the content of this table.

Table 7.14 Sectoral background table for revegetation not included in CRF prepared by the UNFCCC Reporter software

7.9.3.3 **Other emissions (5(I), 5(II), 5(III))**

The direct emissions of N_2O from the use of N-fertilizers on revegetated land are reported separately for revegetation for the first time.

Drainage of revegetated area is reported as not occurring and subsequently no emission reported. Non- CO_2 emission from disturbance associated with conversion of land to cropland is not estimated due to lack of data.

7.9.3.4 Emission/removal factors

The Icelandic Soil Conservation records the revegetation efforts conducted. In 1998-2000 a special governmental effort to sequester carbon with revegetation and afforestation was carried out. Along with that effort a research effort to document carbon sequestration and estimate its rate was carried out (Arnalds et al. 2000).

No Tier 1 default emission/removal factors are available for revegetation effort. The emission factor used for calculating emission/removal due to revegetation efforts are estimated as -0,75 kt C/kha/yr based on precautious estimate of results from the research effort conducted 1998-2000. Also based on the same research effort the contribution of changes in carbon stock of living biomass and soil were estimated 10% and 90% respectively. All revegetated areas are assumed to accumulate carbon stock at same rate.

7.9.3.5 Uncertainties QA/QC

Calculation of removal/emission of carbon due to revegetation depends on the size of the area and the chosen emission/removal factor. The approach is ‘Tier 1 (2)’ approach based on simple removal rate factor based on measurement of chronosequential accumulation of carbon on revegetated areas of a known age. Both numbers have a large uncertainty.

The areas where revegetation is carried out are very variable with regards to soil climate condition and methods used. Success of revegetation efforts is also very variable and consequently, as is the rate of sequestration. Although some of the sources of this variability have been identified, it is far from being totally explained (Arnalds et al. 1999; Arnalds et al. 2000; Arnalds et al. 2002).

The mapping method and registration of the revegetation on the first year of reporting (1998) was based on records of the site name and estimate of hectares within that location where the activity took place. The estimated number of hectares is partly based on amount of seeds and fertilizers used. This method may have introduced a relatively large error into the area estimates and may bring a risk of either double counting or not counting some areas. Since 1998 the reported size of area subjected to revegetation has been increasingly based on GPS recordings. The carbon stock changes, reported this year, are based on the Icelandic Soil Conservation GPS-mapping of area revegetated and revised estimate of those areas not yet mapped.

The size of the land revegetated prior to 1990 is much more uncertain than after that time. It is possible that some of this land should today be identified under a different land use category.

Generally it is a necessary part of the revegetation effort to protect the area from grazing by erecting permanent fences. In some cases the whole area within such fences is reported as revegetated although only a part of it has been directly subject to the field of activities such as fertilization or seed spreading. It is important to bear in mind that the registration was designed to serve other purposes than the needs of greenhouse gas inventories.

7.9.3.6 Planned improvements regarding revegetation

An effort in GIS mapping of the revegetation areas and improvements of the precession of size estimate of the areas has been ongoing since 1998. This effort has resulted in increased accuracy of area estimates reflected in 2007 and this year's submission. In 2005 and 2006 some of the areas, sampled during 1998-2000 research effort, were re-sampled. Results from this research are not yet available. Improvements in both the sequestration rate estimates and area recording, aim at establishing a transparent, verifiable inventory for revegetation efforts accountable according to the Kyoto Protocol.

Three main improvements are planned and partly being carried out. First there is the improvement in recording of activities both, in location and description of activities and management. This has already been implemented regarding new areas and recording of older activities is ongoing. Second improvement is pre-activity sampling to establish a baseline for future comparisons of SOC. This will be been implemented for new areas established in 2008 and later.

The third improvement is the introduction, by the Icelandic Soil Conservation, of a sample based approach combined with GIS mapping to identify land subjected to revegetation and to improve emission/removal factors and quality control on different activity practices. The systematic sampling approach is designed to confirm that land registered as subjected to revegetation is being revegetated and monitor changes in carbon stocks. The system to measure carbon stocks on land reclamation areas adopted in 2007 is based on a specific geographic grid which covers all of Iceland. The same grid is also used by the Icelandic Forestry Service for forest inventory measurements (Snorrason & Kjartansson 2004). The basic unit of this grid is a rectangular, 0.5 x 0.5 km in size. Within this grid a total of ca 1000 permanent measurement plots were systematically selected, with a fixed distance between plots as done by the Icelandic Forestry service. These plots are either on revegetated areas (ca 800 plots) or on a 30m non-revegetated buffer zone established around all revegetation areas (ca 200 plots). The plots on the non-revegetated buffer zone serve as control and are used to estimate carbon stocks in the land before revegetation. The control plots will serve as a baseline for carbon stock until re-measurement of stocks in revegetated areas. However, by 2008 the plan is to measure carbon stocks in all areas prior to revegetation. The permanent plots will be re-measured every 5 years. This sampling will provide more conservative estimates of revegetated land and more accurate estimate of stock changes and enable the quantification of uncertainty for these estimates.

When implemented, these improvements will provide more accurate area and removal factor estimate, subdivided according to management regime, regions and age of revegetation.

7.9.3.7 Recalculation

No recalculation area at present is made for the category revegetation.

7.10 Biomass burning (5V)

Accounting of biomass burning for all land use categories is addressed commonly in this section.

In this year's submission emission due to single large wild-fire event in western Iceland 2006 is reported. Emission is estimated on basis of biomass burned. Only CH_4 and N_2O emission are reported. The biomass burned and dead organic matter is assumed to be restored in few years. The increase in biomass and dead organic matter following the fire is not recorded and consequently the temporal decrease caused by the fire is not reported.

No other emissions due to biomass burning are reported. It is considered not occurring for controlled burning of forest land, land converted to forest land, land converted to cropland, forest land converted to grassland, forest land converted to wetland and wildfires on forest land converted to: cropland, grassland or wetland. For other categories it is not estimated due to lack of information.

Burning the biomass on grazing land near the farm was for a long time common practice in sheep farming. This management regime of grasslands and wetlands is becoming less common. The recording of the activity is minimal although formal approval of local polity authority is needed for safety and birdlife protection purposes.

7.10.1 Planned improvements regarding biomass burning

The large wildfire broke out in the year 2006 initiated a research project aimed at recording the ecological effects of biomass burning. This project is expected to provide data for Tier 2 assessment of amount of biomass burned per area burned. As land use identification is expected to improve in general due to the planned increased effort on establishing a geo-referenced land use database, information on area burned annually are also expected to improve. Systematic compilation of existing information on approved burning and improved recording of the controlled and wild-fire is planed.

7.11 Planned improvements of emission/removal data for LULUCF

Improvements which apply specifically to one of the land use categories and activities or one of their pools are listed above in relevant chapter.

Simultaneously with gathering of land use information for the purpose of the new geo-referenced land use database, data will be collected regarding the carbon stocks of the land use category used in the classification. These efforts are aimed at gradually improving the reliability of reported emission/removal of the LULUCF sector and enable the movement from Tier1, which is presently used to calculate emission/removal in many categories, to higher tier levels.

The results of ongoing and recent research activity on emissions/removal and stocks in several ecosystems will be implemented in emissions calculations.

8 WASTE

8.1 Overview

The waste sector consist of the CRF source category 6.A Solid Waste Disposal on Land, 6.B. Wastewater Handling, 6.C. Waste Incineration and 6.D.

For 6.A. Solid Waste Disposal on Land CH_4 emissions are considered in the following as a result of calculations in continuation of previously used and reported methodology with minor revision.

For 6.B. Wastewater Handling, CH_4 emission was calculated with a methodology that has been somewhat revised from earlier submissions. This submission contains emission estimates from Industrial wastewater handling for the first time.

For 6.C. Waste Incineration, the largest part of the emissions is included in the energy sector as almost all waste incineration in Iceland now is with energy recovery. A gradual decrease is seen in open pit burning since 1990 and from 2005 only bonfires are included in the Waste Incineration sector, along with emissions from one single incineration plant. Bonfires are included in the inventory for the first time.

In table 8.1, an overview of the emissions is presented as rounded figures.

Table 8.1 Emissions of greenhouse gases in Iceland from waste during the period 1990 – 2006. Units: CO_2-eq

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Landfills	138	142	146	149	152	156	158	159	159
Wastewater handling	20	20	21	22	23	25	26	26	25
Waste incineration	19	19	19	16	15	13	11	11	9
Total	177	181	186	187	190	193	195	196	193

	Year							
	1999	2000	2001	2002	2003	2004	2005	2006
Landfills	161	163	169	159	163	162	163	181
Wastewater handling	25	26	26	27	29	27	25	25
Waste incineration	8	7	7	6	5	2	0	0
Total	194	197	201	193	197	191	188	206

8.1.1 Methodology

The calculation of greenhouse gas emissions from waste is based on the methodologies suggested by the IPCC Guidelines and the Good Practice Guidance.

As indicated in Table 1.1, the key source analysis performed for 2006 has revealed that in terms of total level and/or trend uncertainty the only keys sources in the waste sector is the following:

- Emissions from Solid Waste Disposal Sites – CH_4 (6A)

8.1.2 Completeness

Table 8.2 gives an overview of the IPCC source categories included in this chapter and presents the status of emission estimates from all sub-sources in the industry sector.

Table 8.2 Waste – completeness

	Direct GHG			Indirect GHG			
Sector	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Solid waste disposal on land							
Managed waste disposal on land	NE	X	NA	NA	NA	NE	NA
Unmanaged waste disposal on land	NE	X	NA	NA	NA	NE	NA
Wastewater treatment							
Industrial wastewater	NE	X	NE	NE	NE	NE	NE
Domestic and commercial wastewater	NE	X	X	NE	NE	NE	NE
Waste incineration	X	X	X	X	X	X	X
Other	NE	NE	NE	NE	NE	NE	NE

X: estimated

8.2 Solid waste disposal sites

Practices of waste disposal treatment have undergone a radical change in Iceland since 1990. Open pit burning that used to be the most common means of waste disposal outside the capital area, has gradually decreased since 1990, as landfills have become the main option. Recycling of waste has also increased due to efforts made by local municipalities. Municipalities have also increasingly cooperated to run waste collection schemes and operate common landfill sites. This has resulted in larger landfills and enabled closedown of a number of small sites. Currently about 71% of municipal waste is landfilled, 22% recycled or recovered, 4,7% incinerated with energy recovery and 1,5% are incinerated without energy recovery.

Methane from solid waste disposal sites is emitted during the biological decomposition of waste. This transformation of organic matter takes place in several steps. During the first weeks or months, decomposition is aerobic and the main decomposition product is CO_2. When there is no oxygen left, the decomposition becomes anaerobic and methane levels starts to increase. After about one year a peak is seen in CH_4 emissions then the level decreases over some decades.

In Iceland, solid waste disposal is divided between managed landfill sites and unmanaged landfill sites. The definition for Managed sites are landfills deeper than 5 meters and have thorough registration on waste sorts and amounts disposed. Sites that are shallow with less than 5 meters of waste are defined unmanaged landfill sites are. Total waste going to these landfills is divided into two major waste streams, municipal solid waste (MSW) and industrial waste (IW).

The methodology for calculating methane from solid waste disposal on land is in accordance with the IPCC Spreadsheet First Order Decay Model. The total amount of methane gas generated by the disposal of MSW and IW on landfill sites is calculated with the following equations. Definition for MSW is waste collected from ordinary households and IW is waste collected from industry. Waste from the commerce and trade industry can be included both in MSW and IW, where household like waste is included in MSW and non household like waste is included in IW.

8.2.1 Activity data

Activity data on waste in Iceland has proven to have been insufficient in the past. There is little information about actual amounts of generated waste as well as on its composition and characteristics, before 1990. Reporting of waste amounts received by managed landfill sites started after 1980 and is done by the landfill operators. Consistent and relatively reliable data-sets on total waste generation and treatment are available from 1995.

Using the calculation based on the Icelandic GDP (Gross Domestic Product) the total amount of generated waste can be extrapolated from 1994 back to 1950. GDP is strongly correlated with a country's waste production and is a reliable estimation method. Icelandic GDP figures date back before 1950 and are considered reliable. With regard to total waste amounts generated, it has been decided to use available reported waste figures above the on GDP-based waste figure calculations.

In this submission, GDP based calculation uses 1995 as reference year. It calculates the amount of generated MSW per person per year and the total generated for both MSW and IW. Data quality for the reference year is ensured because of accurate waste reporting for that year. In the 2007 submission, 2004 was set as a reference year. An unnaturally large gap in the correlation between the years 1994 and 1995 was formed when using the 2004 as a reference year, and therefore a reference year closer to the years with uncertainty is used in this submission. The effect of this leads to higher values in the total waste disposal prior to 1995 than documented earlier (figure 8.1)

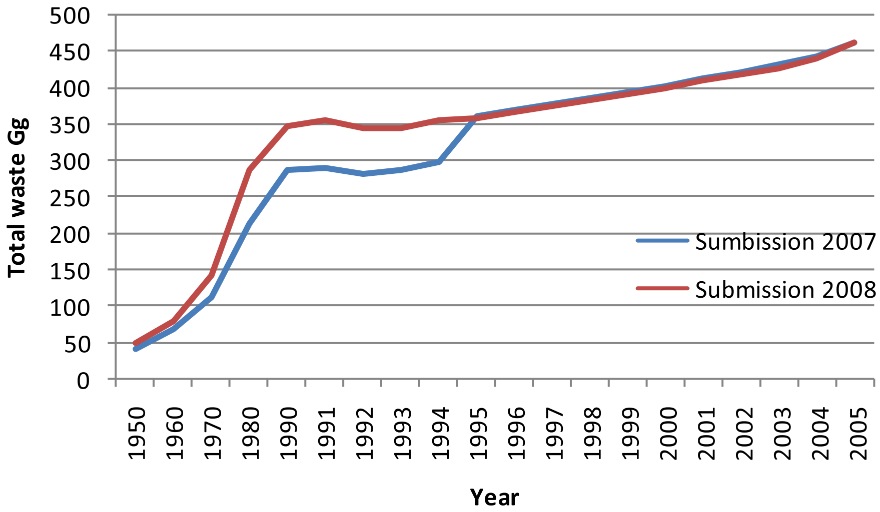

Figure 2.1 Revised estimation on total waste

Data for managed waste disposal and recycling were recalculated and a new estimate was found. Recycling on tins and other municipal waste was initiated in the years 1996/1997, the data for municipal waste are considered reliable. Some recycling has occurred for years in the Industrial sector but relatively accurate data only exist for the years 2002-2006; an estimate was generated for the years 1995 to 2001. The new values are considered more reliable and will be used in this submission.

The activity data was mostly collated by the EA. Secondary data sources are the municipalities and the larger waste companies in Iceland. The total amounts of MSW and IW generated and treated in Iceland between 1950 and 2006 are reported in Table 8.3.

Table 8.3 Waste generation and treatment from 1950 to 2006

Year	Generated (A+B+C)*			A. Landfilled		B. Recycled		C. Incinerated	
	Total	MSW	IW	MSW	IW	MSW	IW	MSW	IW
1950	**49**	10	39	10	39				
1960	**79**	19	60	19	60				
1970	**142**	37	105	37	105				
1980	**287**	75	212	57	190			18	22
1990	**348**	107	241	90	220			17	21
1991	**355**	110	245	93	224			17	21
1992	**345**	108	237	91	217			16	20
1993	**346**	109	237	92	217			17	20
1994	**357**	113	244	97	225			16	19
1995	**358**	112	246	97	208		20	15	18
1996	**368**	115	253	100	208	1	28	14	17
1997	**376**	118	258	102	212	2	29	14	17
1998	**384**	121	263	102	214	6	33	13	16
1999	**392**	124	268	101	220	11	34	12	14
2000	**401**	128	273	100	232	17	27	11	14
2001	**411**	131	280	97	232	23	35	11	13
2002	**418**	135	283	94	230	30	40	11	13
2003	**428**	137	291	95	235	32	43	10	13
2004	**440**	144	296	102	232	31	51	11	13
2005	**463**	153	310	108	234	34	63	11	13
2006	**487**	166	321	103	243	43	63	13	15

* Amounts is x 1.000 tonnes

8.2.2 Emission factors

Municipal solid waste

Municipal Solid Waste corresponds to waste from households and similar waste from the commerce and trade industry. MSW can be disaggregated into a mix of waste categories that contain significant fractions of biodegradable carbon, which are: food, garden, paper, wood, textile and nappies.

The composition of MSW going to landfill has been surveyed starting from 1999 and is done by SORPA, the biggest waste treatment facility in Iceland. SORPA serves the

Reykjavik capital area and thus covers around 63% of the Icelandic population. The composition of MSW over the last 7 years has shown to be relatively consistent. Because very little is known about the MSW composition before 1999 the average composition from 1999 to 2004 has been used in the IPCC model for each year between 1950 and 2006.

It is understood that different MSW compositions are likely to have existed over the last 60 years. For example, the fraction of garden waste in 1950 might have been higher than in 2000. Also the fraction of plastic (packaging) waste in MSW is expected to have increased significantly since 1950.

A sensitivity analysis, however, showed very little variation in total methane emission in Sector 6A when applying different (estimated) waste compositions between 1950 and 2004. The difference calculated did not exceed 2%. Because it is impossible to estimate the exact composition of waste each year and has very little effect on the final outcome, the composition of MSW has not been further investigated. The waste composition surveys results for 1999 to 2004 and their averages are reported in Table 8.4.

Table 8.4: Municipal Solid waste composition survey results 1999 – 2004

Type of waste	1999	2000	2001	2002	2003	2004	Average
Food waste	33%	28%	31%	26%	24%	26%	**28,1%**
Garden waste	4%	0%	1%	0%	2%	1%	**1,4%**
Paper and Cardboard	24%	29%	21%	22%	26%	27%	**24,8%**
Wood waste	0%	1%	1%	1%	1%	0%	**0,6%**
Textile waste	4%	4%	3%	3%	3%	4%	**3,4%**
Diapers/nappies	5%	4%	6%	7%	5%	6%	**5,6%**
Sludge	4%	4%	4%	4%	4%	4%	**3,9%**
Plastics, other inert	26%	30%	33%	37%	35%	32%	**32,2%**

Sludge is excluded from the composition in this year submission as emission from sludge treatment facilities are in the wastewater section. New ratios on the municipal solid waste composition were calculated, excluding sludge. The emission factors and parameters for IPCC Category 6A Municipal Solid Waste are reported in Table 8.5.

Table 8.5: Emission factors and parameters for Municipal Solid Waste

Parameters	Food	Garden	Paper	Wood	Textile	Nappies
MSW composition (average 1999 -2004)	**29,2%**	**1,5%**	**25,8%**	**0,6%**	**3,5%**	**5,8%**
Methane Correction Factor (MCF)*						
- Unmanaged-shallow				**0,4**		
- Managed				**1,0**		
- Uncategorized				**0,6**		
Fraction of degradable organic carbon dissimilated (DOC_F)*				**0,5**		
Degradable organic carbon (DOC)*	**0,15**	**0,2**	**0,4**	**0,43**	**0,24**	**0,24**
Methane generation constant (k)*	**0,185**	**0,1**	**0,06**	**0,03**	**0,06**	**0,1**
Half-life time (h) (years) (h = Ln(2)/k)	**4**	**7**	**12**	**23**	**12**	**7**
Delay time (month)*				**6**		
Number of considered years				**56**		
Fraction of CH_4 in landfill gas (F) *				**0,5**		
Oxidation factor (OX) *				**0,05**		
Conversion factor (C to CH_4)				**1,33**		

* IPCC default value

Industrial waste

Industrial waste (IW) comes from agriculture, fisheries and other industrial activities as well as waste from commerce and trade industry that is not included in MSW. The amounts of IW used in the IPCC model are excluding separated waste fractions such as scrap metal, tires and construction and demolition waste. It is expected that significant fractions of MSW-related waste can be found in IW and will be further explained under paragraph 8.2.3.

The emission factors and parameters for IPCC Category 6A Industrial Waste are reported in Table 8.6.

Table 8.6: Emission factors and parameters for Industrial Waste

Parameters	
Methane Correction Factor (MCF)*	
- Unmanaged-shallow	**0,4**
- Managed	**1,0**
- Uncategorized	**0,6**
Fraction of degradable organic carbon dissimilated (DOC_F)*	**0,5**
Degradable organic carbon (DOC)*	**0,15**
Methane generation constant (k)*	**0,09**
Half-life time (h) (years) (h = Ln(2)/k)	**8**
Delay time (month)*	**6**
Number of considered years	**56**
Fraction of methane in landfill gas*	**0,5**
Oxidation factor (OX) *	**0,05**
Conversion factor (C to CH_4)	**1,33**

* IPCC default value

Landfill gas recovery

The recovery of landfill gas (CH_4) is done at only one landfill site (Álfsnes) in Iceland, which receives the waste from the Reykjavík capital area. The recovery of CH_4 from landfill gas started in 1997 and amounts are reported in Table 8.7. Methane recovery was significantly less in 2006 than in 2005 as the local Power plant failed and the Methane burner burned over in the first half of the year. The value for methane recovery in 2006 is an estimate.

Table 8.7: Landfill gas recovery in Iceland, 1997 - 2006

Gg CH_4	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Methane recovery from Solid Waste disposal sites (SWDS)	0,105	0,240	0,349	0,430	0,407	1,108	1,143	1,4	1,550	0,900

Uncertainties

The preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CH_4 emissions from solid waste disposal sites is 52%. The quality of the activity data for Iceland may be considered sufficient, but needs further improvement to ensure its accuracy and quality. The uncertainties in the IPCC model for Sector 6A are regarding:

- **Landfilled waste between 1950 to 1980**
- The exact amounts of waste going to managed or unmanaged landfill sites between 1950 and 1980 are unknown. Therefore the Methane Correction factor (MCF) in the IPCC model has been set to uncategorized for this period (MCF = 0,6 – see Table 8.5 and 8.6).

- **Amount and composition of Industrial waste**
- The total amount of Industrial Waste has shown to be very significant over the last 11 years (1995-2006). Because of these large amounts of waste going to landfill, the emissions that are calculated using the IPCC model are significant as well.
-
- Although separated waste sorts such as scrap metal, tires and construction and demolition waste are excluded from IW it is expected to include waste amounts that should be allocated to MSW. This is because large amounts of company related waste, thus with a similar composition as MSW, is included in mixed fraction of Industrial Waste.
-
- The exact composition of mixed IW and thus the fraction of biodegradable waste remain unknown. Therefore, both the total amount of mixed IW and its composition need further investigation. This has shown to be a barrier to accurate emission calculations as well as general waste statistics.
-
- The methane emission from landfilled IW might be overestimated. However, if a fraction from IW is allocated to MSW, it will result in an increase of methane emission from landfilled MSW. The resulting absolute difference has not been estimated.

- **MSW composition between 1950 and 1998**
- The composition of MSW for the years between 1950 and 1998 is rather difficult to estimate. The sensitivity analysis, using different estimated waste compositions showed very little change in total methane emissions. The calculated differences in total methane emission in Sector 6A did not exceed 2%.

8.3 Emission from Wastewater Handling (6B)

Practices of wastewater treatment have undergone a radical change in Iceland since 1990. In 1990, 6% of the Icelandic nation was connected to wastewater treatment plants, but in 2006 the ratio was 67,9%.

Very few wastewater treatment plants are operational in Iceland and most of them are located in the greater Reykjavík Capital Area and a few other larger municipalities. The wastewater treating systems are mostly settling tanks or septic tanks, Primary treatment and Secondary treatment. The majority of the Icelandic population lives by the coast or approximately 90%, a non problem area in regard to eutrophication. About 62% of the population is living in the greater Reykjavik Capital Area, and most of the larger industries are within the area, located mostly at the coast. In the last decade improvements have been made to bring the drainage to an acceptable level. The improvements made in Reykjavik, included: 1) consolidation of the drainage system reduces 40 outlets to two, 2) the sewage is pumped out through the outlets into an ocean area 4 km from the land, where mixing is vigorous, 3) treatment of sewage with measures comparable to primary treatment. Only about 6% of the population is living in rural areas and less than 1000 people live above 200 m altitude. This explains the high percentage of primary treatment.

The sludge from wastewater handling is disposed on (managed and unmanaged) landfill sites. Amounts of sludge are excluded in total generated landfill waste as the methane emission is covered by the methodology in methane emission from wastewater handling.

8.3.1 Methodological issues

New methodology was introduced in the 2006 Guidelines. The Revised 1996 IPCC Guidelines included separate equations to estimate emission from wastewater and from sludge removed from the wastewater. The distinction has been removed because the CH_4 generation capacities for sludge and wastewater with dissolved organics are generally the same, and separated equations are not necessary. The 2006 Guidelines include a new section to estimate CH_4 from uncollected wastewater. The industrial wastewater section has been simplified and now for the first time Iceland has estimated emission from the food industrial sources.

Methane emission

The general equation to estimate CH_4 emission from domestic wastewater is as follows:

Total CH_4 Emissions from Domestic Wastewater:

$$CH_4 Emission = \left[\sum_j \left(U_i \cdot T_j \cdot EF_j\right)\right](TOW - S) - R$$

CH_4 Emissions = CH_4 emissions in the inventory year, kg CH_4/yr
TOW = Total organics in wastewater in inventory year, kg BOD/yr
S = organic component removed as sludge in inventory year, kg BOD/yr
U_i = Fraction of population in income group *I* in inventory year
T_{ij} = degree of utilization of treatment/discharge pathway or system, *j*, for each income group fraction *i* in inventory year
j = each treatment/discharge pathway or system
EF_j = emission factor, kg CH_4/kg BOD
R = amount of CH_4 recovered in inventory year, kg CH_4/yr

CH_4 Emission Factor for Each Domestic Wastewater Treatment/Discharge Pathway or System:

$$EF_j = B_o \cdot MCF_j$$

EF_j = Emission factor, kg CH_4/kg BOD
j = each treatment/discharge pathway or system
B_o = maximum CH_4 producing capacity, kg CH_4/kg BOD
MCF_j = methane correction factor (fraction)

Activity data:

$$TOW = P \cdot BOD \cdot 0.001 \cdot I \cdot 365$$

TOW = total organics in wastewater in inventory year, kg BOD/yr
P = country population in inventory year (person)
BOD = country-specific per capita BOD in inventory year, g/person/day
0.01 = conversion from grams BOD to kg BOD
I = Correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00

Nitrous oxides

N_2O was estimated using IPPC 2006 guidelines methods. Variable P (population) in this equation is country specific and only includes the population that is connected to the various wastewater treatment facilities. For the other emission factors, either IPCC default values or estimated values were used.

Nitrous oxide emissions from human sewage were calculated according to the IPCC default method, which is based on the annual per capita protein intake.

N_2O emissions from wastewater Effluent:

$$N_2O\ Emission = N_{EFFLUENT} \cdot EF_{EFFLUENT} \cdot 44/28$$

N_2O emissions = N_2O emissions in inventory year, kg N_2O/yr
$N_{EFFLUENT}$ = nitrogen in the effluent discharged to aquatic environments, kg N/yr
$EF_{EFFLUENT}$ = emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N
The factor 44/28 is the conversion of kg N_2O-N into kg N into N_2O

Total Nitrogen in the Effluent:

$$N_{EFFLUENT} = (P \cdot Protein \cdot F_{NPR} \cdot F_{NON-CON} \cdot F_{IND-COM}) - N_{SLUDGE}$$

$N_{EFFLUENT}$ = total annual amount of nitrogen in the wastewater effluent, kg N/yr
P = human population
Protein = annual per capita protein consumption, kg/person/yr
F_{NPR} = fraction of nitrogen in protein, default = 0.16, kg N/kg protein
$F_{NON-CON}$ = factor for non-consumed protein added to the wastewater
$F_{IND-COM}$ = factor for industrial and commercial co-discharged protein into the sewer system
N_{SLUDGE} = nitrogen removed with sludge (default = zero), kg N/yr

Activity data

The activity data used for estimation on N_2O is represented by the population portion that is connected to wastewater handling facilities and is reported in Table 8.8. The total number of population is obtained from the Statistics Iceland.

The percentage of population that is connected to wastewater handling facilities has been reported in the EFTA report to the Surveillance Authority regarding the implementation of Directive 91/271/EU on the treatment of wastewater from built-up areas.

Table 8.9: Total population and population connected to wastewater handling facilities in Iceland

	Population	Connected to wastewater facilities			
		Total	Primary treatment	Secondary treatment	Septic tanks
1990	255.708	6,0%	2,0%	0,0%	4,0%
1991	259.577	6,0%	2,0%	0,0%	6,0%
1992	262.193	6,0%	2,0%	0,0%	6,0%
1993	264.919	6,0%	2,0%	0,0%	6,0%
1994	266.783	10,0%	4,0%	0,0%	6,0%
1995	267.806	10,0%	4,0%	0,0%	6,0%
1996	269.727	10,0%	4,0,%	0,0%	6,0%
1997	272.069	10,0%	4,0%	0,0%	6,0%
1998	275.264	14,4%	8,4%	0,0%	6,0%
1999	279.049	22,4%	16,4%	0,0%	6,0%
2000	282.849	39,0%	33,0%	0,0%	6,0%
2001	286.250	39,0%	33,0%	0,0%	6,0%
2002	288.201	60,7%	48,7%	1,0%	11,0%
2003	290.490	60,7%	48,7%	1,0%	11,0%
2004	293.291	60,7%	48,7%	1,0%	11,0%
2005	299.404	67,8%	54%	2,4%	11,0%
2006	307.261	67,9%	54%	2,4%	11,0%

Emission factors

Of the total population connected to wastewater handling facilities, the largest part is connected to Primary treatment, some are connected to handling facilities such as septic (and settling) tanks, and in 2002 Secondary treatment (two step treatment) was inducted in a small scale. A different Methane corrector factor applies to these handling methods. It is expected that emissions from wastewater handling in Iceland based on the ´Check method´ used in earlier submission is overestimated. MCF used in this submission is in accordance with The IPCC 2006 guidelines default values. Annual per capita protein intake is based on Dietary Surveys of the Icelandic Nutrition Council and the Dietary Survey Unit for Nutrition Research performed in 2002 to 2003. The emission factors and parameters for IPCC Category 6B Wastewater Handing are reported in Table 8.9.

Table 8.9: Emission factors and parameters for Wastewater

Parameters	
BOD *	**60 g/person/day**
MCF_{septic}*	**0,5**
$MCF_{Primary\ treatment}$*	**0,1**
$MCF_{Secondary\ treatment}$*	**0,3**
$MCF_{Untreatet}$	**0,1**
B_o *	**0,6 kg CH_4/kg BOD**
Protein	**31,76 kg/person/year**
F_{NPR}*	**0,16kg N/kg protein**
$F_{NON\text{-}CON}$*	**1,4**
$F_{IND\text{-}COM}$*	**1,5**
N_{SLUDGE}*	**0 kg N/yr**
I*	**1,25**

* IPCC default value

Uncertainties

The uncertainties in the IPCC model for Sector 6B are regarding:

- **MCF parameter**
  Default MCF parameters for Domestic Wastewater were used. Largest part of Domestic Wastewater falls under the so called Primary treatment and is pumped out in the sea, therefore MCF = 0.1 was assumed appropriate. Wastewater going through Secondary treatment and Septic tanks were assumed to be 0.1 and 0.3 respectively according to IPCC Default MCF values.

- **$F_{IND-COM}$ parameter**
  Default IPCC values for $F_{IND-COM}$ range between 1.0-1.5. As Iceland has significant fish processing, 1.5 was set as factor to allow for co-discharge of industrial nitrogen into sewers. This factor might be higher.

8.4 Industrial Wastewater

Industrial wastewater is estimated now for the first time. Only the Fish, Dairy Products and Meat & Poultry industrial wastewater is included in this submission. The Fish processing is the dominant factor in the estimate. Scandinavian data on tones COD produced per ton for different fish groups were used to estimate wastewater handling in the Fish processing industry. For uncategorized fishing, Meat & Poultry and dairy products, default IPCC values were used.

Following equations were used to estimate Industrial wastewater.

Total CH_4 Emissions from Industrial Wastewater:

$$CH_4Emissions = \sum_i [(TOW_i - S_i)EF_i - R_i]$$

CH_4Emission = CH_4 emissions in inventory year, kg CH_4/yr
TOW_i = Total organically degradable material in wastewater from industry *I* in inventory year, kg COD/yr
i = industrial sector
S_i = organic component removed as sludge in inventory year, kg COD/yr
EF_i = Emission factor for industry *I*, kg CH_4/kg COD for treatment/discharge pathway or system(s) used in inventory year
R_i = amount of CH_4 recovered in inventory year, kg CH_4/yr

CH_4 Emission Factor for Industrial Wastewater:

$$EF_j = B_o \cdot MCF_j$$

Organically Degradable Material in Industrial Wastewater:

$$TOW_i = P_i \cdot W_i \cdot COD_i$$

TOW = total organically degradable material in wastewater for industry *I*, kg COD/yr
i = industrial sector
P_i = total industrial product for industrial sector *I*, t/yr
W_i = wastewater generated, $m^3/t_{product}$
COD_i = Chemical oxygen demand (industrial degradable organic component in wastewater) kg COD/m^3

Activity data

The activity data used for estimation on Industrial Wastewater is obtained from the Statistics Iceland, and from the Icelandic dairy association. Data on COD per ton product are available for different fish/seafood groups according to Scandinavian data. For dairy products, Meat & Poultry produce and uncategorized fish catch, the default IPCC values on water usage and COD were used. B_o is also by IPCC default. See table 8.10

Table 8.10: Emission factors and parameters for Industrial Wastewater

Parameters	
COD $_{\text{white fish}}$	**17 kg O_2/kg COD**
COD $_{\text{Herring}}$	**22 kg O_2/kg COD**
COD $_{\text{Shrimp}}$	**115 kg O_2/kg COD**
COD $_{\text{fishmeal (Capelin)}}$	**1,25 kg O_2/kg COD**
Fish processing $_{\text{uncategorised}}$*	**13 m^3/ton W, 2,5 kg/m^3 COD**
Dairy products*	**7 m^3/ton W, 2,7 kg/m^3 COD**
Meat & Poultry	**13 m^3/ton W, 4,1 kg/m^3 COD**
B_o**	**0,25 kg CH_4/kg COD**
MCF	**0,1**

* IPCC examples value, ** IPCC default value

The Fish industry is the predominant factor in Industrial wastewater handling in Iceland. The CH_4 emission from Fish industry alone was four to seven times more than from Dairy Products and Meat & Poultry produce aggregated in the period from 1995 to 2006. See figure 8.2

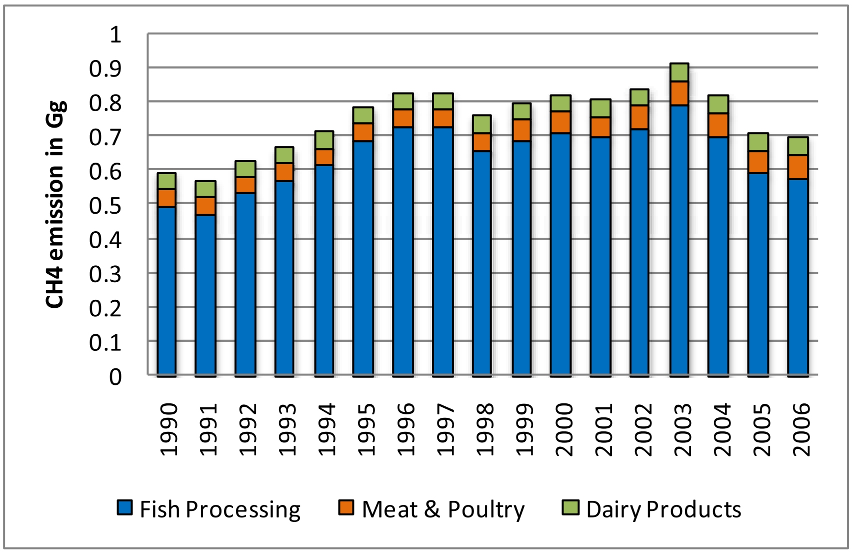

Figure 8.2 Methane emissions of industrial wastewater sections

8.5 Waste incineration

Emissions from waste incineration with energy recovery are reported in sector 1A1a (public electricity and heat production). Emissions from waste incineration have decreased by almost 90% from 1990 to 2006. This is because the total amount of waste being incinerated in Iceland has decreased while increasing levels have been incinerated with energy recovery and thus reported under 1A1a. Waste incineration without energy recovery is virtually non-existent today except from bonfires around New Year celebrations.

The methodology for calculating emissions from waste incineration is in accordance with the IPCC Guidelines. The activity data are the waste inputs into the incinerator, and the emission factor is based on the carbon content of the waste that is of fossil origin only. The burn out efficiency of the combustion is also included in the calculation. The activity data are disaggregated into different waste types (e.g. municipal solid waste, industrial waste, clinical waste and hazardous waste)

The following equation is used for calculating CO_2 emissions from waste incineration:

CO_2 Emission Estimate Based on the Total Amount of Waste Combusted:

$$CO_2 Emissions = \sum_i (SW_i \cdot dm_i \cdot CF_i \cdot FCF_i \cdot OF_i) \cdot 44/12$$

CO_2 emissions = CO_2 emissions in inventory year, Gg/yr
SW_i = total amount of solid waste of type *i* (wet weight) incinerated or open-burned, Gg/yr
dm_i = dry matter content in the waste (wet weight) incinerated or open-burned, (fraction)
CF_i = fraction of carbon in the dry matter (total carbon content), (fraction)
OF_i = oxidation factor, (fraction)
44/12 = conversion factor from C to CO_2
i = type of waste incinerated/open-burned specified as follows:
MSW: municipal solid waste, ISW: industrial solid waste, Bonfires

Activity data

Activity data on incinerated waste from major incineration plants have been collected by the EA since 2000. Historic data as well as data on open pit burning not reported to EA, was estimated with the assumptions that 500 kg of wastes have been incinerated per inhabitant in the communities where waste is known to have been incinerated (both in primitive incineration plants as well as open pit burning) in 1990, 1995 and 2000 and interpolated in the years between. These communities were mapped by EA in the respective years. The data after the year 2000 is considered rather reliable, but pre-2000 data very unreliable. When the data were viewed closer it was noted that bonfires were only partly included in the earlier years and not at all in the last years. This has been corrected in this submission.

Emission factors

Data for estimation of CO_2 from waste incineration are according to IPCC 2006 Good Practice Guidance. Values for municipal solid waste (MSW) were estimated using following equations given in the IPCC 2006 guidelines. Parameters for MSW were calculated using composition of waste according to local data on MSW. Default values for industrial waste were used according to IPCC guidelines. Parameters for bonfires are IPCC default data for wood as it is assumed that bonfires consist exclusively of timber. Values are presented in Table 8.10

Dry Matter Content in MSW:

$$dm = \sum_i (WF_i \cdot dm_i)$$

dm = total dry matter content in the MSW
WF_i = fraction of component *i* in the MSW
dm_i = dry matter content in the component *i*

Total Carbon Content in MSW:

$$CF = \sum_i (WF_i \cdot CF_i)$$

CF = Total carbon content in MSW
WF_i = fraction of component *i* in the MSW
CF_i = carbon content in the waste type/material *i* in MSW

Fossil Carbon Fraction (FCF) in MSW:

$$FCF = \sum_i (WF_i \cdot FCF_i)$$

Table 8.10 Parameters for waste incineration

Waste Stream	MSW	IW	Bonfires
Dry matter	76%	80%	85%
Total carbon content	56%	50%	50%
Fossil carbon fraction	36%	90%	0%
Oxidation factor in % of carbon input	58%	58%	58%

As IPCC guidelines do not account for open pit burning of IW/bonfires, the default oxidation factor for MSW was used. Dry matter of IW is an estimate.

REFERENCES

Ármannsson, H., Friðriksson, Þ., Kristjánsson, B. (2005). "CO2 emissions from geothermal power plants and natural geothermal activity in Iceland". Geothermics.

Arnalds, Ó., Á. L. Aradóttir, A. Snorrason, G. Gudbergsson, T. H. Jónsson and A. M. Ágústsdóttir (1999). Organic carbon sequestration by restoration of severely degraded areas in Iceland. Iceland, Agricultural Research Institute: 1-19.

Arnalds, Ó., G. Guðbergsson and J. Guðmundsson (2000). "Carbon sequestration and reclamation of severely degraded soils in Iceland." Búvísindi 13: 87-97.

Arnalds, O. and E. Gretarsson (2001). Soil Map of Iceland. 2nd edition. Reykjavík, Agricultural Research Institute.

Arnalds, Ó., E.F.Thorarinsdóttir, S. Metúsalemsson, Á. Jónsson, E. Gretarsson and A. Árnason. (2001). Soil erosion in Iceland. Reykjavík, Soil Conservation Service, Agricultural Research Institute.

Arnalds, O., A. L. Aradottir and G. Gudbergsson (2002). Organic Carbon Sequestration by Restoration of Severely Degraded Areas in Iceland. Agricultural Practices and Policies for Carbon Sequestration in Soil. R. L. J.M. Kimble, R.E. Follett, Lewis Publisher: 267-280.

EA (2002). Starfsreglur um góða búskaparhætti (Codes of good agricultural practice). Starfshópur um meðferð úrgangs frá landbúnaði: 17. http://www.ust.is/media/fraedsluefni/buskaparhaettir.pdf

EA (2004). Landsáætlun um meðhöndlun úrgangs 2004 - 2016 (National waste treatment plan 2004 - 2016). Environment Agency of Iceland: 46.

EA (2004). Report to the EFTA Surveillance Authority regarding the implementation of Directive 92/271/EU on the treatment of wastewater from built-up areas. Environmental and Food Agency of Iceland.

EA (2007). Iceland's Initial Report under the Kyoto Protocol. http://unfccc.int/files/national_reports/initial_reports_under_the_kyoto_protocol/application/msword/initial_report_-_iceland.doc

Energy in Iceland: Historic Perspective, Present Status, Future Outlook (2004). National Energy Authority and Ministries of Industry and Commerce.

External trade by HS-numbers (2006). Statistics Iceland. (available on the website: http://hagstofan.is/?PageID=1053)

Friðriksson et al (2005). "CO2 emissions and heat flow through soil, fumaroles, and steam heated mud pools at the Reykjanes geothermal area, SW Iceland". In preparation for Applied Geochemistry.

Geirsson, Ó. (1975). Framræsla ("Drainage"). Votlendi. A. Garðarsson. Reykjavík, Landvernd. 4: 143-154.
Icelandic Agricultural Statistics 2005. Icelandic Agriculture.

Icelandic Association of Farmers, Agricultural Genetic Resources Committee, and Nordic Gene Bank for Domestic Animals (2004). Icelandic Livestock Breeds, ISBN 9979-885-02

Icelandic Nutrition Council (2002). The Diet of Icelanders. Dietary Survey of the Icelandic Nutrition Council 2002. Main findings.

Inga Þórsdóttir, Ingibjörg Gunnarsdóttir (2006). The Diet of Icelandic 9- and 15-year-old children and adolescents. Dietary Survey of Unit for Nutrition Research 2002-2003.

IPCC (1997). Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 1 – 3. Intergovernmental Panel on Climate Change.

IPCC (2000). Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change.

IPCC, Ed. (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry, IGES.

IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories,. B. L. Prepared by the National Greenhouse Gas Inventories Programme. Eggleston H.S., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

Jónsson, T. H. and Ú. Óskarsson (1996). "Skógrækt og landgræðsla til að nema koltvísýring úr andrúmsloftinu. (Afforestration and soil reclamation as tool to remove carbon dioxide from atmosphere)." Ársrit Skógræktarfélags Íslands 1996: 65-87.

Kamsma & Meyles (2003). Landfill Gas Formation in Iceland. Environmental and Food Agency of Iceland: 37

Ministry for the Environment 2007. Protection and restoration of Icelandic birch forests. Ministry for the Environment, Reykjavik, 19 p.

National Energy Forecast Committee (2005). Eldsneytisnotkun Íslendinga eftir notkunarflokkum, innlend notkun. Fuel use in Iceland per type, domestic use. (Available on the committee’s website: http://orkuspa.is/eldsneyti/Innlend.PDF)

Náttúrufræðistofnun_Íslands (2005). Ársskýrsla 2005 (annual report). Reykjavík, Náttúrufræðistofnun Íslands: 42.

Óskarsson, H. (1998). Wetland draining in Western Iceland. Icelandic Wetlands: exploitation and conservation. J. S. Olafsson. Reykjavík, University of Iceland Press.: 121-129.

Óskarsson, H., O. Arnalds, J. Gudmundsson and G. Gudbergsson (2004). "Organic carbon in Icelandic Andosols: geographical variation and impact of erosion." CATENA 56(1-3): 225-238.

Óskarsson, H. and J. Guðmundsson (2008). Gróðurhúsaáhrif uppistöðulóna; Rannsóknir við Gilsárlón 2003-2006, Landsvirkjun: 142.

Óskarsson, M. and Eggertsson, M. (1991). Áburðarfræði (Fertilisers). Búnaðarfélag Íslands: 135.

Road Traffic directorate (2006). http//www.us.is

SFT, SN (2004). National Inventory Report 2004 – Norway. Norwegian Pollution Control Authority & Statistics Norway: 176.

Sigurðsson, B. D. and A. Snorrason (2000). "Carbon sequestration by afforestation and revegetation as a means of limiting net-CO2 emissions in Iceland." Biotechnol. Agron. Soc. Environ. 4(4): 303-307.

Snorrason, A. (2003a). Binding koldíoxíðs samfara nýskógrækt á Íslandi á árunum 1990-2000. Reykjavík, Rannsóknastöð Skógræktar ríkisins Mógilsá: 8.

Snorrason, A., B.D. Sigurðsson, G. Guðbergsson, K.Svavarsdóttir ,and Þ.J.Jónsson (2003b). "Carbon sequestration in forest plantations in Iceland." Búvísindi (Icel. Agr. Sci.) 15(02): 81-93.

Snorrason, A. and B. Kjartansson. (2004). "Íslensk skógarúttekt. Verkefni um landssúttekt á skóglendum á Íslandi. Kynning og fyrstu niðurstöður. (Islandic National Inventory. Project on inventory of forests in Iceland. Presentation and First Results)." Skógræktarritið(2): 101-108 (In Icelandic).

Snorrason A, Harðardóttir VB and Kjartansson BÞ 2007. Staða úttekta á birkiskógum Íslands. [Status on surveys of the natural birch woodlands in Iceland.].
Rit Fræðaþings Landbúnaðarins 2007. pp. 572-574. ISSN 1670-7230. [In Icelandic].

Statistical Yearbook of Iceland, 2006 (Statistics Iceland).

Traustason, B. and A. Snorrason (2008). Stærð Skóglendis á Íslandi byggt á CORINE flokkun. Fræðaþing Landbúnaðarins 2008, Reykjavík.

UNFCCC secretariat (2004). “Report of the individual review of the greenhouse gas inventory of Iceland submitted in the year 2004 (in-country review). FCCC/WEB/IRI/2004/ISL (available on the secretariat web site http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/iceland_final_report_to_web.pdf)

UNFCCC secretariat. "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories" (available on the secretariat web site http://unfccc.int/resource/docs/cop5/07.pdf)

U.S. Department of Energy and the U.S. Environmental Protection Agency (2000). "Carbon Dioxide Emissions from the Generation of Electric Power in the United States" http://tonto.eia.doe.gov/ftproot/environment/co2emiss00.pdf

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3929.php. Revised National Inventory Report 2007, Norway.

http://unfccc.int/resource/docs/2008/irr/isl.pdf. Report of the Review of the Initial Report of Iceland

ANNEX I: KEY SOURCES

According to the IPCC definition, key sources are those that add up to 90% of the total uncertainty in level and/or in trend. In the Icelandic Emission Inventory key source categories are identified by means of Tier 1 method.

A key source analysis was prepared for this round of reporting. Table 1.1 in Chapter 1 lists identified key sources. Table A1 shows the level assessment of the key source analysis for 2006, Table A2 the level assessment of the key source analysis for 1990 and Table A3 the trend assessment of the key source analysis.

Table A1. Key source analysis – level assessment 2006

		1990	2006	Level assessment	Cumulative total
Mobile combustion: Road vehicles	CO_2	509,0	859,4	0,21	0,21
Mobile Combustion: Fishing	CO_2	655,5	549,4	0,13	0,34
CO_2 emissions from aluminium production	CO_2	136,5	506,9	0,12	0,47
CO_2 emissions from ferroalloys production	CO_2	203,5	368,6	0,09	0,56
PFC emissions from aluminium production	PFC	419,6	506,9	0,12	0,64
CH_4 emissions from enteric fermentation in domestic livestock	CH_4	270,3	236,4	0,06	0,70
Mobile combustion: Construction	CO_2	120,7	194,9	0,05	0,74
CH_4 emissions from solid waste disposal sites	CH_4	138,0	181,2	0,04	0,79
CO_2 emissions from stationary combustion, oil	CO_2	237,0	160,8	0,04	0,83
CO_2 emissions from geothermal energy	CO_2	66,6	156,5	0,04	0,87
Direct N_2O emissions from agricultural soils	N_2O	143,2	132,7	0,03	0,90
Indirect N_2O emissions from Nitrogen used in agriculture	N_2O	100,8	93,2	0,02	0,92
Emissions from Substitutes for Ozone Depleting Substances	HFC	NO	64,1	0,02	0,94
CO_2 emissions from Cement Production	CO_2	51,6	61,0	0,02	0,95

Table A2. Key source analysis – level assessment 1990

		1990	Level assessment	Cumulative total
Mobile Combustion: Fishing	CO_2	655,5	0,21	0,21
Mobile combustion: Road vehicles	CO_2	509,0	0,16	0,37
PFC emissions from aluminium production	PFC	419,6	0,13	0,50
CH_4 emissions from enteric fermentation in domestic livestock	CH_4	270,3	0,08	0,58
CO_2 emissions from stationary combustion, oil	CO_2	237,0	0,07	0,66
CO_2 emissions from ferroalloys production	CO_2	203,5	0,06	0,72
Direct N_2O emissions from agricultural soils	N_2O	143,2	0,04	0,76
CO_2 emissions from aluminium production	CO_2	136,5	0,04	0,81
CH_4 emissions from solid waste disposal sites	CH_4	138,0	0,04	0,85
Mobile combustion: Construction	CO_2	120,7	0,04	0,89
Indirect N_2O emissions from Nitrogen used in agriculture	N_2O	100,8	0,03	0,92
CO_2 emissions from Cement Production	CO_2	51,6	0,02	0,94
CO_2 emissions stationary combustion, coal	CO_2	48,3	0,02	0,95

Table A3. Key source analysis – trend assessment

		1990	2006	Level assessment	Trend assessment	Contribution to trend	Cumulative total
CO_2 emissions from aluminium production	CO_2	136,5	408,7	0,12	0,064	0,189	0,19
Mobile combustion: Fishing	CO_2	655,5	549,4	0,13	0,054	0,160	0,35
Mobile combustion: Road vehicles	CO_2	509,0	859,4	0,21	0,041	0,121	0,47
PFC emissions from aluminium production	PFC	419,6	333,2	0,08	0,038	0,113	0,58
CO_2 emissions from stationary combustion, oil	CO_2	237,0	160,8	0,04	0,027	0,079	0,66
CO_2 emissions from ferroalloys production	CO_2	203,5	368,6	0,09	0,021	0,063	0,72
CH_4 emissions from enteric fermentation in domestic livestock	CH_4	270,3	264,4	0,06	0,015	0,045	0,77
CO_2 emissions from geothermal energy	CO_2	66,6	160,8	0,04	0,015	0,043	0,81
Emissions from Substitutes for Ozone Depleting Substances	HFC	NO	76,7	0,02	0,012	0,036	0,85
Direct N_2O emissions from agricultural soils	N_2O	143,2	132,7	0,03	0,009	0,028	0,88
Mobile combustion: Construction	CO_2	120,7	194,9	0,05	0,008	0,024	0,90
Indirect N_2O emissions from Nitrogen used in agriculture	N_2O	100,8	93,2	0,02	0,007	0,020	0,92
Mobile combustion: Road vehicles	N_2O	4,4	38,5	0,01	0,006	0,019	0,94
CO_2 emissions from stationary combustion, coal	CO_2	48,3	35,3	0,01	0,005	0,015	0,95

ANNEX II QUANTITATIVE UNCERTAINTY

Input Data						Uncertainty of Emissions		Uncertainty of Tre		
IPCC Source Category	Gas	Base year emissions (1990)	Year t emissions (2006)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combine uncertainty as % of total national emissions in year 2005	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF unc.
		Gg CO_2 equivalents		%	%	%	%	%	%	%
1.A.3.b Transport - Road Transportation	CO_2	509,02	859,36	10,0	5,0	11,18	2,27	0,067	0,252	0,33
Mobile Combustion - Construction industry	CO_2	120,67	194,87	10,0	5,0	11,18	0,51	0,013	0,057	0,07
Mobile Combustion - Fishing	CO_2	655,49	549,44	2,0	5,0	5,39	0,70	-0,078	0,161	-0,39
Stationary Combustion - Oil	CO_2	237,00	134,47	5,0	5,0	7,07	0,22	-0,047	0,039	-0,23
Stationary Combustion - Coal	CO_2	48,27	35,31	5,0	10,0	11,18	0,09	-0,007	0,010	-0,07
2.A.1 Cement Production	CO_2	51,56	61,05		6,5	6,50	0,09	-0,001	0,018	-0,01
2.C.2 Ferroalloys Production	CO_2	203,47	368,56	5,0	10,0	11,18	0,97	0,034	0,108	0,34
2.C.3 Aluminium Production	CO_2	136,49	506,87	5,0	10,0	11,18	1,34	0,099	0,149	0,99
4.A Enteric Fermentation	CH_4	270,30	236,43	20,0	50,0	53,85	3,01	-0,029	0,069	-1,46
6.A Solid Waste Disposal on Land	CH_4	137,97	181,19	15,0	50,0	52,20	2,23	0,003	0,053	0,14
1.A.3.b Transport - Road Transportation	N_2O	4,39	38,49	50,0	200,0	206,16	1,87	0,010	0,011	1,94
Direct emissions from agricultural soil	N_2O	142,15	132,74	20,0	100,0	101,98	3,20	-0,013	0,039	-1,29
Indirect emissions from Nitrogen used in agriculture	N_2O	99,79	93,17	20,0	100,0	101,98	2,24	-0,009	0,027	-0,90
2.C.3 Aluminium Production										
CF4	PFC	355,02	281,92	5,0	7,0	8,60	0,57	-0,047	0,083	-0,33
C2F6	PFC	64,61	51,30	5,0	22,0	22,56	0,27	-0,008	0,015	-0,19
Substitutes for Ozone Depleting Substances	HFC	0,00	64,06		100,0	100,00	1,51	0,019	0,019	1,88
Other non-key source emissions	All	372,56	445,02		30,0	30,00	3,15	-0,005	0,131	-0,16
Total emissions (all sources):		**3.408,77**	**4.234,23**			**Total H :**	**7,4**	**Level Uncertainty**		

ANNEX III CRF SUMMARY 2 FOR 1990 TO 2006

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**3 310.17**	**458.02**	**691.26**	**NA,NE,NO**	**419.63**	**5.38**	**4 884.46**
1. Energy	**1 740.15**	**4.68**	**26.71**				**1 771.54**
A. Fuel Combustion (Sectoral Approach)	1 673.52	4.68	26.71				1 704.91
1. Energy Industries	20.70	0.02	0.04				20.76
2. Manufacturing Industries and Construction	361.05	0.25	15.92				377.22
3. Transport	600.13	3.08	5.16				608.38
4. Other Sectors	691.52	1.33	5.59				698.44
5. Other	0.12	0.00	0.00				0.12
B. Fugitive Emissions from Fuels	66.63	NA,NE,NO	NA,NO				66.63
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	66.63	NE,NO	NA,NO				66.63
2. Industrial Processes	**392.66**	**0.61**	**48.36**	**NA,NE,NO**	**419.63**	**5.38**	**866.64**
A. Mineral Products	52.34	NE,NO	NE,NO				52.34
B. Chemical Industry	0.36	NE,NO	48.36	NA	NA	NA	48.72
C. Metal Production	339.96	0.61	NA	NA	419.63	NA,NO	760.20
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				NA,NE,NO	NA,NE,NO	5.38	5.38
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**7.94**		**6.00**				**13.94**
4. Agriculture		**294.15**	**278.72**				**572.87**
A. Enteric Fermentation		270.34					270.34
B. Manure Management		23.80	34.67				58.47
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	244.05				244.05
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	**1 150.22**	**1.81**	**323.65**				**1 475.69**
A. Forest Land	-32.88	NE,NO	0.28				-32.60
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 478.11	NE	NE				1 478.11
D. Wetlands	2.11	1.81	NA,NO				3.92
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-297.11	NA,NE,NO	323.37				26.27
6. Waste	**19.19**	**156.77**	**7.82**				**183.78**
A. Solid Waste Disposal on Land	NA,NE,NO	137.97					137.97
B. Waste-water Handling		13.64	6.65				20.29
C. Waste Incineration	19.19	5.16	1.17				25.53
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [(4)]							
International Bunkers	318.65	0.23	2.76				321.64
Aviation	219.65	0.03	1.92				221.61
Marine	99.00	0.20	0.84				100.03
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 408.77
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 884.46

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1991
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**3 225.01**	**460.25**	**680.90**	**NA,NE,NO**	**348.34**	**5.38**	**4 719.87**
1. Energy	**1 694.99**	**4.81**	**26.14**				**1 725.94**
A. Fuel Combustion (Sectoral Approach)	1 628.35	4.81	26.14				1 659.31
1. Energy Industries	22.28	0.02	0.04				22.33
2. Manufacturing Industries and Construction	285.42	0.21	15.08				300.70
3. Transport	611.43	3.22	5.29				619.94
4. Other Sectors	709.10	1.36	5.73				716.19
5. Other	0.14	0.00	0.00				0.14
B. Fugitive Emissions from Fuels	66.63	NA,NE,NO	NA,NO				66.63
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	66.63	NE,NO	NA,NO				66.63
2. Industrial Processes	**359.37**	**0.50**	**46.81**	**NA,NE,NO**	**348.34**	**5.38**	**760.40**
A. Mineral Products	48.71	NE,NO	NE,NO				48.71
B. Chemical Industry	0.31	NE,NO	46.81	NA	NA	NA	47.12
C. Metal Production	310.34	0.50	NA	NA	348.34	NA,NO	659.19
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 (2)				NA,NE,NO	NA,NE,NO	5.38	5.38
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**11.29**		**4.87**				**16.16**
4. Agriculture		**287.96**	**271.17**				**559.12**
A. Enteric Fermentation		264.36					264.36
B. Manure Management		23.60	33.28				56.88
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils (3)		NA,NE	237.89				237.89
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry (1)	**1 140.33**	**6.53**	**324.00**				**1 470.85**
A. Forest Land	-38.65	NE,NO	0.34				-38.31
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 477.52	NE	NE				1 477.52
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-306.16	NA,NE,NO	323.66				17.50
6. Waste	**19.04**	**160.45**	**7.91**				**187.40**
A. Solid Waste Disposal on Land	NA,NE,NO	141.99					141.99
B. Waste-water Handling		13.34	6.75				20.08
C. Waste Incineration	19.04	5.12	1.16				25.33
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: (4)							
International Bunkers	259.64	0.11	2.26				262.01
Aviation	221.99	0.03	1.94				223.96
Marine	37.65	0.08	0.32				38.05
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 249.02
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 719.87

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1992
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**3 331.71**	**456.90**	**658.79**	**0.47**	**155.28**	**5.38**	**4 608.53**
1. Energy	**1 819.99**	**5.04**	**25.84**				**1 850.88**
A. Fuel Combustion (Sectoral Approach)	1 753.36	5.04	25.84				1 784.25
1. Energy Industries	21.29	0.02	0.04				21.35
2. Manufacturing Industries and Construction	338.63	0.24	14.15				353.02
3. Transport	621.54	3.30	5.38				630.22
4. Other Sectors	771.12	1.49	6.27				778.87
5. Other	0.78	0.00	0.00				0.78
B. Fugitive Emissions from Fuels	66.63	NA,NE,NO	NA,NO				66.63
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	66.63	NE,NO	NA,NO				66.63
2. Industrial Processes	**362.43**	**0.52**	**41.85**	**0.47**	**155.28**	**5.38**	**565.92**
A. Mineral Products	45.74	NE,NO	NE,NO				45.74
B. Chemical Industry	0.25	NE,NO	41.85	NA	NA	NA	42.10
C. Metal Production	316.43	0.52	NA	NA	155.28	NA,NO	472.23
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				0.47	NA,NE,NO	5.38	5.85
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**9.94**		**4.77**				**14.71**
4. Agriculture		**279.18**	**254.68**				**533.86**
A. Enteric Fermentation		256.20					256.20
B. Manure Management		22.98	31.79				54.77
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	222.89				222.89
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**1 120.83**	**6.53**	**323.69**				**1 451.05**
A. Forest Land	-45.37	NE,NO	0.40				-44.96
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 476.82	NE	NE				1 476.82
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-318.23	NA,NE,NO	323.29				5.05
6. Waste	**18.53**	**165.63**	**7.95**				**192.11**
A. Solid Waste Disposal on Land	NA,NE,NO	146.03					146.03
B. Waste-water Handling		14.60	6.82				21.41
C. Waste Incineration	18.53	5.00	1.14				24.66
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	263.56	0.15	2.29				266.00
Aviation	203.62	0.03	1.78				205.43
Marine	59.95	0.12	0.51				60.57
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 157.48
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 608.53

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS **Inventory 1993**

(Sheet 1 of 1) **Submission 2008 v1.1**

ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**3 420.83**	**458.93**	**667.73**	**1.56**	**74.86**	**5.38**	**4 629.29**
1. Energy	**1 880.59**	**5.12**	**27.34**				**1 913.06**
A. Fuel Combustion (Sectoral Approach)	1 813.96	5.12	27.34				1 846.43
1. Energy Industries	24.08	0.03	0.14				24.26
2. Manufacturing Industries and Construction	365.40	0.26	15.28				380.93
3. Transport	622.17	3.28	5.39				630.84
4. Other Sectors	800.90	1.55	6.53				808.98
5. Other	1.42	0.00	0.00				1.42
B. Fugitive Emissions from Fuels	66.63	NA,NE,NO	NA,NO				66.63
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	66.63	NE,NO	NA,NO				66.63
2. Industrial Processes	**409.86**	**0.60**	**44.02**	**1.56**	**74.86**	**5.38**	**536.28**
A. Mineral Products	39.73	NE,NO	NE,NO				39.73
B. Chemical Industry	0.24	NE,NO	44.02	NA	NA	NA	44.26
C. Metal Production	369.89	0.60	NA	NA	74.86	NA,NO	445.35
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				1.56	NA,NE,NO	5.38	6.94
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**8.50**		**4.71**				**13.21**
4. Agriculture		**277.44**	**261.12**				**538.55**
A. Enteric Fermentation		254.65					254.65
B. Manure Management		22.78	31.86				54.64
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	229.26				229.26
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	**1 106.11**	**6.53**	**322.64**				**1 435.27**
A. Forest Land	-51.66	NE,NO	0.47				-51.20
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 476.05	NE	NE				1 476.05
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-325.89	NA,NE,NO	322.17				-3.72
6. Waste	**15.77**	**169.25**	**7.90**				**192.92**
A. Solid Waste Disposal on Land	NA,NE,NO	149.40					149.40
B. Waste-water Handling		15.37	6.89				22.26
C. Waste Incineration	15.77	4.48	1.02				21.27
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Memo Items: [(4)]							
International Bunkers	293.02	0.22	2.54				295.78
Aviation	195.64	0.03	1.71				197.38
Marine	97.38	0.19	0.82				98.40
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 194.02
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 629.29

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS **(Sheet 1 of 1)**

Inventory 1994
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**3 365.83**	**464.16**	**672.57**	**3.12**	**44.57**	**5.38**	**4 555.62**
1. Energy	**1 843.02**	**5.11**	**27.49**				**1 875.62**
A. Fuel Combustion (Sectoral Approach)	1 776.39	5.11	27.49				1 808.98
1. Energy Industries	23.95	0.03	0.14				24.12
2. Manufacturing Industries and Construction	344.24	0.25	15.50				359.99
3. Transport	624.79	3.31	5.42				633.52
4. Other Sectors	783.32	1.51	6.42				791.25
5. Other	0.10	0.00	0.00				0.10
B. Fugitive Emissions from Fuels	66.63	NA,NE,NO	NA,NO				66.63
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	66.63	NE,NO	NA,NO				66.63
2. Industrial Processes	**410.71**	**0.57**	**44.33**	**3.12**	**44.57**	**5.38**	**508.68**
A. Mineral Products	37.45	NE,NO	NE,NO				37.45
B. Chemical Industry	0.35	NE,NO	44.33	NA	NA	NA	44.68
C. Metal Production	372.91	0.57	NA	NA	44.57	NA,NO	418.05
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				3.12	NA,NE,NO	5.38	8.50
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**10.02**		**3.88**				**13.89**
4. Agriculture		**279.04**	**266.59**				**545.63**
A. Enteric Fermentation		256.28					256.28
B. Manure Management		22.76	32.17				54.93
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	234.42				234.42
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	**1 087.54**	**6.53**	**322.41**				**1 416.47**
A. Forest Land	-57.93	NE,NO	0.53				-57.41
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 475.28	NE	NE				1 475.28
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-337.42	NA,NE,NO	321.88				-15.54
6. Waste	**14.54**	**172.91**	**7.88**				**195.34**
A. Solid Waste Disposal on Land	NA,NE,NO	152.35					152.35
B. Waste-water Handling		16.38	6.93				23.32
C. Waste Incineration	14.54	4.18	0.95				19.67
D. Other	NA	NA	NA				NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [(4)]							
International Bunkers	307.10	0.22	2.66				309.98
Aviation	213.62	0.03	1.87				215.52
Marine	93.49	0.19	0.79				94.46
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 139.15
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 555.62

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1995
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**3 377.31**	**459.44**	**669.36**	**25.01**	**58.84**	**5.38**	**4 595.34**
1. Energy	**1 861.61**	**4.60**	**37.83**				**1 904.05**
A. Fuel Combustion (Sectoral Approach)	1 779.93	4.60	37.83				1 822.37
1. Energy Industries	26.76	0.04	0.17				26.98
2. Manufacturing Industries and Construction	358.05	0.27	19.29				377.62
3. Transport	600.44	2.75	11.85				615.04
4. Other Sectors	793.06	1.54	6.51				801.11
5. Other	1.62	0.00	0.00				1.62
B. Fugitive Emissions from Fuels	81.68	NA,NE,NO	NA,NO				81.68
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	81.68	NE,NO	NA,NO				81.68
2. Industrial Processes	**427.14**	**0.59**	**42.16**	**25.01**	**58.84**	**5.38**	**559.12**
A. Mineral Products	37.96	NE,NO	NE,NO				37.96
B. Chemical Industry	0.46	NE,NO	42.16	NA	NA	NA	42.62
C. Metal Production	388.72	0.59	NA	NA	58.84	NA,NO	448.16
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				25.01	NA,NE,NO	5.38	30.38
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**9.38**		**4.71**				**14.09**
4. Agriculture		**270.51**	**253.86**				**524.38**
A. Enteric Fermentation		247.82					247.82
B. Manure Management		22.70	29.71				52.40
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	224.15				224.15
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**1 066.36**	**6.53**	**322.98**				**1 395.86**
A. Forest Land	-63.27	NE,NO	0.56				-62.71
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 474.59	NE	NE				1 474.59
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-352.57	NA,NE,NO	322.42				-30.15
6. Waste	**12.82**	**177.21**	**7.82**				**197.85**
A. Solid Waste Disposal on Land	NA,NE,NO	155.56					155.56
B. Waste-water Handling		17.88	6.96				24.84
C. Waste Incineration	12.82	3.77	0.86				17.44
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA	NA

Memo Items: [4]							
International Bunkers	380.15	0.32	3.28				383.76
Aviation	236.15	0.04	2.07				238.25
Marine	144.00	0.29	1.21				145.50
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 199.48
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 595.34

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1996
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	3 449.03	466.61	688.33	28.56	25.15	5.38	4 663.05
1. Energy	1 953.32	4.77	37.80				1 995.90
A. Fuel Combustion (Sectoral Approach)	1 871.14	4.77	37.80				1 913.72
1. Energy Industries	22.74	0.05	0.20				22.98
2. Manufacturing Industries and Construction	398.89	0.30	18.79				417.97
3. Transport	590.81	2.77	11.79				605.37
4. Other Sectors	858.33	1.66	7.03				867.01
5. Other	0.38	0.00	0.00				0.38
B. Fugitive Emissions from Fuels	82.18	NA,NE,NO	NA,NO				82.18
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	82.18	NE,NO	NA,NO				82.18
2. Industrial Processes	426.21	0.57	49.29	28.56	25.15	5.38	535.15
A. Mineral Products	41.87	NE,NO	NE,NO				41.87
B. Chemical Industry	0.40	NE,NO	49.29	NA	NA	NA	49.69
C. Metal Production	383.94	0.57	NA	NA	25.15	NA,NO	409.66
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				28.56	NA,NE,NO	5.38	33.93
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	9.00		4.71				13.71
4. Agriculture		273.05	266.04				539.10
A. Enteric Fermentation		250.20					250.20
B. Manure Management		22.85	30.69				53.54
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	235.35				235.35
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	1 049.01	7.90	322.68				1 379.60
A. Forest Land	-68.53	NE,NO	0.62				-67.91
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 473.93	NE	NE				1 473.93
D. Wetlands	9.22	7.90	NA,NO				17.13
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-365.61	NA,NE,NO	322.06				-43.54
6. Waste	11.49	180.31	7.79				199.60
A. Solid Waste Disposal on Land	NA,NE,NO	158.07					158.07
B. Waste-water Handling		18.80	7.01				25.81
C. Waste Incineration	11.49	3.44	0.78				15.72
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA	NA

Memo Items: [4]							
International Bunkers	395.45	0.29	3.42				399.17
Aviation	271.51	0.04	2.38				273.93
Marine	123.95	0.25	1.04				125.24
Multilateral Operations	NO	NO	NO				NO
CO_2 Emissions from Biomass	NA,NO						NA,NO

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 283.45
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 663.05

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1997
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**3 521.91**	**470.13**	**686.93**	**37.46**	**82.36**	**5.38**	**4 804.16**
1. Energy	**1 989.59**	**4.30**	**48.49**				**2 042.38**
A. Fuel Combustion (Sectoral Approach)	1 918.21	4.30	48.49				1 971.00
1. Energy Industries	18.01	0.04	0.19				18.25
2. Manufacturing Industries and Construction	467.81	0.35	22.64				490.80
3. Transport	602.47	2.29	18.80				623.57
4. Other Sectors	829.89	1.62	6.85				838.36
5. Other	0.03	0.00	0.00				0.03
B. Fugitive Emissions from Fuels	71.38	NA,NE,NO	NA,NO				71.38
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	71.38	NE,NO	NA,NO				71.38
2. Industrial Processes	**484.91**	**0.60**	**41.11**	**37.46**	**82.36**	**5.38**	**651.81**
A. Mineral Products	46.64	NE,NO	NE,NO				46.64
B. Chemical Industry	0.44	NE,NO	41.11	NA	NA	NA	41.54
C. Metal Production	437.83	0.60	NA	NA	82.36	NA,NO	520.79
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				37.46	NA,NE,NO	5.38	42.84
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**8.06**		**4.71**				**12.77**
4. Agriculture		**276.42**	**261.71**				**538.13**
A. Enteric Fermentation		253.53					253.53
B. Manure Management		22.89	31.00				53.89
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	230.71				230.71
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	**1 028.28**	**7.90**	**323.08**				**1 359.26**
A. Forest Land	-73.44	NE,NO	0.62				-72.82
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 473.30	NE	NE				1 473.30
D. Wetlands	9.22	7.90	NA,NO				17.13
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-380.81	NA,NE,NO	322.46				-58.36
6. Waste	**11.07**	**180.90**	**7.83**				**199.81**
A. Solid Waste Disposal on Land	NA,NE,NO	158.74					158.74
B. Waste-water Handling		18.81	7.07				25.89
C. Waste Incineration	11.07	3.34	0.76				15.18
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [(4)]	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
International Bunkers	440.80	0.34	3.81				444.95
Aviation	292.12	0.04	2.56				294.72
Marine	148.68	0.30	1.25				150.23
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 444.90
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 804.16

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1998
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**3 506.92**	**472.20**	**683.92**	**63.90**	**180.13**	**5.38**	**4 912.45**
1. Energy	**1 974.15**	**4.29**	**48.91**				**2 027.35**
A. Fuel Combustion (Sectoral Approach)	1 880.07	4.29	48.91				1 933.27
1. Energy Industries	40.38	0.07	0.25				40.69
2. Manufacturing Industries and Construction	441.43	0.33	22.88				464.64
3. Transport	605.24	2.33	19.19				626.77
4. Other Sectors	788.06	1.56	6.58				796.20
5. Other	4.95	0.00	0.01				4.96
B. Fugitive Emissions from Fuels	94.08	NA,NE,NO	NA,NO				94.08
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	94.08	NE,NO	NA,NO				94.08
2. Industrial Processes	**512.73**	**0.44**	**35.84**	**63.90**	**180.13**	**5.38**	**798.42**
A. Mineral Products	54.49	NE,NO	NE,NO				54.49
B. Chemical Industry	0.40	NE,NO	35.84	NA	NA	NA	36.23
C. Metal Production	457.84	0.44	NA	NA	180.13	NA,NO	638.41
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				63.90	NA,NE,NO	5.38	69.28
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**8.09**		**4.96**				**13.05**
4. Agriculture		**279.69**	**262.75**				**542.44**
A. Enteric Fermentation		256.52					256.52
B. Manure Management		23.17	31.09				54.26
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	231.66				231.66
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	**1 002.57**	**7.97**	**323.61**				**1 334.15**
A. Forest Land	-78.94	NE,NO	0.68				-78.25
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 472.75	NE	NE				1 472.75
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-400.55	NA,NE,NO	322.93				-77.62
6. Waste	**9.38**	**179.80**	**7.85**				**197.04**
A. Solid Waste Disposal on Land	NA,NE,NO	159.29					159.29
B. Waste-water Handling		17.44	7.15				24.59
C. Waste Incineration	9.38	3.07	0.70				13.16
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [(4)]							
International Bunkers	514.67	0.40	4.44				519.51
Aviation	338.13	0.05	2.96				341.14
Marine	176.54	0.35	1.48				178.37
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 578.30
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 912.45

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1999
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	3 681.95	470.99	702.92	59.40	173.21	5.38	5 093.85
1. Energy	2 032.47	3.66	60.34				2 096.47
A. Fuel Combustion (Sectoral Approach)	1 909.51	3.66	60.34				1 973.51
1. Energy Industries	23.44	0.05	0.21				23.70
2. Manufacturing Industries and Construction	466.69	0.35	25.03				492.08
3. Transport	626.84	1.72	28.58				657.14
4. Other Sectors	788.18	1.54	6.51				796.22
5. Other	4.36	0.00	0.01				4.37
B. Fugitive Emissions from Fuels	122.96	NA,NE,NO	NA,NO				122.96
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	122.96	NE,NO	NA,NO				122.96
2. Industrial Processes	659.07	0.67	36.18	59.40	173.21	5.38	933.91
A. Mineral Products	61.52	NE,NO	NE,NO				61.52
B. Chemical Industry	0.43	NE,NO	36.18	NA	NA	NA	36.61
C. Metal Production	597.12	0.67	NA	NA	173.21	NA,NO	771.00
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				59.40	NA,NE,NO	5.38	64.78
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	8.99		4.68				13.67
4. Agriculture		276.93	270.57				547.50
A. Enteric Fermentation		254.20					254.20
B. Manure Management		22.74	30.54				53.28
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	240.02				240.02
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	973.74	7.97	323.30				1 305.01
A. Forest Land	-85.59	NE,NO	0.78				-84.81
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 472.09	NE	NE				1 472.09
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-422.06	NA,NE,NO	322.52				-99.54
6. Waste	7.67	181.75	7.86				197.28
A. Solid Waste Disposal on Land	NA,NE,NO	160.86					160.86
B. Waste-water Handling		18.23	7.25				25.48
C. Waste Incineration	7.67	2.66	0.60				10.94
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA	NA

Memo Items: [(4)]							
International Bunkers	527.25	0.38	4.57				532.20
Aviation	363.37	0.05	3.18				366.61
Marine	163.88	0.33	1.38				165.59
Multilateral Operations	NO	NO	NO				NO
CO_2 Emissions from Biomass	NA,NO						NA,NO

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 788.83
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5 093.85

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS **Inventory 2000**

(Sheet 1 of 1) **Submission 2008 v1.1**

ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**3 707.47**	**462.29**	**678.56**	**32.28**	**127.16**	**5.38**	**5 013.14**
1. Energy	**1 975.23**	**3.53**	**60.13**				**2 038.89**
A. Fuel Combustion (Sectoral Approach)	1 811.75	3.53	60.13				1 875.41
1. Energy Industries	17.21	0.05	0.20				17.45
2. Manufacturing Industries and Construction	419.46	0.33	25.49				445.28
3. Transport	629.42	1.71	28.32				659.45
4. Other Sectors	741.05	1.44	6.11				748.61
5. Other	4.61	0.00	0.01				4.62
B. Fugitive Emissions from Fuels	163.48	NA,NE,NO	NA,NO				163.48
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	163.48	NE,NO	NA,NO				163.48
2. Industrial Processes	**765.57**	**0.93**	**18.63**	**32.28**	**127.16**	**5.38**	**949.96**
A. Mineral Products	65.57	NE,NO	NE,NO				65.57
B. Chemical Industry	0.41	NE,NO	18.63	NA	NA	NA	19.04
C. Metal Production	699.60	0.93	NA	NA	127.16	NA,NO	827.70
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				32.28	NA,NE,NO	5.38	37.66
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**10.36**		**4.53**				**14.89**
4. Agriculture		**265.30**	**264.46**				**529.76**
A. Enteric Fermentation		243.14					243.14
B. Manure Management		22.16	28.55				50.71
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	235.91				235.91
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	**949.10**	**7.97**	**322.88**				**1 279.95**
A. Forest Land	-91.30	NE,NO	0.81				-90.49
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 471.32	NE	NE				1 471.32
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-440.23	NA,NE,NO	322.07				-118.16
6. Waste	**7.21**	**184.55**	**7.93**				**199.70**
A. Solid Waste Disposal on Land	NA,NE,NO	163.26					163.26
B. Waste-water Handling		18.74	7.35				26.09
C. Waste Incineration	7.21	2.55	0.58				10.34
D. Other	NA	NA	NA				NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [(4)]							
International Bunkers	626.29	0.50	5.41				632.20
Aviation	407.74	0.06	3.57				411.37
Marine	218.55	0.44	1.84				220.82
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 733.20
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5 013.14

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2001
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**3 693.62**	**466.37**	**671.92**	**53.78**	**91.66**	**5.38**	**4 982.73**
1. Energy	**1 939.24**	**3.42**	**59.27**				**2 001.93**
A. Fuel Combustion (Sectoral Approach)	1 784.76	3.42	59.27				1 847.45
1. Energy Industries	17.34	0.04	0.20				17.58
2. Manufacturing Industries and Construction	451.59	0.34	25.03				476.96
3. Transport	640.06	1.74	28.58				670.37
4. Other Sectors	656.26	1.28	5.42				662.95
5. Other	19.53	0.01	0.05				19.59
B. Fugitive Emissions from Fuels	154.48	NA,NE,NO	NA,NO				154.48
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	154.48	NE,NO	NA,NO				154.48
2. Industrial Processes	**803.55**	**0.90**	**16.15**	**53.78**	**91.66**	**5.38**	**971.41**
A. Mineral Products	58.77	NE,NO	NE,NO				58.77
B. Chemical Industry	0.49	NE,NO	16.15	NA	NA	NA	16.64
C. Metal Production	744.28	0.90	NA	NA	91.66	NA,NO	836.84
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				53.78	NA,NE,NO	5.38	59.16
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**12.66**		**4.03**				**16.69**
4. Agriculture		**264.49**	**261.54**				**526.03**
A. Enteric Fermentation		242.41					242.41
B. Manure Management		22.08	28.42				50.50
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	233.12				233.12
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**931.48**	**7.97**	**322.94**				**1 262.39**
A. Forest Land	-97.10	NE,NO	0.87				-96.23
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 470.59	NE	NE				1 470.59
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-451.32	NA,NE,NO	322.08				-129.24
6. Waste	**6.69**	**189.60**	**7.99**				**204.28**
A. Solid Waste Disposal on Land	NA,NE,NO	168.69					168.69
B. Waste-water Handling		18.48	7.44				25.92
C. Waste Incineration	6.69	2.43	0.55				9.67
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	498.17	0.35	4.32				502.83
Aviation	349.13	0.05	3.06				352.24
Marine	149.04	0.30	1.26				150.60
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 720.34
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 982.73

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**3 764.34**	**452.10**	**638.10**	**35.16**	**72.54**	**5.38**	**4 967.62**
1. Energy	**2 016.29**	**3.57**	**58.54**				**2 078.39**
A. Fuel Combustion (Sectoral Approach)	1 856.94	3.57	58.54				1 919.04
1. Energy Industries	17.92	0.05	0.20				18.16
2. Manufacturing Industries and Construction	452.83	0.34	23.47				476.64
3. Transport	643.65	1.75	28.84				674.24
4. Other Sectors	720.24	1.41	5.98				727.63
5. Other	22.30	0.01	0.05				22.37
B. Fugitive Emissions from Fuels	159.35	NA,NE,NO	NA,NO				159.35
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	159.35	NE,NO	NA,NO				159.35
2. Industrial Processes	**822.27**	**0.96**	**NA,NE,NO**	**35.16**	**72.54**	**5.38**	**936.31**
A. Mineral Products	40.56	NE,NO	NE,NO				40.56
B. Chemical Industry	0.45	NE,NO	NE,NO	NA	NA	NA	0.45
C. Metal Production	781.25	0.96	NA	NA	72.54	NA,NO	854.75
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				35.16	NA,NE,NO	5.38	40.54
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**8.92**		**4.03**				**12.95**
4. Agriculture		**258.10**	**244.45**				**502.55**
A. Enteric Fermentation		236.93					236.93
B. Manure Management		21.17	27.63				48.80
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	216.81				216.81
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**910.66**	**7.97**	**323.07**				**1 241.70**
A. Forest Land	-104.09	NE,NO	0.93				-103.16
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1 469.93	NE	NE				1 469.93
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-464.49	NA,NE,NO	322.14				-142.35
6. Waste	**6.21**	**181.50**	**8.02**				**195.73**
A. Solid Waste Disposal on Land	NA,NE,NO	159.38					159.38
B. Waste-water Handling		19.80	7.49				27.29
C. Waste Incineration	6.21	2.31	0.53				9.05
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	517.17	0.46	4.46				522.10
Aviation	309.85	0.05	2.71				312.61
Marine	207.32	0.41	1.75				209.49
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 725.92
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 967.62

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

(Sheet 1 of 1)

Inventory 2006
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**3 721.52**	**452.56**	**626.19**	**69.35**	**59.78**	**5.38**	**4 934.78**
1. Energy	**1 999.50**	**3.60**	**57.54**				**2 060.64**
A. Fuel Combustion (Sectoral Approach)	1 861.61	3.60	57.54				1 922.75
1. Energy Industries	16.33	0.04	0.20				16.57
2. Manufacturing Industries and Construction	421.07	0.32	21.52				442.90
3. Transport	738.28	1.89	30.14				770.31
4. Other Sectors	679.14	1.34	5.67				686.15
5. Other	6.80	0.00	0.02				6.82
B. Fugitive Emissions from Fuels	137.89	NA,NE,NO	NA,NO				137.89
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	137.89	NE,NO	NA,NO				137.89
2. Industrial Processes	**824.33**	**0.93**	**NA,NE,NO**	**69.35**	**59.78**	**5.38**	**959.77**
A. Mineral Products	33.08	NE,NO	NE,NO				33.08
B. Chemical Industry	0.48	NE,NO	NE,NO	NA	NA	NA	0.48
C. Metal Production	790.78	0.93	NA	NA	59.78	NA,NO	851.49
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				69.35	NA,NE,NO	5.38	74.72
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**6.33**		**3.72**				**10.05**
4. Agriculture		**253.63**	**232.50**				**486.13**
A. Enteric Fermentation		232.97					232.97
B. Manure Management		20.65	27.02				47.67
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	205.48				205.48
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**886.06**	**7.97**	**324.37**				**1 218.40**
A. Forest Land	-110.62	NE,NO	0.96				-109.66
B. Cropland	2.36	NE,NO	NE,NO				2.36
C. Grassland	1 469.12	NE	NE				1 469.12
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-484.11	NA,NE,NO	323.41				-160.70
6. Waste	**5.30**	**186.44**	**8.06**				**199.79**
A. Solid Waste Disposal on Land	NA,NE,NO	162.86					162.86
B. Waste-water Handling		21.34	7.55				28.90
C. Waste Incineration	5.30	2.23	0.51				8.03
D. Other	NA	NA	NA				NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	476.72	0.34	4.13				481.19
Aviation	333.00	0.05	2.92				335.97
Marine	143.72	0.29	1.21				145.22
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 716.38
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 934.78

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2004
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**3 756.35**	**445.16**	**625.23**	**58.40**	**38.58**	**5.38**	**4 929.10**
1. Energy	**2 050.01**	**3.70**	**62.97**				**2 116.68**
A. Fuel Combustion (Sectoral Approach)	1 925.93	3.70	62.97				1 992.60
1. Energy Industries	20.43	0.07	0.35				20.86
2. Manufacturing Industries and Construction	418.43	0.33	25.69				444.45
3. Transport	790.11	1.99	31.40				823.49
4. Other Sectors	652.25	1.28	5.42				658.95
5. Other	44.71	0.03	0.11				44.85
B. Fugitive Emissions from Fuels	124.08	NA,NE,NO	NA,NO				124.08
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	124.08	NE,NO	NA,NO				124.08
2. Industrial Processes	**846.01**	**0.95**	**NA,NE,NO**	**58.40**	**38.58**	**5.38**	**949.33**
A. Mineral Products	50.93	NE,NO	NE,NO				50.93
B. Chemical Industry	0.39	NE,NO	NE,NO	NA	NA	NA	0.39
C. Metal Production	794.69	0.95	NA	NA	38.58	NA,NO	834.22
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				58.40	NA,NE,NO	5.38	63.78
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**6.91**		**3.41**				**10.32**
4. Agriculture		**249.72**	**226.11**				**475.82**
A. Enteric Fermentation		229.46					229.46
B. Manure Management		20.26	26.87				47.13
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	199.23				199.23
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**850.93**	**7.97**	**324.77**				**1 183.66**
A. Forest Land	-117.98	NE,NO	1.02				-116.96
B. Cropland	2.52	NE,NO	NE,NO				2.52
C. Grassland	1 468.35	NE	NE				1 468.35
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-511.27	NA,NE,NO	323.74				-187.52
6. Waste	**2.49**	**182.82**	**7.98**				**193.28**
A. Solid Waste Disposal on Land	NA,NE,NO	161.87					161.87
B. Waste-water Handling		19.39	7.62				27.01
C. Waste Incineration	2.49	1.55	0.35				4.40
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	576.21	0.45	4.98				581.64
Aviation	380.00	0.06	3.33				383.39
Marine	196.21	0.39	1.65				198.25
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 745.43
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 929.10

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2005
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**3 675.53**	**446.19**	**633.08**	**76.74**	**26.09**	**5.38**	**4 863.01**
1. Energy	**2 006.46**	**3.35**	**70.38**				**2 080.19**
A. Fuel Combustion (Sectoral Approach)	1 883.08	3.35	70.38				1 956.81
1. Energy Industries	23.26	0.09	0.42				23.76
2. Manufacturing Industries and Construction	398.65	0.33	27.80				426.77
3. Transport	795.36	1.67	36.81				833.84
4. Other Sectors	637.44	1.25	5.28				643.98
5. Other	28.37	0.02	0.07				28.45
B. Fugitive Emissions from Fuels	123.38	NA,NE,NO	NA,NO				123.38
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	123.38	NE,NO	NA,NO				123.38
2. Industrial Processes	**835.11**	**0.96**	**NA,NE,NO**	**76.74**	**26.09**	**5.38**	**944.28**
A. Mineral Products	55.10	NE,NO	NE,NO				55.10
B. Chemical Industry		NE,NO	NE,NO	NA	NA	NA	NA,NE,NO
C. Metal Production	780.00	0.96	NA	NA	26.09	NA,NO	807.06
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 (2)				76.74	NA,NE,NO	5.38	82.12
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**12.89**		**3.29**				**16.18**
4. Agriculture		**252.58**	**226.21**				**478.80**
A. Enteric Fermentation		231.82					231.82
B. Manure Management		20.76	27.13				47.89
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils (3)		NA,NE	199.08				199.08
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry (1)	**821.04**	**7.97**	**325.20**				**1 154.21**
A. Forest Land	-125.95	NE,NO	1.22				-124.73
B. Cropland	3.46	NE,NO	NE,NO				3.46
C. Grassland	1 467.47	NE	NE				1 467.47
D. Wetlands	9.30	7.97	NE,NO				17.27
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-533.24	NA,NE,NO	323.98				-209.26
6. Waste	**0.03**	**181.32**	**8.00**				**189.35**
A. Solid Waste Disposal on Land	NA,NE,NO	163.17					163.17
B. Waste-water Handling		17.19	7.78				24.98
C. Waste Incineration	0.03	0.96	0.22				1.21
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: (4)							
International Bunkers	532.59	0.28	4.62				537.50
Aviation	421.63	0.06	3.69				425.39
Marine	110.96	0.22	0.93				112.11
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NA,NO**						**NA,NO**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	3 708.79
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4 863.01

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2006
Submission 2008 v1.1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	3 827.09	470.95	660.73	64.06	333.22	5.38	5 361.43
1. Energy	2 091.39	3.41	69.67				2 164.47
A. Fuel Combustion (Sectoral Approach)	1 934.91	3.41	69.67				2 007.99
1. Energy Industries	33.01	0.12	0.58				33.72
2. Manufacturing Industries and Construction	382.32	0.30	25.25				407.87
3. Transport	938.37	1.88	39.16				979.41
4. Other Sectors	554.84	1.09	4.61				560.55
5. Other	26.36	0.02	0.07				26.44
B. Fugitive Emissions from Fuels	156.48	NA,NE,NO	NA,NO				156.48
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	156.48	NE,NO	NA,NO				156.48
2. Industrial Processes	937.73	0.99	NA,NE,NO	64.06	333.22	5.38	1 341.37
A. Mineral Products	62.30	NE,NO	NE,NO				62.30
B. Chemical Industry		NE,NO	NE,NO	NA	NA	NA	NA,NE,NO
C. Metal Production	875.42	0.99	NA	NA	333.22	NA,NO	1 209.63
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				64.06	NA,NE,NO	5.38	69.44
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	5.93		3.43				9.36
4. Agriculture		258.00	253.72				511.72
A. Enteric Fermentation		236.43					236.43
B. Manure Management		21.57	27.82				49.39
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [(3)]		NA,NE	225.90				225.90
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NA,NO	NA,NO				NA,NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [(1)]	792.02	9.45	325.73				1 127.21
A. Forest Land	-133.67	NE,NO	1.28				-132.39
B. Cropland	3.54	NE,NO	NE,NO				3.54
C. Grassland	1 466.59	0.25	0.09				1 466.94
D. Wetlands	9.30	9.20	0.45				18.96
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	-553.74	NA,NE,NO	323.90				-229.84
6. Waste	0.03	199.09	8.17				207.29
A. Solid Waste Disposal on Land	NA,NE,NO	181.19					181.19
B. Waste-water Handling		17.07	7.99				25.06
C. Waste Incineration	0.03	0.83	0.19				1.04
D. Other	NA	NA	NA				NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA	NA

Memo Items: [(4)]							
International Bunkers	528.09	0.33	4.57				532.99
Aviation	390.86	0.06	3.42				394.34
Marine	137.23	0.27	1.15				138.66
Multilateral Operations	NO	NO	NO				NO
CO_2 Emissions from Biomass	NA,NO						NA,NO

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	4 234.22
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5 361.43

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

ANNEX IV VOLUNTARY SUPPLEMENTARY INFORMATION FOR ARTICLE 3.3 AND 3.4 OF THE KYOTO PROTOCOL

General information

The supplementary information in this Annex is provided in accordance with Decision 15/CP.10. Iceland has decided to account for afforestation, reforestation and deforestation under Article 3.3 for the entire commitment period. Iceland has further elected revegetation under Article 3.4, accounting for revegatation also for the entire commitment period.

Definition of forest

Iceland's definitions of forest are identified as the following, in accordance with decision 16/CMP.1

- Minimum value for forest area: 0.5 ha
- Minimum value for tree crown cover: 10%
- Minimum value for tree height: 2 m

The carbon sequestration under Article 3.3 amounted to 103,8 Gg of CO_2 in 2006.

Election of activities under Article 3.4

Iceland elects Revegetation, defined by Article 3.4 of the Kyoto Protocol as "additional human activities related to changes in greenhouse gas by source and removals by sinks in the agricultural soils and the land-use change and forestry categories".

Revegetation is defined by decision 16/CMP.1 annex paragraph 1(e) as "a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation".

Iceland interprets the definition of Revegetation as following, recalling the LULUCF-Good Practice Guidance:

- A direct human-induced activity to increase carbon stocks on eroding **or** eroded/desertified sites through the establishment of vegetation or the reinforcement of existing vegetation that covers a minimum area of 0.5 hectares and does not meet the definitions of afforestation and reforestation.

The carbon sequestration under Article 3.4 amounted to 295,1 Gg of CO_2 in 2006.

Hierarchy among the elected activities under Article 3.4

Revegetation is the only activity elected by Iceland under article 3.4, therefore hierarchy among activities is not applicable.

Lands identification method in accordance with Article 5.1

LULUCF-Good Practice Guidance, page 4.24, section 4.2.2.2 shows the two methods for identifying and reporting lands subject to Article 3.3 and Article 3.4 activities. Reporting Method 1 entails delineating areas that include multiple land units subject to Article 3.4 activities by using legal, administrative, or ecosystem boundaries. Reporting Method 2 is based on the spatially explicit and complete geographical identification of all lands subject to Article 3.3 activities and all land subject to Article 3.4 activities.
Iceland elects Reporting Method 1.

Information on accounting of credits
(*in accordance with Decision 13/CMP.1 Annex paragraph 8(d)*)

Credits issued by activities under Article 3, paragraph 3 and 4 of the Kyoto Protocol will be accounted for the entire commitment period.

ANNEX V INFORMATION REQUIRED UNDER ARTICLE 7 OF THE KYOTO PROTOCOL

CHANGES IN THE NATIONAL SYSTEM

The national system is unchanged compared to the description given in the Icelandic Initial Report under the Kyoto Protocol. Following an in-country-review of the Initial Report conducted in Iceland in June 2007, formal agreement between the Environment Agency of Iceland and the necessary collaborating agencies involved in the preparation of the inventory to cover such responsibilities as data collection and methodologies, data delivery timelines and estimation of uncertainty estimates have been made. This involves the National Energy Authority on the one hand and with the Agricultural University of Iceland on the other hand. Further the Agricultural University has made formal agreements with its major data providers, the Soil Conservation of Iceland and the Icelandic Forest Service.

CHANGES IN THE NATIONAL REGISTRY

Following is an updated version of chapter 5 from the Initial Report which describes the Icelandic National Registry.

Contact details of registry administrators

Due to organisational changes within the Environment Agency of Iceland, changes have occured in the contact details of the registry administrators though the individuals remain the same.

Institution	Environment Agency of Iceland
Contact	Department for Environmental Quality
Address	Sudurlandsbraut 24, IS-108 Reykjavik, Iceland
Telephone	+354 591 2000
Fax	+354 591 2020
Registry System Administrators	Birna Hallsdottir (birna@ust.is) Sigurdur Finnsson (sigurdurb@ust.is)

Implementing and running the registry system

The Environment Agency of Iceland (EAI) is responsible for the implementation and operation of Iceland's National Registry under the Kyoto Protocol. The software used for the Icelandic National Registry is GRETA (Greenhouse gases Registry for Emissions Trading Arrangements) which is licensed from Defra (Department of Environment, Food and Rural Affairs, United Kingdom).
The IT software supplier of GRETA is Siemens which works under a contract from Defra. Siemens currently develops and gives support to licensees of GRETA.

Technical description

This technical description of the Icelandic National Registry is presented in accordance with the reporting requirements in Annex II under decision 15/CMP.1.

Consolidated registry systems

The Icelandic National Registry is a stand alone registry, it is not operated together in a consolidated form with the registries of other nations.

Compliance with ITL data exchange standards

The GRETA registry software was originally developed for use in the European Union Greenhouse Gas Trading Scheme (EU ETS) which requires the registry to be compliant with the UN Data Exchange Standards (DES) for communication with UN's International Transaction Log (ITL).

Siemens currently works towards implementing in GRETA all functions defined in UN DES version 1.0 for connecting to the ITL. This includes issuance, conversion, external transfer, cancellation, retirement and reconciliation. A relational database (SQL) is used with a suitable data model for implementing this functionality.

The GRETA also contains, or will contain in the upcoming version a 24 Hour clean-up, transaction status enquiry, time synchronisation, different identifier formats as specified in UN DES and data logging for e.g. transactions, reconciliation, internal audits and messages.
A release candidate version of GRETA released in july 2007 which implements the UN DES specification was used to to perform the initialization tests against ITL as required.
The registry communicates with ITL using XML messages and web-services as specified in the UN DES. These methods are used to perform issuance, conversion, external transfer, cancellation, retirement and reconciliation processes.

Strategies employed to minimize discrepancies

The Icelandic national registry will fulfil all required processes to minimize discrepancies in issuance, transactions, cancellation and retirement of ERUs, CERs, AAUs or RMUs. UN DES specifications are followed at every step of the transactions to minimize risks of inconsistent data in the registry database and ITL. Before forwarding requests to ITL the registry validates data entries against a list of checks performed by ITL (see Annex E of UN DES). A transaction is not finalized until the transaction is registered on both registry servers. The transaction is cancelled if ITL sends an error code. The registry administrator has to contact the ITL administrator for instructions if the registry fails to terminate the transaction. It can be necessary to perform manual corrections in the registry database by the registry administrator.

Each unit is marked with unique codes internally in the registry database. This prevents units to be used in more than one transaction until confirmation of successful transaction has been received by ITL and the transaction is completed.

When sending a message, the registry waits for an acknowledgement of the message being received by ITL before completing submission of the message. If no acknowledgement is received after number of retries, the registry terminates the submissions and performs roll-back on any changes possibly made to the involved unit blocks.

Upon receiving the 24 hour clean-up message from ITL, the registry rolls back any pending transactions including units that were involved. This prevents discrepancies of unit blocks between the registry and ITL.

If all automatic roll-back functions of the registry fail to prevent discrepancies with ITL, a number of manual intervention functions exist in the registry software for the administrator to fix the problem. In worst cases a SQL script will be generated to directly fix problems in the registry SQL database.

After any problem, a reconciliation process is run to confirm that both the registry and ITL agree on all relevant data.

Database and registry server specifications

The registry software runs on three separate servers all running as VMware virtual machines on blade servers. All servers run Microsoft Windows 2003.

Server 1: The SQL server
The SQL server runs on a separate virtual server. The specifications are as follows,

- Database server is Microsoft SQL Server 2000 (32-bit) Standard Edition.
- Database software supports databases well over 1 000 000 Tb in size.
- 2 Gb is the maximum memory usable to the SQL Server.

Since only light workloads are expected the above specifications are considered sufficient for running the Icelandic national registry system.

Server 2: The business logic layer and web access for registry system administrators

A single virtual server runs both the business logic layer (a web service) which handles requests to and from the database server and the registry system administrator access (web interface). The server runs .NET 1.1 runtime and IIS 6.

Server 3: The public web server

The public access web interface is run on a single virtual server.

Disaster prevention and recovery

The registry server is located at a dedicated IT hosting company in Iceland named Skyrr. The server is stored in a fire-proof, temperature controlled room with sensitive fire-detection systems. Access to the server room is only allowed by authorized people and all access is logged.
A daily full backup is taken of the SQL database files. The other servers are incrementally backed up daily and full backup is taken monthly (file backup). The retention period is 60 days meaning it is possible to restore the files to any state within the last 60 days with resolution of one day. A full system state of the VMWare servers is taken every 1.5 months.
Very low volume of transactions is expected, therefore the above backup schedule is considered sufficient.
Backups are currently stored in a separate room. However, an off-site data center (located 12 km. away from the main server room) is being prepared to increase data safety in case of disasters. Data will be submitted to the off-site data center daily. The off-site data center should be ready in the first half of 2008.
Critical software patches are applied when they become available.
In general 2 working days are needed to get the registry up and running in case of failure.

Testing of the Icelandic national registry

The current version of the GRETA registry system software has already proved its functionality against CITL (EU´s Community Independent Transaction Log). Testing of GRETA against CITL has been done in co-operation of the members of the GRETA working group (GRETA WG) and the current developers of the software, Siemens.
GRETA WG and Siemens will perform thorough testing of the GRETA registry system against the ITL.

Security of the Icelandic National Registry

Administrators and users are provided access through the web-services with usernames and passwords. Digital certificates are used to increase the strength of user authentication.
The web-services utilise the permissions of an authenticated user to determine his access to the procedures of the registry system. This prevents any unauthorized access to restricted procedures.
Audit logs are used to track actions.
No direct manipulations of the database are possible through the web-services. Changing the database through the web user-interface is only possible by running predefined procedures. This decreases greatly the risk of intentional or unintentional attacks on the integrity of the database through the web-services.
To minimize risks of incorrect actions due to user errors, the registry uses the following checks before submitting user input for processing:

- Validates all user input before processing.
- Users are asked for confirmation of their input.
- Internal approval process is implemented for secondary approval before submitting details to ITL.

Public information accessible through the web page

The registry software will at least allow public access to reports as required under 5/CMP.1, 13/CMP.1 and 14/CMP.1. These reports will be easily accessible through the web-based home page of the registry system.

Webpage of the registry system

The Icelandic national registry system will be accessible through the web address:

http://co2.ust.is

Performing functions as defined in 13/CMP.1

Functionality to deal with tCERS and lCERs and public reports as defined in 13/CMP.1 are currently being developed according to the UN timetable.

Performing functions as defined in 5/CMP.1

Issuance of ERUs, AAUs & RMUs

Information on these units will be transmitted to ITL according to UN DES version 1.0. This functionality is being developed according to the UN timetable.

Transfer, acquisition, cancellation, retirement & carry-over

Transfer of this information and acknowledgements will be according to the UN DES version 1.0. These functionalities are being developed according to the UN timetable.

Transaction procedures

These procedures will be according to UN DES version 1.0, implementation follows the UN timetable.

Public reports

These reports will be developed according to the UN timetable.

SEF, the Standard Electronic reporting Format (14/CMP.1)

The registry will be able to report information according to 14/CMP.1.

ANNEX VI INFORMATION ON DECISION 14/CP.7

Decision 14/CP.7

Decision 14/CP.7 allows Iceland to report certain industrial process carbon dioxide emissions separately and not include them in national totals; to the extent they would cause Iceland to exceed its assigned amount. The total amount that can be reported separately under this decision is set at 1.6 million tonnes of carbon dioxide per year. Only parties where the total carbon dioxide emissions 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 can avail themselves of this Decision. The total carbon dioxide emissions in Iceland in 1990 amounted to 2159 Gg and is thus less than 0.05 per cent of the total carbon dioxide emissions of Annex I Parties in 1990. Iceland availed itself of the provisions of Decision 14/CP.7 with a letter to COP, dated October 17th 2002.

In the 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.

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 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) 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;

For projects which meet the requirements specified above, 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 are to be reported in the annual inventory submissions.

As mentioned above the total carbon dioxide emissions in Iceland in 1990 amounted to 2159 Gg. Industrial process carbon dioxide emissions from a single project which adds in any one year of the first commitment period more than 5 per cent to the total carbon dioxide emissions in 1990, i.e. 108 Gg, shall be reported separately and shall not be included in national totals to the extent that it would cause Iceland to exceed its assigned amount.

In 2006 three projects meet the conditions of Decision 14/CP.7, the expansion of the Alcan Aluminium plant (expanded in 1997), the expansion of the Ferrosilicon plant (expanded in 1999) and the establishment of the Century Aluminium plant (in operation since 1998).

In the next section the following information for each project will be listed

1. How the project adds more than 5% to the total carbon dioxide emission in 1990, i.e. more than 108 Gg

2. How renewable energy is used resulting in reduction in greenhouse gas emissions per unit of production and the resulting emission savings
3. How BEP and BAT is used to minimize process emissions
4. Total process emissions and emission factors

Expansion of the Alcan Aluminium plant at Straumsvík

1. In 2006 the Alcan Aluminium plant produced 167.511 tonnes of aluminium. The resulting industrial process carbon dioxide emission amounted to 253 Gg. In 1990 87.839 tonnes of aluminium were produced resulting in emissions of 136 Gg which means that the difference is 116 Gg which is more than 108 Gg.
2. In Iceland electricity is produced with hydro power plants (73%) and geothermal power plants (27%). The average carbon dioxide emission per kWh is 16 g. The resulting carbon dioxide emissions were 0,2 tonnes per tonne Aluminium produced (for production of 1 tonne of aluminium 13.000 kWh are needed). According to the report Carbon Dioxide Emission from the Generation of Electric Power in the United States from July 2001, electricity generation with coal results in emissions of 12,4 tonnes per tonne of aluminium. The resulting emission savings for the expansion of the plant are therefore 972 Gg of carbon dioxide.
3. The plant uses BAT, IPPC Reference Document on Best Available Technology in non ferrous metals industries, may 2000. Further the plant has certified quality (ISO 9001), environmental (ISO 14001) and security (OHSAS 18001) management plans. This meets the requirement of BEP.
4. The total process emissions in 2006 amounted to 267 Gg of CO_2-equivalents. The implied emission factor is therefore 1,59 t CO_2-eq/t aluminium.

Expansion of the Ferrosilicon plant at Grundartangi

1. In 2006 the Ferrosilicon plant produced 108.803 tonnes of ferrosilicon. The resulting industrial process carbon dioxide emission amounted to 369 Gg. In 1990 62.792 tonnes of ferrosilicon were produced resulting in emissions of 203 Gg, which means that the difference is 165 Gg which is more than 108 Gg.
2. In Iceland electricity is produced with hydro power plants (74%) and geothermal power plants (26%). The average carbon dioxide emission per kWh is 16 g. The resulting carbon dioxide emissions were 0,14 tonnes per tonne ferrosilicon produced (for production of 1 tonne of ferrosilicon 8.800 kWh are needed). According to the report Carbon Dioxide Emission from the Generation of Electric Power in the United States from July 2001, electricity generation with coal results in emissions of 8,4 tonnes per tonne of ferrosilicon. The resulting emission savings for the expansion of the plant are therefore 377 Gg of carbon dioxide.
3. The plant uses BAT, IPPC Reference Document on Best Available Technology in non ferrous metals industries, December 2001. Further the plant has an environmental management plan as a part of a certified ISO 9001 quality management system, meeting the requirement of BEP.
4. The total process emissions in 2006 amounted to 370 Gg of CO_2-equivalents. The implied emission factor is therefore 3,40 t CO_2-eq/t ferrosilicon.

Establishment of the Century Aluminium plant at Grundartangi

1. In 2006 the Century Aluminium plant produced 158.759 tonnes of aluminium. The resulting industrial process carbon dioxide emission amounted to 254 Gg. Since this is a new plant no production and emissions occurred in 1990. This addition is more than 108 Gg.
2. In Iceland electricity is produced with hydro power plants (74%) and geothermal power plants (26%). The average carbon dioxide emission per kWh is 16 g. The resulting carbon dioxide emissions were 0,2 tonnes per tonne Aluminium produced (for production of 1 tonne of aluminium 13.000 kWh are needed). According to the report Carbon Dioxide Emission from the Generation of Electric Power in the United States from July 2001, electricity generation with coal results in emissions of 12,4 tonnes per tonne of aluminium. The resulting emission savings for the expansion of the plant are therefore 1937 Gg of carbon dioxide.
3. As stipulated in the operating permit for Century Aluminium plant at Grundartangi, BAT as defined by the IPPC, is applied at the plant. Century Aluminium needs to further clarify how BEP is used at the plant.
4. The total process emissions in 2006 amounted to 574 Gg of CO_2-equivalents. The implied emission factor is therefore 3,61 t CO_2-eq/t aluminium. The enlargement of the plant in 2006 led to unusually high PFC emissions in that year.

ANNEX VII QUALITY ASSURANCE AND QUALITY CONTROL PLAN

UST-R-2007:06

Quality Assurance and Quality Control Plan for the Icelandic Greenhouse Gas Inventory

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Abbreviations

AUI	Agricultural University of Iceland
AFOLU	2006 IPCC Guidelines for National Greenhouse gas Inventory, vol. 4: Agriculture, Forestry and Other Land Use
CRF	Common reporting format
COP/MOP	Conference of the Parties serving as Meeting of the Parties
EFA	Environment and Food Agency
ERT	Expert review team
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
IPCC-GPG	Intergovernmental Panel on Climate Change Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
IPCC GPG for LULUCF	IPCC Good Practice
LULUCF	Land Use, Land-Use Change and Forestry
NIR	National inventory report
QA	Quality assurance
QC	Quality control
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

Iceland has signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol to the Convention. One of the requirements under the Protocol is that each Party included in Annex I to the Convention must have in place, no later than one year prior to the start of the first commitment period, a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. Article 7 of the Kyoto Protocol and Decision 19/CMP.1 stipulates the reporting of "supplementary information" including details of the National System and QA/QC plans and procedures.

Iceland prepares an inventory consistent with the methods described in the 'Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories' (1996) as elaborated by the 'Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories' (2000), Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003) and the UNFCCC reporting guidelines (FCCC/SBSTA/2004/8).

The greenhouse gases included in the national inventory are the following: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Emissions of the precursors NOx, NMVOC and CO as well as SO_2 are also included, in compliance with the reporting guidelines.

This document describes the quality assurence and quality control programme for the annual greenhouse gas inventory of Iceland. It includes the quality objectives and an inventory quality assurance and quality control plan. It also describes the responsiblilites and the time schedule for the performance of QA/QC procedures. This manual is an integral part of Iceland's National System.

2. Definitions

Definitions of quality assurance, quality control and related terms are those provided in the IPCC Good Practice Guidance and Guidelines for National Systems under the Kyoto Protocol.

Audits - For the purpose of good practice in inventory preparation, audits may be used to evaluate how effectively the inventory agency complies with the minimum QC specifications outlined in the QC plan. It is important that the auditor be independent of the inventory agency as much as possible as to be able to provide an objective assessment of the processes and data evaluated. Audits may be conducted during the preparation of an inventory, following inventory preparation, or on a previous inventory.

Expert peer review - consists of a review of calculations or assumptions by experts in relevant technical fields. The objective of the expert peer review is to ensure that the inventory's results, assumptions, and methods are reasonable as judged by those knowledgable in the specific field. Expert review processes may involve technical experts and, where a country has formal stakeholder and public review mechanism in place, these reviews can supplement but not replace expert peer review.

Good practice – is a set of procedures intended to ensure that GHG inventories are accurate in the sense that they are systematically neither over- nor underestimated as far as can be judged, and that uncertainties are reduced as far as possible. Good practice covers choice of estimation methods appropriate to national circumstances, quality assurance and quality control at the national level, quantification of uncertainties and data archiving and reporting to promote transparency.

Key source category - is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct GHG in terms of the absolute level of emissions, the trend in emissions, or both.

National system - includes all institutional, legal and procedural arrangements made within a Party for estimating anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

QA/QC plan – is an internal document to organise, plan and implement QA/QC activities. The plan should, in general, outline QA/QC activities that will be implemented, and include a scheduled time frame that follows inventory preparation from its initial development through to final reporting in any year.

QA/QC system - the major elements of a QA/QC system are:

- An inventory agency responsible for coordinating QA/QC activities;
- A QA/QC Plan;
- General QC procedures (Tier1);
- Source category-specific QC procedures (Tier 2);
- QA review procedures;
- Reporting, documentation and archiving procedures.

Quality assurance (QA) - activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process to verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the quality control (QC) programme. QA activities include audits and expert peer reviews.

It is good practice for inventory agencies to conduct a basic expert peer review (Tier 1 QA) prior to inventory submission in order to identify potential problems and make corrections where possible. Inventory agencies may also choose to perform more extensive peer reviews or audits or both as additional (Tier 2 QA) procedures within the available resources.

Quality control (QC) – is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- Provide routine and consistent checks to ensure data integrity, correctness, and completeness;
- Identify and address errors and omissions;
- Document and archive inventory material and record all QC activities.

QC activities - include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardised procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. Higher tier QC activities include technical reviews of source categories, activity data and emissions factors, and methods of estimation.

Tier 1 QC procedures

Tier 1 General Inventory Level QC procedures are checks that the inventory agency should use routinely throughout the preparation of the annual inventory. The focus of general QC techniques is on the processing, handling, documenting, archiving and reporting procedures that are common to all the inventory source categories.

Tier 2 QC procedures

Source category-specific QC procedures (Tier 2), are directed at specific types of data used in the methods for individual source categories and require knowledge of the emissions source category, the types of data available and the parameters associated with emissions. The source category specific QC measures are focusing on key source categories and on source categories where significant methodological and data revisions have taken place. Tier 2 QC activities are in addition to the general QC conducted as part of Tier 1.

Quality Objectives - The objectives of QA/QC activities on national greenhouse gas inventories are to improve transparency, consistency, comparability, completeness, accuracy, confidence and timeliness in national inventories.

Transparency - the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of information;

Consistency - an inventory should be internally consistent in all its elements over a period of years. An inventory is consistent if the same methodologies are used for the base year and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. The inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the IPCC GPG;

Comparability - estimates of emissions and removals reported by Parties in inventories should be comparable among Parties. For this purpose, Parties should use the methodologies and formats agreed by the COP for estimating and reporting inventories. The allocation of different source/sink categories should follow the split of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, and the IPCC GPG for Land Use, Land-Use Change and Forestry, at the level of its summary and sectoral tables;

Completeness - an inventory should cover all sources and sinks, as well as all gases, included in the IPCC Guidelines. Completeness also means full geographic coverage of sources and sinks;

Accuracy – is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable;

Timeliness - submission of the complete inventory by the deadlines specified in the relevant decisions or other documents.

Verification – verification processes are intended to help establish an inventory's reliability. These processes may be applied at either national or global levels of aggregation and may provide alternative information on annual emissions and trends. The results of verification processes may:

- Provide inputs to improve inventories;
- Build confidence in emissions estimates and trends;
- Help to improve scientific understanding related to emissions inventories.

3. Elements of the QA/QC system

This QA/QC system was established according to the UNFCCC and Kyoto Protocol's provisions related to GHG inventory preparation and national system establishment and also to 1996 Revised IPCC Methodology and Good Practice Guidance. Therefore, the document comprises information on:

- The inventory agency responsible for coordinating QA/QC activities;
- The objectives of the QA/QC programme;
- The QA/QC plan;
- The QC procedures;
- The QA procedures;
- The reporting, documenting and archiving procedures.

3.1 Responsibilites

Environment and Food Agency of Iceland (EFA)

EFA, an agency under the Ministry for the Environment, has overall responsibility for the national inventory. EFA compiles and maintains the greenhouse gas emission inventory, except agriculture and LULUCF which is compiled by the Agricultural University of Iceland (AUI). The QA/QC elements outlined in this document are the responsibility of the EFA which is the designated Inventory Agency for the Greenhouse Gas National Inventory System. EFA assigns the QA/QC coordinator, who is responsible for ensuring that QA/QC system is implemented and functioning. The EFA is also responsible for designating responsibilities for implementing and documenting these or similar QA/QC procedures to other agencies or organizations who contribute data or advice to the National Inventory.

Agriculture University of Iceland (AUI)

The Agriculture University of Iceland is the sectoral expert for agriculture and LULUCF. The AUI is responsible for implementing QA/QC procedures in the agriculture and LULUCF sectors.

Data providers

The main data providers in the Icelandic GHG Inventory are the National Energy Authority, Statistics Iceland, Iceland Forest Service and Soil Conservation of Iceland. A formal agreement has been established with these data providers, emphasizing their responsibility for the collection and timely submission of activity data to EFA/AUI, applying QC procedures according to chapter 8 of the IPCC GPG and AFOLU, as well as evaluation of uncertainties of the initial data.

Coordinating team

The Coordinating Team, with representatives from the Ministry for the Environment, the EFA and the AUI not directly involved in preparing the inventory, has the role to officially review the emission inventory before submission to UNFCCC, as well as to plan the inventory cycle and formulate proposals on further development and improvement of the national inventory system. After the Coordinating Team has reviewed the inventory and the institutions responsible for preparing the inventory responded accordingly, the greenhouse gas inventory and the NIR are submitted to UNFCCC by the Ministry for the Environment.

The Coordinating team is responsible for identification and prioritization of categories for review, based on key category and uncertainty analysis. The team is also responsible for identification of review personnel in cooperation with EFA and the Ministry for the Environment.

Ministry for the environment

The Ministry for the Environment submits the inventory to the UNFCCC secretariat.

Figure 1 shows the flow chart for the inventory system.

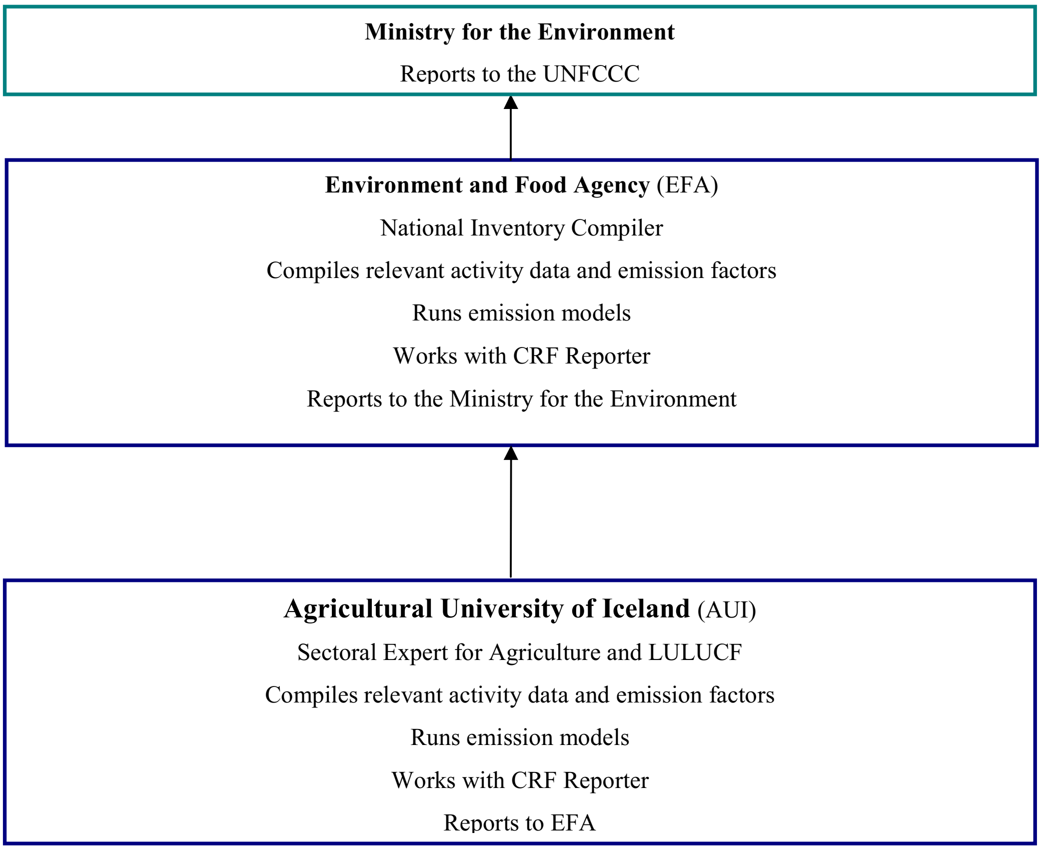

Figure 1

3.2 Quality objectives

The overall aim of the quality system is to maintain and improve the quality in all stages of the inventory work, in accordance with decision 19/CMP.1. The quality objectives of the QA/QC programme and its application are an essential requirement in the GHG inventory and submission processes in order to ensure and improve the inventory principles: transparency, consistency, comparability, completeness, accuracy, timeliness and confidence in the national emissions and removals estimates for the purposes of meeting Iceland's reporting commitments under the UNFCCC and the Kyoto Protocol.

3.3 Implementation of QA/QC system

The quality system described here is designed according to the PDCA-cycle (Plan – Do – Check – Act) presented in figure 2. This is a generally accepted model for pursuing a systematic quality work according to international standards, in order to ensure the maintenance and development of the quality system. This structure is in accordance with structures described in decision 19/CMP.1 and in the

IPCC GPG. Chapter 8, Quality Assurance and Quality Control, refers to ISO systems which are built upon the PDCA-cycle.

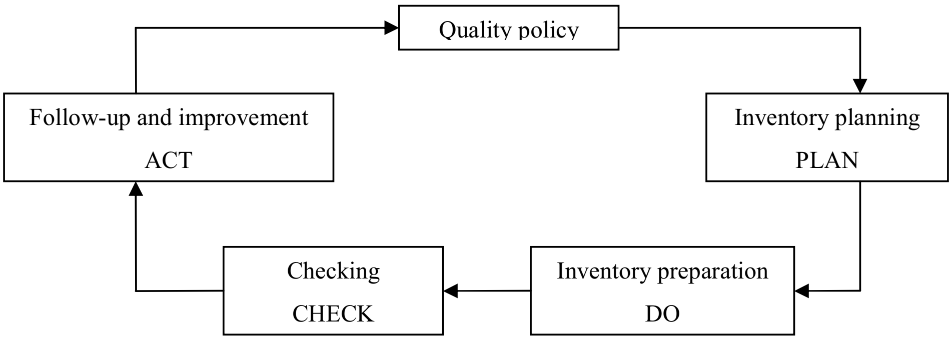

Figure 2

The QA/QC system consists of inventory planning, inventory preparation, inventory quality checking and follow-up improvements which are integrated into the annual cycle and preparation as illustrated in the figure 3.

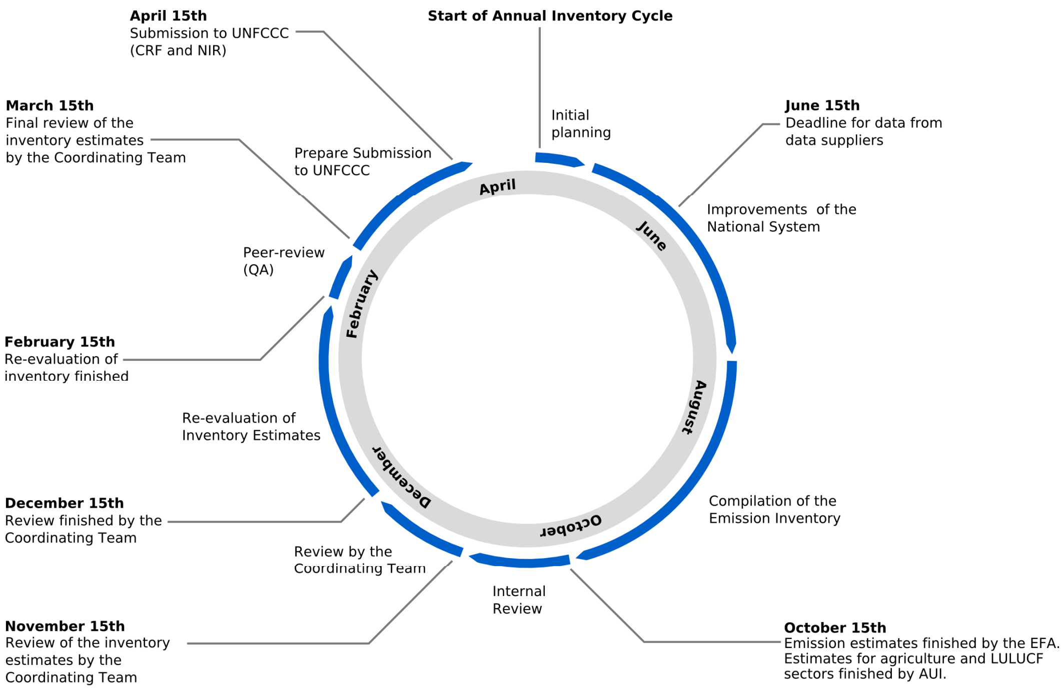

Figure 3

Inventory planning (PLAN)

Each year in May a planning meeting with the Coordinating team is held to plan next inventory's year's work. In the annual planning procedure, suggestions and issues for further consideration are derived from the work with the last inventory, including the audit of work documentation and QC-checklists by the QC-team, as well as from ERT reviews.

Inventory preparation (DO)

After data collection, selection of emission factors and calculations of emissions the quality is checked (units, sources, mass balances, methodology, emission factors, etc). Further uncertainties calculations and analysis are performed, CRF tables are filled and the National Inventory Report is prepared.

Checking (CHECK)

The inventory is reviewed by the coordinating team and inventory estimates re-evaluated if needed. The inventory is then subject to final checking, where i.e. data consistency, documenting, processing and archieving are checked.

Follow-up and improvement (ACT)

The final project eveluation takes places at the next year's inventory planning meeting.

3.4 General QC procedures

Quality manual will be prepared as stated in the ISO 9001 4.2.2. In this document references to normative and descriptive documents (procedures) which govern the inventory and reporting, structure and relationships between all participants acting in preparation of the NIR will be made. One of the purposes of the document is to describe how the coordinated quality system works as a whole and how its different parts work together. This objective will be attained by preparation and implementation of appropriate working procedures.

Preparation of general procedures:

- Control of documents (ISO 9001:2000, 4.2.3). Should define preparation, approvement, review, etc. of documents;
- Control of all records, including those made in electronic form (ISO 9001:2000, 4.2.4). A complete and correct archiving of GHG inventory data should also be included;
- Procedure for audits with responsibilities and requirements for planning and conducting audits, and for reporting results and maintaining records (ISO 9001:2000, 8.2.2), that would be QA activities;
- The controls and related responsibilities and authorities for dealing with non-conforming product shall be defined in nonconforming product procedure (ISO 9001:2000, 8.3);
- Procedures for coreective and preventive actions (ISO 9001:2000, 8.5.2, 8.5.3).

3.5 Specific QC procedures

For full implementation of QA/QC plan the following documented procedures will be prepared:

Data collection procedure with requirements for activity data collection and emissions factors selection. It will include:

- selection of appropriate (i.e. complying with IPCC Good Practice Guidance) methods, activity data and emission factors;
- check for correct calculation and/or modelling of data and consistency of time series, compare with previous estimates;
- documentation of quality control activities in a checklist.

Procedure for emissions calculations, which will include checking of:

- consistent use of emission factors;
- correctness of emission parameters, units, conversion factors;
- correct and complete transcription of data from spreadsheets into CRF tables;
- correctness of recalculations;

Procedure for preparation of national inventory report, which will include checking of:

- integrity of data structures in the inventory
- completeness of the inventory
- consistency of the time series;
- comparison of emission estimates to previous estimates
- check for consistency between data tables and text in the NIR;
- checks the completeness of the inventory submission files

Procedure for data archiving, which will include checking of:

- complete and correct archiving of GHG data
- Integrity of archiving arrangements in the organizations involved in the inventory process.

3.6 QA procedures

The most important external reviews of Iceland's GHG inventory have been performed by the UNFCCC ERTs, which perform extensive reviews of each year's submission. Results from these reviews are considered annually and decisions are taken on how the recommendations will be taken forward in the development and improvement of the national system.

The Coordinating team is responsible for identification and prioritization of categories for external review, as well as for identification of review personnel in cooperation with EFA and the Ministry for the Environment. Quality assurance procedures will involve external reviewers conducting an unbiased review of the national inventory or parts of the inventory. The results of the QA activities will be documented and described in the QA/QC sub-chapter of the NIR.

3.7 Reporting, documentation, and archiving procedures

All National System documents are stored electronically on the EFA's computer network. This includes quality system documents, reports, original data from data providers, the CRF Reporter database files, data submitted to the UNFCCC and spreadsheets of the emission inventory. Also decisions reached by the coordinating team, reviews, and results of key category and uncertainty analysis as well as inventory development is documented and archived in the data base. Geographical database used for preparing the LULUCF intventory is stored at the AUI computer network. Resulting digitized maps of land use classification are stored also at EFA. After each submission to UNFCCC a complete copy is archived.

Inventory data as well as background information on activity data and emission factors are archived by the Environment and Food Agency, which will be the single location where archives of GHG submissions and all supporting reference material is stored and maintained. Backups of each year's data and supportive material are kept as a separate CD.