National Inventory Report

Iceland 2009

Submitted under the United Nations Framework Convention on Climate Change

ENVIRONMENT AGENCY OF ICELAND

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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 2009. 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 – 2007.

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 2009

EXECUTIVE SUMMARY

Kyoto accounting:

Iceland's AAUs for the first commitment period amount to 18,523,847 tonnes of CO_2 equivalents for the period, or 3,704,769 tonnes per year on average. For 2007, Iceland's total Annex A greenhouse gas emissions were estimated at 4,482 Gg CO_2-equivalents. Iceland's total emissions in 2007 were 32% above 1990 levels. Activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol amounted to 279 Gg CO_2-equivalents in 2007. Those removals could thus raise Iceland's AAUs to 3,983 Gg per year. Emissions that could fall under Decision 14/CP.7 amounted to 669 Gg in 2007. Had 2007 been included in the first commitment period, 301 Gg of those emissions would be reported separately and not included in national totals.

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 to 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 do not exceed the limits of Iceland's obligations under the Kyoto Protocol. A second objective is to increase the level of carbon sequestration resulting from 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% by 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 during 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. Iceland AAU's for the first commitment period amount to 18,523,847 tonnes of CO_2 equivalents.
- Decision14/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.

1.1 Trends in emissions and removals

In 1990, the total emissions of greenhouse gases in Iceland were 3,400 Gg of CO_2-equivalents. In 2007, total emissions were 4,482 Gg CO_2-equivalents. This is an increase of 32% over the time period.

A summary of the Icelandic national emissions for 1990, 2006 and 2007 is presented in Table ES1 (without LULUCF). Empty cells indicate emissions not occurring.

Table ES1. Emissions of greenhouse gases during 1990, 2006 and 2007 in Gg CO_2-eq.

	1990	2006	2007	90-07	06-07
CO_2	2160	3038	3289	52%	8%
CH_4	452	467	484	7%	4%
N_2O	368	338	359	-2%	6%
HFC 32		0.1	0.1		16%
HFC 125		19	20		7%
HFC 134a		12	15		26%
HFC 143a		21	23		9%
HFC 152a		0.1	0.1		-4%
CF_4	355	282	238	-33%	-16%
C_2F_6	65	51	43	-33%	-16%
SF_6	1	7	10	842%	41%
Total	3400	4236	4482	32%	6%
CO_2 emissions fulfilling 14/CP.7		537	669		24%
Total emissions excluding CO_2 emissions fulfilling 14/CP.7		3698	3813	12%	3%

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 2007, the contribution of the energy sector to the total emissions decreased from 52% to 50%. 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 33% in 2007.

Table ES2. Total emissions of greenhouse gases by source 1990, 2006 and 2007, Gg CO_2-eq.

	1990	2006	2007
Energy	1704	2009	2070
Industrial processes	863	1335	1486
Emission fulfilling 14/CP.7*		537	669
Solvent Use	14	9	12
Agriculture	573	512	534
Waste	180	213	228
Geothermal	67	156	152
Total without LULUCF	3400	4236	4482
LULUCF	1506	1226	1212

* 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 2007 is shown in Figure ES1. Emissions from the energy sector account for 50% (fuel combustion 46% and geothermal energy 4%) of the national total emissions, industrial processes account for 33% and agriculture for 12%. The waste sector accounts for 5% and solvent and other product use for 0.3%.

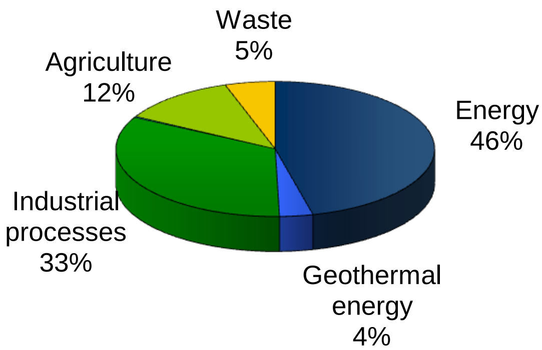

Figure ES1. Emissions of greenhouse gases by UNFCCC sector in 2007

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 of the Framework Convention. The domestic implementation strategy was revised in 2002, based on the commitments of the Kyoto Protocol and the provisions in the Marrakech Accords. 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. Iceland AAU's for the first commitment period were decided in Iceland's Initial Report under the Kyoto Protocol and amount to 18,523,847 tonnes of CO_2 equivalents.
- 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[1]. 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 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 provisions for measures to curb and reduce GHG emissions in six sectors, as well as provisions to increase carbon sequestration resulting from a forestation and revegetation programs.

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

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 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 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 fundamental issue associated with the significant proportional impact of single projects on emissions is one of scale. In small economies such as Iceland, 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. 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 industrial process carbon dioxide emissions falling under Decision 14/CP.7 cannot be transferred by Iceland or acquired by another Party under Articles 6 and

17 of the Kyoto Protocol. If carbon dioxide emissions are reported separately according to the Decision, Iceland can not transfer assigned amount units to other Parties through international emissions trading.

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. 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 – 2007. The methodology used in calculating the emissions is according to the revised 1996 and 2006 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).

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 National system for estimation of greenhouse gases

1.2.1 Institutional arrangement

The Environment Agency of Iceland (EA), an agency under the Ministry for the Environment, carries the overall responsibility for the national inventory. EA compiles and maintains the greenhouse gas emission inventory, except for 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.

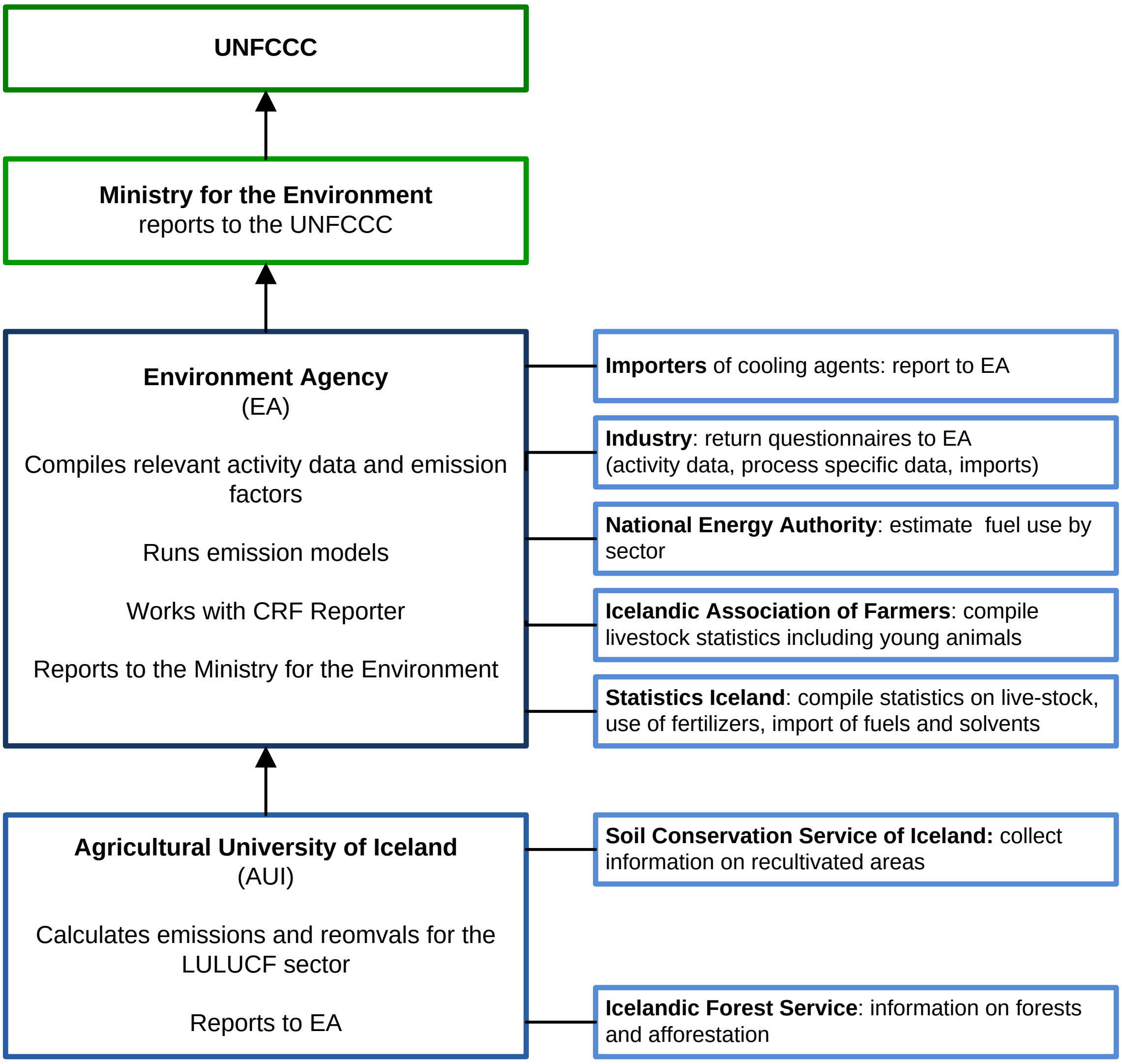

Figure 1.1 Information flow and distribution of responsibilities in the Icelandic emission inventory system for reporting to the UNFCCC

Further, the Coordinating Team was established in 2008 as a part of the national system. The team has representatives from the Ministry for the Environment, the EA and the AUI not directly involved in preparing the inventory. Its official roles are to review the emissions inventory before submission to UNFCCC, plan the inventory cycle and formulate proposals on further development and improvement of the national inventory system. During this inventory cycle the coordinating team held 7 meetings. The work of the team has already led to improvement in cooperation between the different institutions involved with the inventory compilation, especially with regards to the LULUCF and agriculture sectors. Some improvements proposed by the team were incorporated into this inventory submission. Other improvements will be made by the next submission.

1.2.2 Act No. 65 from 2007

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

The act 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 such as data collection and methodologies, data delivery timelines and uncertainty estimates. This involves the National Energy Authority on the one hand and the Agricultural University of Iceland on the other. In addition, the Agricultural University has made formal agreements with its major data providers, the Soil Conservation Service of Iceland and the Icelandic Forest Service.

According to the act a three-member Emissions Allowance Allocation Committee, appointed by the Minister for the Environment in accordance with nominations, on which sit representatives of the Ministry of Industry, Ministry for the Environment and the Ministry of Finance, allocates emissions allowance for operators falling within the scope of the Act during the period 1 January 2008 to 31 December 2012.

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, new legislation, Act No. 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 population, GDP, production of asphalt, imports of solvents and other products, the use of fertilizers in agriculture and on the import and export of fuels. The EA collects various additional data directly. Annually a questionnaire on imports, use of feedstock, and production and process specific information is sent out to industrial producers. Importers of HFCs submit reports on their annual imports by type of HFCs to the EA. EA also estimates activity data with regard to waste. Emission factors are taken mainly from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, IPCC Good Practice Guidance and the 2006

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 the basis of its own geographical database and other 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:

Emission (E) = Activity level (A) · 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 a Tier 1 method.

A key source analysis was prepared for this round of reporting. Table 1.1 lists the identified key sources. Tables showing key source analysis (trend and level assessment) can be found in Annex I. The key source analysis now includes LULUCF sources.

Table 1.1 Key sources

IPCC SOURCE CATEGORIES	Direct GHG	Key source		
		Level '90	Level '07	Trend
ENERGY SECTOR				
1.AA.2: Manufacturing Industry And Construction	CO_2	ν	ν	ν
1.AA.3b: Road Transport	CO_2	ν	ν	ν
1.AA.3b: Road Transport	N_2O		ν*	ν
1.AA.3 (A,D): Transport Other Than Road Transport	CO_2	ν	ν	ν
1.AA.4(A,B): Residential, Commercial, Institutional	CO_2	ν*		ν
1.AA.4c: Fishing	CO_2	ν	ν	ν
1.B.2d Geothermal Energy Utilisation	CO_2	ν	ν	ν
INDUSTRIAL PROCESSES				
2.A: Mineral Industry	CO_2	ν	ν	
2.B: Chemical Industry	N_2O	ν		
2.C.2: Ferroalloys Production	CO_2	ν	ν	ν
2.C.3: Aluminium Production	CO_2	ν	ν	ν
2.C.3: Aluminium Production	PFC	ν	ν	ν
2.F Emissions From Substitutes For Ozone Depleting Substances	HFC		ν	ν
AGRICULTURE				
4.A.1 Enteric Fermentation, Cattle	CH_4	ν	ν	ν
4.A.3 Enteric Fermentation, Sheep	CH_4	ν	ν	ν
4.B Manure Management	N_2O	ν*		
4.D.1 Direct N_2O Emissions From Agricultural Soils	N_2O	ν	ν	
4.D.2 Indirect N_2O Emissions From Nitrogen Used In Agriculture	N_2O	ν	ν*	
LULUCF				
5.A Forest Land	CO_2		ν	ν
5.C.2.3 Wetlands Converted To Grassland	CO_2	ν	ν	ν
5.C.2.5 Other Land Converted To Grassland	CO_2	ν	ν	ν
WASTE				
6.A Solid Waste Disposal Sites	CH_4	ν	ν	ν
6.C Waste Incineration	CO_2			ν

*key source excluding LULUCF

1.6 Quality assurance and quality control (QA/QC)

The objective of QA/QC activities on national greenhouse gas inventories is to improve transparency, consistency, comparability, completeness, accuracy, confidence and timeliness in national inventories. A QA/QC plan for the annual greenhouse gas inventory of Iceland has been prepared. The document describes the quality assurance and quality control programme. It includes the quality objectives and an inventory quality assurance and quality control plan. It also describes the responsibilities and the time schedule for the performance of QA/QC procedures. The 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. Source category specific QC measures have been developed for several key source categories. A quality manual as stated in the ISO 9001 is under preparation.

1.7 Uncertainty evaluation

Uncertainty evaluation of the inventory was not prepared for this round of reporting. A preliminary estimate of the quantitative uncertainty of the Icelandic emission inventory was prepared last year. The uncertainty estimate revealed that the total uncertainty of the Icelandic inventory (excluding LULUCF) is 7.4%. The results of last year's 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 emissions 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 2007.

With regard to sectoral coverage few sources are not estimated.

The main sources not estimated are:

- Emissions of CO_2 and CH_4 from distribution of oil products (1B2a v)
- The emissions/removals of many LULUCF components are not estimated (see Chapter 7). Most important is probably the emissions/removal of mineral soils under various land use including forest land, cropland and degraded grassland and also emissions due to biomass burning.

The reason for not including the above activities/gases in the present submission is a 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

Since last submissions several improvements have been made. The main changes include:

- Estimation of actual emissions of HFCs and SF_6
- Reallocation of fuels in the energy sector
- Key source analysis including LULUCF activities
- Definitions of main land use categories have been elaborated.
- Results from the geographical database (IGLUD) are partly included their geographical identification has been improved.

- Carbon stock changes in Forests land are now based on results from new national forest inventory

In the near future the following improvements are planned:

- Iceland has until now not prepared a national energy balance. The NEA should prepare a national energy balance annually and submit to the EA, in accordance with the formal agreement between EA and NEA.
- The Icelandic geographical land use database has been established. The division of land use into subcategories and improved time and spatial resolution of the land use information is an ongoing task of the AUI.
- Ongoing new national forest inventory (NNFI) will improve both estimates of Forest land area and Carbon stock changes.
- Similar effort regarding Revegetation began in 2007. The revegetation inventory is expected to provide improved data on carbon stock changes and area of revegetated land in the next two years.

The following improvements are under consideration:

- Improving methodologies to estimate emissions from road transportation.
- Developing country-specific emission factor for enteric fermentation.
- Revising country-specific N excretion factors.
- Improving QA/QC for LULUCF.
- Improving the time series for different land use categories and better estimate on past and present land use changes.
- Revising LULUCF emission/removal factors, in order to emphasize key sources and aim toward higher tier levels.
- Evaluation of LULUCF factors, not estimated in present submission and disaggregation of components presently reported as aggregated emission.

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 – 2007 is presented in the following tables, expressed in terms of contribution by gas and source.

Table 2.1 presents emission figures for all greenhouse gases from 1990 to 2007. Table 2.2 presents emission figures for all greenhouse gases in 1990, 2006 and 2007, expressed in CO_2-equivalents along with the percentage change indicated for both time periods 1990 – 2007 and 2006 – 2007.

Table 2.1 Emissions of greenhouse gases in Iceland during the period 1990 – 2007 (without LULUCF). Empty cells indicate emissions not occurring. Units: Gg CO_2-eq.

	1990	1995	2000	2005	2006	2007
CO_2	2160	2313	2761	2864	3038	3289
CH_4	452	449	455	442	467	484
N_2O	368	347	357	310	338	359
HFC		4	27	49	53	59
CF_4	355	50	108	22	282	238
C_2F_6	65	9	20	4	51	43
SF_6	1	1	3	3	7	10
Total	3400	3173	3730	3694	4236	4482
CO_2 emissions fulfilling 14/CP.7			273	441	537	669
Total emissions excluding CO_2 emissions fulfilling 14/CP.7					3458	3253

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

Table 2.2 Emissions of greenhouse gases in Iceland during the period 1990 – 2007 (without LULUCF). Empty cells indicate emissions not occurring. Units: Gg CO_2-eq.

	1990	2006	2007	Changes 90-07	Changes 06-07
CO_2	2160	3038	3289	52%	8.26%
CH_4	452	467	484	7%	3.8%
N_2O	368	338	359	-2%	6%
HFC		53	59	-	12%
CF_4	355	282	238	-33%	-16%
C_2F_6	65	51	43	-33%	-16%
SF_6	1	7	10	842%	41%
Total	3400	4236	4482	32%	6%
CO_2 emissions fulfilling 14/CP.7		537	669		24%
Total emissions excluding CO_2 emissions fulfilling 14/CP.7			3698	3813	12%

*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 not 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 are those CO_2 that fulfill the provision of the decision. 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 3,400 Gg of CO_2-equivalents. In 2007 total emissions were 4,482 Gg CO_2-equivalents. This implies an increase of 32% 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 15% is seen in 2006 followed by an increase of 6% in 2007. The main reason for the 2006 increase was very high PFC emissions. The 2007 increase was seen in all greenhouse gases except for PFC.

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 considerably faster than the population, while the number of passengers using public transport has declined. More traffic is thus not mainly due to population growth, but rather to a larger share of the population owning and using private cars for their daily travel.

During the late nineties large-scale industry expanded in Iceland. In 1990 88,000 tonnes of aluminium were produced in one aluminium plant (Rio Tinto Alcan) in Iceland. This aluminium plant was expanded in 1997. The single ferroalloys production plant (Elkem Iceland) was expanded in 1999. In 1998 a second aluminium plant (Century Aluminium) was established. In 2006 that Century Aluminium was expanded. The sudden increase seen in PFC emission in 2006 was mainly caused by technical difficulties experienced during the expansion. In 2007 a third aluminium plant (Alcoa Fjarðaál) was established. In 2007 455,700 tonnes of aluminium were produced in three aluminium plants.

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 actual emissions of HFCs have risen from 0.1 Gg CO_2-equivalent in 1992 to 59 Gg CO_2-equivalent in 2007.

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 (64%), followed by CH_4 (13%) and N_2O (11%) and then by the fluorinated gases PFCs, HFCs and SF_6 (12%). In 1990 the share of CO_2 was lower than in 2007 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%).

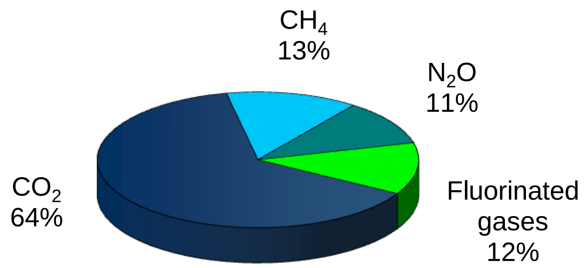

Figure 2.1 Distribution of emissions of greenhouse gases by gas in 2007

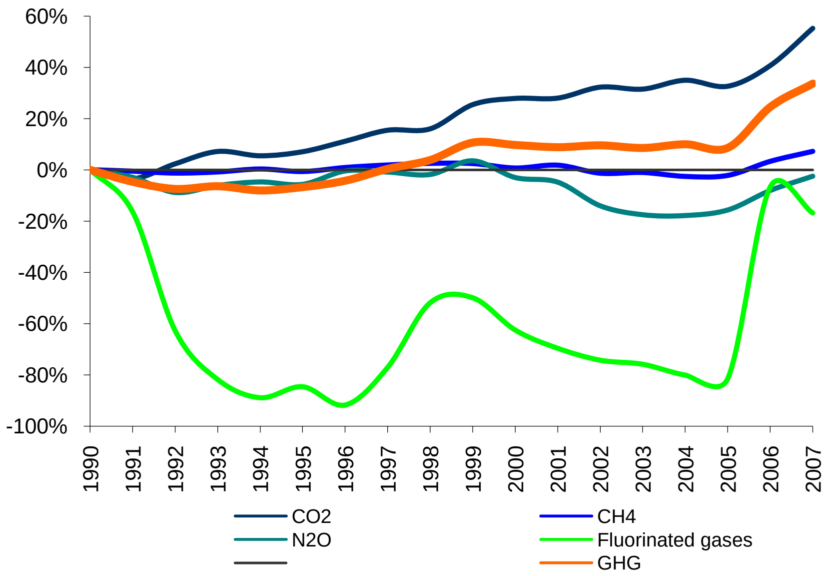

Figure 2.2 Percentage changes in emissions of greenhouse gases by gas 1990 – 2007, compared with 1990

2.2.1 Carbon dioxide (CO_2)

Industrial processes, road transport and fisheries are the three main sources of CO_2 emissions in Iceland. Since emissions from the electricity generation and space heating are low, as 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 in transportation other than road transportation. Table 2.3 lists CO_2 emissions from each source category for the period 1990 – 2007. 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 2007 compared with 1990.

Table 2.3 Emissions of CO2 by sector 1990 – 2007, Gg CO_2-eq.

CO_2	1990	1995	2000	2005	2006	2007
Fishing	655	772	720	626	549	565
Road vehicles	509	534	589	747	859	891
Stationary combustion, oil	231	215	198	171	160	134
Industrial processes	393	428	769	838	941	1134
Construction	121	148	197	215	195	196
Geothermal	67	82	163	123	156	152
Other	183	134	125	142	177	217
Total	2160	2313	2761	2864	3038	3289

In 2007 the total CO_2 emissions in Iceland were 3,289 Gg. This implies an increase of about 8% from the preceding year and an increase of about 52% from 1990. Emissions from stationary oil combustion decreased by 16% from 2006 to 2007. Emissions from construction increased by 1%. Emissions from road vehicles rose by 4% mainly due to an increase in the number of cars per capita, more mileage driven and an increase in larger vehicles. Emissions from industrial processes increased by 21%, emissions from geothermal energy decreased by 3% and emissions from other sources increase by 23%.

The increase in CO_2 emissions between 1990 and 2007 can be explained by the increased emissions from industrial processes (188%), road transport (75%), geothermal energy utilisation (127%), and the construction sector (62%). Emissions from fishing have declined by 14% 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 industrial production grew. The existing aluminium plant and ferroalloys facility were expanded in 1997 and 1999, and in 1998 a new aluminium plant was established. This new plant was expanded in 2006 and a third plant was established in 2007. The economic growth and the growth in energy intensive industries have resulted in higher emissions from most sources, but in particular from the industrial processes sector as well as 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 (Kárahnjúkar).

Since 1990 the vehicle fleet in Iceland has increased nearly by 79%. This has led to increased emissions from road transport. Furthermore the latest trend has been towards larger passenger cars, which consume more fuel. Emissions from both domestic flights and navigation have declined since 1990.

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 2007 emissions were 14% under 1990 levels. 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 2007 when they were 18% above the 1990 level. This is mainly due to changes in the cement industry where production had been slowly decreasing since 1990. The construction of Kárahnjúkar hydropower plant increased demand for cement, and production increased again between 2004 and 2007, although most of the cement used in this project was imported.

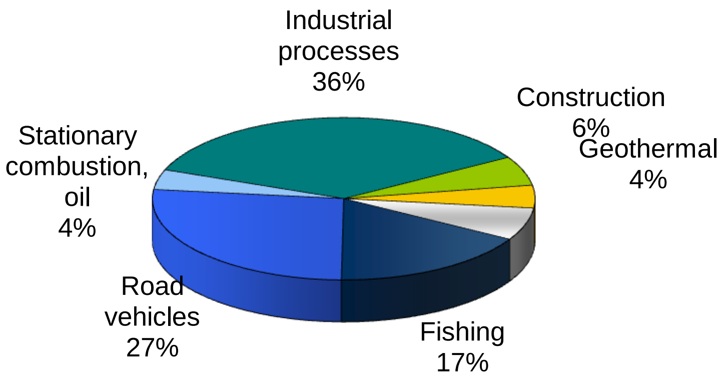

Figure 2.3 Distribution of CO_2 emissions by source in 2007

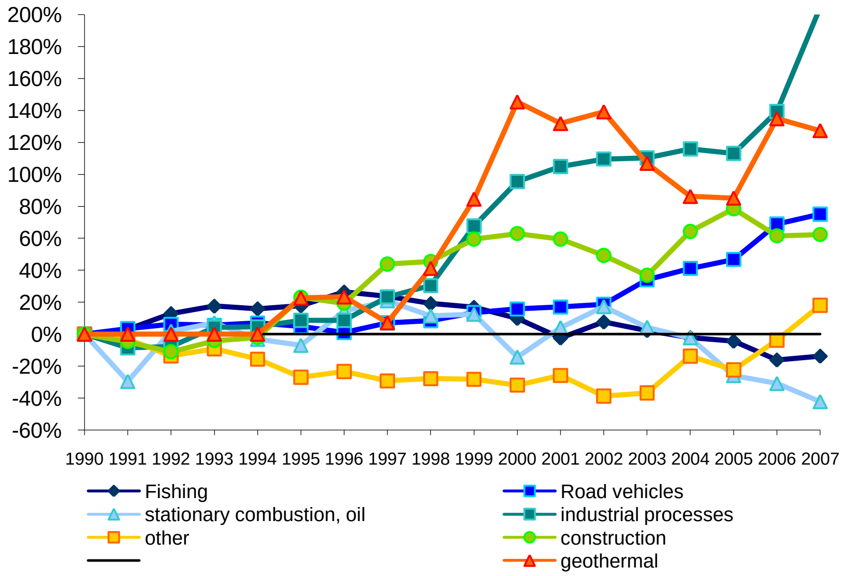

Figure 2.4 Percentage changes in emissions of CO_2 by major sources 1990 – 2007, compared with 1990

2.2.2 Methane (CH_4)

As can be seen from Table 2.4 and Figure 2.5, about 45% and 54% of the emissions of methane in 2007 originated from waste treatment and agriculture respectively. The emissions from agriculture have decreased by 11% between 1990 and 2007,whereas emissions from waste increased by 43%. Emissions from waste treatment increased from 1990 to 2001 due to a greater amount of waste generated and a higher ratio of landfilled waste in managed waste disposal sites. The emissions from landfills decreased slightly from 2001 to 2005, due to increased methane recovery. From 2005 to 2007 emission rose by 18%. This increase is mainly due to failures in the methane capture system at the single landfill site collecting methane, but also due to increased amount of landfilled waste disposed at managed waste disposal sites.

Table 2.4 Emissions of CH4 by sector 1990 – 2007, CO_2-eq.

CH_4	1990	1995	2000	2005	2006	2007
Agriculture	294	271	265	253	258	261
Waste	153	173	185	185	204	219
Other	5.3	5.2	4.4	4.2	4.3	4.4
Total	452	449	455	442	467	484

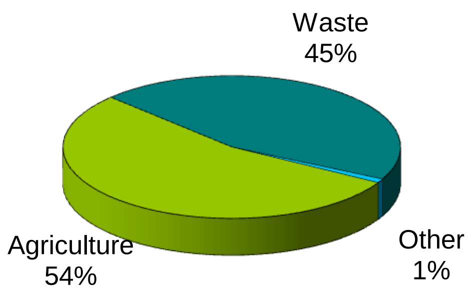

Figure 2.5 Distribution of CH_4 emissions by source in 2007

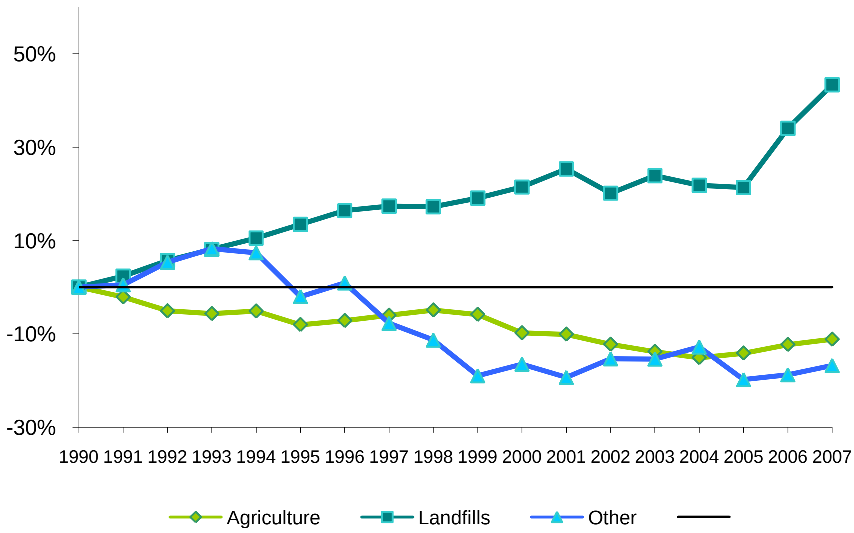

Figure 2.6 Percentage changes in emissions of CH_4 by major sources 1990 – 2007, compared to 1990

2.2.3 Nitrous oxide (N_2O)

As can be seen from Table 2.4 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 increased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995.

The overall nitrous oxide emissions decreased by 2% from 1990 to 2007, 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 N2O by sector 1990 – 2007, CO_2-eq.

N_2O	1990	1995	2000	2005	2006	2007
Agriculture	279	254	264	226	254	273
Road traffic	5	12	29	38	40	41
Other	84	81	63	46	44	45
Total	368	347	357	310	338	359

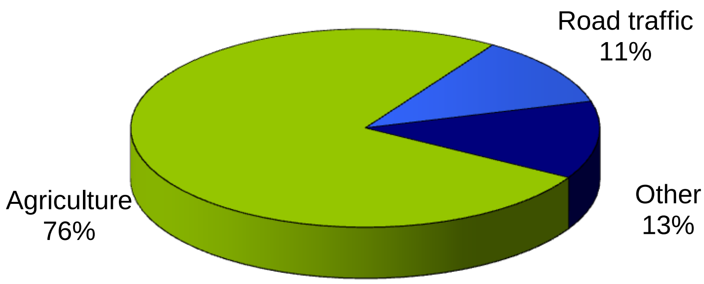

Figure 2.7 Distribution of N_2O emissions by source in 2007

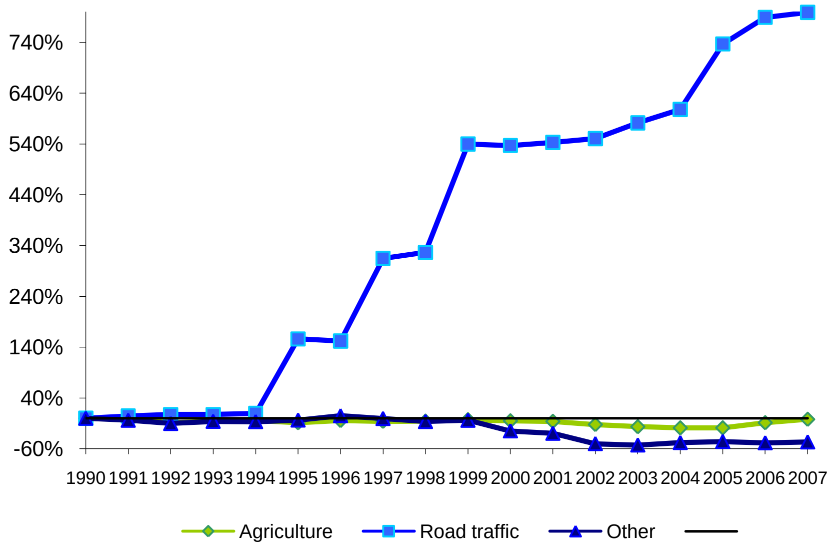

Figure 2.8 Changes in N_2O emission for major sources between 1990 and 2007

2.2.4 Perfluorocarbons

The emissions of the perfluorocarbons, i.e. tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) from the aluminium industry were 238 and 43 Gg CO_2-equivalents respectively in 2007.

Total PFC emissions decreased by 33% in the period of 1990 – 2007. 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 the expansion of the Rio Tinto Alcan aluminium plant in 1997 and the establishment of the Century 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 Century Aluminium The extent of the increase was can be explained by technical difficulties experienced during the expansion. PFC emissions remained high per tonne of aluminium at the Century Aluminium plant in 2007, though not as high as in 2006. The Alcoa Fjarðaál aluminium plant was established in 2007. PFC emissions per tonne of aluminium are generally high during start up and usually rise during expansion.

Table 2.6 Emissions of PFCs by species 1990 – 2007, CO_2-eq.

	1990	1995	2000	2005	2006	2007
CF_4	355	50	108	22	282	238
C_2F_6	65	9	20	4	51	43
Total	420	59	127	26	333	281

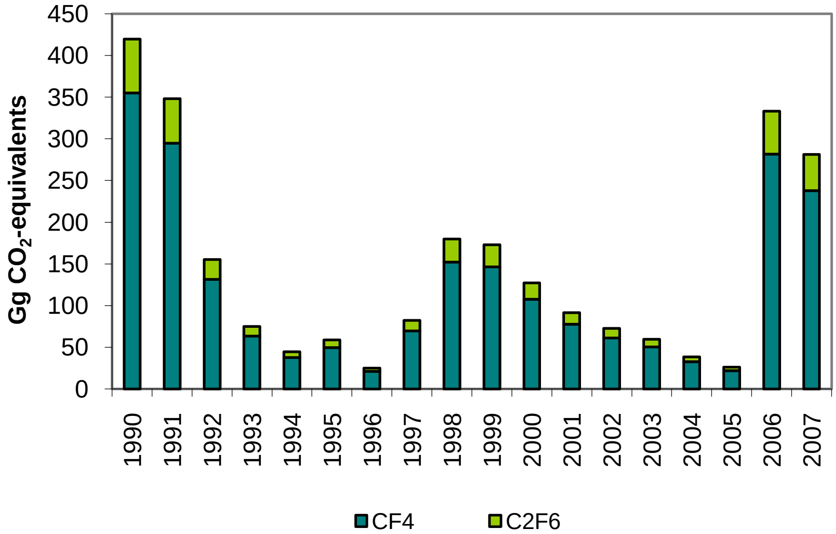

Figure 2.9 Emissions of PFCs from 1990 to 2007, Gg CO_2-equivalent

2.2.5 Hydrofluorocarbons (HFCs)

The total actual emissions of HFCs, used as substitutes for ozone depleting substances, amounted to 59.4 Gg CO_2-equivalents in 2007. The import of HFCs started in 1992 and increased until 1998. Refrigeration contributes by far the largest part of HFCs emissions and air conditioning systems in cars are also minor source that is gradually increasing.

Table 2.7 Emissions of HFCs by species 1990 – 2007, Gg CO_2-eq.

	1990	1995	2000	2005	2006	2007
HFC 32	-	-	-	0.1	0.1	0.1
HFC 125	-	1.6	10.8	18.3	19.2	20.5
HFC 134a	-	1.2	5.0	9.9	11.3	14.6
HFC 143a	-	1.5	11.6	20.0	21.4	23.3
HFC 152a	-	-	0.1	0.06	0.06	0.05
Total	-	4.3	27.4	48.4	52.1	58.5

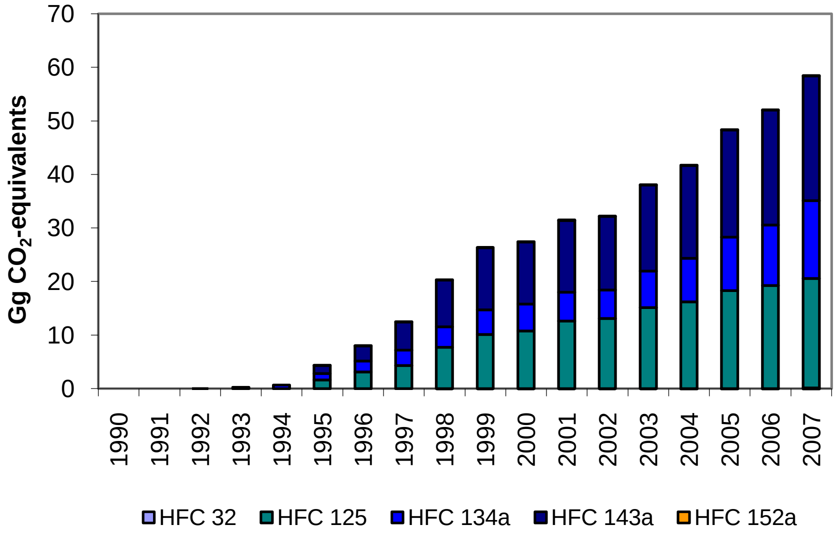

Figure 2.10 Actual emissions of HFCs by species 1990 – 2007, Gg CO_2-eq

2.2.6 Sulphur hexafluoride (SF_6)

Sulphur hexafluoride emissions are now estimated for the first time. In earlier inventories, emissions were not estimated but held constant over the whole time series. The largest source of SF_6 emissions is leakages from electrical equipment. Total emissions in 2007 were 10 Gg CO_2-equivalents. Emissions have varied between 1 to 11 in the years between 1990 and 2007. Peaks in emissions occur during power plant construction.

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 and solvent and other product use. From 1990 to 2007 the contribution of the energy sector to the total net emissions decreased from 52% to 50% respectively. The contribution of industrial processes was 25% in 1990 and 33% in 2007.

Table 2.8 Total emissions of greenhouse gases by sources (without LULUCF) in Iceland 1990 – 2007, CO_2-eq.

	1990	1995	2000	2005	2006	2007
Energy	1771	1906	2039	2088	2166	2222
-Fuel	1704	1824	1876	1965	2009	2070
-Geothermal	67	82	163	123	156	152
Industrial processes	863	535	946	918	1335	1486
Solvent and other product use	14	14	15	16	9	12
Agriculture	573	524	530	479	512	534
Waste	180	194	201	194	213	228
Total without LULUCF	3400	3173	3730	3694	4236	4482

The distribution of the total greenhouse gas emissions over the UNFCCC sectors (excluding LULUCF) in 2007 is shown in Figure 2.11. Emissions from the energy sector account for 50% (fuel combustion 46% and geothermal energy 4%) of the national total emissions, industrial processes account for 33% and agriculture for 12%. The waste sector accounts for 5% and solvent and other product use for 0.3%.

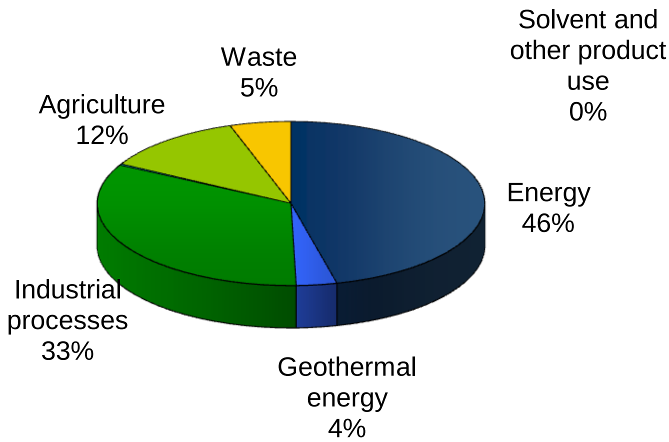

Figure 2.11 Emissions of greenhouse gases by UNFCCC sector in 2007

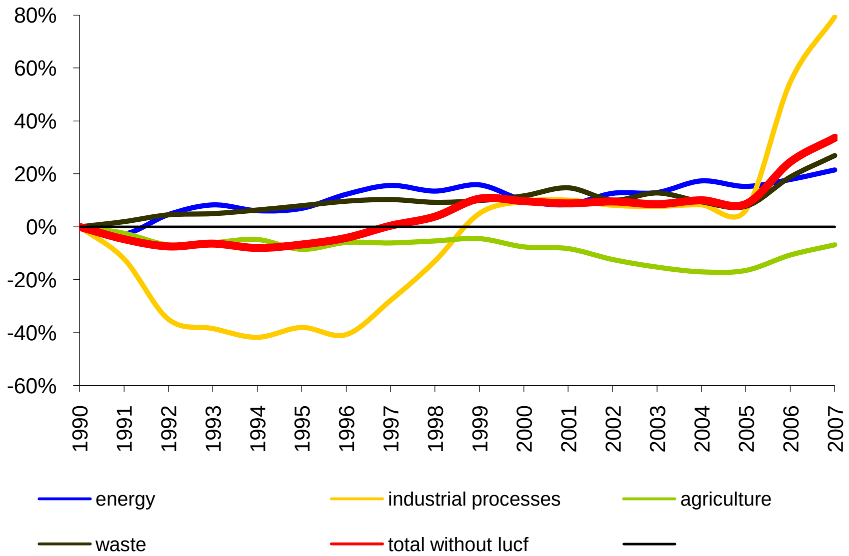

Figure 2.12 Percentage changes in emissions of total greenhouse gas emissions by UNFCCC source categories during the period 1990 – 2007, compared to 1990

2.3.1 Energy

The energy sector in Iceland is unique in many ways. In 2007 per capita energy use was more than 650 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 (77%) is used in metal production. Iceland relies heavily on its geothermal energy sources for space heating and electricity production (30%) and on hydropower for electricity production (70%).

2.3.1.1 Fuel combustion

The total emissions of greenhouse gases from fuel combustion in the energy sector over the period of 1990 – 2007 are listed in Table 2.9. Figure 2.14 shows the distribution of emissions in 2007 by different source categories. The percentage change in the various source categories in the energy sector between 1990 and 2007, compared with 1990, are illustrated in Figure 2.15.

Table 2.9 Total emissions of greenhouse gases from the energy sector in 1990 – 2007, CO_2-eq.

	1990	1995	2000	2005	2006	2007
Energy industries	13	19	10	13	15	30
Manufacturing ind./constr.	377	379	449	454	433	426
Transport	609	615	660	835	981	1017
Other sectors	706	810	756	663	580	598
Total	1704	1824	1876	1965	2009	2070

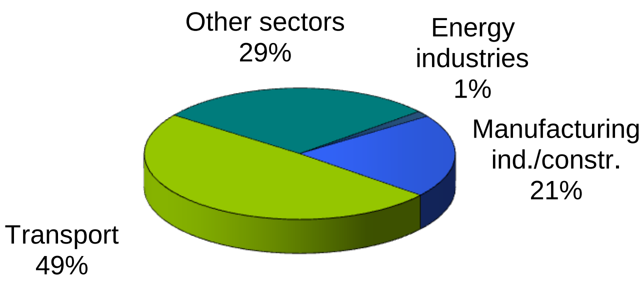

Figure 2.14 Greenhouse gas emissions in the energy sector 2007, distributed by source categories

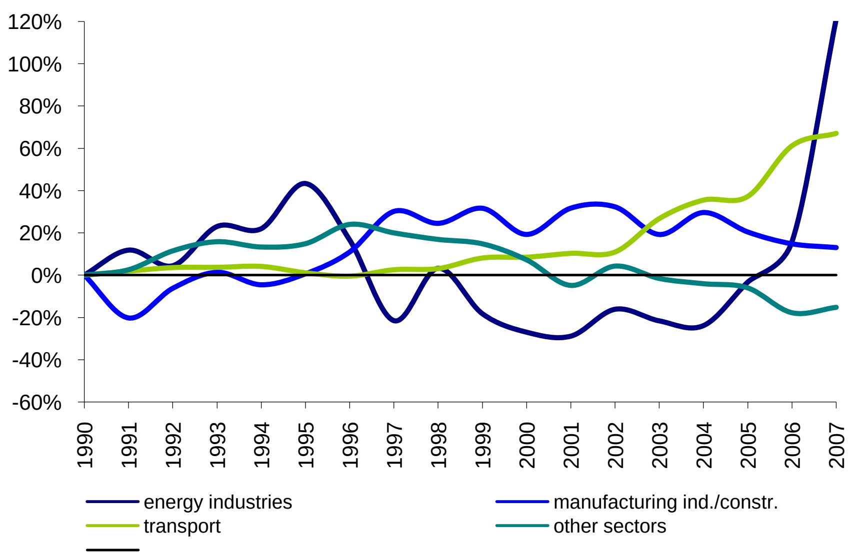

Figure 2.15 Percentage changes in emissions in various source categories of fuel combustion in the energy sector during the period 1990 – 2007, compared to 1990

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.

Energy industries include emissions from electricity and heat production. Iceland relies heavily on renewable energy sources for electricity and heat production, thus emissions from this sector are low. Emissions from energy industries accounted for 1.4% of the sector's total and 0.7% of the total GHG emissions in Iceland in 2007. Electricity is produced with fuel combustion at 3 locations, which are located far from the distribution system. Some generation facilities have back up fuel combustion which they use if problems occur in the distribution system. Some district heating facilities that lack access to geothermal energy sources use electric boilers to produce heat from electricity. They depend on curtailable energy. These heat plants have back-up fuel combustion in case of an electricity shortage or problems in the distribution system. Emissions from the energy industries sector have generally decreased since 1990. In 1995 there were issues in the electricity distribution system that resulted in higher emissions that year. Unusual weather conditions during the winter of 1997/1998 led to unfavorable water conditions for the hydropower plants. This created a shortage of electricity which was met by burning oil for electricity and heat production. In 2007 a new aluminium plant was established. Because the Kárahnjúkar hydropower project was delayed, the aluminium plant was supplied for a while with electricity from the distribution system. This led to electricity shortages for the district heating systems depending on curtailable energy.

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 unusually 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 2007 emissions were 15% under the 1990 level. Annual changes are inherent to the nature of fisheries.

Since 1990 the vehicle fleet in Iceland has increased by nearly 140%. This has led to increased emissions from the transport sector. The latest trend has been towards large passenger cars, which consume more fuel. However, a decrease in navigation and aviation has compensated for rising emissions in the transport sector to some extent.

2.3.1.2 Geothermal energy

Iceland relies heavily on geothermal energy for space heating and electricity production (30% of the total electricity production). The emissions from geothermal power plants are considerably less than from fossil fuel power plants. Table 2.10 shows the emissions from geothermal energy from 1990 to 2007. In the period electricity production with geothermal power plants increased from 283 to 3579 GWh.

Table 2.10 Emissions from geothermal energy from 1990 – 2007, CO_2-eq.

	1990	1995	2000	2005	2006	2007
Total	67	82	163	123	156	152

2.3.2 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 33% of the national greenhouse gas emissions. As can be seen in Figure 2.16 and Table 2.11, emissions from industrial processes decreased from 1990 to 1996, mainly because of a decrease in PFC emissions. During the late nineties large-scale industry expanded in Iceland. The existing aluminium plant and the ferroalloys facility were expanded in 1997 and 1999, and in 1998 a second aluminium plant was established. This second aluminium plant was then expanded in 2006 and a third aluminium plant was established in 2007. This led again to an increase in industrial process emissions.

Table 2.11 Emissions from industrial processes 1990 – 2007, CO_2-eq.

	1990	1995	2000	2005	2006	2007
Mineral products	52	38	66	56	63	65
Chemical industry	49	43	19	-	-	-
Metal production	760	448	830	808	1211	1351
-Ferroalloys	204	239	357	373	371	390
-Aluminium	556	210	473	435	840	961
-Aluminium CO_2	136	151	346	409	507	680
-Aluminium PFC	420	59	127	26	333	281
Consumption of HFCs and SF_6	1	6	30	53	60	69
Total	862	534	945	917	1334	1485
Emissions fulfilling 14/CP.7			273	441	537	669

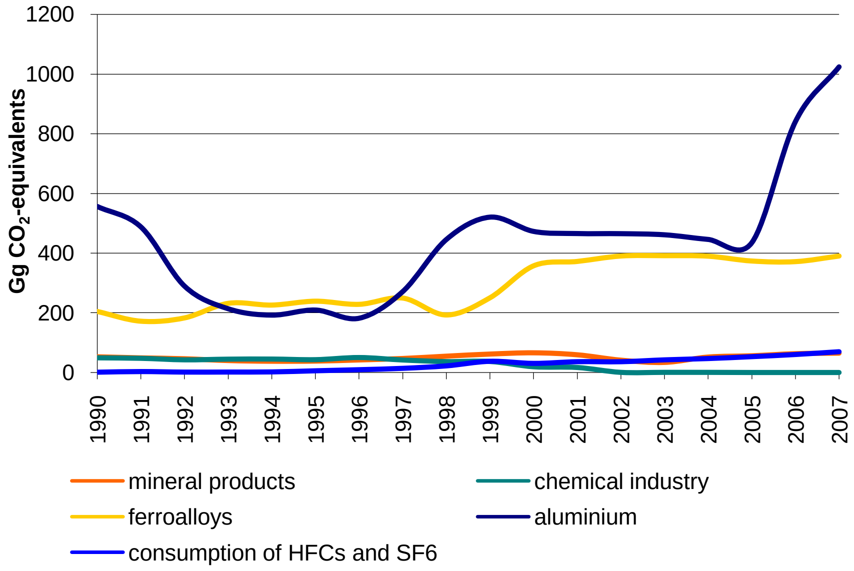

Figure 2.16 Total greenhouse gas emissions in the industrial process sector during the period from 1990 – 2007, Gg CO_2-eq.

The most significant category within the industrial process sector is metal production, which accounted for 86% of the sector's emissions in 1990 and 91% in 2007. Aluminium production is the main source within the metal production category, accounting for 66% of the total industrial process emissions. Aluminium is produced at 3 plants, Rio Tinto Alcan at Straumsvík, Century Aluminium at Grundartangi and Alcoa Fjarðaál at Reyðarfjörður. The production technology in all aluminium plants is based on using prebaked anode cells. The main energy source is electricity, and industrial process CO_2 emission 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 expansion of the existing aluminium plant in 1997 and the establishment of a second 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 at Century Aluminium. The extent of the increase can be explained by technical difficulties experienced during the expansion. PFC emissions remained high per tonne of aluminium at the Century Aluminium plant in 2007, though not as high as in 2006. The Alcoa Fjarðaál aluminium plant was established in 2007. PFC emissions per tonne of aluminium are generally high during start up and usually rise during expansion.

Production of ferroalloys is another major source of emissions, accounting for 25% of industrial processes emissions in 2007. 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 plant was expanded and emissions have therefore increased considerably.

Production of minerals is the sector's second most important category, accounting for 4% of the emissions in 2007. 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 the raw material in the process. Emissions from the cement industry reached a peak in 2000 but declined until 2003, partly because of cement imports. In 2004 to 2007 emissions increased again. This can be explained by increased activity related to the construction of Kárahnjúkar hydropower plant.

Production of fertilizers used to be the main contributor to the process emissions from the chemical industry. Production was terminated in 2001. Silicon production was terminated in 2004 and therefore no chemical industry operated in Iceland in 2007.

Imports of HFCs started in 1992 and increased until 1998. For the first time actual emissions have been estimated in this inventory. An increase is seen in use of HFCs as they are used as substitutes of ozone depleting substances that are being phased out in accordance with Montreal Protocol, EU regulation no. 2037/2000 and Icelandic regulation No. 586/2002 (with subsequent changes). Refrigeration contributes by far the largest part of HFCs and increasing use of air cooling system in cars is also a source. Steady increase is seen from 1992 to 2007. Total emissions were 59 Gg CO_2-equivalents in 2007.

Sulphur hexafluoride emissions are estimated for the first time in this inventory. In earlier inventories emissions were not estimated but held constant over the whole time series. The largest source of SF_6 emissions is leakages from electrical equipment. Emissions have varied between 1 to 11 Gg from 1990 to 2007, showing peaks in years when new power plants were built.

2.3.3 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 oxidize to CO_2 in the atmosphere over time. This conversion has been estimated. Also included in this sector are emissions due to use of N_2O, mainly for medical purposes, but also to a smaller extent for car racing. Total emissions were 7 Gg CO_2-equivalents in 2007 and have declined by 47% since 1990.

2.3.4 Agriculture

As can be seen in Table 2.12 and Figure 2.17, emissions from agriculture decreased from 1990 to 2007. This was mainly due to a decreasing number of livestock. The lowest emissions were observed in 2005. In 2006 and 2007 emissions have risen again due to increased use of synthetic fertilizers.

Table 2.12 Total greenhouse gas emissions from agriculture in 1990 – 2007, Gg CO_2-eq.

	1990	1995	2000	2005	2006	2007
Enteric fermentation	270	248	243	232	236	239
Manure management	58	52	51	48	49	50
Agricultural soils	244	224	236	199	226	245
Total	573	524	530	479	512	534

Greenhouse gas emissions from agriculture comprise methane and nitrous oxide emissions. The greenhouse gas emissions from the agricultural sector accounted for 12% of the overall greenhouse gas emissions in 2007. The largest sources of agricultural greenhouse gas emissions are CH_4 from enteric fermentation and N_2O from agricultural soils.

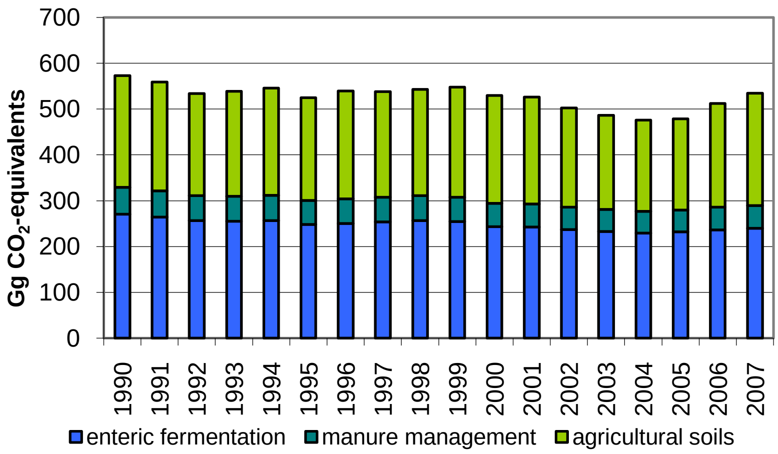

Figure 2.17 Total greenhouse gas emissions from agriculture 1990 – 2007, Gg CO_2-eq.

2.3.5 LULUCF

Emissions from the LULUCF sector in Iceland are high compared to other countries. Research indicates that there are significant emissions of carbon dioxide from drained wetlands. These emissions can be attributed to drainage of wetlands in the latter half of the 20^{th} century, which had largely ceased by 1990. These emissions of CO_2 continue for a long time after drainage.

The time series in the LULUCF sector are incomplete and therefore trend analysis can only be done provisionally. As can be seen in Table 2.13, net emissions (emissions – removals) in the sector have decreased over the time period. This can be explained by both increased removals through forestry and revegetation as well as slightly declining emissions from drained wetlands. Increased removals in Forestry and Revegetation are explained by the increased activity in those sectors. The small increase in emissions from Cropland is due to increased liming. The decrease in emissions from drained wetland is caused by part of the drained area being converted to Forest Land. The increase in emissions from Wetlands is due to increased emissions from hydropower reservoirs as new reservoirs were created during the time period. A large increase in emissions (by 74%) can be seen from 2006 to 2007 when the Kárahnjúkar Hydropower Plant was established. In 2006 the emissions from Wetlands not stemming from hydropower reservoirs are due to a single wild-fire event.

Table 2.13 Emissions from the LULUCF sector from 1990 – 2007, Gg CO_2-eq.

	1990	1995	2000	2005	2006	2007
Forest Land	-19	-30	-44	-61	-68	-78
Cropland	NE	NE	NE	3	4	5
Grassland	1520	1465	1380	1289	1270	1254
- Wetland converted to Grassland	1800	1797	1793	1788	1788	1787
- Revegetation	-280	-332	-412	-499	-518	-534
Wetland	4	14	17	17	19	30
- Hydropower reservoirs	4	14	17	17	17	30
Other emissions	0	0	1	1	2	1
LULUCF Total	1506	1450	1354	1251	1226	1212

Table 2.14 shows the removals from activities under Articles 3.3 and 3.4 of the Kyoto Protocol. Iceland has elected Revegetation as an activity under Article 3.4. In 2007 removals from those activities amounted to 279 Gg using the Net – Net accounting.

Table 2.14 Removals from activities under Articles 3.3 and 3.4 of the Kyoto Protocol 1990 – 2007, Gg CO_2-eq.

	1990	1995	2000	2005	2006	2007
Article 3.3 (Forests)	-4	-8	-14	-22	-26	-29
Article 3.4 (Revegetation)	-8	-60	-141	-227	-247	-262
Article 3.3 and 3.4 (Net-Net)		-56	-143	-238	-261	-279

2.3.6 Waste

As can be seen in 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 and 2007 emissions increased again. From 1990 to 2007 the emissions rose by 51%. 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 28% over the period. Methane recovery started at the largest operating landfill site in 1997, and the amount recovered increased steadily until 2006 when methane recovery equipment failed partly due to technical problems. These problems led to a further failure in methane recovery in 2007.

Emissions from Domestic wastewater handling have increased consistently since 1990 because the total number of inhabitants connected to wastewater facilities has increased in the time period. A small decrease is seen in Domestic wastewater handling in 2007 when a municipality near Reykjavík was incorporated into Reykjavík's wastewater treatment leading to a decrease in emission from that municipality. Emission from Domestic wastewater is a minor factor in total wastewater emission and fluctuation seen in wastewater emission is mainly due to Industrial wastewater where the fishing industry plays the main role.

Emissions from waste incineration have decreased consistently since 1990 because the 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) and 1A4a (commercial and institutional heat production).

Table 2.15 Emissions from the waste sector from 1990 – 2007, Gg CO_2-eq.

	1990	1995	2000	2005	2006	2007
Landfills	134	151	164	167	186	202
Wastewater handling	20	25	26	25	25	23
Waste incineration	19	13	7	0.03	0.03	0.03
Composting	-	0.4	0.4	0.9	1.4	1.8
	173	189	197	192	211	225

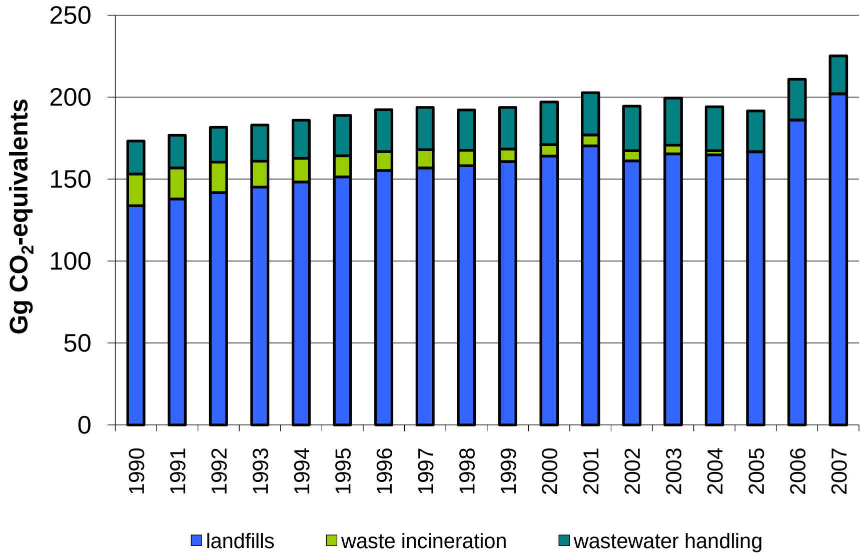

Figure 2.18 Emissions of greenhouse gases in the waste sector 1990 – 2007, Gg CO_2-eq.

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, the 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 2007 emissions were 14% below the 1990 level. Annual changes are inherent to 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 again. The emissions in 2007 were 6% below the 1990 level.

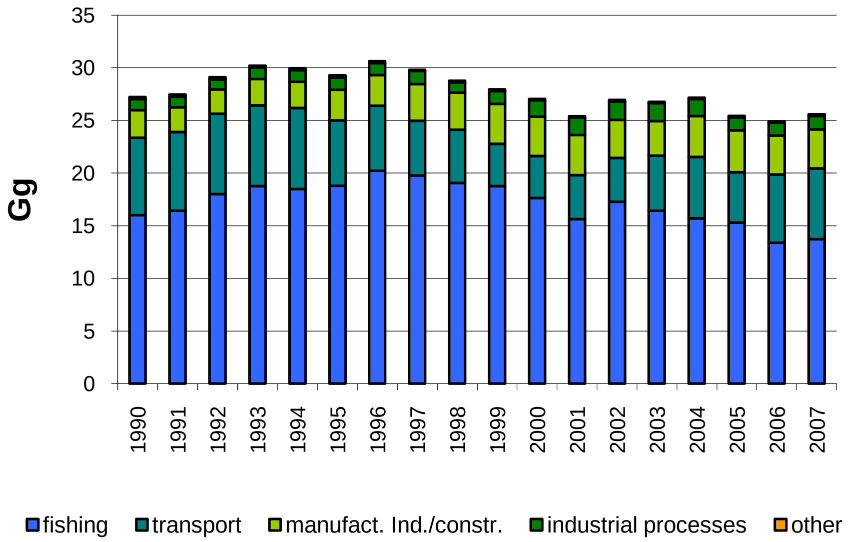

Figure 2.19 Emissions of NOx by sector 1990 – 2007, Gg.

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 2007 with the exception of 2001 and 2005. The emissions in 2007 were 47% below the 1990 level.

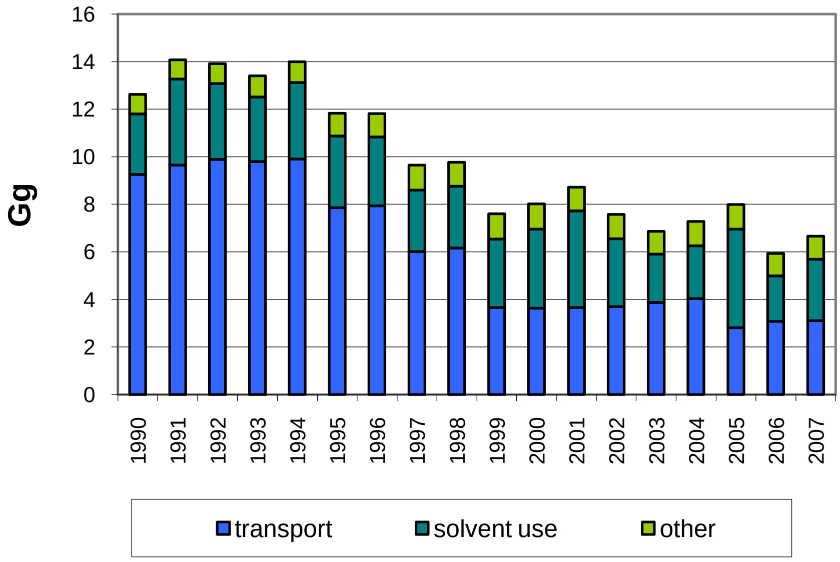

Figure 2.20 Emissions of NMVOC by sector 1990 – 2007, Gg.

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 2007 were 57% below the 1990 level.

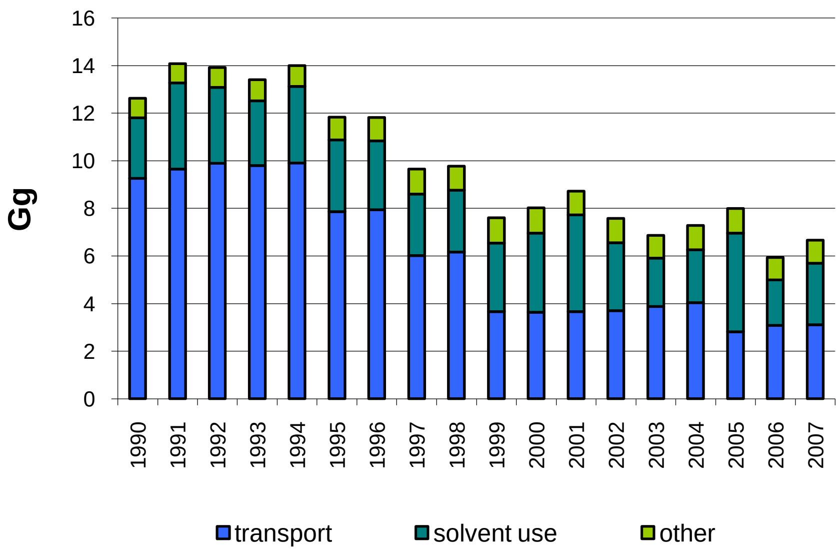

Figure 2.21 Emissions of CO by sector 1990 – 2007, Gg.

2.4.4 Sulphur dioxide (SO_2)

Geothermal energy exploitation is by far the largest source of sulphur emissions in Iceland. Sulphur from geothermal power plants is in the form of H_2S. Emissions have increased by 283% 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. In 1990 around 88,000 tonnes of aluminium were produced at one plant and around 63,000 tonnes of ferroalloys at one plant, Elkem Iceland. In 2007 around 456,000 tonnes of aluminium were produced at three plants and around 114,000 tonnes of ferroalloys were produced at Elkem Iceland. This led to increased emissions of sulphur dioxide. The fishmeal industry is the main contributor to sulphur dioxide emissions from fuel combustion in the sector Manufacturing industries and construction. Emissions from the fishmeal industry increased generally from 1990 to 1997 but have declined since; the emissions were 54% below the 1990 level in 2007.

Total SO_2 emissions in 2007 were 199% above the 1990 level.

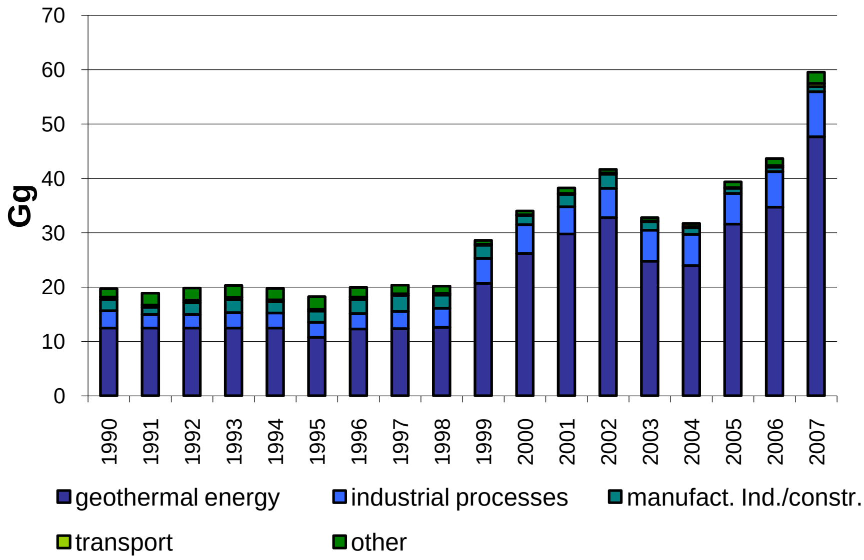

Figure 2.22 Emissions of SO_2 by sector 1990 – 2007, Gg.

3 ENERGY

3.1 Overview

The energy sector in Iceland is unique in many ways. In 2007 the per capita energy use was more than 650 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. The largest portion of the electricity (77%) is used in metal production. Iceland relies heavily on its geothermal energy sources for space heating (92%) and electricity production (30%) and on hydropower for electricity production (70%). Emissions from hydropower reservoirs are included in the LULUCF sector.

The energy sector accounts for 50% of the GHG emissions in Iceland. Energy emissions increased by 21% from 1990 to 2007. From 2006 to 2007 the emissions increased by 3%. Fisheries and road traffic are the sector's largest single contributors. Combustion in manufacturing industries and construction is also an important source.

3.1.1 Methodology

Emissions from fuel combustion activities are estimated at the sectoral level based on the methodologies suggested by the IPCC Guidelines and the Good Practice Guidance. 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. Fuel combustion activities are divided into two main categories; stationary and mobile combustion. Stationary combustion includes Energy Industries, Manufacturing industries and the Other sectors (residential and commercial/institutional sector). Mobile combustion includes Civil Aviation, Road Transport, Navigation, Fishing (part of the Other sectors), mobile combustion in Construction (part of Manufacturing Industries and Construction sector) and International bunkers.

The CO_2 emission factors (EF) used reflect the average carbon content of fossil fuels. They are, with exception of NCV for steam coal, which was obtained from the industry which uses the coal, taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and the Good Practice Guidance. They are presented in Table 3.1 along with sulphur content of the fuels.

Table 3.1 Emission factors for CO_2 from fuel combustion and S-content of fuel

	NCV [TJ/kt]	Carbon EF [t C/TJ]	Fraction oxidised	CO_2 EF [t CO_2/t fuel]	S-content [%]
Kerosene (heating and aviation)	44.59	19.50	0.99	3.16	0.2
Gasoline	44.80	18.90	0.99	3.07	0.005
Gas / Diesel Oil	43.33	20.20	0.99	3.18	0.2
Residual fuel oil	40.19	21.10	0.99	3.08	1.8
Petroleum coke	31.00	27.50	0.99	3.09	IE*
LPG	47.31	17.20	0.99	2.95	0.05
Waste oil	20.06	23.92	0.99	1.74	NE
Electrodes (residue)	31.35	31.42	0.98	3.54	1.55
Steam Coal	27.59	25.80	0.98	2.56	0.9

* sulphur emissions from use of petroleum coke occur in the cement industry. Emission estimates are based on measurements

SO_2 emissions are calculated from the S-content of the fuels. Emission factors for other pollutants for stationary combustion are taken from Table 1-15 to 1-19 of the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. Where EFs were not available the default EF from Tables 1-7 to 1-11 in the Reference Manual was used.

The emission factors for other pollutants from mobile combustion are discussed under each sector in this chapter.

3.1.2 Key source analysis

The key source analysis performed for 2007 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:

- 1A2, Manufacturing Industries and Construction – CO_2
- 1A3, Transport, other than Road Transport – CO_2
- 1A3, Road Transport – CO_2 And N_2O
- 1A4, Residential/Commercial/Institutional – CO_2
- 1A4, Fishing – CO_2
- 1B2, Geothermal Energy – CO_2

3.1.3 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 3.2 Energy – completeness (E: estimated, NE: not estimated, NA: not applicable)

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

3.1.4 Source specific QA/QC procedures

The 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. No source specific QA/QC procedures have been developed yet for the energy sector. A quality manual as outlined in the ISO 9001 is under preparation.

3.2 Energy industries (1A1)

Energy industries include emissions from electricity and heat production. Iceland relies heavily on renewable energy sources for electricity and heat production, thus emissions from this sector are therefore low. Emissions from energy industries accounted for 1.4% of the sectors total and 0.7% of the total GHG emissions in Iceland in 2007.

3.2.1 Electricity production

In 2007 electricity was produced from hydropower, geothermal energy and fuel combustion. In 2007 hydropower was the main source of electricity production. Electricity is produced with fuel combustion at three locations that are located far from the distribution system. Some public electricity plants have back up fuel combustion which they use when problems occur in the distribution system.

Table 3.3 Electricity production in Iceland in 1990, 1995, 2000, 2005, 2006 and 2007. GWh.

	1990	1995	2000	2005	2006	2007
Hydropower	4159	4678	6352	7014	7289	8394
Geothermal	283	288	1323	1658	2631	3579
Fuel combustion	6	8	4	8	5	3
Total	4447	4977	7679	8680	9925	11976

Activity data for fuel combustion and the resulting emissions are given in table 3.4. The resulting emissions of GHG per kWh amount to 1042 g.

Table 3.4 Fuel use and resulting emissions from electricity production. Gg.

	1990	1995	2000	2005	2006	2007
Gas/Diesel oil	1.3	1.5	1.1	2.0	1.3	1.1
Emissions	4.1	4.9	3.4	6.3	4.3	3.5

Emissions from hydropower reservoirs are included in the LULUCF sector and emissions from geothermal power plants are reported in sector 1B2. In 2007, emissions from hydropower reservoirs amounted to 30 Gg of CO_2 equivalents and emissions from geothermal power plants to 152 Gg of CO_2. The resulting emissions of GHG per kWh amount to 3.6 Gg/kWh for hydropower plants and to 42 Gg/kWh for geothermal energy. The average GHG emission from electricity production in Iceland in 2007 was thus 15.5 Gg/kWh.

3.2.2 Heat production

In 2007 geothermal energy was the main source of heat production. Some district heating facilities, which lack access to geothermal energy sources use electric boilers to produce heat from electricity. They depend on curtailable energy. These heat plants have back up fuel combustion in case of electricity shortages or problems in the distribution system. Three district heating stations burn waste to produce heat and are connected to the local distribution system. Emissions from waste incineration with energy recovery are reported under Energy Industries and the method is described in Chapter 8.

Table 3.5 Fuel use and resulting emissions from heat production. Gg.

	1990	1995	2000	2005	2006	2007
Residual fuel oil	3.0	3.1	0.1	0.2	0.1	4.5
Solid waste	NO	4.7	6.0	6.0	10.8	12.0
Emissions (GHG)	9.2	14.2	6.4	6.6	11.2	26.0

Recalculations

In 2007 and 2008 the NEA and EA cooperated in revising the energy statistics. This has resulted in changes in activity data, mainly regarding allocations of fuel use. In earlier submissions there was not a clear distinction between the energy industries sector and the residential and commercial sector in fuel sales statistics. This has now been corrected. Besides that waste incineration with recovery where the heat is used for snow melting or swimming pools, is now reported under the commercial sector. The corrections led to the following changes in emissions from the energy industries sector.

Table 3.6 Recalculation results in the energy industries sector. Gg.

	1990	1995	2000	2005	2006
Public electricity (submission 2008)	4.1	3.5	3.4	0.1	4.3
Public electricity (submission 2009)	4.1	4.9	3.4	6.3	4.3
Public heat (submission 2008)	16.6	23.5	14.1	23.7	29.4
Public heat (submission 2009)	9.2	14.2	6.4	6.6	11.2

3.3 Manufacturing industries and construction

Emissions from manufacturing industries and construction accounted for 21% of the sector’s total and 10% of total GHG emissions in Iceland in 2007. Mobile combustion in the construction sector accounts for 50% of the total emissions from manufacturing industries and the construction sector.

3.3.1 Manufacturing industries, stationary combustion

The total amount of fuel used in by the manufacturing industries is obtained from the National Energy Authority. Total use of different oil products is based on the NEAs annual sales statistics on fossil fuels. The data is considered reliable as all oil companies report their sales data. There is thus a given total, which usage in the different sectors must sum up to. Consumption by the fishmeal industry from 1990 to 2002 is estimated from production statistics, but for 2003 to 2007 consumption is based on data provided by the industry (Green Accounts). All major industries (metal and cement industries) report their fuel use to EA along with other relevant information for industrial processes. Emissions are calculated by multiplying energy use with a pollutant specific emission factor. Emissions from fuel use in the ferroalloys production is reported und 1A2A.

Table 3.7 Fuel use and resulting emissions from stationary combustion in the manufacturing industry. Gg.

	1990	1995	2000	2005	2006	2007
Gas/Diesel oil	5.0	1.6	10.3	24.1	23.8	12.1
Residual fuel oil	55.9	56.2	46.2	25.0	23.6	22.8
LPG	0.5	0.4	0.9	0.9	1.2	1.5
Electrodes (residue)	0.8	0.3	1.5	-	-	0.5
Steam Coal	18.6	8.6	13.3	9.9	13.6	24.4
Petroleum coke	-	-	-	8.1	8.3	0.2
Waste oil	-	5.0	6.0	1.8	0.0	2.3
Emissions	256	231	253	238	238	208

Recalculations

In 2007 and 2008, the NEA and EA cooperated in revising the energy statistics. This has resulted in changes in activity data, mainly regarding allocations of fuel use. In earlier submissions there was a growing part of the fuel consumption reported under 1A5 Other. This has now been corrected. The consumption that was earlier reported as 1A5 is now mainly allocated to industry (a minor proportion is 1A1a). Fuel consumption for the ferroalloys industry in 1990 and 1991 was missing and is now extrapolated from production data. NCV for steam coal is now taken directly from the cement industry. Methane from LPG in the aluminium industry is now included. NCV and C-content for petroleum coke in the cement industry was corrected in this submission. The corrections led to the following changes in emissions from the energy industries sector.

Table 3.8 Recalculation results in the manufacturing industry and construction sector. Gg CO_2 equivalents.

	1990	1995	2000	2005	2006
Stationary combustion in the manufacturing industry (submission 2008)	257	229	249	211	213
Stationary combustion in the manufacturing industry (submission 2009)	256	231	253	238	238

3.3.2 Manufacturing industries, mobile combustion

Activity data for mobile combustion in the construction sector is provided by the NEA. The data is considered reliable since all the oil companies have reported their sales statistics. Oil, which is reported to fall under vehicle usage, is in some instances actually used for machinery and vice versa. This is, however, very minimal and the deviation is believed to level out. Emissions are calculated by multiplying energy use with a pollutant specific emission factor.

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 3.9.

Table 3.9 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 last year's estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from construction is 11%.

3.4 Transport (1A3)

Emissions from transport accounted for 49% of the sector's total and 23% of the total GHG emissions in Iceland in 2007. Road transport accounts for 92% of the emissions in the transport sector.

3.4.1 Civil Aviation

Emissions are calculated by using Tier 1 methodology, thus multiplying energy use with a pollutant specific emission factor. Total use of jet kerosene and gasoline is based on the NEA's annual sales statistics for fossil fuels.

The emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and are presented in Table 3.10. Emissions of SO_2 are calculated from S-content in the fuels.

Table 3.10 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

3.4.2 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. 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 NEA estimates how fuel consumption is divided between different vehicles groups; passenger cars, light duty vehicles and heavy duty vehicles. The number of vehicles in each group comes from the Road Traffic Directorate.

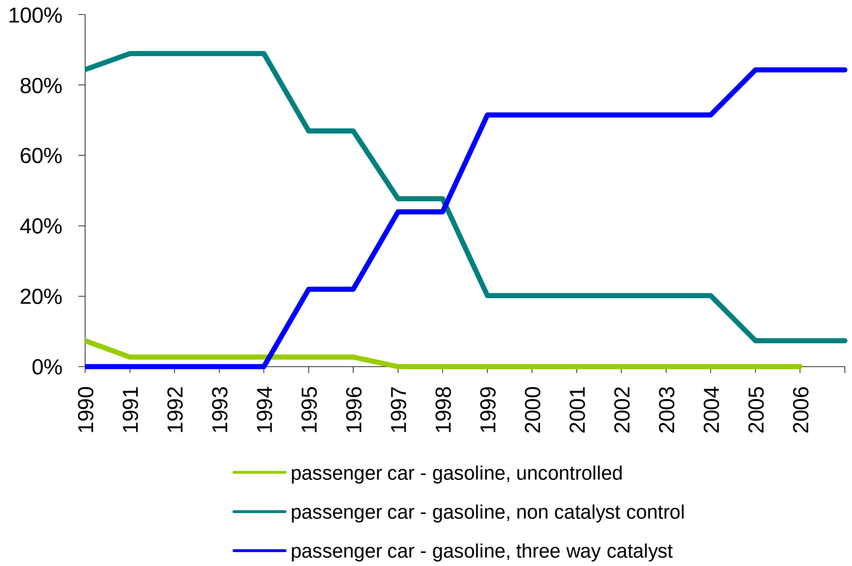

Figure 3.1. Passenger cars by emission control technology

The EA has estimated the amount of passenger cars by emission control technology. The proportion of passenger cars with three-way catalysts has steadily increased since 1995 when they became mandatory in all new cars.

For CO_2 the standard emission factors based on the 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 3.11.

Table 3.11 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

Last year’s 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

The NEA now estimates the fuel split between the different types of vehicles. The activity data therefore differs slightly from earlier estimates by EA. The new method is not accurate but considered better than earlier estimates. This has led to the differences in emission estimates that are presented in table 3.12.

Table 3.12 Recalculation results in the manufacturing industry and construction sector. Gg.

	1990	1995	2000	2005	2006
Road transport (submission 2008)	516	548	619	785	900
Road transport (submission 2009)	517	548	620	786	901

3.4.3 National navigation

Emissions are calculated by multiplying energy use with a pollutant specific emission factor.

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 emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories for ocean-going ships and are presented in Table 3.13.

Table 3.13 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

3.5 International bunker fuels

Emissions from international aviation and marine bunker fuels are excluded from national totals as is outlined in the IPCC Guidelines. These emissions are presented separately for informational purposes and can be seen in Table 3.14.

In 2007, greenhouse gas emissions from ships and aircraft in international traffic bunkered in Iceland amounted to a total of 725 Gg CO_2-equivalents, which corresponds to about 16% of the total Icelandic greenhouse gas emissions. Greenhouse gas emissions from marine and aviation bunkers increased by around 125% from 1990 to 2007; with a 13% increase between 2006 and 2007.

Looking at these two categories separately, it can be seen that greenhouse gas emissions from international marine bunkers increased by 109% from 1990 to 2007, while emissions from aircrafts increased by 132% during the same period. Between 2006 and 2007 emissions from marine bunkers increased by 50% while emissions from aviation bunkers increased by 2%. Foreign fishing vessels dominate the fuel consumption from marine bunkers.

Table 3.14 Greenhouse gas emissions from international aviation and marine bunkers, Gg CO_2-eq.

	1990	1995	2000	2005	2006	2007
Marine	100	146	221	112	139	209
Aviation	222	238	411	425	504	516
Total	322	384	632	537	643	725

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 3.13 above. Emission factors for aviation bunkers are also taken from the IPCC Guidelines and presented in Table 3.10 above.

Recalculations

NEA has corrected the jet kerosene consumption in 2006 since last submission. This has led to an increase of GHG emissions from aviation bunkers from 393 to 504 Gg in 2006.

3.6 Other sectors (1A4)

Sector 1A4 consists of fuel use for commercial, institutional and residential heating as well as fuel use in agriculture, forestry and fishing. Since Iceland relies largely on its renewable energy sources, fuel use for residential, commercial and institutional heating is low. Residential heating with electricity is subsidized and occurs in areas far from public heat plants. Commercial fuel combustion includes the heating of swimming pools, but only a few swimming pools in the country are heated with oil. Emissions from the fishing sector are high, since the fishing fleet is large. Emissions from fuel use in agriculture and forestry are included elsewhere; mainly in the construction sector. Emissions from the Other sector accounted for 29% of the sector's total and for 13% of total GHG emissions in Iceland 2007. Fishing accounted for 95% of the Other sector's total.

3.6.1 Commercial, institutional and residential fuel combustion

This sector's 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. Emissions from waste incineration with recovery, where the energy is used for snow melting or swimming pools are reported here and a description of the method is in Chapter 8.

Recalculations

The 2007 and 2008 revision of energy statistics has resulted in changes in activity data, mainly regarding allocations of fuel use. In earlier submissions there was no clear distinction between the Energy Industries sector and the Residential and Commercial sector in fuel sales statistics. This has now been corrected. Besides that, waste incineration with recovery where the heat is used for snow melting or swimming pools is now reported under the Commercial sector. All waste incineration with energy recovery was in earlier submissions reported under the Energy Industries sector. The corrections led to the following changes in emissions from the commercial, institutional and residential sector.

Table 3.15 Recalculation results in the commercial, institutional and residential sector. Gg. CO_2 eq

	1990	1995	2000	2005	2006
Commercial/institutional/residential (submission 2008)	6.7	1.0	1.4	1.5	1.6
Commercial/institutional/residential (submission 2009)	12.3	6.5	7.0	16.3	14.7

3.6.2 Agriculture, forestry and fishing

Emissions from fuel use in agriculture and forestry are included elsewhere, mainly within the construction sector; thus, emissions here only stem from the fishing fleet. Emissions from fishing are calculated by multiplying energy use with a pollutant specific emission factor.

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 considered reliable since all oil companies report their sales statistics.

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 3.13 above.

Uncertainties
The last year's preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from fishing is 5%.

3.7 Cross-cutting issues

3.7.1 Sectoral versus reference approach

This section will be included in the next submission.

3.7.2 Feedstock and non-energy use of fuels

Emissions from the use of feedstock 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, coking 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.

3.8 Geothermal energy (1B2)

3.8.1 Overview

Iceland relies heavily on geothermal energy for space heating (92%) and to some extent for electricity production (30% of the total electricity production in 2007). 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 2007 has revealed that geothermal energy is a key source in terms of both level and trend.

3.8.2 Methodology

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 can vary greatly between areas and the wells within an area as well as by the time of extraction.

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 determined by adding up the CO_2 discharge from individual wells.

Table 3.16 shows the electricity production with geothermal energy and the total CO_2 and sulphur emissions (calculated as SO_2).

Table 3.16 Electricity production from geothermal energy in Iceland in 1990, 1995, 2000, 2005, 2006 and 2007.

	1990	1995	2000	2005	2006	2007
Electricity production (GWh)	283	288	1323	1658	2631	3579
Carbon dioxide emissions (Gg)	67	82	163	123	156	152
Sulphur emissions (as SO_2, Gg)	12	11	26	32	35	48

4 INDUSTRIAL PROCESSES

4.1 Overview

The production of raw materials is the main source of industrial process-related emissions for CO_2, N_2O and PFCs. Emissions also occur as a result of the use of HFCs as substitutes for ozone depleting substances. The industrial process sector accounted for 33% of the GHG emissions in Iceland in 2007. Emissions in the sector decreased from 1990 to 1996, mainly due to a 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. By 2007, emissions from the industrial processes sector were 72% above the 1990 level. This is mainly due to the expansion of energy intensive industry and high process emissions (PFCs) from an aluminium plant that was expanded in 2006 and 2007 as well as the start-up of another aluminium plant in 2007. The dominant category within the industrial process sector is metal production, which accounted for 91% of the sector's emissions in 2007 (Figure 4.1).

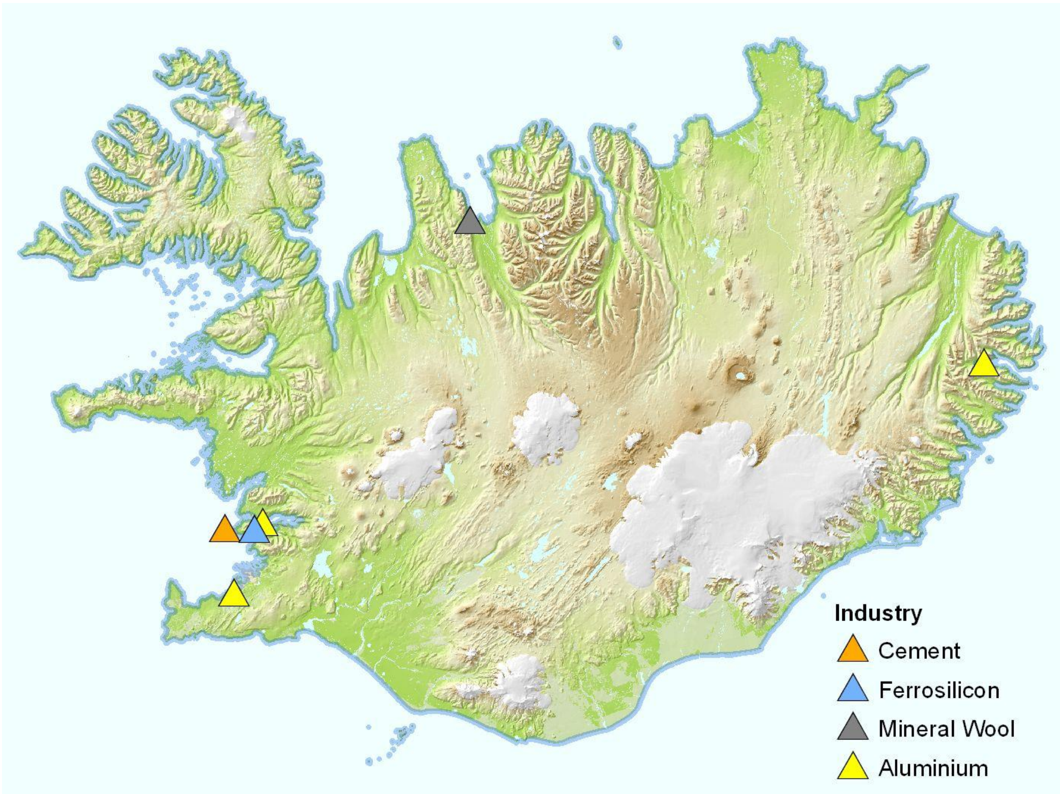

Figure 4.1 Location of major industrial sites in Iceland

4.1.1 Methodology

Greenhouse gas emissions from industrial processes are calculated according to methodologies suggested by the IPCC Guidelines and the Good Practice Guidance.
The key source analysis performed for 2007 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 Mineral industry – CO_2 (2A)
- Emissions from Chemical industry – N_2O (2B)
- Emissions from Ferroalloys – CO_2 (2C2)
- Emissions from Aluminium Production – CO_2 and 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 subcategories in the industry sector.

Table 4.1 Industrial Processes – Completeness (E: estimated, NE: not estimated, NA: not applicable, IE: included elsewhere)

	Greenhouse gases						Other gases			
Sector	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NOx	CO	NMVOC	SO_2
Mineral Products:										
Cement Production	E	NE	NE	NA	NA	NA	NE	NE	NE	IE**
Lime Production	N O T O C C U R R I N G									
Limestone and Dolomite Use	N O T O C C U R R I N G									
Soda Ash Production and Use	N O T O C C U R R I N G									
Asphalt Roofing	N O T O C C U R R I N G									
Road Paving with Asphalt	NE	NE	NE	NA	NA	NA	E	E	E	E
Other (Mineral Wool Production)	E	NE	NE	NA	NA	NA	NE	E	NE	E
Chemical Industry										
Ammonia Production	N O T O C C U R R I N G									
Nitric Acid Production	N O T O C C U R R I N G									
Adipic Acid Production	N O T O C C U R R I N G									
Carbide Production	N O T O C C U R R I N G									
Other (Silicium Production – until 2004)*	E	NE	NE	NA	NA	NA	E	NE	NE	NE
Other (Fertilizer Production – until 2001)*	NA	NE	E	NA	NA	NA	E	NE	NE	NE
Metal Production										
Iron and Steel Production	N O T O C C U R R I N G									
Ferroalloys Production	E	E	NA	NA	NA	NA	E	E	E	E
Aluminium Production	E	NE	NE	NA	E	NA	NE	NE	NE	E
SF_6 used in aluminium/magnesium foundries	N O T O C C U R R I N G									
Other	N O T O C C U R R I N G									
Other Production										
Pulp and Paper	N O T O C C U R R I N G									
Food and Drink	NE	NA	NA	NA	NA	NA	NA	NA	NE	NA
Production of Halocarbons and SF_6	N O T O C C U R R I N G									
Consumption of Halocarbons and SF_6	NA	NA	NA	E	NO	E	NA	NA	NA	NA
Other	N O T O C C U R R I N G									

*Fertilizer production was terminated in 2001 and Silicium production was terminated in 2004
** SO2 emissions from cement production are reported under the energy sector, based on measurements

4.1.3 Source specific QA/QC procedures

The 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. Activity data from all major industry plants is collected through electronic surveys, allowing immediate QC checks. QC tests involve automatic t/t checks on certain emissions and activity data from this industry. A quality manual as outlined in the ISO 9001 is under preparation.

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 to fully calcined dust produced in the kiln. CKD may be partly or completely recycled in 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.

$$CO_2 \text{ Emissions} = M_{cl} \bullet EF_{cl} \bullet CF_{ckd}$$

Where,

M_{cl} is clinker production

EF_{cl} is the clinker emission factor; $EF_{cl} = 0.785 \bullet \text{CaO content}$

CF_{ckd} is a correction factor for non-recycled cement kiln dust.

Activity data

Process-specific data on clinker production, the CaO content of the clinker and the amount of 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 2003-2007. Historical clinker production data has been calculated as 85% of cement production, which was the average proportion for 2003- 2005.

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

Year	Cement production [t]	Clinker production [t]	CaO content of clinker	EF	CKD	CO_2 emissions [kt]
1990	114,100	96,985	63%	0.495	107.5%	51.6
1991	106,174	90,248	63%	0.495	107.5%	48.0
1992	99,800	84,830	63%	0.495	107.5%	45.1
1993	86,419	73,456	63%	0.495	107.5%	39.1
1994	80,856	68,728	63%	0.495	107.5%	36.5
1995	81,514	69,287	63%	0.495	107.5%	36.8
1996	90,325	76,776	63%	0.495	107.5%	40.8
1997	100,625	85,531	63%	0.495	107.5%	45.5
1998	117,684	100,031	63%	0.495	107.5%	53.2
1999	133,647	113,600	63%	0.495	107.5%	60.4
2000	142,604	121,213	63%	0.495	107.5%	64.4
2001	127,660	108,511	63%	0.495	107.5%	57.7
2002	84,684	74,099	63%	0.495	107.5%	39.4
2003	75,314	60,403	63%	0.495	107.5%	32.1
2004	104,829	93,655	63%	0.495	107.5%	49.8
2005	126,123	99,170	63%	0.495	110%	53.9
2006	147,874	112,219	63%	0.495	110%	61.0
2007	148,348	114,668	63.8%	0.501	110%	63.2

Emission factors

It has been estimated by the cement production plant that the CaO content of the clinker is 63% for all years from 1990 to 2006 and 63.8% in 2007. The corrected emission factor for CO_2 is thus 0.495 from 1990-2006, and 0.501 for 2007. For CKD it is 107.5% for all years except 2005 - 2007 when it is 110%.

Uncertainties

The last years' 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 itself, the road surfacing operations and from the subsequent road surface. Information on the amount of asphalt produced comes from Statistics Iceland. The emission factors 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 industries that have existed in Iceland involve the production of silicium and fertilizer. The fertilizer production plant was closed in 2001 and the silicium production plant was closed in 2004.

At the silicium production plant, silicium containing sludge was burned to remove organic material. Emissions of CO_2 and NO_x were estimated on the basis of the 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 EA.

4.4 Metal Production

4.4.1 Ferroalloys

Ferrosilicon (FeSi, 75% Si) is produced at one plant, Elkem Iceland at Grundartangi. The raw material used 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 agents, as well as from the 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 through electronic survey from Elkem Iceland ferroalloys production plant. The data is thus considered reliable.

Emission factors

For CO_2, standard emission factors based on the 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 the Good Practice Guidance. 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 comes 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]
Coking Coal	29.01	25.80	0.98	2.69
Coke Oven Coke	26.65	29.50	0.98	2.82
Electrodes	28.00	32.14	0.98	3.23

Uncertainties

Last year's preliminary estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from ferroalloys production is 11%.

Recalculations

Following the recommendations in the 2008 centralized review, Iceland has changed the NCV for coking coal from 28.00 TJ/ktonnes to 29.01 TJ/ktonnes and for coke oven coke from 28.00 to 26.65 TJ/ktonnes. The new values are taken from the IPCC GPG.

4.4.2 Aluminium Production

Aluminium is produced in 3 smelters in Iceland, Rio Tinto Alcan at Straumsvík, Century Aluminium at Grundartangi and Alcoa Fjarðaál at Reyðarfjörður. They all 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 vary 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 aluminium plants, through electronic surveys. 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 come from the IPCC Good Practice Guidance for Centre Worked Prebaked Technology (0.14 for CF_4 and 0.018 for C_2F_6). For high performing facilities that emit very small amounts of PFCs, the Tier 3 method will likely not provide a significant improvement in the overall facility GHG inventory in comparison with the Tier 2 Method. Consequently, it is *good practice* to identify these facilities prior to selecting methods in the interest of prioritising resources. The status of a facility as a high performing facility should be assessed annually because economic factors, such as the restarts of production lines after a period of inactivity, or, process factors, such as periods of power curtailments might cause temporary increases in anode effect frequency. In addition, over time, facilities that might not at first meet the requirements for high performers may become high performing facilities through implementation of new technology or improved work practices.

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 – 2007.

Year	Aluminium production [kt]	CO_2 emissions [Gg]	AE Anode Effect [min/cell day]	PFC emissions [Gg 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
2007	455.761	679.8	2.59	281.3	1.49	0.62

Uncertainties

The last year's 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. 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 Other production

Other production in Iceland is the Food and Drink Industry. Emissions from this sector have not been estimated.

4.6 Production of Halocarbons and SF_6

There is no production of halocarbons and SF_6 in Iceland.

4.7 Consumption of Halocarbons and SF_6

4.7.1 Emission of HFC

HFCs are used as substitutes for the ozone depleting substances (CFCs and HCFCs) which are being phased out by the Montreal Protocol. In Iceland the F-gases have been regulated since 14 April 1998, and HFC is banned for certain uses. HFCs are imported in bulk for use in stationary and mobile air-conditioning systems, and in imported equipment e.g. refrigerators, cars 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 bulk import of HFCs started in 1992 and increased until 1998. Annual imports have since stayed between 30 and 81 Gg CO_2-equivalents. It is assumed that the import of cars with MAC (mobile air-conditioning systems) started in 1995. Since then there has been a rapid increase in private cars with MAC, and from the year 2005 about 30-40% of all private cars have MAC, all busses and about 60% of larger trucks. The use of HFCs in some applications, specifically rigid foam (typically closed-cell foam), refrigeration and fire suppression, can lead to the development of long-lived banks of HFC. Sufficient data are now available for the first time to calculate actual emissions in most applications. The total HFC import in 2007 was 90 Gg CO_2-equivalents, emissions were 59 Gg CO_2-equivalents and HFC stored in banks was 383 Gg CO_2-equivalents (Figure 4.1). In 2007 the actual emissions of HFCs were about 1% of national total greenhouse gas emissions (without LULUCF). This source category is a key source in both level and trend.

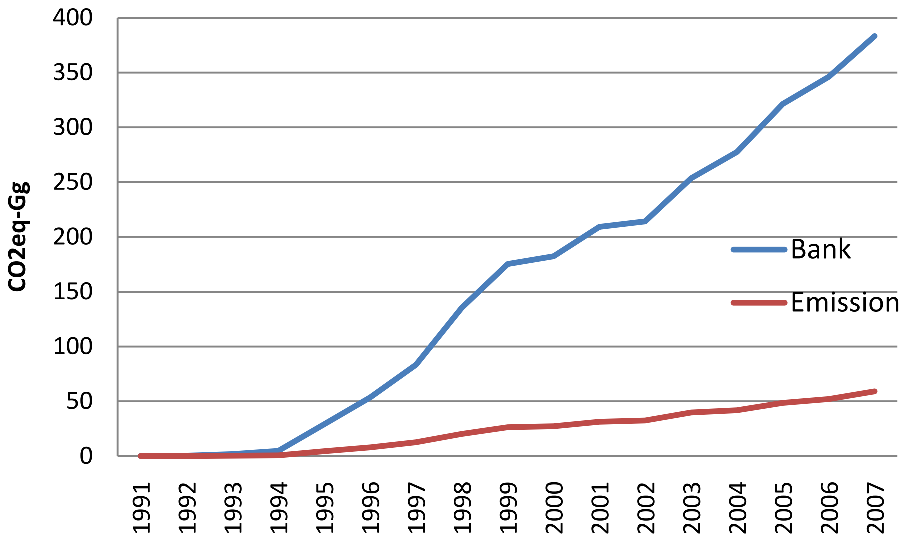

Figure 4.1. HFC emission and HFC accumulated in banks

Method

Emissions of HFCs (sector 2F) are calculated using the Tier 1 methodology which takes into account the import, export and destruction of chemicals in bulk and in equipment with time lag.

Data on imported and exported bulk are reported directly to the EA each year. Data on imported cars are gathered from the Road Traffic Directorate and data on imported dose inhalers are gathered from The Icelandic Medicines Control Agency. Data on HFCs in refrigeration equipment is estimated from import statistics, based on land of origin and type of refrigerator. There is no destruction facility of HFCs in Iceland, but 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 the type and amount of HFC they import in order to release the chemicals from the customs agency. It is assumed that 95% of HFC-134a is used in refrigeration equipment and 5% for air conditioning in vehicles. Other chemicals imported in bulk are assumed to be used in refrigeration equipment.

Estimates of HFCs emissions from cars are based on data of imported cars combined with expert estimates based on surveys performed by EA. An average lifetime of equipment is reported in table 4.6

Table 4.6 Average lifetime of equipment

Refrigeration systems	15 years
MAC	12 years
Dose inhalers	2 years

Uncertainty
The quantitative uncertainty has not been evaluated. The activity data are obtained from official data and are considered reliable. The exact number of cars with MAC systems is not available; approximation is used in accordance with the survey performed by EA. The level of proper disposal of HFCs in used refrigerators and refrigeration system and MAC systems in cars is uncertain.

Uncertainty varies between HFC types. Uncertainty is greatest for HFC-134a due to its widespread application in products that are imported and exported for destruction. Uncertainties that arise due to imperfect measurement and assessment are a significant issue for emission estimates from MAC (HFC-134a) and emissions estimates from commercial refrigerants (HFC-134a).

Planned improvements
Considerable progress has been made towards improving estimates for this source for 2007. Still there are uncertainties; the use of HFC in surgery as well as in foam blowing agents has not been assessed.

4.7.2 Emissions of SF_6 from Electrical Equipment

Sulphur hexafluoride (SF_6) is mainly used for insulation and current interruptions in equipment used in the transmission and distribution of electricity. To a minor extent, SF_6 is used in research particle accelerators in universities.

There is no SF_6 production in Iceland. Consumption of SF_6 is mainly through insulation in electrical distribution systems. Actual emissions of SF_6 have been estimated for the first time through questionnaires addressed to power companies asking for the installed amounts of SF_6 in operating equipment, and the replaced amounts of SF_6 during service. Data on SF_6 use dates back to 1974. The results showed an installed accumulated amount of approximately 17,200 kg SF_6. This is probably slightly underestimated as there might be some data missing. One of the larger power stations (Blanda) has been registering leakage since 2006. Leakage is usually negligible, but taking into account exceptional leakage an annual leakage rate of 0.8% was used as input data in this inventory. A large fluctuation is seen in SF_6 emission. This is due to the leakages that occur during the installation of new distribution systems and expansion of older systems. Emissions of 11 Gg CO_2 equivalents occurred in 1999 when two large power stations were built and enlarged (Sultartangi and Búrfell) (figure 4.2). Average emission since 1990 is 3 Gg CO_2 equivalents. There is no data on retired equipment.

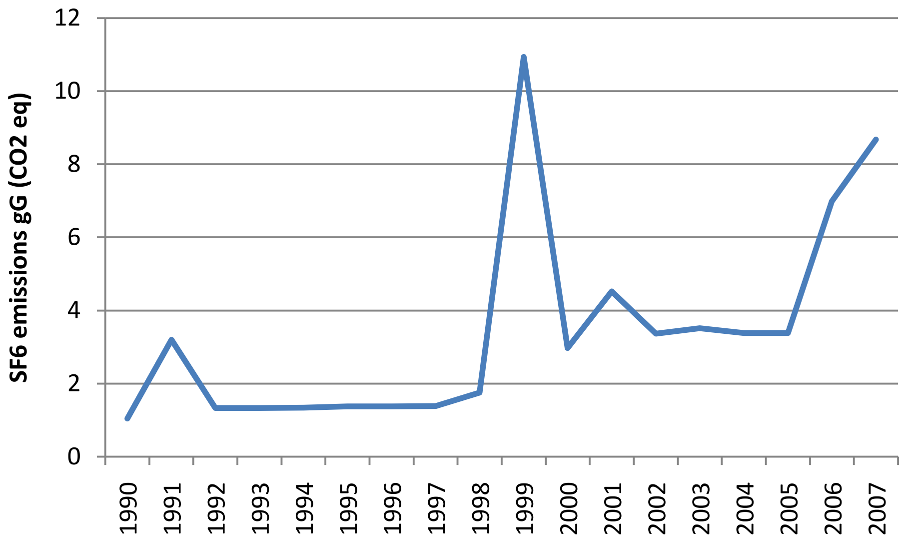

Figure 4.2. SF6 Emissions 1990-2007

The development of the Blanda power project began in 1984 and the first generating unit went online in the autumn of 1991. This can be s seen as a peak in Figure 4.2. In following years expansion took place in the Industrial sector (mainly in expansion and building of aluminium plants and the ferroalloys facility), which called for increased electricity production. This led to a period of development of power plants, where production was increased by 60% in five years. The power plants at Blanda and Búrfell were expanded and new plants were constructed at Sultartangi and Vatnsfell in southern Iceland. In 2002 construction began on Kárahnjúkar Power Plant, Iceland's largest hydropower plant, which resulted in another 60% increase in electricity production.

SF_6 Emission from insulation in the electrical distribution system

Total emissions of SF_6 = Installation Emissions + Use Emission + Disposal Emissions

Parameters in connection to insulation in electrical distribution system	
Installation emission*	**0.06**
Use emission	**0.008**

*IPCC default emission factor table 3.12 in good practice guidance and uncertainty in management of National Greenhouse Gas Inventory

SF_6 emission from university particle accelerators has been estimated by use of import data dating back to 1993. On average, 32 kg of SF_6 have been imported each year for these purposes. According to the IPCC Guidelines, 0.7 is used as an emission factor.

University and Research Particle Accelerator SF_6 Emissions

Total emissions of SF_6 = Use Emission

Parameters in connection to University and Research Particle Accelerator Emissions	
Use emission*	**0.07**

*IPCC default emission factor equation 8.5 2006 IPCC guidelines for National Greenhouse Gas Inventory

Emission factors

Taking into account the information provided by power companies and the IPCC default values for emission factors in electrical insulation and current interruptions in equipment used in the transmission and distribution of electricity, the emission factor was set as 0.008.

Planned improvements

Considerable progress has been made towards improving estimates for this source for 2007. More detailed data will be collected and 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 most are native breeds, i.e. dairy cattle, sheep, horses and goats, which all are of an ancient Nordic origin, one breed for each species. These animals are generally smaller than the breeds common elsewhere in Europe. Beef production, however, is through imported breeds, as is all pork and poultry production. There is not much crop production in Iceland, due to the cold climate and subsequently short growing season. Cropland in Iceland consists mainly of cultivated hayfields, but potatoes and barley are grown on limited acreage.

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 2007 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, Cattle – CH_4 (4A1)
- Emissions from Enteric Fermentation, Sheep – CH_4 (4A3)
- Manure management – N_2O (4B)
- 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 (E: estimated, NE: not estimated, NA: not applicable)

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

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 significant. 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 Farmers Association of Iceland (FAI) is, on behalf of the Icelandic Food and Veterinary Authority, in charge of recording the size of all farm animal population every year, namely the annual livestock census. These numbers are reported to Statistics Iceland that publishes them officially. On request from the EA, the IAF assisted EA in coming up with a method to account for young animals, but those are mostly excluded from national statistics on animal populations. The data are considered relatively reliable. Table 6.2 shows animal population according to Statistics Iceland and Table 6.3 shows the corrected animal population data.

Table 6.2 Animal population data from Statistics Iceland

	1990	1995	2000	2005	2006	2007
Cattle, total	74889	73199	72135	65979	68670	70660
Dairy cattle	32246	30428	27066	24538	25504	26048
Non-dairy cattle	42643	42771	45069	41441	43166	44612
Sheep	548508	458341	465777	454950	455656	454812
Goats	345	350	416	439	449	524
Horses	71693	78202	73995	74820	75644	76982
Swine	3116	3726	3862	3982	4218	4147
Poultry	214936	164402	178093	166119	181857	184244
Mink	42000	29941	36593	35935	41957	41497
Foxes	4800	7308	4132	774	116	93

Table 6.3 Corrected population data

	1990	1995	2000	2005	2006	2007
Cattle, total	75913	74212	73203	66961	69692	71717
Dairy cattle	32249	30428	27066	24538	25504	26048
Non-dairy cattle	43664	43784	46137	42423	44188	45669
Sheep	767031	640835	650948	636094	637081	635901
Goats	518	525	624	659	674	786
Horses	74961	81384	76667	77303	78722	80115
Swine	29645	31130	32267	33269	35241	36648
Poultry	771585	590069	693061	596232	652718	661286
Mink	42000	29941	36593	35935	41957	41497
Foxes	4800	7308	4132	774	116	93

The large difference in swine and poultry levels between the official population data and the corrected data is due to the significant disparity between the breeding stock and the whole population including young animals. For swine, the national statistics include only the breeding stock, so all young animals have to be added. This is done by estimating the total number of pigs per sow (15 pigs/sow from 1990 to 1994 and 17 pigs/sow thereafter) and an estimated average life span of a piglet of 165 days. For poultry, the population of young animals was estimated on basis of the poultry consumption of the Icelandic nation in 2002 and the same ratio used for all years from 1990.

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 6.4. The emission factors are likely to be too high, since domestic livestock breeds are generally smaller (sheep, horses, cows) than in other European countries.

Table 6.4 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

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

Planned improvements

Developing country-specific emission factors from feed intake according to the Tier 2 method is planned, in particular for the Icelandic livestock breeds. All data required for this Tier shift is available at the Agricultural University of Iceland.

6.3 Manure management

Manure production is responsible for methane and nitrous oxide emissions. Methane is produced during the anaerobic decomposition of manure, while nitrous oxide is produced during the storage and treatment of manure prior to it being 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, and the relevant emission factors were 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 those for fur animals which are taken from Norway's NIR 2007. They are presented in Table 6.5, but are likely to be overstated, as domestic livestock breeds of cows, horses and sheep are generally smaller than in other European countries.

Table 6.5 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.

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

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 6.8. Emission factors for N_2O-N/N are those suggested by the IPCC Guidelines. The treatment of manure in different management systems 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 2007. The shares of manure management systems per animal species differ therefore for the period 1990 – 2007. The situation in 1990 to 2007 is reflected in Table 6.6.

Table 6.6 Manure management systems

	1990	1995	2000	2005	2006	2007
Cattle:						
- Liquid	46%	49%	53%	53%	53%	53%
- Solid	20%	17%	13%	13%	13%	13%
- pasture	34%	34%	34%	34%	34%	34%
Sheep and goats:						
- liquid	17%	17%	17%	17%	17%	17%
- solid	41%	41%	41%	41%	41%	41%
- pasture	42%	42%	42%	42%	42%	42%
Horses:						
- solid	17%	17%	17%	17%	17%	17%
- pasture	83%	83%	83%	83%	83%	83%
Swine:						
- liquid	90%	95%	100%	100%	100%	100%
- solid	10%	5%	0%	0%	0%	0%
Poultry:						
- solid	100%	100%	100%	100%	100%	100%
Fur animals:						
- liquid	10%	10%	10%	10%	10%	10%
- solid	90%	90%	90%	90%	90%	90%

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 (applicable to Iceland at the 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

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 and multiplied by the IPCC default emission factor. Since the closure of the fertilizer production plant in 2001, there is no domestic production of synthetic fertilizers in Iceland and Statistics Iceland collects information on the total annual import of synthetic fertilizers. The amount of synthetic fertilizers used in the forestry and revegetation sectors is subtracted from the total imported amount to find out the amount used in agriculture. The emissions are corrected for ammonia that volatilizes during application. The IPCC default fraction of 0.1 for volatilization is used.

Table 6.7 Use of synthetic fertilizer in Iceland, tonnes.

	1990	1995	2000	2005	2006	2007
Total use of synthetic fertilizer	12474	11197	12681	9775	12342	13832
Use in forestry	3	4	16	18	19	23
Use in revegetation	334	303	362	812	831	534
Use in agriculture	12140	10894	12319	8946	11492	12950

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 6.8. They are taken from Óskarsson. and Eggertsson (1991), except for fur animals which are taken from Norway's NIR 2007. The emissions are corrected for ammonia that volatilizes during application. The IPCC default fraction of 0.2 for volatilization is used.

Table 6.8 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

Cropland in Iceland consists mainly of cultivated hayfields. From the crops listed in the IPCC Guidelines only potatoes and barley are grown in Iceland. The potato production was significantly smaller in 1993 to 1995 due to an epidemic of fungal disease. The production of barley started in 1992 and has risen the last few years. Barley is almost solely used as fodder. Only a very small fraction is used for human consumption. Table 6.9 provides an overview of crop production from 1990 to 2007.

Table 6.9 Potato and barley production

	1990	1995	2000	2005	2006	2007
Potatoes (tonnes)	14893	7324	9843	7250	13800	13000
Barley (tonnes)	NE	485	3041	9773	11253	11246

This source is very small, since almost all barley is used as fodder and the crop residue is either used as fodder or in greenhouses. Emissions of N_2O amounted to 0.2 Gg CO_2-equivalents in 2007.

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 last years' 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
The revision of country-specific N excretion factors is planned, as new research indicates that these factors underestimate the N excretion rate, at least for recent years as animal production levels have been rising. A new estimate will be included in next submission.

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 (AUI) in close cooperation with Icelandic Forest Research (IFR) and Soil Conservation Service of Iceland (SCSI) on sections related to Forests and Revegetation.

The CRF for LULUCF was prepared through the UNFCC CRF Reporter program (version 3.2.3). Land use categories have been decided and formally defined. The classification of land according to these definitions is implemented for all the main land use categories. Structure of further subdivision of land has been defined although only implemented for some categories. The structure of information reported is mostly as in last submission. The modifications are; (1) Forest Land: The category “New plantations inventory year” is now included under “Plantations 1-20 years old”, (2) Grassland: Revegetation is now reported under “Land converted to Grassland” instead for “5.G –Other”.

The AUI has since 2007 been constructing the Icelandic Geographic Land use Database (IGLUD) to meet the requirements of LULUCF reporting. In this year’s submission, the area estimate for the main land use categories is based on this database except where more precise estimates are available.

Time series for land conversions are provided for some categories although still incomplete. The conversion period used varies between categories as explained below. Four types of land conversion were reported in the 2008 submission: Grassland converted to Forest Land, Wetlands converted to Grassland, Grassland converted to Wetlands and Other Land converted to Wetland. Additionally in this year’s submission Revegetation is reported under Grassland as Other Land converted to Grassland, instead of under 5.G- Other. Due to limitations of the present version of UNFCCC reporter the Non–CO_2 emissions of Wetlands converted to Grassland and of Revegetation are still reported under 5.G. Part of Grassland converted to Forest Land is now allocated to Other Land converted to Forest Land and deforestation estimated for the first time is reported as Forest Land converted to Settlement.

The QA/QC plan presented in the 2008 NIR has not been fully implemented regarding LULUCF. However, some components of the plan have been included in the preparation of the inventory. Formal QA/QC procedures have not been prepared for LULUCF. The methods used for estimating emission/removal for individual sinks and sources are compliant with the AFOLU guidelines as described for relevant components below. In general, tier 1 QC are applied in preparation of the inventory for the LULUCF sector. Documentation of all the QC results is not included in preparation of the inventory as QC findings are corrected prior to submission if possible. The remaining QC findings are reported in this report.

As stated in Chapter 1.2.1, the Coordinating Team was established in 2008. One role of the team is i.e. to review the inventory. Expert (T1 QC) review on the submitted CRF has not been completed but will be included as part of the preparation for the next inventory submission. The process of preparing the CRF submitted in 2008 has been presented to the Coordinating Team and discussed. The same procedures were applied when preparing this year's submission, although data sources used are in some cases based on improved methodology. The preparation of the LULUCF inventory has also been reviewed of UNFCCC-Expert Review Teams.

Accumulation and processing of land use information is revised through implementing the definitions of land use categories and adopting new data. The processing of land use data is described below.

The reported emissions for the LULUCF sector in 2007 are 1,212 Gg CO_2 equivalents. In this year's submission the estimated LULUCF emissions for 2006 are 1,226 Gg CO_2 equivalents compared to 1,127 Gg CO_2 equivalents in the 2008 submission. This reflects the recalculation effects. Emission/removal estimates for both Forest Land and Revegetation were revised and in both cases the revision resulted in decreased estimate of CO_2 removal. For Forest Land the removal decreased from -134 Gg CO_2 (2008 submission) to -73 Gg CO_2 (2009 submission) for the inventory year 2006, reflecting higher tier methodology (T2-T3) in 2009. Removal of CO_2 due to revegetation decreased likewise from -554 Gg CO_2 (2008 submission) to -518 Gg CO_2 (2009 submission for the inventory year 2006 reflecting revised area estimate).

7.2 Data Sources

The present CRF reporting is based on land use as recorded from IGLUD (Icelandic Geographic Land Use Database), activity data on afforestation and deforestation from Icelandic Forest Research (IFR) and on revegetation from the Soil Conservation Service of Iceland (SCSI). Data on liming is based on sold $CaCO_3$ and imported synthetic fertilizers containing chalk or dolomite.

The data sources and process of compiling the data to IGLUD will be described in details elsewhere (Guðmundsson et al 2009 in prep). Provided below is a short description of the database, a list of its main data sources, the definitions of main land use categories as applied in IGLUD and the present structure of subcategories.

7.2.1 The Icelandic Geographic Land Use Database (IGLUD)

7.2.1.1 Introduction

The objective of the Icelandic Geographic Land Use Database (IGLUD) is to compile information on land use and land use changes to meet the requirements of the IPCC Guidelines for National Greenhouse Gas Inventory (IPCC 2006). The categorization of land use also needs to be, as much as possible, based on existing information and adapted to Icelandic land use practices. An important criterion is that the land use practices most affecting the emission or removal of greenhouse gases and changes in the extent of these practises are recognised by the database. The defined land use classes need to be as recognisable as possible; both through remote sensing and on the ground. This applies especially to those categories not otherwise systematically mapped. Another important objective of the IGLUD is that all six main land use classes of IPCC Guidelines should be geographically identifiable.

Within the database, subdivisions of the main land use categories should either be identified geographically or the relative division commonly known either within a region or the whole country. Relative division can be based on ground surveys or other information.

7.2.1.2 Land use practices and consequences

The dominant land use in Iceland through the ages has been that of livestock grazing. The natural birch woodland, widespread at the time of settlement (AD 875), was exhausted for most part by the end of the 19th century as a result of intensive grazing, collection of firewood and charcoal making (Þórarinsson, 1974). Following vegetation degradation, soil erosion became prevalent leading to the present day situation of highland areas having almost completely lost their soil mantle and large areas in the lowland regions being impacted by erosion as well (Arnalds et al., 2001).

Cultivation of arable land in Iceland has through the ages been very limited. Cereals (barley) were cultivated to some extent in the first centuries after settlement but during the Little Ice-age it completely ceased. Due to better cultivars and a warmer climate, grain cultivation has resurfaced in the last few decades (Hermannsson, 1993). Livestock fodder, hay, was traditionally obtained from uncultivated grasslands and wetlands. With the mechanization of agriculture early in the 20th century, farmers increasingly converted natural grasslands and wetlands into hayfields (Jónsson, 1968).

In the period, 1940-1990, massive excavation of ditches to drain wetlands took place, aided by governmental subsidies. Only a minor portion of these drained areas was turned to hayfields or cultivated, the larger part of the lowland wetlands in Iceland was turned into grassland through this drainage effort.

This land use history needs to be reflected in the national greenhouse gas inventory as do the actions taken to recover some of the lost resources. Definitions of land use categories, thus, need to differentiate between grassland of variable degradation, and areas which are being restored either by direct activity as in revegetation efforts or due to decreased grazing pressure. Grassland and cropland formed by drainage also need to be separated from other land in these categories.

Ongoing land use changes in Iceland are not systematically recorded and consequently its direction or trend is unknown. Certain land use changes are however apparent. Among these are decreased grazing, enlargement of agricultural units and abandonment of others, urban spreading and introduction of new branches in farming. The major challenge of the IGLUD is to detect and quantify these changes.

7.2.1.3 Existing land use information

Geographical mapping of land use in Iceland has not been practiced to the same extent as in many European countries. Historically, the farms were relatively large in area but only a small percentage of the land was cultivated. Use of commons, such as summer grazing in highlands, was based on orally inherited rules rather than written accounts. When written division existed it was generally based on references to names of identities in the landscape. Land use within each farm was entirely based on the decisions of the owner which in most cases was the residing farmer.

It was not until the 20th century that detailed countrywide mapping began. The first complete mapping of Iceland which included major landscape features and vegetation types was completed in 1943 (Landmælingar Íslands, 1943). Since then there have been ongoing efforts to map topography, vegetation, erosion and geology. Land use has only partly been mapped. Mapping of cultivated areas has been attempted a few times but never really completed. Settlements have been recorded on topographical maps and updated regularly. The first soil map of Iceland was produced in 1959 (Jóhannesson, 1988). A new map was produced in the year 2000 and revised in 2001 (Arnalds and Grétarsson, 2001)

Total vegetation mapping started in 1955. The main objective was to estimate the grazing capacity of the land. The project was lead by the Icelandic Agricultural Research Institute and its precursors. The project was taken over by the Icelandic Institute of Natural History 1995. Today 2/3 of the country has been mapped at scales ranging from 1:10.000 to 1:40.000.

The natural birch woodland has been mapped in two surveys, first in 1972-1975 and again in 1987-1991. These maps have been digitised and rectified along with new maps of cultivated forest built on forest management maps and reports (Traustason and Snorrason, 2008).

In the last two decades of the 20th century, satellite images became available and opened up new opportunities in mapping. Several mapping projects were initiated in Iceland based on these images. In the years 1991-1997 soil erosion within the country was assessed and mapped and all farmland was mapped in 1998-2008 according to both vegetation type and grazing land condition. This last mapping project is compiled in a digital geographical database (NYTJALAND) and forms the main data source for the IGLUD.

Iceland has become formal partner of the European land use classification program CORINE. The first CORINE Land Cover (CLC) mapping for 2006 was delivered in 2008. In later stages, CLC 2000/2006 changes will also 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.

The NYTJALAND classification does not completely cover Iceland. For the remaining areas a classification, the CORINE project has been carried out, but with lower resolution and fewer classes accepted. IGLUD is based on this classification for the gaps in NYTJALAND coverage.

7.2.1.4 Main data sources compiled in IGLUD

The resulting classification of land use as presented in this submission is the based on several sources. The most important listed her:

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. The mapping is now complete for approximately 60% of the country, there of 70% of the lowlands below 400 m above sea level, has been covered. This geographical database is based on remote sensing using both *Landsat 7* and *Spot 5* images, existing maps of erosion and vegetation cover and various other sources. Extensive ground-truthing has resulted in a level of approximately 85% correct categorisation on less than 0.05 ha resolution.

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 14×14 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 larger neighbour area, thus leaving 0.196 ha as minimum mapping unit.

The NYTJALAND database is the primary data source of IGLUD.

Table 7-1 Land cover classes of the NYTJALAND database

NYTJALAND Class (Icelandic name in brackets)	Short description
Cultivated land (ræktað land)	All cultivated land including hayfields and cropland.
Grassland (Graslendi)	Land with perennial grasses as dominating vegetation including drained peat-land where upland vegetation has become dominating.
Richly vegetated heath land (Ríkt mólendi)	Heath land with rich vegetation, good grazing plants common, dwarf shrubs often dominating, and mosses common.
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.
Moss land (Mosi)	Land where moss covers more than 2/3 of the total plant cover. Other vegetation includes grasses and dwarf shrubs.
Shrubs and forest (Kjarr og skóglendi)	Land covered to more than 50% of vertical projection with trees or shrubs higher than 50 cm
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.
Wetlands (votlendi)	Mires and fens. Variability of vegetation is high but mires are dominated by Carex and Equisetum species and often shrubs.
Partly vegetated land (hálf gróið)	Land where vegetation cover is from 20-50% generally infertile areas often on gravel soil. Areas where the vegetation is both retreating and in progress can be included in this class
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.
Lakes and rivers	Lakes and rivers
Glaciers	Glaciers

CLC-2006

The National Land Survey of Iceland (NLSI) has as responsible participant for Iceland in the European land use classification program CORINE prepared CLC-2006 map describing the 2006 land cover according to CORINE classification. NYTJALAND was an important source for the CLC-2006 and for the purpose of finishing CLC-2006 the gaps in NYTJALAND were closed with classification taking in to account merging of classes as applied when converting NYTJALAND classes to CLC-2006. The CLC-2006 provides the data for the Settlements category and classification for the gaps in NYTJALAND.

Maps of forests

All known forests including plantations have been mapped at the IFR on basis of aerial photographs, satellite images and activity reports. These maps form the geographical background behind the National Forest Inventory carried out by IFR. The category Forest Land in IGLUD is based on these maps.

Maps of land being revegetated
The SCSI collects information on revegetation activities. All revegetation activities since 1990 are already mapped. These maps form the geographical background for the national inventory of revegetation carried out by SCSI. The mapping of revegetation taking place before 1990 is less reliable with regard to activity as it is more directed toward location than recording activity. The Grassland subcategory Land being Revegetated in IGLUD is identified on the basis of these maps.

Maps of ditches
The AUI in cooperation with NLSI has on the basis of satellite images (SPOT 5) and with the support of aerial photographs digitized all ditches in Iceland. The Grassland subcategory Grassland on Drained Wetland Soils is identified in IGLUD on basis of these maps.

Maps of cultivated land:
AUI is working on digitization of cropland, also in cooperation with NLSI. These preliminary maps are used in IGLUD to identify the Cropland category.

Besides these main sources of information, several supplementary data sources are used in compilation of the land use classes in IGLUD. These supplementary data includes vegetation maps, road maps and geological maps.

7.3 Definitions of Land use categories.

Definitions of the six main land use categories as they are applied in IGLUD are listed below, along with description of how they were compiled from the existing data.

7.3.1 Broad land use categories

Settlements[2]: All artificial areas larger than 0.5 ha with linear features >10 m, as defined in the CORINE land cover classification. This category includes urban areas with >30% impermeable surface, industrial, commercial and transport units, mines, dumps and construction sites and artificial non-agricultural vegetated areas.

Forest Land[3]: All land, not included under Settlements, presently covered with trees or woody vegetation more than 2 m high, crown cover of a minimum 10% and at least 0.5 ha in continuous area and minimum width 20 m and also land which currently fall below these thresholds, but *in situ* could potentially reach these thresholds.

Cropland[4]: All cultivated land not included under Settlements or Forest Land and at least 0.5 ha in continuous area and minimum width 20 m. This category includes harvested hayfields with perennial grasses.

[2] This definition is according to CORINE definition
[3] There is possible overlap of Forest Land or other categories and Settlement in subcategory 1.4. under Settlement "artificial non-agricultural vegetated areas". By this definition these areas are categorized under Settlement.
[4] Definition according is to AFOLU guidelines (2006) with the addition of 20 m minimum width and clarification on harvested hayfields.

Wetlands: All land that is covered or saturated by water for all or part of the year and do not fall into the Settlements, Forest Land, Cropland categories. It includes reservoirs as managed subdivision and natural rivers and lakes as unmanaged subdivision.

Grassland: All land where vascular plant cover is >20% and not included under the Settlements, Forest Land, Cropland or Wetlands categories. This category includes as subcategory land which is being revegetated and meeting the definition of the activity and does not fall into other categories. Drained wetlands[5] not falling into other categories are included in this category as Land being converted to Grassland.

Other Land: This category includes bare soil, rock, glaciers and all land that does not fall into any of the other categories. All land in this category is unmanaged. This category allows the total of identified land area to match the area of the country.

Revegetation is not defined as subjected to one specific land use category according to the FCCC/CP/2001/13/Add.1, but as activity. Revegetation as practiced in Iceland converts eroded or desertified land from Other Land or less vegetated subcategories of Grassland to Grasslands or Grasslands with more Vegetation Cover. Revegetation activity can also result in such land being converted to Cropland, Wetlands or Settlement. Forest Land is excluded by definition.

> *Revegetation: 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.*

7.3.2 Definition of sub-categories

All categories except Other Land are, at least in theory, divided into managed and unmanaged land. Also requested in the CRF, is the division of each category between, land remaining in relevant category and land being converted to that category, subdivided according to previous land use category. The division of the broad land use categories into subcategories will be described in detail elsewhere (Guðmundsson et al 2009 in prep). The subdivisions implemented in this submission are defined below;

> Settlement: No subdivision is used in this submission. The data used is divided into four subcategories according to CORINE land cover technical guide (Bossard et al., 2000) but reported as aggregated area.

[5] In “Report of the individual review of the greenhouse gas inventory of Iceland submitted in 2006” the ERT recommends this activity (drainage) to be reported under the category wetland (5.D). In inventory submitted 2008 the drained wetlands are reported under wetland converted to grassland. This revision of reporting this category was Iceland’s response to the ERT recommendations. In UNFCCC “Report of the individual review of the greenhouse gas inventory of Iceland submitted in 2007 and 2008” the ERT believes that Non-CO_2 emission from drainage of soils and wetlands should be reported under agricultural sector instead of LULUCF. No comparable comment is raised regarding CO_2 emission from the same land. Drained wetlands meeting the criteria for Settlements, Forest Land or Cropland are included under these categories.

Forest Land: Two subcategories are defined; Natural Birch Forest and Cultivated Forest. The Cultivated Forest are further divided according to age into Forest Land remaining Forest Land and Land converted to Forest Land.

(1) Natural Birch Forest: Forest where the dominant species *Betula pubescens* has generated naturally from sources of natural origin
(2) Plantations (Cultivated Forests): Forest where planted and/or directly seeded trees are dominant or trees naturally generated from cultivated forest are dominant..
    a. Plantations 1-20 years old: A plantation is considered one year old the autumn the year the tree was planted[6]. This category is reported under Land converted to Forest Land.
    b. Plantations older than 20 years old: This category is reported under Forest Land remaining Forest Land.

Cropland: No subdivision is used in this submission.

Wetlands: The Wetlands category is subdivided into Natural Wetlands and Reservoirs. Natural Wetlands are divided further into three classes and Reservoirs are subdivided according to type of land being flooded.

(1) Lakes and Rivers
(2) Mires and Fens: This category includes peat land and mineral soil wetlands. In this year's submission this category is reported as an aggregated part of Other Wetlands.
(3) Semi-wet areas: This category includes the ecotone between peat land and upland ecosystems. This land is often grazed by livestock and therefore considered managed. This land is one of the land cover classes of the NYTJALAND database. In this year's submission this category is reported as aggregated part of Other Wetlands along with Mires and Fens land subcategory (2).
(4) Reservoirs: Land minimum of 0.5 ha where freshwater is stored for hydropower or other purposes, behind artificial dams. The area of the reservoirs is subdivided according to the type of land flooded.
    a. Lakes and Rivers: This part of the reservoir area is classified as Land remaining Wetlands.
    b. Land with High Soil Organic Carbon (SOC) >50 kg C/m^2 (High SOC). This category includes land with organic soil or complexes of peatland and upland soils. This land is classified as Land converted to Wetlands or as changes between wetland subcategories. The high SOC soils are in most cases organic soils of peat lands or peat land previously converted to Grassland or Cropland through drainage.
    c. Land with Medium SOC 5-50 kg C/m^2 (Medium SOC). This land includes most grassland, cropland and forestland soils except the drained wetland soils.

[6] *For the inventory year 2007 plantations planted the years 1988-2007 are included.*

d. Land with Low SOC < 5 kg C/m^2 (Low SOC). This category includes land with barren soils or sparsely vegetated areas previously categorized under Other Land.

Grassland: This category is in this year's submission subdivided into three categories.

(1) Grassland on Drained Wetland Soils: This land is defined as previous wetland where the water table has been lowered permanently and now meets the classification criteria for Grassland. The land is identified on basis of existence of ditches or other drainage structures and reported as Wetlands converted to Grassland.
(2) Land being revegetated: All land recorded by the SCSI as land with Revegetation activity that neither meets the definitions of Afforestation and Reforestation nor falls under Settlement, Cropland or Wetland. This land is reported as Land being converted to Grassland subdivided according to what the land is converted from. In this year's submission all land in this category is reported as Other Land converted to Grassland although some areas might previously have been classified as Grassland. SCSI estimates <5% would fall to that category.
(3) All other Grassland: This land is reported as Grassland remaining Grassland.

Other Land: No subdivision of Other Land is applied in this submission.

7.4 Land use map

A land use map for the inventory year was prepared, applying the definitions of land use categories and compiling existing data as described in Guðmundsson et al (2009 in prep.),. This map gives the estimated area for each of the categories mapped. The map for each main category was prepared separately. The overlapping areas can therefore be identified providing valuable feedback for the method used in identifying each category. The hierarchy of the main land use categories as included in the definitions is shown in Figure 7-1.

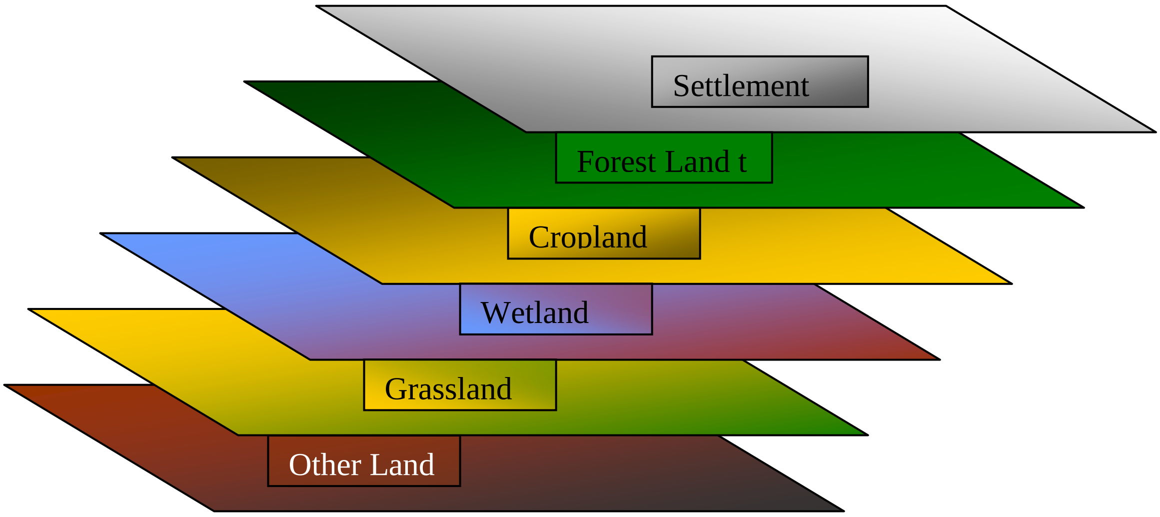

Figure 7-1 Hierarchy of land uses categories as included in the definitions of the categories

The resulting land use map is shown in Figure 7-2. The construction of IGLUD is not complete and this first map is expected to develop considerable in the coming years, including expected changes to the allocation of land between categories and their subcategories. The area of the land use categories as they appear in this map is used as a basis for the area estimates used in the CRF. The land use categories and their area as they appear on the map are listed in Table 7-2. Also listed in the same table is the comparative area as applied to the CRF after the modification described below (see section 7.5). The differences, in these two area estimates, pinpoint the categories where either mapping or area estimate used for CRF needs to be revaluated. Solving these differences may include revised compilation of land use map-layers, improved mapping, adopting the mapping results in the CRF, revision of method used for CRF area estimate or reallocation or subdivision of category area.

7.5 Estimation of area of land use categories used in the CRF LULUCF tables.

For many of the land use categories used in the CRF LULUCF tables additional information is available on the category total area, other than what is already compiled into IGLUD. This additional information is used to adjust the area of each category. The changes are processed downward in the hierarchy of the land use categories.

To obtain the area estimate for each land category, the following changes were made:

Settlement: The Settlements category as prepared for CLC-2006 excludes most of the roads. Accordingly, all roads are added with a buffer zone (a variable buffer zone according to road type). The area of CLC-2006 plus roads area is the estimate used in the CRF. All underlying categories are cut according to the Settlements layer and the overlapping area absorbed into the Settlements layer.

Forest Land: The Forest Land layer remaining when Settlements have been cut out is compared to area of Forest Land as estimated by the IFR through the national forest inventory (see section 7.7). The difference in area is balanced against the Grassland category. The area estimated from the national forestry inventory is used in the CRF. The subdivision of Forest Land to Organic and Mineral soil and by previous land use is done according to the IFR unpublished data from the national forest inventory. Land is allocated to subcategories according to information provided by the IFR.

Cropland: The Cropland layer is determined from maps of cultivated land as remaining when Settlements and Forest Land layers have been subtracted and compared to area of Cropland as reported by Icelandic Agricultural Statistics. The difference is balanced against Grassland. The area estimated by Icelandic Agricultural Statistics is used in the CRF.

Wetlands: The Wetlands layer was obtained from NYTJALAND and CLC-2006 maps as remaining, when layers for Settlement, Forest Land and Cropland have been subtracted and is maintained as is, as no supplementary information is available. This area estimate is used in the CRF as the total category area. This category is reported as three subcategories i.e. Reservoirs, Lakes and Rivers, and Other Wetlands. The Reservoirs area data is from the companies running the reservoirs subtracted from the total area of lakes and rivers as recorded from NLSI IS-50 maps. The remaining area is reported as lakes and rivers. The remaining land is Other Wetlands.

Grassland: The Grassland layer is compiled from NYTJALAND plus CLC-2006, Revegetation area maps and map of ditches, including all land with vascular plant cover >20%. The area remaining when layers of Settlement, Forest Land, Cropland and Wetlands have been subtracted and taken into account the balancing of area against Forest Land and Cropland forms the total area of the category. This area is then balanced against Other Land. In the CRF, this category is divided into three subcategories. Maps are available for two of them, i.e. Land being Revegetated and Grassland on Drained Wetland Soil. The area of these subcategories remains when overlying categories have been subtracted and compared to area estimated through national inventory of revegetation and area of drained soils as estimated from total length of ditches and drainage efficiency (Óskarsson, 1998) respectively. The resulting difference in drained soils is balanced against the area of the subcategory Other Grassland and the difference in land being revegetated against Other Land. 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).

Other Land: The land remaining when all other layers have been subtracted is used as the estimate for the area of this category.

The resulting area estimates of land use categories are listed in Table 7-2.

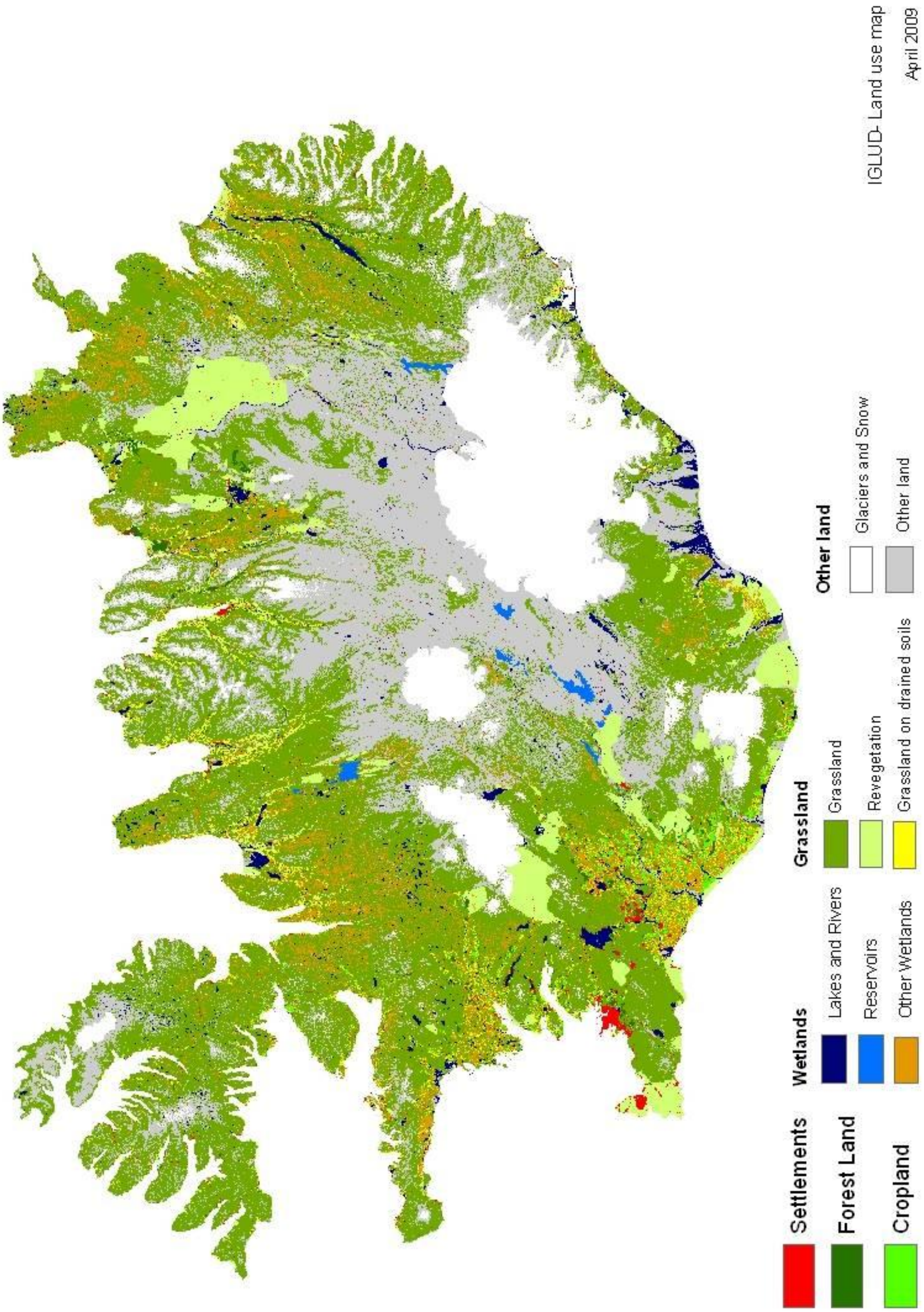

Figure 7-2 Map of Iceland showing the present status of land use classification in IGLUD

Table 7-2 Area of land use categories as mapped in IGLUD and as applied in CRF-tables.

Area of land use categories					
		Main category [kha]		Subdivision in map [kha]	
Main Land use category	Subdivision applied	Mapped area	Area used in CRF tables	Mapped area	Area used in CRF tables
Settlement		86.47	86.47		
Forest Land		66.28	77.61		
	Plantations			42.40	29.61
	Natural birch forest			23.87	48.00
Cropland		163.08	129		
Wetland		812.00	812.00		
	Reservoirs			32.48	44.78
	Lakes and rivers			200.21	187.92
	Other wetlands			579.34	579.34
Grassland		5273.19	4992.71		
	Other Grasslands			4612.06	4427.25
	Total area recorded as revegetation			490.10	194.04
	Drained soils (Grassland)			171.02	371.42
Other land		3891.46	4187.51		
	Glaciers and snows			1326.97	
	Other (Sparsely or not vegetated land)			2.564.75	
Total area		10285.30	10285.30		

7.6 Time series

Time series are lacking for most land use categories. There are only three categories where time series are based on yearly land use information, i.e. Forest Plantations, Revegetation Activity and Reservoirs. Time series for Cropland is also provided although with very low resolution in time. All other reported time series on land use are derivatives of these time series.

7.6.1 Land use changes

Emission/removal of GHG due to land use changes is reported for seven types of land conversions, i.e. Grassland to Forest Land, Other Land to Forest Land, Wetlands to Grassland, Other Land to Grassland, Grassland to Wetland, Other Land to Wetlands and Forest Land to Settlement.

The conversion period varies between categories as explained in relevant sections below. Records of land use changes are still limited in Iceland and only available for a few of the land use categories requested in the CRF. In preparing this submission, maps of all main land use categories and most of the reported subcategories were prepared. The quality of these maps still needs to be ascertained. Gradual updating of the maps and comparison with older maps and land use data is expected to provide better estimates for land use changes than is currently available.

Table 7-3 Land use classification used in GHG inventory 2007 submitted 2009.

Land-Use Category	Sub-division(1)	Area(2) (kha)	Area of organic soil(2) (kha)
Total Forest Land		77.61	3.75
Forest Land remaining Forest Land		53.98	0.68
	Natural birch forest	48.00	
	Plantations older than 20 years	5.98	0.68
Land converted to Forest Land		23.63	3.07
Grassland converted to Forest Land		20.32	3.07
	Plantations 1-20 years old	20.32	3.07
Other land converted to Forest Land		3.31	
	Plantations 1-20 years old	3.31	
Total Cropland		129.00	
Cropland remaining Cropland		129.00	
Total Grassland		4992.71	364.00
Grassland remaining Grassland		4408.25	
Land converted to Grassland(12)		584.47	364.00
Cropland converted to Grassland		19.00	
Wetlands converted to Grassland		371.42	364.00
Other land converted to Grassland		194.04	
Revegetation before 1990		98.81	
Revegetation since 1990		95.24	
Total Wetlands		812.03	
Wetlands remaining Wetlands (7)		786.77	
	Other wetlands	579.34	
	Reservoirs	19.51	
	Lakes and rivers	187.92	
Land converted to Wetlands (8)		25.26	
Grassland converted to Wetlands		9.97	
	High SOC	3.28	
	Medium SOC	6.69	
Other Land converted to Wetlands		15.29	
	Low SOC	15.29	
Total Settlements		86.47	
Settlements remaining Settlements (8)		86.45	
Land converted to Settlements		0.02	
Forest land converted to Settlements		0.02	
Total Other Land		4187.51	
Other Land remaining Other Land (7)		4187.51	

7.6.2 Uncertainties QA/QC

The certainty of the land use information used in this year's submission has for many categories increased considerably. Most importantly the area estimate for Forest

Plantations, Natural Birch Forest and for Land Being Revegetated are now based on national inventories designed for these categories. The quality of information on area of other categories has improved considerably from previous submissions due to the implementation of definitions for the categories and the decision on their internal hierarchy.

Applying new information for compilation of the land use maps has increased the quality of the area estimates for the inventory year. Back tracking the changes in area of the land use categories on the basis of the few time series provided is still highly uncertain as in previous submissions.

7.6.3 Planned improvements regarding land use identification and area estimates.

The IGLUD database compiles land use data obtained through remote sensing, GIS mapping and field surveys on land use. Repeated land classification based on new satellite images through remote sensing, updating and improving GIS-maps and continuing field surveys is included in the IGLUD project. The project is thus expected to gradually provide new land use data and improve the existing data. An important reason for the data sampling for the land use database is to obtain information on various C-pools in each land use category. Data for estimating the size of different C-pools in the land use categories is therefore expected to be available

As a participant in the CORINE mapping project, NLSI has already delivered CLC 2006. Within few months, CLC 2000/2006 changes will also be delivered and integrated into CLC 2000. These maps are expected to identify appropriate changes in at least some of the land use categories applied in the CRF.

There are several projects related to individual land use categories which are designed to improve the quality of their area estimates. These are described in their relevant sections.

The results of the first compilation of data into IGLUD are preliminary and both the compilation process and quality of data used still need to be controlled and analysed to identify its weaknesses. This is expected to be finished before next submission.

7.6.4 Completeness and method

The emission by source and removal by sinks were calculated based on the above described accumulation of land use data and emission factors or C-stock changes.

A summary of methods and emission factors used is provided in Table 7-4, Table 7-5 and Table 7-6.

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,

		CO_2		
Source/sink	**Area kha**	**Method**	**EF**	**Gg Emission/ Removal (-)**
Forest Land remaining Forest Land	53.98			-52.10
Natural Birch forest	48.00	NE		
Plantation older than 20 years	5.98			-52.10
- Living biomass		T3	CS	-52.50
- Dead organic matter		NE		
- Soils				
Mineral Soil		NE		
Organic Soils CO_2	0.68	T1	D	0.40
Land converted to Forest Land(10)	23.63			-29.06
Grassland converted to Forest Land	20.32			-24.77
Plantations 1-20 years old	20.32			-24.77
- Living biomass		T3	CS	-26.35
- Dead organic matter		NE		
- Soils				
Mineral Soil		NE		
Organic Soils CO_2	3.07	T1	D	-1.58
Other Land converted to Forest Land	3.31			-4.30
Plantations 1-20 years old	3.31			-4.30
- Living biomass		T3	CS	-4.30
- Dead organic matter		NE		
- Soils				
Mineral Soil		NE		
Organic Soils		NA		
Cropland remaining Cropland	129.00			
- Living biomass		NO		
- Dead organic matter		NE		
- Soils				
Mineral Soil	NE	NE		
Organic Soils	NE	IE		
Lime application		T1	D,CS	4.80
Grassland remaining Grassland	4,408.25	NE		
Land converted to Grassland(12)	584.47			934.50
Cropland converted to Grassland	19.00	NE		NE
Wetlands converted to Grassland	371.42			1,468.12
- Soils				
Mineral Soil		NE		
Organic Soils CO_2	364.00	T1	D,CS	1,468.12
Other Land converted to Grassland	194.04			-533.62
Revegetation before 1990	98.81			-271.71

...continue on next page ...

		CO_2		
Source/sink	**Area kha**	**Method**	**EF**	**Gg Emission/ Removal (-)**
- Living biomass		T2	CS	-27.17
- Dead organic matter				
- Soils				
Mineral Soil		T2	CS	-244.54
Organic Soils		NO		
Revegetation since 1990	95.24			-261.91
- Living biomass		T2	CS	-26.19
- Dead organic matter				
- Soils				
Mineral Soil		T2	CS	-235.71
Organic Soils		NO		
Wetlands remaining Wetlands (7)	786.77			
Other wetlands	579.34	NE		
Reservoirs	19.51	NE		
Lakes and rivers	187.92	NA		
Land converted to Wetlands (8)	25.26			16.18
Grassland converted to Wetlands	9.97			15.82
High SOC CO_2	3.28	T2	CS	9.11
Medium SOC CO_2	6.69	T2	CS	6.72
Other Land converted to Wetlands	15.29			0.36
Low SOC CO_2	15.29	T2	CS	0.36
Settlements remaining Settlements (8)	86.45	NE		
Land converted to Settlements (9)	0.02			0.07
Forest Land converted to Settlements	0.02			0.07
Other Land remaining Other Land (7)	4,187.51	NA		

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,

		CH_4			
Source/sink	**Area kha**	**Method**	**EF**	**Gg Emission/ Removal (-)**	**Gg CO_2 eq**
Wetlands remaining Wetlands (7)	786,77				
Other wetlands	579,34	NE			
Reservoirs	19,51	NE			
Lakes and rivers	187,92	NA			
Land converted to Wetlands (8)	25,26			0,66	13,92
Grassland converted to Wetlands	9,97			0,65	13,63
High SOC CH_4		T2	CS	0,38	7,89
Medium SOC CH_4		T2	CS	0,27	5,73
Other Land converted to Wetlands	15,29			0,01	0,30
Low SOC CH_4		T2	CS	0,01	0,30

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,

		N_2O			
Source/sink	**Area**			**Gg Emission/**	
	kha	**Method**	**EF**	**Removal (-)**	**Gg CO_2 eq**
Forest Land remaining Forest Land	53,98				
Plantation older than 20 years	5,98			0,00	0,20
N_2O fertilizers		T1	D	0,00	0,00
- Soils					
Mineral Soil		NE			
Organic Soils N_2O		T1	D	0,00	0,20
Land converted to Forest Land(10)	23,63			0,00	
N_2O fertilizers		T1	D	0,00	0,14
Grassland converted to Forest Land	20,32			0,00	0,79
Plantations 1-20 years old	20,32				
Organic Soils N_2O		T1	D	0,00	0,79
Cropland remaining Cropland	129,00				
- Soils					
Mineral Soil		NE			
Organic Soils N_2O		IE			
Grassland remaining Grassland	4.408,25	NE			
Land converted to Grassland(12)	584,47			1,03	319,17
Wetlands converted to Grassland	371,42				
- Soils					
Mineral Soil		NE			
Organic Soils N_2O		T1	D	1,03	319,17

7.6.5 Key sources/sink and key areas

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

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

		CO_2 equivalent Gg			
Source/sink **Subcategories as reported**	**Direct Emission/ Removal (-) Gg**	**Absolute value category**	**Level %**	**Cumulative level %**	**Key source/sink**
Wetlands converted to Grassland -Organic Soils CO2	1,468.12	1468.12	60.04	60.04	x
Wetlands converted to Grassland -Organic Soils N2O	1.03	319.17	13.05	73.09	x
Other Land converted to Grassland- Revegetation before 1990 -Mineral Soil	-244.54	244.54	10.00	83.09	x
Other Land converted to Grassland - Revegetation since 1990 -Mineral Soil	-235.71	235.71	9.64	92.73	x
Forest Land remaining Forest Land -Plantation older than 20 years- Living biomass	-52.50	52.50	2.15	94.87	x
Other Land converted to Grassland - Revegetation before 1990- Living biomass	-27.17	27.17	1.11	95.99	x
Grassland converted to Forest Land- Plantations 1-20 years old- Living biomass	-26.35	26.35	1.08	97.06	
Other Land converted to Grassland- Revegetation since 1990- Living biomass	-26.19	26.19	1.07	98.13	
Grassland converted to Wetlands-High SOC CO2	9.11	9.11	0.37	98.51	
Grassland converted to Wetlands-High SOC CH4	0.38	7.89	0.32	98.83	
Grassland converted to Wetlands-Medium SOC CO2	6.72	6.72	0.27	99.10	
Grassland converted to Wetlands-Medium SOC CH4	0.27	5.73	0.23	99.34	
Cropland remaining Cropland-Lime application	4.80	4.80	0.20	99.53	
Other Land converted to Forest Land- Plantations 1-20 years old- Living biomass	-4.30	4.30	0.18	99.71	
Other Land converted to Grassland-N2O fertilizers	0.01	3.25	0.13	99.84	
Grassland converted to Forest Land- Plantations 1-20 years old-Organic Soils CO2	-1.58	1.58	0.06	99.91	
Grassland converted to Forest Land- Plantations 1-20 years old-Organic Soils N2O	0.00	0.79	0.03	99.94	
Forest Land remaining Forest Land-Plantation older than 20 years-Organic Soils CO2	0.40	0.40	0.02	99.96	
Other Land converted to Wetlands-Low SOC CO2	0.36	0.36	0.01	99.97	
Other Land converted to Wetlands-Low SOC CH4	0.01	0.30	0.01	99.98	
Forest Land remaining Forest Land-Plantation older than 20 years-Organic Soils N2O	0.00	0.20	0.01	99.99	
Land converted to Forest Land-N2O fertilizers	0.00	0.14	0.01	100.00	
Forest Land converted to Settlements	0.07	0.07	0.00	100.00	
Forest Land remaining Forest Land-Plantation older than 20 years-N2O fertilizers	0.00	0.00	0.00	100.00	
Total		**2,445.39**	**100.00**		

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

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

		CO2 equivalent Gg			
Source/sink	**Area**	**Sum of absolute values**			
Main landuse category	**kha**	**main category**	**Level %**	**Cumulative level %**	**Key source/sink**
Land converted to Grassland	584.47	2,002.78	94.29	94.29	x
Forest Land remaining Forest Land	53.98	53.10	2.50	96.79	x
Land converted to Forest Land	23.63	33.15	1.56	98.35	
Land converted to Wetlands	25.26	30.11	1.42	99.77	
Cropland remaining Cropland	129.00	4.80	0.23	100.00	
Land converted to Settlements	0.02	0.07	0.00	100.00	
Total		**2,124.00**	**100.00**		

Trend key source assessment was not completed, as independent time series are not available for most categories. Considering the present status of land use information, the key land use categories were assessed on the basis of area. On the land use categories as reported, two assessments were performed; the highest resolution area subcategories (Table 7-9) and on main land use categories (Table 7-10. Including the highest area subcategories, six were recognised as key area; two of which are by definition unmanaged with no emissions reported: Other Land remaining Other land and Lakes and Rivers. A third category recognised as a key area, Other Wetlands, is an aggregate of two subcategories Mires and Fens and Semi-wet areas where the former is mostly unmanaged. No emissions are presently reported for the subcategory Semi-wet areas. No emissions are presently estimated for Grassland remaining Grassland or for Cropland remaining Cropland. This leaves only one of the categories recognised as a key area considering all subcategories where emission is estimated: Wetlands converted to Grassland- Organic soils. Taking this into consideration, only four main land use categories are recognized as key areas; Other Land remaining Other Land, Grassland remaining Grassland, Wetlands remaining Wetlands and Land converted to Grassland (Table 7-10**)**. Emissions are presently estimated for only one of these categories.

An additional area assessment was carried out, considering only applicable land use categories, excluding the category Other Land and other categories which, by definition, are unmanaged and emission/removal calculation is not applicable.

Considering only applicable land use categories, (Table 7-11) two additional land use categories are assessed as key areas, compared to those included when all categories reported at highest area resolution were considered. These categories were, Other Land converted to Grassland – Revegetation before 1990 and Other Land converted to Grassland – Revegetation since 1990.

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

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

Land use categories at highest reported resolution	Area kha	Area level%	Cumulative Level %	Key area
Grassland remaining Grassland	4,408.25	42.86	42.86	x
Other Land remaining Other Land	4,187.51	40.71	83.57	x
Wetlands remaining Wetlands-Other wetlands	579.34	5.63	89.21	x
Wetlands converted to Grassland-Organic Soils	364.00	3.54	92.74	x
Wetlands remaining Wetlands-Lakes and rivers	187.92	1.83	94.57	x
Cropland remaining Cropland	129.00	1.25	95.83	x
Other Land converted to Grassland-Revegetation before 1990	98.81	0.96	96.79	
Other Land converted to Grassland-Revegetation since 1990	95.24	0.93	97.71	
Settlements remaining Settlements	86.45	0.84	98.55	
Forest Land remaining Forest Land-Natural Birch forest	48.00	0.47	99.02	
Wetlands remaining Wetlands-Reservoirs	19.51	0.19	99.21	
Cropland converted to Grassland	19.00	0.18	99.39	
Grassland converted to Forest Land-Plantations 1-20 years old	17.25	0.17	99.56	
Other Land converted to Wetlands-Low SOC	15.29	0.15	99.71	
Wetlands converted to Grassland Mineral soil	7.43	0.07	99.78	
Grassland converted to Wetlands-Medium SOC	6.69	0.07	99.85	
Forest Land remaining Forest Land-Plantation older than 20 years mineral soil	5.30	0.05	99.90	
Other Land converted to Forest Land-Plantations 1-20 years old	3.31	0.03	99.93	
Grassland converted to Wetlands-High SOC	3.28	0.03	99.96	
Grassland converted to Forest Land-Plantations 1-20 years old-Organic Soils	3.07	0.03	99.99	
Forest Land remaining Forest Land-Plantation older than 20 years-Organic Soils	0.68	0.01	100.00	
Forest Land converted to Settlements	0.02	0.00	100.00	
	10,285.33			

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 emissions or removals reported. These land use changes are conversions of Wetlands and Other Land to Grassland.

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

Main land use category	Area kha	Area level%	Cumulative level %	Key area
Grassland remaining Grassland	4,408.25	42.86	42.86	x
Other Land remaining Other Land	4,187.51	40.71	83.57	x
Wetlands remaining Wetlands	786.77	7.65	91.22	x
Land converted to Grassland	584.47	5.68	96.90	x
Cropland remaining Cropland	129.00	1.25	98.16	
Settlements remaining Settlements	86.45	0.84	99.00	
Forest Land remaining Forest Land	53.98	0.52	99.52	
Land converted to Wetlands	25.26	0.25	99.77	
Land converted to Forest Land	23.63	0.23	100.00	
Land converted to Settlements	0.02	0.00	100.00	
	10,285.33			

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

Applicable land use categories	Area kha	Area level%	Cumulative Level %	Key area
Grassland remaining Grassland	4,408.25	74.59	74.59	x
Wetlands remaining Wetlands-Other wetlands	579.34	9.80	84.39	x
Wetlands converted to Grassland-Organic Soils	364.00	6.16	90.55	x
Cropland remaining Cropland	129.00	2.18	92.74	x
Other Land converted to Grassland-Revegetation before 1990	98.81	1.67	94.41	x
Other Land converted to Grassland-Revegetation since 1990	95.24	1.61	96.02	x
Settlements remaining Settlements	86.45	1.46	97.48	
Forest Land remaining Forest Land-Natural Birch forest	48.00	0.81	98.29	
Wetlands remaining Wetlands-Reservoirs	19.51	0.33	98.62	
Cropland converted to Grassland	19.00	0.32	98.95	
Grassland converted to Forest Land-Plantations 1-20 years old	17.25	0.29	99.24	
Other Land converted to Wetlands-Low SOC	15.29	0.26	99.50	
Wetlands converted to Grassland Mineral soil	7.43	0.13	99.62	
Grassland converted to Wetlands-Medium SOC	6.69	0.11	99.73	
Forest Land remaining Forest Land-Plantation older than 20 years mineral soil	5.30	0.09	99.82	
Other Land converted to Forest Land-Plantations 1-20 years old	3.31	0.06	99.88	
Grassland converted to Wetlands-High SOC	3.28	0.06	99.94	
Grassland converted to Forest Land-Plantations 1-20 years old-Organic Soils	3.07	0.05	99.99	
Forest Land remaining Forest Land-Plantation older than 20 years-Organic Soils	0.68	0.01	100.00	
Forest Land converted to Settlements	0.02	0.00	100.00	
	5,909.90			

7.7 Forest land

In accordance with 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 in the New National Forest Inventory (NNFI). Further description of forest definition will be found in methodological report of carbon accounting of forests (Snorrason, 2009b). Forest Land is second to Settlements in the hierarchy of the main land use categories defined. All forests, both naturally regenerated and planted, are defined as managed, as they are affected directly by human activity. The natural birch woodlands have been under continuous use for ages. Until the middle of the 19th century, 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 and still are used for grazing, although some areas have now been protected from grazing.

Natural birch woodlands in Iceland have been inventoried twice in the 20th century, in 1972-1975 and again in 1987-1991, resulting in area estimates of 125 and 118 kha respectively. Maps and data sampled in the inventories have newly been put into GIS. New SPOT images were used to refine the mapping remotely and the total area of the natural birch woodlands was adjusted to 120 kha (Snorrason et al., 2007). Icelandic Forest Research reported in 2006 that 25 kha of the natural birch woodland was 2 m or more in height. Resent mapping efforts by the IFR due to CORINE participation are consistent with these numbers: 115.5 kha and 23.7 kha for birch woodland and birch >2m height respectively (Traustason and Snorrason, 2008).

Natural birch forest and woodlands are included in the IFR new national forest inventory (NNFI). In the NNFI, the natural birch woodlands are defined as one of the two predefined strata to be sampled. The other stratum is the plantation forest consisting of tree plantation with direct seeding or natural regeneration originating from cultivated forest. The sampling fraction in Natural Birch Woodland is much lower than in Cultivated Forests. Each 200 m^2 plot is representing 1.5 x 3.0 km^2. On basis of the NNFI the area of natural birch woodlands has been revised. The area of natural birch woodlands is now estimated to 83 kha (+/- 8 kha 95% confidence limits), which is much lesser estimate than before Figure 7-3. A possible explanation could be that the woodland mapping data is out of date, or from the first inventory in 1972-1975. The mapping was rather coarse and based on high altitude, black and white aerial photos. Field mapping of vegetation that dominates the height level tends to overestimate area and relative cover. This is probably the case with the old woodland mapping. The NNFI on the other hand estimates the part, reaching 2 m or greater in height at maturity in situ, considerably higher in area than older estimates, or 48 kha (+/-8 kha CL). The explanation for this change is due to the data used for the estimate. Before the NNFI, the data used was either assessments or measurements of actual height of the woodlands, not emerging height at maturity. In the NNFI, the field workers must assess the emerging height at maturity by measuring mature woodlands neighbouring each field plot.

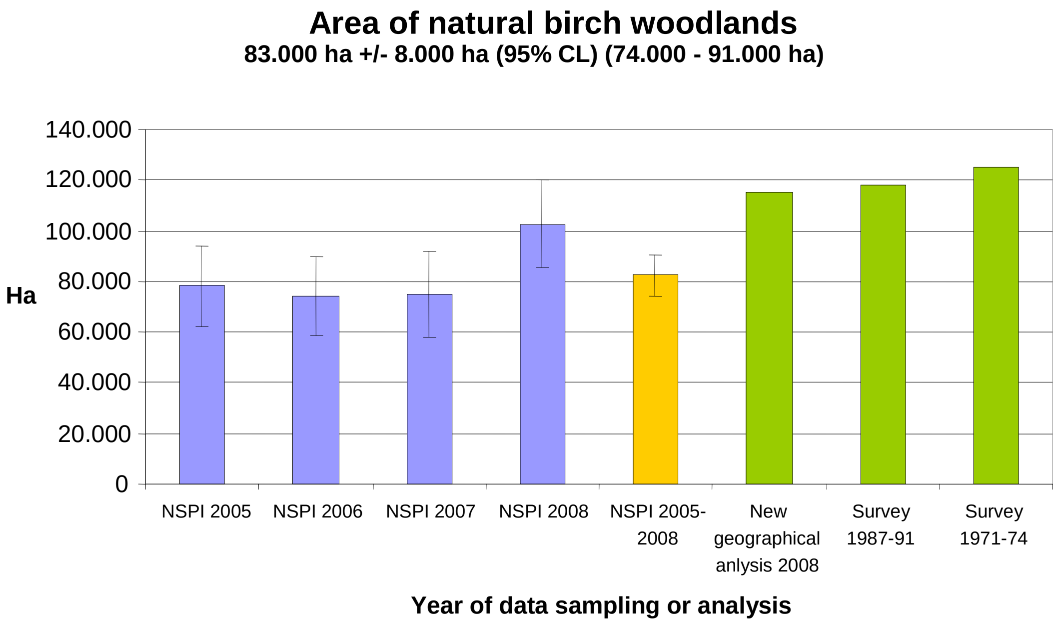

Figure 7-3 Estimates of birch woodlands area. The yellow column is the area weighted average of the estimates of four years of the new systematic plot inventory (NSPI) field measurements (blue columns). The green columns are estimates built on mapping of the woodland.

This year's submission data on plantations is altered from last submission due to revised age categories. The category New Plantation of the inventory year is now allocated to the category Plantations 1-20 years old. New definitions of plantation age were also adopted for new plantation and now plantation is considered one year old the autumn the year it was planted. In the 2008 submission, years passed since planted was used as the plantation age. This definition of age is common practice in forestry, used by IFR and accordingly adapted here to avoid confusion regarding data exchange. Also plantations 1-20 years old are now divided into Grassland and Other Land converted to Forest Land according to results from the NNFI. The ratio of plantations on organic soil is revised according to new data from the NNFI.

The default value of 20 years is applied for transition from one land use to another, 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. Deforestation is reported as Forest Land converted to Settlements (See section 7.11

CO_2 removal to living biomass in Plantations Older than 20 years is recognised as a key source/sink in LULUCF considering the subcategories' resolution as reported. Forest Land remaining Forest Land is recognised as a key source/sink considering only the main land use categories.

According to estimates of data from the NNFI the total area of cultivated forest is 30 kha (+/- 2kha CL).The total area of plantations older than 20 years (planted 1987 and earlier) is estimated at 6 kha in 2007. Plantation 1-20 years old (planted 1988- 2007) are estimated at 24 kha. As shown in Figure 7-4, the area estimated through NNFI is similar to estimates built on the number of seedling which have been used in previous submissions. On the other hand, the NNFI estimate is considerably lower than mapped plantation forest cover. The plantation forest cover map is built on the aggregation of maps used in forest management plans and reports. This result highlights the overestimation common with these maps (Traustason and Snorrason, 2008).

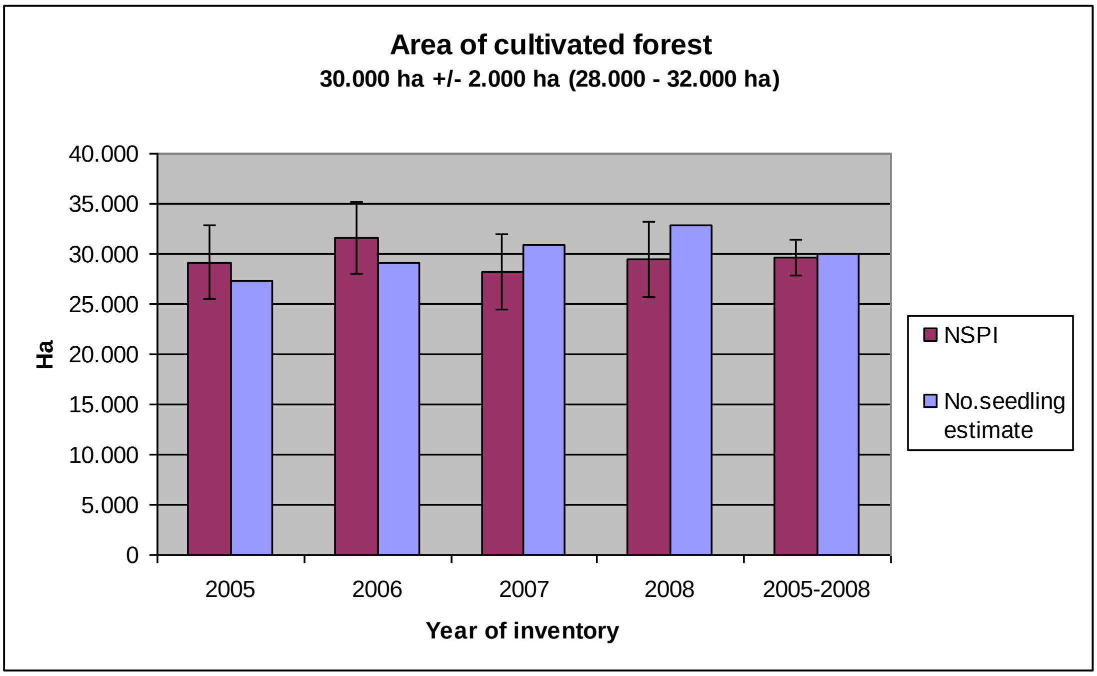

Figure 7-4 Comparison of methods used to estimate the area of cultivated forest. The purple column is the estimates built on data of the four years of the new systematic plot inventory (NSPI) field measurements. The blue columns are estimates built on number of seedling planted annually. Year of inventory refers to NNFI year.

In the maps provided by IFR, the total area of forests is less than the estimated area. The area is subdivided into plantation and natural birch forest. The total mapped area is 42 and 24 kha for plantations and natural birch forest respectively. The area reported in the CRF is 30 kha and 48 kha in same order. The total map area of forest land is 66 kha but CRF total is 78 kha. The difference in mapping area and CRF is balanced against Grassland mapping and CRF reported land use, taking into account the forest land area converted to Settlements.

7.7.1 Carbon stock changes (5A)

Total woody C-stock of birch woodland, in area included in the inventory 1987-1991, was estimated at 1300 ktonnes C with average of 11 t C/ha in 1990. (Sigurðsson and Snorrason, 2000). Taken into account the changes in area the IFR new estimate of the woody C-stock of natural birch forest reaching 2 m or more is 528 ktonnes C. (Snorrason 2009b in prep). This year, as in earlier submissions, the C stock of the natural birch woodlands is assumed to remain constant with no changes reported.

7.7.1.1 Carbon stock changes in living biomass

For the first time carbon stock changes in the living biomass of trees is estimated based on data from the direct field measurements of the NNFI. The figures provided by IFR are preliminary calculations based on the inventory data for four years out of the first five of the forest inventory (Snorrason 2009b, in prep).

Most of the cultivated forests in Iceland are relatively young, with only 20% older than 20 years and clear cutting has not started. Thinning is taking place in some of the oldest plantations but no data is presently available on the amount of wood removed or left behind after thinning (as dead organic matter). Thinning is recorded through the ongoing national forest inventory, but calculations of wood removal have not yet been completed (Snorrason 2009b in prep.). Accordingly no losses are reported for this factor.

7.7.1.2 Net carbon stock changes in dead organic matter

At the moment, estimating changes in dead organic matter is not possible due to a lack of data. Tier 1 (AFOLU Guidelines) default assumes no changes in dead wood or litter. Changes in dead organic matter are connected with forest management in AFOLU Guidelines and due to the young age of most the cultivated forests in Iceland, this category is not considered significant.

7.7.1.3 Net carbon stock change in soils

In the last submission the ratio of plantation on organic soils was estimated as 13% based on information from the IFR. In this year’s submission this ratio has been revised according to new data from IFR obtained in the national forest inventory. The new estimate is that 11.4 % of all forests are grown on former or drained wetlands. If only land afforested since 1990 is included, the ratio is 11.6 % (Table 7-12**Error! Reference source not found.**). The area of organic soils in forest land is estimated by applying the same ratio (11.4%) to all plantations. 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 forest 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 in carbon content. Research results do show an increase in carbon in soil organic matter (C-SOM) in mineral soils (0.3-0.9 t C $ha^{-1}yr^{-1}$) due to afforestation, but the high variation in the carbon content of soil samples give, in most cases, statistically insignificant results (Snorrason et al, 2003, Sigurðsson et al, 2008). Accordingly the IFR estimates that soil carbon stock in forest land on mineral soil is unchanged in time.

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

Direct N_2O emissions from use of N fertilisers are reported separately for Forest remaining Forest and Land converted to Forest Land. In this submission, data on N fertilizers is provided for the years 1990-2004 which were previously not estimated. The reported use of N fertilizers is based on data collected by IFR.

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

Land scarification is sometimes part of the preparation of new plantations sites and might cause N_2O emissions comparable to land being converted to cropland. No data is available on the amount of afforested land scarified or emissions caused by such activity reported under Other in Table 5(III).

7.7.3 Land converted to forest land.

The AFOLU Guidelines default transitional 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. Land converted to Forest Land is reported as converted from the land use categories Other Land (14%) and Grassland (86%). All land with organic soils is assumed to have been converted from Grassland and the area of Organic Soil under Grassland is adjusted accordingly.

Information is available on more detailed land use conversion than is reported (Table 7-12). The type of land converted is not the same when all plantations are included as when only plantations 1-20 years old (2007) are included. Due to high uncertainty in the area for other land use categories, this information is not considered applicable as only source of land use changes.

Table 7-12 Former land categories of afforested land according to NNIF.

Land category	% of all afforested area	% of afforested 1988-2007
Other Land	14	16
Grassland mineral soil	70	71
Wetland	2.5	2.3
Drained wetland	8.9	9.3
Cropland	1	2
Settlement	0.1	0.1
Natural forest	2.9	
Total	100	100

7.7.4 Methodological issues

The methodology for NNFI is based on systematic sampling of nearly 1,000 permanent plots. One-fifth of the plots are measured each year and measurements are repeated at 5 year intervals. The sample is used to estimate both the division of area into subcategories and C-stock changes over time (Snorrason 2009a, and Snorrason and Kjartansson., 2004). Preparation of this work started in 2001 and the measurement on field plots started in 2005. The first forest inventory will finish in 2009 and in 2010 the second one will start with new measurements of the plots measured in 2005, together with new plots on afforested land since 2005. The figures provided by IFR are preliminary calculations based on the inventory data for four years out of five of the first forest inventory (Snorrason 2009b).

The areas of both Natural Birch Forests and Plantation Forest are estimated from the output of the systematic sampling of the NNFI. The sample population for the natural birch forest is the mapped area of natural birch woodland in earlier inventories. The sample population of plantation forest are from aggregations of maps of forest management plans and reports from forestry professionals in Iceland. In some cases the NFI staff do mapping in the field of left out private plantation forests. To ensure that forest areas are not outside the population area, the populations for both strata are increased with the buffering of the mapped border. The current buffer is 16 m. A more detailed description of the methodology is given by Snorrason (2009b in prep).

The area of Natural Birch Forests is assumed to be unchanged since 1990. Historical area of Plantation Forests is estimated by the age distribution of the forests in the sample. The changes in the C-stock of plantations for years other than 2007 are built on tree species specific growth model but are calibrated towards the inventory results of 2007.

7.7.5 Emission/removal factors

Tier 3 is used to estimate the change in carbon stock in living biomass of the trees in plantation forest through the data from the NNFI (Snorrason 2009b in prep).

Emissions from deforestation are estimated for the first time by a special aerial and tree measurement inventory, carried out by IFR, as the sample plot inventory still does not capture deforestation on such a low scale. The deforestation which has occurred is to give way to new roads, power lines or buildings. Losses due to deforestation are reported under Forest Land converted to Settlements.

As mentioned before, carbon stock changes in living biomass in the natural birch forest are reported as not estimated but can be assumed near zero. Emission from wood removals caused by thinning or clear cutting are not included in this inventory. They are assumed to have minor importance as the mean age of plantation forest is very low. Clear cuttings are yet not practiced and thinning is rare. The changes in plantations C-stock for other years than 2007 (1990-2006) are built on tree species specific growth model but are calibrated towards the inventory results of 2007. Carbon stock change in living biomass in other vegetation than trees cannot be estimated at current state.

Tier 1 and default EF of 0.16 [t C ha^{-1} yr^{-1}] (AFOLU Guidelines Table 4.6.) are 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 of 1.25% [kg N_2O-N/kg N input] (GPG2000) and EF of 0.6 [kg N_2O-N $ha^{-1}yr^{-1}$] (AFOLU Guidelines Table 11.1.) were used respectively.

7.7.6 Uncertainties and QA/QC

The estimate of C-stock in the living biomass of trees is based on preliminary results from the new national forest inventory of IFR. These results can be expected to change due to further processing of the data. The NNFI and the special inventory of deforestation have greatly improved the quality of the carbon stock change estimates although some sources are still not included (e.g. soil and litter). Because of the design of NNFI, the possibility exists to estimate realistic uncertainties by calculating statistical error of estimates. At this moment error estimates for all data sources and calculation processes have not been conducted but are planned in the near future. For the moment only error estimates for the area of both Natural Birch Forest and Plantation Forest are available. The IFR estimates the range for total plantation area estimate to be +/- 1.8 kha (95% confidence limits).

The biomass of forest plantations of known age in Iceland has been measured (Snorrason et al 2003, Sigurðsson et al 2008). These measurements have shown biomass increments ranging from 0.1-1.2 t C/ha/yr for young forests (9-16 years old), to 1.1-3.0 t C/ha/yr for middle aged forests (32-54 years old). The C-stock changes estimated through the forest inventory fit well with these earlier measurements.

7.7.7 Recalculations

As described above, the emission/removal estimate for Forest Land has been revised from previous submissions. The C-stock changes are, for the first time, based on direct stock measurements. This revision is reflected in a changed tier for the CRF reporting, from T2 in the 2006 inventory, to T3 in present submission. Revised area estimate also affects C-stock estimates for all years and the emissions estimates from organic soils. As a result of this recalculation, the total reported emission has decreased to -72 Gg CO_2 equivalents for the year 2006 from -132 Gg CO_2 eq, as reported in 2008 submission. This is a 46% reduction.

7.7.8 Planned improvements regarding Forest Land

Data from the NNFI are used for first time to estimate the main sources of carbon stock changes in cultivated forests where changes in carbon stock are most rapid. Next year estimates of carbon stock change in natural birch forest and estimates of emissions from wood removals will be added to the estimate, together with a Tier 1 estimate of carbon stock changes in soil on afforestation sites (Other Land converted to Forest Land).

Sampling of soil, litter, and vegetation other than trees, included as part of NNFI and higher tier estimates of changes in the carbon stock in soil, dead organic material and vegetation other than trees, is expected in future reporting after the first re-measurement of the permanent sample plot.

The national forest inventory will also improve estimates on area and stock changes as deforestation and thinning activity are included. One can therefore expect gradually improved estimates of carbon stock and carbon stock changes in forests in

Iceland. As mentioned before improvements in forest inventories will also improve uncertainty estimates both with area and stock changes.

7.8 Cropland

Cropland in Iceland consists mainly of cultivated hayfields, many of which are on drained organic soil. A small but increasing part is used for cultivation of barley. Cultivation of potatoes and vegetables also takes place.

Mapping of cropland based on satellite images and support of aerial photographs has been included in the construction of IGLUD. The first round of mapping has already been carried out in cooperation of AUI and NLSI. The map layer for Cropland used in the land use map presented in this submission is the result of this mapping effort. According to this mapping effort, the total Cropland area is 156 kha, taking the hierarchy of land use categories into account. Cropland is after to Forest Land in the hierarchy of land categories. According to agricultural statistics the area of cultivated land is 129 kha. That number is used in the CRF tables and the difference is balanced against Grassland in the CRF.

The area of drained soils within the land mapped as Cropland was estimated based on land mapped as Cropland overlapped with the land included in mapped ditches with a 200 m buffer on the outmost ditches. According to this estimate, 12 % of drained soils are on Cropland. The Cropland map layer is still preliminary and this estimate is not used in this submission for partitioning of drained organic soils between categories. All drained soils except those included under Forest Land are reported in this submission as an aggregate number under Grassland.

No information is available on emission/removal regarding different cultivation types and the subdivision of areas is not attempted. Cropland remaining Cropland is identified as a key area in applicable land use categories (Table 7-11).

7.8.1 Carbon stock changes (5B)

7.8.1.1 Carbon stock changes in living biomass

As no perennial woody crops are cultivated in Iceland, no biomass changes need to be reported. Shelterbelts, not fitting the definition of Forest Land, do exist but are not common. This might be considered as cropland woody biomass. No attempt is made to estimate the carbon stock change in this biomass.

7.8.1.2 Net carbon stock changes in dead organic matter

The AFOLU Guidelines Tier 1 methodology assumes no or insignificant changes in DOM in Cropland remaining Cropland and therefore no emission /removal factors or activity data is 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 forms 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 the present status of land use information. Emission due to conversion of Wetlands to Cropland is included under category Wetlands converted to Grassland.

7.8.1.3 Net carbon stock change in soils

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

Emissions from organic cropland soils are reported as an aggregate number included with emission from drained grassland organic soils. Preliminary estimates for the area of Cropland on drained organic soils is available from IGLUD as described above.

Division of Cropland soils to organic and mineral is at this stage not attempted and the emissions and removals not estimated separately for this pool in this year's submission.

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

Direct N_2O emission from use of N fertilisers on cropland in agriculture is included under emissions from agricultural soils.

N_2O emissions from drainage of organic soils are reported as an aggregated number under 5G.- Other –Wetlands converted to Grassland non-CO_2 emissions.

Carbon dioxide emissions from agricultural lime application are estimated. Information on lime application is obtained from distributors. Numbers reported included lime application in the form of shell sand, 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 makes this source relatively large. Numbers on lime application are only available at the national level and all of it is assumed to be applied on cropland.

7.8.3 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 into cropland. The size of these areas could be compiled from geographical data used in IGLUD. Due to the present uncertainty of mapping data, emissions are not reallocated in this submission and all emission reported under Wetlands converted to Grassland.

7.8.4 Emission factors

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

7.8.5 Uncertainty and 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. Large uncertainty still exists in the Cropland 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. Due to the lack of subdivision of cropland to soil type, the emissions/removals of cropland organic soils are included in aggregated numbers of other categories, resulting in relatively substantial uncertainty within the category. The change in C-stock in mineral soils is not estimated. Including these two factors might change the emission/removal estimate for cropland considerably. The quantity of uncertainty for cropland emissions/removals is not estimated.

7.8.6 Planned improvements regarding Cropland

The mapping of Cropland and the division to subcategories according to management, soil and crop types will be finished within the next few years. This will improve the estimated emissions in the category. As mapping of Cropland improves it will be relevant to allocate emissions due to soil drainage of land under Cropland to the category. Data obtained through fertilization experiments on the carbon content of cultivated soils is available at AUI. This data still needs to be processed in order to estimate changes in the carbon content of cultivated soils over time.

7.9 Grassland

Grassland is the largest land use category identified by the present land use mapping described above. The Grassland category is very diverse with regards to vegetation, soil type, erosion and management.

The land included under the Grassland category is reported as three subcategories: Grassland remaining Grassland, Wetlands converted to Grassland and Other Land converted to Grassland.

Grasslands remaining grassland

The category Grassland remaining Grassland includes all land where vascular plant cover is 20% or more as compiled from NYTJALAND and CLC-2006, which does not fall under Settlement, Forest Land, Cropland or Wetlands ,or is included under other Grassland subcategories. This land is e.g. heath-lands with dwarf shrubs, small bushes, grasses and mosses in variable combinations, fertile grasslands, and partly vegetated land.

Large areas in Iceland suffer from severe erosion where vegetation cover is severely damaged or absent, but the remaining Andic soil does still have high amounts of carbon. Recent research indicates that the carbon budget of such areas might be negative, resulting in CO_2 emission to the atmosphere (AUI unpublished data). The vegetation cover in many other grassland areas in Iceland is at present increasing both in vigour and continuity (Náttúrufræðistofnun_Íslands, 2005). In these areas, the annul carbon budget might be positive at present with C being sequestered from the atmosphere. Whether these changes in vegetation are related to changes in climate, management or a combination of both is not clear. The subdivision of Grassland according to land degradation is not implemented in this year's submission, but is one of the IGLUD objectives as described in Guðmundsson et al (2009 in prep). Subdivision based on management regimes, i.e. unmanaged and managed, and the latter further according to grazing intensity, is pending but not yet implemented.

Drained areas

The second subcategory reported is Wetlands converted to Grassland. This category as presented in this submission is an aggregate estimate of all drained soils, except those under Forest Land, although some of it properly is part of other categories such as Wetland, Cropland or Settlements. The size of the area belonging to other categories is indicated by the difference in the reported area and the area mapped Table 7-2 The difference in drained area mapped under Grassland and reported is balanced against subcategory Grassland remaining Grassland and accordingly does not affect the estimated total area of the Grassland category or other main categories. The area of subcategory Grassland remaining Grasslands is underestimated accordingly.

Extensive drainage of wetland has taken place in Iceland mostly in the period 1940-1985 (Figure 7-7). This drainage was aided by governmental subsidies. Only a minor portion of these drained areas was turned to hayfields or cultivated, the larger part of the lowland wetlands in Iceland were turned into grassland or cropland through this drainage effort. The governmental subsides involved official recording of the drainage, kept by the Farmers Association. The subsidies for new drainage were ended in 1987 (Gísladóttir et al., 2007). Since then the drainage records have been limited and no centralised official recording is presently available.

All ditches recognisable on satellite images (SPOT 5) have recently been digitized in a cooperative effort between AUI and NLSI (Figure 7-5). Interpretation of ditches to drained area and stratification according to different soil types and land use is at present a pending assignment at AUI as part of the IGLUD project.

The estimated total area of land drained is calculated from the total length of ditches as recognised on the map of digitised ditches. A conversion factor of 7.3 km ditches/km^2 (Óskarsson, 1998) is applied as in previous submissions. The total length of mapped ditches is 27,240 km. By applying the conversion factor, the total area of land drained is estimated at 375 kha. That area, except that which is included under Forest Land, is reported as Wetlands converted to Grassland, or 371 kha. This method only estimates the total area but does not directly connect the land drained to the ditches.

To estimate drained land in the IGLUD preliminary land use map, a 200 m buffer was applied to the outmost ditches. This method gives considerably lower estimate than the previously mentioned method, or 286 kha, as they are based on different assumptions regarding the ditches net structure and how they were converted to a drained area.

The relative division of drained land included under each main land use category was estimated through overlapping each category mapped in IGLUD with the estimated drained area. The results are shown in Table 7-13.

Table 7-13 Percentages of drained land under different land use categories. 1) Drained land is excluded from the category Other Land through the hierarchy of land use categories and methods used for compiling the data.

Relative division of drained land to land use categories	
Main land use category	% of drained land included under category
Settlements	4
Forestland	2
Cropland	14
Wetlands	20
Grassland	60
Other Land[1]	0
Total	100

According to this estimate 60% of drained land is within the Grassland category, the remaining area is mostly under Settlements, Cropland and Wetlands.

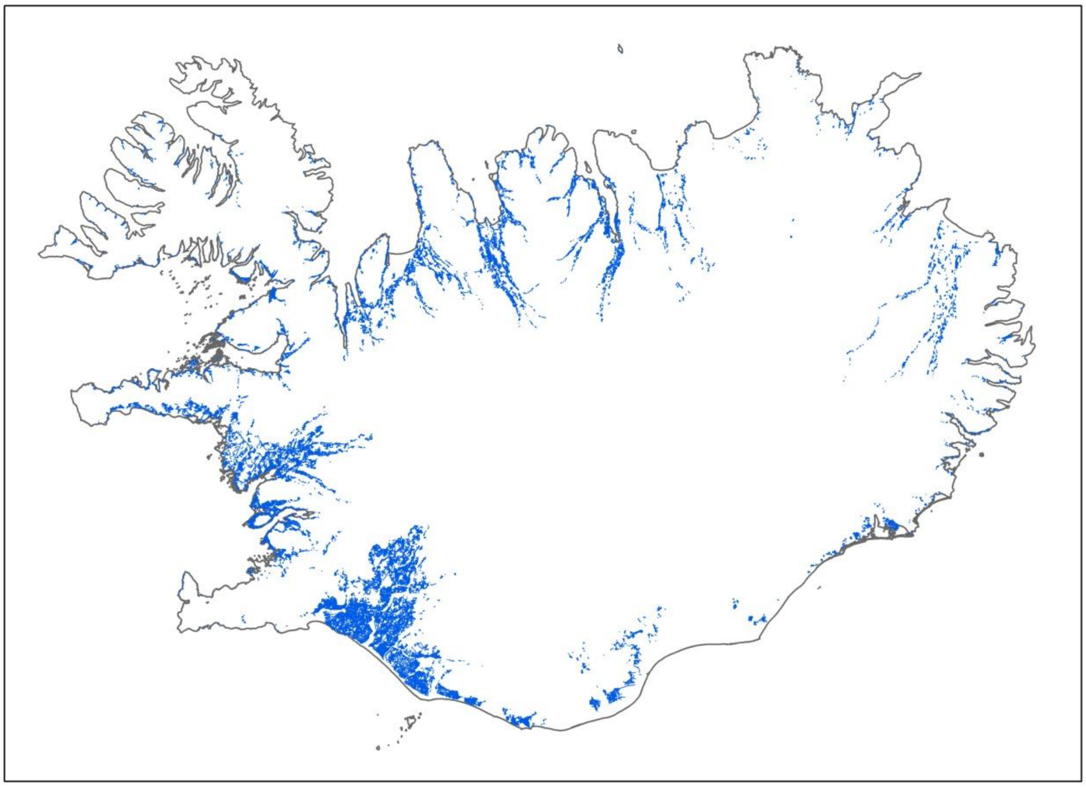

Figure 7-5 Map of Iceland showing all digitized ditches. (AUI 2008)

Revegetation

The third subcategory reported is Other Land converted to Grassland. This land use conversion is the result of revegetation activity. Revegetation has in previous submissions been reported under 5.G. Other, as a separate activity not connected to land use in accordance with the AFOLU definition. In this submission the category is reallocated to the category Other Land converted to Grassland. For the majority of land where revegetation is started on, the vegetation cover is less than 20 %, according to the SCSI. Accordingly this land does not meet the definitions of Grassland.

Since the settlement of Iceland large areas of formerly vegetated areas have been severely eroded and in large areas the entire soil mantle has been lost. It has been estimated that a total of 60-250×10^3 ktonnes 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 ktonnes C/yr (Óskarsson et al., 2004). The revegetation of deserted areas sequesters some of the carbon back into the soil. No attempt is made to include these estimates in the CRF.

The SCSI 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 to ensure sustainable grazing land use. The reclamation work from 1907 to 1990 was primarily carried out in 170 enclosures, covering approximately 3% of the total land area. The exclusion of grazing animals from the reclamation areas and other means of improving livestock land use is estimated to have resulted in soil carbon sequestration, but the quantities remain to be determined. Record keeping of soil conservation and revegetation efforts until 1960 was limited. From 1958 to 1990, most of the activities involved spreading of seeds and/or fertilizer by airplane and direct seeding of lymegrass (*Leymus arenarius* L.) and other graminoids. These activities are recorded to a large extent. The importance of aerial distribution has decreased since 1990 as other methods have proven more efficient, such as increased participation and cooperation with farmers and groups interested in land reclamation work. Methods for recording activities have improved at the same time, most notably by using aerial photographs and GPS-positioning systems. Since 2002, GPS tracking has increasingly been used to record activities as they occur, e.g. the spreading of seeds and/or fertilizer. In 2008 almost all activities were recorded simultaneously with GPS-units (Halldórsson et al in prep.).

The area of land being revegetated is divided into two categories based on when the activity started; Land revegetated before 1990 and Land revegetated since 1990. The latter category represents activity accountable as Kyoto Protocol commitments. This subdivision also reflects difference in methods used for area estimate prior to 1990 and their uncertainty.

The SCSI now keeps a national inventory on revegetation areas since 1990 based on best available data. The detailed description of methods will be published elsewhere (Halldórsson et al, 2009 in prep). The objectives of this inventory are to monitor the changes in C- stocks, control/improve the existing mapping and gather data to improve current methodology. Activities which started prior to 1990 are not included in this inventory at present. The National Inventory on Revegetation Area (NIRA) is based on the systematic sampling on predefined grid points; the same grid as is used by the Icelandic Forestry Service (IFS) for NNFI (Snorrason and Kjartansson., 2004) and in IGLUD field sampling. The basic unit of this grid as applied by SCSI and IFS is a square 1.0 x 1.0 km in size. A subset of approximately 1000 grid points that fall within the land mapped as revegetation since 1990 was selected randomly and will be visited. Points found to fall within areas where fertilizer, seeds, or other land reclamation efforts have been applied, will be used to set up permanent monitoring and sampling plots. Each plot is 10×10 m. Within each, five 0.5×0.5 m randomly selected subplots will be used for soil and vegetation sampling for C-stock estimation.

Data already available in NIRA has already resulted in reduced estimations of revegetated land since 1990. Areas revegetated before 1990 have also been adjusted proportionally, resulting in decreased area. The current estimate for the total area of revegetated areas prior to 1990 is 99 kha and 95 kha for areas since 1990. Revised estimate on EF is not yet available.

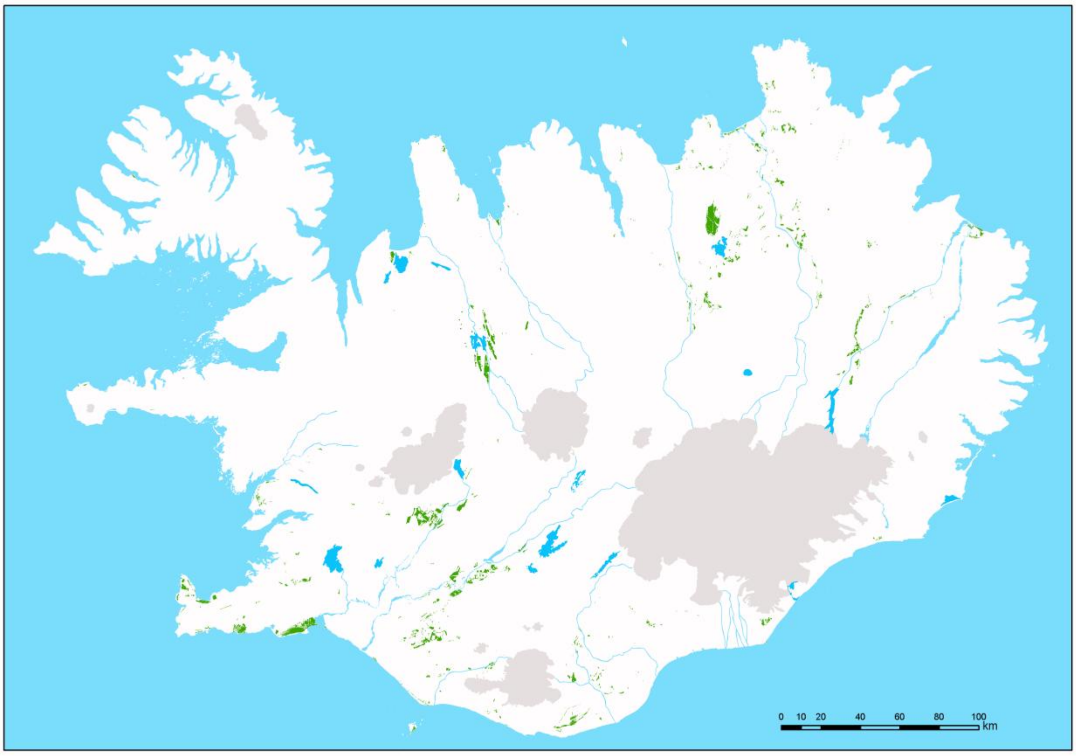

Figure 7-6 Map showing revegetation areas (green) established during 1990-2007. (Halldorsson et al. in prep)

Category key factors

Of the six LULUCF categories recognized as key source/sink, with subcategories reported (**Error! Reference source not found.**), five are Grassland categories:

(1) Wetlands converted to Grassland – Organic soil CO_2
(2) Wetlands converted to Grassland – Organic soil N_2O
(3) Other Land converted to Grassland- Revegetation before 1990- Mineral soil
(4) Other Land converted to Grassland- Revegetation since 1990- Mineral soil
(5) Other Land converted to Grassland- Revegetation before 1990-living biomass

Looking at the main land use categories (Table 7-8) Land converted to Grassland is the far largest source/sink component, with 94% of CO_2 equivalents absolute values in LULUCF. Both the categories Grassland remaining Grassland and Land converted to Grassland are recognised as key land use categories, regarding the area of main land use categories (Table 7-10). Regarding area of land use categories at highest resolution reported (Table 7-9) both the categories Grassland remaining Grassland and Wetlands converted to Grassland- Organic soil are recognized as key areas, and of the categories classified as applicable toward emission removal contribution (Table 7-11) both Revegetation before and since 1990 are added as key areas.

7.9.1 Carbon stock changes (5C)

Carbon stock changes are estimated for both subcategories and included under Land converted to Grassland. The C-stock changes of Grassland remaining Grassland are not estimated in present submission.

Changes in carbon stock in soil and vegetation due to revegetation activities are for the first time reported under the Grassland category. By reporting revegetation as a separate land use category, changes in individual pools and other emissions are addressed more directly in the CRF than in previous submissions. Compared to previous submission where a separate background table for revegetation was included in the NIR, no such table is needed as it is included in the CRF tables.

7.9.1.1 Carbon stock changes in living biomass

No information is available on overall changes in the living biomass within Grassland remaining Grassland although it is known that changes are occurring. Carbon stock changes in living biomass on drained land are possible e.g. due to the invasion of shrubs, changes in grazing pressure or increased nutrient availability due to mineralization as SOC decomposes.

Changes in carbon stock in living biomass in Grassland remaining Grassland or Wetlands converted to Grassland are not estimated, as is consistent with the Tier 1 methodology for the Grassland remaining Grassland. No data is presently available for changes in living biomass in Wetlands converted to Grassland.

Carbon stock changes in living biomass are estimated for the category Other Land converted to Grassland. The stock changes in living biomass reflect the increase in vegetation coverage and biomass achieved through revegetation activities. The changes in biomass are estimated as a relative contribution (10%) of total C-stock increase as estimated in the research project aimed at assessing the rate of carbon sequestration due to revegetation (Arnalds et al., 2000). The carbon stock in living biomass is estimated to have increased by 7.4 Gg C and 7.1 Gg C respectively for the categories Revegetation before 1990 and Revegetation since 1990, removing 27 Gg CO_2 and 26 Gg CO_2 from the atmosphere, respectively.

Carbon stock changes in living biomass in Other Land converted to Grassland-Revegetated before 1990 is recognised as key source/sink in LULUCF regarding the categories reported at highest resolution.

7.9.1.2 Net carbon stock changes in dead organic matter

Tier 1 methodology in AFOLU Guidelines assumes no changes in dead organic matter in Grassland remaining Grassland, and changes are reported as not applicable. For Land converted to Grassland, Tier 1 assumes the stock changes to take place in the 1st year of conversion. Most of the drainages included in category Wetlands converted to Grassland are older. No data is available on Wetlands converted to Grassland the inventory year. Changes in dead organic matter are thus not requested by the AFOLU Guidelines Tier 1 methodology for conversions older than one year and the information needed to move up to higher tiers for the category Wetlands converted to Grassland is at present not available for this stock. The changes in dead organic matter are included in C-stock changes for the category Other Land converted to Grassland.

7.9.1.3 Net carbon stock change in soils

Changes in carbon stock in mineral soils of land under categories Grassland remaining Grassland or Wetlands converted to Grassland are not estimated due to a lack of data. Tier 1 methodology yields no changes by default 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 for these land use categories is at present not available.

For the category Other Land converted to Grassland, the changes in carbon stock in mineral soils are estimated applying Tier 2 methodology and a CS emission factor. The carbon stock in mineral soils is estimated to have increased by 67 Gg C and 64 Gg C respectively for the categories Revegetation before 1990 and Revegetation since 1990, removing 272 Gg CO_2 and 262 Gg CO_2 from the atmosphere.

Carbon stock changes in mineral soil of land both under Other Land converted to Grassland- Revegetated before 1990 and Other Land converted to Grassland-Revegetated since 1990 are recognised as key sources/sinks in LULUCF for categories reported at the highest resolution (**Error! Reference source not found.**).

The carbon stock changes in organic soils of land within Wetlands converted to Grassland are estimated applying T1 methodology. The reported emissions are an aggregate of emissions from all drained soils as explained above. Of the drained area, 98% is assumed to be organic soil based on AUI unpublished data. Three soil types; Histosol, Histic Andosol and Gleyic Andosol are included. 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 carbon stock in drained organic soils is estimated to have decreased by 400 Gg C in the inventory year, emitting 1468 Gg CO_2, thereby being the single largest source of GHG in LULUCF.

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

7.9.2 Other emissions (5(IV))

All CO_2 emissions due to liming are reported as an aggregate number under land use category Cropland. Due to the structure of the CFR-Reporter software version 3.2.3 used in preparing the CRF tables, non CO_2 emission resulting from drainage still needs to be reported under 5.G. Other, where it is included as subdivision Wetlands converted to Grassland Non-CO2 emission-5(II) Non- CO2 emission from drainage of soils and wetlands-Organic soils.

The N_2O emission resulting from use of fertilizers in revegetation is likewise reported under 5.G. Other- Revegetation- 5(I) Direct N2O emission from N fertilization of Forest Land and Other, due to CRF-Reporter limitations.

7.9.3 Emission factors

The Soil Conservation Service of Iceland records revegetation efforts conducted. A special governmental program to sequester carbon with revegetation and afforestation was initiated in 1998-2000 and has continued since then. A parallel research program focusing on determining the carbon sequestration rate in revegetated areas was started at the same time (Arnalds et al., 2000).

No Tier 1 default emission/removal factors are available for the revegetation effort. The emission factor used for calculating emissions/removals resulting from revegetation efforts are estimated at -0.75 ktonnes C/kha/yr, based on precautious estimates from data collected in 1998-2000. Also, based on the same data, the contribution of changes in carbon stock of living biomass and soil were estimated as 10% and 90% respectively. All revegetated areas are assumed to accumulate carbon stock at the same rate. The CS emission factors applied for C-stock changes in living biomass (including dead organic matter) and mineral soils of land under the category Other Land converted to Grassland are -0.075 and -0.675 ktonnes C/kha/yr respectively.

Emissions of CO_2 from organic soil in Wetlands converted to Grassland are calculated according to Tier 1 methodology and uses the emission factor EF of 1.1 t C/ha/yr

(AFOLU Guidelines Table 7.4) because of the high N content and aggregation of areas from different categories. Recent research on upland CO_2 emissions indicates a higher emission factor than is being used. As the category is a key source, establishing higher tier EF are of high importance. EF for N_2O is discussed in section 7.13.2.2.

7.9.4 Land converted to grassland.

Three categories of Land converted to Grassland are reported in this year's submission. All wetlands drained, except those included under Forest Land are reported as Wetlands converted to Grassland. Cropland converted to Grassland is reported more as a balancing of changes in area estimated as cropland by agricultural statistics, than as an estimate of area of land converted. Revegetation is reported as Other Land converted to Grassland. The area converted annually is recorded by SCSI as described above.

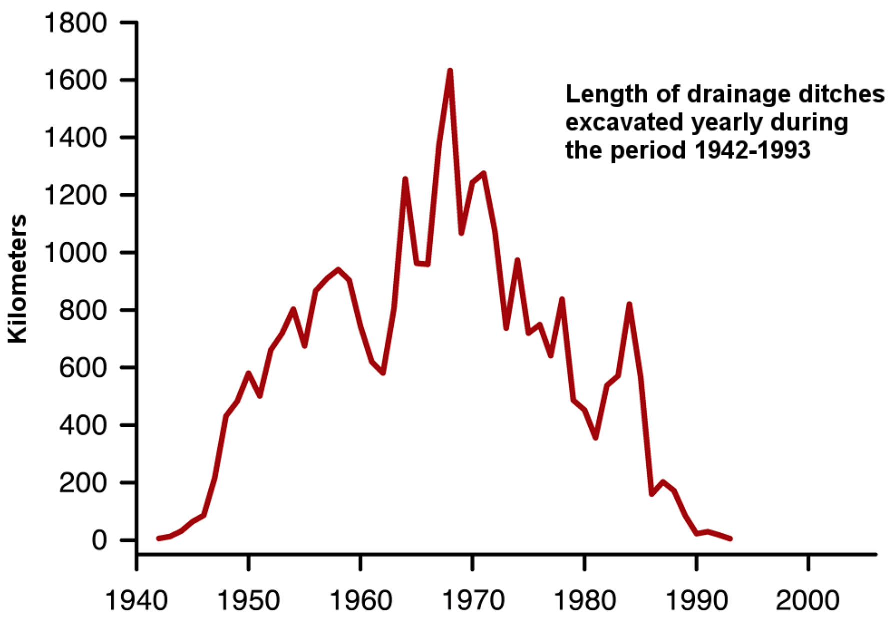

Figure 7-7 Length of ditches subsidised in 1942-1993 (Based on information from the Icelandic Farmers' Association)

Applying the AFOLU criteria on the length of the transition period until reaching stable soil carbon levels of the resulting land use category, all drained land, except for the area already converted to forest land, is reported as being in transition period Wetland Wetlands converted to Grassland. The drained areas have generally not reached the same level of soil carbon as grassland mineral soils (AUI unpublished information). The length of transition period has not been determined. The excavation of ditches was mostly finished before 1990 according to ditch subsidy information (Figure 7-7). Since the subsidy program ended, the centralized recording of drainage has not been maintained and numbers on the area drained annually are not available.

Cropland area as reported by Iceland Agricultural Statistics has not been updated since 1999 and no changes were reported in the period 1990-1998 period. 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 activity involves establishing vegetation on eroded or desertified land or reinforcing existing vegetation. Most land hereto revegetated has involved establishing vegetation on land which did not have 20% cover of vascular plants according to the SCSI, and does therefore not meet the definition of Grassland (Halldórsson et al in prep). The transition period for Other Land converted to Grassland has not been determined and it will take decades to centuries to reach the C level of Brown Andosol (2-7%) at the rate of accumulation assumed in EF. All revegetated land is therefore reported as Land being converted to Grassland.

7.9.5 Uncertainty and QA/QC

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

Uncertainty in reported emissions from drained soil is also substantial. The total drained area 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 of around 8.4 km/km^2 (unpublished data from AUI), which is around 15% more than the effectiveness used. The uncertainty of the total length of ditches is supposed to have decreased compared to previous estimates based on ditch subsidy information, but the uncertainty still needs to be quantified. New estimates on drainage effectiveness indicate a much broader area around ditches being affected, or up to 200 m on average (Gísladóttir et al., 2007). In another study on ditch density, a 200 m buffer was applied on all ditches. The estimated area where minimum density of ditches was 0.1 km/km^2 was 493.9 kha (Gísladóttir et al., 2009). The remaining area within the 200 m buffer is estimated at 61.2 kha (Gísladóttir personal communication). The total area of that study included within the 200 m buffer around ditches is 555 kha which is considerably larger number than the present IGLUD estimate. This inconsistency calls for future revision and a quality check on calculations and data compilation on drained land. Uncertainty in estimates of area of drained land is thus still very high. In this submission the area of land drained is estimated as in previous submissions using the 7.3 km/km^2 conversion factor.

The Grassland category in IGLUD is the result of a compilation of; (1) all land identified in NYTJALAND and CLC-2006, to categories with 20% or more vascular plant cover, (2) land estimated as drained and (3) all land mapped by SCSI as revegetation sites. This area is then compared to land classified to the categories higher in the hierarchy, and to SCSI estimates for revegetation activity as described above. According to this compilation process e.g. Other Land inside an estimated drained area is reported as Grassland. Implementation of the land use category definitions has decreased the uncertainty for which land is included. The uncertainty in area estimate in IGLUD does not affect the emission reported as their calculations are based on other estimates of area.

Calculation of removals/emissions of carbon due to revegetation depends on the size of the area and the chosen emission/removal factor. The approach used is Tier 2 and is based on simple removal rate factor which uses measurement of chrono-sequential accumulation of carbon on revegetated areas of a known age. Both numbers have a large uncertainty.

The areas where revegetation is carried out vary considerably with regards to soil, climate 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 adequately 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 available records for each site and corresponding area estimates. The estimated hectares are based on the amount of seeds and fertilizer used. This method may have introduced relatively large errors into the area estimates and may present risks of either double counting or excluding counting areas. The reported size of the area subjected to revegetation since 1998 is increasingly based on simultaneous GPS recordings. The reported area in this submission is corrected according to preliminary results from the National Inventory of Revegetation. Correction and adjustment will be an ongoing effort in the coming years as information is gathered and knowledge accumulated.

Revegetated land area prior to 1990 is subject to larger uncertainties than area after that time. It is possible that some of these older areas need to be recategorised.

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

7.9.6 Planned improvements regarding Grassland

Due to the potential significance of emissions and removals in the case of e.g. changed management, to and from mineral grassland soils, moving up to a higher tier level for the estimation of carbon stock changes in soil in that subcategory is recognised as high priority issue.

As severely degraded soils are widespread in Iceland as a result of extensive erosion over a long period of time, the changes in mineral soil carbon stocks are a potentially large source of carbon emission. The importance of this source should be emphasised, since Icelandic mineral grassland soils are almost always Andosols with a high C content (Arnalds and Grétarsson, 2001). Dividing the area of grassland remaining grassland into subcategories, based on management and taking soil and vegetation degradation into account, is currently underway as part of the new land use database.

Emissions of both CO_2 and N_2O from Wetlands converted to Grasslands are identified as key sources for LULUCF. Improving the resolution of recorded land use, soil types and refinement of emission factors is highly important for this category. Improvements in ascertaining the extent of drained organic soils both in total and within different land use categories and soil types is also a priority.

Improvements in both the sequestration rate and area estimates will 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 at present. The first is the improvement in activity recording, both location (area) and description of activities as well as management. This is already being actively implemented, as data on reclamation projects started after 1990 are currently under revision. This revision will be concluded by the end of 2009. The mapping of all activities since 1990 is verified by visiting points within the 1×1 km inventory grid. Recording activities initiated before 1990 is also ongoing. The second improvement is pre-activity sampling to establish a zero-activity baseline for future comparisons of SOC. This will be implemented for all new areas established in 2009 and later (Halldórsson et al. in prep.).

The third improvement is the introduction of a sample based approach, combined with GIS mapping, to identify land being revegetated and to improve emission/removal factors and quality control on different activity practices. The approach is designed to both confirm that areas registered as subject to revegetation efforts are correctly registered and to monitor changes in carbon stocks.

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

7.9.7 Recalculation

Reallocating emissions/removals due to Revegetation from category 5.G Other to category 5.C.2.5 Other Land converted to Grassland involves the recalculation of both categories. The area of land being revegetated was also revised by SCSI according to data obtained in the national inventory on revegetation.

7.10 Wetland

The reported emission for this category is structured as in last year's submission. Flooded land is divided into "Land converted to wetland" and "Wetlands remaining wetland". The increase in reported emission is due to new areas being flooded. Definitions for the Wetlands category and its subcategories have been prepared and implemented to this year's submission. The category named Peatland in previous submissions is now renamed Other Wetlands. That category as reported is aggregate of two defined subcategories i.e. (1) Mires and fens and (2) Semi-wet areas. Part of drained land reported under Wetlands converted to Grassland fall within areas identified in IGLUD as wetland. This land should either be reported under Wetlands or identified as Grassland. Emission is only estimated for the categories Grassland and Other Land converted to Wetlands resulting from flooding of land due to the establishment of hydropower reservoirs.

7.10.1 Carbon stock changes (5D)

The category Wetlands remaining Wetlands is divided into three subcategories; Lakes and Rivers, Reservoirs and Other Wetlands. Two categories are considered unmanaged. Reservoirs, which are classified as Wetlands remaining Wetlands, include only lakes and rivers turned into reservoirs. In cases where the water surface area of the lake has only increased, the lake area prior to increase is defined as Wetlands remaining Wetlands. No emission is assumed from natural lakes converted to reservoirs. Peat mining for fuel does not occur. The only peat excavation currently occurring is related to Land converted to Settlements (section 7.7.1.).

Some of the land included under Other Wetlands 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 'Wetlands remaining wetland - other wetland' and 'Wetlands remaining wetland - lakes and rivers' are identified as key areas with regards to reported land use categories at highest resolution reported.

7.10.1.1 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 hydropower companies using 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.

The estimated CO_2 emission from reservoirs is 16 Gg and increased by 74% from last submission. This increase is due to establishment of a new 56 km^2 reservoir Hálslón where large areas were vegetated. Of the 7 Gg CO_2 increase majority or 6 Gg CO_2 (93%) were due to flooding of High SOC soils.

7.10.1.2 Other emissions (5II)

Emission of N_2O from drained wetlands is reported under subcategory "5.G Other-Wetlands converted to Grassland Non CO_2 emission 5(II) Non CO_2 emissions from drainage of soils and wetlands - organic soils".

7.10.1.3 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 as 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 CH_4 emission from reservoirs is estimated as 0.66 Gg CH_4 and increased from last submission by 73% due to the new reservoir Hálslón reservoir.

7.10.1.4 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.

Table 7-14 Emission factors applied to estimate emission from flooded land (Óskarsson and Guðmundsson 2008)

Emission factors for reservoirs in Iceland	**Emission factor [kg GHG/ha/d]**			
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

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

7.10.2 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.

7.10.3 Uncertainty and QA/QC

Main uncertainty is associated with emission factors used and how well they apply to 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 to 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.

7.10.4 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. Introduction of reservoir specific emission factors for more reservoirs is expected as information on land flooded is improved. 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 development of IGLUD in the coming years is expected to improve area estimates for wetland and its subcategories.

7.11 Settlements

The land classified as Settlements, is land identified as artificial area in CLC -2006 plus roads which not included in the CLC. All roads include buffer zones. The Settlements category is highest in the hierarchy of main land use categories. Due to this, some land which should be classified as other land use are included. This is likely to be the case where cropland is adjacent to roads or where roads pass through forest, where forests are planted within area developed for summer houses or a forest is developed to such area.

7.11.1Carbon stock changes (5E)

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

Carbon stock changes are only estimated for Forest Land converted to Settlements. The emission reported is based on carbon stock estimate of the living biomass of the trees on the deforested land.

Potential emissions by source and removals by sinks exist through the excavation of organic soils as a source and the growth of trees, shrubs and herbaceous vegetation as a sink.

Organic soils are sometimes excavated and used in landscaping or for other purposes when former wetlands are converted into settlements or areas already included under settlement are prepared for the construction of streets or buildings. This excavation of organic soil enhances the decomposition of the organic material and emissions 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 neighbourhoods generally have less woody and herbaceous vegetation than the older neighbourhoods. This increase in biomass is not estimated in the inventory.

7.11.2Other emissions (5)

Part of the land identified as drained wetlands is within Settlement areas, although presently reported under Wetlands converted to Grassland. N_2O emission due to this land use is reported under 5.G Other - Wetlands converted to Grassland Non-CO_2 emission 5(II) Non-CO_2 emissions from drainage of soils and wetlands- organic soils”. Burning of biomass in open areas within the category settlement does occur (see section 7.14). No other sources of CH_4 or N_2O have been identified.

7.11.3 Land converted to settlement

At present no official country-wide periodic compilation of Land converted to Settlement is available. Previous land use categories are generally not recorded in municipal area planning.

7.11.4 Planned improvements regarding Settlement

The development of IGLUD the next years is expected to improve area data on previous land use of Land converted to settlement. CLC 2006 has already provided new estimates for Settlements area. The preparation of CLC-2000 will provide estimates for changes to Settlements area over that period (2000-2006) .

Part of the land identified as Settlements is on drained wetland soils and relevant emission is reported under Wetlands converted to Grassland. As geographical the identification of the land drained improves, the emissions due to the drained soils under Settlements will be reallocated to the category.

7.12 Other land (5, 5F)

No emission/removal is reported for Other Land remaining Other Land in accordance with AFOLU Guidelines. Conversion of land into the category Other Land is not recorded. Direct human induced conversion is not known to occur, although potential processes capable of converting land into Other Land are recognised. Among these is soil erosion, floods in glacial and other rivers, changes in river pathways and volcanic eruptions.

Identification of Other Land in IGLUD is based on land remaining when all other categories have been identified. Independent recognition of the land is possible to large extent but not applied. This land is identified as a key area in reported land use categories but not as part of applicable land use categories due to its definition as unmanaged.

7.12.1 Planned improvements regarding other Other Land

The continued development of IGLUD in the coming years is expected to improve area estimates for the category.

7.13 Other (5)

Two emission/removal categories are reported under other. Wetlands converted to Grassland Non-CO_2 emission and emission/removal due to use of fertilizers in revegetation. Harvested Wood Products are not reported.

7.13.1 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.

7.13.2 Wetland converted to Grassland Non CO_2 emissions

Under this item non-CO_2 emission from wetland converted to Grassland are reported as aggregate estimate for all drained soils except those included under Forest Land. Present structure of Reporter software does not allow reporting this emission under Grassland land use category.

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

Grassland in Iceland is generally not fertilized. The main exception when it is a part of revegetation activity. Use of fertilizers in revegetation is reported separately (see below). Direct N_2O emission from the 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 "5(II) Non-CO_2 emissions from drainage of soils and wetlands- Organic soils" consistent with reporting of CO_2 emission from drained soils. This factor is identified as level key source of LULUCF.

7.13.2.2 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 its high N content.

7.13.3 Revegetation

7.13.3.1 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 here.

7.13.3.2 Emission factors

For direct N_2O emission from N fertilization, Tier 1 methodology and the default EF of 1.25% [kg N_2O-N/kg N input] (GPG2000) was used.

7.14 Biomass burning (5V)

Accounting for biomass burning in all land use categories is addressed in this section. The only emissions reported in this category were in 2006 due to a single large wild-fire event in western Iceland.

No other emissions due to biomass burning are reported. Controlled burning of forest land is considered as not occurring. Same applies to Land converted to Forest Land, Land converted to Cropland, Forest Land converted to Grassland, Forest Land converted to Wetlands and Wildfires on Forest Land converted to: Cropland, Grassland or Wetlands. For other categories biomass burning is not estimated due to lack of information.

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

7.14.1 Planned improvements regarding biomass burning

A large wildfire broke out in the year 2006. It initiated a research project aimed assessing effects of biomass burning on ecosystems. This project is expected to provide data for Tier 2 assessment for amount of biomass burned per area. Systematic compilation of existing information on approved burning and improved recording of the controlled and wild-fire is planned.

7.15 Planned improvements of emission/removal data for LULUCF

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

While gathering land use information for the purpose of the new geo-referenced land use database IGLUD, data will be collected on the carbon stocks of each land use category used in the classification. These efforts are aimed at gradually improving the reliability of reported emissions/removals within the LULUCF sector and enable movement from Tier 1, 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

This sector includes emissions from landfills, wastewater handling, small scale waste incineration, and Other (composting).

The waste sector has been in transition since 1990 (Figures 8.1 and 8.2). Open pit burning which used to be the most common means of waste disposal outside the capital area has gradually decreased since 1990 as landfills have become more common. Solid waste disposal is divided between managed landfill sites and unmanaged landfill sites. The definition for a managed site is a landfill deeper than 5 meters with a thorough registration system for waste type and amount. Sites that are shallow, with less than 5 meters of waste are defined as unmanaged landfill sites. The trend has been toward managed landfills as municipalities have increasingly cooperated with each other on running waste collection schemes and operating joint landfill sites. This has resulted in larger landfills and enabled the shutdown of a number of small sites. Today 56% of solid waste is placed on disposal sites that are defined as managed landfill sites. Recycling of waste has also increased due to efforts made by local municipalities. Currently about 63% of municipal waste is landfilled, 29% recycled or recovered, 5% incinerated with energy recovery and 1 % is incinerated without energy recovery.

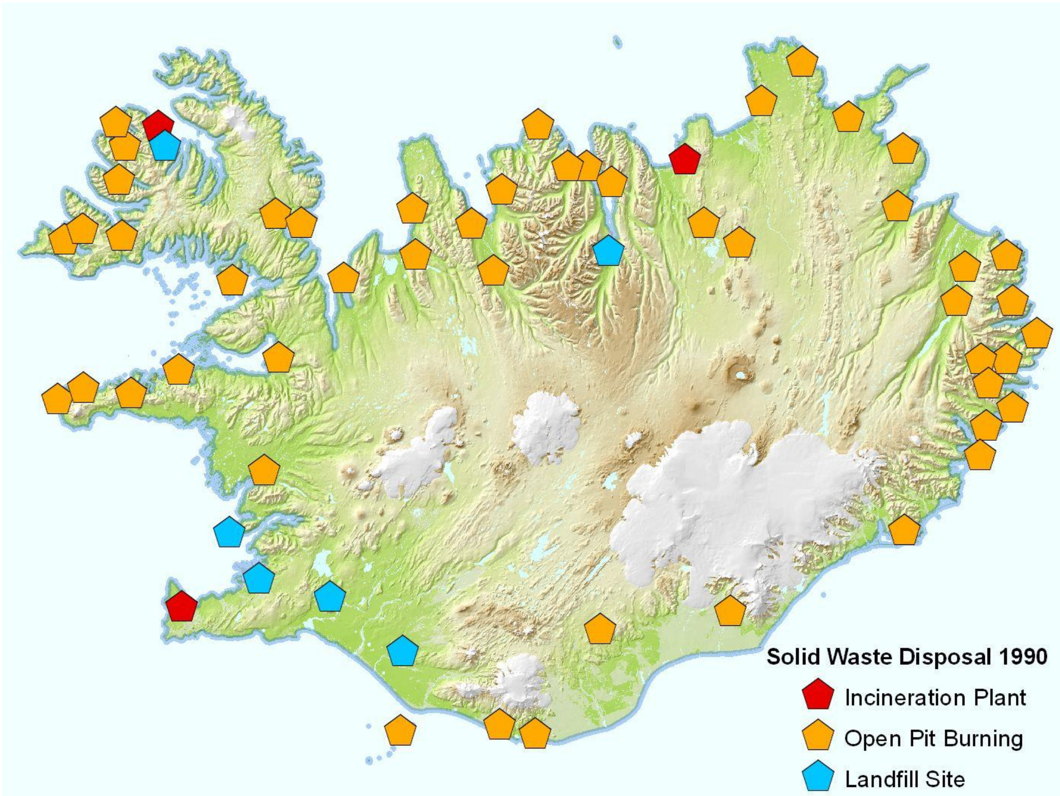

Figure 8.1. Solid waste disposal in 1990

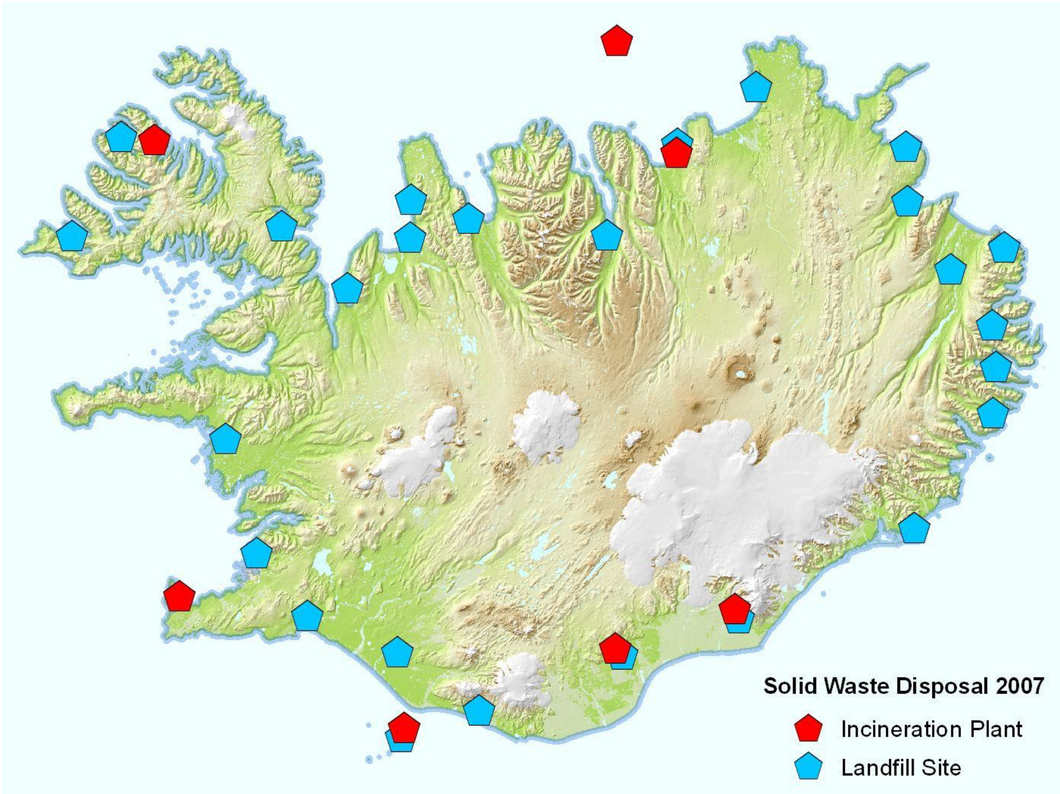

Figure 8.2. Solid waste disposal in 2007

Solid waste disposal on land (Landfills) is the main category within the waste sector, accounting for about 86 % of the sector's total emissions. Wastewater handling and waste incineration account for 5% and 9% respectively. Composting only accounts for less than 1%. The waste sector accounted for 5% of the total GHG emissions in Iceland 2007. In table 8.1, an overview of the emissions is.

Table 8.1 Emissions (Gg CO_2 equivalents) from the waste sector

	1990	1995	2000	2005	2006	2007
Landfills	134	151	164	167	186	202
Wastewater handling	20	25	26	25	25	23
Waste incineration	19	13	7	0	0.03	0.03
	173	189	197	192	211	225

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.

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

For Wastewater Handling (sector 6.B.), CH_4 emissions are calculated in continuation with last year's methodology which was somewhat revised from earlier submissions.

For Waste Incineration (sector 6.C.), a large part of the emissions is included in the energy sector as almost all waste incineration in Iceland is with energy recovery. A striking decrease is seen in open pit burning since 1990, and from 2005 only bonfires is included in the Waste Incineration sector, along with emissions from one single incineration plant.

Other (sector 6.D.), now reported for the first time, includes composting. Composting has been practiced to a small extent since 1995.

As indicated in Table 8.1, the key source analysis performed for 2007 has revealed that in terms of total level and/or trend uncertainty, the only key sources in the waste sector is Emissions from Solid Waste Disposal Sites – CH_4 (6A) and Emissions from waste incineration – CO_2 (6C).

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 (E: estimated, NE: not estimated, NA: not applicable)

	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	E	NA	NA	NA	NE	NA
Unmanaged waste disposal on land	NE	E	NA	NA	NA	NE	NA
Wastewater treatment							
Industrial wastewater	NE	E	NE	NE	NE	NE	NE
Domestic and commercial wastewater	NE	E	E	NE	NE	NE	NE
Waste incineration	E	E	E	E	E	E	E
Other – Composting	NE	E	E	NA	NA	NA	NA

8.2 Solid waste disposal sites

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 the oxygen is depleted the decomposition becomes anaerobic and methane levels start to increase. After about one year, a peak is seen in CH_4 emissions. The level then decreases over several decades.

In Iceland, solid waste disposal is divided between managed landfill sites and unmanaged landfill sites. Total waste going to these landfills is divided into two major waste streams, municipal solid waste (MSW) and industrial waste (IW).

From 1950 to 1980, all waste disposals are rated as uncategorized. The methodology for calculating methane from solid waste disposal on land is in accordance with the IPCC Spreadsheet First Order Decay Model. MSW is defined as waste collected from ordinary households and IW is waste collected from industry. Waste from commerce and trade can be included both in MSW and IW, especially in smaller municipalities where separation between MSW and IW is not well specified.

8.2.1 Activity data

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

Using calculations based on the Icelandic Gross Domestic Product (GDP) and population number, 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 as well as population dates back before 1950 and are considered reliable. Available reported waste figures (dated back to 1995), GDP and population are used to estimate the total amount of waste generated from 1950 to 1995 (Figure 8.3).

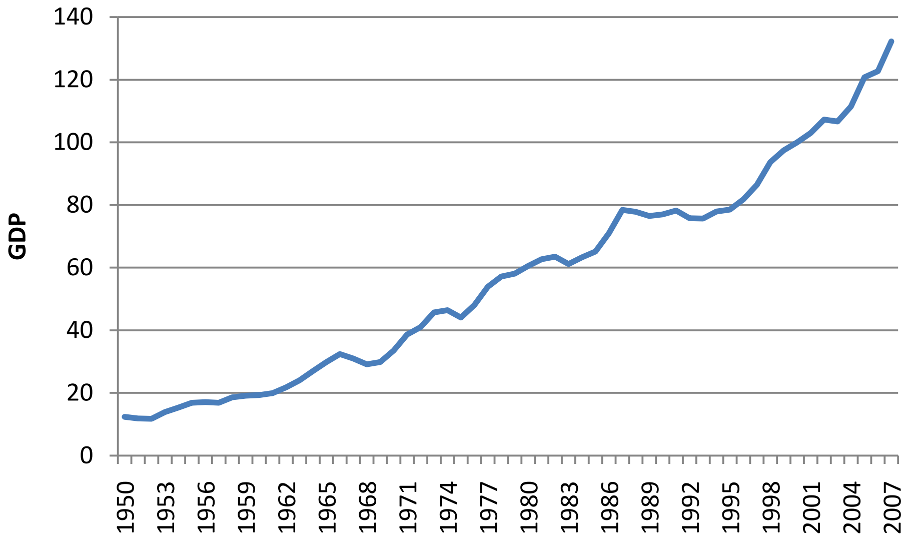

Figure 8.3 Gross Domestic Product in Iceland from 1950 to 2007

In this submission, GDP based calculation uses waste figures generated in 1995, 2000 and 2004 as multiple reference figures. GDP and MSW per person are strongly correlated, and was therefore used to determine the amount of generated MSW per person per year and then multiplied by population to generate the total MSW figures. IW on the other hand is calculated directly from to GDP. Data quality for the multiple reference years is ensured because of accurate waste reporting during those years. In the 2007 submission 2004 was used as reference year for this extrapolation, and in the 2008 submission 1994 was used as the reference year. A flaw is seen in both calculations. When 2004 is used, an unnaturally large gap is seen in the correlation between the years 1994 and 1995. When 1994 is used, the result leads to greater emissions in the early 1990s. In this submission, multiple reference points are used to give greater confidence in the estimates and to reduce the effect of a single reference year (figure 8.4).

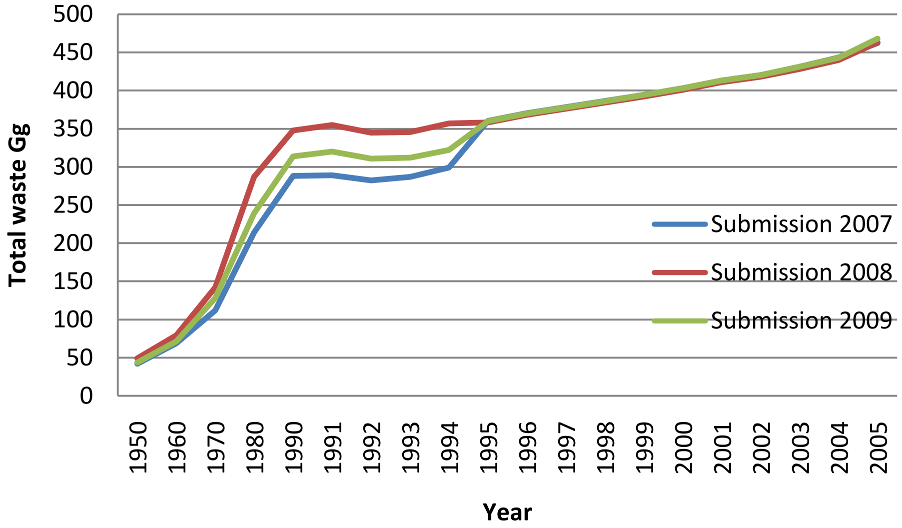

Figure 8.4 Revised estimation on total waste

The activity data was mostly collated by the EA. The municipalities and larger waste companies are secondary data sources. The total amount of MSW and IW generated and treated in Iceland between 1950 and 2007 is shown in Figure 8.5.

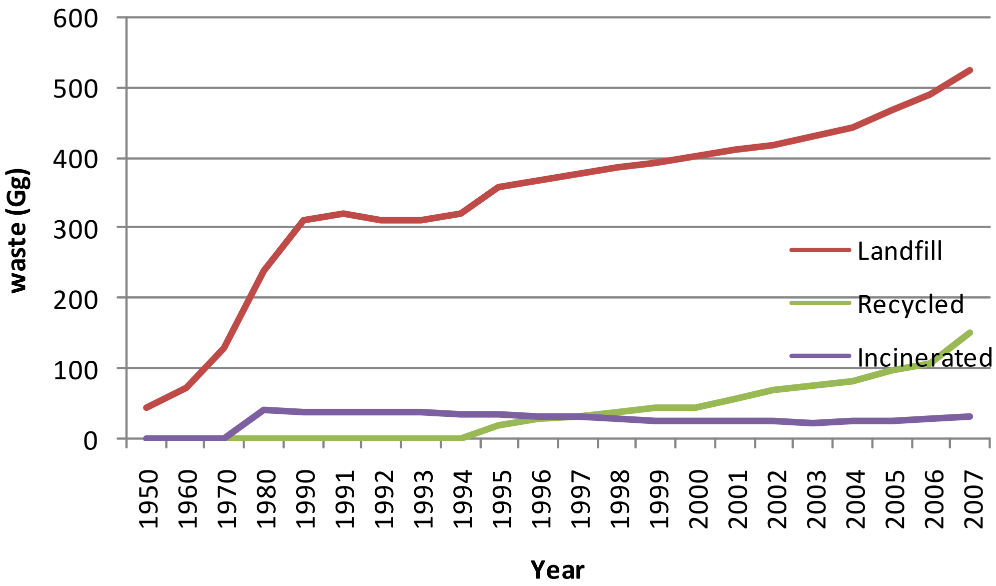

Figure 8.5 Total amounts of MSW and IW generated and treated in Iceland between 1950 and 2007

8.2.2 Emission factors

Municipal solid waste

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

The composition of MSW going to landfills has been surveyed since 1999 and is done by SORPA, the largest waste treatment facility in Iceland. SORPA serves the 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 2007.

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 may 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 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 8.3 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 was excluded from this composition. Proper Wastewater handling started around 1990, but septic tanks were used to some extent prior to 1990. Today 68% of buildings are connected to wastewater handling facilities. Little is known of sludge disposal prior to 1990 and the amount disposed in landfills is considered insignificant. Emissions from sludge in landfills are included in landfill emissions from the year 1990 in accordance with records from landfill sides. Ratios on the municipal solid waste composition are calculated, excluding sludge according to Table. 8.5. The emission factors and parameters for IPCC Category 6A Municipal Solid Waste are reported in Table 8.4.

Table 8.4 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

Iceland's economy historically depended heavily on the fishing industry. The main material exports are fish and fish products and aluminium. Iceland's agriculture consists mainly of potatoes, green vegetables (in greenhouses), mutton and dairy products.

Industrial waste (IW) comes from agriculture, fisheries and other industrial activities as well as waste from commerce and trade (fraction not included in MSW). The amounts of IW used in the IPCC model exclude 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 in the section on Uncertainties.

The emission factors and parameters for IPCC Category 6A Industrial Waste are reported in Table 8.5.

Table 8.5 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) occurs only at one landfill site (Álfsnes) in Iceland which receives waste from the capital area. It serves 65% of the population and receives 55% of total landfill waste. The recovery of CH_4 from landfill gas started in 1997 and the amounts are reported in Table 8.6. Methane recovery was significantly less in 2006 and 2007 than in 2005 as the local power plant failed and the methane burner did not operate during the first half of 2006. This led to the reduction of captured methane from the landfill. Due to this reduction, water accumulated in the landfill and lead to further disruption in recovery of landfill gas in 2007. The values for methane recovery in 2006 and 2007 are estimated.

Table 8.6 Landfill gas recovery in Iceland, Gg CO_2 equivalents from 1997 to 2007

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Landfills	2	5	7	9	9	23	24	29	33	19	9

Uncertainties

The last year's 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 as follows:

Landfilled waste between 1950 to 1980

The exact amount of waste going to managed or unmanaged landfill sites between 1950 and 1980 is unknown. Therefore the Methane Correction factor (MCF) in the IPCC model has been set to uncategorized for this period (MCF = 0.6 – see Table 8.4 and 8.5).

Amount and composition of Industrial Waste

The exact composition of mixed IW and thus the fraction of biodegradable waste are unknown. Scrap metal, tires and construction and demolition waste are excluded from the total. Large amounts of waste from companies are similar in composition to MSW; this is included in mixed fraction of Industrial Waste. Methane emission from landfill IW might be overestimated as studies have revealed that methane emissions from landfills that accept slaughterhouse waste is very low, as this type of waste decompose at a slow rate.

MSW composition between 1950 and 1998

The composition of MSW for the years 1950 to 1998 is 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)

8.3.1 Domestic Wastewater

The majority of the Icelandic population, approximately 90%, lives by the coast, a non problem area with regard to eutrophication, as the coast is circumscribed by an open sea with strong currents and frequent storms which lead to effective mixing. About 65% of the population lives in the capital area. Most of the larger industries are within this area, located mostly at the coast. The practice of wastewater treatment has undergone a radical change in Iceland since 1990. In 1990, 6% of the Icelandic nation was connected to wastewater treatment plants, but in 2007 the ratio was 68%.

Very few wastewater treatment plants are operational in Iceland and most of them are located in the capital area and in a few other larger municipalities. The wastewater treatment systems are mostly settling tanks or septic tanks, with Primary and Secondary treatment. In the last decade improvements have been made to bring the sewage system to an acceptable level. The improvements made in the capital area, included: 1) consolidation of the drainage system reduces 40 outlets to two, 2) the sewage being 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 fewer than 1000 people live above 200 m altitude. This explains the high percentage of primary treatment. In 2007 one of the municipalities located close to Reykjavík that had been using septic tanks as an treatment system was connected to the Reykjavik draining system. This led to a decrease in overall emissions from wastewater handling.

The sludge from wastewater handling is disposed on (managed and unmanaged) landfill sites. As no wastewater treatment existed prior to 1990, and little is known of where sludge was placed earlier, it is assumed that placing of sludge on landfills started in 1990 in connection with wastewater treatment plants.

Methodology

Sludge was excluded from the composition in the 2008 submission, as emissions from sludge treatment facilities are partly included in the wastewater section according to the 2006 Guidelines. In this year's submission, emissions from sludge planted in landfills are estimated and subtracted from wastewater emissions. The industrial wastewater section includes emissions from the food industry.

Methane emissions

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

Total CH_4 Emissions from Domestic Wastewater:

$$CH_4\ Emission = \left[\sum_{i,j}\left(U_i \cdot T_j \cdot EF_j\right)\right](TOW - S) - R$$

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
0.001 = 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)

Total domestic organic sludge:

$$S = P \cdot D_{dom} \cdot DS_{dom}$$

S = organic component removed as sludge in inventory year, kg BOD/yr
P = country population in inventory year
D_{dom} = Domestic degradable organic component in kg BOD/100 person/yr
DS_{dom} = fraction of domestic degradable organic component removed as sludge

Nitrous oxides

N_2O emissions were estimated using the IPPC 2006 Guidelines. Variable P (population) in this equation is country specific and includes only the population that is connected to 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_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
$F_{NON\text{-}CON}$ = factor for non-consumed protein added to the wastewater
$F_{IND\text{-}COM}$ = 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 of N_2O is represented by the population portion that is connected to wastewater handling facilities and is reported in Table 8.7. The total number of population is obtained from the Statistics Iceland.

Table 8.7 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%	2%	0%	4%
1995	267,806	10%	4%	0%	6%
2000	282,849	39%	33%	0%	6%
2005	299,404	68%	54%	2%	11%
2006	307,261	68%	54%	2%	11%
2007	312,872	68%	57%	2%	8%

Emission factors

Of the total population connected to wastewater handling facilities, most are connected to Primary treatment, some are connected to handling facilities such as septic (and settling) tanks. In 2002 Secondary treatment (two step treatment) was introduced on a small scale. A different Methane Corrector Factor applies to these handling methods. The MCF used is in accordance with the IPCC 2006 guideline 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 2002-2003. The emission factors and parameters for IPCC Category 6B Wastewater Handing are reported in Table 8.8.

Table 8.8 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 $_{Untreated}$	**0.1**
B_o *	**0.6 kg CH_4/kg BOD**
Protein	**31.76 kg/person/year**
D_{dom}	**18.25kg BOD/person/year**
DS_{dom}	**15%**
F_{NPR}*	**0,16kg N/kg protein**
$F_{NON-CON}$*	**1.4**
$F_{IND-COM}$*	**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 as follows:

MCF parameter

Default MCF parameters for Domestic Wastewater were used. Most Domestic Wastewater falls under Primary treatment and is pumped out into the sea, therefore MCF = 0.1 was used. Wastewater going through Secondary treatment and Septic tanks were assumed to be 0.3 and 0.5 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.

DS_{dom} parameter

Sludge removed from wastewater treatments are estimated to be 15% regarding to sludge placed on landfills as well as results from survey made on compositions on wastewater treatment plants.

The calculation of emissions from wastewater handling confirms earlier expectation that very little emission is generated from wastewater handling in Iceland (NIR 2005).

8.3.2 Industrial Wastewater

Industrial Wastewater now estimated for the second time and is in accordance with last year's submission. Emission from Fish, Dairy Products and Meat & Poultry industrial wastewater is evaluated in this submission as these groups constitute the majority of industrial emissions in Iceland. The Fish processing is the dominant factor in the estimate. Scandinavian data on tonnes COD produced per tonne for different fish groups were used to estimate wastewater handling in the Fish processing industry. For uncategorized fishing (fish species that are captured as by-catch), 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:

$$EF_j = B_o \cdot MCF_j$$

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)

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 the estimation of Industrial Wastewater emissions is obtained from Statistics Iceland and the Icelandic Dairy Association. Data on COD per ton product are available for different fish/seafood groups from to Scandinavian sources. 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 8.9.

Table 8.9 Emission factors and parameters for Industrial Wastewater

Parameters	
COD $_{\text{white fish}}$	**17 kg O_2/m^3 COD**
COD $_{\text{Herring}}$	**22 kg O_2/m^3 COD**
COD $_{\text{Shrimp}}$	**115 kg O_2/m^3 COD**
COD $_{\text{fishmeal (Capelin)}}$	**1.25 kg O_2/m^3 COD**
Fish processing $_{\text{uncategorised}}$*	**2.5 kg/m^3 COD**
Dairy products*	**2.7 kg/m^3 COD**
Meat & Poultry	**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 dominant emitting 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 8.6.

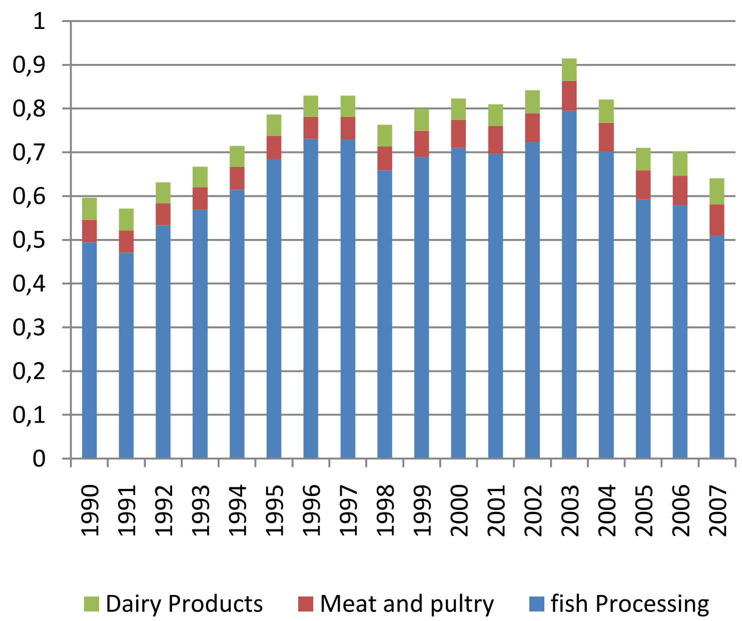

Figure 8.6 Methane emissions of industrial wastewater sections

8.4 Waste incineration

Emissions from waste incineration with energy recovery are reported in sector 1A1a and 1A4a (public electricity and heat production and commercial and institutional heat production). Emissions from waste incineration without energy recovery have decreased by almost 90% from 1990 to 2007. This is because the total amount of waste being incinerated without energy recovery in Iceland has decreased while increasing levels have been incinerated with energy recovery and thus reported under 1A1a and 1A4a. Waste incineration without energy recovery is virtually non-existent today except from bonfires.

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 burnout 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:

$$CO_2Emissions = \sum_i (SW_i \cdot dm_i \cdot CF_i \cdot FCF_i \cdot OF_i) \cdot 44/12$$

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)
FCF_i= total fossil carbon
OF_i = oxidation factor, (fraction)
44/12 = conversion factor from C to CO_2
i = type of waste incinerated/open-burned specified as follows:

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 the EA was estimated with the assumption that 500 kg of waste 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 reliable and data prior to 2000 is considered unreliable.

Emission factors

Data for the estimation of CO_2 from waste incineration are utilised according to the IPCC 2006 Good Practice Guidance. Values for municipal solid waste (MSW) were estimated using following equations from the IPCC 2006 guidelines. Parameters for MSW were calculated using the composition of waste according to local data on MSW. Default values for industrial waste were used according to IPCC guidelines. Bonfires are supervised by local authorities, and only timber is allowed as a burning matter. Parameters for bonfires are IPCC default data for wood.

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:

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

FCF = total fossil carbon in the MSW
WF_i = fraction of waste type *i* in the MSW
FCF_i = fraction of fossil carbon in the waste type *i* of the MSW

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.

8.5 Composting (6D)

Composting has been practiced for some years in Iceland, both domestically as well as municipally. In this submission composting is reported separately. Garden and Park waste has been collected from the Reykjavík capital area and composted according to the “Window method”, where grass, tree crush and horse manure are mixed together. In some small municipalities there is an active composting program where most organic waste is collected and composted. Composting started in 1995 and has been rapidly increasing from the year 2004.

Activity data

Activity data are collected by the Environment Agency of Iceland.

Emission factors

Choice of emission factor is in accordance with IPCC Tier 1 method.

	Emission factors
CH_4	4 g CH_4/kg
N_2O	0.3 g N_2O/kg

*IPCC default values (2006 IPCC Guidelines for National Greenhouse Gas inventory, Table 4.1)

9 RECALCULATIONS

9.1 Overall description of recalculations

The Icelandic greenhouse gas emission inventory has in 2008 been recalculated to minor extend (Table 9.1). All recalculations made are calculated for the entire time series 1990-2007. Recalculation for some components and sources have been made, to account for new knowledge and/or more accurate approximation on activity data and emission factors and to correct for some errors in the calculations. The figures reported in this submission are therefore consistent through the whole time series.

Table 9.1 Total recalculations in 2009 submission compared to 2008 submissions Gg CO_2 eq. (without LULUCF)

Year	Submission 2008	Current Submission 2009	% change 2008-2009
1990	3,409	3,400	-0.3%
1995	3,199	3,173	-0.8%
2000	3,733	3,730	-0.1%
2005	3,709	3,694	-0.4%
2006	4,234	4,236	0.0%
2007		4,482	

9.2 Specific description of the recalculations

9.2.1 Energy

Change in NCV for steam coals used in the cement industry and reallocation of fuels led to a minor changes in emissions (Table 9.2).

Table 9.2 Recalculations of the Energy section in 2009 submission compared to 2008 submissions Gg CO_2 eq. (without LULUCF)

Year	Submission 2008	Current Submission 2009	% change 2008-2009
1990	1,772	1,771	-0.0%
1995	1,904	1,906	0.1%
2000	2,039	2,039	0.0%
2005	2,080	2,088	0.4%
2006	2,164	2,166	0.1%
2007		2,070	

9.2.2 Industrial processes

Decrease in emissions from Industrial processes is mainly due to revision in calculation of emissions from HFCs and SF_6.

2F Consumption of Halocarbons and SF_6

- Revised emission. Emissions of HFCs are calculated using the Tier 1 methodology which considers the import, export and destruction of chemicals in bulk and in equipment with time lag for the first time. This caused reduction in emissions by 11Gg in 2006 and 27Gg in 2005, 5Gg in 2000 and 21Gg in 1995 calculations, as a proportion of HFC is reserved in bank.
- Revised emission. Actual missions of SF_6 were estimated for the first time, time lag was considered. In previous inventory emission of SF_6 was held constant. This revised calculation led to a total reduction in emission from 1990 to 2006 of 38 Gg. In 2005 and 2000 the reduction was 2Gg, and in 1995 and 1990 it was 4Gg. Emissions in 2006 increased by 2Gg (30%) from 2008 calculation.
- To minor degree a change in NCV for coking coal and coke oven coke led to change in emisssions.

Table 9.3 Recalculations of the Industrial processes section in 2009 submission compared to 2008 submissions Gg CO_2 eq. (without lulucf)

Year	Submission 2008	Current Submission 2009	% change 2008-2009
1990	867	863	-0.4%
1995	559	535	-4.3%
2000	950	946	-0.4%
2005	944	918	-2.8%
2006	1,341	1,335	-0.5%
2007		1,486	

9.2.3 Agriculture

No recalculation took place in the Agriculture chapter.

9.2.4 Waste

Main changes in the chapter are due to recalculation on landfill emission and composting.

6 A Solid Waste Disposal on Land

- In this submission, GDP based calculation uses 1995, 2000 and 2004 as multiple reference years to extrapolate waste for the years between 1950 and 1994. In the 2007 submission, 2004 was used as a single reference year for this extrapolation and in 2008 submission, 1994 was used as the reference year. Use of multiple reference years reduces the impact of the single reference years documented earlier. As a result the emission figures of CH_4 have decreased for all years between 1990 and 1995 compared to latest submission (table 9.2)

6 D Other

- Increase in emission from the year 2000 can be explained by combination of various factors. Composting was reported for the first time, composting has been practising since 1995 but was reported for the first time in this submission. This lead to an increase in emissions in 2006 by 1.4 Gg. Somewhat revised calculation on emissions from Managed/Unmanaged waste lead to an increase in emissions, as emissions from Uncategorised waste disposals counts for larger part than previous estimated.

Table 9.4 Recalculations of the Waste section in 2009 submission compared to 2008 submissions Gg CO_2 eq. (without LULUCF)

Year	Submission 2008	Current Submission 2009	% change 2008-2009
1990	190	180	-5.4%
1995	198	194	-2.0%
2000	200	201	0.5%
2005	189	194	2.2%
2006	207	213	3.0%
2007		228	

9.2.5 Land-Use, Land-Use Change and Forestry sector

Recalculation explanation of this chapter will be included in next year submission

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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 2007, 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 2007

			Current year estimate non-LULUCF	Current year estimate LULUCF	Current year estimate absolute value	Level assessment without LULUCF	Cumulative total	Level assessment with LULUCF	cumulative total
			4159.52	**853.33**	**6242.42**	**1**		**1**	
5.C.2.3	Wetlands converted to grassland	CO_2		1468.12	1468.12	0	0	0.227	0.227
1.AA.3b	Road transport	CO_2	891.43		891.43	0.204	0.204	0.138	0.364
2.C.3	Aluminium	CO_2	679.76		679.76	0.155	0.359	0.105	0.469
1.AA.4c	Fishing	CO_2	565.04		565.04	0.129	0.488	0.087	0.556
5.C.2.5	Other land converted to grassland, revegetatior	CO_2		-533.62	533.62	0	0.488	0.082	0.639
1.AA.2	Manufacturing industry and construction	CO_2	400.18		400.18	0.091	0.579	0.062	0.701
2.C.2	Ferroalloys	CO_2	390.04		390.04	0.089	0.669	0.060	0.761
2.C.3	Aluminium	PFC	281.28		281.28	0.064	0.733	0.043	0.804
6.A	Solid waste disposal on land	CH_4	202.14		202.14	0.046	0.779	0.031	0.835
1.B.2	Geothermal energy	CO_2	151.52		151.52	0.035	0.814	0.023	0.859
4.A.3	Enteric fermentation, sheep	CH_4	106.83		106.83	0.024	0.838	0.016	0.875
4.A.1	Enteric fermentation, cattle	CH_4	100.73		100.73	0.023	0.861	0.016	0.891
4.D.1	Direct soil emissions	N_2O	99.58		99.58	0.023	0.884	0.015	0.906
1.AA.3a/d	Transport	CO_2	82.25		82.25	0.019	0.903	0.013	0.919
5.A	Forest land	CO_2		-81.17	81.17	0	0.903	0.013	0.931
2.A	Mineral production	CO_2	64.63		64.63	0.015	0.917	0.010	0.941
2.F	Consumption of halocarbons and SF6	HFC	59.36		59.36	0.014	0.931	0.009	0.951
4.D.2	*Indirect soil emissions **	*N_2O*	*43.92*		*43.92*	*0.010*	*0.941*	*0.007*	*0.957*
1.AA.3b	*Road transport **	*N_2O*	*40.84*		*40.84*	*0.009*	*0.950*	*0.006*	*0.964*

Table A2. Key source analysis – level assessment 1990

			Base year estimate non-LULUCF	Base year estimate LULUCF	Base year estimate absolute value	Level assessment without LULUCF	Cumulative total	Level assessment with LULUCF	cumulative total
			3139.40	**1198.86**	**4897.41**	**1**		**1**	
5.C.2.3	Wetlands converted to grassland	CO_2		1478.44	1478.44	0	0	0.291	0.291
1.AA.4c	Fishing	CO_2	655.49		655.49	0.199	0.199	0.129	0.421
1.AA.3b	Road transport	CO_2	509.02		509.02	0.155	0.354	0.100	0.521
2.C.3	Aluminium	PFC	419.63		419.63	0.127	0.481	0.083	0.604
1.AA.2	Manufacturing industry and construction	CO_2	360.70		360.70	0.110	0.591	0.071	0.675
5.C.2.5	Other land converted to grassland, revegetation	CO_2		-279.58	279.58	0	0.591	0.055	0.730
2.C.2	Ferroalloys	CO_2	204.13		204.13	0.062	0.653	0.040	0.770
2.C.3	Aluminium	CO_2	136.49		136.49	0.041	0.694	0.027	0.797
6.A	Solid waste disposal on land	CH_4	133.86		133.86	0.041	0.735	0.026	0.823
4Asheep	Enteric fermentation, sheep	CH_4	128.86		128.86	0.039	0.774	0.025	0.849
4Acattle	Enteric fermentation, cattle	CH_4	111.74		111.74	0.034	0.808	0.022	0.871
4.D.1	Direct soil emissions	N_2O	96.40		96.40	0.029	0.837	0.019	0.890
1.AA.3a/d	Transport	CO_2	91.11		91.11	0.028	0.865	0.018	0.908
1.B.2	Geothermal energy	CO_2	66.63		66.63	0.020	0.885	0.013	0.921
2.A	Mineral production	CO_2	52.34		52.34	0.016	0.901	0.010	0.931
2.B	Chemical industry	N_2O	48.36		48.36	0.015	0.916	0.010	0.941
4.D.2	Indirect soil emissions	N_2O	46.82		46.82	0.014	0.930	0.009	0.950
1.AA.4a/b	*Residential/institutional/commercial **	*CO_2*	*43.15*		*43.15*	*0.013*	*0.943*	*0.009*	*0.958*
4.B	*Manure management **	*N_2O*	*34.67*		*34.67*	*0.011*	*0.953*	*0.007*	*0.965*

Table A3. Key source analysis – trend assessment

			Base year estimate	Current year estimate	Asbolute estimate	Level assessment	Trend assessment	Contribution to trend	Cumulative total
			4472.81	**5247.83**	**6477.40**		**0.31**	**1**	
2.C.3	Aluminium	CO_2	136.49	679.76	679.76	0.10	0.07	0.217	0.217
1.AA.3b	Road transport	CO_2	509.02	891.43	891.43	0.14	0.04	0.123	0.340
5.C.2.3	Wetlands converted to grassland	CO_2	1478.44	1468.12	1468.12	0.23	0.04	0.111	0.451
2.C.3	Aluminium	PFC	419.63	281.28	281.28	0.04	0.03	0.088	0.540
1.AA.4c	Fishing	CO_2	655.49	565.04	565.04	0.09	0.03	0.085	0.625
5.C.2.5	Other land converted to grassland, revegetation	CO_2	-279.58	-533.62	533.62	0.08	0.03	0.086	0.711
2.C.2	Ferroalloys	CO_2	204.13	390.04	390.04	0.06	0.02	0.063	0.774
1.B.2	Geothermal energy	CO_2	66.63	151.52	151.52	0.02	0.01	0.031	0.804
2.F	Consumption of halocarbons and SF6	HFC	0.00	59.36	59.36	0.01	0.01	0.025	0.829
5.A	Forest land	CO_2	-20.95	-81.17	81.17	0.01	0.01	0.024	0.853
4.A.3	Enteric fermentation, sheep	CH_4	128.86	106.83	106.83	0.02	0.01	0.019	0.871
6.A	Solid waste disposal on land	CH_4	133.86	202.14	202.14	0.03	0.01	0.019	0.890
1.AA.3b	Road transport	N_2O	4.54	40.84	40.84	0.01	0.00	0.015	0.905
4.A.1	Enteric fermentation, cattle	CH_4	111.74	100.73	100.73	0.02	0.00	0.013	0.918
1.AA.2	Manufacturing industry and construction	CO_2	360.70	400.18	400.18	0.06	0.00	0.010	0.927
1.AA.3a/d	Transport	CO_2	91.11	82.25	82.25	0.01	0.00	0.010	0.937
1.AA.4a/b	Residential/institutional/commercial	CO_2	43.15	26.63	26.63	0.00	0.00	0.010	0.947
6.C	Incineration	CO_2	19.19	0.03	0.03	0.00	0.00	0.009	0.957

ANNEX II QUANTITATIVE UNCERTAINTY

TIER 1 UNCERTAINTY CALCULATION AND REPORTING OF SOURCES IN ICELAND

Input Data						Uncertainty of Emissions		Uncertainty of Trend				
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.	Uncertainty in trend in national emissions introduced by a.d.	Uncertainty introduced into the trend in total national emissions
		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	3.57	3.58
Mobile Combustion - Construction industry	CO_2	120.67	194.87	10.0	5.0	11.18	0.51	0.013	0.057	0.07	0.81	0.81
Mobile Combustion - Fishing	CO_2	655.49	549.44	2.0	5.0	5.39	0.70	-0.078	0.161	-0.39	0.46	0.60
Stationary Combustion - Oil	CO_2	237.00	134.47	5.0	5.0	7.07	0.22	-0.047	0.039	-0.23	0.28	0.36
Stationary Combustion - Coal	CO_2	48.27	35.31	5.0	10.0	11.18	0.09	-0.007	0.010	-0.07	0.07	0.10
2.A.1 Cement Production	CO_2	51.56	61.05		6.5	6.50	0.09	-0.001	0.018	-0.01	0.00	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	0.76	0.84
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	1.05	1.44
4.A Enteric Fermentation	CH_4	270.30	236.43	20.0	50.0	53.85	3.01	-0.029	0.069	-1.46	1.96	2.44
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	1.13	1.14
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	0.80	2.10
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	1.10	1.69
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	0.77	1.19
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	0.58	0.67
C2F6	PFC	64.61	51.30	5.0	22.0	22.56	0.27	-0.008	0.015	-0.19	0.11	0.21
Substitutes for Ozone Depleting Substances	HFC	0.00	64.06		100.0	100.00	1.51	0.019	0.019	1.88	0.00	1.88
Other non-key source emissions	All	372.56	445.02		30.0	30.00	3.15	-0.005	0.131	-0.16	0.00	0.16
Total emissions (all sources):		**3,408.77**	**4,234.23**			**Total H :**	**7.4**	**Level Uncertainty**			**Total M :**	**6.1**

ANNEX III CRF SUMMARY 2 FOR 1990 TO 2007

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

Inventory 1990
Submission 2009 v1.2
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)	3,339.90	453.79	691.45	IE,NA,NE,NO	419.63	1.05	4,905.82
1. Energy	**1,739.43**	**4.67**	**26.86**				**1,770.96**
A. Fuel Combustion (Sectoral Approach)	1,672.80	4.67	26.86				1,704.33
1. Energy Industries	13.33	0.01	0.02				13.36
2. Manufacturing Industries and Construction	360.70	0.25	15.91				376.87
3. Transport	600.13	3.08	5.32				608.53
4. Other Sectors	698.64	1.33	5.61				705.57
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**393.32**	**0.61**	**48.36**	**IE,NA,NE,NO**	**419.63**	**1.05**	**862.97**
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	340.62	0.61	NA	NA,NE,NO	419.63	NA,NO	760.86
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)				IE,NA,NE,NO	NA,NE,NO	1.05	1.05
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**	**278.69**				**572.84**
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	244.02				244.02
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)	**1,180.02**	**1.81**	**323.72**				**1,505.55**
A. Forest Land	-20.95	NE,NO	0.27				-20.68
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,198.86	NE	NE				1,198.86
D. Wetlands	2.11	1.81	NA,NO				3.92
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	323.45				323.45
6. Waste	**19.19**	**152.56**	**7.82**				**179.57**
A. Solid Waste Disposal on Land	NA,NE,NO	133.86					133.86
B. Waste-water Handling		13.53	6.65				20.18
C. Waste Incineration	19.19	5.16	1.17				25.53
D. Other	NA	NO	NO				NA,NO
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	3,400.28
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,905.82

(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 neg

(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 2009 v1.2
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)	3,258.97	455.95	681.14	IE,NA,NE,NO	348.34	3.20	4,747.59
1. Energy	**1,694.33**	**4.80**	**26.31**				**1,725.44**
A. Fuel Combustion (Sectoral Approach)	1,627.70	4.80	26.31				1,658.81
1. Energy Industries	14.91	0.01	0.02				14.94
2. Manufacturing Industries and Construction	285.23	0.21	15.07				300.51
3. Transport	611.43	3.22	5.47				620.11
4. Other Sectors	716.14	1.36	5.75				723.25
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**359.76**	**0.51**	**46.81**	**IE,NA,NE,NO**	**348.34**	**3.20**	**758.61**
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	310.74	0.51	NA	NA,NE,NO	348.34	NA,NO	659.59
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)				IE,NA,NE,NO	NA,NE,NO	3.20	3.20
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**	**271.12**				**559.08**
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	237.85				237.85
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)	**1,174.54**	**6.53**	**324.11**				**1,505.18**
A. Forest Land	-23.03	NE,NO	0.34				-22.69
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,189.96	NE	NE				1,189.96
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	323.77				323.77
6. Waste	**19.04**	**156.16**	**7.91**				**183.11**
A. Solid Waste Disposal on Land	NA,NE,NO	137.83					137.83
B. Waste-water Handling		13.20	6.75				19.95
C. Waste Incineration	19.04	5.12	1.16				25.33
D. Other	NA	NO	NO				NA,NO
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	3,242.40
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,747.59

(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 neg

(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 2009 v1.2
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)]	3,371.35	452.52	659.08	0.07	155.28	1.33	4,639.63
1. Energy	**1,819.53**	**5.03**	**26.03**				**1,850.60**
A. Fuel Combustion (Sectoral Approach)	1,752.90	5.03	26.03				1,783.97
1. Energy Industries	13.92	0.01	0.02				13.95
2. Manufacturing Industries and Construction	338.98	0.24	14.15				353.37
3. Transport	621.54	3.30	5.57				630.41
4. Other Sectors	778.46	1.49	6.29				786.24
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**362.74**	**0.53**	**41.85**	**0.07**	**155.28**	**1.33**	**561.79**
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	316.74	0.53	NA	NA,NE,NO	155.28	NA,NO	472.55
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)]				0.07	NA,NE,NO	1.33	1.40
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**	**254.64**				**533.82**
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	222.85				222.85
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)]	**1,160.62**	**6.53**	**323.83**				**1,490.98**
A. Forest Land	-25.26	NE,NO	0.37				-24.89
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,178.27	NE	NE				1,178.27
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	323.46				323.46
6. Waste	**18.53**	**161.25**	**7.95**				**187.73**
A. Solid Waste Disposal on Land	NA,NE,NO	141.79					141.79
B. Waste-water Handling		14.46	6.82				21.28
C. Waste Incineration	18.53	5.00	1.14				24.66
D. Other	NA	NO	NO				NA,NO
7. Other ***(as specified in Summary 1.A)***	NA	NA	NA	NA	NA	NA	NA

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
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	3,148.65
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,639.63

(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 neg

(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 1993
Submission 2009 v1.2
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)]	3,465.41	454.55	668.09	0.27	74.86	1.34	4,664.52
1. Energy	**1,880.07**	**5.11**	**27.57**				**1,912.75**
A. Fuel Combustion (Sectoral Approach)	1,813.44	5.11	27.57				1,846.12
1. Energy Industries	16.27	0.02	0.13				16.43
2. Manufacturing Industries and Construction	366.32	0.26	15.28				381.85
3. Transport	622.17	3.28	5.60				631.04
4. Other Sectors	808.68	1.56	6.56				816.79
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**410.36**	**0.60**	**44.02**	**0.27**	**74.86**	**1.34**	**531.45**
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	370.39	0.60	NA	NA,NE,NO	74.86	NA,NO	445.85
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)]				0.27	NA,NE,NO	1.34	1.61
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**	**261.07**				**538.51**
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	229.22				229.22
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)]	**1,150.71**	**6.53**	**322.81**				**1,480.05**
A. Forest Land	-27.47	NE,NO	0.41				-27.06
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,170.57	NE	NE				1,170.57
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.40				322.40
6. Waste	**15.77**	**164.87**	**7.90**				**188.55**
A. Solid Waste Disposal on Land	NA,NE,NO	145.16					145.16
B. Waste-water Handling		15.24	6.89				22.12
C. Waste Incineration	15.77	4.48	1.02				21.27
D. Other	NA	NO	NO				NA,NO
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	3,184.47
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,664.52

(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 neg

(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 2009 v1.2
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)]	3,415.82	459.81	672.99	0.67	44.57	1.34	4,595.19
1. Energy	**1,842.52**	**5.10**	**27.74**				**1,875.35**
A. Fuel Combustion (Sectoral Approach)	1,775.88	5.10	27.74				1,808.72
1. Energy Industries	16.14	0.02	0.13				16.29
2. Manufacturing Industries and Construction	343.86	0.25	15.50				359.61
3. Transport	624.79	3.31	5.65				633.74
4. Other Sectors	791.10	1.52	6.45				799.07
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**411.36**	**0.57**	**44.33**	**0.67**	**44.57**	**1.34**	**502.84**
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	373.55	0.57	NA	NA,NE,NO	44.57	NA,NO	418.69
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)]				0.67	NA,NE,NO	1.34	2.01
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**	**266.55**				**545.59**
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	234.38				234.38
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)]	**1,137.39**	**6.53**	**322.61**				**1,466.53**
A. Forest Land	-29.41	NE,NO	0.45				-28.96
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,159.19	NE	NE				1,159.19
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.16				322.16
6. Waste	**14.54**	**168.58**	**7.88**				**191.00**
A. Solid Waste Disposal on Land	NA,NE,NO	148.15					148.15
B. Waste-water Handling		16.24	6.93				23.18
C. Waste Incineration	14.54	4.18	0.95				19.67
D. Other	NA	NO	NO				NA,NO
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	3,128.66
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,595.19

(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 neg

(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 2009 v1.2
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)	3,432.81	455.32	670.13	4.36	58.84	1.38	4,622.84
1. Energy	**1,862.71**	**4.58**	**38.21**				**1,905.50**
A. Fuel Combustion (Sectoral Approach)	1,781.03	4.58	38.21				1,823.82
1. Energy Industries	18.95	0.03	0.17				19.15
2. Manufacturing Industries and Construction	359.58	0.27	19.29				379.15
3. Transport	600.44	2.73	12.20				615.38
4. Other Sectors	802.06	1.54	6.55				810.15
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**427.73**	**0.59**	**42.16**	**4.36**	**58.84**	**1.38**	**535.07**
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	389.32	0.59	NA	NA,NE,NO	58.84	NA,NO	448.75
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)				4.36	NA,NE,NO	1.38	5.74
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**	**253.83**				**524.34**
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	224.12				224.12
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)	**1,120.17**	**6.53**	**323.22**				**1,449.91**
A. Forest Land	-31.78	NE,NO	0.49				-31.29
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,144.34	NE	NE				1,144.34
D. Wetlands	7.61	6.53	NA,NO				14.14
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.72				322.72
6. Waste	**12.82**	**173.11**	**8.00**				**193.93**
A. Solid Waste Disposal on Land	NA,NE,NO	151.43					151.43
B. Waste-water Handling		17.74	6.96				24.71
C. Waste Incineration	12.82	3.77	0.86				17.44
D. Other	NA	0.17	0.19				0.35
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	3,172.94
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,622.84

(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 neg

(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 2009 v1.2
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)	3,507.09	463.81	689.06	8.03	25.15	1.38	4,694.52
1. Energy	**1,953.08**	**4.75**	**38.16**				**1,995.99**
A. Fuel Combustion (Sectoral Approach)	1,870.90	4.75	38.16				1,913.81
1. Energy Industries	15.34	0.04	0.20				15.58
2. Manufacturing Industries and Construction	399.03	0.30	18.78				418.11
3. Transport	590.81	2.76	12.11				605.68
4. Other Sectors	865.72	1.66	7.06				874.44
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**427.27**	**0.57**	**49.29**	**8.03**	**25.15**	**1.38**	**511.69**
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	385.00	0.57	NA	NA,NE,NO	25.15	NA,NO	410.72
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)				8.03	NA,NE,NO	1.38	9.41
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**	**266.01**				**539.06**
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	235.32				235.32
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)	**1,106.26**	**7.90**	**322.91**				**1,437.07**
A. Forest Land	-34.38	NE,NO	0.54				-33.84
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,131.41	NE	NE				1,131.41
D. Wetlands	9.22	7.90	NA,NO				17.13
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.37				322.37
6. Waste	**11.49**	**177.53**	**7.98**				**196.99**
A. Solid Waste Disposal on Land	NA,NE,NO	155.25					155.25
B. Waste-water Handling		18.66	7.01				25.67
C. Waste Incineration	11.49	3.44	0.78				15.72
D. Other	NA	0.17	0.19				0.35
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	3,257.45
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,694.52

(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 neg

(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 2009 v1.2
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)]	3,582.35	468.24	687.88	12.52	82.36	1.39	4,834.74
1. Energy	**1,989.18**	**4.27**	**49.07**				**2,042.51**
A. Fuel Combustion (Sectoral Approach)	1,917.80	4.27	49.07				1,971.13
1. Energy Industries	10.25	0.03	0.20				10.48
2. Manufacturing Industries and Construction	467.44	0.35	22.64				490.43
3. Transport	602.47	2.26	19.35				624.08
4. Other Sectors	837.63	1.62	6.88				846.14
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**485.15**	**0.60**	**41.11**	**12.52**	**82.36**	**1.39**	**623.13**
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	438.08	0.60	NA	NA,NE,NO	82.36	NA,NO	521.04
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)]				12.52	NA,NE,NO	1.39	13.91
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**	**261.68**				**538.10**
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	230.68				230.68
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)]	**1,088.89**	**7.90**	**323.30**				**1,420.09**
A. Forest Land	-36.81	NE,NO	0.56				-36.26
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,116.48	NE	NE				1,116.48
D. Wetlands	9.22	7.90	NA,NO				17.13
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.75				322.75
6. Waste	**11.07**	**179.05**	**8.02**				**198.14**
A. Solid Waste Disposal on Land	NA,NE,NO	156.86					156.86
B. Waste-water Handling		18.67	7.07				25.75
C. Waste Incineration	11.07	3.34	0.76				15.18
D. Other	NA	0.17	0.19				0.35
7. Other ***(as specified in Summary 1.A)***	NA	NA	NA	NA	NA	NA	NA

Memo Items: [(4)]							
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	3,414.64
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,834.74

(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 neg

(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 2009 v1.2
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)]	3,572.13	471.15	684.96	20.35	180.13	1.76	4,930.48
1. Energy	**1,974.92**	**4.24**	**49.58**				**2,028.74**
A. Fuel Combustion (Sectoral Approach)	1,880.84	4.24	49.58				1,934.66
1. Energy Industries	13.56	0.03	0.20				13.79
2. Manufacturing Industries and Construction	445.86	0.33	22.89				469.08
3. Transport	605.24	2.30	19.83				627.38
4. Other Sectors	816.18	1.57	6.66				824.41
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**512.84**	**0.44**	**35.84**	**20.35**	**180.13**	**1.76**	**751.36**
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	457.95	0.44	NA	NA,NE,NO	180.13	NA,NO	638.53
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)]				20.35	NA,NE,NO	1.76	22.11
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**	**262.71**				**542.40**
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	231.63				231.63
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)]	**1,066.90**	**7.97**	**323.83**				**1,398.70**
A. Forest Land	-39.76	NE,NO	0.64				-39.12
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,097.36	NE	NE				1,097.36
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	323.18				323.18
6. Waste	**9.38**	**178.81**	**8.04**				**196.23**
A. Solid Waste Disposal on Land	NA,NE,NO	158.27					158.27
B. Waste-water Handling		17.30	7.15				24.45
C. Waste Incineration	9.38	3.07	0.70				13.16
D. Other	NA	0.17	0.19				0.35
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	3,531.78
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,930.48

(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 neg

(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 2009 v1.2
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)	3,752.14	470.86	704.17	26.37	173.21	10.94	5,137.70
1. Energy	**2,032.70**	**3.60**	**61.29**				**2,097.59**
A. Fuel Combustion (Sectoral Approach)	1,909.74	3.60	61.29				1,974.63
1. Energy Industries	10.69	0.03	0.20				10.92
2. Manufacturing Industries and Construction	470.56	0.36	25.04				495.96
3. Transport	626.84	1.67	29.49				658.00
4. Other Sectors	801.65	1.54	6.56				809.75
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**659.24**	**0.68**	**36.18**	**26.37**	**173.21**	**10.94**	**906.62**
A. Mineral Products	61.55	NE,NO	NE,NO				61.55
B. Chemical Industry	0.43	NE,NO	36.18	NA	NA	NA	36.61
C. Metal Production	597.26	0.68	NA	NA,NE,NO	173.21	NA,NO	771.15
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)				26.37	NA,NE,NO	10.94	37.31
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**	**270.53**				**547.46**
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	239.98				239.98
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)	**1,043.53**	**7.97**	**323.46**				**1,374.97**
A. Forest Land	-42.87	NE,NO	0.70				-42.17
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,077.10	NE	NE				1,077.10
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.76				322.76
6. Waste	**7.67**	**181.69**	**8.04**				**197.40**
A. Solid Waste Disposal on Land	NA,NE,NO	160.77					160.77
B. Waste-water Handling		18.08	7.25				25.34
C. Waste Incineration	7.67	2.66	0.60				10.94
D. Other	NA	0.17	0.19				0.35
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	3,762.74
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5,137.70

(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 neg

(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 2000
Submission 2009 v1.2
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)	3,784.34	462.96	679.85	27.44	127.16	2.97	5,084.73
1. Energy	**1,974.68**	**3.47**	**61.13**				**2,039.27**
A. Fuel Combustion (Sectoral Approach)	1,811.20	3.47	61.13				1,875.79
1. Energy Industries	9.52	0.03	0.20				9.75
2. Manufacturing Industries and Construction	423.53	0.33	25.50				449.35
3. Transport	629.42	1.65	29.29				660.36
4. Other Sectors	748.73	1.45	6.15				756.33
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**768.90**	**0.94**	**18.63**	**27.44**	**127.16**	**2.97**	**946.04**
A. Mineral Products	65.77	NE,NO	NE,NO				65.77
B. Chemical Industry	0.41	NE,NO	18.63	NA	NA	NA	19.04
C. Metal Production	702.72	0.94	NA	NA,NE,NO	127.16	NA,NO	830.82
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)				27.44	NA,NE,NO	2.97	30.41
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**	**264.31**				**529.61**
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	235.76				235.76
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)	**1,023.19**	**7.97**	**323.14**				**1,354.30**
A. Forest Land	-46.27	NE,NO	0.83				-45.44
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,060.16	NE	NE				1,060.16
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.31				322.31
6. Waste	**7.21**	**185.28**	**8.12**				**200.61**
A. Solid Waste Disposal on Land	NA,NE,NO	163.97					163.97
B. Waste-water Handling		18.59	7.35				25.95
C. Waste Incineration	7.21	2.55	0.58				10.34
D. Other	NA	0.17	0.19				0.35
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	3,730.43
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5,084.73

(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 neg

(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 2009 v1.2
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)]	3,773.66	467.93	673.25	31.50	91.66	4.52	5,042.52
1. Energy	**1,938.92**	**3.35**	**60.31**				**2,002.58**
A. Fuel Combustion (Sectoral Approach)	1,784.44	3.35	60.31				1,848.10
1. Energy Industries	9.27	0.03	0.20				9.50
2. Manufacturing Industries and Construction	470.80	0.35	25.08				496.23
3. Transport	640.06	1.68	29.58				671.32
4. Other Sectors	664.32	1.28	5.45				671.06
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**805.37**	**0.91**	**16.15**	**31.50**	**91.66**	**4.52**	**950.11**
A. Mineral Products	59.08	NE,NO	NE,NO				59.08
B. Chemical Industry	0.49	NE,NO	16.15	NA	NA	NA	16.64
C. Metal Production	745.80	0.91	NA	NA,NE,NO	91.66	NA,NO	838.37
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)]				31.50	NA,NE,NO	4.52	36.02
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**	**261.40**				**525.89**
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	232.98				232.98
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)]	**1,010.02**	**7.97**	**323.18**				**1,341.17**
A. Forest Land	-49.38	NE,NO	0.87				-48.51
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,050.10	NE	NE				1,050.10
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.31				322.31
6. Waste	**6.69**	**191.21**	**8.18**				**206.08**
A. Solid Waste Disposal on Land	NA,NE,NO	170.28					170.28
B. Waste-water Handling		18.34	7.44				25.78
C. Waste Incineration	6.69	2.43	0.55				9.67
D. Other	NA	0.17	0.19				0.35
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	3,701.34
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5,042.52

(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 neg

(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 2002

(Sheet 1 of 1) Submission 2009 v1.2

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)	3,848.88	453.80	639.45	32.59	72.54	3.37	5,050.63
1. Energy	**2,016.60**	**3.50**	**59.63**				**2,079.72**
A. Fuel Combustion (Sectoral Approach)	1,857.25	3.50	59.63				1,920.38
1. Energy Industries	10.96	0.04	0.20				11.20
2. Manufacturing Industries and Construction	474.63	0.35	23.52				498.51
3. Transport	643.65	1.69	29.89				675.23
4. Other Sectors	728.01	1.42	6.01				735.44
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**824.06**	**0.97**	**NA,NE,NO**	**32.59**	**72.54**	**3.37**	**933.53**
A. Mineral Products	40.98	NE,NO	NE,NO				40.98
B. Chemical Industry	0.45	NE,NO	NE,NO	NA	NA	NA	0.45
C. Metal Production	782.62	0.97	NA	NA,NE,NO	72.54	NA,NO	856.13
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)				32.59	NA,NE,NO	3.37	35.96
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**	**244.27**				**502.37**
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	216.64				216.64
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)	**993.09**	**7.97**	**323.32**				**1,324.37**
A. Forest Land	-52.60	NE,NO	0.95				-51.66
B. Cropland	IE,NA,NE,NO	NE,NO	NE,NO				IE,NA,NE,NO
C. Grassland	1,036.39	NE	NE				1,036.39
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.37				322.37
6. Waste	**6.21**	**183.27**	**8.20**				**197.68**
A. Solid Waste Disposal on Land	NA,NE,NO	161.20					161.20
B. Waste-water Handling		19.59	7.49				27.08
C. Waste Incineration	6.21	2.31	0.53				9.05
D. Other	NA	0.17	0.19				0.35
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	3,726.26
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5,050.63

(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 neg

(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 2003
Submission 2009 v1.2
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)]	3,812.50	455.04	627.92	38.64	59.78	3.51	4,997.41
1. Energy	**2,000.99**	**3.52**	**58.87**				**2,063.38**
A. Fuel Combustion (Sectoral Approach)	1,863.10	3.52	58.87				1,925.49
1. Energy Industries	10.23	0.03	0.20				10.46
2. Manufacturing Industries and Construction	427.42	0.33	21.52				449.27
3. Transport	738.28	1.81	31.44				771.53
4. Other Sectors	687.17	1.35	5.71				694.23
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**826.87**	**0.94**	**NA,NE,NO**	**38.64**	**59.78**	**3.51**	**929.75**
A. Mineral Products	33.55	NE,NO	NE,NO				33.55
B. Chemical Industry	0.48	NE,NO	NE,NO	NA	NA	NA	0.48
C. Metal Production	792.83	0.94	NA	NA,NE,NO	59.78	NA,NO	853.56
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)]				38.64	NA,NE,NO	3.51	42.16
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**	**232.34**				**485.97**
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	205.33				205.33
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)]	**973.02**	**7.97**	**324.65**				**1,305.64**
A. Forest Land	-56.00	NE,NO	0.99				-55.01
B. Cropland	2.36	NE,NO	NE,NO				2.36
C. Grassland	1,017.36	NE	NE				1,017.36
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	323.66				323.66
6. Waste	**5.30**	**188.98**	**8.34**				**202.61**
A. Solid Waste Disposal on Land	NA,NE,NO	165.37					165.37
B. Waste-water Handling		21.13	7.55				28.68
C. Waste Incineration	5.30	2.23	0.51				8.03
D. Other	NA	0.25	0.28				0.53
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	3,691.76
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,997.41

(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 neg

(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 2009 v1.2
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)]	3,857.64	448.10	627.19	43.13	38.58	3.39	5,018.02
1. Energy	**2,056.04**	**3.64**	**64.52**				**2,124.21**
A. Fuel Combustion (Sectoral Approach)	1,931.96	3.64	64.52				2,000.13
1. Energy Industries	9.93	0.04	0.20				10.17
2. Manufacturing Industries and Construction	462.26	0.36	25.79				488.41
3. Transport	790.11	1.91	32.77				824.78
4. Other Sectors	669.66	1.34	5.76				676.77
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**848.68**	**0.96**	**NA,NE,NO**	**43.13**	**38.58**	**3.39**	**934.74**
A. Mineral Products	51.54	NE,NO	NE,NO				51.54
B. Chemical Industry	0.39	NE,NO	NE,NO	NA	NA	NA	0.39
C. Metal Production	796.75	0.96	NA	NA,NE,NO	38.58	NA,NO	836.29
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)]				43.13	NA,NE,NO	3.39	46.52
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**	**225.92**				**475.64**
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	199.05				199.05
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)]	**943.51**	**7.97**	**325.08**				**1,276.56**
A. Forest Land	-59.53	NE,NO	1.05				-58.48
B. Cropland	2.52	NE,NO	NE,NO				2.52
C. Grassland	991.16	NE	NE				991.16
D. Wetlands	9.30	7.97	NA,NO				17.27
E. Settlements	0.07	NE	NE				0.07
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	324.03				324.03
6. Waste	**2.49**	**185.81**	**8.26**				**196.56**
A. Solid Waste Disposal on Land	NA,NE,NO	164.83					164.83
B. Waste-water Handling		19.17	7.62				26.80
C. Waste Incineration	2.49	1.55	0.35				4.40
D. Other	NA	0.25	0.28				0.53
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	3,741.46
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5,018.02

(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 neg

(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 2009 v1.2
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)]	3,780.68	449.87	635.51	49.38	26.09	3.39	4,944.93
1. Energy	**2,012.78**	**3.27**	**72.14**				**2,088.18**
A. Fuel Combustion (Sectoral Approach)	1,889.40	3.27	72.14				1,964.80
1. Energy Industries	12.68	0.04	0.20				12.91
2. Manufacturing Industries and Construction	425.51	0.35	27.85				453.71
3. Transport	795.36	1.57	38.43				835.36
4. Other Sectors	655.85	1.31	5.66				662.82
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**837.86**	**0.97**	**NA,NE,NO**	**49.38**	**26.09**	**3.39**	**917.68**
A. Mineral Products	55.82	NE,NO	NE,NO				55.82
B. Chemical Industry	NA,NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Metal Production	782.04	0.97	NA	NA,NE,NO	26.09	NA,NO	809.10
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)]				49.38	NA,NE,NO	3.39	52.77
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**				**478.79**
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)]	**917.12**	**7.97**	**325.42**				**1,250.51**
A. Forest Land	-65.64	NE,NO	1.09				-64.55
B. Cropland	3.46	NE,NO	NE,NO				3.46
C. Grassland	969.93	NE	NE				969.93
D. Wetlands	9.30	7.97	NE,NO				17.27
E. Settlements	0.07	NE	NE				0.07
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	324.33				324.33
6. Waste	**0.03**	**185.09**	**8.47**				**193.58**
A. Solid Waste Disposal on Land	NA,NE,NO	166.74					166.74
B. Waste-water Handling		16.97	7.78				24.75
C. Waste Incineration	0.03	0.96	0.22				1.21
D. Other	NA	0.42	0.47				0.89
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	3,694.42
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	4,944.93

(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 neg

(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 2009 v1.2
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)]	3,928.44	476.22	664.12	52.97	333.22	6.98	5,461.95
1. Energy	**2,090.72**	**3.29**	**71.72**				**2,165.74**
A. Fuel Combustion (Sectoral Approach)	1,934.24	3.29	71.72				2,009.26
1. Energy Industries	15.07	0.06	0.34				15.47
2. Manufacturing Industries and Construction	407.01	0.32	25.31				432.64
3. Transport	938.37	1.76	41.07				981.20
4. Other Sectors	573.79	1.16	5.00				579.95
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
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	**940.92**	**0.99**	**NA,NE,NO**	**52.97**	**333.22**	**6.98**	**1,335.09**
A. Mineral Products	62.82	NE,NO	NE,NO				62.82
B. Chemical Industry	NA,NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Metal Production	878.11	0.99	NA	NA,NE,NO	333.22	NA,NO	1,212.32
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)]				52.97	NA,NE,NO	6.98	59.95
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**	**254.04**				**512.04**
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	226.22				226.22
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)]	**890.84**	**9.45**	**326.01**				**1,226.30**
A. Forest Land	-73.12	NE,NO	1.13				-71.99
B. Cropland	3.54	NE,NO	NE,NO				3.54
C. Grassland	950.16	0.25	0.09				950.50
D. Wetlands	9.30	9.20	0.45				18.96
E. Settlements	0.96	NE	NE				0.96
F. Other Land	NE	NE	NE				NE
G. Other	IE,NE,NO	NA,NE,NO	324.33				324.33
6. Waste	**0.03**	**204.48**	**8.92**				**213.42**
A. Solid Waste Disposal on Land	NA,NE,NO	186.13					186.13
B. Waste-water Handling		16.85	7.99				24.84
C. Waste Incineration	0.03	0.83	0.19				1.04
D. Other	NA	0.67	0.74				1.42
7. Other ***(as specified in Summary 1.A)***	NA	NA	NA	NA	NA	NA	NA

Memo Items: [(4)]							
International Bunkers	637.13	0.35	5.53				643.00
Aviation	499.89	0.07	4.38				504.35
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	4,235.65
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5,461.95

(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 neg

(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 2007
Submission 2009 v1.2
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)	4,163.04	498.35	682.17	59.36	281.28	9.86	5,694.06
1. Energy	**2,146.14**	**3.36**	**72.52**				**2,222.01**
A. Fuel Combustion (Sectoral Approach)	1,994.62	3.36	72.52				2,070.49
1. Energy Industries	29.09	0.07	0.40				29.56
2. Manufacturing Industries and Construction	400.18	0.32	25.42				425.91
3. Transport	973.68	1.78	41.53				1,016.99
4. Other Sectors	591.67	1.19	5.17				598.03
5. Other	NA,NO	NA,NO	NA,NO				NA,NO
B. Fugitive Emissions from Fuels	151.52	NA,NE,NO	NA,NO				151.52
1. Solid Fuels	NA,NO	NA,NO	NA,NO				NA,NO
2. Oil and Natural Gas	151.52	NE,NO	NA,NO				151.52
2. Industrial Processes	**1,134.42**	**1.04**	**NA,NE,NO**	**59.36**	**281.28**	**9.86**	**1,485.95**
A. Mineral Products	64.63	NE,NO	NE,NO				64.63
B. Chemical Industry	NA,NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Metal Production	1,069.79	1.04	NA	NA,NE,NO	281.28	NA,NO	1,352.12
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)				59.36	NA,NE,NO	9.86	69.21
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**8.08**		**4.16**				**12.24**
4. Agriculture		**261.32**	**272.69**				**534.01**
A. Enteric Fermentation		239.39					239.39
B. Manure Management		21.93	28.00				49.92
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils(3)		NA,NE	244.69				244.69
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)	**874.38**	**13.92**	**323.55**				**1,211.86**
A. Forest Land	-81.17	NE,NO	1.13				-80.04
B. Cropland	4.80	NE,NO	NE,NO				4.80
C. Grassland	934.50	NE	NE				934.50
D. Wetlands	16.18	13.92	NE,NO				30.11
E. Settlements	0.07	NE	NE				0.07
F. Other Land	NE	NE	NE				NE
G. Other	NA,NE,NO	NA,NE,NO	322.43				322.43
6. Waste	**0.03**	**218.72**	**9.25**				**227.99**
A. Solid Waste Disposal on Land	NA,NE,NO	202.14					202.14
B. Waste-water Handling		14.91	8.13				23.05
C. Waste Incineration	0.03	0.83	0.19				1.04
D. Other	NA	0.84	0.93				1.77
7. Other ***(as specified in Summary 1.A)***	NA	NA	NA	NA	NA	NA	NA

Memo Items: (4)							
International Bunkers	718.45	0.49	6.21				725.15
Aviation	511.53	0.08	4.48				516.09
Marine	206.92	0.41	1.73				209.06
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	4,482.20
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	5,694.06

(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 neg

(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 25 Gg of CO_2 in 2007.

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 254 Gg of CO_2 in 2007.

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 National Inventory Report – Iceland 2008.

In 2007 the Coordinating Team was established a part of the national system. The team has representatives from the Ministry for the Environment, the EA and the AUI not directly involved in preparing the inventory. Its official roles are to review the emissions inventory before submission to UNFCCC, plan the inventory cycle and formulate proposals on further development and improvement of the national inventory system. During this inventory cycle the coordinating team held 7 meetings. The work of the team has already led to improvement in cooperation between the different institutions involved with the inventory compilation, especially with regards to the LULUCF and agriculture sectors. Some improvements proposed by the team were incorporated into this inventory submission. Other improvements will be made by the next submission.

Changes in the national registry
There are no changes regarding the National Registry since the 2008 submission.

Following is an updated version of chapter 5 from the Initial Report which describes the Icelandic National Registry (same as in NIR 2008).

Contact details of registry administrators
Due to organisational changes within the Environment Agency of Iceland, changes have occurred 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 (Iceland's Initial Report under the Kyoto Protocol, 2006) and the total 1990 CO_2 emissions from all Annex I Parties amounted to 13,728,306 Gg (FCCC/CP/1997/7/Add.1). Iceland's CO_2 emissions were 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:

- Renewable energy is used, resulting in a reduction in greenhouse gas emissions per unit of production (Article 2(b));
- Best environmental practice is followed and best available technology is used to minimize process emissions (Article 2(c));

For projects that 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.

Practically all electricity in Iceland is produced with renewable energy sources, hydropower and geothermal (Chapter 3 – Energy). Electricity is only produced with fuel combustion at three locations located far from the distribution system. All electricity used in heavy industry is produced from renewable energy sources.

As is explained in chapter 1.2.2, the Icelandic legislature, Althing, passed a new act on emission of greenhouse gases (No. 65/2007). According to the Act, a three-member Emissions Allowance Allocation Committee was established with representatives of the Ministry of Industry, Ministry for the Environment and the Ministry of Finance. The role of the committee is to publish a plan on how Icelandic Emission Allowances is to be distributed to industry in the first Commitment Period, and how they are divided between general allowances according to the Kyoto Protocol and the special emission allowances according to Decision 14/CP.7.

The Allowance Allocation Committee has allocated emissions allowances to four production plants, operating in 2007, based on Decision 14/CP.7. Those are:

1. the expansion of the Rio Tinto Alcan Aluminium plant at Straumsvík,
2. the expansion of the Elkem Iceland Ferrosilicon plant at Grundartangi,
3. the establishment of the Century Aluminium plant at Grundartangi, and
4. the establishment of the Alcoa Fjarðaál Aluminium plant at Reyðarfjörður. As this project started in 2007 it did not during that year fulfil the requirements regarding adding more than 5 per cent to the total carbon dioxide emissions in 1990.

In the next section the following information for each of the projects, fulfilling the provisions of the decision will be listed:

1. Description of single projects that have been allocated allowances.
2. How the projects add more than 5% to the total carbon dioxide emission in 1990, i.e. more than 108 Gg.
3. How renewable energy is used resulting in reduction in greenhouse gas emissions per unit of production and the resulting emission savings.
4. How BEP and BAT is used to minimize process emissions.
5. Total process emissions and emission factors.

Expansion of the Rio Tinto Alcan Aluminium plant at Straumsvík

1. Aluminium production started at the Aluminium plant in Straumsvík in 1969. The plant consisted in the beginning of one potline with 120 pots which was expanded to 160 pots in 1970. In 1972 a second potline was taken into operation with 120 pots. The second potline was expanded in 1980 to 160 pots. In 1996 a further expansion of the plant took place. The 1996 expansion project entailed increased plant capacity by building a new third potline with increased current intensity in the electrolytic pots and a current intensity increase in potlines one and two. This has led to increased production in potlines one and two. The process used in all potlines is point feed prebake (PFPB) with automatic multiple point feed. The 1996 expansion is a single project as defined in Decision 14/CP.7.

2. In 2007 182,230 tonnes of aluminium were produced compared to 100,198 tonnes in 1995. In 2007 the production increase resulting from this project amounted to 82,032 tonnes of aluminium (66,534 tonnes in potline 3 and 15,498 tonnes in potlines 1 and 2). The resulting emissions from the production of 82,032 tonnes of aluminium are 116 Gg of CO_2. This amount adds more than 5% to the total carbon dioxide emissions in 1990. In 2007 115,696 tonnes of aluminium were produced in

potlines 1 and 2 leading to emissions of 169 Gg of CO_2. In potline 3 66,534 tonnes of aluminium were produced, leading to emissions of 98 Gg of CO_2.

3. In 2007 the plant used 2,683 GWh of electricity, thereof 1,289 GWh were used for producing the 82,032 tonnes that belong to the single project. As stated before all the electricity used is produced from renewable sources. The average emission from this electricity is 15.2 g/kWh. The total CO_2 emissions from the electricity used for the project amounts to 59 Gg. Had the energy been from coal powered power plant the emissions would amount to 954 g/kWh. Corresponding emissions from the project would have amounted to 1230 Gg. The resulting emissions savings are 1210 Gg.

4. To minimize process emissions BAT, as defined in the IPPC, Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, December 2001, is used in the production:
    a. All pots are closed and the pot gases are collected and cleaned via a dry absorption unit; the technique is defined as BAT.
    b. Prebake anodes are used and automatic multiple point feed.
    c. Computer control is used in the potlines to minimize energy use and formation of PFC.

    BEP is used in the process and the facility has a certified environmental management system according to ISO 14001. The environmental management system was certified in 1997. Besides the environmental management system , the facility also has a certified ISO 9001 quality management system and an OHSAS 18001 occupational health and safety management system .

5. Total process emissions from production of 182,230 tonnes of aluminium at Rio Tinto Alcan in 2007 were 274 Gg CO_2 equivalents, 267 Gg of CO_2 from electrodes consumption and 7 Gg of PFCs due to anode effect. Besides that 13 Gg were emitted from fuel combustion. The resulting IEF are 1.46 tonnes CO2 per tonne of aluminium and 0.04 tonnes of PFC in CO2 equivalents per tonne of aluminium. The IEF for fuel use is 0.07 t CO_2 eq per tonne of aluminium. For the expansion project, production of 82,032 tonnes of aluminium the process emissions amounted to 121 Gg of CO_2 from electrodes consumption and 3.6 Gg of PFCs due to anode effect. Besides that 6 Gg were emitted from fuel combustion. The resulting IEF are 1.47 tonnes CO_2 per tonne of aluminium and 0.04 tonnes of PFC in CO_2 equivalents per tonne of aluminium. For comparison, the median value of PFC emissions in 2006 for prebake plants worldwide was 0,24 CO_2 equivalents per tonne of aluminium[7]. The IEF for fuel use is 0.07 t CO_2 equivalents per tonne of aluminium.

[7] International Aluminum Institute

Expansion of the Ferrosilicon plant at Grundartangi

1. The Elkem Iceland Ferrosilicon plant at Grundartangi was established in 1977, when construction of two furnaces started. The first furnace came on stream in 1979 and the second furnace a year later. The production capacity of the two furnaces was in the beginning 60,000 tonnes of ferrosilicon, but was later increased to 72,000 tonnes. In 1993 a project was started that enabled overloading of the furnaces in comparison to design, resulting in increased production. The production was further increased in 1999 by the addition of a third furnace. The production increase since 1990 is a single project as defined in Decision 14/CP.7. 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. All furnaces are semi-covered.

2. In 1990 62,792 tonnes were produced leading to emissions of 203 Gg of CO_2. In 2007 114,149 tonnes were produced (35,459 tonnes in furnace 1; 34,593 tonnes in furnace 2; and 44,097 tonnes in furnace 3) leading to emissions of 390 Gg of CO_2. The production increase since 1990 is thus 51,357 tonnes of ferrosilicon; 44,097 tonnes in furnace 3; 7,260 tonnes in furnaces 1 and 2. This production increase lead to emissions of 176 Gg of CO_2. This amount adds more than 5% to the total carbon dioxide emissions in 1990. In 2007 35,459 tonnes were produced in furnace 1 leading to emissions of 120 Gg of CO_2; 34,593 tonnes were produced in furnace 2 leading to emissions of 119 Gg of CO_2 and 44,097 tonnes were produced in furnace 3 leading to emissions of 151 Gg of CO_2.

3. In 2007 the plant used 938 GWh of electricity, thereof 422 GWh were used for the production increase since 1990 (51,357 tonnes of ferrosilicon). All the electricity used for the production comes from renewable sources. The average CO_2 emissions from producing this electricity are 15.2 g/kWh. The total CO_2 emissions from the electricity use for the project amounts to 6 Gg. Had the energy been from a coal powered power plant the emissions would amount to 954 g/kWh. The resulting emissions resulting from the project would in this case have amounted to 402 Gg. Emissions savings from using renewable energy for the project are 396 Gg.

4. The plant uses BAT according to the IPPC Reference Document on Best Available Technology in non ferrous metals industries (December 2001), and further the plant has an environmental management plan as a part of a certified ISO 9001 quality management system, meeting the requirement of BEP.

5. Total process emissions from production of 114,149 tonnes of ferrosilicon at Elkem Iceland in 2007 were 390 Gg CO_2 equivalents. The resulting IEF are 3.42 tonnes CO_2 per tonne of ferrosilicon. Besides that 1.6 Gg were emitted from fuel combustion. The IEF for fuel use is 0.01 t CO_2 equivalents per tonne of ferrosilicon. For the expansion project, production of 51,357 tonnes of ferrosilicon the process emissions amounted to 176 Gg of CO_2. The resulting IEF are 3.43 tonnes CO_2 per tonne of ferrosilicon. Besides that 0.7 Gg were emitted from fuel combustion. The IEF for fuel use is 0.01 t CO_2 equivalent per tonne of ferrosilicon.

Establishment of the Century Aluminium plant at Grundartangi

1. The Century Aluminium plant at Grundartangi was established in 1998. The plant consisted in the beginning of one potline. In 2001 a second potline was taken into operation. In 2006 a further expansion of the plant took place. The Century Aluminium plant is a single project as defined in Decision 14/CP.7.

2. In 2007 the Century Aluminium plant produced 238,041 tonnes of aluminium. The resulting industrial process carbon dioxide emission amounted to 359 Gg. This amount adds more than 5% to the total carbon dioxide emissions in 1990.

3. In 2007 the plant used 2,590 GWh of electricity, all from renewable sources. Average emissions from producing this electricity are equivalent to 15.2 g/kWh. The resulting total CO_2 emissions from the electricity use are 39 Gg. Had the energy been from coal powered power plant the emissions would amount to approximately 954 g/kWh, resulting in emissions equivalent to 2471 Gg. Emissions savings from using renewable energy equal 2431 Gg.

4. Best available techniques, as defined by the IPPC, are applied at the Century Aluminium plant as stipulated in the operating permit. Century Aluminium has reported that they are preparing implementation of an environmental management system according to ISO 14001.

5. Total process emissions from production of 238,041 tonnes of aluminium at Century Aluminium in 2007 were 562 Gg CO_2 equivalents, 359 Gg of CO_2 from electrodes consumption and 209 Gg CO_2 equivalents of PFCs due to anode effect. Besides that 2.6 Gg were emitted from fuel combustion. The resulting IEF are 1.48 tonnes CO_2 per tonne of aluminium and 0.88 tonnes of PFC in CO_2 equivalents per tonne of aluminium. The IEF for fuel use is 0.01 t CO_2 equivalents per tonne of aluminium.

Fact sheet Single Projects under 14/CP.7

Name of the single project	Rio Tinto Alcan – expansion of aluminium plant
Name of the company/ production facility	Rio Tinto Alcan
Location of the project	PO 224, 220 Hafnarfjordur, Iceland
NIR category	2.C.3 Aluminium production
Description of the industrial process facility	Aluminium production started at the Aluminium plant in Straumsvík in 1969. The plant consisted in the beginning of one potline. In 1972 a second potline was taken into operation. In 1996 a further expansion of the plant took place. The project involves an expansion in the plant capacity by building a new potline with increased current in the electrolytic pots. At the same time current was also increased in potlines one and two. This has led to increased production in potlines one and two. The process used in all potlines is PFPB with automatic multiple point feed.
Evidence that the projects fulfils paragraph 1[#]	The Environment Agency of Iceland issues Operating licences for the Aluminium production plant in Straumsvik and is responsible for the supervision of the plant. Statistics on production is supplied to the Agency each year. See also description previously in this annex.
Evidence that the Party fulfils paragraph 2.(a)	Iceland's total 1990 CO_2 emissions amounted to 2172 Gg. Total 1990 CO_2 emissions from all Annex I Parties amounted to 13,728,306 Gg*. Iceland's CO_2 emissions are thus 0.016% of the Annex I Parties total, calculated in accordance with the table contained in the annex to document FCCC/CP/1997/7/Add.1 This is lower than the 0.05% threshold in paragraph 2(a).
Provide evidence that the selected project fulfils paragraph 2	- Iceland's total CO_2 emissions for 1990 were 2159 Gg (according to Iceland's Initial Report under the Kyoto Protocol). - total industrial CO_2 emissions from the project in 2007 were 116 Gg or 5,4% of the 1990 CO_2 emissions. - this is higher than the 5% threshold in paragraph 2.
Reporting of CO2 emissions from the project, according to paragraph 5	The production increase resulting from this project amounted in 2007 to 82,032 tonnes of aluminium (182,230 tonnes in 2007 compared to 100,198 tonnes in 1995). The resulting CO_2 emissions are 116 Gg of CO_2. CO_2 emissions are calculated based on the quantity of electrodes used in the process and the emission factors from the IPCC Guidelines. The implied emission factor for the expanded part in 2007 is thus 1.47 t CO_2 per tonne of aluminium. In the existing part of the plant 100,198 tonnes of aluminium were produced leading to emissions of 146 Gg of CO_2. The implied emission factor in for the existing part in 2007 is thus 1.46 t CO_2 per tonne of aluminium. QA/QC procedures include collecting activity data through electronic surveys allowing immediate QC-check on IEF.
Provide evidence that the project fulfils paragraph 2.(b) and paragraph 5.	Rio Tinto Alcan uses LPG for heating of melting pots and residual fuel oil in the foundry. In 2007 the total energy consumption was 4,152 tonnes of residual fuel oil leading to emissions of 12.8 Gg of GHG and 189 tonnes of LPG leading to emissions of 0.6 Gg of GHG. The EF for residual fuel oil is thus 3.08 t CO_2 eq per tonne of fuel. The EF for LPG is 2.95 t CO_2 eq per tonne of fuel. The IEF for energy use is 0.07 t CO_2 eq per tonne of aluminium. For the expansion project the corresponding fuel consumption and GHG emissions are: 1,869 tonnes of residual fuel oil, 85 tonnes of LPG and 6.0 Gg CO_2 of GHG. These emissions are reported in the Energy sector. In 2007 the total use of electricity was 2,863 GWh, thereof 1289 GWh were used for the expansion project. - As stated in chapter 3.2. almost all energy in Iceland is produced from

[#] All references to paragraphs are relating to the paragraphs of decision 14/CP.7

	renewable energy sources (99,97%). Electricity for all heavy industry in Iceland is produced from renewable energy sources. The average emissions per kWh from electricity production in Iceland is 15.2 g. The total CO_2 emissions from the electricity use for the project amounts to 20 Gg. - Had the energy been from coal powered power plant the per kWh emissions would amount to 954 g. The resulting emissions from the project would thus have amounted to 1230 Gg. The resulting emissions savings are 1210 Gg. The emissions savings are 14.7 tonnes per tonne of aluminium.
Provide evidence that the project fulfils paragraph 2.(c)	To minimize process emissions BAT, as defined in the IPPC, Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, December 2001, is used in the production: - all pots are closed and the pot gases are collected and cleaned via a dry absorption unit; the technique is defined as BAT. - prebake anodes are used and automatic multiple point feed. - Besides that computer control is used in the potlines to minimize energy use and formation of PFC. BEP is used in the process and the facility has a certified environmental management system according to ISO 14001. The environmental management system was certified in 1997. Besides that, the facility also has a certified ISO 9001 quality management system and an OHSAS 18001 occupational health and safety management system .

*http://unfccc.int/resource/docs/2007/sbi/eng/30.pdf

Fact sheet Single Projects under 14/CP.7

Name of the single project	Elkem Iceland – expansion of ferrosilicon plant
Name of the company/ production facility	Elkem Iceland
Location of the project	Grundartanga, 301 Akranes, Iceland
NIR category	2.C.2 Ferrosilicon production
Description of the industrial process facility	The Elkem Iceland Ferrosilicon plant at Grundartangi was established in 1977, when construction of two furnaces started. The first furnace came on stream in 1979 and the second furnace a year later. The production capacity of the two furnaces was in the beginning 60,000 tonnes of ferrosilicon, but was later increased to 72,000 tonnes. In 1993 a project started enabling overloading of the furnaces in comparison to design. Thus it has been possible since to increase the production in those furnaces. In 1999 a third furnace was taken into operation. The project involves an expansion in the plant capacity by building a new furnace as well as over lasting the older furnaces. Electric (submerged) arc furnaces with Soederberg electrodes are used. All furnaces are semi-covered.
Evidence that the projects fulfils paragraph 1[#]	The Environment Agency of Iceland issues Operating licences for the Ferrosilicon plant in Grundartangi and is responsible for the supervision of the plant. Statistics on production is supplied to the Agency each year. See also description previously in this annex.
Evidence that the Party fulfils paragraph 2.(a)	Iceland's total 1990 CO_2 emissions amounted to 2172 Gg. Total 1990 CO_2 emissions from all Annex I Parties amounted to 13,728,306 Gg*. Iceland's CO_2 emissions are thus 0.016% of the Annex I Parties total, calculated in accordance with the table contained in the annex to document FCCC/CP/1997/7/Add.1 This is lower than the 0.05% threshold in paragraph 2(a).
Provide evidence that the selected project fulfils paragraph 2	- Iceland's total CO_2 emissions for 1990 were 2159 Gg (according to Iceland's Initial Report under the Kyoto Protocol). - total industrial CO_2 emissions from the project in 2007 were 116 Gg or 5,4% of the 1990 CO_2 emissions. - this is higher than the 5% threshold in paragraph 2.
Reporting of CO2 emissions from the project, according to paragraph 5	The production increase resulting from this project amounted in 2007 to 51,357 tonnes of ferrosilicon (62,792 tonnes in 1990; 114,149 tonnes in 2007). The resulting CO_2 emissions are 176 Gg. CO_2 emissions are calculated based on the quantity of coal and coke as reducing agents, as well as from the consumption of electrodes, using emission factors from the IPCC Guidelines. The implied emission factor for the expanded part in 2007 was 3.4 t CO_2 per tonne of ferrosilicon. In the existing part of the plant 62,792 tonnes were produced leading to emissions of 230 Gg of CO_2. The implied emission factor for the existing part is therefore 3.2 t CO_2 per tonne of ferrosilicon. QA/QC procedures include collecting activity data through electronic surveys allowing immediate QC-check on IEF.
Provide evidence that the project fulfils paragraph 2.(b) and paragraph 5.	Elkem Iceland uses gasoil for heating of melting pots In 2007 the total energy consumption was 0.5 tonnes of gasoil leading to emissions of 1.6 Gg of GHG. The EF for gasoil is 3.18 t CO_2 eq per tonne of fuel. For the expansion project the corresponding fuel consumption and GHG emissions are: 0.2 tonnes of gasoil and 0.7 Gg CO_2 of GHG. These emissions are reported in the Energy sector. In 2007 the total use of electricity was 938 GWh, thereof 422 GWh were used for the expansion project.

[#] All references to paragraphs are relating to the paragraphs of decision 14/CP.7

	- as stated in chapter 3.2. almost all energy in Iceland is produced from renewable energy sources (99,97%). Electricity for all heavy industry in Iceland is produced from renewable energy sources. The average emissions per kWh from electricity production in Iceland is 15.2 g. The total CO_2 emissions from the electricity use for the project amounts to 6 Gg. - Had the energy been from coal powered power plant the per kWh emissions would amount to 954 g. The resulting emissions from the project would thus have amounted to 403 Gg. The resulting emissions savings are 396 Gg. The emissions savings are 7.7 tonnes per tonne of ferrosilicon.
Provide evidence that the project fulfils paragraph 2.(c)	To minimize process emissions BAT, as defined in the IPPC, Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, December 2001, is used in the production. Further the plant has an environmental management plan as a part of a certified ISO 9001 quality management system, meeting the requirement of BEP.

Fact sheet Single Projects under 14/CP.7

Name of the single project	Century aluminium – establishment of aluminium plant
Name of the company/production facility	Century Aluminium
Location of the project	Grundartanga, 301 Akranes, Iceland
NIR category	2.C.3 Aluminium production
Description of the industrial process facility	Aluminium production started at the Century Aluminium plant at Grundartangi in 1998. The plant consisted in the beginning of one potline. In 2001 a second potline was taken into operation. In 2006 a further expansion of the plant took place. The process used in all potlines is PFPB with automatic multiple point feed.
Evidence that the projects fulfils paragraph 1[#]	The Environment Agency of Iceland issues Operating licences for the Aluminium production plant at Grundartangi and is responsible for the supervision of the plant. Statistics on production is supplied to the Agency each year. See also description previously in this annex.
Evidence that the Party fulfils paragraph 2.(a)	Iceland's total 1990 CO_2 emissions amounted to 2172 Gg. Total 1990 CO_2 emissions from all Annex I Parties amounted to 13,728,306 Gg*. Iceland's CO_2 emissions are thus 0.016% of the Annex I Parties total, calculated in accordance with the table contained in the annex to document FCCC/CP/1997/7/Add.1 This is lower than the 0.05% threshold in paragraph 2(a).
Provide evidence that the selected project fulfils paragraph 2	- Iceland's total CO_2 emissions for 1990 were 2159 Gg (according to Iceland's Initial Report under the Kyoto Protocol). - total industrial CO_2 emissions from the project in 2007 were 359 Gg or 5,4% of the 1990 CO_2 emissions. - this is higher than the 5% threshold in paragraph 2.
Reporting of CO2 emissions from the project, according to paragraph 5	The production increase resulting from this project amounted in 2007 to 238,041 tonnes of aluminium. The resulting CO_2 emissions are 359 Gg of CO_2. CO_2 emissions are calculated based on the quantity of electrodes used in the process and the emission factors from the IPCC Guidelines. The implied emission factor in 2007 is thus 1.48 t CO_2 per tonne of aluminium. QA/QC procedures include collecting activity data through electronic surveys allowing immediate QC-check on IEF.
Provide evidence that the project fulfils paragraph 2.(b) and paragraph 5.	Century Aluminium uses LPG and gasoil for heating of melting pots. In 2007 the total fuel consumption was 443 tonnes of gasoil leading to emissions of 1.4 Gg of GHG and 390 tonnes of LPG leading to emissions of 1.2 Gg of GHG. The EF for gasoil is 3.18 t CO_2 eq per tonne of fuel. The EF for LPG is 2.95 t CO_2 eq per tonne of fuel. The IEF for energy use is 0.01 t CO_2 eq per tonne of aluminium. These emissions are reported in the Energy sector. 2,590 GWh of electricity As stated before all the electricity used is produced from renewable sources. The average emission from this electricity is 15.2 g/kWh. The total CO_2 emissions from the electricity use for the project amounts to 39 Gg. Had the energy been from coal powered power plant the per kWh emissions would amount to approximately 954 g. The resulting emissions from the project would thus have amounted to 2471 Gg. The resulting emissions savings are 2431 Gg In 2007 the total use of electricity was 2,590 GWh - as stated in chapter 3.2. almost all energy in Iceland is produced from renewable energy sources (99,97%). Electricity for all heavy industry in Iceland is produced from renewable energy sources. The average emissions per kWh

[#] All references to paragraphs are relating to the paragraphs of decision 14/CP.7

	from electricity production in Iceland is 15.2 g. The total CO_2 emissions from the electricity use for the project amounts to 39 Gg. - Had the energy been from coal powered power plant the per kWh emissions would amount to 954 g. The resulting emissions from the project would thus have amounted to 2471 Gg. The resulting emissions savings are 2431 Gg. The emissions savings are 10.2 tonnes per tonne of aluminium.
Provide evidence that the project fulfils paragraph 2.(c)	To minimize process emissions BAT, as defined in the IPPC, Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, December 2001, is used in the production. - All pots are closed and the pot fumes are collected (less than 1% of the pot fumes can escape). Fumes are cleaned via a dry absorption unit; the technique is defined as BAT. - The newer potline is equipped with increased suction of fumes from the pots during working time in the potline. - Minimum time is used for anode changing. - Prebake anodes are used and automatic multiple point feeding. - Besides that computer control is used in the potrooms to optimize production and therefore minimize use of energy and formation of PFC. - Automatic anode effect quenching is included in the computer program. - Continuous supervision of measuring equipment regarding environmental issues. To ensure BEP the facility has an environmental management plan, comparable to ISO 14001. The plan is continuously under improvement. It is foreseen to implement ISO 14001 within 2 years and even have the plan certified.

*http://unfccc.int/resource/docs/2007/sbi/eng/30.pdf