UMHVERFISSTOFNUN

NATIONAL INVENTORY REPORT

Emissions of Greenhouse Gases in Iceland from 1990 to 2014

Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

2016

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Preface

The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol to the Convention requires the parties 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 2016. The NIR together with the associated Common Reporting Format tables (CRF) and the Standard Electronic format (SEF) is Iceland's contribution to this round of reporting under the Convention in the period 1990 – 2014.

The NIR is written by the Environment Agency of Iceland (EA), with major contributions by the Agricultural University of Iceland (AUI), Icelandic Forest Research (IFR), and the Soil Conservation Service of Iceland (SCSI).

Environment Agency of Iceland, Reykjavík, 6 May 2016.

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List of Abbreviations

1996 GL	1996 IPCC Guidelines for Greenhouse Gas Inventories
2006 GL	2006 IPCC Guidelines for Greenhouse Gas Inventories
AAU	Assigned Amount Units
AUI	Agricultural University of Iceland
BAT	Best Available Technology
BEP	Best Environmental Practice
BOD	Biological Oxygen Demand
C_2F_6	Hexafluoroethane
C_3F_8	Octafluoropropane
CER	Certified Emission Unit
CF_4	Tetrafluoromethane
CFC	Chlorofluorocarbon
CH_4	Methane
CITL	Community Independent Transaction Log
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide Equivalent
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CRF	Common Reporting Format
DOC	Degradable Organic Carbon
EA	The Environment Agency of Iceland
EF	Emission Factor
ERT	Expert Review Team
ERU	Emission Reduction Unit
EU ETS	European Union Greenhouse Gas Emission Trading System
FAI	Farmers Association of Iceland
FeSi	Ferrosilicon
FRL	Farmers Revegetate the Land
GDP	Gross Domestic Product
Gg	Gigagrams
GHG	Greenhouse Gases
GIS	Geographic Information System
GPG	IPCC Good Practice Guidance in National Greenhouse Gas Inventories
GPS	Global Positioning System
GRETA	Greenhouse gases Registry for Emissions Trading Arrangements
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
IEF	Implied Emission Factor
IFR	Icelandic Forest Research
IFS	Iceland Forest Service
IFVA	Icelandic Food and Veterinary Association
IPCC	Intergovernmental Panel on Climate Change
ITL	International Transaction Log
IW	Industrial Waste
Kha	Kilohectare

Table continued	
KP	Kyoto Protocol
LULUCF	Land Use, Land-Use Change and Forestry
MAC	Mobile Air Conditioning
MAC	Mobile Air-Conditioning Systems
MCF	Methane Correction Factor
MSW	Municipal Solid Waste
N_2O	Nitrogen Dioxide
NEA	National Energy Authority
NFI	National Forest Inventory
NIR	National Inventory Report
NIRA	The National Inventory on Revegetation Area
NMVOC	Non-Methane Volatile Organic Compounds
NNFI	New National Forest Inventory
NOx	Nitrogen Oxides
ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
OX	Oxidation Factor
PFC	Perfluorocarbons
QA/QC	Quality Assurance/Quality Control
RMU	Removal Unit
SCSI	Soil Conservation Service of Iceland
SEF	Standard Electronic Format
SF_6	Sulfur Hexafluoride
Si	Silicon
SiO	Silicon Monoxide
SiO_2	Quarts
SO_2	Sulfur Dioxide
SO_2-eq	Sulfur Dioxide Equivalents
SSPP	Systematic sampling of permanent plots
SWD	Solid Waste Disposal
SWDS	Solid Waste Disposal Sites
t/t	Tonne per Tonne
TOW	Total Organics in Wastewater
UNFCCC	United Nations Framework Convention on Climate Changes

Global Warming Potentials (GWP) of Greenhouse Gases

Greenhouse gas	Chemical formula	2006 IPCC GWP
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298
Sulphur hexafluoride	SF_6	23,900
Perfluorocarbons (PFCs)		
Tetrafluoromethane (PFC 14)	CF_4	7,900
Hexafluoroethane (PFC 116)	C_2F_6	12,200
Octafluoropropane (PFC 218)	C_3F_8	8,830
Hydrofluorocarbons		
HFC-23	CHF_3	14,800
HFC-32	CH_2F_2	675
HFC-125	C_2HF_5	3,500
HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1,430
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	4,470
HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	124
HFC-227ea	C_3HF_7	3,220

Source: table 2.14 of the Fourth Assessment report (AR4).

Definitions of Prefixes and Symbols Used in the Inventory

Prefix	Symbol	Power of 10
kilo-	k	10^3
mega-	M	10^6
giga-	G	10^9

Executive Summary

ES.1 Background

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol 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, IPCC Good Practice Guidance for LULUCF, the Revised 1996 Guidelines, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, 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 of Iceland (EA), which compiles and maintains the greenhouse gas inventory. Emissions and removals from the Land use, Land use change and forestry (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 through 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. An Action plan for climate change mitigation was adopted in 2010. The Action Plan builds on an expert study on mitigation potential and cost from 2009 and takes account of the 2007 climate change strategy and likely international commitments. In 2012 the first yearly progress report was published, where the emissions and removals are compared with the goals put forward in the Action plan.

The Kyoto Protocol commits Annex I Parties to individual, legally binding targets for their greenhouse gas emissions. Iceland's obligations according to the Kyoto Protocol have been and are as follows:

- For the first commitment period, from 2008 to 2012, the greenhouse gas emissions were not to increase by more than 10% from the level of emissions in 1990. Iceland AAUs for the first commitment period were decided in Iceland's Initial Report under the Kyoto Protocol and amounted 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" allowed Iceland to report certain industrial process carbon dioxide emissions separately and not include them in national totals; to the extent they caused Iceland to exceed its assigned amount. For the first commitment period, from 2008 to 2012, the carbon dioxide emissions falling under decision 14/CP.7 were not to exceed 8,000,000 tonnes.
- In 2015 an agreement between the European Union, its Member States and Iceland concerning Iceland´s participation in the joint fulfilment of commitments of the Union, the Member States and Iceland in the second commitment period of the Kyoto Protocol entered into force. Therein the Parties agree to fulfil their quantified emission limitation and reduction commitments for the second commitment period inscribed in the third column of Annex B to the Kyoto Protocol jointly.

ES.2 Summary of national emission and removal related trends

In 1990, the total emissions of greenhouse gases (excluding LULUCF) in Iceland were 3,633 kt of CO_2-equivalents. In 2014, total emissions were 4,597 kt CO_2-equivalents. This is an increase of 26.5% over the time period.

A summary of the Icelandic national emissions for 1990, 2005, 2010, 2013 and 2014 is presented in Table ES. 1 (without LULUCF).

Table ES. 1 Total GHG emissions by gas 1990, 2005, 2010, 2013 and 2014 in kt CO_2-eq (excluding LULUCF).

	1990	2005	2010	2013	2014	Changes ´90-´14	Changes ´13-´14
CO_2	2,106	2,797	3,384	3,301	3,271	55%	-1%
CH_4	522	562	584	546	592	13%	8%
N_2O	510	432	436	426	468	-8%	10%
PFCs	495	31	172	88	99	-80%	12%
HFCs	0	69	146	171	164	NA	-4%
SF_6	1	3	5	3	2	102%	-31%
Total emissions	**3,633**	**3,894**	**4,726**	**4,536**	**4,597**	**27%**	**1%**

ES.3 Overview of source and sink category emission estimates and trends

The largest contributor of greenhouse gas emissions in Iceland in 2014 when excluding LULUCF were Industrial Processes, followed by the Energy sector, then Agriculture, Waste, and Solvent and other Product Use (Table ES. 2). From 1990 to 2014, the contribution of Industrial Processes increased from 26% to 42%, emissions from the Energy sector decreased from 50% to 38% during the same period.

Table ES. 2 Total GHG emissions by source 1990, 2005, 2010, 2013 and 2014 (kt. CO_2-eq.).

	1990	2005	2010	2013	2014	Changes ´90-´14	Changes ´13-´14
Energy	1,738	2,024	1,825	1,674	1,680	-3%	0%
Industrial Processes	948	953	1,942	1,944	1,915	102%	-2%
Agriculture	780	674	713	688	747	-4%	9%
LULUCF	11,495	11,652	11,857	11,872	11,868	3%	0%
Waste	168	246	243	229	255	52%	12%
Total emissions w/o LULUCF	**3,633**	**3,896**	**4,723**	**4,536**	**4,597**	**27%**	**1%**

The distribution of total greenhouse gas emissions over the UNFCCC sectors (dissecting the energy sector into fuel combustion and geothermal energy and excluding LULUCF) in 2014 is shown in Figure ES. 1. Emissions from the Energy sector account for 36% (fuel combustion 31% and geothermal energy 5%) of the national total emissions, industrial processes account for 42% and agriculture for 16% and the Waste sector accounts for 6%.

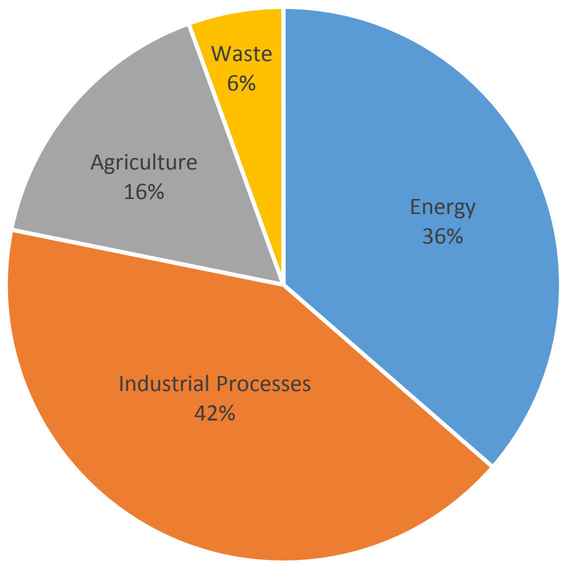

Figure ES. 1 Emissions of GHG by sector, without LULUCF, from 1990 to 2014 in CO_2-eq.

ES.4 Other information – Kyoto Accounting

Iceland's initial AAUs for the first commitment period amounted to 18,523,847 tonnes of CO_2-equivalents for the period or 3,704,769 tonnes per year on average. Added to that are a total of 1,541,960 RMUs from Art. 3.3 and Art. 3.4 activities and total of 33,125 AAUs, CERs and ERUs from Joint Implementation projects, resulting in an available assigned amount of 20,098,931 AAUs.

Emissions from Annex A sources during CP1 were 23,356,071 tonnes CO_2-eq. This means that Annex A emissions were 3,257,140 tonnes CO_2 in excess of Iceland´s available assigned amount.

Total CO_2 emissions falling under Decision 14/CP.7 during CP1 were 5,912,964 tonnes CO_2. Therefore, in order to comply with its goal for CP1, Iceland reported 3,257,140 tonnes of the CO_2 emissions falling under decision 14/CP.7 separately and not include them in national totals Table ES. 3 and Figure ES. 2 demonstrate this.

The CRF tables accompanying the 2016 NIR, however, still contain Iceland´s Annex A emissions in their entirety.

Table ES. 3 Summary of Kyoto Accounting for CP1.

		2008	2009	2010	2011	2012	CP1
Initial assigned amount	AAUs	3,704,769	3,704,769	3,704,769	3,704,769	3,704,769	18,523,847
KP-LULUCF Art. 3.3	RMUs	103,268	115,465	135,426	153,265	172,805	680,229
KP-LULUCF Art. 3.4	RMUs	152,293	159,608	171,719	184,453	193,658	861,730
Available assigned amount	AAUs	3,960,330	3,979,843	4,011,914	4,042,487	4,071,233	20,065,807
Emissions from Annex A sources	t CO_2 eq.	5,021,786	4,779,267	4,646,161	4,441,127	4,467,730	23,356,071
Difference AAU - Annex A emissions	t CO_2 eq.	1,061,456	799,424	634,247	398,639	396,497	3,290,264
Emissions falling under Decision 14/CP.7	t CO_2 eq.	1,160,862	1,205,354	1,225,141	1,209,095	1,278,871	6,079,323
Emissions falling under Decision 14/CP.7 reported under national totals	t CO_2 eq.	99,406	405,930	590,894	810,456	882,373	2,789,059
Emissions falling under Decision 14/CP.7 not reported under national totals	t CO_2 eq.	1,061,456	799,424	634,247	398,639	396,497	3,290,264

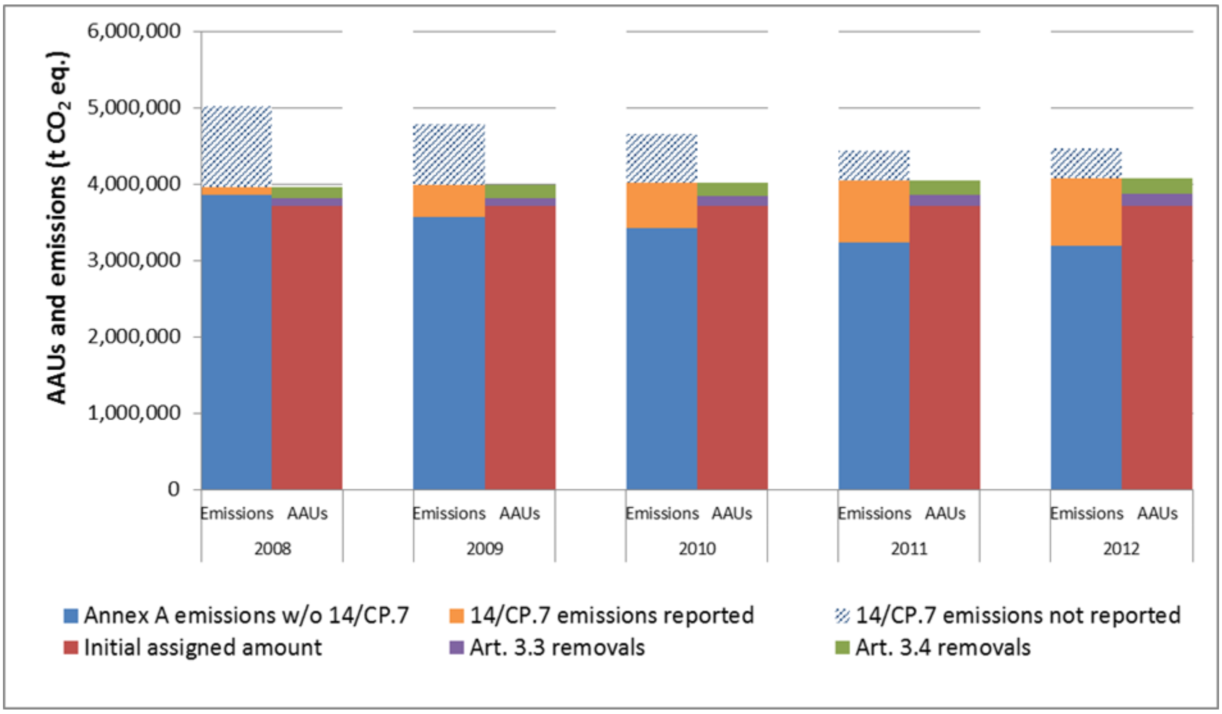

Figure ES. 2 Summary of Kyoto Accounting for CP1.

As part of its submission to UNFCCC, Iceland submits SEF tables for the Kyoto Protocol units issued in 2015 for the second commitment period (CP2). There were no annual external transactions made and at the end of the reported year there were no units in the party holding account.

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 (GHG) 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. Iceland's obligations according to the Kyoto Protocol have been and are as follows:

- For the first commitment period, from 2008 to 2012, the greenhouse gas emissions shall were not to increase by more than 10% from the level of emissions in 1990. Iceland AAUs for the first commitment period were decided in Iceland's Initial Report under the Kyoto Protocol and amounted 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" allowed Iceland to report certain industrial process carbon dioxide emissions separately and not include them in national totals; to the extent they caused Iceland to exceed its assigned amount. For the first commitment period, from 2008 to 2012, the carbon dioxide emissions falling under decision 14/CP.7 were not to exceed 8,000,000 tonnes.
- In 2015 an agreement was concluded between the European Union, its Member States and Iceland concerning Iceland´s participation in the joint fulfilment of commitments of the Union, the Member States and Iceland in the second commitment period of the Kyoto Protocol. Therein the Parties agree to fulfil their quantified emission limitation and reduction commitments for the second commitment period inscribed in the third column of Annex B to the Kyoto Protocol jointly.

A new climate change strategy was adopted by the Icelandic government in February 2007. 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. In November 2010, the Icelandic government adopted a Climate Change Action Plan in order to execute the strategy (Ministry for Environment, 2010). The action plan proposes 10 major tasks to curb and reduce GHG emissions in six sectors, as well as provisions to increase carbon sequestration resulting from afforestation and revegetation programs. The main tasks are:

a) Implementing the EU Emission Trading Scheme (ETS)
b) Implementing carbon emission charge on fuel for domestic use
c) Changing of tax systems and fees on cars and fuel
d) Enhance the use of environmentally-friendly vehicles at governmental and municipality bodies
e) Promote alternative transport methods like walking, cycling, and public transport
f) Use of biofuel in the fishing fleet
g) Using electricity as an energy resource in the fishmeal industry
h) Increase afforestation and revegetation
i) Restoring wetlands
j) Increase research and innovation regarding climate issues

In 2012 the first yearly progress report was published, where the emissions and removals are compared with the goals put forward in the Action plan.

The greenhouse gas emissions profile for Iceland is unusual in many respects. First, emissions from generation of electricity and from space heating are very low owing to the use of renewable energy sources (geothermal and hydropower). Second, almost 80% of emissions from the Energy sector stem from mobile sources (transport, mobile machinery and commercial fishing vessels). Third, 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 had 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 aluminium 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 the question of scale. In small economies such as Iceland, a single project 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 shall not be 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 8 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 (BEP) and best available technology (BAT) 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 that will imply that Iceland cannot 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. Emissions that fall under Decision 14/CP.7 are not excluded from national totals in this report, as Iceland undertook the accounting with respect to the Decision at the end of the commitment period. The projects, from which emissions fulfil the provisions of Decision 14/CP.7, are described in Chapter 4.5 and Fact sheets for the project can be found in Annex IV.

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 1990-2014. The methodologies 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.

As part of its submission to UNFCCC Iceland submits SEF tables for the Kyoto Protocol units issued in 2014. Annual external transactions consisted of additional 182 AAUs from SE and 5087 ERUs from EU, no subtractions were made. The total quantities of Kyoto Protocol units in Party holding accounts at the end of reported year were 18,524,029 AAUs and 5,087 ERUs.

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 NO_X, 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 auspices of the Ministry for the Environment and Natural Resources, 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 Convention. Figure 1.1 illustrates the flow of information and allocation of responsibilities.

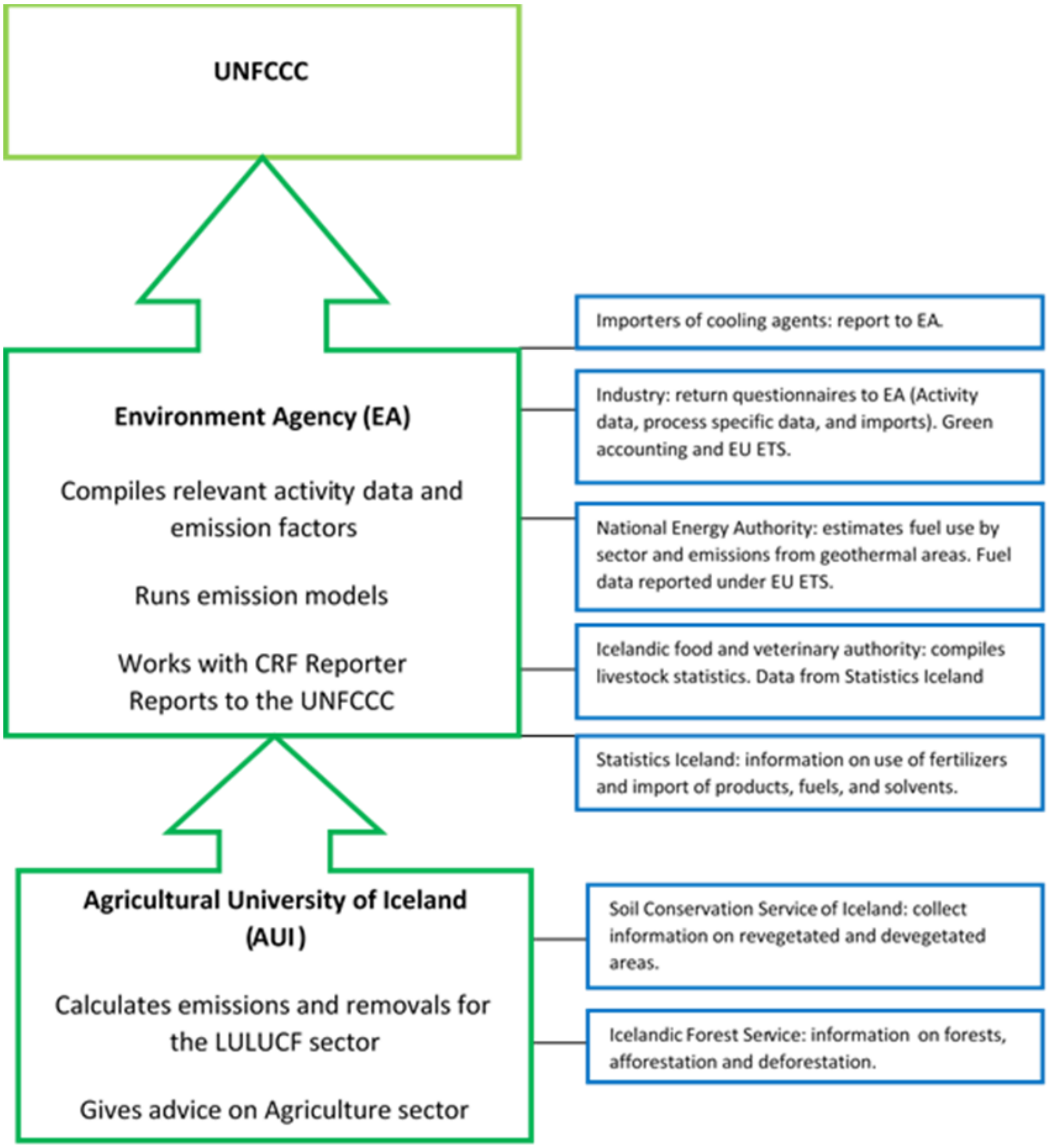

Figure 1.1 Information flow and distribution of responsibilities in the Icelandic emission inventory system for reporting to the UNFCCC.

A Coordinating Team was established in 2008 as a part of the national system and operated until 2012. The team had representatives from the Ministry for the Environment, the EA and the AUI not directly involved in preparing the inventory. Its official roles was 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 each inventory cycle in the period 2008 to 2012 the Coordinating Team held several meetings, of which some meetings were only with the Coordinating Team's members and other meetings were held with the team members as well as major data providers. The work of the team 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 also incorporated into the inventory. The Coordinating Team ceased to operate in 2012 when a new Act no. 70/2012 on climate change was passed by the Icelandic legislature Althingi.

1.2.2 The Climate Change Act No 70/2012

In June 2012 the Icelandic Parliament passed a new law on climate change (Act No 70/2012). The Climate Change Act was passed in 2012 and the objectives of the Act are the following:

- Reducing greenhouse gas emissions efficiently and effectively,
- To increase carbon sequestration from the atmosphere,
- Promoting mitigation to the consequences of climate change, and
- To create conditions for the government to fulfil its international obligations regarding climate change.

Act No 70/2012 supersedes Act No 65/2007 on which basis the Environment Agency made formal agreements with 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. The data collection for the first commitment period of the Kyoto protocol was based on these agreements. Articles 7 to 15 of Act No 65/2007 regarding the allocation of allowances in the period 2008 to 2012 were in effect until the completion of reporting obligations for the period. Regulation No 244/2009, put forward on basis of Act No 65/2007 further elaborated on the reporting of information from the industrial plants falling under that part of Act No 65/2007. Based on Act No 65/2007 a three-member Emissions Allowance Allocation Committee, appointed by the Minister for the Environment with representatives of the Ministry of Industry, Ministry for the Environment and the Ministry of Finance, allocated emissions allowance for operators falling within the scope of the Act during the period 1 January 2008 to 31 December 2012.

Act No 70/2012 establishes the national system for the estimation of greenhouse gas emissions by sources and removals by sinks, a national registry, emission permits and establishes the legal basis for installations and aviation operators participating in the EU ETS. 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.

Article 6 of Act No 70/2012 addresses Iceland´s greenhouse gas inventory. It states that the Environment Agency (EA) compiles Iceland´s GHG inventory in accordance with Iceland´s international obligations. Act No 70/2012 changes the form of relations between the EA and other bodies concerning data handling. The Act states that the following institutions are obligated to collect data necessary for the GHG inventory and report it to the EA, further to be elaborated in regulations set by the Minister for the Environment and Natural Resources:

- Iceland Forest Service (IFS)
- National Energy Authority (NEA)
- Agricultural University of Iceland (AUI)
- Iceland Food and Veterinary Authority
- Statistics Iceland
- The Road Traffic Directorate
- The Icelandic Recycling Fund
- Directorate of Customs

The relevant regulation regarding manner and deadlines of the said data has been drafted by the EA and sent to the Ministry for Environment and Natural Resources. From 2016 onwards, however, Iceland will submit its GHG inventory to the European Union before submitting it to the UNFCCC. The deadline for submission of GHG data and a NIR draft to the EU is January 15th. This makes it necessary to change dates proposed in the regulation draft. This will be done in unison with the main data providers later this year. Therefore the regulation has not been published, yet. It is foreseen that the new regulation will facilitate the responsibilities, the data collection process and the timelines.

As the prospective regulation on data collection, based on Act No 70/2012, formalizes the cooperation and data collection process between the EA and all responsible institutions, it takes over the role of the Coordinating Team regarding the cooperation between different institutions. The other role of the Coordinating Team, i.e. reviewing the GHG inventory and facilitating improvements, has been taken over on a more informal basis by other employees of the EA not directly involved in the inventory preparation process. The scheduled cooperation with the EU regarding the GHG inventory entails elaborated QA/QC procedures by the EU and will lighten the need for domestic QA/QC procedures to some extent.

1.2.3 Joint Fulfilment Agreement

According to Article 4, cf. Annex I, of the 2015 Joint Fulfilment Agreement on Iceland´s participation in the joint fulfilment of the commitments of the European Union, its Member States and Iceland in the second commitment period of the Kyoto Protocol, Regulation (EU) No 525/2013[1] and current and future Delegated and Implementing Acts based on Regulation (EU) No 525/2013 shall be binding upon Iceland. The legal acts were rendered applicable in Iceland in 2015 with an amendment to Act No 70/2012.

1.2.4 Green Accounting

According to Icelandic Regulation No. 851/2002 on green accounting, industry is required to hold, and to publish annually, information on how environmental issues are handled, the amount of raw material and energy consumed, the amount of discharged pollutants, including greenhouse gas emissions, and waste generated. Emissions reported by installations have to be verified by independent auditors, who need to sign the reports before their submission to the Environment Agency. The green accounts are then made publicly available at the website of the EA.

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. From 2008 and onwards, Act No. 48/2007 enables the NEA to obtain sales statistics from the oil companies. Until 2011 the Farmers Association of Iceland (FAI), on behalf of the Ministry of Agriculture, was responsible for assessing the size of the animal population each year, when the Food and Veterinary Authority took over that responsibility. On request from the EA, the FAI assisted to come up with a method to

[1] Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC, OJ 2013 L165/13, as amended by Regulation (EU) No 662/2014, OJ 2014 L189/155.

account for young animals that are mostly excluded from national statistics on animal population. Animal statistics have been further developed to better account for replacement animals in accordance with recommendations from the ERT that came to Iceland for an in-country review in 2011. Statistics Iceland provides information on population, GDP, production of asphalt, food and beverages, imports of solvents and other products, the import of fertilizers and on the import and export of fuels. The EA collects various additional data directly. Annually an electronic questionnaire on imports, use of feedstock, and production and process specific information is sent out to industrial producers, in accordance with Regulation no. 244/2009. Green Accounts submitted under Regulation no. 851/2002 from the industry are also used. For this submission the data contained in applications for free allowances under the EU ETS is also used. Importers of HFCs submit reports on their annual imports by type of HFCs to the EA. The Icelandic Directorate of Customs supplies the EA with information on the identity of importers of open and closed-cell foam. The 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, IPCCC Good Practice Guidance for LULUCF, and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, since limited information is available from measurements of emissions in Iceland.

The 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. The AUI then calculates emissions and removals for the LULUCF sector and reports to the EA.

The annual inventory cycle (Figure 1.2) describes individual activities performed each year in preparation for next submission of the emission estimates.

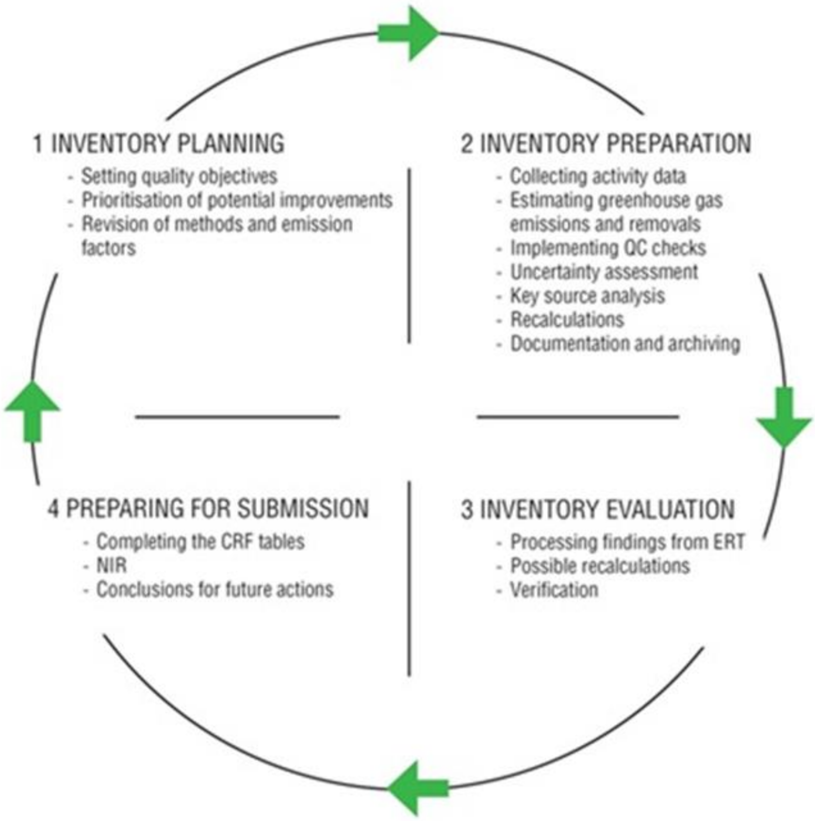

Figure 1.2 The annual inventory cycle.

A new annual cycle begins with an initial planning of activities for the inventory cycle by the inventory team and major data providers as needed (NEA, AUI, IFS and SCSI), taking into account the outcome of the internal and external review as well as the recommendations from the UNFCCC review. The initial planning is followed by a period assigned for compilation of the national inventory and improvement of the National System.

After compilation of activity data, emission estimates and uncertainties are calculated and quality checks performed to validate results. Emission data is received from the sectoral expert for LULUCF. All emission estimates are imported into the CRF Reporter software.

A series of internal review activities are carried out annually to detect and rectify any anomalies in the estimates, e.g. time series variations, with priority given to emissions from industrial plants falling under Decision 14/CP.7, other key source categories and for those categories where data and methodological changes have recently occurred.

After an approval by the director and the inventory team at the EA, the greenhouse gas inventory is submitted to the UNFCCC by the EA.

1.4 Methodologies & 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 NO_x, SO_2, NMVOC and CO, as well as some other pollutants (POPs).

Methodologies and data sources for LULUCF are described in Chapter 0.

1.5 Archiving

Gopro.net, a document management system running on .NET, is used to store email communications concerning the GHG inventory. Paper documents, e.g. written letters, are scanned and also stored in Gopro.net. The system runs on its own virtual server and uses a MS SQL server 2012 running on a separate server. Both servers are running Windows Server 2012 R2.

Each staff member at EA has online Office 365 subscription and are emails sent and received using Microsoft Office 365 servers hosted in Ireland.

Numerical data, calculations and other related documents are stored on a fileserver running Windows Server 2012 R2. EA´s virtual servers are using VMWare software running on Dell Blade Servers.

Advania, a local IT company, hosts EA´s servers. Their hosting is fully ISO-9001 and ISO-27001 certified. Their hosting rooms are in two locations in Hafnarfjordur, a town very close to Reykjavik. One room is the primary server room while the other is a secondary backup room storing off-site backups, the rooms are separated by roughly 5 km.

Backups are taken daily and stored for 30 days. Every 3 months a full backup is taken and stored for 18 months. Backups are done with solutions from Veeam Backup & Replication using reverse incremental backup.

Hard copies of all references listed in the NIR are stored in the EA. The archiving process has improved over the last years, i.e. the origin of data dating years back cannot always be found out. The land use database IGLUD is stored on a server of the Agricultural University of Iceland (AUI). All other data used in LULUCF as well as spread sheets containing calculations are stored there as well. This excludes data regarding Forestry and Revegetation which is stored on servers of the Icelandic Forestry Service and Soil Conservation Service of Iceland, respectively.

1.6 Key Source Categories

According to 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 the Tier 1 method. The results of the key source analysis prepared for the 2016 submission are shown in Table 1.1 .Tables showing the key source analysis (trend and level assessment) can be found in Annex I. The key source analysis includes LULUCF greenhouse gas sources and sinks.

Table 1.1 Key source categories of Iceland's 2016 GHG inventory. ✓= Key source category.

IPCC source category			Level 1990	Level 2014	Trend
Energy (CRF sector 1)					
1.A.2	Fuel combustion - Manufacturing Industries and	CO_2	✓		✓
1.A.2	Fuel combustion - Manufacturing Industries and	CO_2	✓		✓
1.A.3.b	Road Transportation	CO_2	✓	✓	✓
1.A.3.d	Domestic Navigation - Liquid Fuels	CO_2	✓		
1.A.4	Other Sectors - Liquid Fuels	CO_2	✓	✓	✓
1.B.2.d	Fugitive Emissions from Fuels - Other	CO_2	✓	✓	✓
IPPU (CRF sector 2)					
2.A.1	Cement Production	CO_2	✓		
2.C.2	Ferroalloys Production	CO_2	✓	✓	✓
2.C.3	Aluminium Production	CO_2	✓	✓	✓
2.C.3	Aluminium Production	PFCs	✓	✓	✓
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases		✓	✓
Agriculture (CRF sector 3)					
3.A	Enteric Fermentation	CH_4	✓	✓	✓
3.B	Manure Management	CH_4	✓		
3.B	Manure Management	N_2O	✓	✓	✓
3.D.1	Direct N2O Emissions From Managed Soils	N_2O	✓	✓	✓
3.D.2	Indirect N2O Emissions From Managed Soils	N_2O	✓	✓	
Land use, Land use change and Forestry (CRF sector 4)					
4.A.2	Land Converted to Forest Land	CO_2		✓	✓
4.B.1	Cropland Remaining Cropland	CO_2	✓	✓	✓
4.B.2	Land Converted to Cropland	CO_2	✓		✓
4.C.1	Grassland Remaining Grassland	CO_2	✓	✓	✓
4.C.2	Land Converted to Grassland	CO_2	✓	✓	✓
4.D.1.3	Other Wetlands Remaining Other Wetlands	CO_2			
4(II).	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2			
4(II).	Emissions and removals from drainage and rewetting	CH_4	✓	✓	✓
4(III).	Direct N2O emissions from N mineralization/immobilization	N_2O	✓	✓	✓
Waste (CRF sector 5)					
5.A	Solid Waste Disposal	CH_4	✓	✓	✓

1.7 Quality Assurance & Quality Control (QA/AC)

The objective of QA/QC activities in national greenhouse gas inventories is to improve transparency, consistency, comparability, completeness, accuracy, confidence and timeliness. A QA/QC plan for the annual greenhouse gas inventory of Iceland has been prepared and can be found on the EA's website (ust.is/library/Skrar/Atvinnulif/Loftslagsbreytingar/Iceland_QAQC_plan.pdf). 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 for the Icelandic emission inventory has been prepared and can also be found on the EA's website (ust.is/library/Skrar/Atvinnulif/Loftslagsbreytingar/Iceland_QAQC_manual.pdf). To further facilitate the QA/QC procedures all calculation sheets have been revised. They include a brief description of the method used. They are also provided with colour codes for major activity data entries and emissions results to allow immediate visible recognition of outliers.

1.8 Uncertainty Evaluation

Uncertainty estimates are an essential element of a complete inventory and are not used to dispute the validity of the inventory but rather help prioritise efforts to improve the accuracy of the inventory. Here, the uncertainty analysis is according to the Tier 1 method of the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories where different gases are reviewed separately as CO_2-equivalents. Total base and current years´ emissions within a greenhouse gas sector, category or subcategory are used in the calculations as well as corresponding uncertainty estimate values for activity data and emission factors used in emission calculations.

Uncertainties were estimated for all greenhouse gas source and sink categories (i.e. including LULUCF) according to the IPCC Good Practice Guidance. Estimates for activity data uncertainties are mainly based on expert judgement whereas emission factor uncertainties are mainly based on IPCC source category defaults. Errors in the determination of EF uncertainty factors for the Agriculture and Waste sectors were corrected. All source category uncertainties were first weighted with 2012 emission estimates and then summarized using error propagation. This calculation yielded an overall uncertainty of the 2012 emission estimate of 33.5%.

Uncertainty estimates introduced on the trend of greenhouse gas emission estimates by uncertainties in activity data and emission factors are combined and then summarized by error propagation to obtain the total uncertainty of the trend. This calculation yielded a total trend uncertainty of 16%. The decrease from the value of the 2014 submission (16.7%) is caused by the above mentioned correction of errors.

The results of the uncertainty estimate can be found in Annex II.

1.9 General Assessment of 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 2014.

With regard to sectoral coverage few sources are not estimated.

The main sources not estimated are:

- Emissions of CO_2 and CH_4 from road paving with asphalt (2D3b).
- In the LULUCF sector the most important estimates remaining are the ones regarding emissions/removals of mineral soil in few categories.

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.

1.10 Planned and Implemented Improvements

Planned and implemented improvements to Iceland's GHG Inventory can be found in chapter 8 Recalculations and Improvements.

2 Trends in Greenhouse Gas Emissions

2.1 Emission Trends in Aggregated GHG Emissions

Total amounts of greenhouse gases emitted in Iceland during the period 1990-2014 are presented in the following tables and figures, expressed in terms of contribution by gas and source.

Table 2.1 presents emission figures for greenhouse gases by sector in 1990, 2005, 2013 and 2014 expressed in kt CO_2-equivalents along with percentage changes for both time periods 1990-2014 and 2013-2014. Table 2.2 presents emission figures for all greenhouse gases by gas in 1990, 2005, 2013, and 2014 expressed in kt CO_2-equivalents along with percentage changes for both time periods 1990-2014 and 2013-2014.

Table 2.1 Emissions of greenhouse gases by sector in Iceland during the period 1990-2014 (kt CO_2-eq.)

	1990	2000	2010	2013	2014	Changes ´90-´14	Changes ´13-´14
1. Energy	1,738	2,000	1,825	1,674	1,680	-3.5%	0.4%
1.A Fuel combustion	1,676	1,849	1,635	1,498	1,493	-10.9%	-0.3%
1.B Geothermal	62	155	195	177	187	201.6%	5.6%
2. Industrial Processes	948	1,010	1,942	1,945	1,914	101.9%	-1.5%
2.D, 2.G. Solvent and Other Product Use	4	5	4	4	5	5.4%	6.1%
3. Agriculture	780	719	713	688	748	-4.1%	8.7%
4. Land Use, Land Use Change and Forestry	11,495	11,652	11,653	11,871	11,868	3.2%	-0.03%
5. Waste	168	230	246	229	255	51.8%	11.4%
Total emissions without LULUCF	3,633	3,959	4,726	4,536	4,597	26.5%	1.3%

Table 2.2 Emissions of greenhouse gases by gas in Iceland during the period 1990-2014 (without LULUCF) in kt CO_2-equivalents.

	1990	2000	2010	2013	2014	Changes ´90-´14	Changes ´13-´14
CO_2	2,106	2,729	3,384	3,290	3,272	55.4%	-0.9%
CH_4	522	559	584	546	592	13.5%	8.3%
N_2O	510	477	436	440	468	-8.2%	10.0%
PFCs	494.6	149.9	171.7	88.2	99.0	-80.0%	12.3%
HFCs	NO	43	146	171	164	NA	-3.9%
SF_6	1.1	1.3	4.7	3.2	2.2	102.1%	-30.8%
Total emissions	3,633	3,959	4,726	4,536	4,597	26.5%	1.3%

In 1990 total GHG emissions (excluding LULUCF) in Iceland were 3,633 kt CO_2-equivalents. In 2014 total emissions were 4,597 kt CO_2-equivalents. This is tantamount to an increase of 26.5% over the whole time period. Total emissions show a slight decrease between 1990 and 1994, with the exception of 1993. From 1995-1999 total emissions increased by about 5% per year, then plateau from 2000 to 2005. Between 2005 and 2008 emissions increased rapidly or by 10% per year. Between 2008 and 2010 annual emissions decreased again by on average 4% per year. Emissions decreased by 1.76% between 2013 and 2014.

By the middle of the 1990s economic growth started to gain momentum in Iceland. Until 2007 Iceland experienced one of the highest GDP growth rates among OECD countries. In the autumn of 2008, Iceland was hit by an economic crisis when three of the largest banks collapsed. The blow was particularly hard owing to the large size of the banking sector in relation to the overall economy as the sector´s worth was about ten times the annual GDP. The crisis resulted in a serious contraction of the economy followed by an increase in unemployment, a depreciation of the Icelandic króna (ISK), and a drastic increase in external debt. Private consumption contracted by 20% between 2007 and 2010. Emissions of greenhouse gases decreased from most sectors between 2008 and 2011.

The main driver behind increased emissions since 1990 has been the expansion of the metal production sector. In 1990, 87,839 tonnes of aluminium were produced in one aluminium plant in Iceland. A second aluminium plant was established in 1998 and a third one in 2007. In 2014, 839,449 tonnes of aluminium were produced in three aluminium plants. Parallel investments in increased power capacity were needed to accommodate for this roughly nine fold increase in aluminium production. The size of these investments is large compared to the size of Iceland´s economy.

The increase in GDP since 1990 further explains the general growth in emissions as well as the fact that the Icelandic population has grown by roughly 28% from 1990 to 2014. This has resulted in higher emissions from most sources, but in particular from transport and the construction sector. Emissions from the transport sector have risen considerably since 1990, as a larger share of the population uses private cars for their daily travel. Since 2008 fuel prices have risen significantly leading to lower emissions from the sector compared to preceding years. A knock-off effect of the increased levels of economic growth until 2007 was an increase in construction, especially residential building in the capital area. The construction of a large hydropower plant (Kárahnjúkar, building time from 2002 to 2007) led to further increase in emissions from the sector. The construction sector collapsed in late 2008. Emissions from fuel combustion in the transport and construction sector decreased in 2008 by 5% compared to 2007, in 2009 by 8% compared to 2008, in 2010 by 7% compared to 2009 and in 2011 by 5% compared to 2010, because of the economic crises. This has turned around again and between 2013 and 2014 there was an increase of 2.4%. The total emissions in 2014 are still 18% below the peak in 2007. Emissions from Cement production had decreased by 69% since 2007 (process emissions and emissions from fuel consumption) also as a result of the economic crises and the collapse of the construction sector. Cement production was shut down in late 2011.

The overall increasing trend of greenhouse gas emissions until 2005 was counteracted to some extent by decreased emissions of PFCs, caused by improved technology and process control in the aluminium industry. Increased emissions due to an increase in production capacity of the aluminium industry (since 2006) led to a trend of overall increase in greenhouse gas emissions between 2006 and 2008, when emissions from the aluminium sector peaked. In 2014 total emissions from the aluminium sector were 14% lower than in 2008 due to less PFC emissions from the sector.

2.2 Emission Trends by Gas

All values in this chapter refer to Iceland´s total GHG emissions without LULUCF. As shown in Figure 2.1the largest contributor by far to total GHG emissions is CO_2 (71%), followed by CH_4 (13%), N_2O

(10%) and fluorinated gases (PFCs, HFCs, and SF_6, 6%). In the year 2014, the changes in gas emissions compared to 1990 levels for CO_2, CH_4, N_2O, and fluorinated gases were 55.4%, 13.5%, -8.2%, and -80%, respectively (Table 2.2 and Figure 2.1).

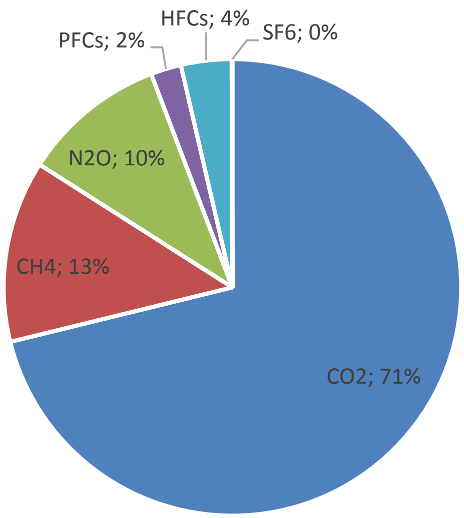

Figure 2.1 Distribution of emissions of GHG by gas in 2014.

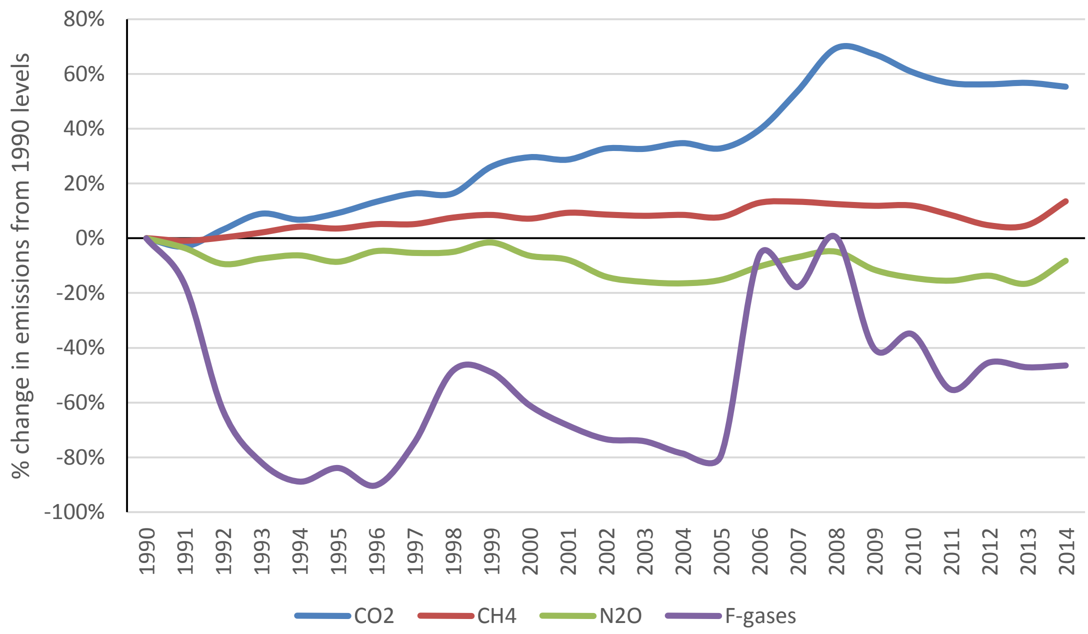

Figure 2.2 Percentage changes in emissions of GHG by gas 1990-2014, compared to 1990 levels.

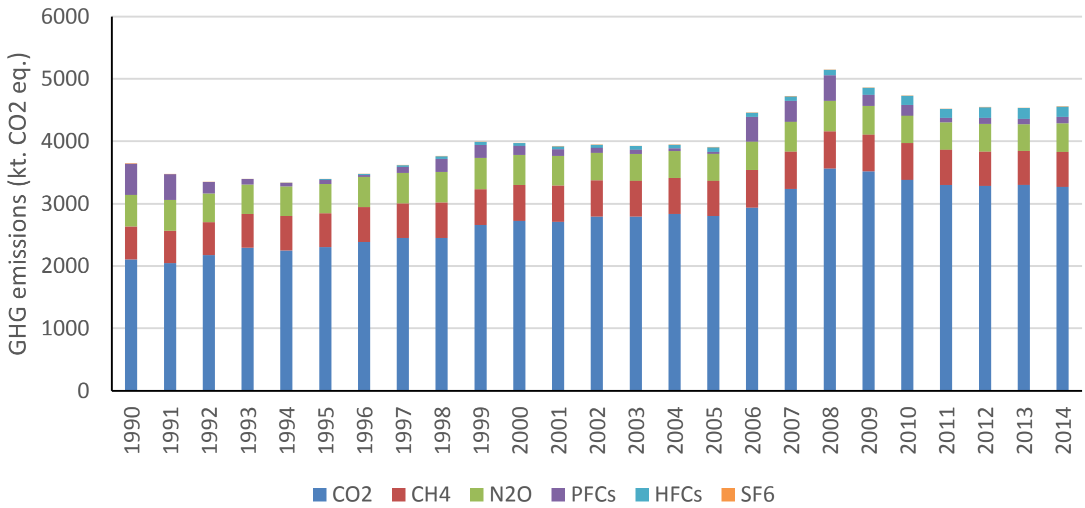

Figure 2.3 Emissions of greenhouse gases by gas, 1990-2014.

2.3 Carbon Dioxide (CO_2)

Industrial processes, road transport and commercial fishing are the three main sources of CO_2 emissions in Iceland. Since emissions from 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 sector are also significant (though much lower since 2008 than in the years before). Emissions from geothermal energy exploitation are considerable. Other sources consist mainly of emissions from non-road transport and waste incineration. Table 2.3 lists CO_2 emissions from the main source categories for the period 1990-2014. Figure 2.4 shows the percentage change in emissions of CO_2 by source from 1990 to 2014 compared with 1990 levels.

Table 2.3 Emissions of CO_2 by sector 1990-2014 in kt.

	1990	2005	2010	2013	2014
Fishing	652	623	532	474	438
Road vehicles	509	747	794	787	765
Stationary combustion, liquid fuels	202	171	71	49	25
Industrial processes	399	846	1,616	1,678	1,646
Construction	120	214	102	87	128
Geothermal	61	118	190	172	182
Other	163	78	79	53	88
Total CO_2 emissions	**2,106**	**2,798**	**3,384**	**3,301**	**3,272**

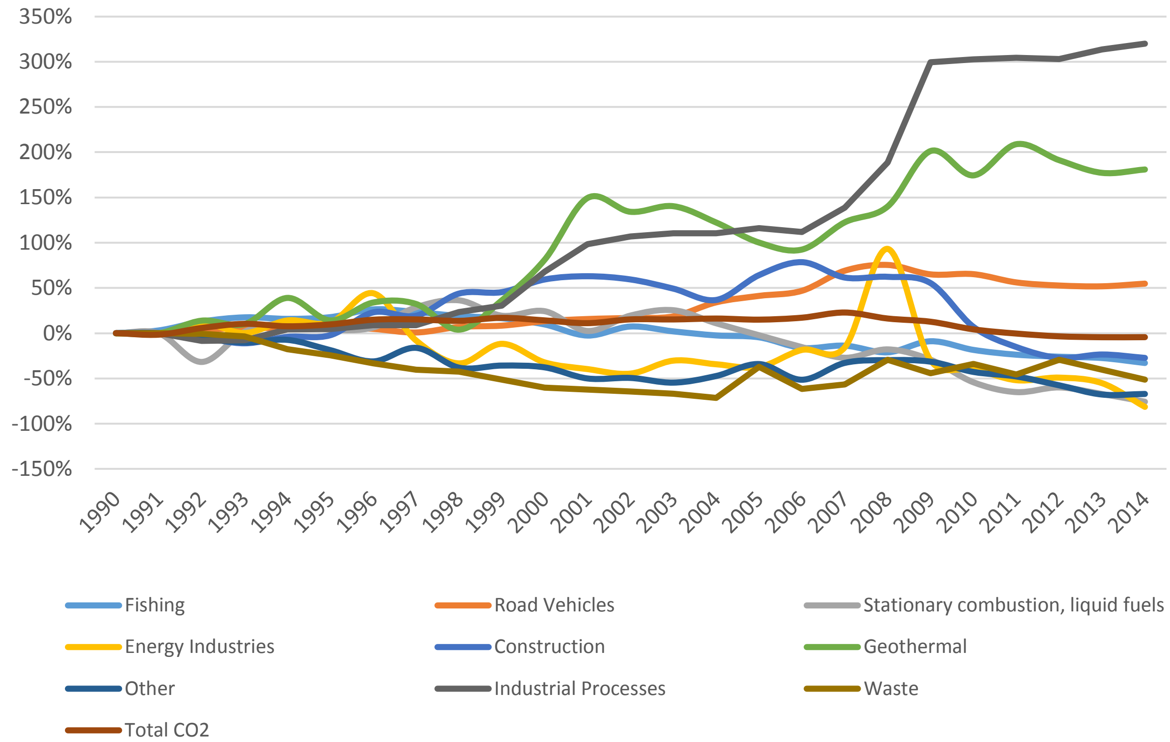

Figure 2.4 Percentage changes in emissions of CO_2 by major sources 1990-2014, compared to 1990.

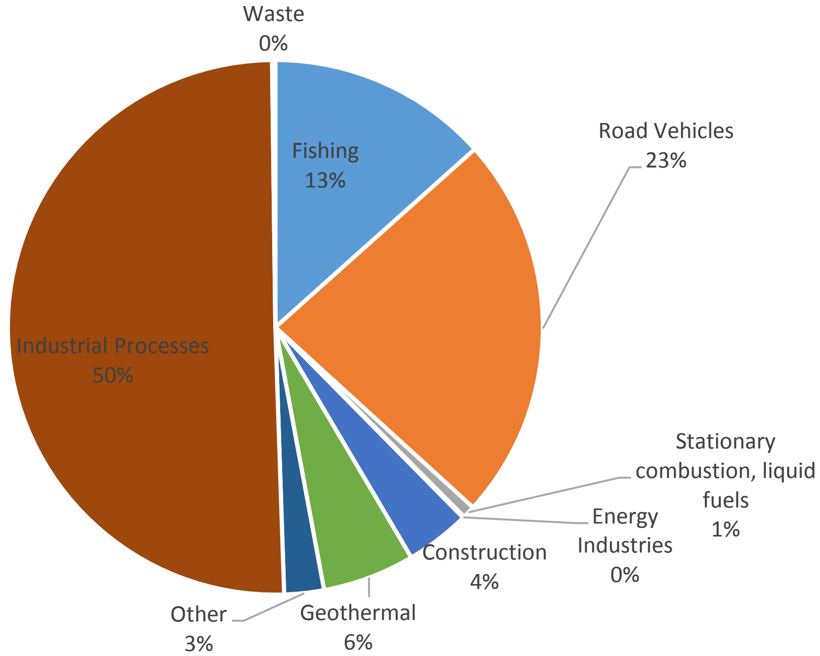

Figure 2.5 Distribution of CO_2 emissions by source in 2014.

In 2014, Iceland´s total CO_2 emissions were 3,272 kt. This is tantamount to an increase of 55% from 1990 levels and a decrease of 0.1% from the preceding year. CO_2 emissions from Industrial Processes decreased by 1.9% from 2013 to 2014 due to less emissions from metal production. Emissions from geothermal energy exploitation increased by 5.8% between 2013 and 2014. Emissions from road vehicles peaked in 2007 but have decreased by 14% since then. This decreasing trend is caused by significantly higher fuel prices, owing to the depreciation of the Icelandic króna since 2008, and by an increasing share of fuel efficient vehicles in the fleet. This can also be seen in decreased international aviation in 2008 and 2009 (Table 2.15). In 2009, 2010 and 2011 fuel prices continued to rise. In recent years more fuel efficient vehicles have been imported – a turn-over of the trend from the years 2002 to 2007 when larger vehicles were imported. This can be seen in less fuel consumption in 2010 than in 2009 despite the fact that driven mileage stayed almost the same. Driven mileage decreased by 5% for gasoline passenger cars and by 6% for diesel fueled cars between 2011 and 2012 but is on the rise again. Emissions from stationary combustion of liquid fuels decreased by 46.1% from 2013 to 2014. Emissions from construction increased by 47% and emissions from other sources increased by 73.3% during the same time period.

The increase in CO_2 emissions between 1990 and 2014 can be explained by increased emissions from industrial processes (312%), road transport (50%), construction (6%) and geothermal energy utilisation (196%). Total CO_2 emissions from the commercial fishing on the other hand declined by 32% respectively. In 2007 residual oil use in energy industries increased significantly due to insufficient supply of electricity

The main driver behind increased emissions from industrial processes since 1990 has been the expansion of the metal production sector, in particular the aluminium sector. In 1990, 87,839 tonnes of aluminium were produced in one aluminium plant in Iceland. A second aluminium plant was established in 1998 and a third one in 2007. In 2014, a total of 839,449 tonnes of aluminium were produced in these three aluminium plants, slightly less than in 2013.

CO_2 emissions from road transport have increased by 50% since 1990, owing to increases in population, number of cars per capita, more mileage driven, and - until 2007 - an increase in the share of larger vehicles. Since 1990 the vehicle fleet in Iceland has increased by 78%. Emissions from both domestic flights and navigation have declined since 1990.

Emissions from geothermal energy exploitation have increased by 196% since 1990. Electricity production using geothermal energy has increased from 283 GWh in 1990 to 5,238 GWh in 2014, or more than 18-fold.

CO_2 emissions from commercial 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 then increased again by 10% between 2001 and 2002, but in 2003 they dropped to 1990 levels. In 2014, the emissions were 33% below the 1990 levels and 7% below the 2014 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 the Kárahnjúkar hydropower plant (building time from 2002 to 2007) increased demand for cement, and the production at the cement plant increased again between 2004 and 2007, although most of the cement used in this project was imported. In 2011, emissions from cement production were 67% lower than in 2007, due to the collapse of the construction sector. The sole cement plant ceased operation in late 2011. CO_2 emissions from other sources in 2014 were 4.7% below the 1990 levels however emissions increased from 2013 to 2014 by 73.3% which is mostly related to growth in the economy.

2.4 Methane (CH_4)

Agriculture and waste treatment have been the main sources of methane emissions since 1990. In 2014 they comprised 62% and 36% of total methane emissions, respectively (Table 2.4 and Figure 2.6). The main methane source in the agriculture sector is enteric fermentation, the main source in the waste sector is solid waste disposal on land. Together they accounted for roughly 98% of sector methane emissions.

Methane emissions from agriculture decreased by 5% between 1990 and 2014 due to a decrease in livestock population. Emissions from waste, on the other hand, increased by 34% during the same period. Emissions from waste treatment increased sharply from 1990 to 2007 although the amount of waste landfilled had been oscillating between 300 and 350 kt from 1986 to 2005. The increase was due to an increasing share of waste landfilled in well managed solid waste disposal sites which are characterised by a higher methane correction factors than unmanaged sites. The decrease in methane emissions from the waste sector since 2007 by 18% is due to a decrease in the amount of waste landfilled since 2005 (Table 2.4).

Table 2.4 Emissions of CH_4 by sector 1990-2014 (kt CO_2-eq.).

	1990	1995	2000	2005	2010	2013	2014
Agriculture	364	338	332	322	342	323	344
Waste	150	195	219	232	231	215	239
Other	7	7	7	8	10	9	9
Total	522	540	559	562	584	546	592

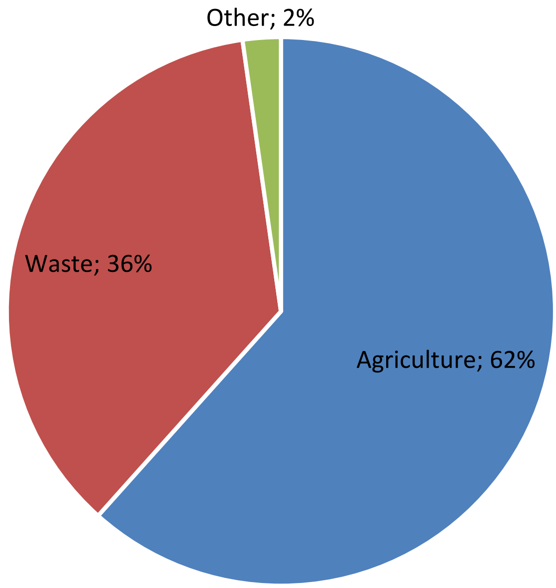

Figure 2.6 Distribution of CH_4 emissions by source in 2014.

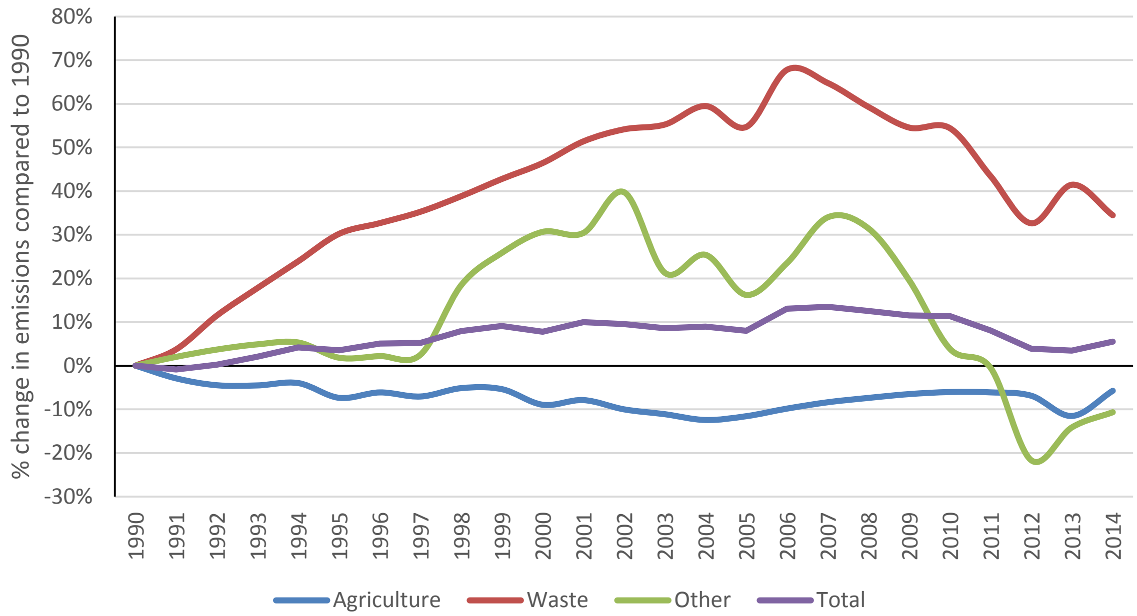

Figure 2.7 Percentage changes in emissions of CH_4 by major sources 1990-2014, compared to 1990 levels.

2.5 Nitrous Oxide (N_2O)

Agriculture has been the main source of N_2O emissions in Iceland and accounted for 87% of nitrous oxide emissions in 2014 (Table 2.5 and Figure 2.8). Direct and indirect N_2O emissions from agricultural soils were the most prominent emission contributors, followed by emissions from unmanaged manure and manure managed in solid storage. Emissions from the agriculture sector decreased by 10% since 1990. This development was mainly due to a decrease in livestock populations accompanied by a decrease in manure production. The second most important source of N_2O, since the shutdown of the fertilizer plant in 2001, is road transport. Emissions increased rapidly when catalytic converters became obligatory in all new vehicles in 1995. N_2O is a by-product of NO_x reduction in catalytic converters. Total nitrous oxide emissions have decreased by 9.7% since 1990.

Table 2.5 Emissions of N_2O by sector 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Agriculture	415	370	387	352	370	365	403
Road transport	15	20	31	38	37	34	34
Other fuel combustion	21	25	31	32	18	15	20
Chemical industry	46	41	18	NO	NO	NO	NO
Other	12	11	11	10	11	11	11
Total	**510**	**466**	**477**	**432**	**436**	**426**	**468**

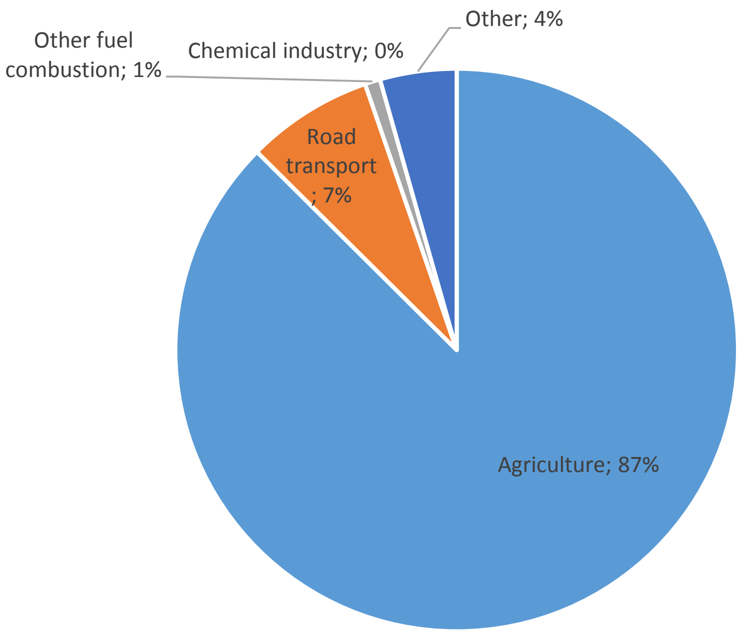

Figure 2.8 Distribution of N_2O emissions by source in 2014.

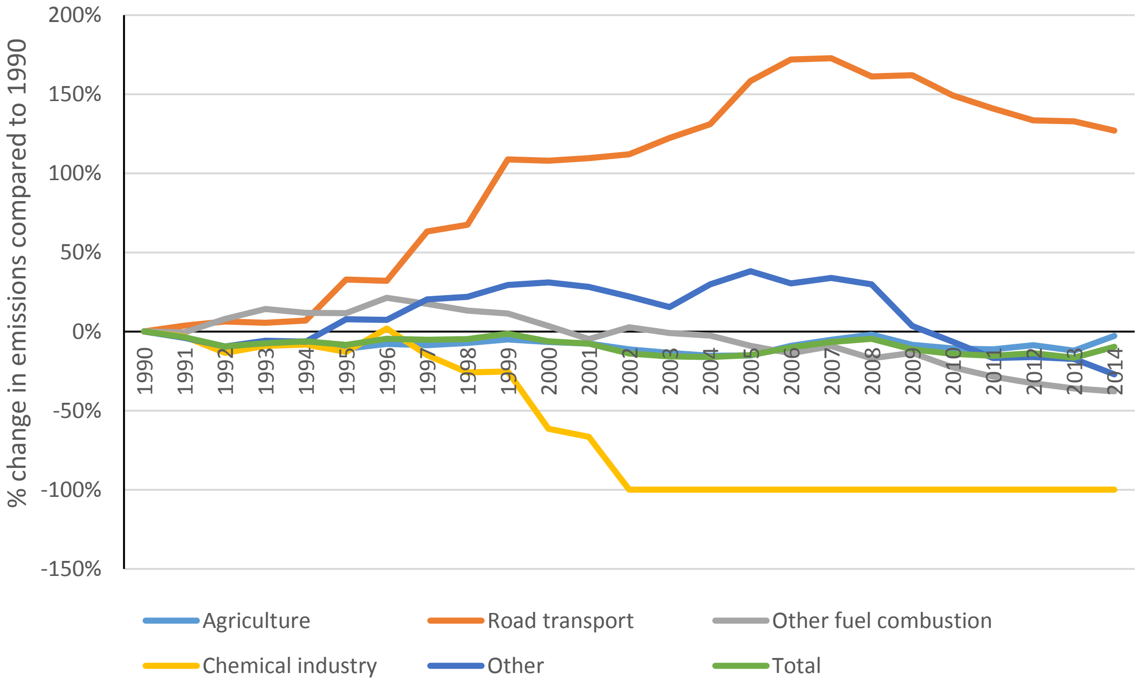

Figure 2.9 Changes in N_2O emission for major sources between 1990 and 2014.

2.6 Perfluorocarbons (PFCs)

The emissions of the perfluorocarbons, i.e. tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) from the aluminium industry were 82.5 and 16.4 kt CO_2-equivalents respectively in 2014, or roughly 99 kt CO_2-equivalents in total. Emissions of PFCs (PFC 116 and PFC 218) from consumption of halocarbons in refrigeration and air conditioning equipment were 0.007 kt CO_2-equivalents in 2014 (Table 2.6).

Total PFC emissions decreased by 80% in the period of 1990-2014. The emissions decreased steadily from 1990 to 1996 with the exception of 1995, as can be seen from Figure 2.10. At that time one aluminium plant was operating in Iceland. PFC emissions per tonne of aluminium are generally high during start up and usually rise during expansion. The emissions therefore 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. The emissions showed a steady downward trend between 1998 and 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. The PFC emissions rose significantly in 2006 due to an expansion of the Century Aluminium facility. The extent of the increase can be explained by technical difficulties experienced during the expansion. PFC emissions per tonne of aluminium went down from 2007 to 2010 and reached 2005 levels in 2010 at the Century Aluminium plant. The Alcoa Fjarðarál aluminium plant was established in 2007 and reached full production capacity in 2008. The decline in PFC emissions in 2009, 2010 and 2011 was achieved through improved process control at both Century Aluminium plant and Alcoa Fjarðarál (except in December at Alcoa), as the processes have become more stable after a period of start-up in both plants. In December 2010 a rectifier was damaged in fire at Alcoa. This led to increased PFC emissions leading to higher emissions at the plant in 2010 than in 2009.

To a very small extent PFCs have also been used as refrigerants. C_2F_6 has been used in refrigeration and air conditioning equipment since 2002 (0.001 to 0.007 kt CO_2-equivalents per year) and C_3F_8 was used in refrigeration and air conditioning equipment for the first time in 2009.

Table 2.6. Emissions of PFCs 1990-2014 (kt CO_2-equivalents).

	1990	**1995**	**2000**	**2005**	**2010**	**2013**	**2014**
CF_4	412	58	125	26	143	73	83
C_2F_6	82	12	25	5	29	15	16
C_3F_8	NO	NO	NO	NO	0.01	0.00	0.01
Total	**495**	**69**	**150**	**31**	**172**	**88**	**99**

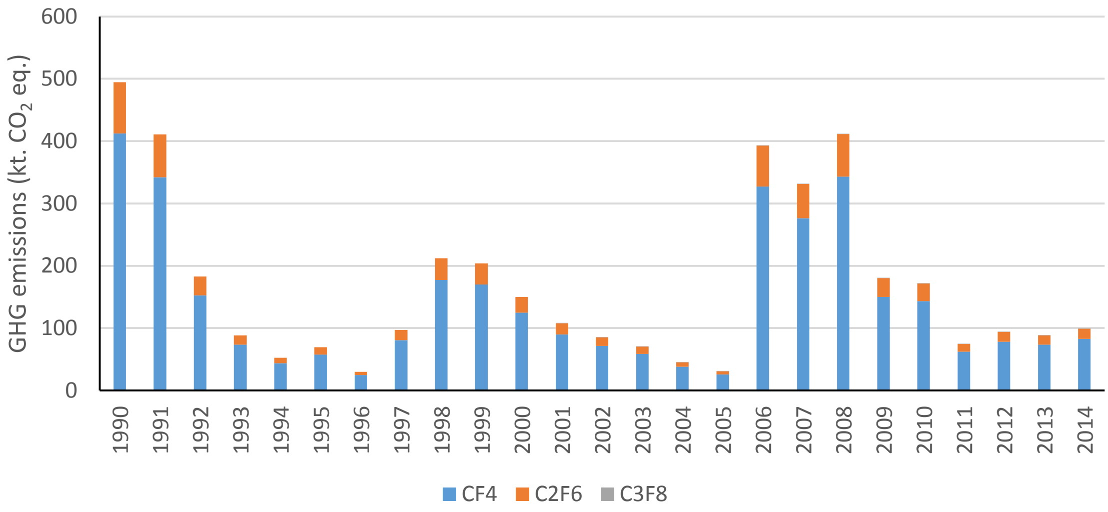

Figure 2.10 Emissions of PFCs from 1990 to 2014, kt CO_2-equivalents.

2.7 Hydrofluorocarbons (HFCs)

Total actual emissions of HFCs, used as substitutes for ozone depleting substances (ODS), amounted to 164 kt CO_2-equivalents in 2014 (Table 2.7). The import of HFCs started in 1993 and has increased until 2010 in response to the phase-out of ODS like chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). Import numbers decreased strongly in 2011, causing only a slight decrease in emissions due to the time lag between refrigerant use and leakage. Refrigeration and air-conditioning were by far the largest sources of HFC emissions and the fishing industry plays an eminent role.

Over the years, the use of ozone depleting substances (ODS) in the fishing industry has been decreasing due to restrictions on ODS import. The ban on importing new R-22, which became effective in 2010 and the impending ban on importing recovered R-22 mean a price increase for R-22 and add urgency to the process of retrofitting and replacing refrigerant systems in the fishing industry (Figure 2.7Figure 2.11). HFC-23, HFC-32, HFC-152 and HFC-227 cannot be seen in Figure 2.11 due to proportionally low levels compared to three major HFCs. Between 2008 and 2010 the import of HFCs had increased more than twofold. Total HFC emissions amounted to to 164 kt in 2014 which is lower compared to 2013.

Table 2.7. Emissions of HFCs 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
HFC-23	NO	NO	NO	0.02	0.02	0.01	0.01
HFC-32a	NO	NO	0.01	0.03	0.05	0.17	0.22
HFC-125	NO	5.08	17.47	25.32	53.21	63.65	64.79
HFC-134a	NO	1.92	7.48	13.13	21.41	22.42	22.45
HFC-143	NO	2.46	17.46	30.52	70.73	84.08	76.06
HFC152a	NO	0.04	0.07	0.05	0.02	0.01	0.01
HFC-227ea	NO	NO	NO	0.08	0.03	0.28	0.00
Total	NO	9.50	42.49	69.15	145.47	170.61	163.54

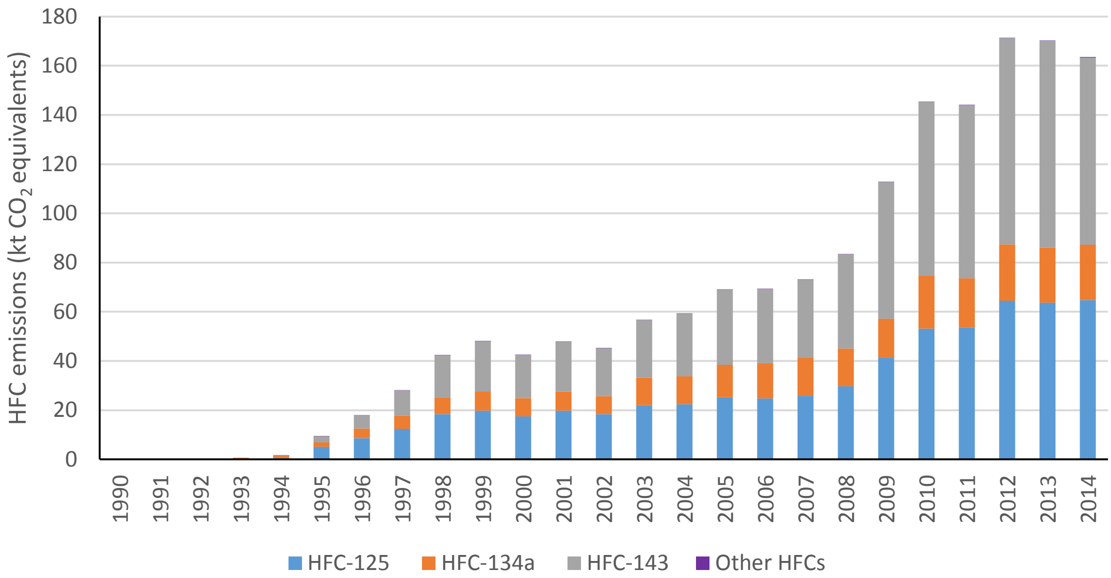

Figure 2.11 Emissions of HFCs 1990-2014 (kt CO_2-equivalents).

2.8 Sulphur Hexafluoride (SF_6)

The sole source of SF_6 emissions in Iceland is leakage from electrical equipment. Total emissions in 2014 were 97 kg SF_6 which is tantamount to 2.2 kt CO_2-equivalents. Emissions have increased by 102% since 1990. This increase reflects the expansion of the Icelandic electricity distribution system since 1990 which is accompanied by an increase in SF_6 used in high voltage gear. The emission peak in 2010 was caused by two unrelated accidents during which the SF_6 amounts contained in the gear affected by the accidents was emitted (Figure 2.12). The emission peak in 2012 was caused by increased leakage in the transmission grid of Landsnet LLC.

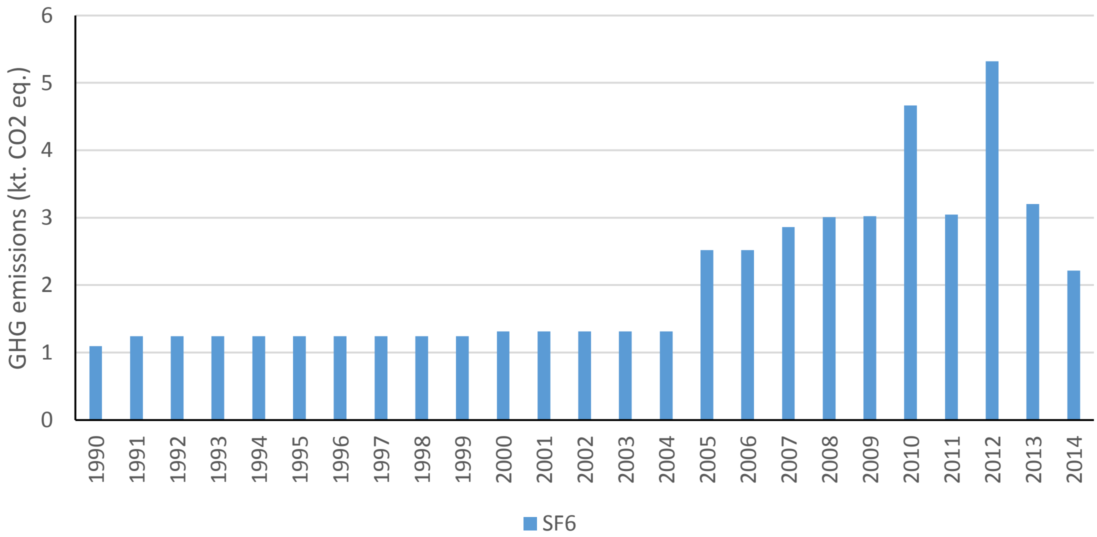

Figure 2.12 Emissions of SF_6 from 1990 to 2014 (kt CO_2-equivalants).

2.9 Emission Trends by Source

Industrial processes are the largest contributor of greenhouse gas emissions in Iceland (without LULUCF), followed by Energy, Agriculture, and Waste. The contribution of Industrial Processes to total net emissions (without LULUCF) increased from 25% in 1990 to 41% in 2014. The contribution of the Energy sector decreased from 51% in 1990 to 38% in 2013. Agriculture and the Waste sector accounted for 17% and 5% of 2014 emissions, respectively (cf. Table 2.1 and Figure 2.13).

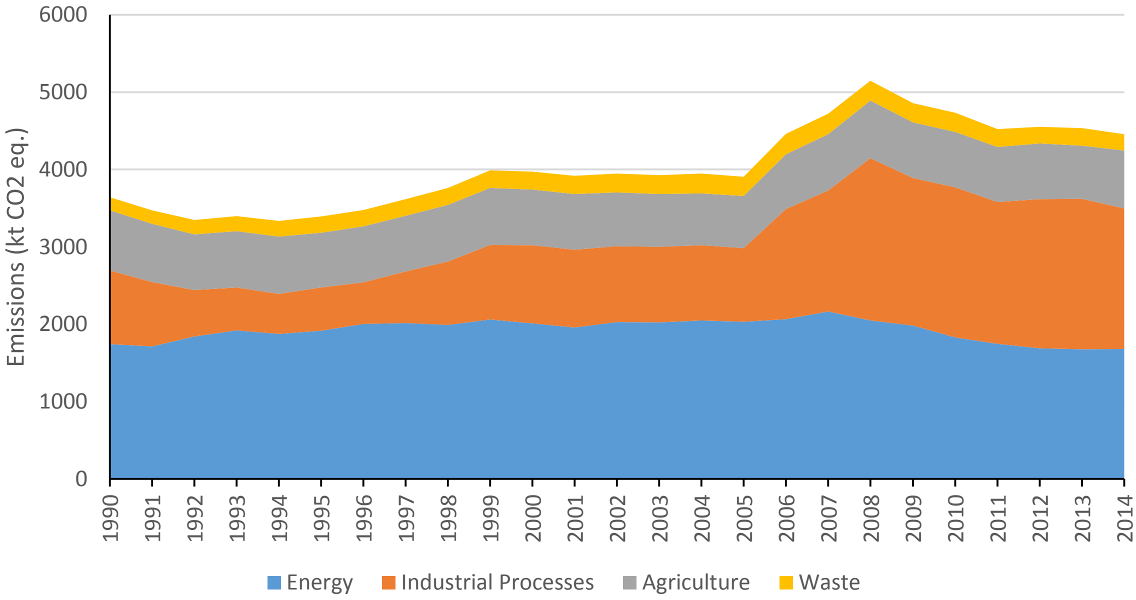

Figure 2.13 Emissions of GHG by sector, without LULUCF, from 1990 to 2014 (CO_2-equivalents).

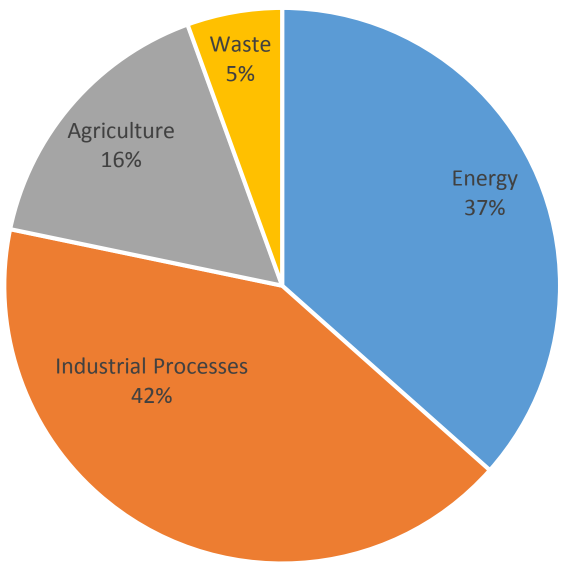

Figure 2.14 Emissions of greenhouse gases by UNFCCC sector in 2014.

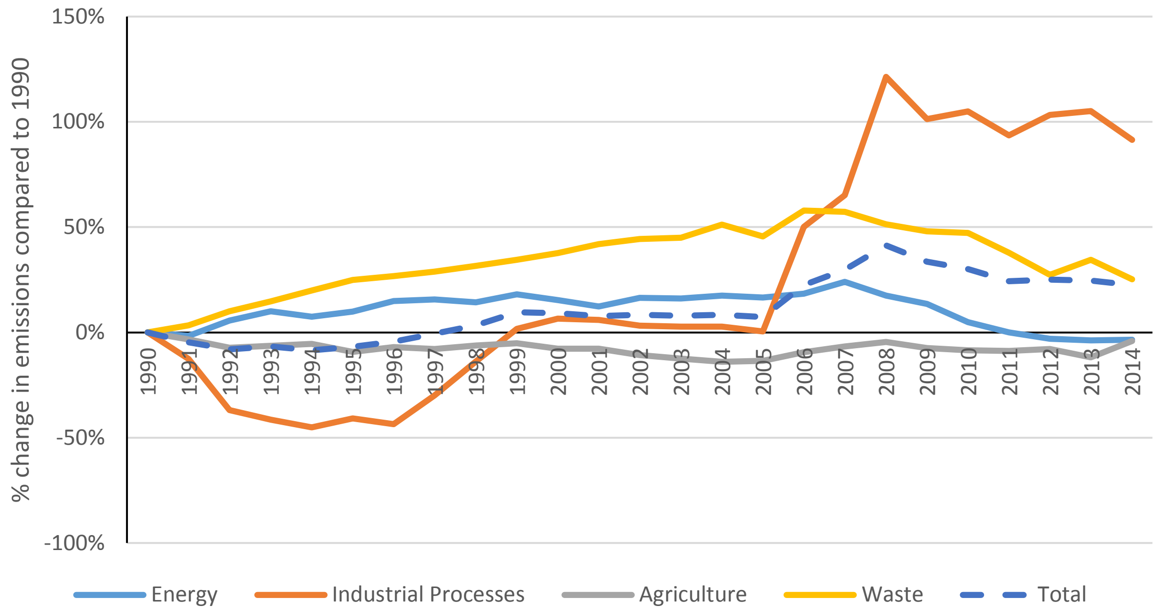

Figure 2.15 Percentage changes in total GHG emissions by UNFCCC source categories 1990-2014, compared to 1990 levels.

2.9.1 Energy

The Energy sector in Iceland is unique in many ways. Iceland ranks 1st among OECD countries in the per capita consumption of primary energy and in 2013 the consumption per capita was about 796 GJ. However, the proportion of domestic renewable energy in the total energy budget is 85%, 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, key export industries such as fisheries and metal production are energy-intensive. The metal industry used around 75% of the total electricity produced in Iceland in 2014. Iceland relies heavily on its geothermal energy sources for space heating (over 90% of all homes) and electricity production (30% of the electricity) and on hydropower for electricity production (70% of the electricity).

The development of the energy sources in Iceland can be divided into three phases. The first phase covered the electrification of the country and harnessing the most accessible geothermal fields, mainly for space heating. In the second phase, steps were taken to harness the resources for power-intensive industry. This began in 1966 with agreements on the building of an aluminium plant, and in 1979 a ferrosilicon plant began production. In the third phase, following the oil crisis of 1973-1974, efforts were made to use domestic sources of energy to replace oil, particularly for space heating and fishmeal production. Oil has almost disappeared as a source of energy for space heating in Iceland, and domestic energy has replaced oil in industry and in other fields where such replacement is feasible and economically viable.

2.9.1.1 Fuel Combustion

The total emissions of greenhouse gases from fuel combustion in the Energy sector over the period 1990 to 2014 are listed in Table 2.8. Emissions from fuel combustion in the Energy sector accounted for 32% of the total greenhouse gas emissions in Iceland in 2014.

Table 2.8 shows the distribution of emissions in 2014 by different source categories. The percentage change in the various source categories in the Energy sector between 1990 and 2014, compared with 1990, is illustrated in Figure 2.16.

Table 2.8. Total emissions of GHG from the fuel combustion in the Energy sector in 1990-2014(CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Energy industries	14	20	9	11	7	3	3
Manufacturing industry and construction	250	226	248	217	104	80	40
Transport	619	624	662	836	890	859	861
Road	527	557	622	787	833	824	800
Other	92	67	40	48	56	35	61
Other sectors	840	970	971	888	668	587	604
Fishing	659	776	723	629	538	478	443
Residential/ commercial	47	28	29	19	16	10	18
Total	1723	1840	1890	1953	1669	1529	1508

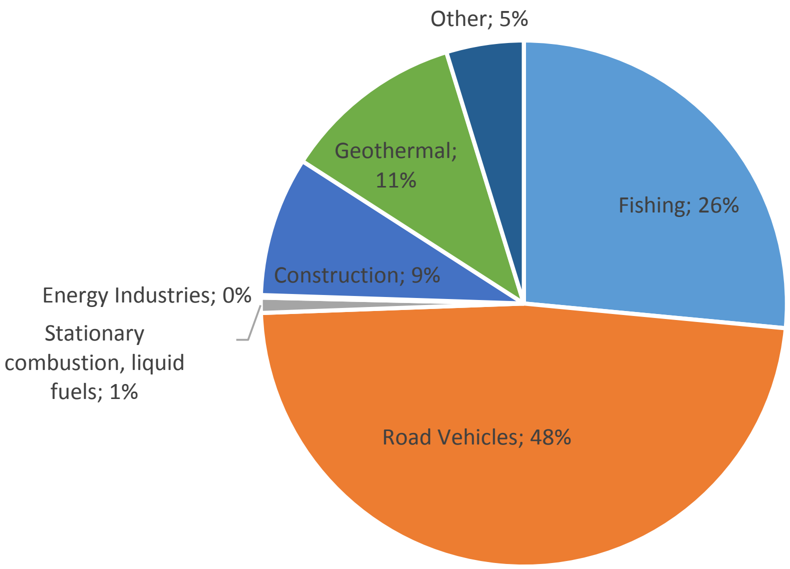

Figure 2.16 Greenhouse gas emissions in the Energy sector 2014, distributed by source categories.

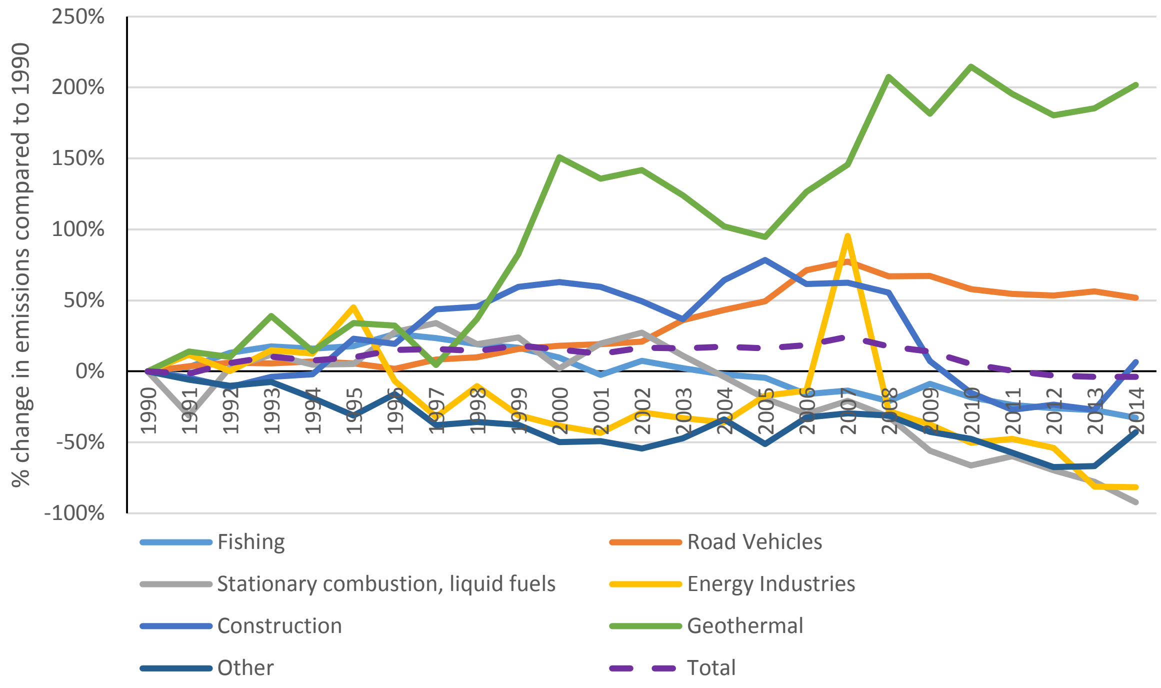

Figure 2.17 Percentage changes in emissions for source categories in the Energy sector during 1990-2014, compared to 1990.

Table 2.8 and Figure 2.17 show that emissions from road vehicles have increased by 52% since 1990 as emissions from fishing have decreased by 33%. Emissions from energy industries are 82% below 1990 levels and emissions from manufacturing industries and construction are 7% below 1990 levels.

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 very low. Since 1997 emissions have been around 40% lower in normal years than in 1990. Emissions from energy industries accounted for 0.2% of the sector's total and 0.1% of the total GHG emissions in Iceland in 2013. Electricity is produced with fuel combustion at 2 locations, which are located far from the distribution system (two islands, Flatey and Grimsey). Some electricity facilities have backup systems using 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 (snow avalanches in the west fjords and icing in the northern part of the country) 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 and industry depending on curtailable energy, leading to increased fuel combustion and emissions. This also has an effect on the implied emission factor (IEF) for energy industries, as waste and residual fuel oil have different emission factors. In years where more oil is used in the sector the IEF is considerably higher than in normal years.

Increased emissions from the manufacturing industries and construction source category over the period 1990 to 2007 are explained by the increased activity in the construction sector during the period. The knock-off effect of the increased levels of economic growth was increased activity in the construction sector. Emissions rose until 2007, where the rise, particularly in the years prior to 2007, was related to the construction of Iceland's largest hydropower plant (Kárahnjúkar, building time from 2002 to 2007). The construction sector collapsed in fall 2008 due to the economic crises and the emissions from the sector decreased by 55% between 2007 and 2011. Emissions from fuel combustion at the cement plant decreased rapidly due to the collapse of the construction sector and in 2011 the plant closed down. The fishmeal industry is the second most important source within manufacturing industries and construction. Emissions from fishmeal production decreased over the period due to replacement of oil with electricity as well as a drop in production.

Emissions from the Transport sector increased by 39% from 1990 to 2014. Emissions from road transport have increased by 52% since 1990, owing to an increase in the number of cars per capita, more mileage driven and until 2007 an increase in larger vehicles. Since 1990 the vehicle fleet in Iceland has increased by 78%. Also, the Icelandic population has grown by 28% from 1990 to 2014. Emissions from road vehicles peaked in 2007 and have decreased by 14% since then. In recent years more fuel economic vehicles have been imported – a turn-over of the trend from the years 2002 to 2007 when larger vehicles were imported. Another factor in reducing fuel consumption is the fact that the mean mileage per vehicle has been in decline from 2010-2014. Emissions from both domestic flights and navigation have declined since 1990 and this decrease in navigation and aviation has compensated for rising emissions in the transport sector to some extent.

The fisheries dominate the Other sector as heating in Iceland relies on renewable energy sources. 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 2014 emissions were 33% below the 1990 level and 5% below the 2013level. Annual changes are inherent to the nature of fisheries.

2.9.1.2 Geothermal Energy

Emissions from geothermal energy utilization accounts for 4% of the total greenhouse gas emissions in Iceland in 2014. Iceland relies heavily on geothermal energy for space heating (over 90% of the homes) and electricity production (27% of the total electricity production). The emissions from geothermal power plants are considerably less, or 19 times lower, than from fossil fuel power plants. Table 2.9 shows the emissions from geothermal energy from 1990 to 2014. Electricity production using geothermal power increased more than 18-fold during this period from 283 to 5,238 GWh. Emissions during the same time increased by 180%. Emissions from geothermal utilization are site and time-specific, and can vary greatly between areas and the wells within an area as well as by the time of extraction.

Table 2.9. Emissions from geothermal energy from 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Geothermal energy	62	83	154	121	195	177	187

2.9.1.3 Distribution of oil products

Emissions from distribution of oil products are a minor source in Iceland. Emissions are around 0.3 to 0.5 kt per year.

2.9.2 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. Emissions also occur as a result of the consumption of HFCs as substitutes for ozone depleting substances and SF_6 from electrical equipment. The Industrial Process sector accounts for 43% of the national greenhouse gas emissions. As can be seen in *Table 2.10* and Figure 2.18 emissions from industrial processes decreased from 1990 to 1996, mainly because of a decrease in PFC emissions. Increased production capacity has led to an increase in industrial process emissions since 1996, especially after 2005 as the production capacity in the aluminium industry has increased. By 2014, emissions from the industrial processes sector were 102% above the 1990 level.

Table 2.10. Emissions from industrial processes 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Mineral products	52	38	65	55	10	1	1
Chemical industry	47	41	18	NO	NO	NO	NO
Metal production	842	466	878	823	1,778	1,767	1,746
- Ferroalloys	208	243	375	375	369	405	367
- Aluminium	634	223	503	448	1,409	1,362	1,379
Aluminium CO_2	139	154	353	417	1,238	1,274	1,280
Aluminium PFC	495	69	150	31	172	88	99
Non-Energy Products from Fuels and Solvent Use	4	5	5	5	4	4	5
Product Uses as Substitutes for Ozone Depleting Substances	0	2	43	69	146	171	164
Other Product Manufacture and Use	7	5	6	6	8	6	5
Total	**948**	**560**	**1,010**	**953**	**1,942**	**1,945**	**1,915**

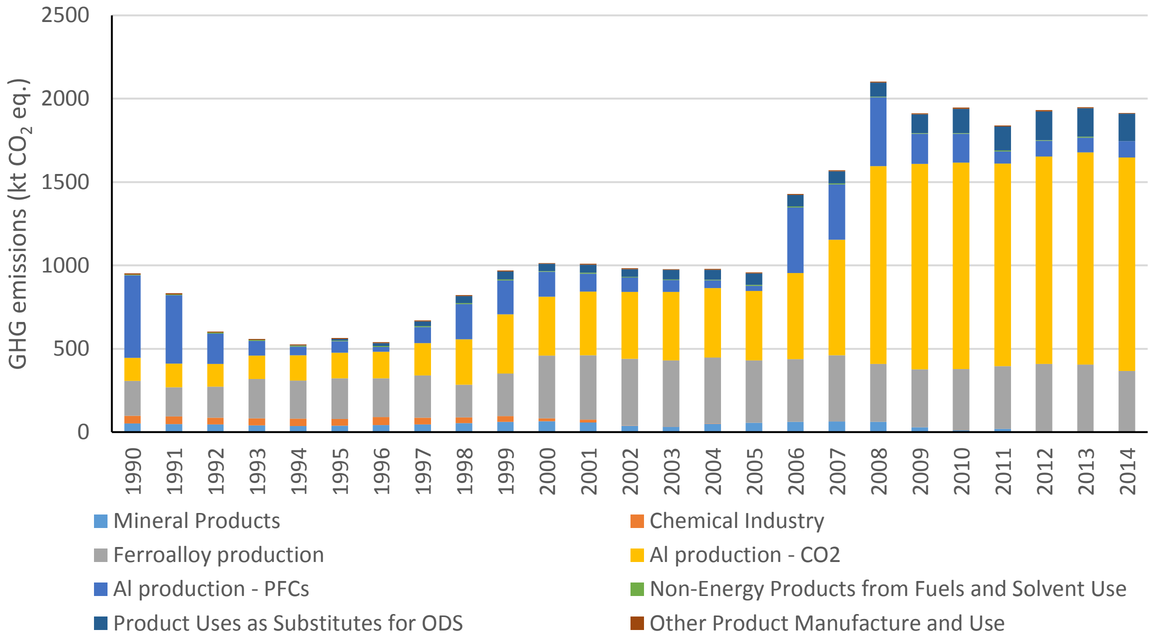

Figure 2.18 Total GHG emissions in the Industrial Process sector during 1990-2014 (kt CO_2-equivalents).

The most significant category within the Industrial Processes sector is metal production, which accounted for 88% of the sector's emissions in 1990 and 92% in 2014. Aluminium production is the main source within the metal production category, accounting for 67% of the total Industrial Processes emissions. Aluminium is produced at three 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 emissions are 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; 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 per tonne of aluminium at the Century Aluminium plant went down from 2007 to 2011 through improved process technology, reaching 0.12 tonnes CO_2-equivalents per tonne aluminium in 2011. The Alcoa Fjarðaál aluminium plant was established in 2007 and reached full production capacity in 2008. PFC emissions per tonne of aluminium are generally high during start up and usually rise during expansion. PFC emission declined in 2009 and 2010 through improved process technology until December 2010 at Alcoa Fjarðaál, when a rectifier was damaged in fire. This led to increased PFC emissions leading to higher emissions at the plant in 2010 than in 2009. In 2011 PFC emissions per tonne of aluminium at the Alcoa Fjarðaál went down to 0.07 tonnes CO_2-equivalents per tonne aluminium before increasing again to 0.2 tonnes CO_2-equivalents per tonne aluminium in 2014.

Production of ferroalloys is another major source of emissions, accounting for 19% of Industrial Processes emissions in 2014. 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 ferrosilican plant, resulting in exceptionally low emissions that year. In 1999, however, the plant was expanded (addition of the third furnace) and emissions have therefore increased considerably, or by 76% since 1990. Emissions in 2014 were 4% higher than in 2013.

Production of minerals accounted for only 0.1% of the emissions in 2011. Cement production was the dominant contributor until 2011 when the sole cement plant shut down. CO_2 derived from carbon in the shell sand used as raw material is the source of CO_2 emissions from cement production. 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 because of increased activity related to the construction of the Kárahnjúkar hydropower plant (built 2002 to 2007) although most of the cement used for the project was imported.

Production of fertilizers, which used to be the main contributor to the process emissions from the chemical industry was closed down in 2001. No chemical industry has been in operation in Iceland after the closure of a silicon production facility in 2004.

Imports of HFCs started in 1993 and have increased steadily since then. HFCs are used as substitutes for ozone depleting substances that are being phased out in accordance with the Montreal Protocol. Refrigeration and air conditioning are the main uses of HFCs in Iceland and the fishing industry plays a preeminent role. HFCs stored in refrigeration units constitute banks of refrigerants which emit HFCs during use due to leakage. The process of retrofitting older refrigeration systems and replacing ODS as refrigerants is still on-going which means that the size of the refrigerant bank is still increasing, causing an accelerated increase of emissions since 2008. The amount of HFCs emitted by mobile air conditioning units in vehicles has also been increasing steadily (Table 2.11).

The sole source of SF_6 emissions is leakage from electrical equipment. Emissions have been increasing since 1990 due to the expansion of the Icelandic electricity distribution (*Table 2.11*). The peak in 2010 was caused by two unrelated accidents during which the SF_6 contained in equipment leaked into the atmosphere. The peak in 2012 was caused by increased emissions from the operator of the Icelandic grid Landsnet LLC.

Table 2.11. HFC and SF_6 emissions from consumption of HFC and SF_6 (kt-CO_2 equivalents).

	1990	1995	2000	2005	2010	2013	2014
HFCs (refrigeration)	0.0	9.5	42.5	69.2	145.7	171.1	164.4
SF6 (electrical equipment)	1.1	1.3	1.4	2.6	4.9	3.2	2.2

2.9.3 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 compounds are oxidized to CO_2 in the atmosphere over time. Also included in this sector are emissions of N_2O from product uses and emissions of CO_2 from paraffin wax use. N_2O is used mainly for medical purposes. To a smaller extent it is also used in car racing and fire extinguishing.

Total NMVOC emissions from solvent and other product use amounted to 4.4 kt CO_2-equivalents in 2014 (less than 0.1% of total GHG emissions), which was 1% below the 1990 level and the same as 2013. This development was mainly due to a decrease in paint application. Emissions from N_2O use decreased by 55% between 1990 and 2014 due to decreasing imports for medical purposes (anaesthesia).

2.9.4 Agriculture

Emissions from agriculture are closely coupled with livestock population sizes, especially cattle and sheep. Since emission factors were assumed to be stable during the last two decades (with the exception of gross energy intake of dairy cows, whose increase reflects an increase in milk production), changes in activity data translated into proportional emission changes. The only other factor that had considerable impact on emission estimates was the amount of nitrogen in fertilizer applied annually to agricultural soils. A 17% decrease in livestock population size of sheep between 1990 and 2005 – partly counteracted by increases of livestock population sizes of horses, swine, and poultry - led to emission decreases from all subcategories and resulted in a 13% decrease of total agriculture emissions during the same period (Table 2.12 and Figure 2.19)

Since 2005 emissions from agriculture have increased by 7% due to an increase in livestock population size but still remain 4% below 1990 levels. This general trend is modified by the amount of synthetic nitrogen applied annually to agricultural soils. The amount was highest in 2008, when it amounted to more than 15,300 tonnes, but has decreased to less than 15,300 tonnes in 2014. This development was due to the economic crisis in Iceland which was accompanied by a weakening of the Icelandic króna thus increasing the price of imported fertilizer. The largest sources of agricultural greenhouse gas emissions in 2014 were nitrous oxide emissions from agricultural soils: direct soil N_2O emissions, indirect soils N_2O emissions, and N_2O emissions from pasture and range manure accounted for 49% of total agriculture emissions (Figure 2.19). The remaining 51% were made up of methane emissions from enteric fermentation and methane and nitrous oxide emissions from manure management (i.e. before the manure is applied to soils).

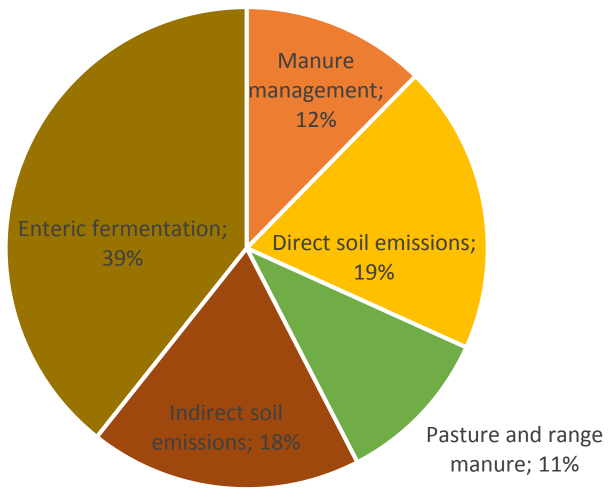

Figure 2.19 GHG emissions from the agriculture sector 2014, distributed by source categories.

Table 2.12. Total GHG emissions from agriculture in 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Manure management	101	87	89	86	91	88	92
Direct soil emissions	143	130	138	120	126	129	145
Pasture and range manure	86	79	79	78	81	74	80
Indirect soil emissions	136	122	129	115	122	121	136
Enteric fermentation	314	290	285	276	293	276	294
Total emissions	**780**	**708**	**719**	**674**	**713**	**688**	**747**

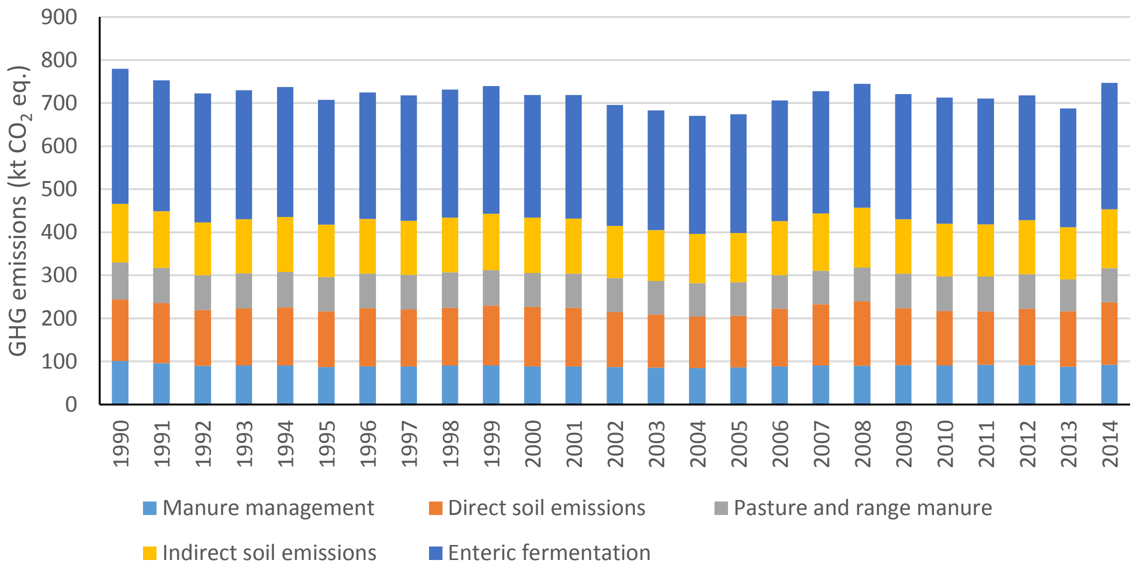

Figure 2.20 Total GHG emissions from agriculture 1990-2014, (kt CO_2-equivalents).

2.9.5 Land Use, Land-Use Change and Forestry (LULUCF)

Net emissions from the LULUCF sector in Iceland are high; the sector had the highest net emission 1990-2014. A large part of the absolute value of emissions from the sector in 2014 was from cropland and grassland on drained organic soil. The emissions can be attributed to drainage of wetlands in the latter half of the 20th century, which had largely ceased by 1990. Emissions of CO_2 from drained wetlands continue for a long time after drainage.

Net emissions (emissions – removals) in the sector have decreased over the time period, as can be seen in *Table 2.13*. This is explained by increased removals through afforestation and revegetation as well as a decrease in emissions from land converted to cropland. Increased removals in afforestation and revegetation are explained by the increased activity in those categories and changes in forest growth with stand age.

Table 2.13. GHG emissions from the LULUCF sector from 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Forest Land	-44	-66	-100	-150	-203	-249	-271
Cropland	2,014	1,963	1,912	1,859	1,804	1,772	1,761
Grassland	8,388	8,428	8,614	8,842	9,207	9,335	9,369
Wetlands	1,125	1,129	1,109	1,082	1,043	1,030	1,027
Settlements	13	6	15	20	5	5	5
Harvested Wood Products	NE	NE	NE	NE	NE	NE	NE
Net emissions LULUCF	11,496	11,460	11,549	11,652	11,857	11,891	11,890

Analyses of trends in emissions of the LULUCF sector must be interpreted with care as some potential sinks and sources are not included. Uncertainty estimates for reported emissions are considerable and observed changes in reported emissions therefore not necessarily significantly different from zero.

2.9.6 Waste

Emissions from the Waste sector accounted for 5.5% of total GHG emissions in 2014. About 91% of these emissions were methane emissions from solid waste disposal on land. 4.4% were CH_4 and N_2O emissions from wastewater treatment and 3.1% were CO_2, CH_4 and N_2O emissions from waste incineration. The remaining 1.5% originated from biological treatment of waste, i.e. composting. Emissions from the waste sector increased steadily from 1990 to 2007 due to an increase in emissions from solid waste disposal on land (SWD) (*Table 2.14* and Figure 2.21). This increase was caused by the accumulation of degradable organic carbon in recently established managed, anaerobic solid waste disposal sites which are characterised by higher methane production potential than the unmanaged SWDS they succeeded. The decrease in emissions from the waste sector since 2007 is caused by a decrease in SWD emissions which is due to a rapidly decreasing share of waste landfilled since 2005 and by an increase in methane recovery at SWDS. The total increase of SWD emissions between 1990 and 2014 amounted to 45%.

Table 2.14. Total emissions from the Waste sector from 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Solid waste disposal	142	188	214	225	225	209	232
Wastewater	7	8	9	12	11	11	11
Incineration	19	13	7	5	7	8	8
Composting	NO	0	0	1	3	3	4
Total emissions	**168**	**209**	**230**	**243**	**246**	**229**	**255**

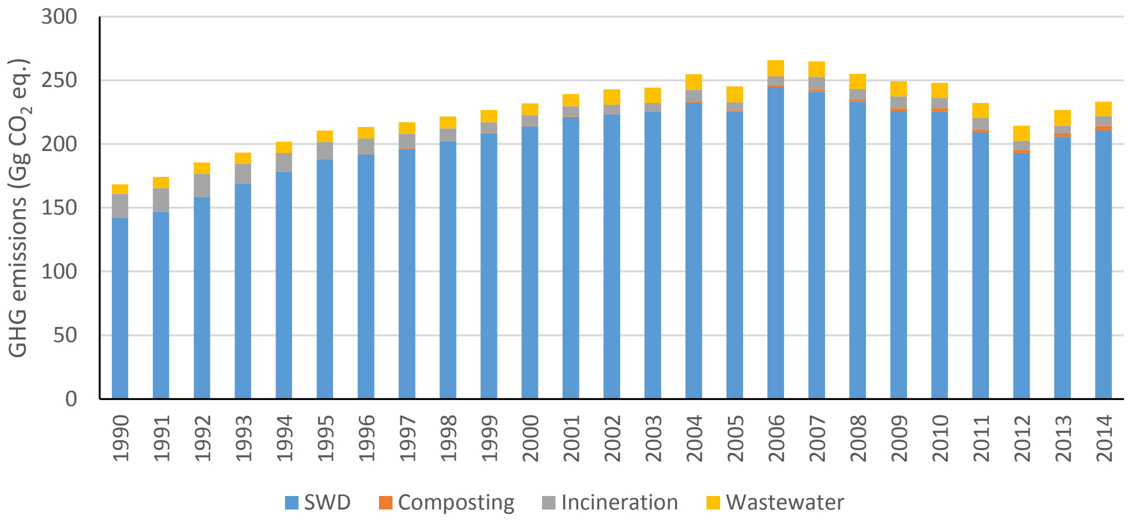

Figure 2.21 Aggregated GHG emissions of the Waste sector 1990-2014 (kt CO_2-equivalents).

Total wastewater handling emissions increased by 63% since 1990 due to increasing N_2O and CH_4 emissions. The increase in N_2O emission estimates is proportional to an increase in population. The increase in methane emissions is mainly due to an increase in the share of wastewater treated in septic systems. All other wastewater discharge pathways were assumed to emit no methane since the wastewater is either treated aerobically or discharged into fast running rivers or straight into the sea.

Emissions from waste incineration decreased by 58% between 1990 and 2014 due to a decrease in the amount of waste incinerated and a change in waste incineration technology. During the early 1990s waste was either burned in open pits or in waste incinerators at low or varying temperatures. Since the mid-1990s increasing amounts of waste are incinerated in proper waste incinerators that control combustion temperatures which lead to lower emissions of CO_2, CH_4 and N_2O per waste amount incinerated (Figure 2.22).

The CO_2 emission factor for waste incineration is slightly higher than for open burning of waste (oxidisation factor of 1 vs. 0.58), but the CH_4 emission factor for open burning of waste is, however, 27 times higher and the N_2O emission factor 2.5 times higher than the one for waste incineration.

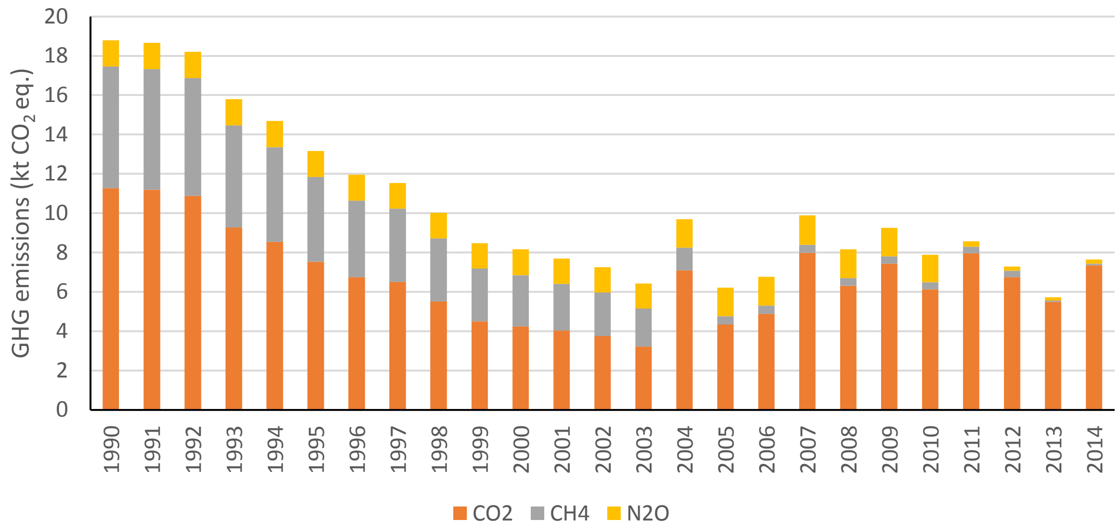

Figure 2.22 Emissions from incineration and open burning of waste 1990-2014 (kt CO_2-equivalents).

Emissions from composting have been steadily increasing from 1995 when composting started. Between 1995 and 2014 composting emissions increased tenfold due to increasing amounts of waste composted.

2.9.7 International Bunkers

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 information purposes and can be seen in Table 2.15.

In 2014, greenhouse gas emissions from ships and aircrafts in international traffic bunkered in Iceland amounted to a total of 788 kt CO_2-equivalents, which corresponds to about 17% of the total Icelandic greenhouse gas emissions. Greenhouse gas emissions from marine and aviation bunkers increased by 147% from 1990 to 2014; with an 11% increase between 2013 and 2014.

Looking at these two categories separately, it can be seen that greenhouse gas emissions from international marine bunkers increased by 131% from 1990 to 2014, while emissions from aircrafts increased by 155% during the same period. Between 2013 and 2014 emissions from marine bunkers decreased by 9% while emissions from aviation bunkers increased by 12%. Emissions from international bunkers are rising again after decline since 2007. Foreign commercial fishing vessels dominate the fuel consumption from marine bunkers.

Table 2.15. GHG emissions from international aviation and marine bunkers 1990-2014 (kt CO_2-equivalents).

	1990	1995	2000	2005	2010	2013	2014
Aviation	219	236	407	421	376	498	559
Marine	99	143	218	111	182	210	229
Total	**318**	**379**	**624**	**531**	**559**	**707**	**788**

2.10 Emission Trends for Indirect Greenhouse Gases and SO_2

Nitrogen oxides (NO_x), 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.

2.10.1 Nitrogen Oxides (NOx)

The main sources of nitrogen oxides in Iceland are commercial fishing, transport, and the manufacturing industry and construction, as can be seen in Figure 2.23. The NO_x emissions from commercial fishing rose from 1990 to 1996 when a substantial portion of the commercial fishing fleet was operating in distant fishing grounds. From 1996 emissions decreased, reaching the 1990 levels in 2001. Emissions rose again in 2002 but have declined since with exception of 2009 due to less fuel consumption. Emissions in 2014 were 33% 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 (by 23%) after the use of catalytic converters in all new vehicles became obligatory in 1995, despite the fact that fuel consumption has increased by 48%. The rise in emissions from the manufacturing industries and construction until 2007 are dominated by increased activity in the construction sector during the period. In 2008 the construction sector collapsed leading to much lower emissions from the sector. In 2014 emissions from manufacturing industry and construction were 52% lower than in 1990. This is due to the collapse of the construction sector (including lower emissions from the cement plant) and to less fuel consumption at fishmeal plants where fuel has been replaced with electricity and production has decreased. Total NO_x emissions, like the emissions from fishing, increased until 1996 and decreased thereafter until 2001. Emission rose again between 2001 and 2004 and then decreased again. Total NO_x emissions in 2014 were 27% below the 1990 level.

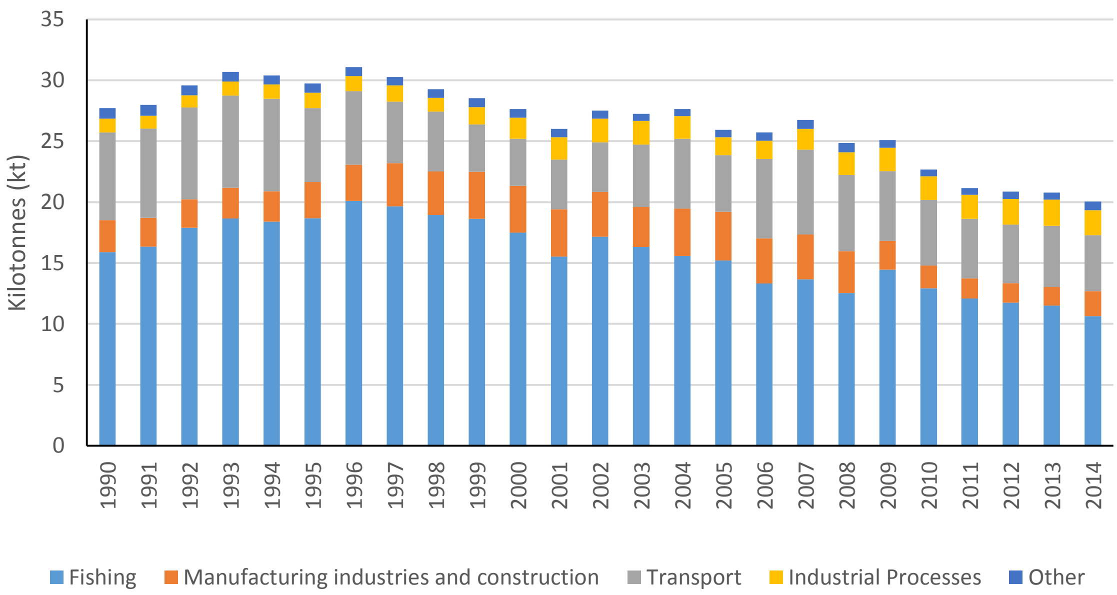

Figure 2.23 Emissions of NO_x by sector 1990-2014 in kt.

2.10.2 Non-Methane Volatile Organic Compounds (NMVOC)

The main sources of non-methane volatile organic compounds are transport and solvent use, as can be seen in Figure 2.24. Emissions from transport are dominated by road transport. These emissions decreased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995. Emissions from solvent use have been around 1 kt and show a downward trend in recent years. Other emissions include emissions from industrial processes, where food and drink production is the most prominent contributor. The total emissions showed a downward trend from 1994 to 2014. The emissions in 2014 were 50% below the 1990 level.

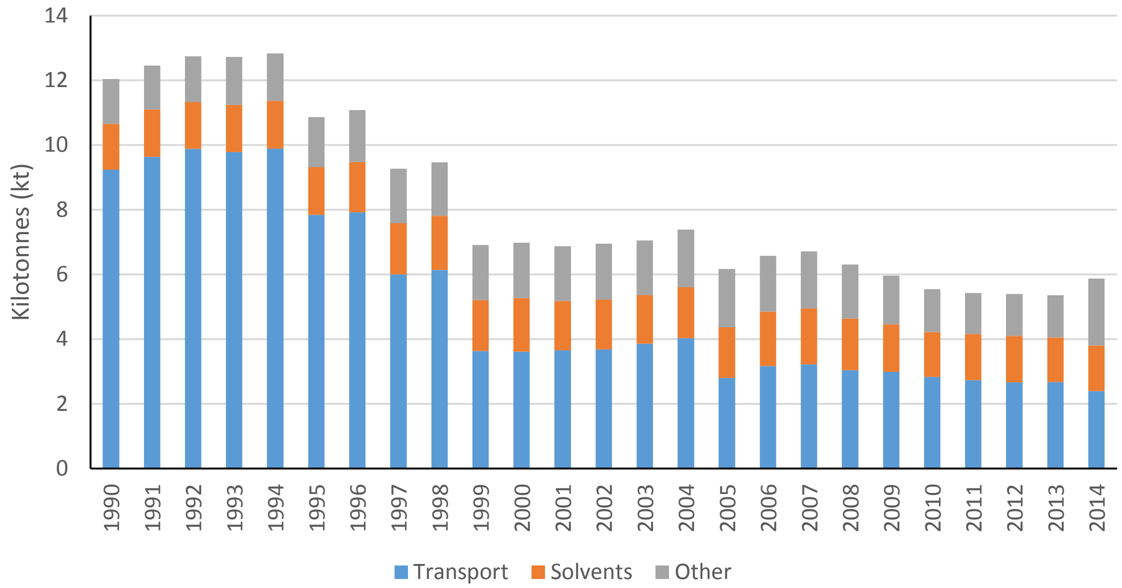

Figure 2.24 Emissions of NMVOC by sector 1990-2014 in kt.

2.10.3 Carbon Monoxide (CO)

Industrial Processes is the most prominent contributor to CO emissions in Iceland, as can be seen in Figure 2.25. , being responsible for over 88% of total CO emissions. It is worth mentioning that emissions from road transport have decreased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995. The emissions in 2014 were 101% above the 1990 level.

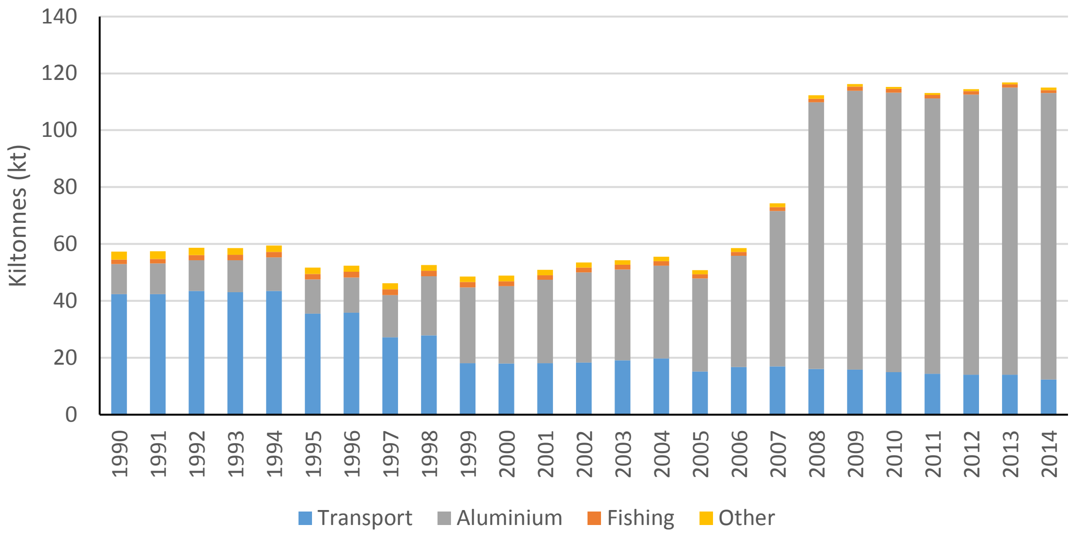

Figure 2.25 Emissions of CO by sector 1990-2014 in kt.

2.10.4 Sulphur Dioxide (SO_2)

Geothermal energy exploitation is by far the largest source of sulphur emissions in Iceland. Sulphur emitted from geothermal power plants is in the form of H_2S. Emissions have increased by 251% since 1990 due to increased activity in this field, as electricity production at geothermal power plants has increased more than 18-fold since 1990. Other significant sources of sulphur dioxide in Iceland are industrial processes, manufacturing industry and construction, as can be seen in Figure 2.26.

Emissions from industrial processes are dominated by metal production. Until 1996 industrial process sulphur dioxide emissions were relatively stable. Since then, the metal industry has expanded. In 1990, 87,839 tonnes of aluminium were produced at one plant and 62,792 tonnes of ferroalloys at one plant. In 2014 839,449 tonnes of aluminium were produced at three plants and 107,785 tonnes of ferroalloys were produced at one plant. This led to increased emissions of sulphur dioxide (400% increase from 1990 levels). 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 from 1990 to 1997 but have declined since as fuel has been replaced with electricity and production has decreased; the emissions were 88% below the 1990 level in 2014.

Sulphur emissions from the fishing fleet depend upon the use of residual fuel oil. When fuel prices rise, the use of residual fuel oil rises and the use of gas oil drops. This leads to higher sulphur emissions as the sulphur content of residual fuel oil is significantly higher than in gas oil. The rising fuel prices since 2008 have led to higher sulphur emissions from the commercial fishing fleet in recent years. Emissions from the fishing fleet in 2014 were 7% below 1990 level although fuel consumption was 28% less.

In 2014 total sulphur emissions in Iceland, calculated as SO_2, were in 210% above the 1990 level, but 142% when excluding emissions from geothermal power plants.

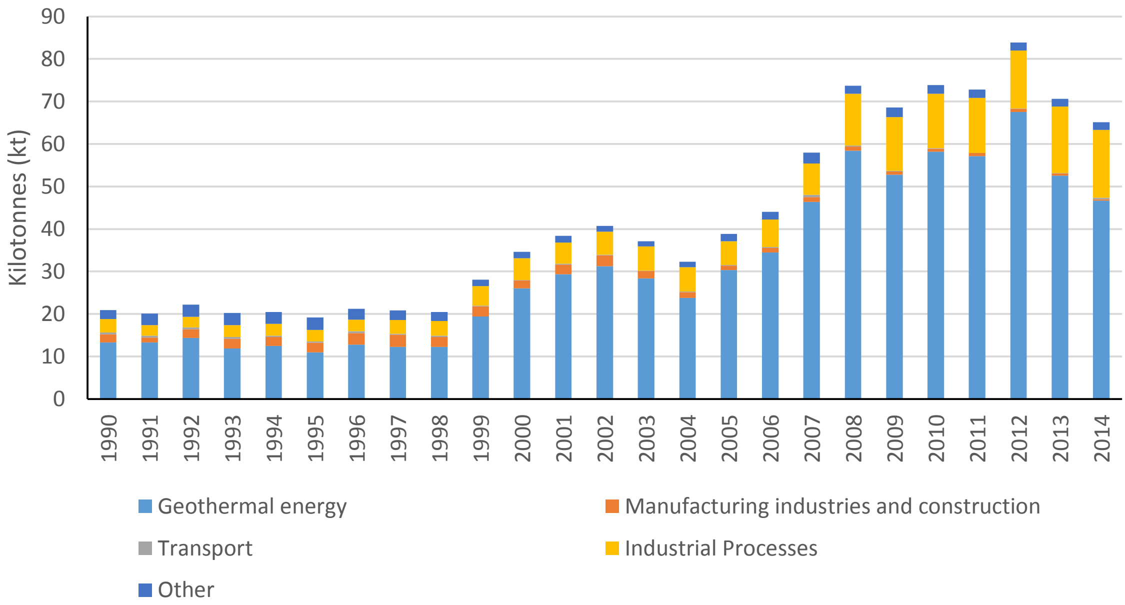

Figure 2.26 Emissions of S (sulphur) by sector 1990-2014 (kt SO_2-equivalents).

In 2010 the volcano Eyjafjallajökull started eruption. The eruption lasted from 14th of April until 23rd of May. During that time 127 kt of SO_2 were emitted or 71% more than total anthropogenic emissions in 2010. In 2011 the volcano Grímsvötn started erupting. The eruption lasted from 21st until 28th of May. During that time around 1000 kt of SO_2 were emitted or 12 times more than total man made emissions in 2011. These emissions are given here for information purposes and are not included in the inventory.

3 Energy (CRF sector 1)

3.1 Overview

The Energy sector in Iceland is unique in many ways. Iceland ranks the 1st among OECD countries in the consumption of primary energy per capita. The per capita consumption in 2014 was around 796 GJ. However, the proportion of domestic renewable energy in the total energy budget is about 85%, 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, key export industries such as fisheries and metal production are energy-intensive. The metal production industry used around 75% of the total electricity produced in Iceland in 2014. Iceland relies heavily on its geothermal energy sources for space heating (over 90% of all homes) and electricity production (30% of the electricity) and on hydropower for electricity production (70% of the electricity). Only 0.01% of the electricity in 2014 was produced with fossil fuels.

The Energy sector accounts for 36.0% (fuel combustion 32%, geothermal energy 4%, fugitive emissions from fuels 0%) of the GHG emissions in Iceland. Total energy related emissions decreased by 7% from 1990 to 2014. Emissions from fuel combustion decreased by 14% from 1990 to 2014 while emissions from geothermal energy increased by 196.7%. From 2013 to 2014 the emissions from fuel combustion decreased by 1.5%, while emissions from geothermal energy increased by 5%. Total emissions related to energy decreased by 0.8% from 2013 to 2014. Fisheries and road traffic are the sector’s largest single contributors. Combustion in manufacturing industries and construction is also an important source. No recalculations have been made in the Energy sector since last submission.

3.1.1 Methodology

Emissions from fuel combustion activities are estimated at the sector level based on methodologies suggested by the 2006 IPCC Guidelines. 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. The division of fuel sales by sector does not reflect the 2006 IPCC sectors perfectly so EA has made adjustments to the data where needed to better reflect the IPCC categories. This applies for the sectors 1A1a Energy industries, 1A2 Manufacturing industry (stationary combustion) and 1A4 Residential. Tables explaining this adjustment are in Annex III. The first table in Annex III is named “Fuel sales (gas oil and residual fuel oil) by sectors 1A1a, 1A2 (stationary) and 1A4 (stationary) – as provided by the National Energy Authority”. This table contains the original values. The adjustment is done in the following way for gasoil: First fuel consumption needed for the known electricity production with fuels is calculated (1A1a – electricity production), assuming 34% efficiency of the diesel engines. The values calculated are compared with the fuel sales for the category 10X60 Energy industries (nomenclature from the NEA).

- In years where there is less fuel sale to energy industries, according to the sales statistics (1,423 tonnes in 2014), as would be needed for the electricity production (603 tonnes in 2014), the fuel needed to compensate is taken from the category 10X90 Other; and if that is not sufficient from the category 10X40 House heating and swimming pools.
- In years where there is surplus, the extra fuel is added to the category 10X40 House heating and swimming pools. In 2014 there was a surplus in the energy industries category, so 820

tonnes were added to the category 10X40 House heating and swimming pools. So now the category 10X40 has 3929 tonnes in 2014 (3109+820).

- NEA has estimated that the fuel use by swimming pools (1A4a), but it should be noted that the majority of swimming pools in Iceland have geothermal water. The estimated fuel use values are given in the lower table of Annex III. It is 300 tonnes in 2014. These values are subtracted from the adjusted 10X40 category, leaving 3,629 tonnes in the category in 2014 (3,929-300). This rest is then 1A4c – Residential.
- For years where there is still fuel in the category 10X90 Other (214 tonnes were left in that category in 2014), this is added to the 10X5X Industry (originally with 4357 tonnes in 2014). This is the fuel use in 1A2 – Industry (4357+214=4571 tonnes in 2014).

Explanation for the adjustment for residual fuel oil is given in Annex III.

Fuel combustion activities are divided into two main categories; stationary and mobile combustion. Stationary combustion includes Energy Industries, Manufacturing Industries and a part of 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.

3.1.2 Key Source Analysis

The key source analysis performed for 2014 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:

Table 3.1 Key Categories for Energy 1990, 2014 and trend (excluding LULUCF).

IPCC source category			Level 1990	Level 2014	Trend
Energy (CRF sector 1)					
1.A.2	Fuel combustion - Manufacturing Industries and	CO_2	✓		✓
1.A.2	Fuel combustion - Manufacturing Industries and	CO_2	✓		✓
1.A.3.b	Road Transportation	CO_2	✓	✓	✓
1.A.3.d	Domestic Navigation - Liquid Fuels	CO_2	✓		
1.A.4	Other Sectors - Liquid Fuels	CO_2	✓	✓	✓
1.B.2.d	Fugitive Emissions from Fuels - Other	CO_2	✓	✓	✓

3.1.3 Completeness

Table 3.2 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 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**	**NO_x**	**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	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	E	E	NA	NA	NA	NA	NA	NA	E	NA
- 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, estimating uncertainties, archiving information and reporting, as further elaborated in the QA/QC manual. No source specific QA/QC procedures have yet been developed for the Energy sector.

3.2 Fuel Combustion (CRF sector 1A)

3.2.1 Energy Industries (CRF 1A1)

Iceland has extensively utilised renewable energy sources for electricity and heat production, thus emissions from this sector is low. Emissions from electricity and heat production accounted for 0.15% of the energy industry total and 0.05% of the total GHG emissions in Iceland in 2014.

Activity data for the electricity and heat production are based on data provided by the NEA and adjusted by EA, see Annex III. The CO_2 emission factors reflect the average carbon content of fossil fuels. They are taken from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and presented in Table 3.5along with sulphur content of the fuels. Emissions of SO_2 are calculated from the S-content of the fuels. Emission factors for other pollutants are taken from the 2006 IPCC Guidelines. The EF for CH_4 is based on the one for large diesel fuel engines (4 kg/TJ). Default emission factors (EFs) were used where EFs are missing. It has to be noted that only 0.01% of the electricity in Iceland is produced with fuel combustion and less than 5% of buildings in Iceland are heated with fossil fuels. The CO_2 emission factor for waste incineration was calculated using Tier 2 methodology and default values from the 2006 Guideline. The IEF for energy industries is affected by the different consumption of waste and fossil fuels, as waste, gasoil and residual fuel oil have different EF. In years where more oil is used the IEF is considerably higher than in normal years.

3.2.2 Main Activity Electricity and Heat Production (CRF 1A1a)

3.2.2.1 Electricity Generation

Electricity was produced from hydropower, geothermal energy, fuel combustion and wind power in 2014 (Table 3.3) with hydropower as the main source of electricity (Orkustofnun, 2014). Emissions from hydropower reservoirs are included in the LULUCF sector and emissions from geothermal power plants are reported in sector 1B3. Electricity was produced with fuel combustion at two places that are located far from the distribution network (two islands, Grimsey and Flatey). Some public electricity facilities have emergency backup fuel combustion power plants which they can use when problems occur in the distribution system. Those plants are however very seldom used, apart from testing and during maintenance. In 2013 the first wind turbines were connected and used for public electricity production. In 2014 there were two (900kW capacity) wind turbines, both owned by Landsvirkjun and stationed within the construction area of Búrfell Power Station in the south of Iceland.

Table 3.3 Electricity production in Iceland (GWh).

	1990	1995	2000	2005	2010	2013	2014
Hydropower	4,159	4,678	6,352	7,014	12,592	12,863	12,873
Geothermal	283	288	1,323	1,658	4,465	5,245	5,238
Fuel combustion	5.6	8.4	4.4	7.8	1.7	2.8	2.4
Wind power	NO	NO	NO	NO	NO	5.5	8.1
Total	**4,447**	**4,977**	**7,679**	**8,680**	**17,059**	**18,116**	**18,120**

Activity Data

Activity data for electricity production is calculated from the information on electricity production, from the energy content of the gasoil (43.00 TJ/kt) assuming 34% efficiency. In 2014 only 0.01% of the electricity in Iceland is produced with fuel combustion. Activity data for fuel combustion and the resulting emissions are given in Table 3.4.

Table 3.4 Fuel use (kt) and result in emissions (GHG total in kt CO_2-eq.) from electricity production.

	1990	1995	2000	2005	2010	2013	2014
Gas/Diesel oil (kt)	1.4	2.1	1.1	2.0	0.4	0.7	0.6
Emissions (kt)	**4.5**	**6.8**	**3.6**	**6.3**	**1.4**	**2.2**	**1.9**

Emission Factor

The CO_2 emission factors (EF) used reflect the average carbon content of fossil fuels. They are taken from the revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories and the Good Practice Guidance. They are presented in Table 3.5along with sulphur content of the fuels.

Table 3.5 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 [%]
Gas/Diesel oil	43.00	20.20	0.98	3.18	0.2

The resulting greenhouse gas emissions from electricity produced from fuels in CO_2 equivalent per kWh amount to 790 g of CO_2 per kWh.

Emissions from hydropower reservoirs amounted to 20.4 kt of CO_2-equivalents and emissions from geothermal power plants to 186 kt of CO_2-equivalents, in 2014. The resulting emissions of GHG per kWh amount to 1.6 g CO_2-equivalents/kWh for hydropower plants and to 35.5 g CO_2-equivalents/kWh for geothermal energy. The weighted average GHG emissions from electricity production in Iceland in 2014 were thus 11.8 g/kWh.

Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from electricity production with fuels is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%), the uncertainty of CH_4 emissions is 100% (with an activity data uncertainty of 5% and emission factor uncertainty of 100%), and for N_2O emissions it is 150% (with an activity data uncertainty of 5% and emission factor uncertainty of 150%). This can be seen in the quantitative uncertainty table in Annex II.

3.2.2.2 Heat Plants

Geothermal energy was the main source of heat production in 2014. 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 burned waste to produce heat and were connected to the local distribution system. They stopped production in 2012. Emissions from these waste incineration plants are reported here.

Activity Data

Activity data for heat production with fuel combustion and waste incineration and the resulting emissions are given in Table 3.6. No fuel consumption for heat production was reported by the NEA for 2010. According to Annex II in the waste framework Directive 2008/98/EC incineration facilities dedicated to the processing of municipal solid waste need to have their energy efficiency equal or above 60%-65% in order to qualify as recovery operations. Since 2013 there has been only one incineration facility, Kalka, in Iceland and it does not qualify as a recovery operation. For the years 2013 and 2014 no solid waste was used for the production of heat.

Table 3.6 Fuel use (kt) and resulting emissions (GHG total in kt. CO_2-eq.) from heat production.

	1990	1995	2000	2005	2007	2008	2009	2010	2013	2014
Residual fuel oil	3.0	3.1	0.1	0.2	4.5	0.1	0.1	-	0.1	0.2
Gas/Diesel oil	-	-	-	-	-	-	-	-	-	-
Solid waste	-	4.7	6.1	5.4	12.0	10.3	9.5	8.2	-	-
Emissions (GHG)	**9.2**	**12.3**	**3.8**	**3.1**	**21.3**	**6.0**	**6.7**	**5.5**	**0.4**	**0.6**

Emission Factors

Fuel combustion used for CO_2 emission factors (EF) reflects the average carbon content of fossil fuels. They are taken from the revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories and the Good Practice Guidance. They are presented in Table 3.7 along with the sulphur content of the fuels. The CO_2 emission factor for waste incineration was calculated using Tier 2 methodology and default values from the 2006 GL. Therefore the waste amounts incinerated are dissected into eleven categories. The dry matter content, total, and fossil carbon fractions are calculated separately for each waste category and then added up. In the years that have higher fractions of fossil carbon containing waste categories such as plastics the EF is higher than in other years since the EF is related to the total amount of waste incinerated. CO_2 EF varied between 0.44 and 0.78 t CO_2 per tonne waste (cf. chapter 7.4.3).

Table 3.7 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 [%]
Residual fuel oil	40.4	21.10	0.99	3.13	1.8
Gas/Diesel oil	43.00	20.20	0.99	3.18	0.2
Solid waste	10.70	14.53	1	0.60[1]	0.17

[1] *mean value. Annual values vary between 0.44 and 0.78 t CO_2/t waste depending on fossil carbon content of waste incinerated*

Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from heat production with fuels is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%), the uncertainty of CH_4 emissions is 100% (with an activity data uncertainty of 5% and emission factor uncertainty of 100%), and for N_2O emissions it is 150% (with an activity data uncertainty of 5% and emission factor uncertainty of 150%). This can be seen in the quantitative uncertainty table in Annex II.

3.3 Manufacturing Industries and Construction (CRF 1A1a)

Emissions from the Manufacturing Industries and Construction account for 10.68% of the Energy sector's total and 3.50% of total GHG emissions in Iceland in 2014. Mobile Combustion in the Construction sector accounts for 79.5% of the total emissions from Manufacturing Industries and the Construction sector.

3.3.1 Manufacturing Industries, Stationary Combustion

3.3.1.1 Activity Data

Information about the total amount of fuel used by the manufacturing industries was obtained from the National Energy Authority and adjusted by EA (see Annex III). The sales statistics for the manufacturing industry (as adjusted by EA) are given for the sector as a total. There is thus a given total, which the usage in the different subcategories must sum up to. The sales statistics do not specify the fuel consumption by the different industrial sources. This division is made by EA on basis of the reported fuel use by all major industrial plants falling under Act 70/2012 (metal production, cement) and from green accounts submitted by the industry in accordance with regulation no. 851/2002. All major industries, falling under Act 70/2012 report their fuel use to the EA along with other relevant information for industrial processes. Fuel consumption in the fishmeal industry from 1990 to 2002 was estimated from production statistics, but the numbers for 2003 to 2014 are based on data provided by the industry (application for free allowances under the EU ETS for the years 2005 to 2010, information from the Icelandic Association of Fishmeal Manufacturers for 2003, 2004, 2011 and 2012 and from EU ETS annual reporting for 2013 and 2014). The difference between the given total for the sector and the sum of the fuel use of the reporting industrial facilities are categorized as 1A2f other non-specified industry. Emissions are calculated by multiplying energy use with a pollutant specific emission factor (Table 3.8 and Table 3.9). Emissions from fuel use in the ferroalloys production is reported under 1A2a, Iron and Steel.

Table 3.8 Fuel use (kt) and emissions (GHG total in kt.CO_2-eq.) from stationary combustion in the manufacturing industry.

	1990	1995	2000	2005	2010	2013	2014
Gas/Diesel oil	5.1	1.1	10.3	22.2	9.4	7.6	4.6
Residual fuel oil	55.9	56.2	46.2	25.0	16.5	13.8	3.8
LPG	0.5	0.4	0.9	0.9	1.0	1.3	1.2
Electrodes (residue)	0.8	0.3	1.5	-	0.4	-	-
Steam Coal	18.6	8.6	13.3	9.9	3.6	-	-
Petroleum coke	-	-	-	8.1	-	-	-
Waste oil	-	5.0	6.0	1.8	1.4	2.1	0.9
Total Emissions	**241**	**210**	**228**	**205**	**97**	**80**	**40**

3.3.1.2 Emission Factors

The CO_2 emission factors (EF) used reflect the average carbon content of fossil fuels. They are, with the exception of NCV for steam coal, which was obtained from the cement industry which uses the coal, taken from the 2006 IPCC Guideline. They are presented in Table 3.9 along with Sulphur content of the fuels.

Table 3.9 CO_2 emission factors from fuel combustion and S-content of fuel (IE: Included Elsewhere).

	NCV [TJ/kt]	Carbon Content [t C/TJ]	Fraction oxidised	CO_2 EF [t CO_2/t fuel]	S-content [%]
Kerosene (heating and aviation)	44.1	19.5	0.99	3.15	0.2
Gasoline	44.3	18.9	0.99	3.07	0.035
Gas/Diesel oil	43.0	20.2	0.99	3.18	0.2
Residual fuel oil	40.4	21.1	0.99	3.13	1.8
Petroleum coke	32.5	26.6	0.99	3.17	IE[1]
LPG	47.3	17.2	0.99	2.98	0.05
Waste oil	40.2	20.0	0.99	2.95	NE
Electrodes (residue)	31.35	31.42	0.98	3.61	1.55
Steam coal	27.6	25.8	0.98	2.61	0.9

1: Sulphur emissions from use of petroleum coke occur in the cement industry. Further waste oil has mainly been used in the cement industry. Emission estimates for SO_2 for the cement industry are based on measurements.

SO_2 emissions are calculated from the S-content of the fuels. Emission factors for CH_4 and N_2O are taken from Table 2.7 and 2.8 of the 2006 IPCC Guideline. Where EFs were not available the default EF from Table 2.3 was used. Table 3.10 gives an overview of the EFs used.

Table 3.10 Emission factors CH_4 and N_2O in the manufacturing industry.

	CH_4 [kg/TJ]	N_2O [kg/TJ]
Gasoil: cement and silicium production	1.0	0.6
Gasoil: other use	3.0	0.6
Residual fuel oil: cement and silicium production	1.0	0.6
Residual fuel oil: fishmeal production, steam boilers	3.0	0.3
Residual fuel oil: fishmeal production, heaters	1.0	0.6
Residual fuel oil: other use	3.0	0.6
Waste oil: fishmeal production	3.0	0.3
Waste oil: cement production	1.0	0.6
LPG	1.0	0.1
Petroleum coke: cement production	1.0	0.6
Petroleum coke, coal, electrodes residues: cement production	1.0	1.5

3.3.1.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from manufacturing industries and constructions is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%), the uncertainty of CH_4 emissions is 100% (with an activity data uncertainty of 5% and emission factor uncertainty of 100%), and for N_2O emissions it is 150% (with an activity data uncertainty of 5% and emission factor uncertainty of 150%). This can be seen in the quantitative uncertainty table in Annex II.

3.3.2 Manufacturing Industries, Mobile Combustion

3.3.2.1 Activity Data

Activity data for mobile combustion in the construction sector is provided by the NEA. Oil, which is reported to fall under vehicle usage, is in some instances actually used for machinery and vice versa as machinery sometimes tanks its fuel at a tank station, (thereby reported as road transport), as well as it happens that fuel sold to contractors, for use on machinery, is used for road transport (but reported under construction). This is, however, very minimal and the deviations is believed to level each other out. Emissions are calculated by multiplying energy use with a pollutant specific emission factor. Activity data for fuel combustion and the resulting emissions are given in Table 3.11.

Table 3.11 Fuel use (kt) and resulting emissions (GHG total in kt. CO_2-eq.) from mobile combustion in the construction industry.

	1990	1995	2000	2005	2010	2013	2014
Gas/Diesel oil	38	47	62	68	32	27.6	40.5
Emissions	**136**	**167**	**222**	**243**	**115**	**97**	**143**

3.3.2.2 Emission Factors

The CO_2 emission factors used reflect the average carbon content of fossil fuels. 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, CH_4 and N_2O are presented in Table 3.12.

Table 3.12 Emission factors for CO_2, CH_4 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]	CH_4 EF [t CH_4/kt fuel]	N_2O EF [t N_2O/kt fuel]
Gas/Diesel Oil	43.00	20.20	0.99	3.18	0.7	1.3

3.3.2.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from manufacturing industries and constructions is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%), the uncertainty of CH_4 emissions is 100% (with an activity data uncertainty of 5% and emission factor uncertainty of 100%), and for N_2O emissions it is 150% (with an activity data uncertainty of 5% and emission factor uncertainty of 150%). This can be seen in the quantitative uncertainty table in Annex II.

3.4 Transport (CRF sector 1A3)

Emissions from Transport accounted for 50.3% of the Energy sector's total and 18.1% of the total GHG emissions in Iceland in 2014. Road Transport accounts for 92.9% of the emissions in the transport sector.

3.4.1 Civil Aviation (CRF 1A3a)

Emissions are calculated by using Tier 1 methodology, thus multiplying energy use with a pollutant specific emission factor.

3.4.1.1 Activity Data

Total use of jet kerosene and gasoline is based on the NEA's annual sales statistics for fossil fuels. Activity data for fuel combustion and the resulting emissions are given in Table 3.13.

Table 3.13 Fuel use (kt) and resulting emissions (GHG total in kt. CO_2-eq.) from domestic aviation.

	1990	1995	2000	2005	2008	2009	2010	2013	2014
Jet kerosene	8.409	8.253	7.728	7.390	7.601	6.271	6.066	5.735	12.300
Gasoline	1.681	1.131	1.102	0.872	0.731	0.649	0.648	0.494	0.500
Emissions	**32**	**30**	**28**	**26**	**26**	**22**	**21**	**20**	**40**

3.4.1.2 Emission Factors

The emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and are presented in Table 3.14. Emissions of SO_2 are calculated from S-content in the fuels.

Table 3.14 Emission factors for CO_2 and other pllutants for aviation.

	NCV [TJ/kt]	C 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	44.1	19.50	0.99	3.15	300	0.5	50	100	2
Gasoline	44.3	19.10	0.99	3.07	300	0.5	50	100	2

3.4.1.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from domestic aviation is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%) and for CH_4 emissions it is 200% (with an activity data uncertainty of 5% and emission factor uncertainty of 200%). This can be seen in the quantitative uncertainty table in Annex II.

3.4.1.4 Planned Improvements

Planned improvements involve moving emission estimates from aviation to the Tier 2 methodology by next submission.

3.4.2 Road Transportation (CRF 1A3b)

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. Iceland has plans of setting up COPERT in order to estimate pollution from road transportation more accurately.

3.4.2.1 Activity Data

Total use of diesel oil and gasoline are based on the NEA's annual sales statistics for fossil fuels (Table 3.15).

Table 3.15 Fuel use (kt) and resulting emissions (GHG total in kt CO_2-eq) from road transport.

	1990	1995	2000	2005	2010	2013	2014
Gasoline	127.812	135.601	142.599	156.730	148.214	134.941	132.046
Diesel oil	36.567	36.862	47.463	83.478	106.433	117.052	112.746
Emissions	**527**	**553**	**610**	**772**	**819**	**811**	**788**

NEA estimates on how the fuel consumption is divided between different vehicles groups, i.e. passenger cars, light duty vehicles and heavy duty vehicles are used for the period 1990 to 2005. From 2006 to 2014 EA estimated how the fuel consumption is divided between the different vehicles groups, using information on the number of vehicles in each group and the driven mileage in each group from the Road Traffic Directorate, using average fuel consumption based on the 1996 IPCC Guidelines regarding average fuel consumption per group. The data for 2006 to 2014 also contains information on motorcycles. The Road Traffic Directorate does not have similar data for previous years. Therefore the time series is not fully consistent as two different methodologies are used.

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. The assumptions are shown in Figure 3.1.

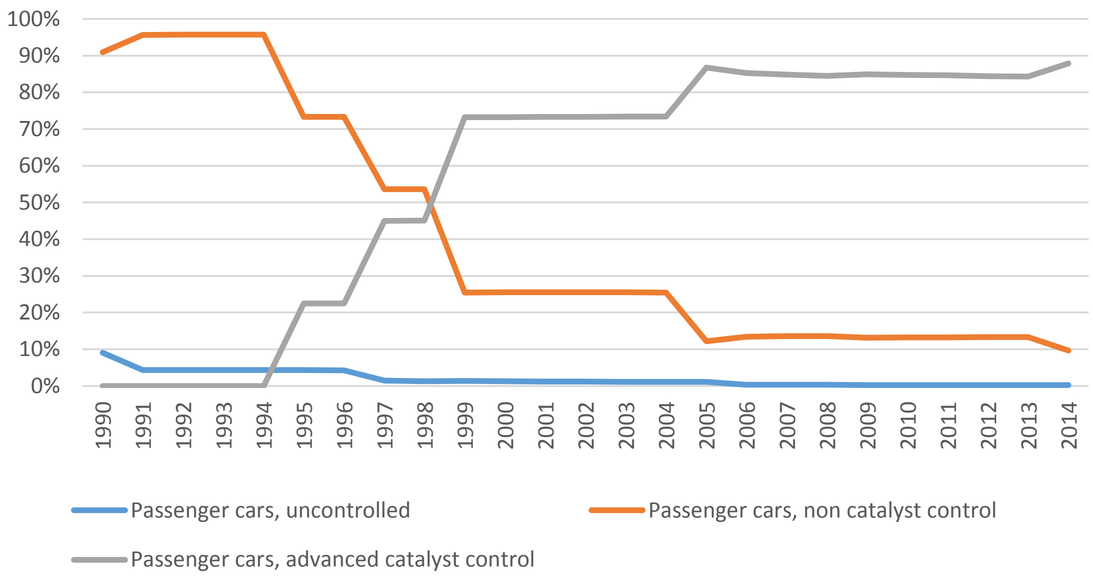

Figure 3.1 Passenger cars by emission control technology.

3.4.2.2 Emission Factors

Emission factors for CO_2, 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 3.16.

Table 3.16 Emission factors for GHG from European vehicles, g/kg fuel.

	CH_4	N_2O	CO_2
Passenger car – gasoline, uncontrolled	1.5	0.1	3,070
Passenger car – gasoline, non catalyst control	1.1	0.4	3,070
Passenger car – gasoline, three way catalyst	1.1	0.4	3,070
Light duty vehicle – gasoline	0.2	0.3	3,070
Heavy duty vehicle – gasoline	0.7	0.04	3,070
Motorcycles - gasoline	5.0	0.07	3,070
Passenger car – diesel	0.2	0.2	3,190
Light duty vehicle – diesel	0.2	0.2	3,190
Heavy duty vehicle – diesel	0.2	0.2	3,190

3.4.2.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from road vehicles is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%). For N_2O, both activity data and emission factors are quite uncertain. The uncertainty of N_2O

emissions from road vehicles is 50% (with an activity data uncertainty of 5% and emission factor uncertainty of 50%) and for CH_4 emissions it is 40% (with an activity data uncertainty of 5% and emission factor uncertainty of 40%). This can be seen in the quantitative uncertainty table in Annex II.

3.4.2.4 Planned Improvements

It is planned to implement COPERT, a software tool used worldwide to calculate air pollutant and greenhouse gas emissions from road transport, in the 2017 submission.

3.4.3 Navigation (shipping) (CRF 1A3d)

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

3.4.3.1 Activity Data

Total use of residual fuel oil and gas/diesel oil for national navigation is based on NEA's annual sales statistics for fossil fuels. Activity data for fuel combustion and the resulting emissions are given in Table 3.17.

Table 3.17 Fuel use (kt) and resulting emissions (GHG total in kt CO_2-equivalents) from national navigation.

	1990	1995	2000	2005	2010	2013	2014
Gas/Diesel oil	11.749	7.043	3.425	6.199	8.464	3.725	4.287
Residual fuel oil	7.170	4.755	0.542	0.881	2.612	1.236	2.137
Emissions	**60**	**37**	**13**	**23**	**35**	**16**	**20**

3.4.3.2 Emission Factors

The emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories for ocean-going ships and are presented in Table 3.18.

Table 3.18. Emission factors for CO_2, CH_4 and N_2O for ocean-going ships.

	NCV [TJ/kt]	C 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	43.00	20.20	0.99	3.18	2	0.086	7	0.30
Residual fuel oil	40.4	21.10	0.99	3.13	2	0.084	7	0.28

3.4.4 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from national navigation is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%). This can be seen in the quantitative uncertainty table in Annex II.

3.4.5 International Bunker Fuels (CRF 1A3di)

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. In Iceland there is one main airport for international flights, Keflavík Airport. Under normal circumstances almost all international flights depart and arrive from Keflavík Airport, except for flights to Greenland, the Faroe Islands, and some flights with private airplanes which depart/arrive from Reykjavík airport. Domestic flights sometimes depart from Keflavík airport in case of special weather conditions. Oil products sold to Keflavík airport are reported as international usage. The deviations between national and international usage are believed to level out. Emission estimates for aviation will be moved to Tier 2 methodology by next submissions. A better methodology for the fuel split between international and domestic aviation will be developed in the near future as Iceland will take part in the EU ETS for aviation from 2012 onward and better data will become available. Emission factors for aviation bunkers are taken from the IPCC. Planned improvements are using data from Eurocontrol in order for more accurate estimates. This will be further introduced in next year's NIR.

The reported fuel use numbers are based on fuel sales data from the retail suppliers. The retail supplier divides their reported fuel sales between international navigation (including foreign fishing vessels) and national navigation based on identification numbers which differ between Icelandic and foreign companies. 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 3.18 above.

3.5 Other Sectors (CRF sector 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 as well as in the Residential sector. Emissions from the Other sector accounted for 27.4% of the Energy sector's total and for 9.86% of total GHG emissions in Iceland 2014. Fishing accounted for 95.7% of the Other sector's total.

3.5.1 Commercial, Institutional, and Residential Fuel Combustion

The emissions from this sector are calculated by multiplying energy use with a pollutant specific emission factor.

3.5.1.1 Activity Data

Activity data is provided by the NEA, which collects data on fuel sales by sector. EA adjusts the data provided by the NEA as further explained in Annex III. Activity data for fuel combustion the Commercial/Institutional sector and the resulting emissions are given in Table 3.19.

Table 3.19. Fuel use (kt) and resulting emissions (GHG total in kt CO_2-equivalents) from the commercial/institutional sector.

	1990	1995	2000	2005	2010	2013	2014
Gas/Diesel oil	1.8	1.6	1.6	1.0	0.3	0.3	0.3
Waste oil	3.3	-	-	-	-	-	-
LPG	0.3	0.3	0.5	0.5	0.2	0.5	0.3
Solid waste	-	0.5	0.6	0.6	0.3	-	-
Emissions	**12.3**	**6.3**	**6.8**	**4.9**	**1.7**	**2.5**	**2.0**

Activity data for fuel combustion in the Residential sector and the resulting emissions are given in Table 3.20. As can be seen in the table the use of kerosene increased substantially from 2008 to 2011. Kerosene is used in summerhouses, but also to some extent in the Commercial sector for heating of commercial buildings. The usage has been very low over the years and therefore the kerosene utilization has all been allocated to the Residential sector. The increase in usage in the years 2008 to 2011 is believed to be attributed to rapidly rising fuel prices for the Transport sector. This has motivated some diesel car owners to use kerosene on their cars as the kerosene did not have CO_2 tax, despite the fact that it is not good for the engine. Since 2012 the CO_2 tax also covers kerosene and the use decreased rapidly again. In the beginning of 2014 the fuel use increased again due to insufficient supply of electricity which forced heat plants to use oil for heating.

Table 3.20. Fuel use (kt) and resulting emissions (GHG total in kt CO_2-equivalents) from the residential sector.

	1990	1995	2000	2005	2010	2013	2014
Gas/Diesel oil	8.8	6.4	6.0	3.2	1.9	1.7	3.6
LPG	0.4	0.5	0.7	0.9	1.4	0.7	0.8
Kerosene	0.5	0.2	0.1	0.2	1.2	0.1	0.8
Emissions	**30.6**	**22.1**	**21.8**	**13.6**	**14.3**	**7.7**	**16.3**

3.5.1.2 Emission Factors

The CO_2 emission factors (EF) used reflect the average carbon content of fossil fuels. They are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and the Good Practice Guidance. They are presented in Table 3.21 along with Sulphur content of the fuels. Emissions of SO_2 are calculated from the S-content of the fuels. Emission factors for other pollutants are taken from Table 1.18 and 1.19 of the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. Default EFs from Tables 1.7 to 1.11 in the Reference Manual were used in cases where EFs were not available. Table 3.21 gives an overview of the used EFs.

Table 3.21. Emission factors for CH_4 and N_2O in the residential, commercial and institutional sector

	CH_4 [kg/TJ]	N_2O [kg/TJ]
Gasoil	0.7	0.6
LPG	1.1	NA
Kerosene	0.7	0.6
Waste oil	10.0	0.6

The CO_2 emission factor for waste incineration was calculated using Tier 2 methodology and default values from the 2006 GL. Therefore the waste amounts incinerated are dissected into eleven categories. The dry matter content, total, and fossil carbon fractions are calculated separately for each waste category and then added up. In years that have higher fractions of fossil carbon containing waste categories such as plastics the EF is higher than in other years since the EF is related to the total amount of waste incinerated. CO_2 EF varied between 0.44 and 0.69 t CO_2 per tonne waste (cf. chapter 7.4.4). The IEF for the sector shows fluctuations over the time series. From 1993 onwards waste has been incinerated to produce heat at two locations (swimming pools, school building). The IEF for waste is considerably higher than for liquid fuel. Further waste oil was used in the sector from 1990 to 1993. This combined explains the rise in IEF for the whole sector.

3.5.1.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from Commercial/Institutional and Residential sector is 7% (with an activity data uncertainty of 5% and emission factor uncertainty of 5%), for CH_4 emissions it is 100% (with an activity data uncertainty of 5% and emission factor uncertainty of 100%), and for N_2O emissions it is 150% (with an activity data uncertainty of 5% and emission factor uncertainty of 150%). This can be seen in the quantitative uncertainty table in Annex II.

3.5.2 Agriculture, Forestry and Fishing (CRF 1A4c)

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

3.5.2.1 Activity Data

Total use of residual fuel oil and gas/diesel oil for the fishing is based on the NEA's annual sales statistics for fossil fuels. Activity data for fuel combustion in the Fishing sector and the resulting emissions are given in Table 3.22.

Table 3.22. Fuel use (kt) and resulting emissions (GHG total in kt CO_2-equivalents) from the fishing sector.

	1990	1995	2000	2005	2010	2013	2014
Gas/Diesel oil	174.9	191.3	211.1	171.7	128.2	112.8	102.2
Residual fuel oil	32.4	53.4	16.0	26.3	41.4	38.2	37.4
Emissions	**662.3**	**779.8**	**727.5**	**632.9**	**540.2**	**478.5**	**442.6**

3.5.2.2 Emission Factors

The emission factors are taken from the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories for ocean-going ships and are presented in Table 3.18 above.

3.5.2.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from fishing is 6% (with an activity data uncertainty of 3% and emission factor uncertainty of 5%), for CH_4 emissions it is 100% (with an activity data uncertainty of 3% and emission factor uncertainty of 100%), and for N_2O emissions it is 150% (with an activity data uncertainty of 3% and emission factor uncertainty of 150%). This can be seen in the quantitative uncertainty table in Annex II

3.6 Cross-Cutting Issues

3.6.1 Sectoral versus Reference Approach

As explained in Chapter 1, a formal agreement has been made between the EA and the National Energy Authority (NEA) to cover the responsibilities of NEA in relation to the inventory process. According to the formal agreement the NEA is to provide an energy balance every year, but has not yet fulfilled this provision. EA has therefore compiled data on import and export of fuels, made comparison with sales statistics, and assumptions regarding stock change. Exact information on stock change does not exist. This has been used to prepare the reference approach. As explained in Chapter 1.2.2 Act 70/2012 changes the form of relations between the EA and the NEA concerning data handling. The law states that the NEA, among other institutions, is obligated to collect data necessary for the GHG inventory and report it to the EA, further to be elaborated in regulations set by the Minister for the Environment and Natural Resources. The relevant regulation will be in place for the next inventory cycle and will clarify the role of NEA in the inventory process, so better data for use in the reference approach (energy balance) as well as better data for the fuel split for the sectoral approach will be obtained. The NEA has already started some projects to fulfil these commitments, with the aim to have a complete energy balance within two years.

Iceland is not a member of the International Energy Agency (IEA). The NEA has provided data to IEA on a voluntary basis. The data is provided in physical units and IEA uses its own conversion factors to estimate energy units. Further the IEA rounds the numbers provided by Iceland. In many cases the numbers are quite low so this rounding can have significant percentage difference. This explains partially the differences with the data used for the annual submission under UNFCCC.

3.6.2 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 coking coal, coke-oven coke, and electrodes, except residues of electrodes combusted in the cement industry, which are accounted for under the Energy sector (Manufacturing industry and construction).

When compiling the data on import and export of fuels an error in the data has been discovered, as stocks of coking coal seem to have been building up since 2007 and at the same time as less import than use of coke has occurred. This can be explained by mistakes at the custom reports, where certain coke (imported cargo from Alabama) has been registered as coal instead of coke. Some mistakes seem to have occurred as well when registering steam coal and coking coal. As stated before the NEA is working on preparing an energy balance. In that work these issues will be tackled.

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.

3.7 Fugitive Emissions From Fuels (CRF sector 1B)

3.7.1 Distribution of oil products (CRF 1B2av)

CO_2 and CH_4 emissions from distribution of oil products are estimated by multiplying the total imported fuel with emission factors. The emission factors are taken from Table 2.16 in the 2000 IPCC GPG; the CO_2 EF is 2.3E-06 kt per 1000 m^3 and the CH_4 EF is 2.5E-05 kt per 1000 m^3 transported by tanker truck. Data on total import of fuels are taken from Statistics Iceland. Activity data and resulting emissions are provided in Table 3.23.

Table 3.23. Fuel use (kt) and resulting emissions from distribution of oil products.

	1990	1995	2000	2005	2010	2013	2014
Gasoline	**129.35**	**132.19**	**153.42**	**164.17**	**144.53**	**132.81**	**133.39**
Jet Kerosene	78.70	72.28	146.55	139.37	120.36	167.11	187.67
Other Kerosene	**0.03**	**0.02**	**0.00**	**0.01**	**0.00**	**0.12**	**0.01**
Gas/Diesel oil	335.78	309.35	427.92	418.23	292.31	273.19	288.09
Residual Fuel Oil	**105.96**	**151.92**	**64.08**	**62.90**	**93.05**	**108.85**	**90.39**
LPG	1.29	1.32	1.68	2.46	2.62	3.07	2.45
Emissions	**0.49**	**0.50**	**0.60**	**0.60**	**0.49**	**0.52**	**0.53**

3.7.2 Geothermal Energy (CRF 1B2d)

3.7.2.1 Overview

Iceland relies heavily on geothermal energy for space heating (90%) and to a significant extent for electricity production (30% of the total electricity production in 2014). Geothermal energy is generally considered to have a 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 than from fossil fuel power plants, or 19 times (Baldvinsson, Þórisdóttir, & Kristjánsson, 2011). Very small amounts of methane but considerable quantities of Sulphur in the form of hydrogen sulphide (H_2S) are emitted from geothermal power plants.

3.7.2.2 Key Source Analysis

The key source analysis performed for 2014 has revealed that geothermal energy is a key source in terms of both level and trend, as indicated in Table 1.1.

3.7.2.3 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 of CO_2 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.

Emissions of CH_4 and H_2S are also calculated in a similar way that CO_2 is calculated, i.e. based on direct measurements. H_2S has been measured for the whole time series. Methane was measured in 2010, 2011 and 2012. Older measurements exist for the years 1995 to 1997. Based on the measurements from 1995 to 1997 and 2010 an average methane emission factor was calculated and used for the years where no information has been provided. The methane emissions for those years (1995, 1996, 1997 and 2010) range from 35.5 to 55.8 kg/GWh, with an average of 45.7 kg/GWh.

Table 3.24 shows the electricity production with geothermal energy and the total CO_2, CH_4 and Sulphur emissions (calculated as SO_2).

Table 3.24. Electricity production and emissions from geothermal energy in Iceland.

	1990	1995	2000	2005	2010	2013	2014
Electricity production (GWh)	283	288	1323	1658	4465	5245	5238
Carbon dioxide emissions (kt)	61	82	153	116	189	172	182
Methane emissions (kt CO_2 eq)	0.3	0.3	1.5	1.9	4.4	3.6	4.1
Sulphur emissions (as SO_2, kt)	13	11	26	30	58	53	47

3.7.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from geothermal energy is 10% (with an activity data uncertainty of 10% and emission factor uncertainty of 1%). The uncertainty of CH_4 emissions from geothermal energy is 10% (with an activity data uncertainty of 6% and emission factor uncertainty of 8%). This can be seen in the quantitative uncertainty table in Annex II.

4 Industrial Processes (CRF sector 2)

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 and SF_6 from electrical equipment. The Industrial Processes sector accounted for 43% of the GHG emissions in Iceland in 2014. By 2014, emissions from the industrial processes sector were 102% above the 1990 level. This is mainly due to the expansion of energy intensive industry. The dominant category within the Industrial Process sector is metal production, which accounted for 92% of the sector's emissions in 2014. Figure 4.1 shows the location of major industrial plants in Iceland.

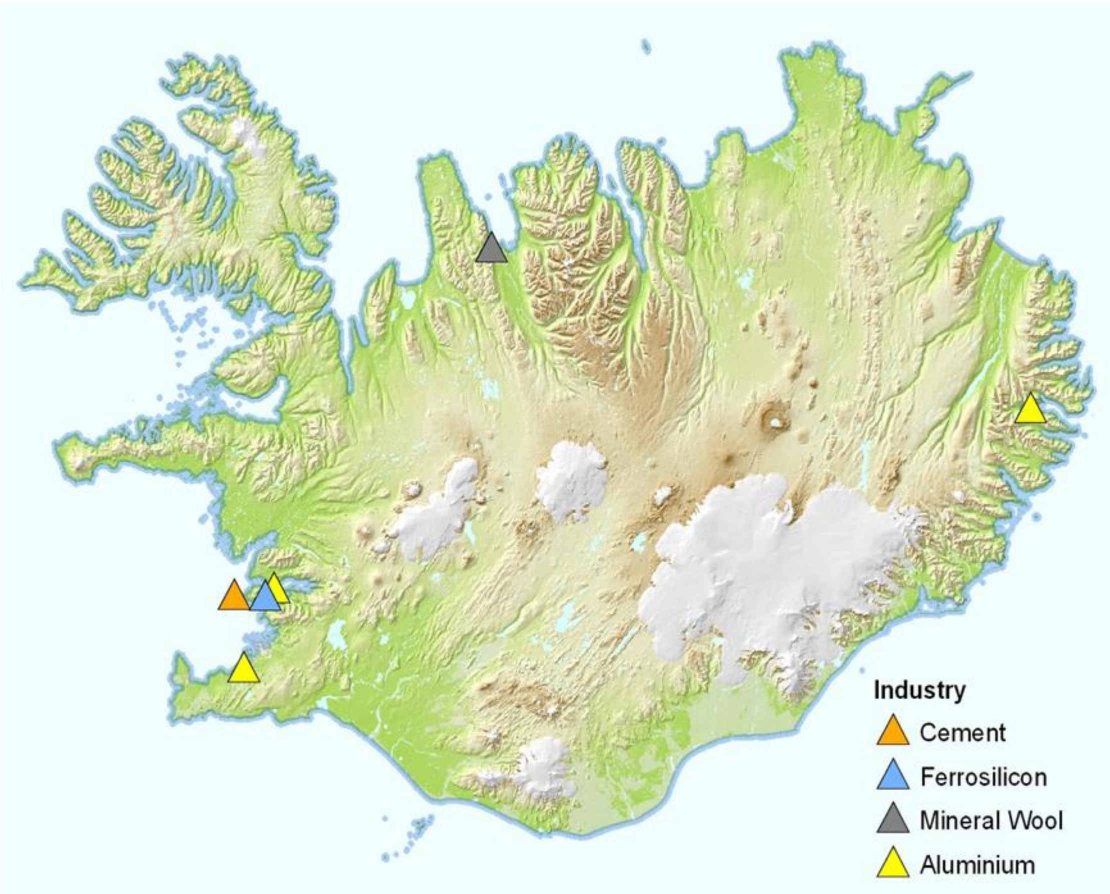

Figure 4.1 Location of major industrial sites in Iceland.

4.1.1 Methodology

Greenhouse gas emissions from industrial processes are calculated according to methodologies suggested by the 2006 IPCC Guidelines and the IPCC Good Practice Guidance.

4.1.2 Key Source Analysis

The key source analysis performed for 2014 has revealed the following greenhouse gas sources from the Industrial Processes Sector as key sources in terms of total level and/or trend (Table 1.1).

Table 4.1 Key source analysis for Agriculture, 1990, 2014 and trend (excluding LULUCF).

IPCC source category			Level 1990	Level 2014	Trend
IPPU (CRF sector 2)					
2.A.1	Cement Production	CO_2	✓		
2.C.2	Ferroalloys Production	CO_2	✓	✓	✓
2.C.3	Aluminium Production	CO_2	✓	✓	✓
2.C.3	Aluminium Production	PFCs	✓	✓	✓
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases		✓	✓

4.1.3 Completeness

Table 4.2 gives an overview of the 2006 IPCC source categories included in this chapter and presents the status of emission estimates from all subcategories in the Industrial Process and Product Use sector. NF_3 emissions have not been estimated, but are most likely minimum or not occurring.

Table 4.2 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**	**NO_X**	**CO**	**NMVOC**	**SO_2**
2A Mineral Industry											
2A1	Cement Production (until 2011)	E	NE	NA	NA	NA	NA	NA	NA	NA	IE[1]
2A2	Lime Production	NOT OCCURRING									
2A3	Glass Production	NOT OCCURRING									
2A4(a-c)	Other Process Uses of Carbonates	NOT OCCURRING									
2A4d	Other: Mineral Wool Production	E	NE	NE	NA	NA	NA	NE	E	NE	E
2B Chemical Industry											
2B1	Ammonia Production (IE)[3]	NA	NA	E	NA	NA	NA	E	NA	NA	NA
2B2	Nitric Acid Production	NOT OCCURRING									
2B3	Adipic Acid Production	NOT OCCURRING									
2B4	Caprolactam, Glyoxal and Glyoxylic Acid Production	NOT OCCURRING									
2B5	Carbide Production	NOT OCCURRING									
2B6	Titanium Dioxide Production	NOT OCCURRING									
2B7	Soda Ash Production	NIOT OCCURRING									
2B8	Pertochemical and Carbon Black Production	NOT OCCURRING									
2B9	Fluorochemical Production	NOT OCCURRING									
2B10	Other: Silicium Production – until 2004	E	NE	NE	NA	NA	NA	E	NE	NE	NE
2B10	Other: Fertilizer Production – until 2001	NA	NE	E	NA	NA	NA	E	NE	NE	NE
2C Metal Industry											
2C1	Iron and Steel Production	NOT OCCURRING									
2C2	Ferroalloys Production	E	E	NA	NA	NA	NA	E	E	E	E
2C3	Aluminium Production	E	NE	NE	NA	E	NA	NE	NE	NE	E
2C4	Magnesium Production	NOT OCCURRING									
2C5	Lead Production	NOT OCCURRING									
2C6	Zinc Production	NOT OCCURRING									
2C7	Other	NOT OCCURRING									

2D Non-Energy Products from Fuels and Solvent Use											
2D1	Lubricant Use	NOT ESTIMATED									
2D2	Paraffin Wax Use	E	NE	NE	NA	NA	NA	NE	NE	NE	NE
2D3	Solvent Use	E	NA	NA	NA	NA	NA	NA	NA	E	NA
2D4	Other	NE	NE	NE	NA	NA	NA	NA	NA	E	NA
2E Electronics Industry											
2E1	Intergraded Circuit or Semiconductor	NOT OCCURRING									
2E2	TFT Flat Panel Display	NOT OCCURRING									
2E3	Photovoltaics	NOT OCCURRING									
2E4	Heat Transfer Fluid	NOT OCCURRING									
2E5	Other	NOT OCCURRING									
2F Product Uses as Substitutes for Ozone Depleting Substances											
2F1	Refrigeration and Air Conditioning	NA	NA	NA	E	E	NA	NA	NA	NA	NA
2F1a	Refrigeration and Stationary Air Conditioning	NA	NA	NA	E	NO	E	NA	NA	NA	NA
2F2b	Mobile Air Conditioning	NA	NA	NA	E	NO	E	NA	NA	NA	NA
2F2	Foam Blowing Agents	NOT OCCURING									
2F3	Fire Production	NOT OCCURING									
2F4	Aerosols	NA	NA	NA	E	NO	E	NA	NA	NA	NA
2F5	Solvents	NOT OCCURING									
2F6	Other Applications	NOT OCCURING									
2G Other Product Manufacture and Use											
2G1	Electrical Equipment	NOT OCCURING									
2G1b	Use of Electric Equipment	NA	NA	NA	NA	NE	E	NA	NA	NA	NA
2G2	SF_6 and PFCs from Other Product Uses	NOT ESTIMATED									
2G3	N_2O from Product Use	E	NA	NA	NA	NA	NA	NA	NA	E	NA
2G4	Other	E	NA	NA	NA	NA	NA	NA	NA	E	NA
2H Other											
2H1	Pulp and Paper Industry	NOT OCCURING									
2H2	Food and Beverage Industry	NE	NA	NA	NA	NA	NA	NA	NA	E	NA
2H3	Other	NOT ESTIMATED									

1 SO_2 emissions from cement production are reported under the Energy sector, based on measurements.
2 Soda Ash was used at the Silicon plant which closed down in 2004, resulting CO_2 emissions from soda ash use are reported under silicon production.
3 Ammonia was produced at the fertilizer production plant that closed down in 2001. Resulting emissions of N_2O and NO_x are reported under fertilizer production.

4.1.4 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, 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. Further information can be found in the QA/QC manual.

4.2 Mineral Products (CRF sector 2A)

4.2.1 Cement Production (CRF 2A1)

The single operating cement plant in Iceland was closed down in 2011. The plant produced cement from shell sand and rhyolite 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 of the 2006 IPCC Guideline (Equation 2.2), 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.

Equation 2.2

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

Where:

- CO_2 Emissions = emissions of CO_2 from cement production, tonnes
- M_{cl} = weight (mass) of clinker production, tonnes
- EF_{cl} = clinker emission factor, tonnes CO_2/tonnes clinker; EF_{cl} = 0.785 × CaO content
- CF_{ckd} = emissions correction factor for non-recycled cement kiln dust, dimensionless

4.2.1.1 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. Data on clinker production is only available from 2003 onwards. Historical clinker production data has been calculated as 85% of cement production, which was recommended by an expert at the cement plant. This ratio is close to the average proportion for the years 2003 and 2004.

The production at the cement plant decreased slowly from 2000 - 2004. The construction of the Kárahnjúkar hydropower plant (building time from 2002 to 2007) along with increased activity in the construction sector (from 2003 to 2007) increased demand for cement, and the production at the cement plant increased again between 2004 and 2007, although most of the cement used in the country was imported. In 2011, clinker production at the plant was 69% less than in 2007, due to the collapse of the construction sector. Late 2011 the plant ceased operation.

Table 4.3 Clinker production and CO_2 emissions from cement production from 1990-2011. The cement factory closed down in 2011.

Year	Cement production [t]	Clinker production [t]	CaO content of clinker	EF_{cl}	CF_{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	71,981	63%	0.495	107.5%	38.3
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	64%	0.501	110%	63.2
2008	126,070	110,240	63.9%	0.502	110%	60.8
2009	59,290	51,864	63.9%	0.502	108%	28.1
2010	33,389	18,492	63.3%	0.497	108%	9.9
2011	38,048	35,441	64.2%	0.504	110%	19.6
2012	-	-	-	-	-	-

4.2.1.2 Emission Factors

It has been estimated by an expert at the cement production plant that the CaO content of the clinker was 63% for all years from 1990 to 2006. From 2007 the CaO content is based on chemical analysis at the plant, as presented in. The CO_2 emission factor for clinker (EFcl) is thus 0.495 from 1990-2006, 0.501 in 2007, 0.502 in 2008 and 2009, 0.497 in 2010 and 0.504 in 2011. The correction factor for cement kiln dust (CFckd) was 107.5% for all years from 1990 to 2004, 110% from 2005 - 2008 and 108% in 2009 and 2010. In 2011 the CFckd correction factor was 110%.

4.2.2 Lime Production (CRF 2A2)

Limestone has been used at the Elkem Iceland Ferrosilicon plant since 1999. Emissions are calculated based on the consumption of limestone and emission factors from the IPCC Guidelines. The consumption of limestone is collected from Elkem Iceland by EA through an electronic reporting form, based on the EU ETS. The emission factor is 440 kg CO_2 per tonne limestone, assuming the fractional purity of the limestone is 1.

4.2.3 Other: Mineral Wool Production (CRF 2A5)

There is one Mineral Wool Production Plant in operation in Iceland. Emissions of CO_2 are calculated from the carbon content and the amount of shell sand and electrodes used in the production process. Emissions of SO_2 are calculated from the S-content of electrodes and amount of electrodes used. Emissions of CO are based on measurements performed at the plant in the year 2000 and mineral wool production. Activity data are provided by the plant (application for free allowances under the EU ETS for the years 2005 to 2010 and reporting under the EU ETS after that).

4.3 Chemical Industry (CRF sector 2B)

4.3.1 Methanol Production (CRF 2B8a)

A methanol production facility started its operation in 2012. The facility uses CO_2 from a geothermal power plant as a source of carbon. Emissions of CO_2 from this facility are, for now, allocated to the geothermal power plant and reported in the Energy Sector (CRF subcategory 1B2d). Future improvements involve an estimation of emissions from the methanol production facility and consequently the reduced emissions from the upstream geothermal power plant.

4.3.2 Other (CRF 2B10)

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, sludge containing silicium 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 in the production process and those emissions are reported here. The uncertainty of the CO_2 estimate is 3%, see Annex II.

When the fertilizer production plant was operational it reported its emissions of NO_x and N_2O to the EA. The uncertainty of the N_2O estimate is 50%, see Annex II.

4.4 Metal Production (CRF 2C)

4.4.1 Ferroalloys Production (CRF 2C2)

Ferrosilicon (FeSi, 75% Si) is produced at one plant, Elkem Iceland at Grundartangi. The raw material used is quartz (SiO_2). In the production raw ore, carbon material and slag forming materials are mixed and heated to high temperatures for reduction and smelting. Ready-to-use carbon free iron pellets for the production are imported, so no additional emissions occur from the iron part of the FeSi production. The carbon materials used are coal, coke, and wood. Electric (submerged) arc furnaces with consumable 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 3 method from the 2006 IPCC Guidelines, based on the consumption of reducing agents and electrodes and plant specific carbon content. The amount of carbon in the ferrosilicon produced and coarse and fine microsilica is subtracted. The carbon content of electrodes and reducing agents is calculated by using equation 4.19 of the 2006 IPCC Guidelines, based on measurements at the plant.

The IEF fluctuates over the time series depending on the consumption of different reducing agents and electrodes (3.13 – 3.6 t CO_2/t FeSi). CO_2 emissions resulting from the use of wood and charcoal are calculated but not included in national totals. Non CO_2-emissions from the use of wood and charcoal are included in national totals.

Limestone has been used at the Elkem Iceland Ferrosilicon plant since 1999. Emissions are calculated based on the consumption of limestone and emission factors from the IPCC Guidelines. Emissions from limestone use is reported under Lime Production (CRF sector 2A2).

4.4.1.1 Activity Data

The consumption of reducing agents and electrodes are collected from Elkem Iceland by EA through an electronic reporting form based on the EU ETS. Activity data for raw materials, products and the resulting emissions are given in Table 4.4.

Table 4.4 Raw materials (kt), production (kt) and resulting emissions (kt CO_2-eq) from Elkem Iceland.

	1990	1995	2000	2005	2010	2013	2014
Electrodes	3.8	3.9	6.0	6.0	4.79	5.1	4.3
Coking coal	45.1	52.4	88.0	86.9	96.1	111.0	103
Coke oven coke	24.9	30.1	35.8	42.6	30.3	33.7	29.5
Char coal	-	-	-	2.1	-	-	-
Waste wood	16.7	7.7	16.2	15.6	11.3	26.4	25.7
Limestone	-	-	0.5	1.6	0.5	2.3	2.1
Production (FeSi)	62.8	71.4	108.4	111.0	102.2	119.6	107.8
Coarse Microsilica	0.9	1.0	1.4	1.6	1.1	1.4	1.4
Fine Microsilica	13.2	15.0	21.4	24.3	17.0	23.7	21.0
Emissions	**207.4**	**242.4**	**373.5**	**373.6**	**367.6**	**402.5**	**364.9**

4.4.1.2 Emission Factors

Plant and year specific emission factors for CO_2 are based on the carbon content of the reducing agents, electrodes, the ferrosilicon and microsilica. This information was taken from Elkem's application for free allowances under the EU ETS for the years 2005 to 2010. Upon request by the EA, Elkem provided this information for the years 2000 to 2004 and 2011. In 2013 and 2014 the information came from the electronic reports submitted under the EU ETS and Green Accounting. Carbon content of coking coal, coke and charcoal are based on routine measurements of each lot at the plant. These measurements are available for the years 2000 to 2013. For the years 1990 to 1999 the average values for the years 2005 to 2010 were used. The carbon content of the electrodes is measured by the producer of the electrodes. Carbon content of wood is taken from a Norwegian report (SINTEF. Data og informasjon om skogbruk og virke, Report OR 54.88). Carbon content of products (ferrosilicon, coarse and fine microsilica) is based on measurements at the plant. The carbon content is presented in

Table 4.5. The emission factor for the major source streams coal and coke are plant and year specific. The implied emission factor differs from year to year based on different carbon content of inputs and outputs as well as different composition of the reducing agents used, from 3.13 tonne CO_2 per tonne Ferrosilicon in 1998, to 3.66 tonne CO_2 per tonne Ferrosilicon in 2005.

Emission factors for CH4, NOx, and NMVOC are taken from Tables 1.7, 1.9, and 1.11 in the IPCC Guidelines Reference Manual. Values for NCV are from the Good Practice Guidance. 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 Reference Manual of the 1996 IPCC Guidelines. These emission factors will be updated in the 2017 submission, in accordance with the 2006 IPCC Guidelines.

Table 4.5 Carbon content of raw material and products at Elkem Iceland.

	1990	1995	2000	2005	2010	2013	2014
Electrodes	94%	94%	94%	94%	94%	94%	95%
Coking coal	74.8%	74.8%	79.0%	75.5%	74.6%	72.6%	72.2%
Coke oven coke	78.8%	78.8%	76.6%	73.8%	80.9%	74.6%	73.6%
Char coal	-	-	-	80.9%	84.3%	-	-
Waste wood	48.7%	48.7%	48.7%	48.7%	48.7%	50.0%	50.0%
Production (FeSi)	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Coarse Microsilica	18%	18%	18%	18%	18%	18%	18%
Fine Microsilica	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%

4.4.1.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from ferroalloys production is 1.8% (with an activity data uncertainty of 1.5% and emission factor uncertainty of 1%). It is estimated that the uncertainty of the CH_4 emission factor is 100%. In combination with above mentioned activity data uncertainty this leads to a combined uncertainty of 100%. This can be seen in the quantitative uncertainty table in Annex II.

4.4.1.4 Source specific QA/QC procedures

Activity data is collected through electronic reporting form, allowing immediate QC checks. QC tests involve automatic t/t checks on certain emissions and activity data from this industry. Further information can be found in the QA/QC manual.

4.4.2 Aluminium Production (CRF 2C3)

Aluminium is produced in 3 smelters in Iceland, Rio Tinto Alcan at Straumsvík, Century Aluminium at Grundartangi and Alcoa Fjarðaál at Reyðarfjörður (See location of major industrial sites in Iceland in Figure 4.1). They all use the Centre Worked Prebaked Technology. Primary aluminium production results in emissions of CO_2 and PFCs. The emissions of CO_2 originate from the consumption of electrodes during the electrolysis process. Emissions are calculated according to the Tier 3 method from the 2006 IPCC Guidelines, based on the quantity of electrodes used in the process and the plant and year specific carbon content of the electrodes.

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. The PFCs emissions are calculated according to the Tier 2 Slope Method, using equation 4.26 from the 2006 IPCC Guideline. Default coefficients are taken from table 4.16 in the 2006 IPCC Guideline for Centre Worked Prebaked Technology.

EQUATION 4.26

$$E_{CF4} = S_{CF4} \cdot AEM \cdot MP$$
and
$$E_{C2F6} = E_{CF4} \cdot F_{C2F6/CF4}$$

Where:

- E_{CF4} = emissions of CF_4 from aluminium production, kg CF_4
- E_{C2F6} = emissions of C_2F_6 from aluminium production, kg C_2F_6
- S_{CF4} = slope coefficient for CF_4, (kg CF_4/tonne Al)/(AE-Mins/cell-day)
- AEM = anode effects per dell-day, AE-Mins/cell-day
- MP = metal production, tonnes Al
- $F_{C2F6/CF4}$ = weight fraction of C_2F_6/ CF_4, kg C_2F_6/kg CF_4

4.4.2.1 Activity Data

The EA collects annual process specific data from the aluminium plants, through electronic reporting forms in according to the EU ETS. Activity data and the resulting emissions can be found in Table 4.6.

Table 4.6 Aluminium production, CO_2 and PFC emissions, IEF for CO_2 and PFC 1990-2014.

Year	Aluminium production [kt]	CO_2 emissions [kt]	PFC emissions [kt CO_2-eq]	CO_2 [t/t Al]	PFC [t CO_2-eq/t Al]
1990	87.839	139.2	494.6	1.58	5.63
1991	89.217	142.0	410.6	1.59	4.60
1992	90.045	136.8	183.0	1.52	2.03
1993	94.152	141.6	88.2	1.50	0.94
1994	98.595	151.0	52.5	1.53	0.53
1995	100.198	154.0	69.4	1.54	0.69
1996	103.362	160.3	29.6	1.55	0.29
1997	123.562	192.8	97.1	1.56	0.79
1998	173.869	271.1	212.3	1.56	1.22
1999	222.014	354.3	204.2	1.60	0.92
2000	226.362	353.0	149.9	1.57	0.66
2001	244.148	382.4	108.0	1.57	0.44
2002	264.107	401.2	85.5	1.52	0.32
2003	266.611	410.2	70.5	1.54	0.26
2004	271.384	415.9	45.5	1.53	0.17
2005	272.488	417.1	30.8	1.53	0.11
2006	326.270	516.4	392.8	1.58	1.20
2007	455.761	693.0	331.4	1.52	0.73
2008	781.151	1186.8	411.4	1.52	0.53
2009	817.281	1231.5	180.0	1.51	0.22
2010	818.859	1237.6	171.7	1.51	0.21
2011	806.319	1214.3	74.5	1.51	0.09
2012	821.021	1244.2	94.0	1.52	0.11
2013	840.975	1274.2	88.2	1.51	0.10
2014	839.975	1279.5	99.0	1.52	0.12

4.4.2.2 Emission Factors

Emission factors for CO_2 are based on the plant and year specific carbon content of the electrodes. This information was taken from the aluminium plants' applications for free allowances under the EU ETS for the years 2005 to 2010. Upon request by the EA, the aluminium plants also provided information on carbon content of the electrodes for all other years in which the corresponding aluminium plant was operating in the time period 1990 to 2012. In 2013 and 2014 the information comes from submitted data from the operators under the EU ETS. The weighted average carbon content of the electrodes ranges from 98.0% to 98.8%.

The default slope and weight fraction coefficients for the calculation of PFC emissions come from the 2006 IPCC Guideline for Centre Worked Prebaked Technology (0.143 for CF_4 and 0.121 for C_2F6/CF_4). For high performing facilities that emit very small amounts of PFCs, the Tier 3 method will probably 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.

4.4.2.3 Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from aluminium production is 1.8% (with an activity data uncertainty of 1% and an emission factor uncertainty of 1.5%). This can be seen in the quantitative uncertainty table in Annex II.

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 6% for CF_4 and 11% for C_2F_6.

4.4.2.4 Source specific QA/QC procedures

Activity data is collected through electronic reporting forms, allowing immediate QC checks. QC tests involve automatic t/t checks on certain emissions and activity data from this industry. Further information can be found in the QA/QC manual.

4.5 Non-Energy Products from Fuels and Solvent Use (CRF 2D)

4.5.1 Lubricant Use (CRF 2D1)

Lubricants are mostly used in industrial and transportation applications. Lubricants are produced either at refineries through separation from crude oil or at petrochemical facilities. They can be subdivided into (a) motor oils and industrial oils, and (b) greases, which differ in terms of physical characteristics (e.g., viscosity), commercial applications, and environmental fate (IPCC, 2006).

Preliminary estimations of the remaining CO_2 emissions from lubricant use for non-energy use in 2014 are 1.2 kt CO_2 which is below 0.05 % of total emissions in 2014. These emissions are omitted for the current submission and future improvements involve, in addition to a better estimate of the emissions, a review of activity data related to this category.

4.5.2 Paraffin Wax Use (CRF 2D2)

4.5.2.1 Overview

Paraffin waxes are used in applications such as: candles, corrugated boxes, paper coating, board sizing, food production, wax polishes, surfactants (as used in detergents) and many others. Emissions from the use of waxes derive primarily when the waxes or derivatives of paraffins are combusted during use (e.g., candles), and when they are incinerated with or without heat recovery or in wastewater treatment (for surfactants). In the cases of incineration and wastewater treatment the emissions should be reported in the Energy or Waste Sectors, respectively (IPCC, 2006).

The emissions from Paraffin Wax Use were estimated to be 0.31 kt CO_2 in 1990 and 0.25 kt CO_2 in 2014. Activity data for this category is limited and improvements are discussed section 4.5.2.5.

4.5.2.2 Methodology

CO_2 Emissions from paraffin wax use are calculated using equation 5.4 (Tier 1) in the IPCC 2006 guidelines (IPCC, 2006).

EQUATION 5.4

$$CO_2\ Emissions = (PW \cdot CC_{WAX} \cdot ODU_{WAX} \cdot 44/12)/1000$$

Where:

- CO_2 emissions = emissions of CO_2 from paraffin waxes, kt CO_2
- PW = Total paraffin wax consumption, TJ
- CC_{WAX} = Carbon content of paraffin wax, tonne C/TJ
- ODU_{WAX} = “Oxidized during use”-factor for paraffin wax, fraction
- 44/12 = mass ratio of CO_2/C
- /1000 = conversion from tonnes to kilotonnes.

For calculating the total paraffin wax consumption, PW, in energy units, the activity data given in tons are multiplied by the Net Calorific Value of 40.2 TJ/kt given in table 1.2 in the IPCC 2006 guidelines. The default CC_{WAX} factor of 20.0 kg C/GJ (on a Lower Heating Value basis) and the default ODU_{WAX} factor of 0.2 (Tier 1) given in the IPCC 2006 guidelines is applied. The proportion of paraffin candles used is assumed to be 66%, taken from the Norwegian Inventory Report for 2015 as the activity data does not distinguish between paraffin candles and others.

4.5.2.3 Activity data

Activity data for the imports and exports of candles exist from 2004 and is published by Statistics Iceland (Statistics Iceland, 2015). For 1990-2003, the 2004 values are used. Activity data for the production of candles is missing. Imported and exported paraffin (less than 0.75% oil) is also published by Statistics Iceland from 2004. For 1990-2003 the 2004 values are used. Activity data for paraffin production is missing but is considered insignificant based on expert judgement.

4.5.2.4 Emissions

The emissions from Paraffin Wax Use were estimated to be 0.31 kt CO_2 in 1990 and 0.25 kt CO_2 in 2014.

4.5.2.5 Planned improvements

Better activity data for all sources of paraffin wax use in Iceland. Activity data should furthermore distinguish between paraffin candles and other types of candles.

4.5.3 Solvent use (CRF 2D3)

4.5.3.1 Overview

This section describes non-methane volatile organic compounds (NMVOC) emissions from solvents use. NMVOC are not considered direct greenhouse gases but once they are emitted, they will oxidize to CO_2 in the atmosphere over a period of time. They are therefore considered as indirect greenhouse gases. NMVOCs also act as precursors to the formation of ozone. When volatile chemicals are exposed to air, emissions are produced through evaporation of the chemicals. The use of solvents and other organic compounds in industrial processes and households is an important source of NMVOC emissions.

In 1990 emissions Solvent Use was 4.43 kt CO_2 equivalents. Emissions increased by 5.4 % between 1990 and 2014 and were 4.66 kt CO_2 equivalents in 2014 accounting for roughly 0.1% of the total greenhouse gas emissions of Iceland in 2014.

4.5.3.2 Methodology

NMVOC emissions are estimated according to the EMEP/EEA air pollutant emission inventory guidebook (EMAP/EEA, 2013). The source category “solvent use” is divided into subcategories in accordance with the EMEP guidebook classification, as the nature of this source requires somewhat different approaches to calculate emissions than other emissions categories.

4.5.3.3 Key source analysis

The key source analysis performed for 2014 has revealed that the sector Non-Energy Products from Fuels and Solvent Use is neither a key source category in level nor in trend.

4.5.3.4 Source specific QA/QC procedures

The QC activities include general methods such as accuracy checks on data acquisition and calculations as well as the use of approved standardised procedures for emission calculations, estimating uncertainties, archiving information and reporting. Further information can be found in the QA/QC manual.

4.5.3.5 Road Paving with Asphalt (CRF 2D3b)

Asphalt road surfaces are composed of compacted aggregate and asphalt binder. Gases are emitted from the asphalt plant itself, the road surfacing operations and subsequently from the road surface. Information on the amount of asphalt produced comes from Statistics Iceland. The emission factors for NMVOC (0.016 kg/t asphalt) are taken from Table 3.1, in chapter 2D3b in the EMEP/EEA emission inventory guidebook (EMAP/EEA, 2013). Emissions of SO_2, NO_x and CO are expected to originate mainly from combustion and are therefore not estimated here but accounted for under sector 1A2f.

4.5.3.6 Paint applicants (2D3d)

The EMEP/EEA guidebook (EMAP/EEA, 2013) provides emission factors based on amounts of paint applied. Data exists on imported paint since 1990 (Statistics Iceland, 2015) and on domestic production of paint since 1998 (Icelandic Recycling Fund, 2014). The Tier 1 emission factor refers to all paints applied, e.g. waterborne, powder, high solid and solvent based paints. The existing activity data on production and imported paints, however, makes it possible to narrow the activity data down to conventional solvent based paints. Subsequently, Tier 2 emission factors for conventional solvent based paints could be applied. The activity data does not permit a distinction between decorative coating application for construction of buildings and domestic use of paints. Their NMVOC emission factors, however, are identical: 230 g/kg paint applied. It is assumed that all paint imported and produced domestically is applied domestically during the same year. Therefore the total amount of solvent based paint is multiplied with the emission factor. For the time before 1998 no data exists about the amount of solvent based paint produced domestically. Therefore the domestically produced paint amount of 1998, which happens to be the highest of the time period for which data exists, is used for the period from 1990-1997. The amounts of solvent based paint produced domestically and imported are shown Figure 4.2.

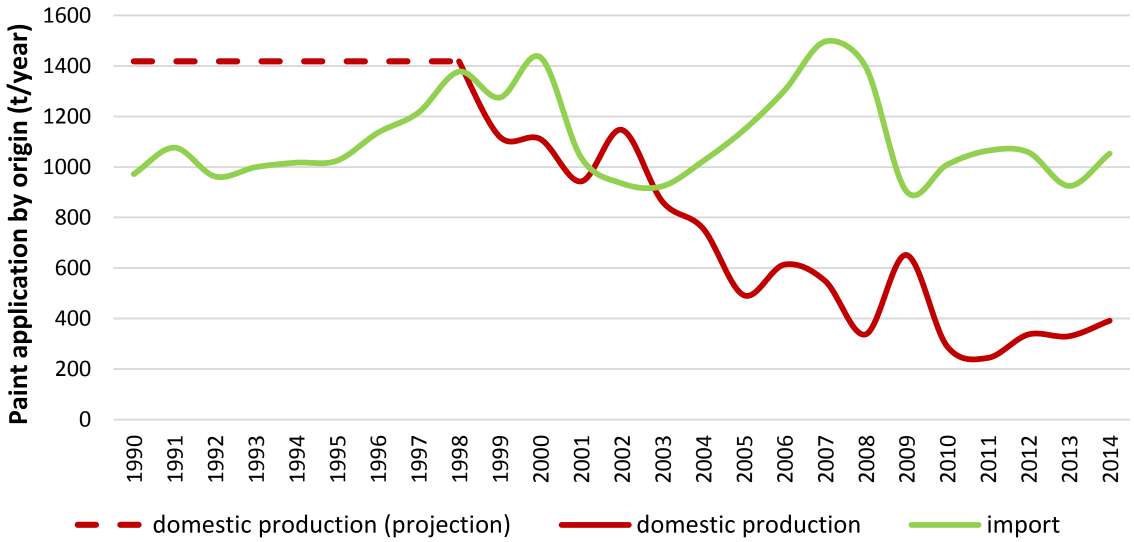

Figure 4.2 Amounts of imported solvent based paints and produced domestically 1990-2014.

4.5.3.7 Degreasing and dry cleaning (2D3e, 2D3f)

The EMEP/EEA guidebook (EMAP/EEA, 2013) provides a Tier 1 emission factor for degreasing based on amounts of cleaning products used. Data on the amount of cleaning products imported is provided by Statistics Iceland. Activity data consisted of the chemicals listed by the EMEP/EEA guidebook (EMAP/EEA, 2013) methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL). In Iceland, though, PER is mainly used for dry cleaning (expert judgement). In order to estimate emissions from degreasing more correctly without underestimating them, only half of the imported PER was allocated to degreasing. Emissions from dry cleaning are estimated without using data on solvents used (see below). The use of PER in dry cleaning, though, is implicitly contained in the method. In Iceland, Xylenes are mainly used in paint production (expert judgement). In order to estimate emissions from degreasing more correctly without underestimating them, only half of the imported xylenes were allocated to degreasing. Emissions from paint production are estimated without using data on solvents used but xylene use is implicitly contained in the method. In addition to the solvents mentioned above, 1,1,1-trichloroethane (TCA), now banned by the Montreal Protocol, is added for the time period during which it was imported and used. Another category included is paint and varnish removers. The amount of imported solvents for degreasing was multiplied with the NMVOC Tier 1 emission factor for degreasing: 460 g/kg cleaning product.

Emissions from dry cleaning were calculated using the Tier 2 emission factor for open-circuit machines provided by the EMEP/EEA guidebook. Activity data for calculation of NMVOC emissions is the amount of textile treated annually, which is assumed to be 0.3 kg/head (EMAP/EEA, 2013) and calculated using demographic data. The NMVOC emission factor for open-circuit machines is 177g/kg textile treated. Since all dry cleaning machines used in Iceland are conventional closed-circuit PER machines, the emission factor was reduced using the respective EMEP/EEA guidebook (EMAP/EEA, 2013) reduction default value of 0.89. NMVOC emissions from dry cleaning were calculated thus:

$$E_{NMVOC}(t) = population(t) \bullet 0.3 \bullet (177/1000) \bullet (1-0.89)$$

Where:

- $E_{NMVOC}(t)$ = emissions of NMVOC in year t, kg
- Population (t) = population in year t
- 0.3 = amount of textiles treated inhabitant/year, kg
- 177 = g NMVOC emissions/kg textile treated
- 0.89 = abatement efficiency of closed circuit PER machines

4.5.3.8 Chemical products, manufacturing and processing (2D3g)

The only activity identified for the subcategory chemical products, manufacture and processing is manufacture of paints. NMVOC emissions from the manufacture of paints were calculated using the EMEP/EEA guidebook (EMAP/EEA, 2013)Tier 2 emission factor of 11 g/kg product. The activity data consists of the amount of paint produced domestically.

4.5.3.9 Other use of solvent and related activates (2D3a, 2D3h, 2D3i)

NMVOC emissions for printing were calculated using the EMEP/EEA guidebook (EMAP/EEA, 2013) Tier 1 emission factor of 500g/kg ink used. Import data on ink was received from Statistics Iceland (Statistics Iceland, 2015).

NMVOC emissions from other domestic use were calculated using the EMEP/EEA guidebook (EMAP/EEA, 2013) emission factor of 2.7 kg/inhabitant/year.

Emissions from wood preservation were calculated using the EMEP/EEA guidebook (EMAP/EEA, 2013) Tier 2 emission factors for creosote preservative type (105 g/kg creosote) and organic solvent borne preservative (945 g/kg preservative). Import data on both wood preservatives was received from Statistics Iceland (Statistics Iceland, 2015).

4.5.3.10 Emissions

Figure 4.3 shows NMVOC emissions from the sector from 1990-2014. NMVOC emissions were around 1.4 kt from 1990 to 1995. Between 1996 and 2007 emissions oscillated between 1.5 and 1.8 kt. The decrease of emissions during the last years is mainly due to decreasing emissions from paint application, printing and organic wood preservatives.

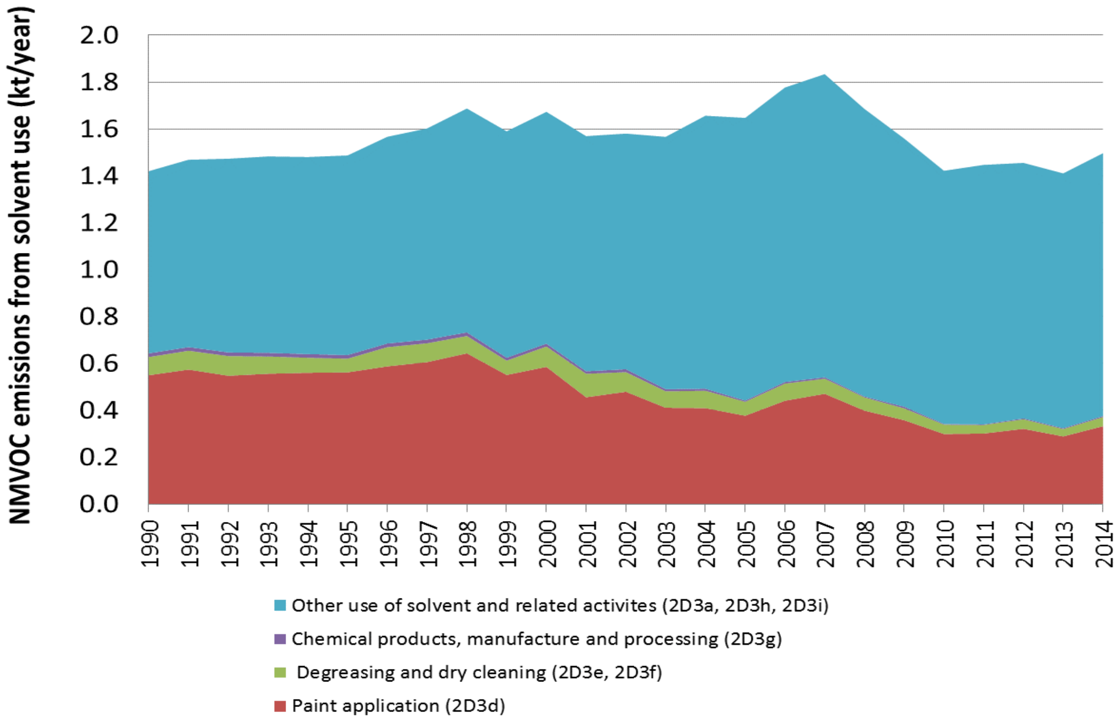

Figure 4.3 NMVOC emissions from solvent and other product use (kt/year) from 1990-2014.

NMVOC emissions will oxidize to CO_2 in the atmosphere over a period of time. This conversion has been estimated with the following equation:

E_{NMVOC} (t Emissions from NMVOCs in CO_2-equivalents

CO_2 equivalents = 0.85 • $NMVOC_t$ • 44/12) = population (t) • 0.3 • (177/1000) • (1-0.89)

Where:

- 0.85 = Carbon content fraction of NMVOC
- $NMVOC_t$ = Total NMVOC emissions in the year t
- 44/12 = Conversion factor

4.5.3.11 Uncertainties

Uncertainty estimates for emissions from Solvent use were revised in response to a remark by the ERT during the review of Iceland´s 2013 submission. NMVOC emissions along with respective uncertainty estimates were calculated for nine subcategories. Subsector AD and EF uncertainties were combined by multiplication using equation 3.1 (page 3.28) of the 2006 IPCC Guideline. The main source for EF uncertainties were uncertainties and value ranges given in the EMEP GB. The combined subsector uncertainties were then combined into one value due to the relative insignificance of CO_2 emissions from this sector. Combination of uncertainties was achieved by using equation 3.2 (page 6.28) using 2013 emissions as uncertain quantities. Combined AD uncertainty for the sector was 59%, combined EF uncertainty 170%. This resulted in 180% total uncertainty for CO2 emission from the sector. Table 4.7 shows the uncertainties for the subsectors and the respective references.

Table 4.7. Subsector AD and EF uncertainties for CO_2 emissions from solvent use

Subsector	AD uncertainty	EF uncertainty
Paint application	100[a]	57[b]
Degreasing	200[a]	96[b]
Dry cleaning	1000[b]	105[b]
Chemical products	20[a]	500[b]
Printing	50[a]	320[b]
Other domestic use	5[a]	200[b]
Other product use: wood preservation, creosote	100[a]	36[b]
Other product use: wood preservation, organic solvent borne preservative	100[a]	44[b]
Other product use: tobacco[c]	50[a]	108[b]

a = expert judgement; b = EMEP GB; c= reported in 2G

4.6 Product Uses as Substitutes for Ozone Depleting Substances (CRF sector 2F)

4.6.1 Overview

In Iceland Hydrofluorocarbons (HFCs) are used first and foremost in refrigerants. HFCs substitutes' ozone depleting substances like the chlorofluorocarbon (CFC) R-12 and the hydrochlorofluorocarbons (HCFCs) R-22 and R-502, which are being phased out by the Montreal Protocol.

HFCs were first imported to Iceland in 1993. The use of fluorinated gases were regulated in 1998 with the implementation of regulation 230/1998 later repealed with regulation no. 834/2010. Regulation 834/2010 bans production, import and sale of HFCs (and CFCs) or products containing HFCs with the exception of HFCs used in refrigerants, air conditioning equipment and in metered dose inhalers (MDIs). This diction thus implies a ban of HFC use as foam blowing agent and HFC contained in hard cell foams imported (2F2), its use in fire protection (2F3), as aerosols (2F4) with the exception of metered dose inhalers and as solvents (2F5). The bans of production, import and sale of HFCs reached to the year 2013 and have not been re-established.

The use of HFCs in the refrigeration and air conditioning sector (2F1) spans the following applications:

- domestic refrigeration,
- commercial refrigeration,
- transport refrigeration,
- industrial refrigeration,
- Residential and Commercial AC, including heat pumps
- mobile air conditioning (MAC).

HFCs are also used in metered dose inhalers (2F4). The structure of the source category consumption of product uses as substitutes for ozone depleting substances is shown in Table 4.8. Use of HFCs in other sub-source categories is not occurring.

Table 4.8 Source category structure of product uses as substitutes for ozone depleting substances.

<table>
<tr><th>GHG source category</th><th colspan="2">GHG sub-source category</th><th>Further specification</th></tr>
<tr><td rowspan="9">2F1
Refrigeration and Air Conditioning</td><td rowspan="6">Refrigeration and Stationary Air Condition (2F1a)</td><td>Domestic Refrigeration</td><td></td></tr>
<tr><td>Commercial Refrigeration</td><td>Combination of stand-alone and medium & large commercial refrigeration</td></tr>
<tr><td rowspan="2">Transport Refrigeration</td><td>Reefers</td></tr>
<tr><td>Fishing vessels</td></tr>
<tr><td>Industrial Refrigeration</td><td>Food industries such as fish farming, meat processing, and vegetable production</td></tr>
<tr><td>Residential and Commercial AC, including heat pumps</td><td></td></tr>
<tr><td colspan="2" rowspan="3">2F1b
Mobile Air Conditioning (MAC) (2F1b)</td><td>Passenger cars</td></tr>
<tr><td>Trucks</td></tr>
<tr><td>Coaches</td></tr>
<tr><td>2F4
Aerosols</td><td colspan="3">Metered Dose Inhalers (MDI)</td></tr>
</table>

The commercial fishing industry is one of Iceland´s most important industry sectors, yielding total annual catches between one and two million tonnes since 1990. Directly after catch and processing, fish is either cooled or frozen and shipped to the market. A substantial part of the Icelandic fleet replaced refrigeration systems that used CFCs and HCFCs as refrigerants with systems that use ammonia. Some ships, especially smaller ones, retrofitted their systems with HFCs due to the fact that the additional space requirements of ammonia based systems exceeded available space. The phase of retrofitting and replacing refrigerant systems in the fishing industry is still on-going. A ban of importing new R-22, became effective in 2010 and the impending ban on importing recovered R-22 leads to a price increase for R-22 and adds urgency to the process.

Refrigeration systems on-board ships are fundamentally different from systems on land regarding their susceptibility to leakage. Therefore they are allocated to transport refrigeration, as are refrigerated containers (reefers). Industrial refrigeration, on the other hand, comprises refrigeration systems used in food industries such as fish farming, meat processing, and vegetable production.

The most commonly used HFCs are HFC-125, HFC-134a, and HFC-143a. They are imported in bulk and in equipment such as domestic refrigerators, vehicle air conditionings, reefers and MDIs. All other HFCs are imported in bulk only.

In this chapter the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 34 is used to label HCFCs and HFCs (ASHRAE, 2007). It consists of the letter R and additional numbers and letters. HFC notations are used later on when the R-blends have been disaggregated by calculations into the HFCs contained in them.

4.6.2 Refrigeration and Air Conditioning (CRF 2F1)

4.6.2.1 Methodology

Emissions for the refrigeration and air conditioning sector are estimated using the 2006 IPCC Guideline Tier 2a - Emission-factor approach. For some sectors, however, the approach had to be modified since no information on the amount of units and their average charge could be collected. Instead the bulk import of HFCs was allocated to sub-source categories based on expert judgement. This will be explained in more detail in the chapter on activity data.

4.6.2.2 Source specific QA/QC procedures

The spread sheets employed in the calculation of HFC emissions from refrigeration and air conditioning equipment were designed thus that they included error diagnoses and control mechanisms. An example for such a control mechanism is the comparison between the HFC amounts imported for a certain refrigeration sub-source until 2013 and the sum of all sub-source emissions until 2013 and the amount allocated to the sub-sources 2014 stock. This difference had to be zero.

4.6.2.3 Activity data

All HFCs used in Iceland are imported, the majority of which in bulk. The amounts imported are recorded by Customs Iceland whence it is reported to the EA. Since 1995 importers also have to apply at the EA for permits to import HFCs. R-134A and R-404A are also imported in equipment such as reefers, vehicle ACs and domestic refrigerators.

The bulk import of refrigerants is subdivided thusly into the following applications:

- All R-407C and R-410A amounts are allocated to Residential and Commercial AC, including heat pumps.
- Since reefers are refilled, the amount of R-134A and R-404A leaking from reefers is replaced by corresponding amounts of imported R-134A and R-404A.
- 65% of the import of each remaining refrigerant - all refrigerants with the exceptions of R-407C, R-410A and fractions of R-134A and R-404A - are allocated to fishing vessels (transport refrigeration)
- 20% of all remaining refrigerants are allocated to industrial refrigeration
- 15% of all remaining refrigerants are allocated to commercial refrigeration

This division is based on two sources of information: A) sales data supplied by the main importers of refrigerants as well as B) a poll of the majority of companies designing, installing and servicing a broad range of refrigeration systems. Nevertheless, the EA is aware that this method simplifies the sector. Figure 4.4 shows the quantity of HFCs introduced to Iceland in bulk between 1993 and 2014.

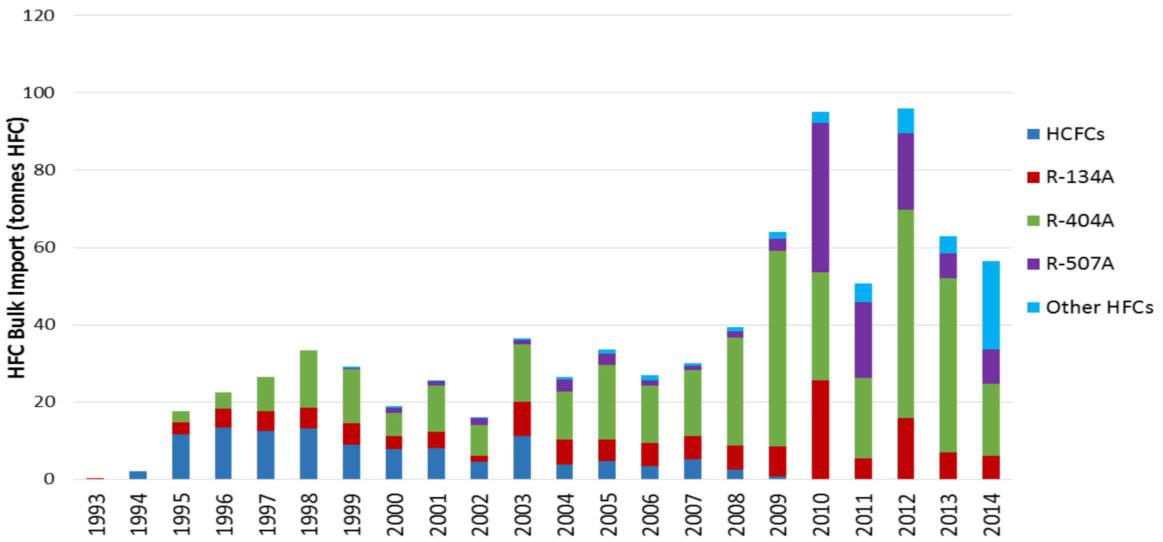

Figure 4.4 Quantity of HFCs imported in bulk to Iceland between 1993 and 2014.

Information on the amount of reefers in stock along with information on the sort of refrigerants contained in them was obtained from major stakeholders. During the 1990s R-12 in reefers was replaced by R-134A. Today reefers contain either R-134A or R-404A. The average refrigerant charge per reefer is 5 kg refrigerant. Due to the limited amount of stakeholders involved in the sector, further information is confidential.

Information on registered vehicles was obtained from the Road Traffic Directorate. This data consisted of annual information dating back to 1995 on the number of registered vehicles subdivided by vehicle classes and their first registration year. Vehicle classes were aggregated based on estimated refrigerant charges:

- EU classes M1, M2, and N1: GPG default of 0.8 kg for passenger cars
- EU classes N2 and N3 (trucks): GPG default of 1.2 kg for trucks
- EU class M3 (coaches): country specific value of 10 kg (expert judgement)

The information on vehicles' first registration years was used to estimate the amount of vehicles equipped with (R-134A containing) MACs. Based on a study by the EU (Schwarz et al., 2011) it is assumed that 80% of all vehicles manufactured today (i.e. since 2010) contain MACs. This value was reduced linearly to 5% in 1995, the first year in which the automobile industry used R-134A in new vehicles.

Based on expert judgement it is assumed that all domestic refrigerators imported to Iceland from the US since 1993 contain R-134A as refrigerant whereas refrigerators from elsewhere contain non-HFC refrigerants. The average charge per refrigerator is estimated at 0.25 kg. This estimation is in line with the range given by the 2006 IPCC GL 0.05-0.5 kg (Table 7.9, page 7.52).

4.6.2.4 Emission factors

Total emissions from refrigeration and air conditioning equipment are calculated using equation 7.4 from the 2006 IPCC Guideline (p. 7.17).

EQUATION 7.4

Total Emissions = Assembly/Manufacture Emissions + Operation Emissions + Disposal Emissions

Assembly or Manufacture emissions include the emissions associated with product manufacturing or when new equipment is filled with chemical for the first time.

Operation emissions include annual leakage or diffusion from equipment stock in use as well as servicing emissions.

Disposal emissions occur when the product or equipment reaches its end-of-life and is decommissioned and disposed of.

Assembly or manufacture emissions are calculated by multiplying the amount of HFC and PFC charged into new equipment with an emission factor k that represents the percentage of initial charge that is released during assembly of the e.g. refrigeration system (equation 7.12 in the 2006 IPCC Guideline). Sub-source values used as k are presented in Table 4.9.

Operation emissions are calculated by multiplying the amount of HFC and PFC in stock with an annual leak rate x (equation 7.13 in the 2006 IPCC Guideline). Sub-source values used for x are shown in Table 4.9.

The calculation of disposal emissions requires information on the average lifetime n of equipment, see equation 7.14. The average lifetime is not only necessary to allocate disposal emissions to an appropriate year but also to estimate the charge remaining in equipment (y) by continually discounting the original charge with n years. If refrigerants are recovered during disposal, the disposal emissions have to be reduced with a recovery efficiency factor z. This factor will be zero if no refrigerant recycling takes place. Recovery efficiency factors used are also shown in Table 4.9 (Sources for the majority of values are taken for the 2006 IPCC Guideline, Tables 7.9 pages 7.52.).

The equation for disposal emissions is shown below:

EQUATION 7.14

Disposal Emissions = (HFC and PFC Charged in year t – n) • (y / 100) • (1 – z / 100) – (Amount of Intentional Destruction)

Table 4.9 Values used for charge, lifetime and emission factors for stationary refrigeration equipment and mobile air conditioning.

Application	HFC charge (kg/unit)	Lifetime n (years)	Initial EF k (% of initial charge)	Lifetime EF x (%/year)	End-of-life EF z (% recovery efficiency)
Domestic refrigeration	0.25	12	NO	0.3%	70%
Commercial refrigeration	NE	9	2%	10%	80%
Transport ref.: reefers	5	NE	NO	15%	NE
Transport ref.: fishing vessels	NE	7	2%	Linear decrease from 50% in 1993 to 20% in 2012	75%
Industrial refrigeration	NE	15	2%	10%	85%
Residential AC	NE	12	1%	3%	75%
MAC: passenger cars	0.8	14	NO	10%	0%
MAC: trucks	1.2	14	NO	10%	0%
MAC: coaches	10	14	NO	10%	0%

The lifetime for domestic refrigerators is at the lower end of the range given by the 2006 IPCC Guideline. The lifetime EF and the efficiency of recovery at end of life are 2006 IPCC Guideline default values. Initial emissions are not occurring as domestic refrigeration equipment's are assembled prior to import. The same applies for reefers and MACs. Transport refrigeration equipment on fishing vessels, commercial and industrial refrigeration equipment as well as residential ACs; however they are assembled on site and are therefore attributed with initial EFs. These initial EFs as well as lifetimes for other sub-source categories are taken from the ranges given in the 2006 IPCC Guideline default values. Stand-alone and medium & large commercial refrigeration are combined into one sub-source. Both commercial and industrial refrigeration lifetime EFs are estimated at 10%. Thus they are in the lower half of the ranges given by the 2006 IPCC Guideline (both commercial applications together have a lifetime EF range from 1-35%). The value was chosen based on information from the poll of the Icelandic refrigeration sector mentioned above.

Leakage on shipping vessels has decreased to a considerable extent in the last decades. This is mainly a consequence of the higher prices of HFC refrigerants compared to the prices of their predecessors. Higher refrigerant prices make leakage detection and reduction more feasible. The employments of leak detectors and routine leakage searches have become common practice on fishing vessels. Therefore it can be assumed that the lifetime EF of shipping vessels has decreased since the introduction of HFCs. The lifetime EF of shipping vessels for the beginning of the period is assumed to be at the upper end of the range for transport refrigeration (50%). This EF is lowered linearly to 20% in 2012, which equals 1.6% decrease each year. The latter value was determined after evaluation of information from the above mentioned poll.

Values for residential AC are default values given by the 2006 IPCC Guideline as are the recovery efficiencies for all applications.

No HFC charge amounts are given for commercial refrigeration, fishing vessels, industrial refrigeration and residential AC. No information exists on the average charge and the number of units for these sub-source categories. Therefore the bottom-up approach was modified. Instead of estimating sub-source specific HFC amounts by multiplying units with their average charge, imported HFC bulk amounts were divided between sub-sources using fractions (cf. explanations above). The bulk import is then treated as the equipment in which it is contained thus that it is attributed with a sub-source specific lifetime n. After n years the part of initially imported HFC not yet emitted is disposed of or rather recovered. The poll revealed that the majority of refrigerants are recovered. Therefore it is assumed that the share not lost during recovery (1-z) is reused thus remaining in the same sub-source´s stock.

Reefers are periodically refilled. Therefore their initial charge is deemed constant and the amount emitted (and refilled) is subtracted from the amounts of R-134A and R-404A imported in bulk during the same year. Based on expert judgment the lifetime EF for reefers is estimated to be 15%. This method implies end-of-life emissions in lifetime emissions: by assuming refill the charge of each reefer is renewed every 6-7 years.

The lifetime of vehicles is based on information collected by the Icelandic recycling fund. The average age of vehicles at end-of-life is 14 years. The lifetime EF is at the lower end of the range given in the 2006 IPCC Guideline. This is justified by the prevailing cold temperate climate which limits AC use. The recovery efficiency is set to zero since no refrigerant recovery takes place when vehicles are prepared for destruction.

4.6.2.5 Emissions

Emitted refrigerants are dissected into constituent HFCs. HFC emissions are aggregated by multiplying individual HFCs with respective GWPs leading to totals in CO_2 eq. All values and fractions below relate to aggregated emissions are expressed in CO_2 eq.

Total emissions from all refrigeration and air conditioning equipment amounted to 170.1 kt in 2013 which is 0.4% decrease compared to 2012 emissions Figure 4.5.

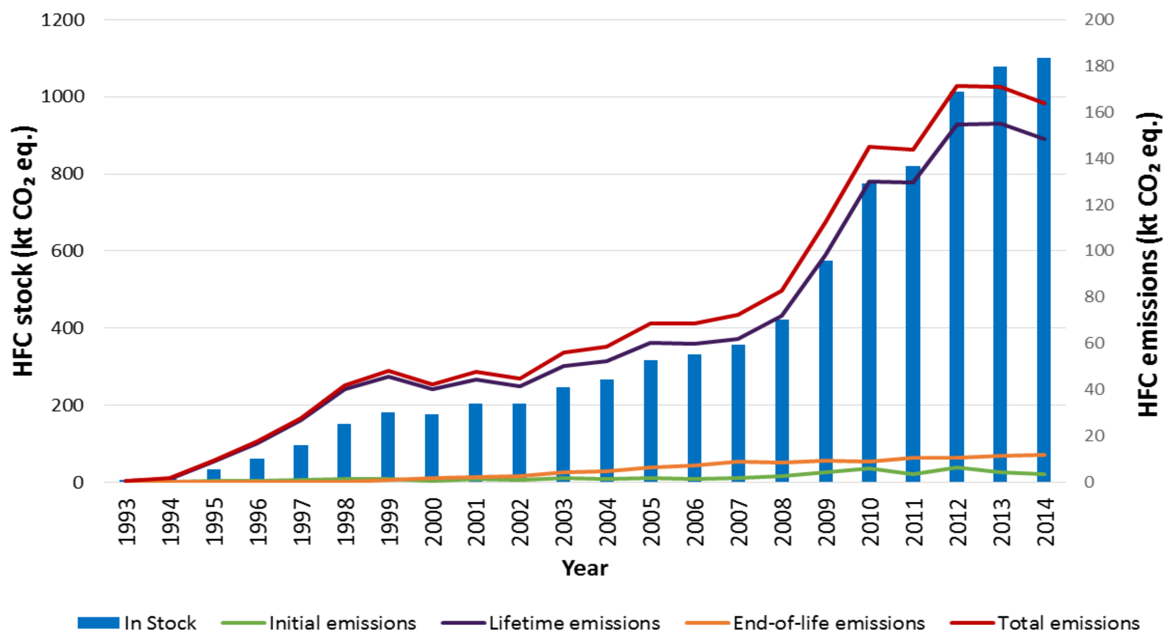

Figure 4.5 HFC stock (primary y-axis) and emissions (secondary y-axis) from refrigeration and air conditioning equipment. Included are domestic refrigeration, commercial refrigeration, industrial refrigeration (fishing vessels and reefers), residential ACs and MACs.

Lifetime emissions are 94.3% of total emissions, 3.1% are end-of-life emissions and 2.6% are initial emissions. The low fraction of initial emissions is mainly caused by comparably low initial EFs and to a lesser extent by the fact that equipment of some sub-sources is assembled outside Iceland. The low fraction of end-of-life emissions is caused by the fact that the majority of refrigerants are recovered at-end-of-life. Another factor is that the amount of imported HFCs has been steadily increasing since their introduction. The amount of equipment being retired now, i.e. equipment imported or installed during the late 90s and early 2000s is therefore comparatively low. This also means that end-of-life emissions will increase in years to come.

Almost two thirds of the 2014 emissions stem from refrigeration systems on fishing vessels. Total transport refrigeration emissions, i.e. including reefers, account for 65% of all HFC emissions. Other important sectors are industrial refrigeration (17%), commercial refrigeration (13%), and MACs (4%). Residential AC emission shares are within 1% of total refrigeration and AC emissions due to low EFs and no sub-source HFC import until 1999. Emissions from domestic refrigeration constitute less than 0.1% of total refrigeration emissions due to the insignificance of imported refrigerant amounts (Figure 4.6).

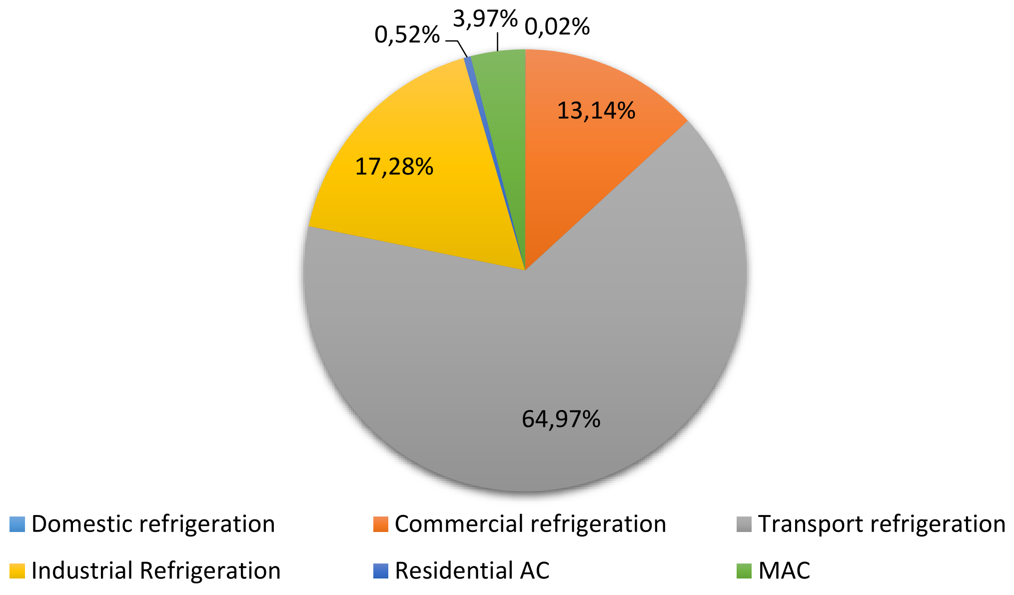

Figure 4.6 2014 emission distribution of refrigeration and AC sub-source categories.

The relations between imports, stock development and emission trends are shown below for fishing vessels and MAC. The stock of HFCs in refrigeration systems on fishing vessels (Figure 4.7) shows a distinct increase between 2008 and 2010 an again in 2012. This is caused by a stark import increase of especially R-404A and R-507A, two refrigerants with high GWPs. The import decrease in 2011 which slows the growth of the sub-source´s HFC stock but the record import of bulk HFC in 2012 accelerates stock growth again. Lifetime emissions increase between 2013 and 2014 (although the EF is being decreased from 21.6% to 20%) due to greater amounts in stock. End-of-life emissions start in 1999 when the first equipment containing HFC imported in 1993 is retired (after emitting lifetime emissions for 7 years). The imports, stock development and emission trends for commercial and industrial refrigeration follows the same trends on different scales and with different onset years for end-of-life emissions.

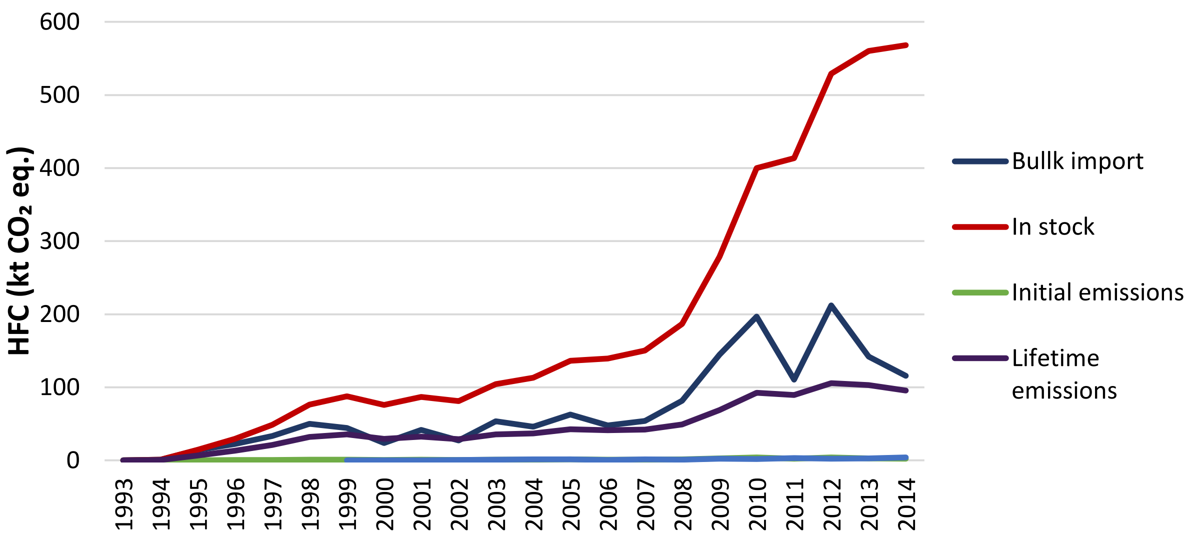

Figure 4.7 Import, stock development and emissions from refrigeration systems on fishing vessels between 1993 and 2014.

The graph for MACs (Figure 4.8) does not show import quantities as information exists on the vehicle stock. HFC amount in stock rises between 1995 and 2007 not only because of the assumed linear increase in the share of vehicles with ACs but also because of a 75% increase in fleet size. Since 2007 the fleet size has been more or less stagnant at around 240,000 vehicles. The stable fleet size from 2007 to 2011, in interaction with a stagnant vehicle AC share of 80% since 2010, led to a decrease in stock until 2011 which was caused by the precedence of lifetime emissions over additions to the stock in form of new vehicles. The vehicle fleet size increased again in 2013 leading to a stock increase during the same year.

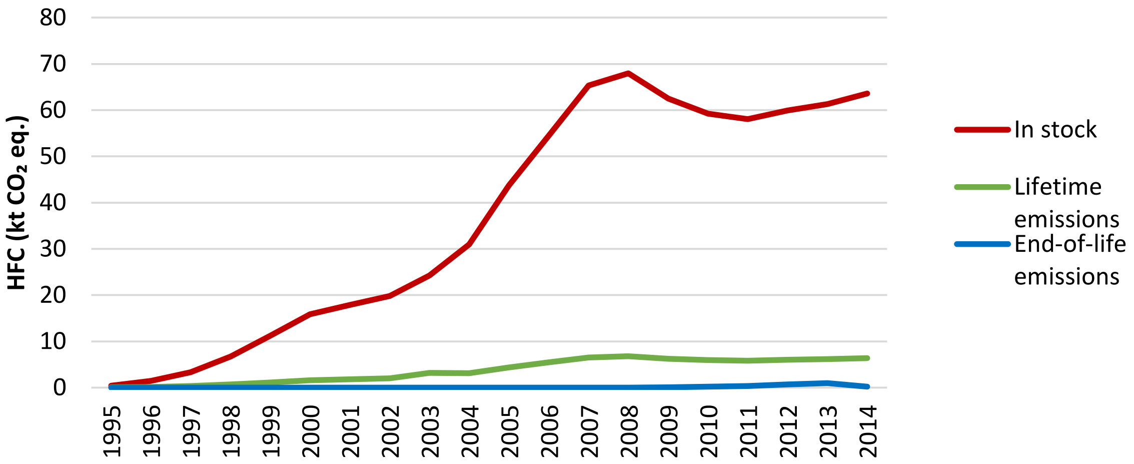

Figure 4.8 Emissions from mobile air conditioning (MACs).

4.6.2.6 Uncertainties

Emission factor uncertainty of the refrigeration and air conditioning sector were calculated by relating the lifetime emission factor ranges given in tables 3.22 and 3.23 to the respective values used. Initial and end-of-life emission factors were not considered since they play a very minor role when compared to lifetime emissions and activity data uncertainty. The only exception to this rule is domestic refrigeration where end-of-life emissions outweigh lifetime emissions. Their relative share of total refrigeration emissions, however, is only 0.02%.

AD uncertainty was estimated by expert judgement and is deemed to be a factor of one or two for most sub-source categories. In order to comply with the methodology of uncertainty calculations for the inventory as a whole, sub-source EF and AD uncertainties were first summarized separately by weighting them with 2013 emission quantities. The resulting EF and AD certainties were then combined by multiplication. Uncertainty factors are summarized in Table 4.10.

Table 4.10 Lifetime EFs used along with EF ranges given in the GPG; calculated EF uncertainties and estimated AD uncertainties as well as 2014 emission shares used to weight uncertainties.

Value ranges (Lifetime EF)	EF, lower bound	EF, upper bound	Lifetime EF used	EF uncertainty (%)	AD uncertainty (%)	2014 emission share	Combined unceratinty (%)
Domestic ref.	0.1	0.5	0.3	67	500	0.0%	
Commercial ref.	5.5	20	10	100	200	12.7%	
Fishing vessels	15	50	35	57	200	C	
Reefers	5	20	10	100	50	C	
Industrial ref.	7	25	10	150	100	16.4%	
Residential AC	1	5	3	67	200	0.4%	
MAC	10	20	10	100	100	4.2%	
Weighted unc.				81	176		193

4.6.2.7 Recalculations and improvements

For the 2015 submissions, the GWP was updated in accordance with table 2.14 of the Fourth Assessment report (AR4). Minor recalculations took place between 2015 and 2016 submissions. Activity data for 2013 was updated according to reports submitted according to the EU-ETS. Refilling of HFC amounts leaked from reefers between 1993 and 1995 had not been dealt with in the 2016 submission. In this submission the HFC 134A amount that had leaked from reefers between 1993 and 1995 was subtracted from the bulk amount imported in 1995. This reduced HFC 134A import allocated to fishing vessels, commercial and industrial refrigeration and subsequent HFC emissions from these subsectors. The difference is greatest in the year of the reallocation (1995: 0.57 kt CO_2 eq.) but decreases with time due to the decreasing influence of stock changes in 1995 on more recent lifetime emissions. In 2012 the difference was less than 0.01 kt CO_2 eq.

4.6.3 Aerosols (CRF 2F4)

Regulation 834/2010 bans the production, import, and sale of aerosols products containing HFCs with the exception of HFCs used metered dose inhalers (MDIs).

4.6.3.1 Methodology

Emissions from MDIs are calculated using equation 3.35 in the GPG.

4.6.3.2 Activity data

The Icelandic Medicines Agency records import of MDIs containing R-134A since 2002. The amount of R-134A in MDIs imported has been oscillating between 500 and 650 kg since that time.

4.6.3.3 Emission factors

According to GPG methodology it is good practice to use an EF of 50% for MDIs. This entails that 50% of R-134A imported in MDIs is emitted during the import year, whereas the remaining 50% are emitted during the following year along with 50% of that following year´s import.

4.6.3.4 Emissions

Emissions from MDIs in 2014 were 0.90 kt CO_2 eq. which is similar to emissions since 2012.

4.6.3.5 Uncertainties

Uncertainty of HFC emissions from MDIs was not calculated separately. Although uncertainty of emission estimates for MDIs is deemed less than uncertainty of emission estimates for refrigeration subsector uncertainty, it is implied in total HFC consumption uncertainty. This is justified by the relative insignificance of MDI emissions compared to refrigeration emissions.

4.7 Other Product Manufacture and Use (CRF sector 2G)

4.7.1 Electrical Equipment (CRF 2G1)

4.7.1.1 Use of Electrical Equipment (2G1b)

Overview

Sulphur hexafluoride (SF_6) is used as insulation gas in gas insulated switchgear (GIS) and circuit breakers. The number of SF_6 users in Iceland is small. The bulk of SF_6 used in Iceland is used by Landsnet LLC which operates Iceland´s electricity transmission system. Additionally, a number of energy intensive plants, like aluminium smelters and the aluminium foil producer have their own high voltage gear using SF_6.

Methodology

SF_6 nameplate capacity development data as well as SF_6 quantities lost due to leakage were obtained from the above mentioned stakeholders. The data regarding leakage consisted of measured quantities as well as calculated ones. Measurements consisted mainly of weighing amounts used to refill or replace equipment after incidents. Quantities were calculated either by allocating periodical refilling amounts to the number of years since the last refilling or by assuming leakage percentages. This approach can best be described as a hybrid of GPG Tiers 2b and 3C.

Emissions

SF_6 emissions amounted to 107.9 kg in 2014 which is tantamount to 2.5 kt CO_2 eq. or less than 0.1% of Iceland´s total GHG emissions in 2014. Emissions increased by 124% since 1990. However, this increase is slightly less than proportional compared to the net increase in SF_6 nameplate capacity since 1990.

Figure 4.9 shows both nameplate capacity development and emissions between 1990 and 2014. The spike in 2010 is caused by two unrelated incidents during which switchgear was destroyed and SF_6 emitted. The spike in 2012 is caused by an increase of emissions from Landsnet LLC.

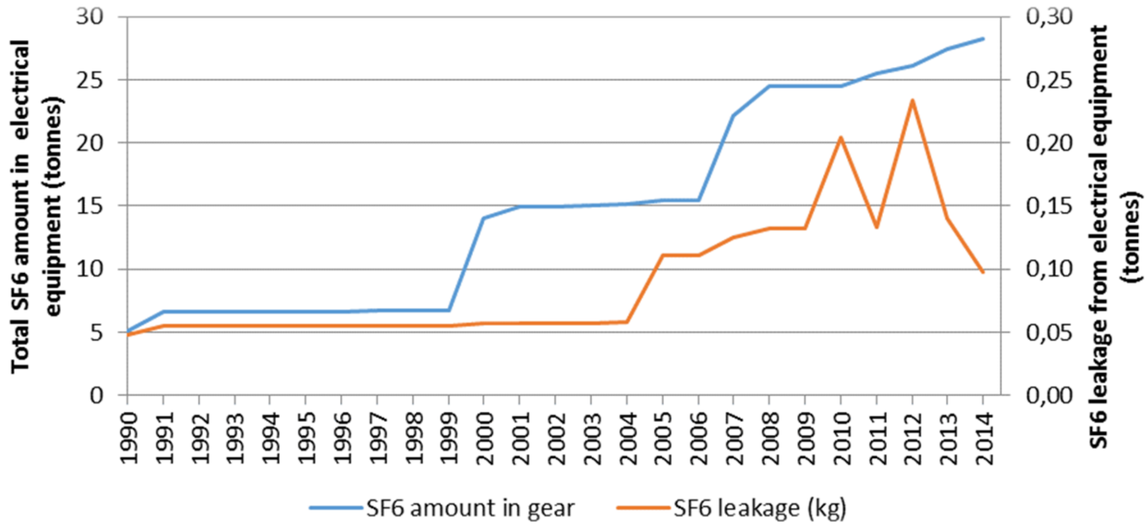

Figure 4.9 Total SF_6 amounts contained in and SF_6 leakage from electrical equipment (tonnes).

Uncertainty

Data regarding SF_6 nameplate capacity development during the last years is deemed to be accurate but deemed to be less accurate for the 1990s. The same holds true for emission estimates from the 1990s. Another source of uncertainty is a possible time lag between emissions and serving, i.e. that emissions detected by inspections performed less frequently than annual happened years ago. Monitoring devices, however, have greatly improved during the last years and the amounts in equipment and leaking from equipment are measured annually and known with good accuracy today. Uncertainty is divided into activity data uncertainty (measured amounts) and emission factor uncertainty (calculated amounts). By integrating the accuracy differences between more and less recent years AD uncertainty is estimated at 20% and EF uncertainty at 50% (expert judgement).

Recalculations

For the 2015 submissions, the GWP was updated in accordance with table 2.14 of the Fourth Assessment report (AR4). No recalculations were performed between 2013 and 2014 submissions.

4.7.2 N_2O from Product Use (CRF 2G3)

4.7.2.1 Medical Applications (2G3a)

Other (2G3c)

N2O in Iceland is almost exclusively used as anaesthetic and analgesic in medical applications, or 95%. Minor uses of N_2O in Iceland comprise its use in fire extinguishers and as fuel oxidant in auto racing.

N_2O emissions from product uses were calculated using the 2006 guidelines. Activity data stems from import and sales statistics from the two importers of N_2O to Iceland and is therefore confidential. It is assumed that all N_2O is used within 12 months from import/sale. Therefore emissions were calculated using equation 8.24 of the 2006 IPCC guideline, which assumes that half of the N_2O sold in year t are emitted in the same year and half of them in the year afterwards.

EQUATION 8.24

$$EN_2O\,(t) = \Sigma i \{ [0.5 \bullet Ai(t) + 0.5 \bullet Ai(t-1)] \bullet EFi \}$$

Where:

- $E_{N2O}(t)$ = emissions of N_2O in year t, tonnes
- A_i (t) = total quantity of N_2O supplied in year t for application type i, tonnes
- A_i (t-1) = total quantity of N_2O supplied in year t-1 for application type i, tonnes
- EF_i = emission factor for application type i, fraction

The 2006 IPCC Guideline recommends an emission factor of 1 for medical use of N_2O. This emission factor is also used for other N_2O uses. Total emissions from N_2O use decreased from 19.4 tonnes N_2O in 1990 to 9.7 tonnes N_2O in 2014.

Uncertainties

The 2006 IPCC Guideline methodology accounts for a time lag between N_2O sale and its application. Activity data used in the emission inventory did not consist of sales data but of import data. Therefore the time lag might be greater than the 12 months the methodology accounts for. Therefore AD uncertainty is estimated to be +- 20% accurate in spite of accurate data on imports (expert judgement). An EF uncertainty of 5% is estimated in compliance with the value used in Denmark´s NIR (Nielsen et al., 2012). Combined uncertainty for N_2O emissions from other product use is therefore estimated to be 21%.

4.7.3 Other: Tobacco combustion (CRF 2G4)

NMVOC, NOx and CO emissions from tobacco combustion were calculated using the EMEP/EEA (EMAP/EEA, 2013) guidebook. Tier 2 emission factors for tobacco combustion were 4.84 g/tonne tobacco for NMVOC, 18,000 g/tonne tobacco for NOx and 55,100 g/tonne tobacco for CO. Activity data consisted of all smoking tobacco imported and was provided by Statistics Iceland (Statistics Iceland, 2015).

5 Agriculture (CRF sector 3)

5.1 Overview

Icelanders are self-sufficient in all major livestock products, such as meat, milk, and eggs. Traditional livestock production is grassland based and most farm animals are native breeds, i.e. dairy cattle, sheep, horses, and goats, which are all 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 partly through imported breeds, as is most poultry and all pork production. There is not much arable crop production in Iceland, due to a cold climate and short growing season. Cropland in Iceland consists mainly of cultivated hayfields, but potatoes, barley, beets, and carrots are grown on limited acreage.

The total GHG emissions from Agriculture amounted to 747 kt CO_2-eq in the year 2014 and were 4% below the 1990 level. Emissions of CH_4 and N_2O accounted for around 99% of the total emissions and CO_2, NOx and NMVOC accounted for the rest. The decrease of GHG emissions since 1990 is mainly due to a decrease in sheep livestock population, reducing methane emissions from enteric fermentation and reduced fertilizer application reducing N_2O emissions from agricultural soils. 86% of CH_4 emissions were caused by enteric fermentation, the rest by manure management. 88% of N_2O emissions were caused by agricultural soils, the rest by manure management, i.e. storage of manure.

5.1.1 Methodology

The calculation of greenhouse gas emissions from agriculture is based on the methodologies suggested by the 2006 IPCC Guidelines (IPCC, 2006).

The methodology for calculating methane emissions of cattle and sheep from enteric fermentation and manure management is based on the enhanced livestock population characterisation and therefore in accordance with tier 2 methodology. Tier 1 methodology is used to calculate methane emissions from enteric fermentation and manure management of other livestock. The methodology for calculating N_2O emissions from agricultural soils is in accordance with the Tier 1a method of the IPCC Good Practice Guidance, GPG (IPCC, 2000). The sub-source N in crop residue returned to soils, however, was calculated using the Tier 1b method. Indirect N_2O emissions from nitrogen used in agriculture were calculated using the Tier 1a method.

5.1.2 Key Source Analysis

The key source analysis performed for 2014 revealed the following greenhouse gas source categories from the agriculture sector to be key sources in terms of total level and/or trend:

Table 5.1 Key source analysis for Agriculture, 1990, 2014 and trend (excluding LULUCF).

IPCC source category			Level 1990	Level 2014	Trend
Agriculture (CRF sector 3)					
3.A	Enteric Fermentation	CH_4	✓	✓	✓
3.B	Manure Management	CH_4	✓		
3.B	Manure Management	N_2O	✓	✓	✓
3.D.1	Direct N_2O Emissions From Managed Soils	N_2O	✓	✓	✓
3.D.2	Indirect N_2O Emissions From Managed Soils	N_2O	✓	✓	

5.1.3 Completeness

Table 5.2 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 Agricultural sector.

Table 5.2 Agriculture – completeness (E: estimated, NE: not estimated, NA: not applicable, NO: not occurring).

Sources	CO_2	CH_4	N_2O
Enteric Fermentation (3A)	NA	E	NA
Manure Management (3B)	NA	E	E
Rice Cultivation (3C)	NOT OCCURING		
Agricultural Soils (3D)	NA	NA	E
Other	NOT OCCURING		
Prescribed burning of Savannas (3B)	NOT OCCURING		
Field burning of Agricultural Residues (4F)	NOT OCCURING		
Other (4G)	NOT OCCURING		

5.2 Activity Data

5.2.1 Animal Population Data

The Icelandic Food and Veterinary Authority (IFVA) conducts an annual livestock census. For the census, farmers count their livestock once a year in November and send the numbers to the IFVA. Consultants from local municipalities visit each farm during March of the following year and correct the numbers from the farmers in case of discrepancies. The IFVA reports the census to Statistics Iceland which publishes them.

This methodology provides greenhouse gas inventories which need information on livestock throughout the year with one problem: young animals that live less than one year and are slaughtered at the time of the census are not accounted for (lambs, piglets, kids, a portion of foals, and chickens). The population of lambs was calculated with information on infertility rates, single, double, and triple birth fractions for both mature ewes and animals for replacement, i.e. one year old ewes (Farmers Association of Iceland, written information, 2012). Number of piglets was calculated with data on piglets per sow and year (Farmers Association of Iceland, written information, 2012). Number of kids was calculated with information on birth rates received from Iceland´s biggest goat farmer (Þorvaldsdóttir, oral information, 2012). Numbers of foals missing in the census as well as hen, duck and turkey chickens were added with information received from the association of slaughter permit holders and poultry slaughterhouses. Numbers for young animals with a live span of less than one year were weighed with the respective animal ages at slaughter:

- Lambs: 4.5 months
- Piglets: 5.9 months (1990) – 4.5 months (2010)
- Foals: 5 months
- Kids: 5 months
- Chickens (hens): 1.1 months
- Chickens (ducks): 1.7 months
- Chickens (turkeys): 2.6 months

As a result, the numbers of several animal species are higher in the NIR than they are in the national census. While differences are small for horses (2% in 2014), they are considerably higher for sheep and poultry (36 and 250%, respectively). Number of swine, however, is twelve times higher in the NIR than in the national census.

5.2.2 Livestock Population Characterization

Enhanced livestock population characterisation was applied to cattle and sheep and subsequently used in estimating methane emissions from enteric fermentation and manure management.

In accordance with the census there are five subcategories used for cattle in the livestock population characterisation: mature dairy cows, cows used for producing meat, heifers, steers used principally for producing meat, and young cattle. The subcategories “cows used for producing meat” and “heifers, and steers used principally for producing meat” were aggregated in the category “other mature cattle”. The subcategory steers used principally for producing meat was the most heterogeneous in the census since it contains all steers between one year of age and age at slaughter (around 27 months) as well as heifers between one year of age and insemination (around 18 months). The population data did not permit dividing this subcategory further. The share of females inside the category was estimated by assuming that there were as many cows as steers inside the subcategory, only for a shorter time (6 vs. 15 months). This results in a share of cows of 29%. The subcategory young cattle contained both male and female calves until one year of age. Fractions of male and female calves fluctuated slightly between years.

For sheep, the subcategory lambs was added to the census data. The following four categories were used for the livestock population characterization: mature ewes, other mature sheep, animals for replacement and lambs.

Table 5.3 shows the equations used in calculating net energy needed for maintenance, activity, growth, lactation, wool production and pregnancy for cattle and sheep subcategories. Equation 4.9 was used to calculate the ratio of net energy available in the animals´ diets for maintenance to the digestible energy consumed and equation 4.10 from the GPG was used to calculate the ratio of net energy available in the animals´ diets for growth to the digestible energy consumed. Net energy needed and ratios of net energy available in diets to digestible energy consumed were subsequently used in equation 4.11 calculate gross energy intake for cattle and sheep subcategories.

Table 5.3. Overview of equations used to calculate gross energy intake in enhanced livestock population characterisation for cattle and sheep (NA: not applicable).

Subcategory	Equations from IPCC 2006 guidelines. Net energy for maintenance, activity, growth, lactation, wool, and pregnancy					
	maintenance	activity	growth	lactation	wool	pregnancy
Mature dairy cows	10.3	10.4	NA	10.8	NA	10.13
Cows used for producing	10.3	10.4	NA	10.8	NA	10.13
Heifers	10.3	10.4	10.6	NA	NA	4.8
Steers used principally for producing meat	10.3	10.4	10.6	NA	NA	NA
Young cattle	10.3	10.4	10.6	NA	NA	NA
Mature ewes	10.3	10.4	NA	10.10	10.12	10.13
Other mature sheep	10.3	10.4	NA	NA	10.12	NA
Animals for replacement[1]	10.3	10.4	10.7	NA	10.12	10.13
Lambs	10.3	10.4	10.7	NA	10.12	NA

1: Animals for replacement are considered from their birth until they are one year of age, which is also when they give birth for the first time. Therefore net energy for pregnancy is calculated whereas net energy for lactation is not applicable.

Table 5.4 shows national parameters that were used to calculate gross energy intake for cattle in 2014. Not all parameters have been constant over the last two decades. The ones that have changed during that time period are *months on stall*, *months on pasture* and *kg milk per day*.

Table 5.4. Animal performance data used in calculation of gross energy intake for cattle in 2014. (NA: Not applicable, NO: Not occurring).

	Mature dairy cows	Cows for producing meat	Heifers	Steers for producing meat	Young cattle
Weight (kg)	430	500	370	328	126
Months in stall	8.71	1	8	11[1]	12
Months on pasture	3.29	11	4	1	0
Mature body weight (kg)	430	500	430	515[2]	515[2]
Daily weight gain (kg)	NO	NO	0.5	1	0.5
Kg milk per day	15.7	5.5	NA	NA	NA
Fat content of milk (%)	4.2	4.2	NA	NA	NA

1: Steers are not allowed outside. The young cows inside the category are grazing on pasture for 120 days. 2: average for cows and steers, not weighted.

Table 5.5 shows national parameters that were used to calculate gross energy intake for sheep in 2014.

Table 5.5. Animal performance data used in calculation of gross energy intake for sheep from 1990-2014 (no time dependent data). NA: Not applicable, NO: Not occurring

	Mature ewes	Other mature sheep	Animal for replacement	Lambs
Weight (kg)	65	95	36	21
Months in stall	7	7	7	0
Months on flat pasture	2	2	2	1
Months on hilly pasture	3	3	3	3
Body weight at weaning (kg)	NA	NA	22	22
Body weight at 1 year or old or at slaughter (kg)	NA	NA	55	38
Birth weight (kg)	4	4	4	4
Single birth fraction	0.2[1]	NA	0.6[1]	NA
Double birth fraction	0.7[1]	NA	0.1	NA
Triple birth fraction	0.1[1]	NA	NO	NA
Annual wool production (kg)	3	3	2	2
Digestible energy (in % of gross energy)	64	64	64	77

1: Difference between sum of birth fractions and one is due to infertility rates of 3.5% for mature ewes and 31% for animals for replacement.

5.2.3 Feed Characteristics and Gross Energy Intake

Submission characteristics of cattle and sheep build on feed composition, daily feed amounts, their dry matter digestibility and feed ash content. This information was collected by the AUI (Sveinbjörnsson, written communication) and is based on feeding plans and research. Feed ash content (instead of manure ash content) was used in all calculations in accordance with (Dämmgen et al. 2011). Dry matter digestibility and feed ash content were weighted with the respective daily feed amounts in order to calculate average annual values. This method included seasonal variations in feed, e.g. stall feeding versus grazing on pasture, lactation versus non-lactation period etc. Dry matter digestibility was transformed into digestible energy content using a formula from Guðmundsson and Eiríksson (1995). Table 5.6 shows dry matter digestibility, digestible energy and ash content of feed for all cattle and sheep categories. All values used as well as calculations and formulas for all cattle and sheep categories are reported in Annex V. These values are used for the 2016 submission.

Table 5.6. Dry matter digestibility, digestible energy and ash content of cattle and sheep feed.

	DMD (%)	DE (%)	Ash in feed (%)
mature dairy cows	74	68	7
cows used for producing meat	74	68	7
heifers	74	68	7
steers used principally for producing meat	73	66	7
young cattle	80	73	8
mature ewes	71	64	7
other mature sheep	71	64	7
animals for replacement	71	64	7
lambs	84	77	7

Figure 5.1 shows the gross energy intake (GE) in MJ per day for all cattle and sheep subcategories. As of the 2014 submission only mature dairy cattle have time dependent values for GE (see: chapter5.2.3). The GE of mature dairy cattle has increased from 200 MJ/day in 1990 to 239 MJ/day in 2014. This increase is owed in small part to increased activity, i.e. more days grazing on pasture) and in large part to the increase in average annual milk production from 4.1 t in 1990 to 5.7 t in 2014.

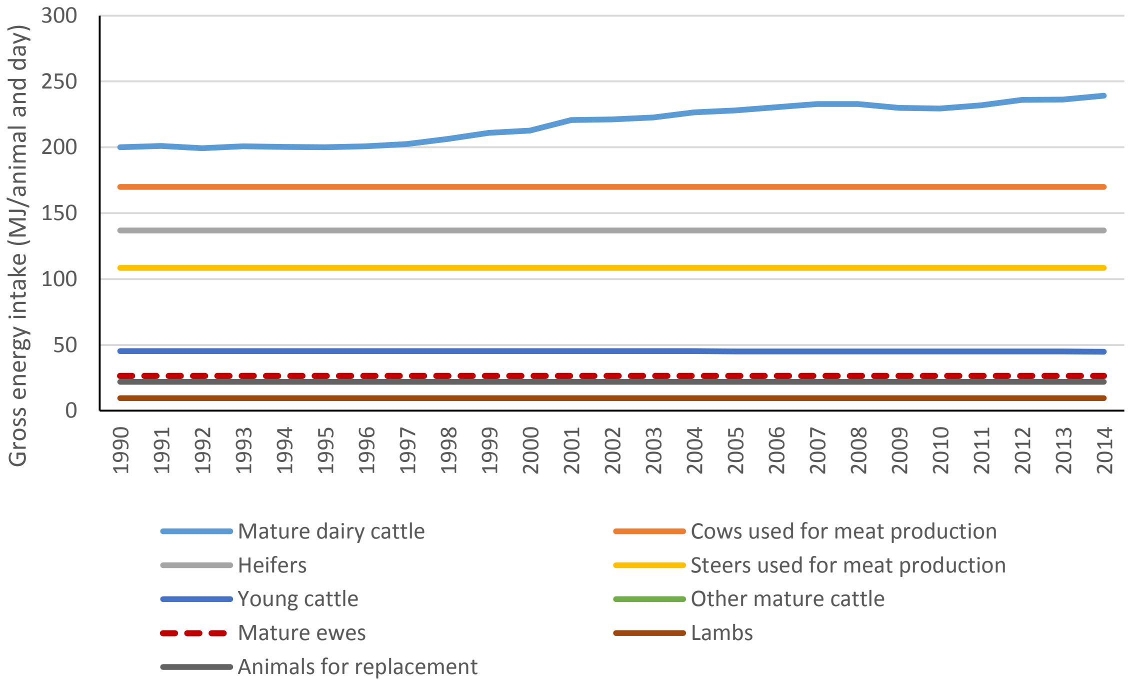

Figure 5.1 Gross energy intake (MJ/day) for cattle and sheep subcategories from 1990-2014.

5.2.4 Planned Improvements

For future submissions, characterization parameters for different animal types need to be revised. For example there is a need for updating the digestible energy content of feed for both cattle and sheep in order to reflect changes in animal nutrition that have occurred since 1990. Also there are plans of reviewing the gross energy intake (GE) in MJ per day for all cattle and sheep subcategories and animal weights for all animal types.

5.3 CH_4 Emissions from Enteric Fermentation in Domestic Livestock

The amount of enteric methane emitted by livestock is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed. Cattle and sheep are the largest sources of enteric methane emissions (IPCC, 2006).

5.3.1 Emission Factors

Livestock population characterisation was used to calculate gross energy intake of cattle and sheep. The values for gross energy intake were used to calculate emission factors for methane emissions from enteric fermentation. To this end equation 10.21 from the GPG was applied:

EGUATION 10.21

Emission factor development

$$EF = (GE * Ym * 365 \text{ days/yr}) / (55.65 \text{ MJ/kg } CH_4)$$

Where:

- EF = emission factor, kg CH_4/head/yr
- GE = gross energy intake, MJ/head/day
- Y_m = methane conversion rate which is the fraction of gross energy in feed converted to methane

Gross energy intake is calculated in the livestock population characterisation. Methane conversion rate depends on several interacting feed and animal factors; good feed usually means lower conversion rates. Default values from the GPG were applied (Table 5.7).

Table 5.7. Methane conversion rates for cattle and sheep (IPCC, 2006).

Category/subcategory	Cattle	Mature sheep	Lambs (<1 year old)
Y_m	0.06	0.07	0.05

For pseudo-ruminant and mono-gastric animal species methane emission factors were taken from the 2006 Guidelines. Values from the Norwegian NIR (2011) were used for poultry and fur animals as the agricultural practises and climate are similar and most Icelandic farmers take their further education in Norway.

5.3.2 Emissions

Methane emissions from enteric fermentation in domestic livestock are calculated by multiplying emission factors per head for the specific livestock category with respective population sizes and subsequent aggregation of emissions of all categories.

There is only one livestock subcategory that has a gross energy intake that varies over time and as a result a fluctuating emission factors: mature dairy cattle (mainly due to the increase in milk production during the last two decades). Therefore the fluctuations in methane emissions from enteric fermentation for all other livestock categories shown in Table 5.8 are solely based on fluctuations in population size. The population size of mature dairy cattle has decreased by 19% between 1990 and 2014. Methane emissions, however, have only decreased by 3% from 2.54 kt to 2.46 kt during the same period due to the increase in the emission factor associated with the increase in milk production. The livestock category emitting most methane from enteric fermentation is mature ewes. Due to a proportionate decrease of population size, emissions from mature ewes decreased by 15% between 1990 and 2014 (from 5.4 to 4.6 kt). Similar decreases can be seen for other sheep subcategories. The only non-ruminant livestock category with substantial methane emissions is horses. Emissions from horses increased from 1.33 kt methane in 1990 to 1.20 kt methane in 2014 due to an equal increase in population size.

The decrease in methane emissions from cattle and sheep caused total methane emissions from enteric fermentation in agricultural livestock to drop from 12.6 kt in 1990 to 11.7 kt in 2014, or by 6% (Table 5.8).

Table 5.8. Methane emissions from enteric fermentation from agricultural animals for years 1990, 1995, 2000, 2005 and 2011-2014 in t CH_4.

livestock category	1990	1995	2000	2005	2010	2013	2014
mature dairy cattle	2,540	2,395	2,267	2,201	2,323	2,251	2,463
cows used for producing meat	0	49	64	91	112	115	123
heifers	247	689	343	362	369	373	386
steers used for producing meat	766	656	847	650	810	731	783
young cattle	358	247	319	322	365	333	378
mature ewes	5,437	4,541	4,553	4,397	4,567	4,512	4,634
other mature sheep	171	159	156	144	150	149	151
animals for replacement	651	535	582	604	679	648	687
lambs	987	823	831	808	846	833	859
swine	44	47	48	57	61	46	54
horses	1,332	1,447	1,364	1,382	1,422	1,026	1,199
goats	2	2	3	3	5	6	7
fur animals	4	4	4	4	4	6	5
poultry	13	7	11	15	14	16	17
total methane emissions	12,553	11,601	11,390	11,041	11,725	11,045	11,746
emission reduction (year-base year)/base year	0%	-8%	-9%	-12%	-7%	-12%	-6%

5.3.3 Recalculations

No recalculations were made for Enteric Fermentation in the 2016 submission.

5.3.4 Uncertainties

Uncertainties of CH_4 emission estimates for enteric fermentation were assessed separately for cattle, sheep and other livestock categories. Cattle and sheep AD uncertainties were calculated as combined uncertainties of livestock population and livestock characterisation. Cattle and sheep population data were deemed reliable and were therefore attributed with an uncertainty of +-5% (expert judgement). Livestock characterisation uncertainty was calculated by propagating uncertainties of net and digestible energies. A +-20% uncertainty was attributed to all net energies used in the calculation. Digestible energy was attributed with an uncertainty of +-10% (expert judgement). Propagation of uncertainty throughout the calculation of gross energy led to AD uncertainties between 15 and 19% for cattle (mean weighted with 2013 emissions = 17.8%) and 16 and 22 % for sheep (weighted mean = 17.2%). The combination of AD and EF uncertainties for cattle and sheep were therefore estimated to be 27 and 26 %, respectively. These values are also shown in Annex II.

Enteric fermentation emission estimates for other animals were calculated using Tier 1 methodology. This entailed that AD uncertainty stemmed from livestock population data only. Livestock population estimates of other livestock categories were deemed to be slightly more uncertain than the ones of cattle and sheep (+-20%, expert judgement). This is mainly due to the fact that the population of e.g. poultry at the time of the census does not allow for as good an estimate of the mean annual population as the population of other livestock categories. The GPG estimates EF accuracy between +-30 and +-50 % (page 4.27). This submission used a value of +-40%. This resulted in a combined uncertainty for CH4 emissions from other animals of +- 45%.

5.4 CH_4 Emissions from Manure Management (CRF 3B)

Livestock manure is principally composed of organic material. When this organic material decomposes in an anaerobic environment, methanogenic bacteria produce methane. These conditions often occur when large numbers of animals are managed in confined areas, e.g. in dairy, swine and poultry farms, where manure is typically stored in large piles or disposed of in storage tanks (IPCC, 2006).

5.4.1 Emission Factors

Emission factors for manure management were calculated for cattle and sheep using data compiled in the livestock population characterization. For all other livestock categories IPCC default values were used. They originate from the 2006 Guidelines. In order to calculate emission factors from manure management, daily volatile secretion (VS) rates have to be calculated first. VS are calculated using gross energy intake per day in the livestock population characterisation and national values for digestible energy and ash content of feed (cf. 5.2.3). Equation 4.16 from the GPG was used.

EGUATION 4.16

Volatile solid excretion rates

$$VS = GE * (1\ kg\text{-}dm/18.45\ MJ) * (1 - DE/100) * (1 - ASH/100)$$

Where:

- VS = volatile solid excretion per day on a dry-matter weight basis, kg-dm/day
- GE = Estimated daily average feed intake in MJ/day
- DE = Digestible energy of the feed in percent
- ASH = Ash content of the manure in percent

Volatile solid excretion per day is then used in equation 4.17 from the GPG to calculate emission factors for manure management.

EGUATION 4.17

Emission factor from manure management

$$EF_i = VS_i * 365\ days/year * B_{oi} * 0.67\ kg/m3 * \Sigma_{(j)} MCF_j * MS_{ij}$$

Where:

- EF_i = annual emission factor for defined livestock population i, in kg
- VS_i = daily VS excreted for an animal within defined population i, in kg
- B_{oi} = maximum CH_4 producing capacity for manure produced by an animal within defined
- population i, m^3/kg of VS
- MCF_j = CH_4 conversion factors for each manure management system j
- MS_{ij} = fraction of animal species/category i's manure handled using manure system j

Maximum methane producing capacity values are taken from the 2006 Guidelines. They are 0.17 m^3/kg VS for non-dairy cattle, 0.19 m^3/kg VS for sheep, and 0.24 m^3/kg VS for dairy cattle. Methane conversion factors (MCF) for the three manure management systems used in cattle and sheep farming, i.e. pasture/range/paddock, solid storage and liquid/slurry are taken from the 2006 Guidelines.

Table 5.9. Methane correction factors (fractions) included in 2006 Guidelines for different manure management systems.

		Cattle	Cattle	Cattle	Sheep
	Conditions	pasture/range	solid storage	liquid/ slurry	all manure manag. systems
2006 GL	Average annual temperature <10°C	1%	2%	10%1 17%2	same as for cattle

1: with natural crust cover. 2: without natural crust cover; MCF used for liquid/slurry

5.4.2 Manure Management System Fractions

The fractions of total manure managed in the different manure management systems impact not only CH_4 emissions from manure management but also N_2O emissions from manure management and, as a consequence, N_2O emissions from agricultural soils. The fractions used are based on expert judgement (Sveinsson, oral communication; Sveinbjörnsson, oral communication; Dýrmundsson, oral communication) and are assumed to be constant since 1990 except for mature dairy cattle. The average amount of time mature dairy cattle spend on pasture has increased from 90 to 100 days over the last 20 years. Heifers spend 120 days per year on pasture whereas cows used for meat production spend 11 months on grazing pastures. Young cattle and steers are housed all year round. All cattle manure, i.e. not spread on site by the animals themselves, is managed as liquid/slurry without natural crust cover. Sheep spend 5.5 months on pasture and range; this includes the whole live span of lambs. 65% of the manure managed is managed as solid storage, the remaining 35% as liquid/slurry (Table 5.10).

Table 5.10. Manure management system fractions for all livestock categories.

	liquid/slurry	solid storage	pasture/ range/ paddock
mature dairy cattle	73%		27%
cows used for producing meat	8%		92%
heifers	67%		33%
steers used for producing meat	91%		9%
young cattle	100%		0%
mature ewes	19%	36%	45%
other mature sheep	19%	36%	45%
animals for replacement	19%	36%	45%
lambs			100%
goats		55%	45%
horses		14%	86%
young horses		14%	86%
foals			100%
sows	100%		
piglets	100%		
poultry, fur animals		100%	

Emission factors both calculated with volatile solid excretion rates, methane conversion factors, and manure management fractions as well as IPCC default values for other livestock categories than cattle and sheep were used to calculate methane emissions from manure management and are shown in Table 5.11.

Mature dairy cows and steers have the highest emission factors for methane from manure management. Although mature dairy cows have a roughly 60% higher gross energy intake (average from 1990-2010), their emission factors are very similar. This is caused by two things: all steer manure is managed and therefore multiplied with a higher MCF than the share of manure accumulated by mature dairy cattle during grazing on pasture. More importantly, their feed has a lower digestible energy content, which in turn increases volatile solid excretion.

Table 5.11. Emission factors values, range and origin used to calculate methane emissions from manure management.

livestock category	emission factor 2014	emission factor range 1990-2014	source
	(kg CH_4/head year)	(kg CH_4/head year)	
mature dairy cattle	28.00	24.4-28.4	LPS
cows used for producing meat	2.65		LPS
heifers	10.70		LPS
steers used for producing meat	11.84		LPS
young cattle	4.23	4.23-4.27	LPS
mature ewes	0.99		LPS
other mature sheep	1.04		LPS
animals for replacement	0.82		LPS
lambs	0.05		LPS
swine	6		2006 GL
horses	1.09		2006 GL
goats	0.13		2006 GL
minks	0.68		2006 GL
foxes	0.68		2006 GL
rabbits	0.08		2006 GL
poultry	0.08		2006 GL

1: Livestock population characterisation

5.4.3 Emissions

As can be seen in Table 5.11 above, there are no emission factor fluctuations for most livestock categories and only minor fluctuations for the remaining cattle subcategories. This implies that fluctuations in methane emission estimates for all livestock subcategories except mature dairy cattle can be explained by fluctuations in population sizes. Three livestock categories alone are responsible for roughly two thirds of methane emissions from manure management: mature dairy cattle, steers used for producing meat and mature ewes. The high emission factor for mature dairy cattle and steers has already been addressed. Mature ewes have an emission factor that is roughly twenty times lower than the ones for dairy cattle and steers but have a much bigger population size. Other important livestock categories for methane emissions from manure management are young cattle, animals for replacement, swine, horses, and poultry.

Total methane emissions from manure management drop from 2.026 kt in 1990 to 1.995 kt in 2014 or by 2%.

Table 5.12. Methane emissions from manure management in tonnes.

livestock category	1990	1995	2000	2005	2010	2013	2014
mature dairy cattle	793	742	696	671	701	679	743
cows used for producing meat	0	2	3	4	4	5	5
heifers	49	137	68	72	73	74	77
steers used for producing meat	213	182	235	180	225	203	212
young cattle	86	59	76	77	87	80	90
mature ewes	439	367	368	355	369	364	374
other mature sheep	14	13	13	12	12	12	12
animals for replacement	74	60	66	68	77	74	78
lambs	16	13	14	13	14	14	14
swine	178	187	194	231	243	183	217
horses	81	87	82	84	86	62	72
goats	0	0	0	0	0	0	0
fur animals (minks and foxes)	32	26	28	25	25	44	35
rabbits	0	0	0	0	0	0	0
poultry	53	28	43	60	56	62	65
total methane from manure management	2,026	1,904	1,883	1,852	1,973	1,855	1,995
emission reduction (year-base year)/base year	0%	-6%	-7%	-9%	-3%	-8%	-2%

5.4.4 Recalculations

No recalculations were made for Manure Management for the 2016 submission.

5.4.5 Uncertainties

Uncertainties of CH_4 emission estimates for manure management were assessed separately for cattle, sheep and other livestock categories. Cattle and sheep AD uncertainty was calculated as combined uncertainty of livestock population and volatile solid excretion rate uncertainty. Cattle and sheep population data were deemed reliable and were therefore attributed with an uncertainty of +-5% (expert judgement). Uncertainty related to volatile solid excretion rates was calculated by propagating uncertainties throughout the calculation of VS: i.e. combination of gross energy intake uncertainty, feed digestibility uncertainty and ash content uncertainty (cf. chapter 6.3.3). VS uncertainties ranged between 26 and 33% for cattle and 23 and 36% for sheep. AD uncertainty category means were deducted by weighting means with 2013 emission estimates. The respective values for cattle and sheep were 28% and 24%, respectively. EF uncertainties were estimated by combining assumed uncertainties for maximum methane producing capacity and methane correction factor uncertainty. The latter was estimated to be higher (100%, expert judgement) than the former (30%, expert judgement).

Emissions from other animals were attributed with a livestock uncertainty of 20% and an EF uncertainty of 200% (both expert judgement).

The above mentioned AD and EF uncertainties were combined by weighting them with 2013 emission estimates. This was done in order not to unnecessarily fragment categories for key source and uncertainty analyses. Category AD uncertainty amounted to 25% and category EF uncertainty to 121% combining to a total uncertainty of 124% for methane emission estimates from manure management. These values are summarized in Annex II.

5.5 N_2O Emissions from Manure Management (CRF 3B)

The nitrous oxide estimated in this section is the N_2O produced during the storage and treatment of manure before it is applied to land. The emission of N_2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment (IPCC, 2000). In the case of animals whose manure is unmanaged (i.e. animals grazing on pasture or grassland, animals that forage or are fed in paddocks, animals kept in pens around homes) the manure is not stored or treated but is deposited directly on land. The N_2O emissions generated by manure in the system pasture, range, and paddock occur directly and indirectly from the soil, and are therefore reported in chapters 5.6 and 5.7.

5.5.1 Activity Data

Equation 10.25 in the 2006 guidelines lists the input variables (printed in bold and discussed below) necessary to estimate N_2O emissions from manure management. Note that all remaining formulae in this chapter report N_2O emissions in units of nitrogen. N_2O emissions are subsequently calculated by multiplying units of nitrogen with 44/28 (molar mass of N_2O divided by molar mass of N_2).

EGUATION 10.25

N_2O EMISSIONS FROM MANURE MANAGEMENT

$$(N_2O\text{-}N) = \Sigma_{(S)} \{[\Sigma_{(T)} (N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)})] \bullet EF_{(S)}\}$$

Where:

- $(N_2O\text{-}N)$ = N_2O-N emissions from manure management in the country (kg N_2O-N/yr)
- $N_{(T)}$ = Number of head of livestock species/category T in the country
- $Nex_{(T)}$ = Annual average N excretion per head of species/category T in the country (kg N/animal/yr)
- $MS_{(T,S)}$ = Fraction of total annual excretion for each livestock species/category T that is managed in manure management system S in the country
- $EF_{(S)}$ = N_2O emission factor for manure management system S in the country (kg N_2O-N/kg N in manure management system S)
- S = Manure management system
- T = Species/category of livestock

Numbers for head of livestock species/category exist (with distinction between adult and young animals for all livestock categories with the exceptions of rabbits and fur animals). The manure management system fractions for cattle and sheep have been discussed in chapter 5.4.2. Two thirds of Icelandic horses are on pasture all year round. The remaining third spends around five months in stables, where manure is managed in solid storage. All swine manure is managed as liquid/slurry whereas the manure of fur animals and poultry is managed in solid storage. Manure management system fractions are assumed to be stable during the past twenty years and were summarized above in Table 5.10.

Average annual nitrogen excretion rates were calculated using 2006 GL default values (Table 5.13). The defaults relate to 1000 kg animal mass. This means that they account for two cows weighing 500 kg each or roughly 15 ewes weighing 65 kg each. The calculated default for dairy cattle was not used since national, time dependent values existed: Ketilsdóttir and Sveinsson (2010) measured the Annual N excretion rates for dairy cows. The resulting value of 94.8 kg N was applied to dairy cows from 2000-2014. Since the value is based on new measurements for dairy cows with an annual milk production in excess of 5000 kg, it was adjusted for the 1990s (average milk production of 4200 kg) by interpolating linearly between it and a national literature value of 72 kg (Óskarsson and Eggertsson, 1991).

Table 5.13 Nitrogen excretion rates (Nex).

livestock category	Nex default (kg N/1000 kg animal mass/day)	animal weight (kg)	annual N excretion rates (kg N/animal year)
mature dairy cattle	0.48	430	75.3[1]
cows used for producing meat	0.33	500	60.2
heifers	0.33	370	44.5
steers used for producing meat	0.33	328	39.5
young cattle	0.33	126	15.2
mature ewes	0.85	65	20.2
other mature sheep	0.85	95	29.5
animals for replacement	0.85	36	11.1
lambs	0.85	21	6.5
sows	0.42	150	23.0
piglets	0.51	41	7.6
horses	0.26	375	35.6
young horses	0.26	175	16.6
foals	0.26	60	5.7
goats	1.28	44	20.3
minks	0.0	0	4.6
foxes	0.0	0	12.1
rabbits	0.0	0	8.1
hens	0.96	4	1.4
broilers	1.10	4	1.6
pullets	0.55	3	0.6
chickens	0.55	1	0.2
ducks/geese	0.83	4	1.2
turkeys	0.74	5	1.4

1: National, time dependent values ranging from 72 to 94.8 kg N were used instead.

5.5.2 Emission Factors

Emission factors are taken from the IPCC 2006 Guidelines, table 10.21: 0.001 kg N_2O-N is emitted per kg nitrogen excreted when manure is managed as liquid slurry. 0.02 kg N_2O-N is emitted per kg nitrogen excreted when manure is managed in solid storage as well as when it is unmanaged, i.e. deposited directly on soils by livestock.

5.5.3 Emissions

N_2O emissions from the manure management systems liquid/slurry and solid storage amounted to 142 tonnes N_2O in 2014 and 168 tonnes in 1990 (-15%).

Emissions from liquid systems make up only a small part of total emissions from managed systems or only 6% of total N_2O emissions from manure management systems in 2014. This is because the emission factor is twenty times lower for liquid systems than for solid storage. The majority of emissions originated from the solid storage of sheep manure 72% in 2014, followed by solid storage of poultry manure (11.2%), horse manure (5.8%), and fur animal manure (5.2%).

Figure 5.2 shows N_2O emissions from liquid systems and solid storage. It also includes emissions from manure deposited directly onto soils from farm animals. Although they are reported under emissions from agricultural soils in national totals, they are included here to show their magnitude in comparison to other emissions. In 2014 N_2O emissions from manure spread on pasture by livestock amounted to 267 tonnes or almost twice as much as aggregated emissions from liquid systems and solid storage. Emissions from sheep manure were 184 tonnes, emissions from horse manure were 52 tonnes, and emissions from cattle manure amounted to 30 tonnes N_2O.

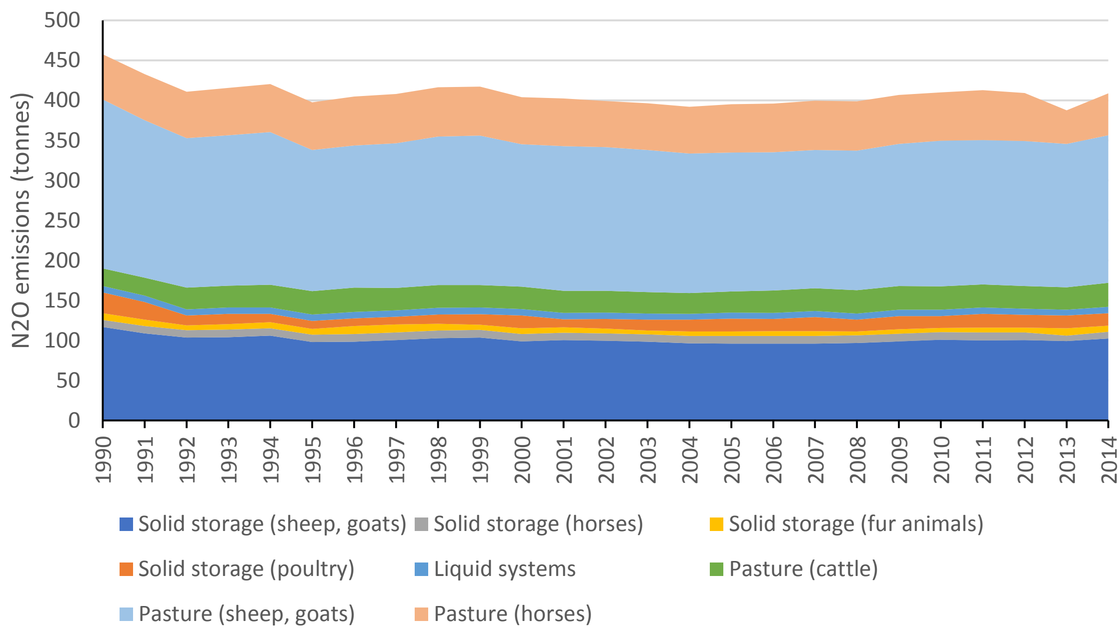

Figure 5.2 N_2O emissions from manure management in kt N_2O.

5.5.4 Uncertainties

Uncertainty for N_2O emissions from manure management was estimated by combining cattle, sheep and other animal uncertainties. AD uncertainty was calculated as combined uncertainty of livestock population, nitrogen excretion and manure management system uncertainties. Livestock population uncertainties were 5 % for cattle and sheep and 20 % for all other animals (expert judgement). Nitrogen excretion rates were drawn from the 2006 GL which state their uncertainty as +-50% (page 10.66). Manure management system uncertainty is highest for sheep due to the variability in sheep manure management (25%) and less for other livestock categories (10%). These uncertainties were combined by multiplication for each of the three categories and then weighted by 2012 emission estimates, resulting in an AD uncertainty of 56%. Tables 4.12 and 4.13 in the 2006 GL attribute an EF uncertainty of 100% to N_2O emission factors from manure management. The weighted combined uncertainty for N_2O emissions from manure management was therefore estimated to be 114%.

Uncertainty estimates for emissions from animal production were calculated analogously and weighted with emissions from pasture, range, and paddock manure yielding a combined uncertainty of 114%.

5.5.5 Planned Improvements

The nitrogen excretion rate for cattle and sheep will be recalculated using data on feed and crude protein intake developed in the livestock population characterisation and default N retention rates to recalculate nitrogen intake.

5.6 Direct N_2O Emissions from Agricultural Soils (CRF 3D)

Nitrous oxide (N_2O) is produced naturally in soils through the microbial processes of nitrification and denitrification. Agricultural activities like the return of crop residue, use of synthetic fertilizer and manure application add nitrogen to soils, increasing the amount of nitrogen (N) available for nitrification and denitrification, and ultimately the amount of N_2O emitted. The emissions of N_2O that result from anthropogenic N inputs occur through both a direct pathway (i.e. directly from the soils to which the N is added), and through two indirect pathways, i.e. through volatilisation as NH_3 and NO_x and subsequent redeposition and through leaching and runoff (IPCC, 2006). Direct N_2O emissions from agricultural soils are described here, indirect emissions in chapter 5.7.

5.6.1 Activity Data and Emission Factors

Direct N_2O emissions from agricultural soils are calculated with equation 11.2 from the 2006 GL. Of the five possible sources of input into soils four are applicable for Iceland:

- Synthetic fertilizer nitrogen
- Animal manure nitrogen used as fertilizer
- Nitrogen in crop residues returned to soils
- Cultivation of organic soils

EGUATION 11.2

DIRECT N_2O EMISSIONS FROM AGRICULTURAL SOILS (TIER 1a)

$$N_2O_{Direct}\text{-}N = [(F_{SN} + F_{AM} + F_{BN} + F_{CR}) \bullet EF_1] + (F_{OS} \bullet EF_2)$$

Where:

- N_2O_{Direct} -N = Emission of N_2O in units of Nitrogen
- F_{SN} = Annual amount of synthetic fertiliser nitrogen applied to soils adjusted to account for the amount that volatilises as NH_3 and NO_x
- F_{AM} = Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilises as NH_3 and NO_x
- F_{BN} = Amount of nitrogen fixed by N-fixing crops cultivated annually
- F_{CR} = Amount of nitrogen in crop residues returned to soils annually
- F_{OS} = Area of organic soils cultivated annually
- EF_1 = Emission factor for emissions from N inputs (kg N_2O-N/kg N input)
- EF_2 = Emission factor for emissions from organic soil cultivation (kg N_2O-N/ha-yr)

-

5.6.2 Synthetic Fertilizer Nitrogen (FSN)

Activity data comes from the Icelandic Food and Veterinary Authority (IFVA) and consists of the amount of nitrogen in synthetic fertilizer applied to soils with the exception of the amount of fertilizer applied in forestry (Figure 5.3). The amount has to be adjusted for the amount that volatilizes as NH_3 and NO_x. The IPCC default for volatilization of synthetic fertilizer N is 0.1.

5.6.3 Animal Manure Nitrogen (FAM)

Animal manure nitrogen is calculated by multiplying Nitrogen excretion rates per head and year for livestock species/categories with the respective population sizes (see chapter: 5.5.2). The amounts have to be adjusted for N that volatilizes as NH_3 and NOx. The IPCC default for volatilization of animal manure N is 0.2. The nitrogen amount from manure has to be further reduced by the amount deposited onto soils by grazing livestock, which is accounted for separately. Activity data development can be seen in Figure 5.3.

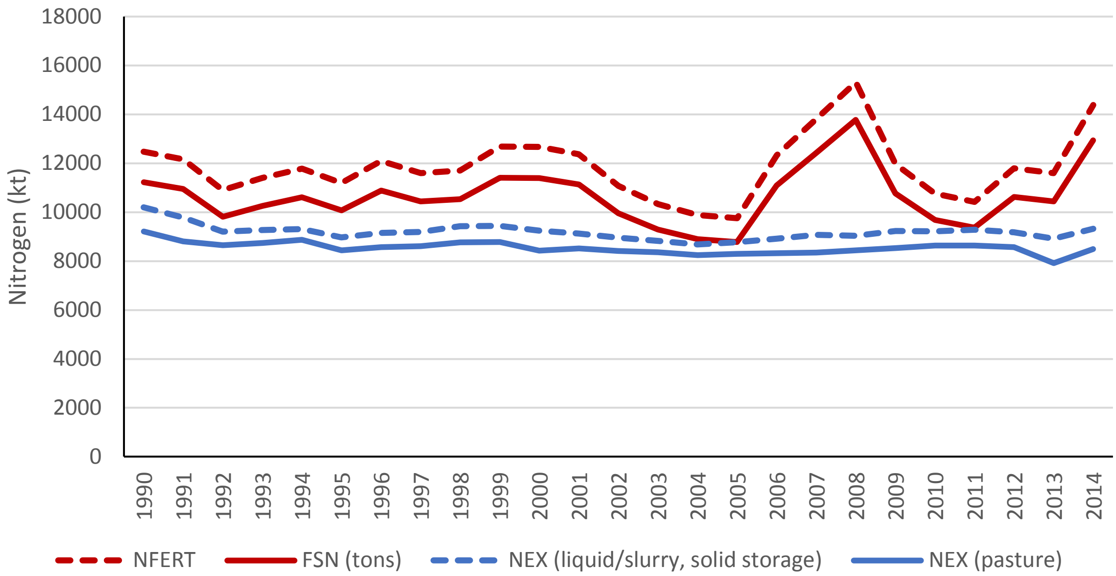

Figure 5.3 Amounts of nitrogen from synthetic fertilizer and animal manure application. Solid lines show nitrogen amounts adjusted for volatilization. Total N amounts are shown in dashed lines of same colour.

5.6.4 Nitrogen in crop residues returned to soils (FCR)

There are four crops cultivated in Iceland: potatoes, barley, beets and carrots. After harvest crop residues are returned to soils. The amount of residue returned to the soils are derived from crop production data. Statistics Iceland has production data for the four crops. The amount of residue per crop returned to soils is calculated using equation 11.6 for the 2006 GL.

Residue/crop ratio, dry matter fraction and nitrogen fraction are IPCC default values. Dry matter fraction defaults, though, do not exist for potatoes and beet. By expert judgement, they are estimated to be 0.2 for both crops. No defaults exist for carrots. Therefore beet defaults are applied. It is estimated that 80% of barley residue is used as fodder. Crop produce amounts are shown in (Figure 5.4).

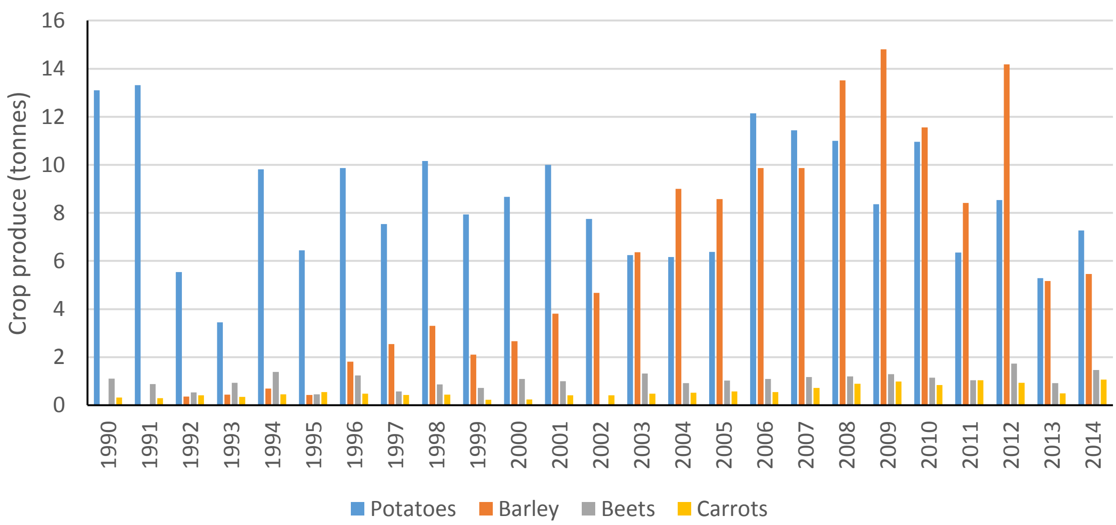

Figure 5.4 Crop produce in kilotonnes for 1990-2014.

The amount of nitrogen in crop residues returned to soils was lowest in 1993, when it amounted to roughly 5 tonnes and highest in 2008 when it amounted to roughly 27 tonnes. It has to be noted, however, that there is a difference in scale between amounts of nitrogen in crop residues returned to soils and N amounts in synthetic fertilizer and animal manure applied to soils. Whereas the first amount ranges between 10 and 20 tonnes, the latter range from 5,000 – 15,000 tonnes annually.

5.6.5 Cultivation of organic soils

In response to a remark of the review of the Icelandic 2010 submission, the N_2O emissions from cultivated organic soils were included under the Agriculture sector. Data about the area of cultivation of organic soils, including histosols, histic andosols, and hydric andosols, is supplied by the Agricultural University of Iceland. The area estimate for cultivated organic soils in 1990 was 65 kha. This area has decreased steadily since then and was estimated to be less 56.6 kha in 2014.

Emission Factors

The common emission factor for FSN, FAM, and FCR was the IPCC default value of 1.25% kg N_2O-N/kg N.

A country specific emission factor of 0.97 kg N_2O-N per ha was used as organic soil emission factor. It is based on measurements in a recent project where N_2O emissions were measured on drained organic soils. In this project, at total of 231 samples were taken from drained organic soils in every season over three years. The results have shown that the EF is higher for cultivated drained soils (0.97 kg N_2O-N per ha) than other drained soils (0.01 and 0.44 kg N_2O-N per ha) and much lower than the EF for tilled drained soils (8.36 kg N_2O-N per ha). This research was conducted in Iceland over the period from 2006 to 2008 and is considered to be reliable. The results have not been published in peer reviewed papers, yet, but publication is in preparation. Results are available in a project report to the Icelandic Research Council (Guðmundsson, 2009).

Emissions

The product of nitrogen amounts and respective emission factors was subsequently transformed into N_2O emissions by multiplying units of nitrogen with 44/28 (molar mass of N_2O divided by molar mass of N_2). Direct emission from agricultural soils amounted to 486 tonnes N_2O in 2014, which meant an increase of 1.5% in comparison to 1990 emissions. The main driver behind the increase was increased amounts of synthetic fertilizer. A decrease is observed in animal manure applied to soils as well as in the total area of cultivated soils. 52% of 2014 emissions originated from synthetic fertilizer application, 30% from animal manure application and 18% from organic soils. The contribution of N in crop residues returned to soils is extremely low (0.1%). Annual fluctuations in emissions are mainly caused by the amount of fertilizer applied to soils (Figure 5.5).

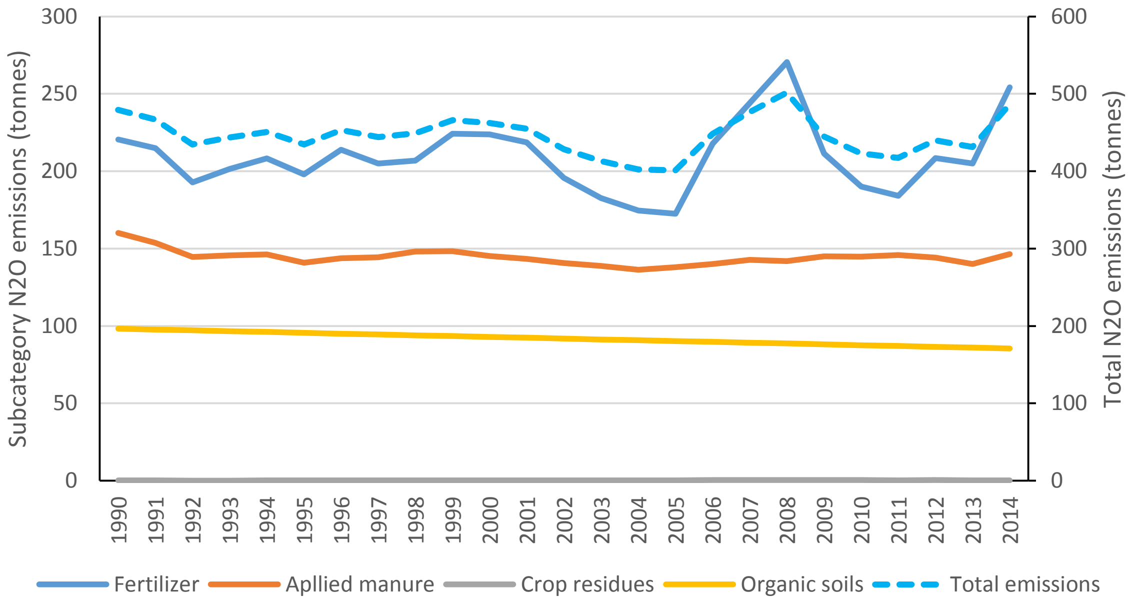

Figure 5.5 Direct N_2O emissions from soils (kt).

5.6.6 Uncertainties

Uncertainties from direct soil emissions were estimated for the category as a whole. To this end AD and EF uncertainties of fertilizer nitrogen, manure nitrogen, and area of organic soils cultivated annually were first weighted with respective 2013 emissions and then combined by multiplication in order to result in combined uncertainty estimates for the emission category. The amount of N in fertilizer applied was deemed to be known with an uncertainty of +-20% mainly stemming from possible differences between annual import and final application (expert judgement). The uncertainty in the amount of nitrogen in manure applied to soils was with higher (54%) as a result of multiplying NEX uncertainties (as described in chapter 6.5.4) with a livestock population uncertainty of 20%. The area of cultivated organic soils was attributed with an uncertainty of +-20% in accordance with area uncertainty estimates for cropland in LULUCF. Total AD uncertainty for direct N_2O emissions from soils weighted with 2012 emission estimates was therefore 31%.

AD uncertainty, however, is overshadowed by emission factor uncertainty related to nitrogen application to soils. According to the GPG the best estimate of the 95% confidence interval range from one fifth to five times the EF of 1.25%, i.e. 400% uncertainty. Uncertainty for the country specific value for N2O emissions from cultivated organic soils is 25%. EF uncertainty was weighted in the same way as AD uncertainty resulting in a value of 326%. Combination of AD and EF uncertainties for direct soil emissions yielded a value of 328%.

5.6.7 Planned improvements

For the next submission it is planned to update the emission factor for N_2O such that the default factor will be used.

5.7 Indirect N_2O emissions from nitrogen used in agriculture

5.7.1 Activity data and emission factors

Indirect N_2O emissions originate from three sources:

- Volatilization of applied synthetic fertilizer and animal manure and subsequent atmospheric deposition
- Leaching and runoff of applied fertiliser and animal manure and
- Discharge of human sewage nitrogen into rivers or estuaries

The last source is covered in chapter 6. The first two sources are covered here.

5.7.2 N_2O from atmospheric deposition

Atmospheric deposition of nitrogen compounds such as nitrogen oxides (NOx) and ammonium (NH_4) fertilises soils and surface waters, which results in enhanced biogenic N_2O format According to the 1996 guidelines, the amount of applied agricultural N that volatilizes and subsequently deposits on nearby soils is equal to the total amount of synthetic fertiliser nitrogen applied to soils plus the total amount of animal manure nitrogen excreted in the country multiplied by appropriate volatilisation factors (IPCC, 1996). That means that this emission source shares activity data with direct emissions from agricultural soils. Here, this includes manure deposited on pasture by grazing livestock. The amounts of nitrogen that were subtracted from total N in order to adjust for volatilization from fertilizer and animal manure application in chapter 5.6 “Direct emissions from agricultural soils” constitute activity data for N_2O from atmospheric deposition. That means that N amounts in fertilizer are multiplied with 0.1 and amounts in animal manure with 0.2 in order to calculate N_2O from atmospheric deposition. This is summarized in equation 4.31 of the GPG. The IPCC emission factor for estimating indirect emissions due to atmospheric deposition of N_2O is 0.01 kg N_2O-N/kg NH_4-N & NOx-N deposited.

EQUATION 11.9

N_2O FROM ATMOSPHERIC DEPOSITION OF N (TIER 1a)

$$N_2O_{(G)}\text{-}N = [(N_{FERT} \bullet Frac_{GASF}) + (\Sigma T(N_{(T)} \bullet Nex_{(T)}) \bullet Frac_{GASM})] \bullet 0.01$$

Where:

- N_2O_{Direct} -N = Emission of N_2O in units of Nitrogen
- F_{SN} = Annual amount of synthetic fertiliser nitrogen applied to soils adjusted to account for the amount that volatilises as NH_3 and NO_x
- F_{AM} = Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilises as NH_3 and NO_x
- F_{BN} = Amount of nitrogen fixed by N-fixing crops cultivated annually
- F_{CR} = Amount of nitrogen in crop residues returned to soils annually
- F_{OS} = Area of organic soils cultivated annually
- EF_1 = Emission factor for emissions from N inputs (kg N_2O-N/kg N input)
- EF_2 = Emission factor for emissions from organic soil cultivation (kg N_2O-N/ha-yr)

5.7.3 N_2O from leaching and runoff

A large proportion of nitrogen is lost from agricultural soils through leaching and runoff. This nitrogen enters groundwater, wetlands, rivers, and eventually the ocean, where it enhances biogenic production of N_2O (IPCC; 2006). To estimate the amount of applied N that leaches or runs off, amount of synthetic fertilizer and animal manure applied to soils (including manure deposited on pasture by grazing livestock) is multiplied by the fraction that is lost through leaching and runoff. Indirect N_2O emissions from leaching and runoff are calculated by multiplying the resulting nitrogen amount with the 2006 GL emission factor for estimating indirect emissions due to leaching and runoff of N_2O: 0.025 kg N_2O-N/kg N leached & runoff.

5.7.4 Emissions

The development of indirect N_2O emissions from 1990-2014 - after conversion from nitrogen to nitrous oxide - is shown in Figure 5.6. N_2O emissions amounted to 458 tonnes N_2O in 2014, which meant a 0.4% increase from the 1990 value of 456 tonnes. The general slight downward trend in emissions was reversed from 2006 to 2008, when high amounts of synthetic fertilizer application caused an increase of indirect N_2O emissions from agricultural soils above the 1990 level.

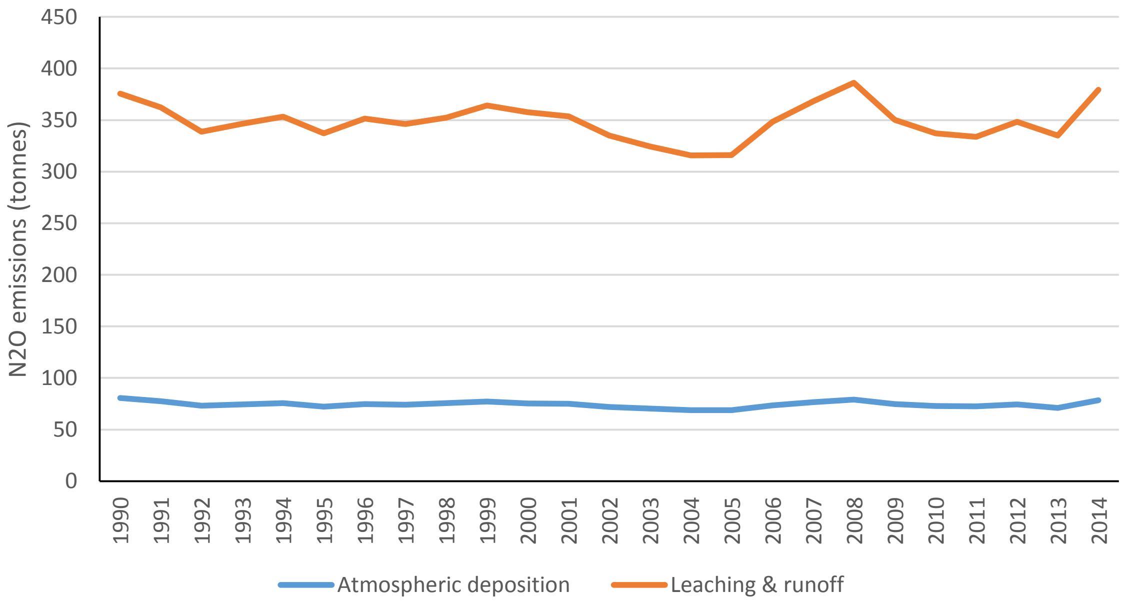

Figure 5.6 Indirect N_2O emissions from agricultural soils.

5.7.5 Uncertainties

Uncertainties from indirect soil emissions were estimated for the category as a whole. To this end AD and EF uncertainties of fertilizer nitrogen and manure nitrogen were first weighted with respective 2012 emissions and then combined by multiplication in order to result in combined uncertainty estimates for the emission category. AD uncertainty consists of AD the uncertainty regarding the amount of nitrogen in fertilizer and manure (cf. chapter 6.6.5) combined with uncertainty regarding the fraction of N that volatilizes, which is estimated by the GPG to be +-50% (p. 4.75). Combined weighted AD uncertainties of 67% are dwarfed by an order of magnitude uncertainty for the EF (GPG, page 4.75). Combined uncertainties are estimated to be 1002%.

6 Land-Use, Land-Use Changes and Forestry (CRF sector 4)

6.1 Overview

This sector covers emissions and removals related to land use, land use changes and forestry (LULUCF). The land use is categorized to the six main land use categories defined by inventory guidelines (IPCC 2006) and conversions between those categories. Emissions and removals of GHG are reported for all managed land within these categories according to guidelines given in Volume 4: Agriculture, Forestry and Other Land Use of the 2006 Guidelines (IPCC 2006), hereafter named AFOLU Guidelines, and the 2013 Supplement to the 2006 Guidelines: Wetlands (IPCC 2014), hereafter named 2013 Wetland Supplement. The Agricultural University of Iceland, the Icelandic Forestry Research and the Soil Conservation Service of Iceland are responsible for preparing the inventory for this sector.

More than 90% of the total area of Iceland is included in two land use categories i.e. Grassland and Other Land. Figure 6.1 shows the relative division of the area of Iceland to the main six land use categories reported.

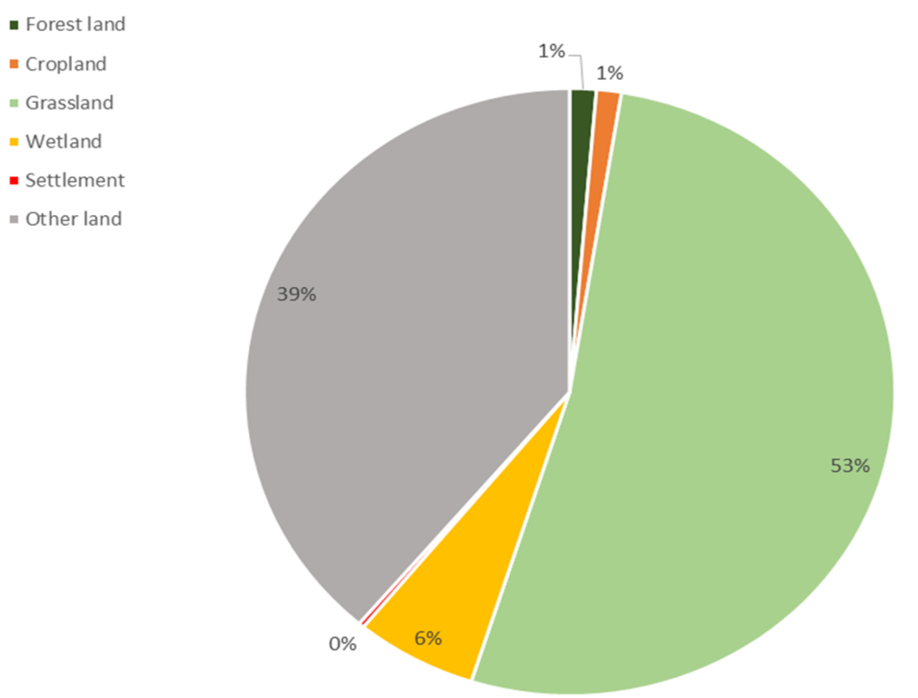

Figure 6.1 Relative size of land use categories in Iceland according to IGLUD land use map 2013 and other land use estimates available for the reporting

Both emissions from sources and removals by sinks are reported for this sector. The net contribution of the main land use categories is summarized in Fig 6-2, Table 6-1.

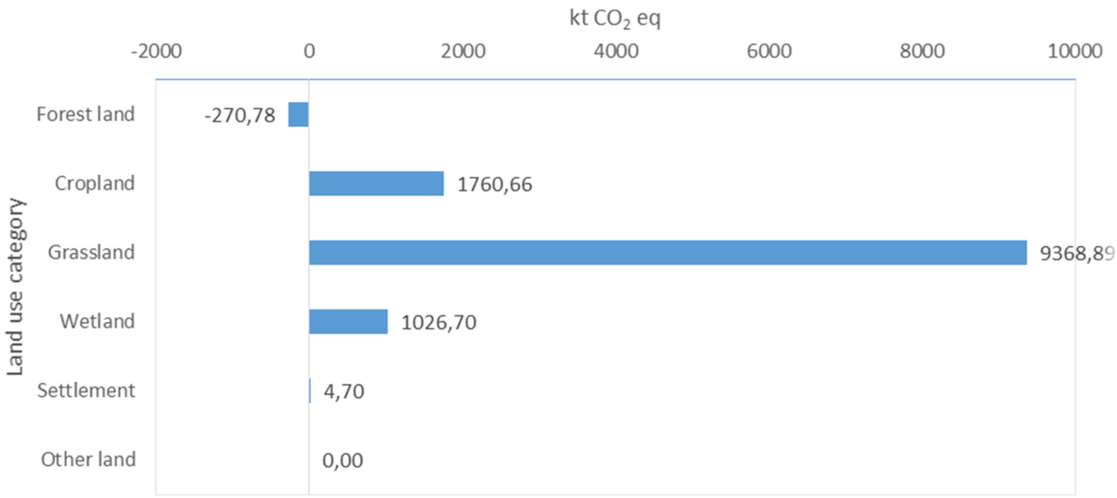

Figure 6.2 The net emission/removals of land use categories in kt CO_2 equivalents, according to this submission.

The sum of all emissions reported is 13,502 kt CO_2 eq, and is dominated 87.0% by 11,747 kt CO_2 eq emissions related to drainage of organic soils, mostly of included under Grassland, Cropland and small areas of Forest land. Another important emission component 12.0% or 1,626 kt CO_2 eq, is methane emission from managed wetlands. The remaining reported emissions are assigned to biomass burning, application of N-fertilizers, hydropower reservoirs (CO_2), losses of soil organic carbon (SOC) from mineral soils, loss of biomass due to conversion of land to Settlements. The removal by sinks reported is by sequestration of carbon to wetlands 43.9 % or 708 kt CO_2 eq, to biomass and SOC in revegetation 34.8 % or 560 kt CO_2 eq, to biomass and SOC in forest 17.6 % or 283 kt CO_2 eq. Other contributing components 3.7% include; increase in SOC of mineral soils in some Cropland, increase in biomass and mineral soil SOC in Natural birch shrubland, increase in biomass of abandoned Cropland.

Compared to last year's submission the net emission reported for this sector has decreased slightly or from 11,891 kt CO_2 eq to 11,890 kt CO_2 eq.

The CRF tables are prepared through new version of the CRF reporter (version 5.12.0). The structure of the information from last submission is maintained in all categories. The N_2O emission associated with the drainage, is as in last year's submission reported under *"4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils"* for Forest land, for Cropland it is reported under Agricultural sector as previously but for Grassland it is reported under *"4(III) Direct N_2O emissions from N Mineralization/Immobilization"* with the notation that emission reported is of drained soils.

6.2 Land use practise and consequences

The present state of vegetation and soils is the result of past and present climatic conditions, volcanic activity and land use history. The possible pattern of anthropogenic impact on the landscape and soil erosion in southern Iceland has been studied (Dugmore, Gisladottir et al. 2009). There a two stage process of soil erosion is suggested involving overgrazing causing patterns of damaged vegetation cover in the uplands followed by soil erosion and rapid total denudation of large areas of relatively shallow soils before beginning of the 16th century. Later the soil erosion on lowland areas started, triggered by disruption in vegetation cover. At the time of settlement the natural birch woodlands were widespread but by the end of the 19th century it was mostly exhausted as result of land clearance, intensive grazing, collection of firewood and charcoal making (Þórarinsson 1974).

At the onset of the 20th century the country had suffered from extensive soil erosion and most of the woodland lost. Cultivation was limited and large part of livestock fodder was obtained from uncultivated meadows and wetlands. In the 20th century cultivation was increased considerable especially in the period 1930 to 1990 (Figure 6.3) both on naturally drained soils and also through drainage of wetland soils. The drainage of wetlands was far more extensive than what was ever cultivated leaving large areas as drained grassland.

At the beginning of the 20th century the Soil Conservation Service of Iceland (SCSI) was established to combat the progress of drifting sand threatening farmlands in many areas. The SCSI has ever since been combating soil erosion and actively re-vegetating land. The soil erosion was first mapped at the end of the 20th century showing still ongoing soil erosion and large areas of degraded land. The highland areas have almost completely lost their soil mantle and large areas in the lowland regions are impacted by erosion as well (Arnalds, E.F.Thorarinsdóttir et al. 2001). At the beginning of 20th century there was increased interest in protecting the remaining birch forest and cultivation of new forest. The Icelandic Forest Service was established in the beginning of the 20th century and has since worked on protection of remaining natural forest and cultivation of new forest.

The increased cultivation along with other factors was reflected in increased livestock. The number of sheep reached a maximum in 1977 leading to over-production of lamb meat and high grazing pressure on many areas. This maximum in sheep number was followed by rapid decline in number until 1990 when present winterfeed stock size level was reached (Figure 3). This decline is almost but not entirely reflected in the decline in sheep numbers on the grazing areas as the average fertility has increased in the period (Jónmundson and Eyþórsdóttir 2013) and the time spent on highland grazing areas is better managed than before also affecting the overall grazing pressure.

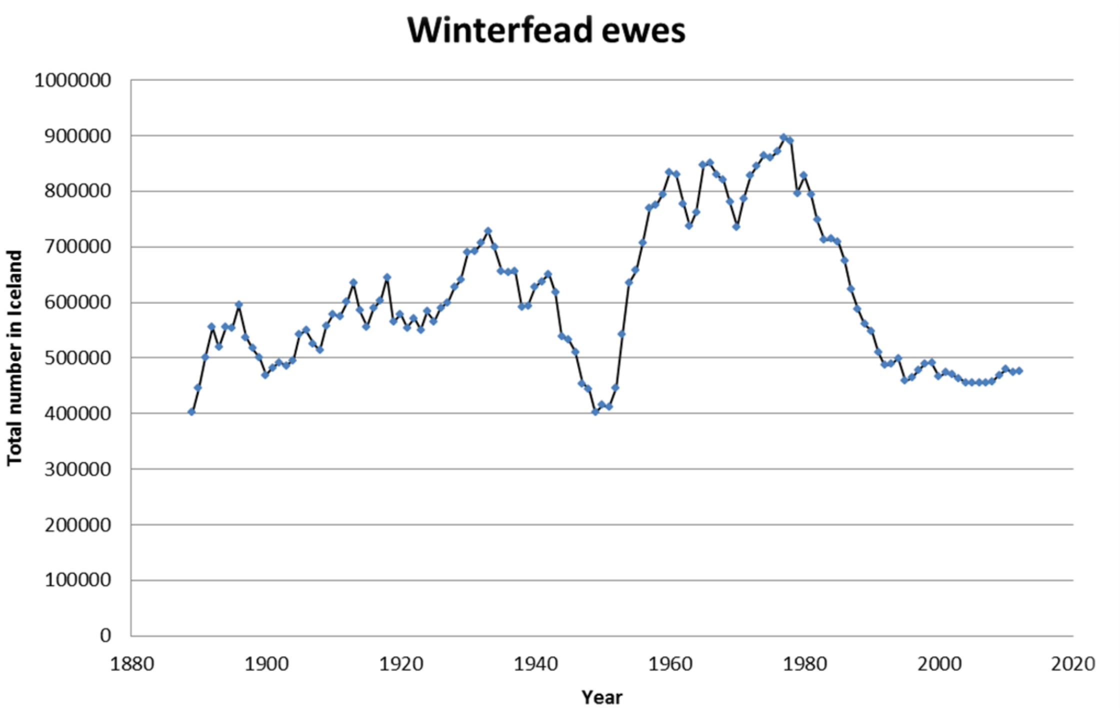

Figure 6.3 Changes in number of winterfed sheep as officially recorded (Statistic Iceland website 2014).

The land use history of Iceland is thus marked by losses and degradation of natural resources including forest, other vegetation, soils and wetlands. According to new mapping effort of natural birch forest and monitoring of afforestation, reforestation and deforestation by the Icelandic Forest Research, forest is presently increasing in area and accumulating carbon. Area of land in revegetation process is presently increasing and accumulating carbon both in vegetation and soil but monitoring of ongoing soil erosion and vegetation losses is fragmentary. The balance of soil formation and losses is thus unknown. According to information presented in this report the area of wetlands drained each year is still larger than the area rewetted. The drained wetland soil is in this inventory estimated to lose much more carbon than is accumulated in the un-drained wetlands.

The degradation of these resources in the past and those still ongoing holds in it potentials to prevent ongoing losses and restore their previous state. The degradation of these resources and their restoration is tightly connected to the carbon stocks included. As clearly reflected in this report the impact of the land use sector of Iceland is very large and consequently holds opportunities to drastically change the emission profile of the nation. Afforestation and revegetation are examples of this restoration work already practised in Iceland and acting as carbon sinks. The impact of the drainage of wetland soils on the emission profile is in this submission larger than before as emission factors have been revised and completeness of emission components improved. The potential for changing the emission profile through wetland rewetting is likewise expanded by this new emission estimate. Ongoing losses of soil and vegetation is still not included in the emission profile and the potential embedded in counter actions likewise unknown. The impact of these sinks and sources will be discussed further in the following chapters on the relevant land use category.

6.3 Data sources

The present CRF reporting is based on; land use as recorded in the Icelandic Geographical Land Use Database (IGLUD), activity data and mapping on afforestation and deforestation from Icelandic Forest Research (IFR), maps of natural birch forest and shrubland from IFR, activity data and maps on revegetation from the Soil Conservation Service of Iceland (SCSI), time series of Afforestation, Reforestation, Cropland and Grassland categories, including revegetation, drainage and cropland abandonment, and of reservoirs. Data on biomass burning is based on area mapping of the Icelandic Institute of Natural History and Westfjord's Natural History Institute and biomass estimation for relevant land categories obtained through IGLUD field sampling as described in (Gudmundsson, Gísladóttir et al. 2010).

The available geographical data and it's compilation of into this year's IGLUD land use map is described below (Ch. 6.3.1). The methodology of the compilation process has been described elsewhere (Gudmundsson, Brink et al. 2013). For several land use categories other estimates than IGLUD land use map exist. If these estimates are considered more accurate than the land use map then that area estimate is used. This applies e.g. to the total area of cultivated forest, where the maps compiled to IGLUD land use map is the area sampling points are selected from. Few of these sampling points do not include cultivated forest and consequently the total area is estimated smaller than the mapped area. As this decrease in area is not geographically identifiable, only the total area can be corrected. The area mapped as cultivated forest in IGLUD land use map, but not reported in the CRF has to be reported under other land use category/ies. In other cases the area reported is larger than the comparable mapping unit, as with land re-vegetated before 1990, then the difference in area has to be transferred from other land use categories to that category. These adjustments of mapped area are described in chapter 6.3.5.

6.3.1 The Icelandic Geographic Land Use Database (IGLUD)

6.3.1.1 Introduction

The objective of the Icelandic Geographic Land Use Database (IGLUD) is to compile information on land use and land use changes compliant to requirements of the AFOLU Guidelines (IPCC 2006), and the 2013 Supplement to the 2006 Guidelines: Wetlands (IPCC 2014). Second objective is to extract from this information reliable land use map containing the land use categories applied in the national inventory to the UNFCCC. As first goal of this objective, all the six main land use classes defined in AFOLU guidelines (IPCC 2006) should be geographically identified. Important criteria regarding subdivision of land use categories is to recognise the land use practices most affecting the emission or removal of greenhouse gasses. This subdivision can either be relative and thus not geographically identifiable or it can be geographically identifiable at various resolutions. The relative division can be known within a region or the whole country. Relative division can be based on ground surveys or other available additional information. To aid the geographical identification of land use categories the definitions of each category need to take in account as much as possible if the category is recognisable both through remote sensing and on the ground. This applies especially to those categories not otherwise systematically mapped.

From the available map layers the land use map is extracted in such way that consistency is ensured and overlapping avoided. The IGLUD database contains; map layers of diverse origin as explained below, geographically referable datasets obtained through IGLUD field work, results of analyses of the samples obtain in that field work, photographs taken at sampling points, geographical data related to surveys on specific map layers or topics related to the database, metadata describing the above data.

The sources of the map layers in IGLUD are described below. Description of field work for collecting land information for the database and some preliminary results can be found in (Gudmundsson, Gísladóttir et al. 2010).

Provided below is a short description of the database, list of its main data sources, definitions of main land use categories as applied in IGLUD and present structure of subcategories.

6.3.1.2 Definitions of IGLUD 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.

Broad Land Use Categories

Settlements: All areas included within map layers “Towns and villages” and “Airports” as defined in the IS 50 v2013 geographical database. Also included as Settlement are roads classified with 15 m wide road zone, including primary and secondary roads. Roads within forest land are excluded as road zone does not reach 20 m.

Forest land: All land, not included under Settlements, presently covered with trees or woody vegetation more than 2 m high, crown cover of minimum 10% and at least 0.5 ha in continuous area and a minimum width of 20 m and also land which currently falls below these thresholds but is expected to reach them in situ at mature state.

Cropland: 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.

Wetland: All land that is covered or saturated by water for all or part of the year and does not fall into the Settlements, Forest land, Cropland categories. It includes intact mires and reservoirs as managed subdivisions 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 Wetland 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 not falling into other categories are included in this category.

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 area of identified land to match the area of the country.

Subcategories applied in IGLUD land use map

In the land use map applied for this and last year’s submission, land is divided to 16 land use classes.

Forest land is represented by two classes prepared through combination of available forest map layers from IFR. The classes are “Cultivated forest” and “Natural birch forest”.

Cropland is presented as two classes i.e. “Cropland” and “Cropland on drained soils”. The separation of these classes is based on total area of drained croplands estimated through time series on

Cropland and delineation of area of same size by choosing lower limits for the density of the ditches network, calculated as described in (Gísladóttir, Gudmundsson et al. 2010).

Grassland is represented as five classes in the land use map; “Natural birch shrubland” as mapped by IFR, “Revegetation before 1990” and “Revegetation since 1990” as mapped by SCSI, “Grassland drained” as identified on basis of the map layer drained land, and “Grassland other” as all other land included as Grassland.

Wetland is in the land use map represented as three classes; “Lakes and rivers”, “Reservoirs”, and “Other Wetland”.

Settlement is in the land use map represented as two classes; “Settlements towns” and “Settlements other”.

Other land is represented as two classes; “Glaciers and perpetual snow” and “Other land”.

Table 6.1 List of map layers used in compiling the IGLUD map showing the categorization of layers and order of compilation.

Land use categories	Sub categories	Map layers included in land use category	ID	Hierarchy of map layers
1.Settlement	Settlement towns	Towns and villages	101	4
	Settlements other	Airports	102	5
		Roads with buffer zone	103	6
2.Forest land	Cultivated forest	Forest cultivations 1908-1989	201	7
		Forest cultivations 1990-2013	203	8
		Forest cultivations mostly after 1990 but some older	202	9
		Forest cultivations most probably planted before 1990	204	10
		Forest cultivations probably after 1990	208	12
		Forest cultivations uncertain age	205	11
	Natural birch forest	Natural birch forest- potentially on drained soils	207	13
		Natural birch forest	206	14
3.Cropland	Cropland	Cropland	301	16
	Cropland on drained soils	Cropland with ditch density 45-8 km km^{-2}	302	17
4.Wetland	Other wetlands	Semi-wetland (wetland upland eco-tone)	401	38
		Wetland	402	39
		Semi-wetland/wetland complex	403	40
	Lakes and rivers	Lakes and rivers	404	15
	Reservoirs	Reservoirs 1	405	1
		Reservoirs 2	406	2
5.Grassland	Other grassland	Grassland (true grassland)	501	27
		Richly vegetated heath land	502	28
		Cultivated land	503	36
		Poorly vegetated heath land	504	29
		Mosses	505	30
		Partly vegetated land (1)	506	31
		Shrubs and forest potentially on drained soils	508	23
		Shrubs and forest	507	27
		Grassland, heath-land shrubs and forest complex	509	34
		Partly vegetated land (2)	510	35
		Pasture	511	37
	Land revegetated before 1990	Farmers revegetation before 1990	512	19
		Revegetation before 1990	515	21
	Land revegetated since 1990	Farmers revegetation 1990-2013	513	20
		Revegetation activity 1990-2013	516	18
	Grassland on drained soils	Drained land	514	24
	Natural birch shrubland	Natural birch Woodland <2m –potentially on drained soils	518	22
		Natural birch Woodland <2m	517	25
6.Other land	Other land	Historical lava fields with mosses (1)	601	32
		Historical lava fields with mosses (2)	602	33
		Sparely vegetated land (1)	603	42
		Sparely vegetated land (2)	604	43
		Zone of recently retreated glaciers	606	41
		Unclassified of IFD lakes and rivers origin	607	43
		Unclassified of revised border origin.	608	42
	Glaciers	Glaciers and perpetual snow	605	3

6.3.1.3 Main Data Sources compiled in IGLUD

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

NYTJALAND - Icelandic Farmland Database (IFD): Geographical Database on Condition of Farming Land

The Agricultural University of Iceland and its predecessor the Agricultural Research Institute in cooperation with other institutions constructed a geographical database (IFD) on the condition of vegetation on all farms in Iceland.

Table 6.2 The original land cover classes of the IFD showing the full scale classes and the coarser class aggregation.

IFD full scale Classes (Icelandic name in brackets)	Short description	Coarse class name
Cultivated land (Ræktað land)	All cultivated land including hayfields and cropland.	Cropland and pasture
Grassland (Graslendi)	Land with perennial grasses as dominating vegetation including drained peat-land where upland vegetation has become dominating.	Grassland, heath-land shrubs and forest complex
Richly vegetated heath land (Ríkt mólendi)	Heath land with rich vegetation, good grazing plants common, dwarf shrubs often dominating, and mosses common.	Grassland, heath-land shrubs and forest complex
Poorly vegetated heath land (Rýrt mólendi)	Heath land with lower grazing values than richly vegetated heath land. Often dominated by less valuable grazing plants and dwarf shrubs, mosses and lichens apparent.	Grassland, heath-land shrubs and forest complex
Moss land (Mosi)	Land where moss covers more than 2/3 of the total plant cover. Other vegetation includes grasses and dwarf shrubs.	Grassland, heath-land shrubs and forest complex
Shrubs and forest (Kjarr og skóglendi)	Land where more than 50% of vertical projection is covered with trees or shrubs higher than 50 cm	Grassland, heath-land shrubs and forest complex
Semi-wetland-wetland-upland ecotone- (Hálfdeigja)	Land where vegetation is a mixture of upland and wetland species. Carex and Equisetum species are common as well as dwarf shrubs. Soil is generally wet but without standing water. This category includes drained land where vegetation is not yet dominated by upland species.	Semi-wetland/wetland complex
Wetland (Votlendi)	Mires and fens. Variability of vegetation is high but this class is dominated by Carex and Equisetum species and often shrubs.	Semi-wetland/wetland complex
Partially vegetated land (Hálfgróið)	Land where vegetation cover ranges between 20-50%. Generally infertile areas often on gravel soil. This class can both include areas where the vegetation is retreating or in progress.	Partly vegetated land
Sparsely vegetated land (Líttgróið)	Areas where less than 20% of the vertical projection is covered with vegetation. Many types of surfaces are included in this class.	Sparsely vegetated land
Lakes and rivers (Vötn og ár)	Lakes and rivers	Lakes and rivers
Glaciers (Jöklar)	Glaciers and perpetual snows	Glaciers

The full scale mapping was completed for approximately 60% of the country and 70% of the lowlands below 400 m elevation in Iceland. 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. The categorization used in the full scale mapping divides the land into twelve classes, ten for vegetation and two for lakes, rivers and glaciers. The classes used in IFD are listed in Table 6.2. The area not covered by full-scale classification of IFD was classified by applying coarser classification (seven classes) modified according to CORINE requirements (Bossard, Feranec et al. 2000). Adding these two levels of classification, i.e. one with seven classes and other with 12 classes, a whole country map layer of this classification is available. This work is has recently been summarised and ground truth work analysed revealing 76% overall accuracy (proportion of correctly classified- %PCC) for the whole picture applying clumped categories of the coarser classification for the full scale classification (Gísladóttir, Brink et al. 2014). This clumping is comparable to the merging of categories applied in IGLUD Land use map.

The pixel size in this database is 15×15 m and the reference scale is 1:30,000. The data was simplified by merging areas of a class covering less than 10 pixels to the nearest larger neighbour area, thus leaving 0.225 ha as the minimum mapping unit.

Before compiling the IFD classes into IGLUD each land cover class is converted to a separate map layer thereby creating 18 map layers.

The two level IFD modified as described above is the primary data source of IGLUD.

IS 50 V2013

The IS 50V2013 geographical database of the National Land Survey of Iceland (NLSI) includes eight map layers. From that database five map layers are used in IGLUD, i.e. “Towns and villages”, “Airports”, “Roads”, and “Glaciers and perpetual snows”. The roads in the IS 50V2013 database are linear features representing the centreline of the road. To allocate area to roads a buffer zone, defined according to road type, was added. In last years submission the buffer zone applied in previous submissions was revised to better reflect the actual land cover of the roads rather than administrative boundaries of the roads. The buffer applied on the roads was decreased accordingly. In this submission that revised buffer zone is maintained. This buffer zone was compared with the map layer of Forest land and overlapping area removed from the buffer to avoid reduction of forest land by excluding treeless land less than 20 m wide. These map layers are in vector format and before entering the IGLUD they are converted to raster format and resampled to 15x15m pixel size.

Maps of Forest and Other Wooded Land

All known woodland (synonym for forest and other wooded land) including both the natural birch woodland and the cultivated forest has been mapped at the IFR on the basis of aerial photographs, satellite images and activity reports. This map forms the geographical background for the National Forest Inventory (NFI) carried out by IFR. The control and correction of this map is part of the NFI work. The IFR has completed the revision of the map layers on birch forest and shrubland based on field mapping. The revised maps of these categories are applied in preparing the IGLUD land use map for this submission. The category Forest Land in IGLUD map is based on the IFR maps. The maps of natural birch forest and natural birch shrubland were split to two layers one with the area overlapping with the buffer on the drainage ditches and remaining area in the other layer. The area overlapping with the buffer is defined as potentially drained area. The maps are in vector format including classification attributes connected to each mapping unit. Before entering the IGLUD database they are converted to raster format and resampled to 15x15m pixels and then divided to seven separate map layers according to their feature attributes. In this submission, updated version of the IFR map layers on cultivated forest is applied.

Maps of Land being re-vegetated

The SCSI collects information on revegetation activities. The majority of revegetation activities since 1990 are already mapped and available in vector format. Mapping of the activity “Farmers re-vegetate the land” (FRL) has now been completed and is also available in vector format. FRL is a cooperative revegetation activity between SCSI and voluntary participating farmers. These maps form the geographical background of the “National inventory of revegetation activities” (NIRA), carried out by SCSI. The recorded activities, which are currently not mapped are not included in the NIRA but will be added consequently as their mapping proceed. Unmapped activities are included as activity in CRF and the difference in maps and activity is balanced against other land use (see chapter 6.3.6). The SCSI has revised the maps of land re-vegetated since 1990, and that revision is applied in preparing the IGLUD land use map for this submission. The revegetation taking place before 1990 is presently far less mapped. The documentation of the activities at that time focuses more on site of the activity rather than its geographical delineation. Efforts are currently being made to locate and delineate currently un-located activities prior to 1990 based on available information and data. The activities before 1990 already mapped are available in vector format. The category Re-vegetated land in IGLUD is based on these maps.

Maps of Drained land

The extensive drainage that took place mostly in last century was not recorded geographically. Some of the ditches were included though in the NLSI topographical maps. All ditches recognizable on satellite images (SPOT 5) were digitized 2008 in a cooperative effort of the AUI and the NLSI.

The map layer “Drained land” was prepared by AUI from the map of ditches. The first step was to attach a 200 m buffer zone on every ditch. From the area such included the overlap with following map layers extracted form IFD was excluded; “Sparsely vegetated land” (ID: 603 and 604), “Partly vegetated land” (ID: 506 and 510), “Lakes and Rivers” (ID: 404), “Shrubs and forest” (ID: 507) and the IFR map layer Natural birch woodland <2 m (ID: 517). Additionally all areas where slope exceeded 10° or extended below seashore line were excluded. To exclude steep areas the AUI elevation model (unpublished), based on NLSI elevation maps, was used. The map layer is in raster format. This map layer of drained land was used in the IGLUD compilation process and further limited by the map layers ranking higher in compilation order. The Grassland subcategory “Drained Grassland” is identified in IGLUD on basis of this map. The map layers of potentially drained area; natural birch forest (ID: 207), natural birch shrubland (ID: 518), and shrubs and forest (ID: 508) were prepared by extracting the overlap of layers ID: 206, 517 and 507 respectively with the 200 m buffer zone (where land with slope exceeding 10° and land included in the layer “Lakes and Rivers” excluded).

Maps of cultivated Land

The map layer Cropland was also produced in cooperation with NLSI. The digitization was completed in 2009 by AUI. This map layer is the only source of identification of Cropland in IGLUD. The map layers identifying Cropland in IFD are not included as Cropland in IGLUD land use map, as considered far less accurate. The area of Cropland on drained wetland (“organic”) soils is included in the IGLUD land use map. The geographic identification of drained wetland soils within Cropland is ongoing project of AUI. The area shown as Cropland on drained soil is estimated by GIS processing by adjusting density classes of the ditch network to the area of cropland drained soils estimated through time series (see chapter 6.3.3).

Maps of reservoirs

Two map layers on reservoirs are available one with the reservoirs of Landsvirkjun which is the main hydropower company in Iceland, and a second layer prepared by AUI on basis of available information (Sigurðsson 2002) and local knowledge. Included in this second layer are many smaller reservoirs and reservoirs managed by others than Landsvirkjun. This map layer still needs to be verified. These layers are available in vector format and are converted to raster and resampled to 15x15 m pixels before entering IGLUD.

Map of zone of recently retreated glaciers.

The comparison of previous map of glaciers and perpetual snows included in IFD to the one from IS50 V2013 reveals less area included in the IS 50V2013. This shrinkage of glaciers and perpetual snows exposes land not previously classified. This land is included as a separate map layer in IGLUD. This data is in raster format.

Map of pixels from the old layer of lakes and rivers with lost classification

In previous submissions two map layers were representing lakes and rivers, i.e. one from IFD and the other from IS 50 v3.2. In the land use map prepared for 2014 submission both these map layers were replaced by a new layer from IS 50V2013. Small areas of land, which in the IFD was classified as lakes and rivers but is not included in the new IS 50V2013 layer, are not identified to any of the other map layers included. This land is included as separate layer while no classification is available. This map layer is prepared in raster format.

Map of unclassified land added through revision of outer boundaries.

In submissions prior to the year 2014 the outer boundaries of Iceland were represented by the total area classified in the IFD. In the 2014 submission the outer boundaries lines were extracted form IS 50V2013. This revision resulted in an addition of many small islands and islets and the costal outline changes. Through this revision some areas were removed from the IFD classes and new areas not previously classified were added. These new areas were added as a separate map layer in the 2014 submission and that map layer is also included in this submission.

Map of historical lava fields covered with mosses

To separate land with almost full vegetation cover but less than 20% cover of vascular plant, geological maps and vegetation maps were compared to identify areas of historical lava fields covered with mosses. The map of historical lava fields is from the Icelandic Institute of Natural History as well as vegetation maps identifying mosses in areas where only courser classification in IFD is available. In areas of IFD full scale classification the geological maps were compared to the IFD class "Mosses" to this purpose. From this comparison two map layers in raster format were prepared.

6.3.1.4 Compilation of map layers to land use map

The process of compiling the data to a land use map is described in more details in (Gudmundsson, Brink et al. 2013). Before entering the database, all map layers, if not already so, were converted to raster format and resampled to 15x15m pixel size. Layers in vector format were converted to raster. The compilation process is done by overlay analyses using "*ArcGIS version 10.1*" software. In that process the hierarchy of the map layers plays an essential role, as the map layer higher in the hierarchy replaces all overlaid pixels in a map layer of lower order with its own pixels. Thus e.g. the pixels common to the map layer "Reservoirs 1", and "Reservoirs 2", with hierarchy order 1 and 2, and the map layer, "Lakes and rivers" with hierarchy order 15 are defined as reservoirs. The criteria applied to determine the hierarchical order of map layers and the compilation process is further described in (Gudmundsson, Brink et al. 2013). Before entering the compilation all map layers are cut by the outer boundaries lines were extracted form IS 50V2013, excluding all area outside these boundaries. The layer of all area within the new boundaries is then included at the bottom of the hierarchical order of map layers.

Each map layer is categorized to the relevant land use category considering its order in the compilation hierarchy. The category "Cultivated land" originating from the IFD database is categorized to other Grassland as the “Cropland” map layers are above it in the hierarchy and all cropland therefore excluded from what is left behind of that map layer in the compilation process. The map layers used in compiling the IGLUD land use map are listed in Table 6.1.

The land use map resulting from the preparation of map layers and the compilation process is shown in (Figure 6.4, Figure 6.5, Figure 6.6, Figure 6.7) and is also available at the website http://www.lbhi.is/vefsja.

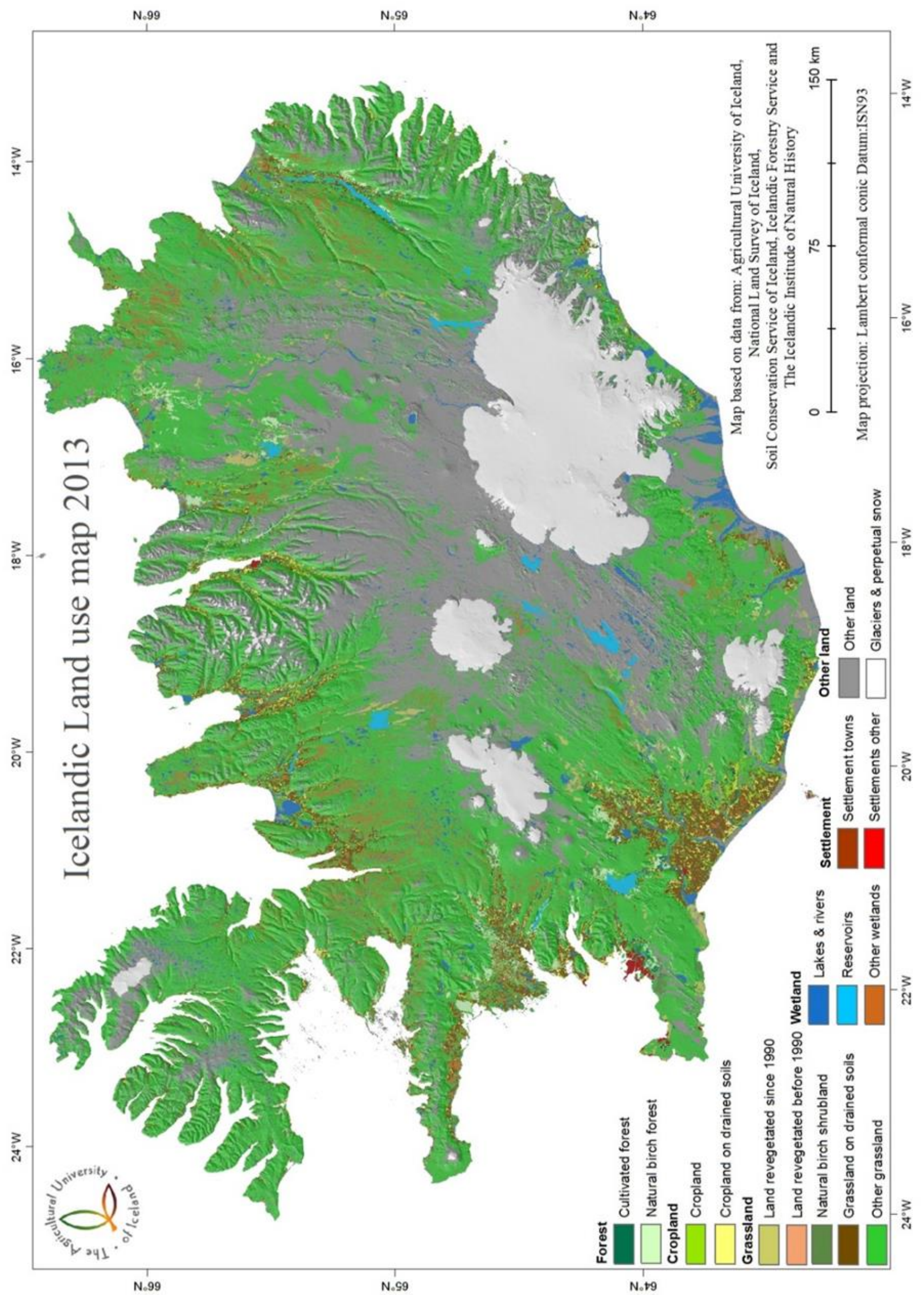

Figure 6.4 The land use map of IGLUD prepared for the year 2013.

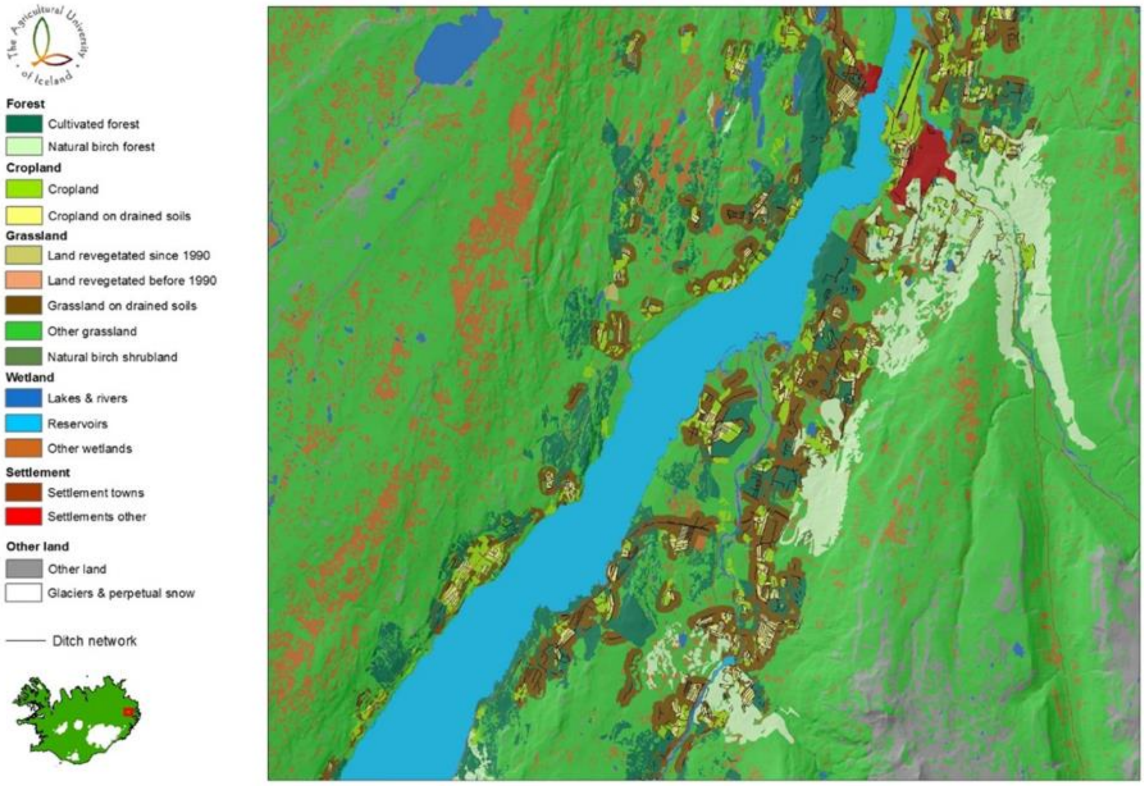

Figure 6.5 Enlargement of land use map emphasizing the different Forest land subcategories.

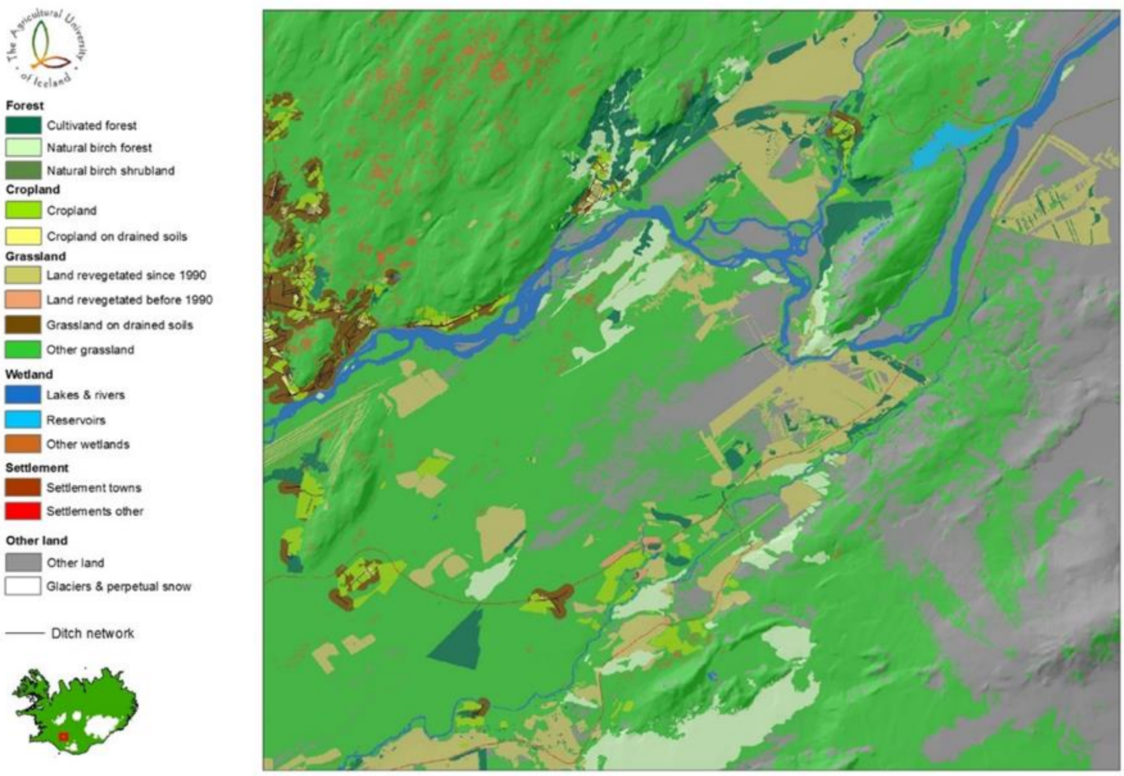

Figure 6.6 Enlargement of land use map emphasizing the Revegetation area mapped.

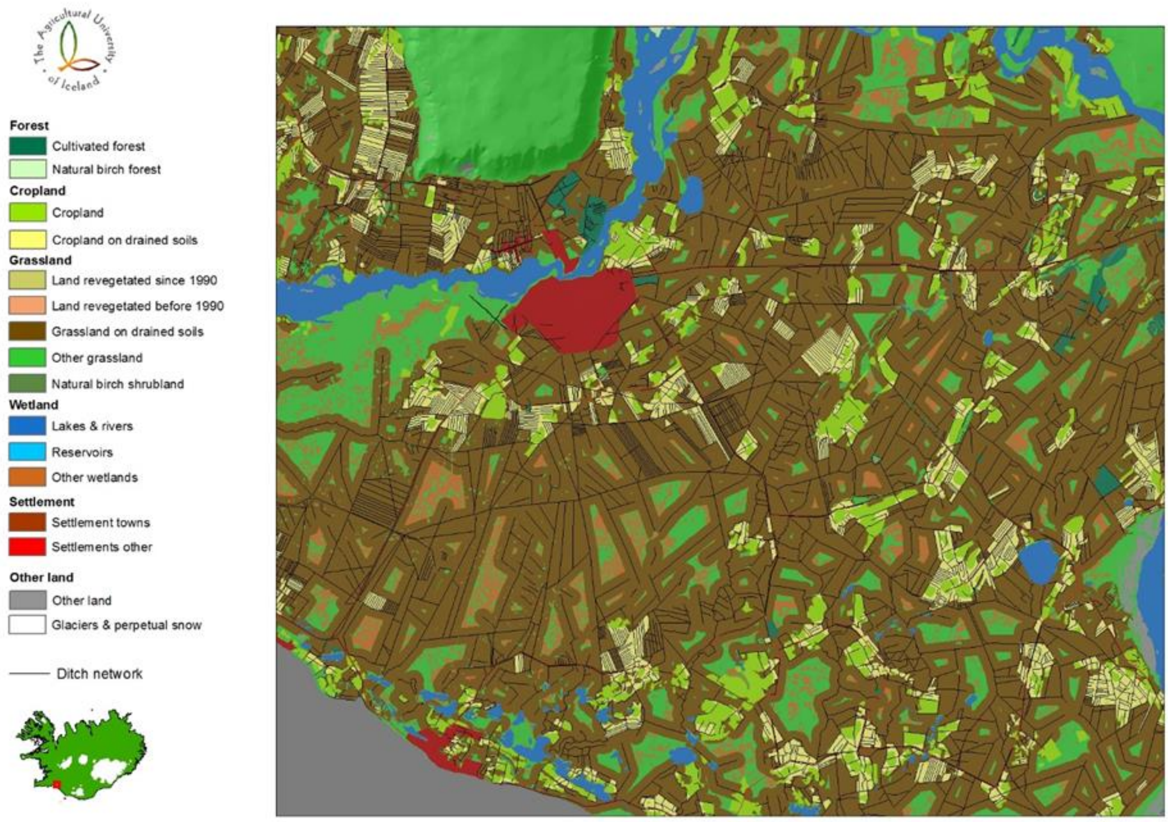

Figure 6.7 Enlargement of land use map emphasizing the subcategory Grassland on drained soils.

6.3.2 Changes in land use map

In this submission the land use map from last submission is applied unchanged.

6.3.3 Time series

Land use map does not provide all the information needed for estimating the area of each land use category requested. The map summarize geographical data extending over long period and can accordingly not be taken as accurate land use at a specific year nor can land use maps changes from one year to the next be interpreted as land use changes unless relevant map layer was updated. To estimate the changes in land use and separate the area within each category remaining in category and land being converted to the category time series are needed. From available data independent time series have been created for; afforestation, deforestation, expansions of natural birch forest and shrubland, cropland converted to forest land, other land converted to forest land, wetland drainage, land converted to cropland, cropland abandonment, revegetation, settlements and establishment of new reservoirs. All other reported time series on land use are derivatives from these time series adjusted to the area of the category as emerging from the land use map, if more reliable estimates of total area is not available. All land use categories for which emission or removal is reported are now represented by time series.

Most of the data the time series are based on, hold information about changes, i.e. new input or output to or from the area of the respective category, without assigning the origin of the input or destination of the output to certain other land use category. The time series for cropland are thus constructed from data based on records of new cultivations each year and available estimates of abandoned cropland at specific points in time. This data does not specifically state which land use categories were turned to cropland or what became of the abandoned fields.

Extensive drainage of Icelandic wetlands took place in the period 1940-1985 and is still ongoing at a lower rate. This drainage was aided by governmental subsidies. The outcome of this drainage effort was that the larger part of the lowland wetlands in Iceland was converted to Grassland or Cropland. Only a small portion of these drained areas was turned to hayfields or cultivated. Part of this land has since been afforested or converted to Settlement. The governmental subsides involved official recording of the drainage, kept by the Farmers Association. The subsidies of new drainage ended in 1987 (Gísladóttir, Metúsalemsson et al. 2007). Since then, the recording of drainage has been limited, and no official recording is presently available and only one region updates its records annually (Kristján Bjarndal Jónsson personal communication). In this year's submission the new drainage ditches of the year 2014 in that region were assumed to be the average of the two previous years. These records are applied to estimate the new drainage in the country. These records of excavation of drainage ditches are applied to construct the time series of conversion of wetland soils to other land use categories.

The evaluation of cropland origin as it appears in the time series is based on two assumptions. First assumption is that land that has been converted to cropland originated mostly from either Grassland on mineral soil or from wetlands. The second assumption is that the ratio of new cropland of wetland origin has been constant. This ratio has in the construction of the time series been adjusted to ratio of wetland originated hayfields evaluated in the period 1990-1993 (Þorvaldsson 1994).

The destination of abandoned cropland is assumed as first approach to be all to the Grassland category, and the ratio of organic and mineral soil of abandoned cropland is the same as the ratio within the cropland category on the year of abandonment. This time series is then corrected according to an independent time series of "Cropland converted to Forest land".

The time series for settlements are prepared from total basal area of all buildings in towns and villages. It is assumed that the ratio of total area of towns and villages and of other settlements to the basal area of buildings has remained the same as in 2013, extracted from the IS50 V2013 map. The settlement area is then assumed to have changed proportionally to the basal area as recorded officially by Registers Iceland. More detailed description of time series preparations is pending.

6.3.4 CRF subcategories and their relation to land use map

In the CRF tables land use categories are divided to subcategories. This division, and how the subcategories are related to the categories of the land use map, is described below.

6.3.4.1 Forest land

Two subcategories of Forest land are defined on the land use map, natural birch forest and cultivated forest. The resolution applied in land use map of last year's submission is revised omitting the separation of individual map layers on the land use map applied in that submission. Both categories are in the CRF tables divided further according to age of forest to land remaining forest land and land converted to forest land. The IFR finished last year mapping of all natural birch forest and shrubland. The mapping effort took five years (2010-2014) and the resulting area is reported as the area in the year 2012. The total area of natural birch forest reported in this submission is bit larger than the mapped area, representing the ongoing expansion of natural birch forests. Accordingly the land use map unit Natural birch forest represent all CRF categories of Natural birch forest except new expansions in the years 2013 and 2014. Individual CRF categories of natural birch forest can't be related to specific mapping units.

All of the cultivated forest reported in the CRF tables is included in the mapping unit Cultivated forest and as no further division of that mapping unit is applied the CRF subdivision are not tracked.

6.3.4.2 Cropland

Two subcategories of Cropland are defined on the Land use map, “Cropland” and “Cropland on drained soils”. As explained above the mapping unit Cropland on drained soils is approximation of the geographical location of drained soils assuming fixed ditch density to separate between the freely drained soils and those drained through the ditches network. Accordingly it is assumed that most of the soils reported in CRF as organic are include in the land use map unit Cropland on drained soils and the mineral soils likewise in the mapping unit Cropland. In the CRF tables Cropland is as other land use category divided to “Cropland remaining Cropland” and “Land converted to Cropland”. The category “Land converted to Cropland” is in the CRF reported from two sources, i.e. “Grassland converted to Cropland” and “Wetland converted to Cropland”. The separation to land remaining and land converted to Cropland is not recognizable in the land use maps. Grassland and Wetland, converted to Cropland are assumed to be included in the mapping units “Cropland”, and “Cropland on drained soils”. The mapping units of Cropland show larger area than area reported in CRF tables based on time series for Cropland. The excess area is considered as abandoned cropland and is reported under Grassland.

6.3.4.3 Grassland

Grassland is represented by five subcategories on the Land use map, i.e. “Other grassland”, “Land re-vegetated before 1990”, “Land re-vegetated since 1990”, “Grassland on drained soils”, and “Natural birch shrubland”. In CRF twelve land use subcategories are reported under Grassland. Two of them i.e. “Cropland converted to Grassland” and “Cropland abandoned for more than 20 years” are related to the land use map unit Cropland. The two CRF categories “Wetland drained for more than 20 years” and “Wetland converted to Grassland” are together mostly represented by the mapping unit Grassland on drained soil. Some part of the latter category is still to be found under the mapping category “Other wetlands”. The area of the CRF categories “Natural birch shrubland -old” and “Natural birch shrubland -recently expanded into other grassland” is represented by the mapping unit “Natural birch shrubland”, except for small area of expected shrubland expansion in the year 2013. Revegetation is on the land use map represented by two mapping units, i.e. “Land re-vegetated before 1990” and “Land re-vegetated since 1990”. The CRF two categories “Revegetation since 1990 – protected from grazing” and “Revegetation since 1990 – limited grazing allowed” are fully covered by the mapping category “Land re-vegetated since 1990”, leaving some excess area within the mapping unit. Only a small part of the area of the remaining two CRF categories of revegetation, “Re-vegetated land older than 60 years” and “Revegetation before 1990” are represented by the map unit “Revegetation before 1990”. The remaining area is assumed to be found within the land use map unit “Other grassland”. Natural birch shrubland is divided to three categories in the CRF. These categories are almost completely covered by the map unit “Natural birch shrubland”, the area missing is the expansion of shrubland in 2013 and 2014. The CRF subcategory Other Grassland is represented by the land use mapping unit “Other Grassland” taken into account the claims of other CRF categories to that mapping unit as described above.

6.3.4.4 Wetland

Wetlands are in the land use map represented by three mapping units; “Lakes and rivers”, “Reservoirs” and “Other wetlands”. In CRF, Wetland is reported in eight subcategories. The CRF category “Lakes and rivers” is almost fully represented by the land use mapping unit with same name. Only one refilled lake is included in land use map unit “Other grassland”. The land use map unit “Reservoirs” represents fully the CRF units of “Mires converted to reservoirs”, “Lakes and rivers converted to reservoirs”, “Medium SOC to reservoirs”, “Low SOC to reservoirs”. The CRF category “Intact mires” is all included in the land use map unit “Other wetland”. The CRF category “Refilled lakes and ponds”, is included in land use map unit “Lakes and rivers”, except one lake. The CRF category “Rewetted wetland soil” has no matching land use map unit yet, but is assumed to be included in the map units, “Other wetlands” and “Grassland on drained soils”.

6.3.4.5 Settlement

Settlement is represented in the land use map by two map units, “Settlement- towns”, and “Settlement –other”. In CRF Settlements are reported under four categories “Settlements remaining Settlements”, “Forest converted to Settlements”, “Natural birch shrubland converted to Settlements” and “all other Grassland categories converted to Settlements”. The CRF categories are not directly connected to either of the land use map units, but collectively their area matches the area of the map units.

6.3.4.6 Other land

In the land use map “Other land” is represented by two map units, “Glaciers and perpetual snow” and “Other land”. In CRF all of the area in land use category “Other land” is reported as “Other land remaining Other land”.

6.3.5 Combining different estimates of land use area

For many of the land use categories information on area is available from time series or through direct estimates. For other categories the land use map unit is the only source of area estimate available. To obtain as good estimate of the area of land use categories relying on land use map estimate, it is necessary to harmonize the area of land use map units to other estimates. For those categories where the map unit cover larger area than the more reliable estimate used, some area has to be transferred to other land use categories and vice versa where area estimate is larger than the relevant mapping unit. These area adjustment are summarized in Table 6.3. Area estimates considered more accurate than relevant land use map unit are available for eight land use map units listed in Table 6.3.

The IFR provides estimates for the categories; “Cultivated forest”, “Natural birch forest” and “Natural birch shrubland”. The area of cultivated forest estimated in the National Forest inventory and is annually updated. The IFR finished last summer revised mapping of all Natural birch forest and birch shrubland, and the resulting estimate is set as the area of the mid-year of the mapping i.e. 2012.

The area of Cropland in use is estimated from time series prepared by AUI from official statistics on annual new cultivations and available data on abandoned cropland. The ratio of drained Cropland abandoned is also estimated by the Cropland time series. The excess area of the cropland map unit is transferred to “Grassland drained soils” and “other Grassland” accordingly.

Drainage of Icelandic wetlands mostly in the period 1940- 1990 was aided by governmental subsides and included certain recording of the excavation. The time series of new drainage are constructed from these records, plus additional data on drainage since 1990, drained soils under other land use categories, and known area of rewetting. The land use map unit “Grassland on drained soils” is an underestimate compared to estimate of the time series. Both sources are based on conversion of ditches length to drained area but the time series include ditches excavated since 2008 when the ditch network was digitized and also the drained area included in abandoned Cropland. Most of the difference in area is clarified by drained soils of abandoned Cropland but remaining difference is assumed new drainage and transferred to the category from the category “other wetlands”.

The reported revegetation activities since 1990 is bit less than the comparative land use map unit. The excess area is divided equally between “Other Grassland” and “Other land”. The land use map unit “Revegetation before 1990” is largely under representative of the area reported by SCSI as re-vegetated in that period. The revegetation activities are recorded as successful and should have been detected as vegetated area in the IFD. Accordingly the area lacking in the land use map unit is transferred from the land use map unit “Other Grassland”.

The land use map unit “Lakes and rivers was checked against the lakes and ponds recorded as refilled and one lake identified as not appearing in the land use map unit. The area of that lake was accordingly transferred from “Grassland on drained soil” to the category.

The area of three land use map unit “Grassland Other”, “Wetland other” and “Other land” is changed through the above area transfers. The resulting area estimates are reported for those land use categories in the year 2014.

Table 6.3 Land use map area transfer matrix showing area transfer between land use categories to adjust other mapped area to other estimates available. Lines shows area moved from category and columns area moved to category.

Land use map units From\to [ha]	FL C	FL NB	CL	GL. drained	GL. Nb. shrub	RV before. “90	RV s. “90	O.GL	WL.O	WL. L&R	WL. Reserv.	Settlements	OL	Glaciers
FL C								7,521						
FL NB														
CL				15,869				30,545						
GL. drained									498	8				
GL. Nb. shrub														
RV before. “90														
RV since. “90														
O.GL		788			750	161,574	848				230	141		
WL.O				7,984										
WL. L&R											1			
WL. Reserv.														
Settlements														
OL							848				430			
Other														
Other estimate	39,908	96,691	126,169	365,190	54,939	165,356	105,622			207,108				
Map area	47,429	95,903	172,583	341,843	54,189	3,782	103,927	4,811,805	361,195	207,101	57,901	27,468	2,896,546	1,086,616
Difference	7,521	-788	46,414	-23,347	-750	-161,574	-1,696			-7				
Corrected area	39,908	96,691	126,169	365,190	54,739	165,356	105,622	4,685,540	353,709	207,108	58,562	27,609	2,895,269	1,086,616
Total area [ha]														**10,268,287**

FL C: Cultivated forest.	RV b. “90: Revegetation initiated before 1990	WL. Reserv.: reservoirs
FL NB: Natural birch forest.	RV s. “90: Revegetation initiated since 1990	Settlements: settlements
CL: Cropland	O.GL: other Grassland	OL: other land
GL. Drained: Grassland on drained soils	WL. O: other wetlands	Glaciers: Glaciers and perpetual snow
GL Nb. shrub: Natural birch shrubland	WL. L&R: Lakes and rivers	

The area of the land use map unit “Glaciers” is not affected by these area transfer.

6.3.6 Land use changes

Land use changes are reported as land being converted from one category to another. For each land use conversion a conversion period is defined as the period it takes the C-pools of the land converted to reach stable level. Land converted stays in the category “land converted to” until end of conversion period then it is transferred to the category “Land remaining in category”. The default conversion period suggested in IPCC 2006 Guidelines (IPCC 2006) is 20 years. The land reported as converted to a category is thus the cumulative area converted for the number of years defined as conversion period of the category. In this submission 20 categories of land conversion involving conversion between main land use categories, are reported. Beside those conversion four changes in land use within main land categories are reported involving; expansion of Natural birch shrubland into other grassland, conversion of intact mires to reservoirs, plantation in natural birch forest and conversion of lakes and rivers to reservoirs. In available records of land use change the previous land use of the land converted are in many cases not recorded. This applies e.g. to land converted to Cropland and, Revegetated land and to some extent afforested land. Assigning the land converted to these categories therefore is based on assumptions regarding the origin of the land. New Cropland is thus assumed to come from either the Grassland or the Wetland category. In some instances “Other land” might have been the previous land use category or Natural birch forest, but no data is available to estimate the proportion of these land use categories in land converted to Cropland at different times. Revegetated land is assumed to be conversion of “Other land” to Grassland, although previous land use category was not recorded at the initiation of the revegetation process. The conversion of “Other land” to Forest land has already been excluded for the category Revegetated land. The area of Cropland converted to Forest land is based on data from the National Forest Inventory where previous land use of the afforested sampling points is recorded. That recording does not differentiate cropland in use and abandoned cropland at the time of afforestation. Abandonment of Cropland at different times is not geographically identifiable and no support can be sought in that direction on whether the afforested land was in use as Cropland or was already abandoned at the time of afforestation. The assumptions made regarding the categories of land use changes reported are discussed in the chapters on land converted to each land use category.

In the new CRF Reporter v 5.12.0 and the reporting tables created by the reporter there is a discrepancy in what is included under the categories “Land converted to a category”, between the Land Transition matrix and the division to “Land remaining in a category” and “Land converted to a category” in the main land use categories. In the Land Transition matrix and specially the reporting table created from it (CRF table 4.1) land converted to a category is supposed to include only land converted the relevant year and land remaining in category is the area included the previous year still not converted to other categories. In the division between “land remaining in a category” and “land converted to the category” in the main land use categories land remains as land being converted to throughout the defined conversion period when it is moved to the category. The ongoing land use conversions are summarized in Table 6.4. The final area is the total area of the land use category in that column in the inventory year. The initial area is area of land defined as remaining in a category plus the cumulative area of all conversion from the category over the conversion period for the land use category converted to. The initial area can’t therefore not be pinpointed to a specific year as the conversion period is variable.

Table 6.4 Summary of land use conversions in the inventory year. Land is defined as being converted throughout the defined conversion period. The final area is the total area of the land use category in that column in the inventory year. The initial area is area of land defined as remaining in a category plus the cumulative area of all conversion from the category over the conversion period for the land use category converted to. The initial area can't therefore not be pinpointed to a specific year as the conversion period is variable. Net change is the difference between the initial and the final area negative values meaning decrease in the category at the column heading.

TO:	Forest land (managed)	Forest land unmanaged)	Cropland	Grassland (managed)	Grassland (unmanaged)	Wetlands (managed)	Wetlands (unmanaged)	Settlements	Other land	Total unmanaged land	Initial area
FROM:	(kha)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest land (managed)	89.66	NO	NO	NO	NO	NO	NO	0.05	NO	NO	89.71
Forest land (unmanaged)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Cropland	0.92	NO	120.91	23.46	NO	NO	NO	IE	NO	NO	145.28
Grassland (managed)	36.11	NO	2.53	5,050.83	NO	7.80	NO	0.15	NO	NO	5,097.41
Grassland (unmanaged)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Wetlands (managed)	IE	NO	2.73	33.36	NO	385.68	NO	IE	NO	NO	421.77
Wetlands (unmanaged)	NO	NO	NO	NO	NO	31.48	206.99	NO	NO	NO	238.47
Settlements	NO	NO	NO	NO	NO	NO	NO	27.41	NO	NO	27.41
Other land	9.01	NO	IE	269.62	NO	NO	NO	IE	3,981.88	NO	4,261.42
Total unmanaged land	IE	NO	IE	IE	NO	IE	NO	IE	NO	IE	IE,NO
Final area	136.59	NO	126.17	5,377.26	NO	424.96	206.99	27.61	3,981.88	IE,NO	10,281.48
Net change	46.89	NO	-19.11	279.85	NO	3.19	-31.48	0.20	-279.53	IE,NO	0.00

6.3.7 Uncertainties QA/QC of land use estimates

The bulk of the area in the land use map (80%) is classified on the basis of map layers from the IFD. A report on the IFD was recently published, describing thoroughly the methodology applied its data sources and analyzing the resulting land cover classification (Gísladóttir, Brink et al. 2014). The overall accuracy of the classification as applied in the land use map is estimated as being 76 %. Many factors contribute to the classification error observed, including the basic classification problem the land cover being gradient rather than distinctive classes with clear boundaries. Large part of the control points in IFD incorrectly identified is thus confusion between similar categories.

The classification of the area in the land use map not classified from IFD data is based on map layers originating through direct mapping in field, on screen digitation from satellite images or aerial photographs, or through GIS processing of other map layers supported by additional data and assumptions. The uncertainty of some of these map layers has been estimated but for others no estimate is available. For some map layers like roads the location can be considered highly accurate but the conversion of the vector data to raster data and estimate of area covered by the roads is not as accurate. The compilation of the map layers and determination of its hierarchical order in that process can potentially both increase or decrease the area wrongly classified. The sampling points of the IGLUD are presently 2,336, of these 72% are correctly related to the present land use map according to preliminary results. That estimate is presently the only specific estimate available on the land use map classification as presented. The area of most of the land use categories applied in the CRF reporting is further affected by the transfer of area described above to adjust the land use map estimates to other available data. The effects of these transfers on the uncertainty of area estimates is not known. The uncertainty of area estimate of one land use category has different impact on the emission/removal reported depending on the emission/removal per land unit of the category. Small uncertainty of e.g. drained Grassland has much more impact on the emission the relatively high uncertainty of classifying land to e.g. other land or the less vegetated areas included as other grassland.

6.3.8 Planned improvements regarding Land use identification and area estimates

As outlined above the uncertainty of the area estimate of reported land use categories is relatively high. For other categories e.g. Natural birch forest and Natural birch shrubland new mapping effort is assumed to have decreased considerably the uncertainty of the area estimates. A survey on the drainage efficiency of the ditch network in Grassland was completed in 2014. The analyses of the data is pending and expected to enable revision of the area estimate of that category. Besides those specific improvements the land use identification is planned to be updated as new information becomes available. Generally only abandoned cropland is afforested. In next submission the category Cropland converted to Forest land will be changed to abandoned cropland converted to Forest land.

6.3.9 Completeness and method

The 2013 Supplement to the 2006 Guidelines: Wetlands (IPCC 2014) and the new CRF provided methodology for estimation of emission and removal of many components previously not reported. Off-site emission of CO_2 via waterborne losses from drained soils, CH4 emission and removal from drained soils including both the drained land and the ditches network. Emissions from intact mires, rewetted soils and Grassland converted to Settlements are reported for the first time. Emission factors have also been revised for many categories. The completeness of the reporting of the emissions and removals is thus increased from previous submissions. The completeness is further explained and discussed in chapters on emissions/removals of individual land use categories.

The emission and removals for each main land use category are separated to three groups in the CRF reporter and the CRF reporting tables; emission and removals of “Land remaining in a land uses category”, of “Land converted to a category”, and “From drainage and rewetting and other management of organic and mineral soils”. The separation of the emission/removal components is not self-evident. The carbon stock change in drained soils could be identified as “emissions and removals from drainage”, and the “Off-site emission from waterborne carbon losses” could be identified as additional carbon stock changes. In this submission off-site emission of waterborne carbon losses and methane emission from drained land and managed wetlands is included in the category “Emission and removals from drainage and rewetting and other management of organic and mineral soils”

Summary of method and emission factors used is provided in Table 6.5, Table 6.6 and Table 6.7.

Table 6.5 Summary of method and emission factors applied on CO_2 emission calculation, including area and calculated emission/removals.

Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Forest Land	136.60			-295.99
Forest Land remaining Forest Land	89.66			-32.95
Carbon stock changes	136.60			-297.56
Afforestation older than 50 years	0.89			-7.55
Living biomass		T3		-7.61
Dead wood		IE		
Litter		NE		
Mineral soil	0.83	NE		
Organic soil	0.05	T1	D	0,06
Natural Birch forest	87.72			-16.00
Living biomass		T3		-16.11
Dead wood		NE		
Litter		NE		
Mineral soil	87.64	NE		
Organic soil	0.08	T1	D	0.11
Plantations in natural birch forest	1.06			-9.40
Living biomass		T3		-9.40
Dead wood		IE		
Litter		NE		
Mineral soil		NE		
Organic soil		NO		
Land converted to Forest Land	46.94			-264.61
Carbon stock changes				
Cropland converted to Forest Land	0.92			-4.00
Afforestation 1-50 years old - Cultivated forest	0.92			-4.00
Living biomass		T3		-2,91
Dead wood		IE		
Litter		T2	CS	-0.48
Mineral soil	0.69	T2	CS	-0.92
Organic soil	0.23	T1	D	0.31
Grassland converted to Forest Land	36.11			-215.61
Afforestation Natural birch forest 1 - 50 years old	6.85			-17.76
Living biomass		T2	CS	-6.39
Dead wood		IE		
Litter		T2	CS	-3.32
Mineral soil	6.24	T2	CS	-8.61
Organic soil	0.42	T1	D	0.57
Afforestation 1-50 years old - Cultivated forest	29.26			-197.84
Living biomass		T3	CS	-151.05
Dead wood		NO		
Litter		T3	CS	-15.13
Mineral soil	26.46	T2	CS	-35.46
Organic soil	2.80	T1	D	3.79

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Other land converted to Forest land	9.91			45.01
Afforestation 1-50 years old - Cultivated forest				
Living biomass		T3		-19.14
Dead wood		IE		
Litter		T2	CS	-4.03
Mineral soil	7.78	T2	CS	-14.64
Organic soil	NO			
Natural birch forest 1-50 years old	2.12			-7.20
Living biomass		T2	CS	-2.11
Dead wood		NE		
Litter		T2	CS	-1.10
Mineral soil	2.12	T2	CS	-3.99
Organic soil	NO			
Off-site emission via waterborne carbon losses from drained soils	3.57			1.57
FL remaining FL Afforestation more than 50 years old	0.05	T1	D	0.02
FL remaining FL Natural birch forest older than 50 years	0.08	T1	D	0.04
CL converted to FL Afforestation 1-50 years old	0.23	T1	D	0.10
GL converted to Natural birch forest	0.40	T1	D	0.18
GL converted to FL Afforestation 1-50 years old	2.80	T1	D	1.23
Cropland	126.17			1,678.14
Carbon stock changes	126.17			1,653.21
Cropland remaining Cropland	120,91			1,562.26
Living biomass		T1		NO
Dead organic matter		T1		NO
Mineral soil	66.97	NE		NE
Organic soil	53.93	T1	D	1,562.26
Land converted to Cropland	5.26			90.95
Grassland converted to Cropland	2.53			3.95
Living biomass		T1	CS	4.92
Dead organic matter		IE		
Mineral soil		T1	CS	-0.97
Organic soil	NO			
Wetlands converted to Cropland	2.73			87.00
Living biomass		NE		7.94
Dead organic matter		IE		
Mineral soil	NO			
Organic soil	2.73	T1	D	79.06

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Off-site emission via waterborne carbon losses from drained soils	56.66			24.93
CL remaining CL	53.93	T1	D	23.73
WL converted to CL	2.73	T1	D	1.20
Grassland	5,377.26			7,192.47
Carbon stock changes	5,377.26			7,031.40
Grassland remaining Grassland	5,050.83			6,735.51
Cropland abandoned for > 20 years	22.90			126.70
Living biomass		NO		
Dead organic matter		NO		
Mineral soil	16.83	NO		
Organic soil	6.06	T1	D	126.70
Natural birch shrubland-old	49.84			-1.22
Living biomass		T2	CS	-3.51
Dead organic matter	NE			
Mineral soil	NE			
Organic soil	0.11	T1	D	2.29
Natural birch shrubland -recently expanded into Other Grassland	3.56			-6.90
Living biomass		T2	CS	-3.55
Dead organic matter		T2	CS	-1.85
Mineral soil	3.42	T2	CS	-4.58
Organic soil	0.15	T1	D	3.08
Other Grassland	4,655.04	NE		
Re-vegetated land older than 60 years	2.89	NO		
Wetland drained for > 20 years	316.60			6,616.91
Living biomass		NE		
Dead organic matter		NO		
Mineral soil		NO		
Organic soil	316.90	T1	D	6,616.91
Land converted to Grassland	326.44			295.90
Cropland converted to Grassland	23.46			164.20
Living biomass		T1	CS	-45.51
Dead organic matter		IE		
Mineral soil	13.67	T2	CS	5.22
Organic soil	9.78	T1	D	204.50
Wetlands converted to Grassland	33.36			697.20
Living biomass		NO		
Dead organic matter		NO		
Mineral soil	NO	NA		
Organic soil	33.36	T1	D	697.20
Other Land converted to Grassland	269.62			-565.51
Other land converted to natural birch shrubland	1.53			-5.20
Living biomass		T2	CS	-1.52
Dead organic matter		T2	CS	-0.79
Mineral soil		T2	CS	-2.89

Table 6.5 continued				
Source/sink	**Area (kha)**	**Method**	**EF**	**kt CO_2 Emission(+) /Removal (-)**
Organic soil	NO			
Revegetation before 1990	162.47			-339.55
Living biomass		T2	CS	-33.96
Dead organic matter		IE		
Mineral soil	162.47	T2	CS	-305.60
Organic soil	NO			
Revegetation since 1990	105.62			-220.75
Revegetation since 1990- limited grazing allowed	11.26			23.53
Living biomass		T2	CS	-2.35
Dead organic matter		IE		
Mineral soil	11.26	T2	CS	-21.18
Organic soil	NO			
Revegetation since 1990- protected from grazing	94.36			-197.22
Living biomass		T2	CS	-19.72
Dead organic matter		IE		
Mineral soil	94.36	T2	CS	-177.50
Organic soil	NO			
Off-site emission via waterborne carbon losses from drained soils[1)]	366.06			161.07
Wetland	619.38			-599.27
Carbon stock changes	619.38			
Wetlands remaining Wetlands	592.67			-709.56
Mires converted to Reservoirs –High SOC	0.99			2.75
Living biomass		IE		
Dead organic matter		IE		
Mineral soil		NO		
Organic soil	0.99	RA/T2	CS	2.75
Reservoirs on former Lakes and rivers	31.48	NA		
Other wetlands- intact mires	353.21			-712.31
Living biomass		NO		
Dead organic matter		IE		
Mineral soil		IE		
Organic soil	353.21	T1	D	-712.31
Lakes and rivers	206.99	NA		
Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Land converted to Wetlands	26.71			6.21
Grassland converted to Wetlands	7.80			5.31
Grassland converted to Reservoirs - Medium SOC	7.18	RA/T2	CS	6.32
Living biomass		IE		
Dead organic matter		IE		

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Mineral soil	7.18	RA/T2	CS	6.32
Organic soil		NO		
Grassland converted to Refilled lakes and ponds	0.12			
Living biomass		NE		
Dead organic matter		NE		
Mineral soil		NE		
Organic soil		NE		
Grassland converted to Rewetted wetland soil	0.50			-1.00
Living biomass		IE		
Dead organic matter		IE		
Mineral soil		IE		
Organic soil		T1	D	-1.00
Other Land converted to Wetlands	18.90			0.90
Low SOC CO2	18.90	RA/T2	CS	0.90
Living biomass		IE		
Dead organic matter		IE		
Mineral soil		RA/T2	CS	0.90
Organic soil		NO		
Off-site emission via waterborne carbon losses from wet soils	354.82			104.08
Mires converted to Reservoirs –High SOC	0.99	T1	D	0.29
Other wetlands- intact mires	353.21	T1	D	103.61
Refilled lakes and ponds	0.12	T1	D	0.03
Rewetted wetland soils	0.50	T1	D	0.15
Settlement	27.61			4.70
Carbon stock changes				
Settlements remaining Settlements	27.41	NA		
Land converted to Settlement	0.20			4.70
Forest land converted to Settlement	0.05			0.11
Living biomass		NO		
Dead organic matter		NO		
Mineral soil	0.05	T2	CS	0.11
Organic soil		NO		
Grassland converted to Settlement	0.15			4.59
Natural birch shrubland to Settlement	0.01			
Living biomass		NO		
Dead organic matter		NE		
Mineral soil		NE		
Organic soil		NO		
All other grassland to Settlement	0.14			4.59
Living biomass		T2	CS	4.59
Dead organic matter		IE		
Mineral soil		NE		
Organic soil		NE		
Other Land remaining Other Land	3,981.88	NA		
Harvested wood products	NA	NE		
EF = emission factor, D = default (IPCC), CS = country specific, RA= reference approach, NA = not applicable, NE= not estimated, NO = not occurring, IE=included elsewhere, T1 = Tier 1, T2 = Tier 2 and T3 = Tier 3.				
[1)] disaggregation to subcategories is in chapter on relevant category				

Table 6.6 Summary of method and emission factors applied on CH_4 emission calculations, including area and calculated emission.

Source/sink	Area kha	Method	EF	kt CH_4 Emission	kt CO_2 –eq emitted
Forest land				0.03	0.66
Drained soils of				0.03	0.66
Forest land remaining Forest land	0.13			0.00	0.02
Afforestation older than 50 years	0,05	T1	D	0.00	0.01
Natural birch forest older than 50 year	0.08	T1	D	0.00	0.02
Land converted to Forest land				0.03	0.64
Cropland converted to Forest land	0.23	T1	D	0.00	0.04
Grassland converted to Natural birch forest	0.42	T1	D	0.00	0.08
Grassland converted to Cultivated forest	2.80	T1	D	0.02	0.52
Biomass burning- wildfire	NO				
Cropland	56.66			3.30	82.51
Drained soils of	56.66			3.30	82.51
Cropland remaining Cropland	53.93	T1	D	3.15	78.54
Land converted to Cropland	2.73			0.16	3.97
Wetland converted to Cropland	2.73	T1	D	0.16	3.97
Biomass burning	NO				
Grassland				21.71	545.26
Drained soils of	366.06			21.71	545.25
Grassland remaining Grassland	322.92			19.24	480.99
Cropland abandoned for more than 20 years	6.06	T1	D	0.36	9.03
Natural birch shrubland old	0.11	T1	D	0.01	0.16
Natural birch shrubland recently expanded	0.15	T1	D	0.01	0.22
Wetlands drained for more than 20 years	316.60	T1	D	18.86	471.57
Land converted to Grassland	43.14			2.57	64.26
Cropland converted to Grassland	9.78	T1	D	0.58	14.57
Wetland converted to Grassland	33.36	T1	D	1.99	49.69
Biomass burning	0.04	T2	CS,D	0.00	0.01
Wetland (managed)	380.92			64.63	1,615.84
Wetland remaining Wetland	354.20			64.63	1,615.83
Intact mires	353.21	T1	D	64.52	1,613.00
Flooded land- Mires converted to reservoirs	0.99	RA/T2	CS	0.11	2.83
Land converted to wetland	26.72			0.41	10.12
Grassland converted to reservoirs	7.19	RA/T2	CS	0.05	1.13
Other land converted to reservoirs	18.91	RA/T2	CS	0.25	6.19
Grassland rewetted					
Refilled lakes and ponds	0.12	T1	D	0.02	0.53
Rewetted wetland soils	0.50	T1	D	0.09	2.27
Biomass burning	0.01	T2	CS,D	0.00	0.01
Other land					
Biomass burning-wildfire	NO				

EF = emission factor, D = default (IPCC), CS = country specific, RA= reference approach, NA = not applicable, NE= not estimated, NO = not occurring, IE=included elsewhere, T1 = Tier 1, T2 = Tier 2 and T3 = Tier 3.

Table 6.7. Summary of method and emission factors applied on N_2O emission calculations

Source/sink	Area kha	Method	EF	kt Emission / Removal (-)	kt CO_2 eq
Indirect N_2O emission from managed soils	NA	IE		IE	
Forest land					
Forest land remaining Forest land					
Direct N_2O emission from N-input to managed soils	NO				
Direct N_2O emission from N mineralization / immobilization	NE				
Biomass burning- wildfires	NO				
Drained soils of					
Afforestation more than 50 years old	0.05	T1	D	0.00	0.07
Natural birch forest older than 50 years	0.08	T1	D	0.00	0.13
Land converted to forest land					
Direct N_2O emission from N-input to managed soils	NA	T1	D	0.00	0.05
Direct N_2O emission from N mineralization / immobilization	NE				
Drained soils of					
Cropland converted to Forest land- Afforestation 1 to 50 years old	0.23	T1	D	0.00	0.35
Grassland converted to Natural birch forest	0.42	T1	D	0.00	0.63
Grassland converted to Forest land- Afforestation 1 to 50 years old	2.80	T1	D	0.01	4.19
Cropland					
Direct N_2O emission from N-input to managed soils	NA	IE	NA	NA	NA
Direct N_2O emission from N mineralization / immobilization	NA	IE	NA	NA	NA
Biomass burning	NO				
Grassland					
Grassland remaining Grassland [2)]					
Direct N_2O emission from N mineralization / immobilization[1)]	322.91	T1	D	4.82	1,436.57
Land converted to Grassland [2)]					
Direct N_2O emission from N mineralization / immobilization[1)]	43.14	T1,T2	D,CS	0.65	187.04
Biomass burning					
Biomass burning- wildfire	0.04	T2	CS,D	0.00	0.02
Wetland					
Direct N_2O emission from N-input to managed soils	NO				
Direct N_2O emission from N mineralization / immobilization	NO				
Biomass burning- wildfire	0.01	T2	CS,D	0.00	0.01
Continuation of table 6.7					
Source/sink	Area kha	Method	EF	kt Emission / Removal (-)	kt CO2 eq
Flooded land					
Mires converted to reservoirs	0.99	RA/T2	CS	NO	
Grassland converted to reservoirs	7.19	RA/T2	CS	NO	
Other land converted to reservoirs	18.91	RA/T2	CS	NO	
Settlements					
Direct N_2O emission from N-input to managed soils	IE				

Direct N_2O emission from N mineralization / immobilization	NE				
Other land					
Biomass burning wildfire	NO				
EF = emission factor, D = default (IPCC), CS = country specific, RA= reference approach, NA = not applicable, NE= not estimated, NO = not occurring, IE=included elsewhere, T1 = Tier 1, T2 = Tier 2 and T3 = Tier 3.					
[1)] The emission of N_2O from drained Grassland remaining Grasslands is reported here, as present version of CRF-reporter (version 5.12.1) does not include N_2O emission from Grassland on drained soils [2)] Disaggregation to subcategories is shown under chapter on relevant category					

6.4 Forest land

In accordance to the GPG arising from the Kyoto Protocol a country-specific definition of forest has been adopted. The minimal crown cover of forest is 10%, the minimal height 2 m, minimal area 0.5 ha and minimal width 20 m. This definition is also used in the National Forest Inventory (NFI). All forest, both naturally regenerated and planted, is defined as managed as it is all directly affected by human activity. The natural birch woodland has been under continuous usage for many centuries. Until the middle of the last 19th century it was the main source for fuel wood for house heating and cooking in Iceland (Ministry for the Environment 2007). Most of the woodland was used for grazing and still is, although some areas have been protected from grazing.

Natural birch woodland is included in the IFR national forest inventory (NFI). In the NFI the natural birch woodland is defined as one of the two predefined strata to be sampled. The other stratum is the cultivated forest consisting of tree plantation, direct seeding or natural regeneration originating from cultivated forest. The sampling fraction in the natural birch woodland is lower than in the cultivated forest. Each 200 m2 plot is placed on the intersection of 1.5 x 3.0 km grid (Snorrason 2010). The part of natural birch woodland defined as forest (reaching 2 m or greater in height at maturity in situ) is estimated on basis of new map of natural birch woodlands mapped in 2010-2014.

By analyzing the age structure in the natural birch woodland that does not merge geographically the old map from the survey in 1987-1991; it is possible to re-estimate the area of natural birch woodland in 1987-1991 and the area of birch woodland today. Preliminary results of these estimates are that the area of birch woodland was 137.69 kha at the time of the initial survey in 1987-1991. Earlier analyses of the 1987-1991 survey did result in 115.40 kha (Traustason & Snorrason 2008). The difference is the area of woodland that was missed in the earlier survey. Current area of natural birch woodland is estimated to 150.65 kha. The difference of 12.95 kha is an estimate of a natural expansion of the woodland over the time period of 1989 to 2012 (23 years) where the midyears of the two surveys are chosen as reference years. In the new map of 2010-2014 the ratio of the natural birch woodland that can reach 2 m height in mature state and is defined a forest was 64% of the total area. Natural birch forest is accordingly estimated 87.72 kha in 1989 and 95.97 kha in 2012, the former figure categorizing the natural birch forest classified as Forest remaining Forest and the differences between the two figures (8.25 kha) as natural birch forest classified as Grassland converted to forest land or Other land converted to forest land with mean annual increase of 0.36 kha.

In a chronosequence study (named ICEWOODS research project) where afforestation sites of the four most commonly used tree species of different age where compared in eastern and western Iceland, the results showed significant increase in the soil organic carbon (SOC) on fully vegetated sites with well-developed deep mineral soil profile (Bjarnadóttir 2009). The age of the oldest afforestation sites examined were 50 years so an increase of carbon in mineral soil can be confirmed up to that age. The conversion period for afforestation on Grassland soil is accordingly 50 years. Conversion period for land use changes to “Forest land” from “Other land” is also assumed to be 50 years.

The area of cultivated forest in 2013 is estimated in NFI as 39.05 kha (±1.55 kha 95% CL) whereof; 28.74 kha (±1.66 kha 95% CL) are Afforestation 1-50 years old on “Grassland converted to Forest land”, 0.92 kha (±0.42 kha 95% CL) are Afforestation 1-50 years old on “Cropland converted to Forest land”, 7.50 kha (±1.12 kha 95% CL) are Afforestation 1-50 years old on “Other Land converted to Forest land”, 1.06 kha (±0.45kha 95% CL) are Plantations in natural birch forests and 0.82 (±0.40 kha 95% CL) are Afforestation older than 50 years.

The total area of Forest land other than natural birch forest was revised on basis of new data obtained in NFI sample plot measurements from the year of 2014. In 2014 submission this area was estimated 38.02 kha (±1.63 kha 95% CL) in 2012 but in this year’s submission the estimate for 2012 is 38.19 kha (±1.57 kha 95% CL) reflecting the effect of the recalculation.

The area of Forest land other than natural birch forest on organic soil was also revised according to new data from NFI. The area of organic soil in the cultivated forest was for the inventory year 2012 reported 3.17 kha (±0.76 kha 95% CL) in 2014 submission but is estimated 3.07 kha (±0.75 kha 95% CL) for 2012 in this year’s submission reflecting the recalculation.

The area of natural birch forest was revised according to the final results of the remapping project in the period 2010-2014. Natural birch forest as “Forest remaining forest” was for the year 2012 estimated to 85.58 kha in the 2014 submission. In this year submission it was estimated to 87.64 kha. Expansion of natural birch forest in 2012 was estimated to 10.30 kha in last year submission but in this year submission 8.25 kha.

The area of natural birch forest on drained organic soil was also revised according to the new maps. Natural birch forest on organic soils as “Forest remaining forest” was for the year 2012 estimated to 0.45 kha in the 2014 submission. In this year submission it was estimated to 0.08 kha. Expansion of natural birch forest on organic soil in 2012 was not estimated in last year submission but in this year submission it was estimated to 0.40 kha.

As the area estimate of natural birch forest is entirely built on in field mapping a sample error propagation as for the cultivated forest is not applicable. It can be stated that areal errors of in field mapping are much lower than systematic sample errors and not significant in an uncertainty estimate of C-stock change.

The area of the cultivated forest used in land use class Forest Land in the CRF is based on the NFI sample plot measurements and is updated with new field measurements annually. Maps provided by IFR shows a larger area of cultivated forests than the NFI sample plot estimate. Map of cultivated forest cover is built on an aggregation of maps used in forest management plans and reports that is revised with new activity data annually. This overestimation of the area of cultivated forest on these maps is known (Traustason and Snorrason 2008) but the differences between these two approaches decreases every year as the quality of the maps sources increase.

6.4.1 Carbon Stock Changes

Changes in C-stock of natural birch forest are reported for the fifth time in this year’s submission. Same method as was used in last year submission is used again. In 1987 a tree data sampling was conducted to i.a. estimate the biomass of the natural birch woodland in Iceland (Jónsson 2004). These data have now been used to estimate the woody C-stock of the natural birch woodland in

1987. The new estimate take into account treeless areas inside the woodland that are measured to be 35% for shrubland (under 2 m at maturity) and 19% for forest in the sample plot inventory of 2005-2011. The new estimate is built on same newly made biomass equations as used to estimate current C-stock. Total biomass of birch trees and shrubs in natural birch woodlands was according to the new estimates 1,025 kt C (±615 kt 95% CL) with average of 7.44 t C ha-1 in 1987. A rough older estimate from same raw data was only for biomass above ground 1,300 kt C with average of 11 t C ha-1 (Sigurðsson and Snorrason 2000). A new estimate of the current C-stock of the natural birch woodland built on the sample plot inventory of 2005-2011 is 1,159 kt C (±325 kt 95% CL) with average of 8.42 t C ha-1. The C-stock in the forest and the shrub part of the natural birch woodland is estimated to 758 kt C with an average of 8.64 t C ha-1 and 253 kt C with average of 5.06 t C ha-1. Carbon stock changes in Forest land is recognized as key sources/sinks in level 2013 and in trend.

Carbon Stock Changes in Living Biomass

Carbon stock gain of the living biomass of trees in the cultivated forest is estimated based on data from direct sample plot field measurement of the NFI. The figures provided by IFR are based on the inventory data from the first national forest inventory conducted in 2005-2009 (Snorrason 2010). In 2010 the second inventory of cultivated forest started with re-measurement of plots measured in 2005 and of new plots since 2005 on new afforestation areas. In each inventory year the internal annual growth rate of all currently living trees is estimated by estimating the differences between current biomass and the biomass five years ago. Trees that die or are cut and removed in this 5 years period are not included so the C-stock gain estimated is not a gross gain.

Carbon stock losses in the living woody biomass are estimated based on two sources:

1. Annual wood removal is reported as C-stock losses using data on activity statistics of commercial round-wood and wood-products production from domestic thinning of forest (Gunnarsson 2010; Gunnarsson 2011; Gunnarsson 2012; Gunnarsson 2013, Gunnarsson 2014). Most of the cultivated forests in Iceland are relatively young, only 27% older than 20 years, and clear cutting has not started. Commercial thinning is taking place in some of the oldest forests and is accounted for as losses in C-stock in living biomass. A very restricted traditional selective cutting is practiced in few natural birch forests managed by the Icelandic Forest Service. The volume of the wood from the natural birch forest cannot be distinguished from reported annual volume of cultivated forest.
2. Dead wood measurements on sample plots. (See description of dead wood definition and measurements in next chapter: Net Carbon Stock Changes in Dead Organic Matter). Dead wood measured is reported as C-stock losses in the assessed year of death.

In the natural birch forest only a net C-stock change in living biomass of the trees is estimated:

1 In the natural birch forest, classified as Forest remaining Forest: by comparing biomass stock of the trees in two different times and use mean annual change as an estimate for the annual change in the C- stock. This method is in accordance to Equation 3.1.2 in GPG for LULUCF (page 3.16).

2 In the natural birch forest expansion since 1987: by using a linear regression between biomass per area unit in trees on measurement plots in natural birch woodland and measured age of sample trees ($N=147$, $P < 0.0001$) to measure net annual C-stock change.

In both cases all losses are included in the estimate of the net C-stock change.

In the already mentioned ICEWOODS research project, the carbon stock in other vegetation than trees did show a very low increase 50 years after afforestation by the most commonly used tree species, Siberian larch, although the variation inside this period was considerable. Carbon stock samples of other vegetation than trees are collected on field plots under the field measurement in NFI. Estimate of carbon stock changes in other vegetation than trees will be available from NFI data when sampling plots will be revisited in the second inventory and the samples will be analyzed.

6.4.1.1 Net Carbon Stock Changes in Dead Organic Matter

As for other vegetation than trees, carbon stock samples of litter are collected on field plots under the field measurement in the NFI. Estimate of carbon stock changes in dead organic matter will be available from the NFI data when sampling plots have been revisited in the second inventory and samples analyzed.

In the meantime, results from two separate researches of carbon stock change are used to estimate carbon stock change in litter. (Snorrason et al. 2000; Snorrason et al. 2003; Sigurdsson et al. 2005). In the ICEWOOD research project carbon removal in form of woody debris and dead twigs was estimated to 0.083 t C ha-1 yr-1. Snorrason et al (2003 and 2000) found significant increase in carbon stock of the whole litter layer (woody debris, twigs and fine litter) for afforestation of various species and ages ranging from 32 to 54 year. The range of the increase was 0.087-1.213 t C ha-1 yr-1 with the maximum value in the only thinned forest measured resulting in rapid increase of the carbon stock of the forest floor. A weighted average for these measurements was 0.199 t C ha-1 yr-1.

Dead wood is measured on the field plot of the NFI and reported for the third time in this year submission. Current occurrence of dead wood that meet the definition of dead wood (>10 cm in diameter and >1 m length) on the field plot is rare but with increased cutting activity carbon pool of dead wood will probably increase. Measured dead wood is reported as a C-stock gain on the year of death. As occurrence of dead wood on measurements plot is rare, reporting of dead wood is not occurring every year. With re-measurements of the permanent plot it will be possible to estimate the Carbon stock changes in this pool from one time to another as the dead wood will be composed and in the end disappear.

6.4.1.2 Net carbon Stock Change in Soils

Drained organic soil is reported as a source of C-emission. In this year's submission forest on drained organic soil is reported in the category "Grassland converted to Forest Land - Afforestation 1-50 years old – Cultivated forest", "Grassland converted to Forest Land – Afforestation 1-50 years old – Natural birch forest", "Cropland converted to Forest Land-Afforestation 1-50 years old", "Forest Land remaining Forest Land" – subcategory "Afforestation older than 50 years" and subcategory "Natural birch forest". Drained organic soil is not occurring in other categories reported.

Research results do show increase of carbon of soil organic matter (C-SOM) in mineral soils (0.3-0.9 t C ha-1 yr-1) due to afforestation (Snorrason et al. 2003; Sigurðsson et al. 2008), and in a recent study of the ICEWOODS data a significant increase in SOC was found in the uppermost 10 cm layer of the soil (Bjarnadóttir 2009). The average increase in soil carbon detected was 134 g CO2 m-2 yr-1 for the three most used tree species. This rate of C-sequestration to soil was applied to estimate changes in soil carbon stock in mineral soils at Grassland and Cropland converted to Forest Land.

Research results of carbon stock changes in soil on revegetated and afforested areas show mean annual increase of soil C-stock between 0.4 to 0.9 t C ha-1 yr-1 up to 65 years after afforestation. A comparison of 16 years old plantation on poorly vegetated area to a similar open land gave an annual increase of C-SOM of 0.9 t C ha-1 (Snorrason et al. 2003). New experimental research result show removal of 0.4 to 0.65 t C ha-1 yr-1 to soil seven year after revegetation and afforestation on poorly vegetated land (Arnalds et al. 2013). Another chronosequence research with native birch did show a mean annual removal of 0.466 t C ha-1 to soil up to 65 years after afforestation of desertified areas (Kolka-Jónsson 2011). All these findings highly support the use of a country specific removal factor of the dimension 0.51 t C ha-1 yr-1 which is same removal factor as used for revegetation activities.

6.4.2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

In the new CRF-web Reporter (v 5.10.1) emissions and removals from drainage and rewetting and other management of organic and mineral soils is included as new emission category compared to previous submissions. The new 2013 Supplement to the 2006 Guidelines: Wetlands (IPCC 2014), provides guidelines for estimation of emissions related to two factors not previously estimated. These factors are the off-site decomposition of dissolved organic carbon (DOC) and emission and removal of CH4 from drained soils.

6.4.2.1 Off-site CO_2 emission via waterborne losses from drained inland soils

Off-site CO_2 emission is calculated according to T1 applying equation 2.4. in the 2013 wetland Supplement (IPCC 2014). This emission is calculated for the five categories of Forest land reported with organic soils, i.e. "Afforestation more than 50 years old", "Natural birch forest older than 50 years", "Cropland Converted to Forest land Afforestation 1-50 years old", "Grassland converted to Natural birch Forest", "Grassland converted to Cultivated Forest". The total emission calculated is 1.57 kt CO_2 for organic soils of Forest land.

6.4.2.2 CH_4 emission and removals from drained Forest land soils

The CH_4 emission from drained land is calculated according to T1 applying equation 2.6 in 2013 wetland supplement (IPCC 2014). The equations separate the emission into two components, i.e. emission from the drained land and the emission from the ditches. The total emission reported is 0.03 kt CH4 or 0.66 kt CO_2 eq. No estimate on the fraction of area covered by ditches is available and the indicated value from table 2.4 in the 2013 wetland supplement (IPCC 2014) is applied.

6.4.2.3 N_2O emission from drained soils of Forest land

The N_2O emissions from drained soils under Forest land is estimated according to T1 applying equation 2.7 in the 2013 wetland supplement (IPCC 2014). The total emission calculated for drained Forest land is 0.02 kt N2O or 5.33 kt CO_2 eq.

6.4.2.4 Rewetted soils under Cropland

No rewetting of soils in land included as Forest land and no other source or sink of GHG related to drainage or rewetting of Cropland soils is recognized and the relevant categories of 4(II) reported with notation key NO.

6.4.3 Other Emissions (4(I), 4(III))

Direct N_2O emission from use of N fertilizers is reported for Land converted to Forest Land since fertilization is usually only done at planting. Fertilization on Forest Land remaining Forest Land and in Natural birch forest expansion is not occurring. The reported use of N fertilizers is based on data collected by IFR from the Icelandic forestry sector. N2O emissions from drainage of organic soils are also reported separately for forest land. Direct N2O emission from N mineralization/mobilization is not estimated as all C-stock changes estimates show increase in stock. Potential emission from mineral soils is in the categories where changes are still not estimated.

6.4.4 Land converted to Forest Land.

The AFOLU Guidelines define land use conversion period as the time until the soil carbon under the new land use reaches a stable level. Land converted to forest land is reported as converted from the land use categories “Grassland”, “Cropland” and “Other Land”. Small part of the land converted to Forest land is converted from Wetland, but this land is included as Grassland converted to Forest land as data for separating these categories is unavailable.

6.4.5 Methodological Issues

One of the main data sources of the NFI is a systematic sampling consisting of a total of around 1000 permanent plots for field measurement and data sampling. One fifth of the plots in cultivated forest are visited and measured each year. Same plots are revisited at five year intervals for the cultivated forest and at ten years intervals for the natural birch forest. Currently the sampling is used to estimate both the division of the area into subcategories and C-stock changes over time for the cultivated forest and the current C-stock of the natural birch forest as already described in Chapter 0(Snorrason 2010). Preparation of this work started in 2001 and the measurement of field plots started in 2005. The first forest inventory was finished in 2009 and in 2010 the second one started with re-measurements of the plots measured in cultivated forest in 2005 together with new plots on afforested land since 2005. The second forest inventory of the cultivated forest is now finalized. The figures provided by IFR are based on the inventory data of the first forest inventory of both cultivated and natural forest and the second inventory of the cultivated forest. The sample population for the natural birch forest is the mapped area of natural birch woodland in earlier inventories. The sample population of cultivated forest is an aggregation of maps of forest management plans and reports from actors in forestry in Iceland. In some cases the NFI staff does mapping in the field of private cultivated forests. To ensure that forest areas are not outside the population area, the populations for both strata are increased with buffering of mapped border. Current buffering is 24 m in cultivated forest but 32 m in natural birch forest.

Historical area of cultivated forest is estimated by the age distribution of the forest in the sample.

The biomass stock change estimates of the C-stock of cultivated forest are for each year built on five years sample plot measurements (Table 6.8). The most accurate estimates are for 2007-2012 as they are built on growth measurement of; two nearest years before, two nearest years after and of the year of interest (here named midvalue estimates). In these cases biomass growth rate is equally forwarded and backwarded. For the year 2013 the estimated is forwarded one year compared to the midvalue for 2012. As relative growth rate decreases with age the 2013 estimate is an overestimate and was calibrated by 0.87, which is the relative difference between the midvalue and a forwarded value of the period 2008-2012. Estimates for the year 2005 and 2006 are backwarded values for two and one year accordingly, from the midvalue for the field measurements of the period 2005-2009. They are calibrated with the relative difference between forwarded value and the midvalue of the year 2008 which is 1.21. For later years (1990-2005) a species specific growth model that is calibrated towards the inventory results is used to estimate annual stock changes.

Table 6.8 Measurement years used to estimate different annual estimates of biomass stock change.

Mid value estimates	Forwarded estimates	Backwarded estimates	Built on measure-ment years
	2013		2010-2014
2012			2010-2014
2011			2009-2013
2010			2008-2012
2009			2007-2011
2008			2006-2010
2007			2005-2009
		2006	2005-2009
		2005	2005-2009

Changes in the area of natural birch forest is estimated by comparing estimated area in old surveys with estimated area in newly finished remapping. As no historical data before 1987 exists, a time series for changes in area and C-stock of natural birch forest is only available since 1989. They are built on interpolation between 1989 and the mid-year of the remapping 2010-2014 and extrapolations from 2012 with even annual increase in area.

A mean annual change in the area of the natural birch forest was estimated to 0.359 kha increase between 1989 and 2012.

As for the area, the biomass stock change estimates of the C-stock of natural birch forest are built on comparison of an estimate of historical biomass stock in the year of 1987 using a stock sampling inventory conducted in 1987 and the NFI inventory of 2005-2011. The difference between these inventories shows a slight increase in biomass C-stock between 1987 and 2007. Same increase rate is used for 2008-2013. The method used only gives a mean net annual C-stock change in the period 1990-2013, not gains and losses.

6.4.6 Emission/Removal Factors

Tier 3 approaches is used to estimate the carbon stock change in living biomass of the trees in both cultivated forest and the natural birch forest through the data from NFI and older surveys.

The losses reported in living biomass removed as wood are estimated by Tier 3 on basis of activity data of annual wood utilization from Icelandic forest (Gunnarsson 2014).

Carbon stock change in living biomass in other vegetation than trees is currently not estimated. In-country research results (Sigurdsson et al. 2005) did show small or no changes of carbon stocks in these sources.

Tier 2, country specific factors are used to estimate annual increase in carbon stock in mineral soil and litter. The removal factor (0.365 Mg C ha-1 yr-1) for the mineral soil of the Grassland conversion is taken from the already mentioned study of Bjarnadóttir (2009). For the mineral soil of “Other land” converted to Forest land the same removal factor is used as for revegetation 0.51 t C ha-1 yr-1 (see chapter 0). Revegetation and afforestation on non-vegetated soil are very similar processes, except that the latter includes tree-planting and tree layer formation. A removal factor of 0,141 Mg C ha-1 yr-1 which is an nominal average of two separate research (Snorrason et al. 2000; Snorrason et al. 2003; Sigurdsson et al. 2005) is used to estimate increase in carbon stock in the litter layer.

Tier 3 approach is used to estimate changes in dead wood stock. As already described dead wood meeting the minimum criteria of 10 cm in diameter and 1 m in length is measured in the field sample plot inventory. Decay class and initiation year are also assessed. Dead wood is then reported in the dead wood stock at the imitation year. The changes in litter and dead wood stock are reported together as changes in dead organic matter stock.

Tier 1 and default factors from the new “2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands” are used for the first time, for both CO_2, N_2O and CH_4 emission on forested drained wetland. The emission factor of carbon stock changes of drained organic soils is 0.37 t C ha-1 yr-1 from table 2.1 in the “2013 Supplement”. Off-site CO_2 emission is estimated applying emission factor 0.12 t C ha-1 yr-1 from table 2.2 in the “2013 Supplement Chosen default factor of N_2O emission from drained organic soils is 3.2 kg N2O-N ha-1 yr-1. (Table 2.5 in the “2013 Supplement”). For CH4 emission compound factor of 7.375 kg CH4 ha-1 yr-1 is used were the default factor for the ditches is 217 kg CH_4 ha-1 yr-1 and for other part of the drained land 2.0 kg CH_4 ha-1 yr-1 (Table 2.3. and 2.4 in “2013 Supplement”).

For direct N_2O emission from N fertilization Tier 1 and default emission factor of 1.25% [kg N_2O-N/kg N input] (GPG2000) is used.

In accordance to the Forest Law in Iceland, the Icelandic Forest Service holds a register on planned activity that can lead to deforestation (Skógrækt ríkisins 2008). Deforestation activities has to be announced to the Icelandic Forest Service. IFR has sampled activity data of the affected areas and data about the forest that has been removed. This data is used to estimate emissions from lost biomass. Deforestation is reported for the inventory years 2004-2007, 2011 and 2013. Two rather different types of deforestation has occurred in these years. The first and most common type is road building, house building and construction of snow avalanche defences. This type is occurring in all years mentioned. In these cases not only the trees were removed but also the litter and dead wood, together with the uppermost soil layer. These afforestation areas were relatively young (around 10 years from initiation) so dead wood did not occur. According to the 2006 IPCC Guidelines Tier 1 method for dead organic matter of Forest Land converted to settlements (Vol. 4-2, chapter 8.3.2), all carbon contained in litter is assumed to be lost during conversion and subsequent accumulation not accounted for. Carbon stock in litter has been measured outside of forest areas as control data in measuring the change in the C-stock with afforestation. Its value varies depending on the situation of the vegetation cover. On treeless medium to fertile sites a mean litter C stock of 1.04 ton ha-1 was measured (n=40, SE=0.15; data from research described in Snorrason et al., 2002). Given the annual increase of 0.141 ton C ha-1 as used in this year submission, the estimated C stock in litter of afforested areas of 10 years of age on medium to fertile land is 2.45 ton C ha-1. Treeless, poorly vegetated land has a much sparser litter layer. Data from the research cited above showed a C-stock of 0.10 ton ha-1 (n=5, SE: 0.03). A litter C-stock of a 10 year old afforestation site would be 1.51 ton C ha-1. Using the same ratio between poor and fully vegetated land as in last year submission, i.e. 17%

and 83%, accordingly, will give 2.29 tons C ha-1 as weighted C-stock of 10 year old afforestation. As with carbon in litter, soil organic carbon (SOC) has been measured in research projects. SOC in the same research plots that were mentioned above for poorly vegetated areas was 14.9 tons C ha-1, for fully vegetated areas with thick developed andosol layers it was 72.9 tons C ha-1 (n=40; down to 30 cm soil depth). Annual increase in poor soil according to this year submission is 0.513 ton C ha-1 yr-1 for poorly vegetated sites and 0.365 ton C ha-1 yr-1 for fully vegetated sites. Accordingly, ten year old forests will then have a C-stock of 20 and 76.6 tons ha-1 on poor and fully vegetated sites, respectively. Weighted C-stock of treeless land is then 66.9 tons ha-1. According to the 2006 IPCC guidelines Tier 1 method for mineral soil stock change of land converted to Settlements, land that is paved over is attributed a soil stock change factor of 0.8. Using a 20 year conversion period this means an estimated carbon stock loss of 1% during the year of conversion, i.e. the annual emission from SOC will be 0.67 ton C ha-1. These factors were used to estimate emission from litter and soil in this first type of deforestation.

The second type of deforestation is one event in 2006 were trees in an afforested area were cut down for a new power line. Bigger trees were removed. In this case litter and soil is not removed so only the biomass of the trees is supposed to cause emissions instantly on the year of the action taken and reported as such.

6.4.7 Uncertainties and QA/QC

The estimate of C-stock in living biomass of the trees is mostly based on results from the field sample plot inventory which is the major part of the national forest inventory of IFR. The C-stock changes estimated through the forest inventory fit well with earlier measurements in research project (Snorrason et al. 2003; Sigurðsson et al. 2008).

The NFI and the special inventory of deforestation have greatly improved the quality of the carbon stock change estimates. The same can be stated in the case of new approach to estimate the net change of C-stock in biomass of the natural birch woodland. By comparing two national estimates from two different times, errors caused by the difficulty of estimating natural mortality are eliminated.

Because of the design of the NFI it is possible to estimate realistic uncertainties by calculating statistical error of the estimates. Error estimates for all data sources and calculation processes has currently not been conducted but are planned in the near future. Currently, error estimates are available for the area of forest, and the biomass C-stock of the natural birch woodland at two different times as already stated. As the sample in the cultivated forest is much bigger than the sample in the natural birch woodland (769 plots compared to 210 plots in the natural birch woodland) one should expect a relative lower statistical error of the biomass C-stock of cultivated forest then for the natural birch woodland.

6.4.8 Recalculations

As described above the emission/removal estimate for forest land has been slightly revised in comparison to previous submissions. The C-stock changes are based on direct stock measurements (Tier 3) as in last year’s submission but reviewed on basis of additional data obtained and new approaches used. Time series built on direct stock measurement is calculated and reported for cultivated forest. Estimates for the natural birch forest are built on the same methodology as in last year´s submission but recalculated according to the final results of the remapping project. As a result of these recalculations the total reported removal has decreased from -267.24 kt CO_2-equivalents for the year 2012 as reported in 2014 submission to -241.94 kt CO_2-equivalents in this year's submission or a 9.0% decrease in removal. The changes in reported emission removal of the category reflect the improvement in data, new EF's and estimation of factors previously not estimated as well as development in the methodology applied for estimating this category.

6.4.9 Planned Improvements regarding Forest Land

Data from NFI are used for the seventh time to estimate main sources of carbon stock changes in the cultivated forest where changes in carbon stock are most rapid.

Sampling of soil, litter, and other vegetation than trees, is included as part of NFI and higher tier estimates of changes in the carbon stock in soil, dead organic matter and other vegetation than trees is expected in future reporting when data from re-measurement of the permanent sample plot will be available.

New biomass functions for trees in natural birch woodland are planned to replace contemporary biomass functions used in current estimate.

One can therefore expect gradually improved estimates of carbon stock and carbon stock changes regarding forest and forestry in Iceland. As mentioned before improvements in forest inventories will also improve uncertainty estimates both on area and stock changes

6.5 Cropland

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

Carbon dioxide emissions from Carbon stock changes in "Cropland remaining Cropland" is recognized as key source/sink in level and trend in 2013 and "Land converted to Cropland" as key category of trend 2013.

The Cropland map layer was digitized from satellite images supported by aerial photographs in 2008 by AUI and NLSI in cooperation. This map layer was then revised by AUI in 2009. The total area of Cropland emerging from this map layer through the IGLUD processing, taking into account the order of compilation applied, is 172.58 kha. The mapped area includes both Cropland in use and abandoned Cropland reported as Grassland. The area reported in CRF as Cropland is 126.17 kha, whereof 56.66 kha is estimated as organic soil. The reported area is a product of the primary time series for new cultivation, drainage of wetland for cultivation, and Cropland abandonment. The time series are prepared by AUI from agricultural statistics, available reports and unpublished data. The preparation of time series will be described in detail elsewhere. These time series are shown in Figure 6.8.

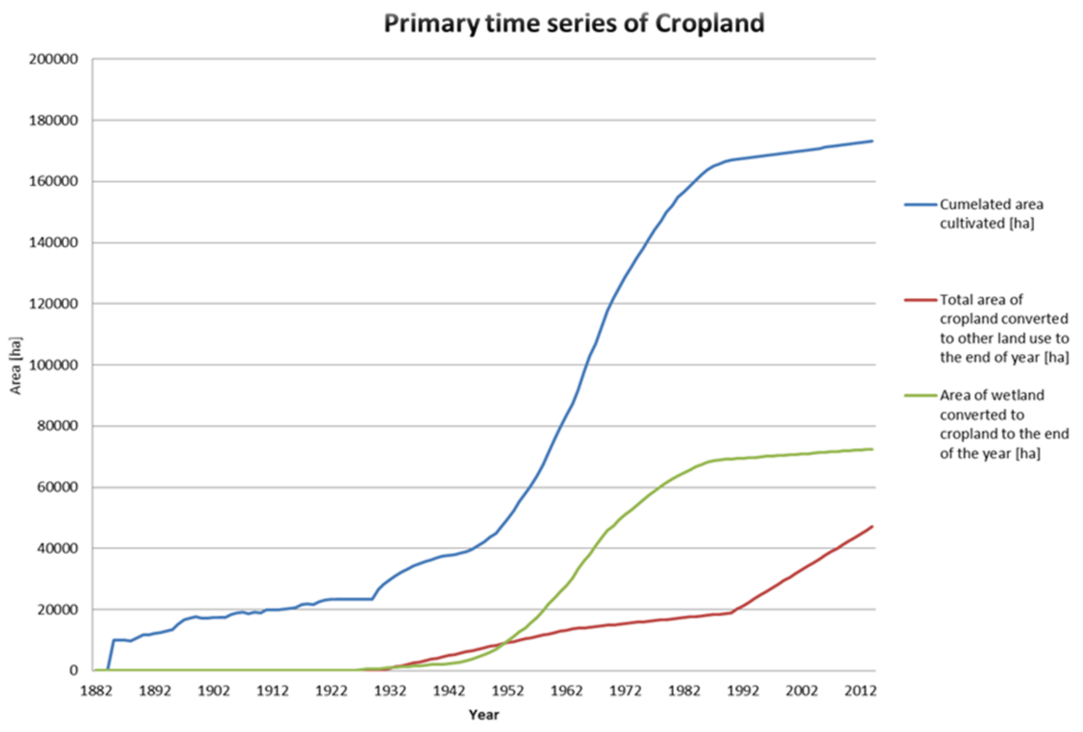

Figure 6.8 Primary time series of Cropland area: Cumulated area represents all land that has been cultivated to that time. Area of wetland converted to cropland represents the part of that area on organic soil. Total area converted to other land use represents the estimated area of abandoned Cropland.

From these primary time series, secondary times series of Cropland remaining Cropland, total area and area on organic soil, Grassland converted to Cropland and Wetland converted to Cropland are calculated (Figure 6.9).

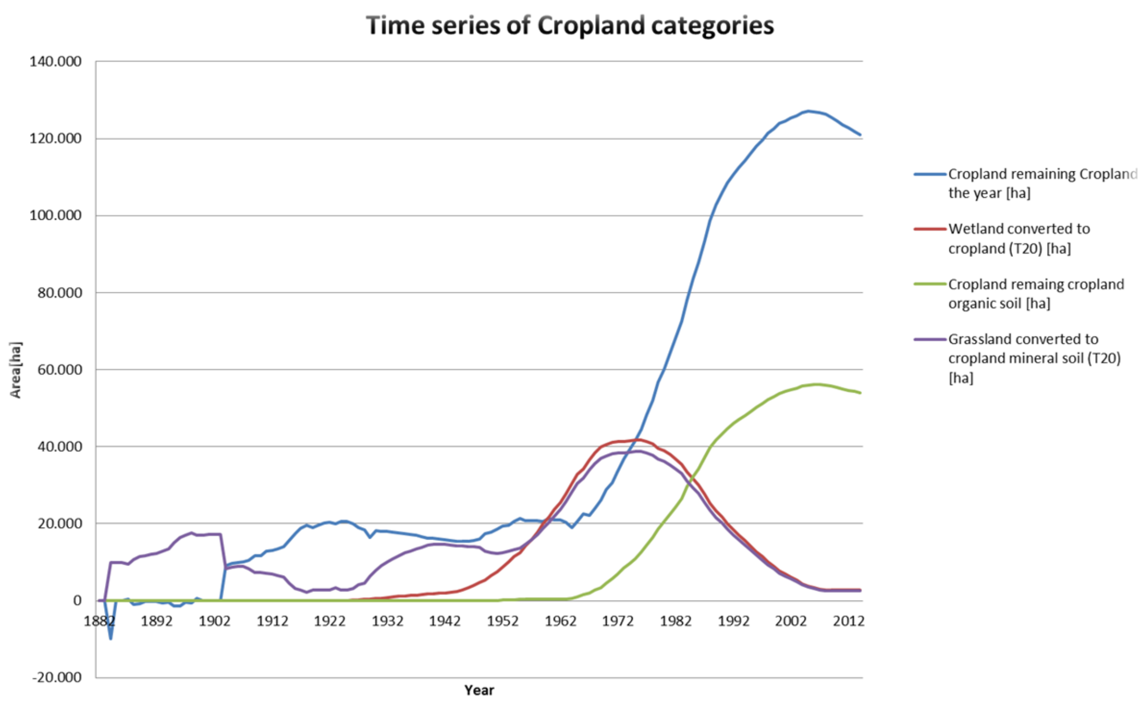

Figure 6.9 Time series of Cropland as reported. Area in hectares as estimated at the end of the year.

The area of Cropland organic soils is estimated through the time series available as described above (chapter 0). The geographical identification of Cropland organic soils as appearing on IGLUD maps is still preliminary based on ditches network density analyses. A special project in IGLUD aiming at identifying cropland organic soils was started in 2011 and the fieldwork is still ongoing. The results of this project is expected to improve geographical identification of Cropland organic soils.

No information is available on emission/removal regarding different cultivation types and subdivision of areas according to the types of crops cultivated is not attempted.

6.5.1 Carbon stock changes

6.5.1.1 Carbon stock changes in living biomass

As no perennial woody crops are cultivated in Iceland, no biomass changes need to be reported. Shelterbelts, not reaching the definitions of forest land, do occur 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. Time series for land converted to Cropland applied in last year's submission are extended to the present inventory year. Changes in living biomass in connection with conversion of land to Cropland are, according to the Tier 1 method, assumed to occur only at the year of conversion as all biomass is cleared and assumed to be zero immediately after conversion. Changes in living biomass of land converted to Cropland are in this year's submission estimated for both losses and gains. Losses are estimated for the area converted in the year. The biomass prior to conversion is estimated from preliminary results from IGLUD field sampling (Gudmundsson et al. 2010). Based on that sampling the above ground biomass, including litter and standing dead, for Grassland below 200 m height above sea level, is 1.27 kg C m^{-2}, and for Wetland below 200m 1.80 kg C m^{-2}. The losses in biomass following conversion of land to Cropland are estimated 4.06 kt C, whereof 1.61 kt C is from Grassland converted and 2.45 kt C from Wetland converted. The CO_2 emission is thus 14.89, 5.90 and 8.98 kt CO_2 respectively. Gains are estimated for the area converted to Cropland the year before assuming biomass after one year of growth to be 2.1 t C ha^{-1}. The total gain in biomass for land converted to Cropland is thus estimated as 0.55 kt C, with 0.27 kt C from Grassland converted and 0.29 kt C from Wetland converted. The CO2 removal of the gain is 2.01, 0.99, and 1.06 kt CO_2 respectively. The net loss is 3.51 kt C for all land converted or emission of 12.87 kt CO_2.

6.5.1.2 Carbon stock changes in dead organic matter

The AFOULU Guidelines Tier 1 methodology assumes no or insignificant changes in dead organic matter (DOM) in cropland remaining cropland and that no emission/removal factors or activity data are needed. No data is available to estimate the possible changes in dead organic matter in cropland remaining cropland. The majority of land classified as cropland in Iceland is hayfields with perennial grasses only ploughed or harrowed at decade intervals. A turf layer is formed and depending on the soil horizon definition it can partly be considered as dead organic matter. This is therefore recognized as a possible sink/source. Changes in DOM in the year of conversion and in the first year of growth after conversion are included in the changes estimated for living biomass.

6.5.1.3 Carbon stock changes in soils

Net carbon stock changes in mineral cropland soil for the category "Grassland converted to Cropland" are estimated according to Tier 1 method. Most croplands in Iceland are hayfields with perennial grasses, which are harvested once or twice during the growing season. Ploughing or harrowing is only done occasionally (10 years interval). Many hayfields are also used for livestock grazing for part of the growing season (spring and autumn in case of sheep farming). Most hayfields are fertilized with both synthetic fertilizers and manure. Changes in SOC for mineral soil are calculated according to T1 using equation 2.25 in 2006 IPPC guidelines. Default relative stock change factors considered applicable to hayfields with perennial grasses were selected from Table 5.5 in 2006 IPCC guidelines (IPCC 2006). For Land use the “set aside-dry” FLU = 0.93 was selected based on the descriptions in Table 5.5 as best describing the hayfields in Iceland. For management and input, FMG =1.10 no tillage- temperate boreal -dry and FI =1.00 medium input, were selected. The SOCREF, 90.5 t C ha^{-1}, is the average SOC (0-30 cm) from IGLUD field sampling for Grassland (AUI unpublished data). The initial mineral soil organic C stock is accordingly SOC0 = 90.5 tC ha^{-1} * 0.93*1.10*1.00 = 92.6 t C ha^{-1}. For the 20 year conversion period the annual change in ΔCMineral = 0.10 t C ha^{-1} for Grassland converted to Cropland. The area of Grassland on mineral soil being converted to Cropland is estimated from the above described time series as 2.53 kha and the C-stock of these soils as increasing by 0.26 kt C in the inventory year. Consequently these soils are estimated as removing 0.97 kt CO_2 from the atmosphere. No mineral soil is assumed under Wetland converted to Cropland. Changes in C-stock of mineral soils under “Cropland remaining Cropland” are not estimated as no information on changes in management is available.

Changes in SOC of organic soils are calculated according to T1 applying equation 2.3 in the 2013 Supplement to the 2006 Guidelines: Wetlands (IPCC 2014). Organic soils of Cropland are reported in two categories i.e. Cropland remaining Cropland and Wetland converted to Cropland 53.93 kha and 2.73 kha respectively. These organic soils are estimated to annually lose 426.07 kt C and 21.56 kt C in the same order. The consequent emission is estimated as 1562.26 kt CO_2 for organic soils of Cropland remaining Cropland and 79.06 kt CO_2 for soils of Wetland converted to Cropland. All soils of Wetland converted to Cropland are assumed to be organic.

6.5.2 Land converted to Cropland

The conversion of land to Cropland is reported in two categories. It is thus assumed that all mineral Cropland originates from Grassland and Cropland on organic soil originates directly from Wetland. Some of the Cropland on organic soils may have been drained Grassland for some period before converted to Cropland. Also, some areas of Cropland on mineral soil may have originated from other land use categories such as “Other land” or “Forest land” (Natural birch forests). There is presently no data available for the separation of conversion into more categories and until then all conversions are reported as aggregates area under the two categories. The default conversion period 20 years is applied for Grassland converted to Cropland and Wetland converted to Cropland.

6.5.3 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

In the new CRF- Reporter (v 5.10.1) emissions and removals from drainage and rewetting and other management of organic and mineral soils is included as new emission category compared to previous submissions. The new 2013 Supplement to the 2006 Guidelines: Wetlands (IPCC 2014), provides guidelines for estimation of emissions related to two factors not previously estimated. These factors are the off-site decomposition of dissolved organic carbon (DOC) and emission and removal of CH_4 from drained soils.

6.5.3.1 Off-site CO_2 emission via waterborne losses from drained inland soils

Off-site CO_2 emission is calculated according to T1 applying equation 2.4 in the 2013 wetland Supplement (IPCC 2014). For the two categories of organic Cropland soils the emission calculated is

23.73 kt CO_2 for organic soils of Cropland remaining Cropland and 1.20 kt CO_2 for soils of Wetland converted to Cropland.

6.5.3.2 CH_4 emission and removals from drained inland soils

The CH_4 emission from drained land is calculated according to T1 applying equation 2.6 in 2013 wetland supplement (IPCC 2014). The equations separate the emission into two components, i.e. emission from the drained land and the emission from the ditches. The T1 default EF for drained land under Cropland is zero and consequently the emission reported is only from the ditches. The emission reported is 3.30 kt CH_4 or 82.51 kt CO_2 eq. No estimate on the fraction of area covered by ditches is available and the indicated value from table 2.4 in the 2013 wetland supplement (IPCC 2014) is applied.

6.5.3.3 Rewetted soils under Cropland

No rewetting of soils in land included as Cropland and no other source or sink of GHG related to drainage or rewetting of Cropland soils is recognized and the relevant categories of 4(II) reported with notation key NO.

6.5.4 Other emissions

6.5.4.1 N_2O emission from drained inland soils

All N_2O emissions from drainage of organic soils are reported under the Agriculture sector 3.D.1.6-Cultivation of Histosols. N_2O emissions from disturbance associated with conversion of land to cropland (4(III)-Direct N_2O emissions from N Mineralization/Immobilization) are included there as indicated by use of the notation key IE.

6.5.5 Biomass burning

No biomass burning of cropland occurred in the inventory year and reported as such. Method for estimating area of biomass burned is described in chapter 6.13.

6.5.6 Emission factors

The CO_2 emission from C- stock changes in Cropland organic soil are calculated according to a Tier 1 methodology using the EF= 7.9 t CO_2-C ha-1yr-1 from table 2.1 in 2013 wetland supplement (IPCC 2014).

The off-site CO_2 emission via waterborne losses from drained cropland soils is calculated according to T1 using EF = 0.12 t C ha-1yr-1 from table 2.2 in 2013 wetland supplement (IPCC 2014)

The emissions of CO_2 caused by conversion of land to Cropland is calculated on the basis of country specific estimate of C stock in living biomass, litter and standing dead biomass 1.27 ± 0.24 kg C m^{-2} and 1.80 ± 0.51 kg C m^{-2} for Grassland and Wetland respectively as estimated from field sampling. Methods are described in (Gudmundsson et al. 2010). The Cropland biomass after one year of growth is 2.1 t C ha^{-1} from Table 5.9 in 2006 IPCC guidelines (IPCC 2006). The SOC_{Ref} = 90.5 ±28.2 t C ha^{-1}, for mineral soils of Grassland converted to Cropland is country specific and based on preliminary results from IGLUD soil sampling. For the 20 year conversion period, the annual change is in ΔC Mineral = 0.10 t C ha^{-1} for Grassland converted to Cropland.

The CH4 emission and removal from drained cropland is calculated according to T1 applying $EFCH_{4\_land}$ = 0 and $EFCH_{4\_ditch}$ = 1165 kg CH_4 ha^{-1} yr^{-1} from table 2.3 and 2.4 in 2013 wetland supplement (IPCC 2014) respectively.

6.5.7 Uncertainties and QA/QC

According to the time series for Cropland the cumulated area of cultivated land is in good agreement with the area mapped as Cropland 172.5 kha versus 173.2 kha. Abandoned cropland is included in both estimates.

The mapping in IGLUD has been controlled through systematic sampling where land use is recorded in the sampling points. Preliminary results indicate that 91% of land mapped as Cropland is cropland and that 80% land identified in situ as cropland is currently mapped in IGLUD as such (AUI unpublished data). A survey of cropland was initiated the summer 2010 to control the IGLUD mapping of cropland. Randomly selected 500*500m squares below 200 m a.s.l. were visited and the mapping of cropland inside these squares was controlled. Total number of squares visited was 383 with total area 9187 ha including mapped cropland of 998 ha. Of this mapped cropland 216 ha or 21% were not confirmed as cropland and 38 ha or 4% were identified as cropland not included in the map layer. Uncertainty in area of Cropland is therefore set as 20%.

The area of drained Cropland is in this year's submission estimated through preparation of time series of land use conversion as described above. The ratio of hayfields on organic soil was estimated in a survey on vegetation in hayfields 1990-1993 (Þorvaldsson 1994) as 44%. The time series of Cropland organic soil were adjusted to that ratio. In the summer 2011 a survey on Cropland soils was initiated as part of the IGLUD project involving systematic sampling on 50x50m grid of randomly selected polygons of the Cropland mapping unit. Preliminary results from this sampling effort show similar ratio of organic soils. The uncertainty for the area of Cropland on organic soil is for this submission assumed 20% or the same as for Cropland total area.

The emission/removal estimated for land converted to Cropland is based on factors estimated with standard error of 20-30%. The uncertainty of the calculated emission removal is accordingly in the same range.

The emissions reported from drained organic Cropland soils are based on default EF from table 2.1 in 2013 wetland supplement (IPCC 2014) 95% confidence intervals ± 1.5 t CO_2-C $ha^{-1}yr^{-1}$, or approximately 20%.

The off-site CO_2 emission via waterborne losses from drained cropland soils is calculated based on default EF from table 2.2 in 2013 wetland supplement (IPCC 2014) with range ± 50%.

Emission of CH_4 from drained Cropland only includes emission from drainage ditches and is calculated according to EF from table 2.4 in 2013 wetland supplement (IPCC 2014) with range ± 70%.

6.5.8 Recalculations

No recalculations are done for this category in this submission. The new emission factors of 2013 Supplement (IPCC 2014) made in last year's submission and new emission components are in this also applied in this submission.

6.5.9 Planned improvements regarding Cropland

In this submission as in last year's submission time series of Cropland categories were used to estimate the area of each category. Further improvements of the mapping and subdivision are still needed as e.g. revealed through the cropland mapping survey described above. The area of land converted to Cropland from other categories than Grassland or Wetland needs to be determined. Continued field controlling of mapping, improved mapping quality and division of cropland soil to soil classes and cultivated crops is planned in coming years. As the introduction of time series revealed that a considerable area of the mapping unit Cropland is abandoned cropland. Identifying the abandoned cropland within the mapping unit is considered of high importance. Information on soil carbon of mineral soil under different management and of different origin is important to be able to obtain a better estimate of the effect of land use on the SOC. Establishing reliable estimate of cropland biomass is also important and is planned.

Considering that the CO_2 emission from both “Cropland remaining Cropland” and “Land converted to Cropland” are recognized as key sources, it is important to move to a higher tier in estimating that factor. Establishing country specific emission factors, including variability in soil classes, is already included in on-going research projects at the AUI. These studies are assumed to result in new emission factors. Data, obtained through fertilization experiments, on carbon content of cultivated soils is available at the AUI. The data is currently being processed and is expected to yield information on changes in carbon content of cultivated soils over time.

The new emission components of offsite CO_2 emission and CH_4 emissions from Cropland have not gained much attention in Iceland. Data on that emissions and area involved is needed for Iceland e.g. the ratio of dich area. It is therefore considered important to promote the research needed and improve the estimate of relevant area.

6.6 Grassland

Grassland is the largest land use category identified by present land use mapping as described above. The total area of the Grassland category is reported as 5,377.26 kha, making it by far the largest land use category in Iceland. Grassland is a very diverse category with regard to vegetation, soil type, erosion and management.

The Grassland category is divided into twelve subcategories in this year´s submission. The Grassland time series reported are prepared from three primary time series (Figure 6.10), and an independent time series for expansion of birch shrubland into other grassland. The time series of Other Grassland is prepared from the Grassland mapping unit when all other mapping units of grassland subcategories have been taken into account. The backward tracking of area within that category was done by correcting the area of the year after according to all area within other land use categories considered originate from Other Grassland, including Forest land, Cropland, other Grassland subcategories, Reservoirs, and Settlement.

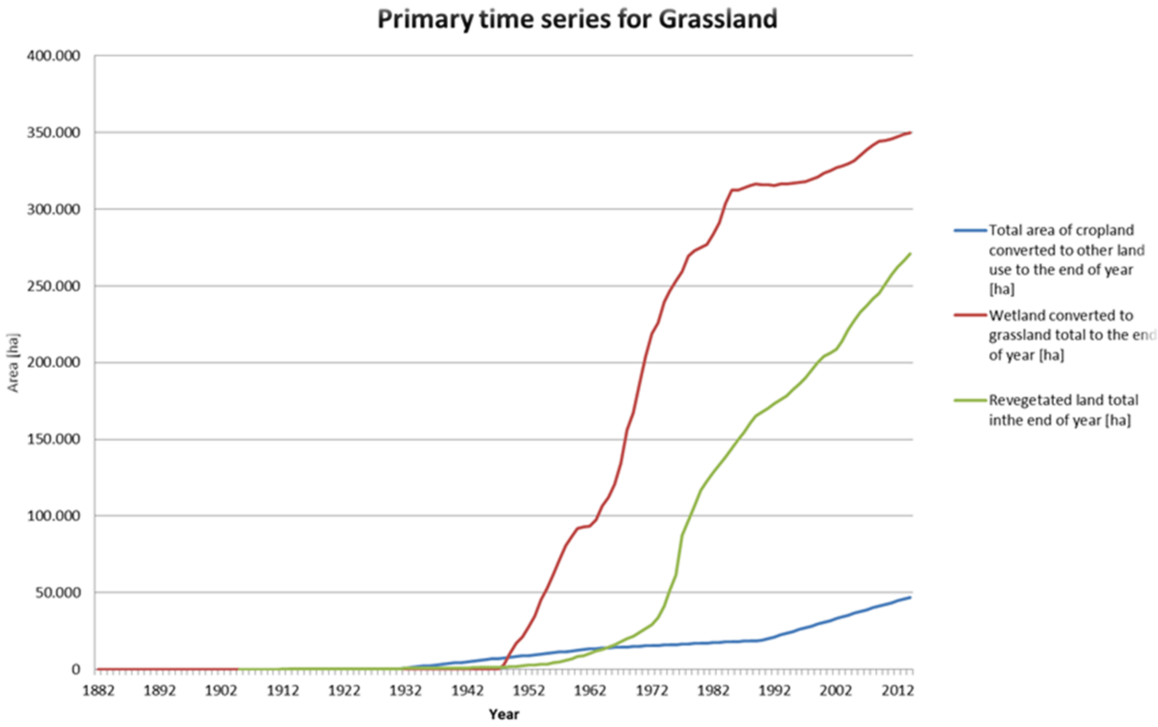

Figure 6.10 Primary time series for Grassland: Total area of Cropland converted to other land uses at the end of the year, Wetland converted to Grassland at the end of the year, Revegetated land at the end of the year. All graphs showing cumulative area at the end of the year from the beginning of time series.

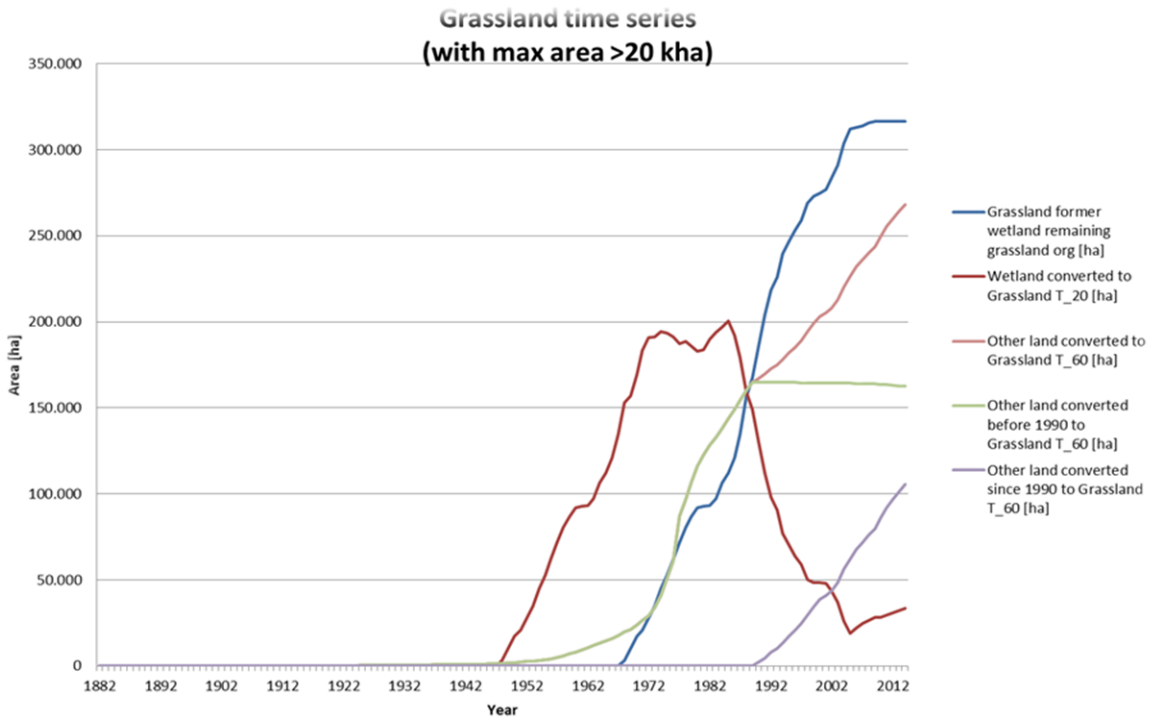

Figure 6.11 Time series of reported Grassland categories with max area >20 kha: Grassland former Wetland remaining Grassland organic soil, Wetland converted to Grassland T_20, Other land converted to Grassland T_60, Other land converted to Grassland before 1990 T_60, Other land converted to Grassland since 1990 T_60. All graphs showing the area in hectares at the end of the year.

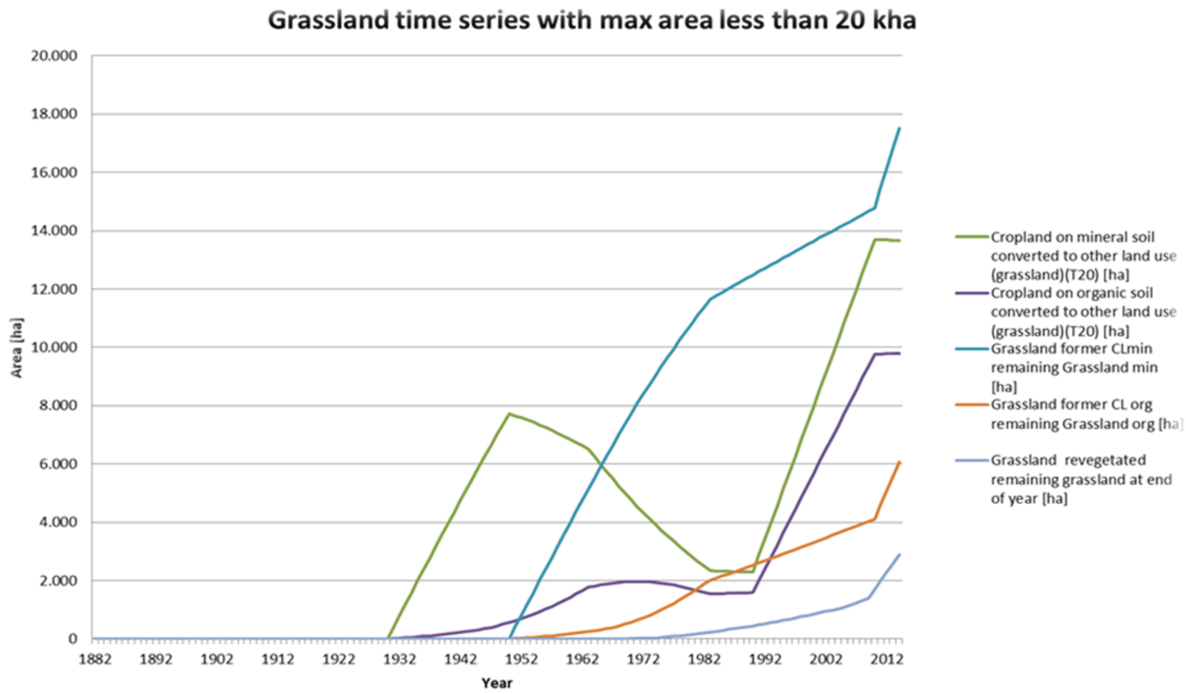

Figure 6.12 Time series of reported Grassland categories with max area <20 kha: Cropland on mineral soil converted to Grassland T_20, Cropland on organic soil converted to Grassland T_20, Grassland former Cropland remaining Grassland mineral soil, Grassland former Cropland remaining Grassland organic soil, Grassland former revegetated Other land remaining Grassland. All graphs showing the area in hectares at the end of the year

6.6.1 Grassland remaining Grassland

The time series and conversion period applied enable keeping track of the area of different origin under the category Grassland remaining Grassland. The subcategories are described below.

6.6.1.1 Cropland abandoned for more than 20 years.

This category includes all previous cropland abandoned for more than 20 years still remaining under the Grassland land use category. The area reported for this category is the area emerging from the time series and estimated as 22.90 kha whereof 6.06 kha is organic soil.

6.6.1.2 Natural Birch Shrubland

Natural birch shrubland is the part of the natural birch woodland not meeting the thresholds to be accounted for as forest, but covered with birch (Betula pubescens) to a minimum of 10% in vertical cover and at least 0.5 ha in continuous area. The natural birch shrubland is included in the NFI and its area and stock changes are estimated by the IFR. The estimates of total area and changes in carbon pools are based on the same methods and data sources as used to estimate the natural birch forest.

Similar to natural birch woodland, three subcategories of natural birch shrubland are reported here. One i.e. “Natural birch shrubland –old” is for shrubland remaining shrubland including shrubland surveyed in the 1987-1991 inventory. As for natural birch forest, the C-stock of natural birch shrubland has slightly increased between 1987 and 2007 although the mean annual net change is very low (0.019 t C ha-1 yr-1). The second subcategory i.e. “Natural birch shrubland – recently expanded from Other Grassland” is representing “Other Grassland” converted to shrubland. As this change in vegetation cover does not shift the land between categories this land remains as Grassland. Conversion period is set to 50 years as for natural birch forest and with same; in country removal factors for biomass, dead organic matter and mineral soil and the IPCC default emission factor for organic soil. The third and the last subcategory is “Natural birch shrubland – recently expanded from Other Land”. That is expansion of natural birch shrubland on poorly vegetated land. As no historical data before 1987 exists, a time series for changes C-stock of natural birch shrubland only exist after 1987 and in C-stock after 1989. They are built on interpolation between 1989 and 2007 and extrapolations from 2012 with even annual increase in area. The third subcategory of Natural birch shrubland is reported under “Other land converted to Grassland” (see chapter 6.9.1.8)

6.6.1.3 Other Grassland

The mapping unit Other grassland includes all land where vascular plant cover is 20% or more as compiled from IGLUD and not included in the other Grassland subcategories. Accordingly, all land within the land use categories, higher ranked than Grassland in the hierarchy (table 1), are excluded a priory. The map layers classified as Land converted to grassland are all ranked above the map layers included in the category “Other grassland”. The land in this category is e.g. heath-lands with dwarf shrubs, small bushes other than birch (Betula pubescens), grasses and mosses in variable combinations (respecting the 20% minimum vascular plant cover), fertile grasslands, and partly vegetated land. The area mapped is then adjusted to other Grassland categories (chapter 6.6.5) and the time series prepared as described above. The total area reported in this year’s submission for this category is 4,655.04 kha.

Large areas in Iceland suffer from severe degradation where the vegetation cover is severely damaged or absent and the soil is partly eroded but the remaining Andic soil still has 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). This land has not been identified in the IGLUD maps, but is likely to be included in this category to a large extent.

Since the settlement of Iceland a large share of the former vegetated areas has been severely eroded and large areas have lost their entire soil mantle. It has been estimated that a total of 60-250×103 kt C has been oxidized and released into the atmosphere in the past millennium (Óskarsson et al. 2004). The estimated current on-going loss of SOC due to erosion is 50-100 kt C yr-1 according to the same study. That study only takes in account the soil lost through one type of erosion i.e. erosion escarpments. This loss is comparable to 183-366 kt CO_2 if all of this lost SOC is decomposed or 92-183 kt CO_2 if 50% of it is decomposed as argued for in the paper (Óskarsson et al. 2004). This loss is at present not included in the CRF, but the possible amount of C being lost is in the same order of magnitude as CO_2 removal reported as revegetation since 1990 (194 kt CO_2). The revegetation of deserted areas sequesters carbon back into vegetation and soil and thereby counteracts these losses.

The vegetation cover in many other Grassland areas in Iceland is at was noted to be increasing both in vigor and continuity (Magnússon et al. 2006). Tis increase has in another recent study been shown to have slowed down or even turned to a decrease in some areas (Raynolds, Magnusson et al. 2015). In these areas, the annual carbon budget might have been positive for a period 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 or improvement is one of the IGLUD objectives as described in (Gudmundsson et al. 2010). Through this subdivision estimates of both ongoing losses and gains can be attempted. Subdivision based on management regimes, i.e. unmanaged and managed and the latter further according to grazing intensity is pending but not implemented.

6.6.1.4 Revegetated land older than 60 years

By defining a conversion period of 60 years, for Revegetation ("Other land converted to Grassland – revegetation) which is shorter than the time revegetation has been practiced in Iceland, a small area of revegetated land older than 60 years emerges as category. The total area of the category is in this year's submission 2.89 kha. This area is not at present recognised as separate mapping unit but assumed to be included in the mapping unit Revegetation before 1990, despite currently limited area of that mapping unit (see chapter 6.3.1.3 - *Maps of Land being re-vegetated*).

6.6.1.5 Wetland drained for more than 20 years.

This category also appears as result of time series and application of default 20 years conversion period for "Wetland converted to Grassland". As most of the drained land was drained for at least 20 years the majority of the drained wetlands are now reported under this category. The total area reported in this year's submission is 316.59 kha and all of it assumed to be with organic soils. This category is not at present identified as separate mapping unit, but together with the category "Wetland converted to Grassland" is presented as the mapping unit "Grassland on drained soils". The preparation of that mapping unit is described in (chapter 6.3.1.3 – *Maps of drained land*).

6.6.2 Land converted to Grassland

Land converted to Grassland is reported for three main categories i.e.; "Cropland converted to Grassland", "Wetland converted to Grassland" and "Other land converted to Grassland". Conversions of Forest land and Settlement to Grassland are reported as not occurring.

6.6.2.1 Cropland converted to Grassland

The area reported is as emerging from the time series available for Cropland using the default conversion period of 20 years. The category is at present not identified as a specific mapping unit but is included in both the mineral and organic soil part of the Cropland mapping unit. The total area reported for this category is 23.46 kha with 9.78 kha on organic soil.

6.6.2.2 Wetland converted to Grassland

The area included under this subcategory includes the area drained for the last 20 years prior to the inventory year. The total area reported for this subcategory is 33.36 kha and the whole area assumed to be on organic soil. The area estimate is based on available time series and applies 20 years as the conversion period.

6.6.2.3 Other Land converted to Grassland

This category is divided to four subcategories three of them originating from revegetation activities i.e.; "Revegetation before 1990", "Revegetation since 1990- (areas) protected from grazing", and "Revegetation since 1990 – (areas with) limited grazing allowed". The forth subcategory "Other land converted to Natural birch shrubland" originate from the ongoing expansion of birch shrubland noted in the NFI.

Revegetation

The revegetation activity where no afforestation is included the land is reported as "Other land converted to Grassland". The original vegetation cover is less than 20% for the vast majority of land where revegetation is started, according to the SCSI. Accordingly, this land does not meet the definition of Grasslands and is all classified as "Other land being converted to Grassland".

The SCSI was established in 1907. Its main purpose is the prevention of on-going land degradation and erosion, the revegetation of eroded areas, restoration of lost ecosystem and to ensure sustainable grazing land use. The reclamation work until 1990 was mostly confined to 170 enclosures, covering approximately 3% of the total land area. The exclusion of grazing livestock from the reclamation areas, and other means of improving livestock land use, is estimated to have resulted in autogenic 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 airplanes and direct seeding of Lyme grass (Leymus arenarius L.) and other graminoids. These activities are to a large extent recorded. The emphasis on aerial spreading has decreased since 1990 as other methods, such as increased participation and cooperation with farmers and other groups interested in land reclamation work, have proven more efficient. Methods for the recording of activities have been improved at the same time, most noticeably by using aerial photographs and GPS-positioning systems. Since 2002, GPS tracking has increasingly been used to record activities in real time, e.g. spreading of seeds and/or fertilizer. Since 2008 almost all activities have been recorded simultaneously with GPS-units (Thorsson et al. in prep.).

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 (Thorsson et al. in prep.). The objectives of this inventory are to monitor the changes in C-stocks, control and 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 systematic sampling on predefined grid points in the same grid as is used by the IFR for NFI (Snorrason and Kjartansson. 2004) and in IGLUD field sampling. The basic unit of this grid as applied by SCSI and IFS is a rectangular, 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 have been visited although all data from the survey is still not available. 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 plot, five 0.5×0.5 m randomly selected subplots will be used for soil and vegetation sampling for C-stock estimation.

A conversion period of 60 year has been defined on basis of NIRA data sampling. The length of the conversion period is preliminary as the data remains to be analysed further. The categories “Revegetation since 1990-protected from grazing” and “Revegetation since 1990-limited grazing allowed” represents activity since 1990 accountable as Kyoto Protocol commitments. The area reported as land revegetated before 1990 is reported as “Revegetation before 1990” and “Revegetated land older than 60 years” the latter as subcategory of Grassland remaining Grassland.

The subdivision of land revegetated since 1990 is based on different management regimes as some land has been opened up for grazing of limited intensity.

The area of Revegetation since 1990 reported for the year 2014 is 105.62 kha compared to 101.24 kha reported for the year 2013 in last year´s submission.

The area reported as Revegetation before 1990 is calculated from the best available data of revegetation before 1990. The mapping of these areas is still subjected to high uncertainty and only small portion of this land is presented in IGLUD map layer Revegetation before 1990. The area not included in that map layer is assumed to be located within the SCSI’s designated areas. Estimation on total revegetation area before 1990 is finished based on best available documentation and is presented here, but mapping has not been finished at this point but will be provided in next year’s submission (Thorsson J. personal communication).

6.6.2.4 Other land converted to Natural birch shrubland.

This category emerges from the expansion of Natural birch shrubland noted in the NFI mapping of birch woodlands. The shrubland has compared to the 1989 survey expanded into “Other land” by 1.53 kha.

6.6.3 Carbon stock changes

Carbon stock changes are estimated for all subcategories included both under Grassland remaining Grassland and Land converted to Grassland. Carbon stock changes of “Grassland remaining Grassland” and “Land converted tor Grassland” are recognized as key categories of both level and trend in 2014.

6.6.3.1 Carbon stock changes in living biomass

The changes in living biomass of the subcategories “Natural birch shrubland–old” and Natural birch shrubland-recently expanded into Other Grassland” are estimated by IFR based on NFI data. The living biomass of these categories is estimated to have increased by 0.96 kt C and 0.97 kt C respectively removing 3.51 kt CO_2 and 3.55 kt CO_2 from the atmosphere. Carbon stock changes in living biomass of other subcategories of Grassland remaining Grassland i.e. “Revegetation older than 60 years”, “Wetland drained for more than 20 years”, “Cropland abandoned for more than 20 years”, and “Other Grassland” are reported as not occurring based on Tier 1 method for Grassland remaining Grassland.

Carbon stock changes in living biomass are estimated for all categories of Land converted to Grassland where conversion is reported to occur. Conversions of “Forest land” and “Settlements” to Grassland are reported as not occurring. Changes in living biomass in the category Wetland converted to Grassland are reported as not occurring as vegetation is more or less undisturbed, as no ploughing or harrowing takes place. Changes in living biomass in the category Cropland converted to Grassland are estimated on basis of default Cropland biomass (Table 5.9. in 2006 IPCC guidelines (IPCC 2006)) and average C stock in living biomass, litter and standing dead biomass of Grassland as estimated from IGLUD field sampling (see chapter 6.6.6). The living biomass of this category is estimated to have increased by 12.41 kt C in 2013, consequently removing 45.51 kt CO_2.

The stock changes in living biomass of the subcategories of “Other land converted to Grassland” representing revegetation activities reflect the increase in vegetation coverage and biomass achieved through those activities. The changes in biomass are estimated as relative contribution (10%) of total C-stock increase (Aradóttir et al. 2000; Arnalds et al. 2000). The total C-stock increase is estimated on basis of NIRA sampling. The carbon stock in living biomass of the revegetation subcategories is estimated to have increased by 9.26 kt C, 5.38 kt C, and 0.64 kt C respectively for the categories Revegetation before 1990, Revegetation since 1990-protected from grazing, and Revegetation since 1990-limited grazing allowed, removing 33.95 kt CO_2, 19.72 kt CO_2, and 2.35 kt CO_2 from the atmosphere, respectively. The carbon stock in living biomass of the forth subcategory “Other land converted to Natural birch shrubland” is estimated in the NFI to have increased by 0.42 kt C removing 1.52 kt CO_2 from the atmosphere.

6.6.3.2 Carbon stock changes in dead organic matter

Changes in carbon stock of dead organic matter are estimated for the category “Natural birch shrubland-recently expanded into Other Grassland” and the category “Other land converted to Natural birch shrubland” by the IFR in the NFI. The carbon stock in dead organic matter of these categories is estimated to have increased by 0.50 kt C for “Natural birch shrubland-recently expanded into Other Grassland” and 0.22 kt C for “Other land converted to Natural birch shrubland” in the year 2014 and accordingly removing 1.85 kt CO_2 and 0.79 kt CO_2 respectively from the atmosphere.

The changes in dead organic matter are included in C-stock changes in living biomass for the category "Cropland converted to Grassland" see above (chapter 6.6.2). The changes in dead organic matter are also included in living biomass of the three revegetation subcategories under "Other land converted to Grassland" (Aradóttir et al. 2000).

Changes in dead organic matter of "Wetland converted to Grassland" are reported as not occurring consequent with no changes in living biomass.

6.6.3.3 Carbon stock changes in soils

Mineral soil

Changes in the carbon stock of the mineral soil of subcategory "Natural birch shrubland recently expanded to Other Grassland" is estimated as having increased by 1.25 kt C in the year 2014 and thereby removing a total of 4.58 kt CO_2 form the atmosphere. Changes in carbon stock in mineral soils of land under other subcategories of Grassland remaining Grassland are reported as not occurring in line with Tier 1 method. The Tier 1 methodology gives by default no changes if land use, management and input (F_{LU}, F_{MG}, and F_I) are unchanged over a period.

The changes reported in mineral soil of Cropland converted to Grassland are assumed to be reversed changes estimated for Grassland converted to Cropland (chapter 6.5.2). The loss from mineral soils of Cropland converted to Grassland is reported as 1.42 kt C and consequently emitting 5.22 kt CO_2. No mineral soil is included as "Wetland converted to Grassland".

For the three subcategories of "Other land converted to Grassland" representing revegetation the changes in carbon stock in mineral soils are estimated applying Tier 2 and CS emission (removal) factor. The carbon stock in mineral soils is estimated to have increased by 83.35 kt C, 48.41 kt C, and 5.78 kt C respectively for the categories "Revegetation before 1990" and "Revegetation since 1990 – protected from grazing" and "Revegetation since 1990- limited grazing allowed" and removing 305.60, 177.50, and 21.18 kt CO_2 from the atmosphere in the same order. The changes in carbon stock in mineral soils of the forth subcategory of "Other land converted to Grassland", "Other land converted to Natural birch shrubland" is estimated applying same CS emission (removal) factor as used for revegetation categories. The increase in mineral soil of this sub category is estimated as 0.78 kt C and to have removed 2.89 kt CO_2 from the atmosphere.

Organic soils

Organic soils are reported for the Grassland subcategories "Cropland abandoned for more than 20 years", "Natural birch shrubland- old", "Natural birch shrubland recently expanded into Other Grassland", "Wetland drained for more than 20 years", "Cropland converted to Grassland", and "Wetland converted to Grassland". The carbon stock changes in organic soils of land under these categories are estimated applying Tier 1 methodology. 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. The carbon stock in drained organic soils included under the Grassland subcategories is estimated to have decreased by 2086.55 kt C in the inventory year emitting 7,650.69 kt CO_2. The disaggregation of these numbers to the subcategories involved is shown in Table 6.9.

Table 6.9. Drained soils, estimated C losses and on site CO_2 emission of Grassland categories/subcategories.

Category/subcategory	Drained "organic" soils [kha]	Carbon stock changes in organic soils [kt C]	Emission [kt CO_2]
Grassland remaining Grassland	322.92	-1840.63	6748.99
Cropland abandoned for more than 20 years	6.06	-34.56	126.70
Natural birch shrubland (N.b.s)- old	0.11	-0.63	2.29
N.b.s.- recently expanded into Other Grassland	0.15	-0.84	3.08
Wetland drained for more than 20 years	316.60	-1804.61	6616.91
Land converted to Grassland	43.14	-245.92	901.70
Cropland converted to Grassland	9.78	-55.77	204.50
Wetland converted to Grassland	32.26	-190.14	697.20
Total	**366.06**	**-2086.55**	**7650.69**

6.6.4 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

The emissions and removals included under this component were reported for first time in last year's submission.

6.6.4.1 Off-site CO_2 emission via waterborne losses from drained inland soils

The off-site emission of CO_2 waterborne organic matters from drained soils is estimated according to equation 2.4 in 2013 wetland supplement (IPCC 2014) applying T1 methodology. The off-site emission is reported for all Grassland subcategories with drained soils reported. The total emission for Grassland is estimated as 161.07 kt CO_2. The disaggregation of these numbers to the subcategories involved is shown in Table 6.10.

Table 6.10 Drained soils, estimated of- site CO_2 emission of Grassland categories/subcategories.

Category/subcategory	Drained "organic" soils [kha]	Off-site CO_2 emission [kt CO_2]
Grassland remaining Grassland	322.92	142.08
Cropland abandoned for more than 20 years	6.06	2.67
Natural birch shrubland (N.b.s)- old	0.11	0.05
N.b.s.- recently expanded into Other Grassland	0.15	0.06
Wetland drained for more than 20 years	316.60	139.30
Land converted to Grassland	43.14	18.98
Cropland converted to Grassland	9.78	4.31
Wetland converted to Grassland	33.36	14.68
Total	**366.06**	**161.07**

6.6.4.2 CH_4 emission and removals from drained inland soils

The CH_4 emission from drained land is calculated according to T1 applying equation 2.6 in 2013 wetland supplement (IPCC 2014). The equations separate the emission into two components, i.e. emission from the drained land and the emission from the ditches. No estimate on the fraction of area covered by ditches is available and the indicated value from table 2.4 in the 2013 wetland supplement (IPCC 2014) is applied. In general the drainage ditches in Iceland are deep 1.5m-4m and EF for Grassland ditches selected accordingly. The emission of CH_4 is reported for all the Grassland subcategories including drained soils. The total emission reported is 22.81 kt CH_4 or 545.25 kt CO_2 eq. Of this emission 22.32 kt CH_4 is reported from the ditches while only 0.48 kt CH_4 is reported from the drained land. The disaggregation of these numbers to emission from drained land and ditches of the subcategories involved is shown inTable 6.11.

Table 6.11 Drained soils, estimated CH_4 emission from drained land and ditches of Grassland categories/subcategories.

Category/subcategory	Drained "organic" soils [kha]	CH_4 land [kt CH_4]	CH_4 ditches [kt CH_4]	CH_4 total	
				[kt CH_4]	[kt CO_2 eq]
Grassland remaining Grassland	322.91	0.43	18.81	19.24	480.99
Cropland abandoned for more than 20 years	6.06	0.01	0.35	0.36	9.03
Natural birch shrubland (N.b.s)- old	0.11	0.00	0.01	0.01	0.16
N.b.s.- recently expanded into Other Grassland	0.15	0.00	0.01	0.01	0.22
Wetland drained for more than 20 years	316.60	0.42	18.44	18.86	471.57
Land converted to Grassland	43.14	0.06	2.51	2.57	64.26
Cropland converted to Grassland	9.78	0.01	0.57	0.58	14.57
Wetland converted to Grassland	33.36	0.04	1.94	1.99	49.69
Total	**366.06**	**0.48**	**22.32**	**22.81**	**545.25**

6.6.4.3 Rewetted soils under Grassland

The rewetting of Grasslands occurring is reported as Grassland converted to Wetland. No other source or sink of GHG related to drainage or rewetting of Grassland soils is recognized and the relevant categories of 4(II) reported with notation key NO.

6.6.5 Other emissions

6.6.5.1 N_2O emission from drained inland soils

The emission of N_2O form drained Grassland soil is in CRF reported as three subcategories, Grassland remaining Grassland, Cropland converted to Grassland, and Wetland converted to Grassland under "4.H Other -N_2O from Grassland drained soils-4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils -Total Organic Soils - Drained Organic Soils". This emission is included as Grassland emission in this report, although reported under 4H in the CRF tables.

The emissions are calculated according to T1 applying equation 2.7 in the 2013 wetland supplement (IPCC 2014). The total emission of N_2O reported under 4H is 5.47 kt N_2O or 1628.50 kt CO_2 eq. The disaggregation of this emission to subcategories is shown in Table 6.12.

Table 6.12 Drained soils, estimated N_2O emission from drained soils of Grassland categories/subcategories.

Category/subcategory	**Drained "organic" soils [kha]**	**Direct N_2O from N min/immob.**	
		[kt N_2O]	[kt CO_2 eq]
Grassland remaining Grassland	322.91	4,82	1436,57
Cropland abandoned for more than 20 years	6.06	0,09	26,97
Natural birch shrubland (N.b.s)- old	0.11	0,00	0,49
N.b.s.- recently expanded into Other Grassland	0.15	0,00	0,66
Wetland drained for more than 20 years	316.60	4,73	1408,46
Land converted to Grassland	43.14	0,65	187,04
Cropland converted to Grassland	9.78	0,15	43,51
Wetland converted to Grassland	33.36	0,50	143,53
Total	366.06	5,47	1628,50

6.6.5.2 *Direct N_2O emissions from N Mineralization/Immobilization*

Conversion of Cropland on mineral soils to Grassland result in loss of SOC. Emission of associated mineralization of N is calculated by assuming C:N of 15. The resulting N_2O emission is estimated 1.5 t N_2O or 0.44 kt CO_2 eq.

6.6.6 Biomass burning

Biomass burning on Grassland is reported for Grassland remaining Grassland. All subcategories are reported as aggregate number but emission is estimated separately from estimated biomass of each subcategory. Only wildfires are included in the present estimate. The methodology for estimating the biomass burned and the consequent emissions is explained in chapter 6.13. The area of Grassland burned in the inventory year in wildfires is estimated from available maps of the burned area and overlays of the IGLUD land use map as 44.9 ha of Grassland remaining Grassland. The emission caused by these fires is estimated as 1.54 Mg CH_4 plus 0.14 Mg N_2O for Grassland remaining Grassland. This emission is equivalent to total 80.50 Mg CO_2.

6.6.7 Emission factors

The CO_2 emissions from C- stock changes in Grassland drained soils is calculated according to a Tier 1 methodology using the EF= 5.7 t CO_2-C $ha^{-1}yr^{-1}$ from table 2.1 in 2013 wetland supplement (IPCC 2014).

The C-stock changes in living biomass of Natural birch shrubland is in the NFI applying T3 methodology of direct estimate of stock changes.

The changes in annual living biomass (including litter and dead organic matter) of Cropland converted to Grassland are estimated from C stock in living biomass, litter and standing dead biomass of Grassland as estimated from IGLUD sampling 1.27 ± 0.24 kg C m^{-2} (12.7 t C ha^{-1}) and default Cropland biomass 2.1 t C ha^{-1} from Table 5.9 in 2006 IPCC guidelines (IPCC 2006). The average annual increase in living biomass including dead organic matter is accordingly estimated as 0.53 t C ha^{-1} yr^{-1} with 20 years conversion period.

The Soil Conservation Service of Iceland records the 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 carbon sequestration rate in revegetation areas was started the same time (Aradóttir et al. 2000; Arnalds et al. 2000). The contribution of changes in carbon stock of living biomass (including dead organic matter) and soil were estimated as 10% and 90% respectively is based on these studies. The SCSI has since 2007 been running National Inventory on Revegetation area (NIRA), including sampling of soil and vegetation. Emission factors for changes in C-stocks are based on analyses of these samples (Thorsson et al. in prep). 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 -0.06 and -0.51 t C/ha/yr respectively. All revegetated areas 60 years old or less are assumed to accumulate carbon stock at the same rate. The changes in C-sock of mineral soils of the category “Other land converted to Natural birch shrubland” is estimated applying the same EF as for revegetation activities.

The C- stock changes in mineral soils of the subcategory “Natural birch shrubland–recently expanded into Other Grassland” are estimated applying same EF (0.365 t C ha^{-1} yr^{-1}) as for mineral soils of afforested Grassland (Bjarnadóttir 2009)

Carbon stock changes for mineral soil of Cropland converted to Grassland are estimated as the reversal of changes in opposite land use changes i.e. Grassland converted to Cropland (see chapter 0) EF= -0.10 t C ha^{-1}.

The off-site CO_2 emission via waterborne losses from drained Grassland soils is calculated according to T1 using EF = 0.12 t C $ha^{-1}yr^{-1}$ from table 2.2 in 2013 wetland supplement (IPCC 2014)

The CH4 emission and removal from drained Grassland is calculated according to T1 applying EFCH4_land = 1.4 and EF_{CH4_ditch} = 1165 kg CH_4 ha^{-1} yr^{-1} from table 2.3 and 2.4 in 2013 wetland supplement (IPCC 2014) respectively.

The N_2O emission from drained Grassland soils is estimated applying EF= 9.5 kg N_2O-N ha^{-1} yr^{-1} from table 2.5 in 2013 wetland supplement (IPCC 2014).

6.6.8 Uncertainties and QA/QC

The uncertainty of area of the categories reported is estimate 20% except for Revegetation where the currently estimated uncertainty in area is 10% according to SCSI. Uncertainties of the subcategories of “Other land converted to Grassland” involving revegetation have been estimated using data from the KP LULUCF sampling program (see chapter 10.1.3 in (Wöll, Hallsdóttir et al. 2014)). It indicates that revegetation areas prior to 2008 are overestimated by a factor of 1.3 (30%) but after 2008 this error is assumed to be 10% due to GPS real-time tracking of activities. The area of “Other land converted to Natural birch shrubland” is estimated through the IFR effort of remapping birch woodlands and subjected to same uncertainty as other categories in that mapping effort.

The size of the drained area is in this year’s submission estimated from IGLUD as described above. In the summer 2011 a survey of drained Grassland was initiated. The results of that survey have not yet been analyzed, but subsample analysis indicate a 20-30% area uncertainty. Many factors can potentially contribute to the uncertainty of the size of drained area. Among these is the quality of the ditch map. On-going survey on the type of soil drained has already revealed that some features mapped as ditches are not ditches but e.g. tracks or fences. During the summer 2010 the reliability of the ditch map was tested. Randomly selected squares of 500*500 m were controlled for ditches.

Preliminary results show that 91% of the ditches mapped were confirmed and 5% of ditches in the squares were not already mapped. The width of the buffer zone, applied on the mapped ditches, is set to be 200 m to each side as determined from an analysis of the Farmland database (Gísladóttir et al. 2007). The AUI launched in 2011 project to check the validity of this number. The field work was finished in 2014, but analyses of the data is pending. The map layers used to exclude certain types of land cover from the buffer zone put to estimate area of drained land have their own uncertainty, which is transferred to the estimate of the area of drained land. The decision to rank the map layers of wetland, semi-wetland and wetland/semi-wetland complex lower than drained land most certainly included some areas as drained although still wet.

It can be assumed that the area with drained soil decreases as time passes, simply because the drained soil decomposes and is “eaten” down to the lowered water level and thus becomes wet again. On the other hand the decomposition of the soil also results in sloping surface toward the ditch, which potentially increases runoff from the area and less water becomes available to maintain the water level. No attempt has been made to evaluate the effects of these factors for drained areas.

Changes in C stock of living biomass and dead organic matter of the category Grassland remaining Grassland are reported as not occurring (Tier 1) except for living biomass of Natural birch shrubland. The CO_2 emissions from mineral soils of Grassland remaining Grassland are also reported as not occurring following Tier 1 assumption of steady stock. The uncertainty introduced by applying Tier 1, is as such not estimated.

Carbon stock changes of living biomass in land remaining Grassland is estimated for “Natural birch shrubland-old” and “Natural birch shrubland recently expanded to Other grassland” The C-stock changes of these categories are estimated by IFR through NFI, and subjected to the same uncertainty as other estimates obtained through NFI. These estimates shows that changes are occurring in the living biomass of that category. Comparable changes in other pools of that category are expected until the area reaches a new equilibrium. As no specific actions have been taken to increase the living biomass of that category, the observed changes indicate that this is the result of some general causes e.g. changes in climate or management (grazing pressure). The same components would be likely to act similarly on other categories. Considering the severe erosion in large areas included as Grassland, this category could potentially be a large source. These emissions might be counteracted or even annulated by carbon sequestration in areas where vegetation is recovering from previous degradation (Magnússon et al. 2006).

The changes in living biomass of land converted to Grassland is estimated for Cropland and Other land and it´s subcategories. The C- stock changes in living biomass for the conversion of Cropland to Grassland is based on factors estimated with standard error of 20-30%. The uncertainty of the calculated emission removal is accordingly in the same range. The C-stock changes in living biomass in subcategories of Other land converted to Grassland is for the revegetation subcategories based on estimate of total C-stock changes in all categories and estimate of average proportion of vegetation in those changes being 10%. The uncertainty in C-stock changes in revegetation is estimated as ± 10%. The C-stock changes in living biomass of “Other land converted to Natural birch shrubland” is estimated by IFR in NFI and subjected to same uncertainty as other estimates of C-stock changes in living biomass in that inventory.

The emissions reported from drained Grassland soils are based on default EF from table 2.1 in 2013 wetland supplement (IPCC 2014) 95% confidence intervals ± 2.8 t CO_2-C ha^{-1} yr^{-1}, or approximately 50%.

The off-site CO_2 emission via waterborne losses from drained Grassland soils is calculated based on default EF from table 2.2 in 2013 wetland supplement (IPCC 2014) with range ± 50%.

Emission of CH_4 from drained Grassland includes emission from drained land and drainage ditches and is calculated according to EF's from table 2.3 and 2.4 in 2013 wetland supplement (IPCC 2014) the 95% confidence interval is ± 3.0 kg CH4 ha-1 yr-1 (approx. 200%) and ± 830 kg CH_4 ha^{-1} yr^{-1} (approx. 70%), for drained land and ditches respectively.

The emission of N_2O from drained soils of Grassland categories is estimated by applying EF from table 2.5 in 2013 wetland supplement (IPCC 2014) the 95% confidence interval is 4.6-14 kg CH4 ha^{-1} yr^{-1} (approx. ± 50%).

Applying the same EF's for all drained land also involves many uncertainties. The emissions vary according to age of drainage, e.g. due to changes in the quality of the soil organic matter, it can also vary according to depth of the drained soil and type of soil drained among other factors. This uncertainty has not been evaluated.

6.6.9 Recalculations

No recalculations are done for this category in this submission. The new emission factors of 2013 Supplement (IPCC 2014) made in last year's submission and new emission components are in this also applied in this submission.

6.6.10 Planned improvements regarding Grassland

The total emission related to drainage of Grassland soils is a principal component in the net emission reported for the land use category. The total emission reported from drained soils of Grassland is in this submission 9,985.51 kt CO_2 eq. making that component the far largest identified anthropogenic source of GHG in Iceland. The estimation of this component is still based on T1 methodology and basically no disaggregation of the drainage area. Improvements in emission estimates for the grassland and other categories to adopt higher tiers is planned in next year's.

Improvements in ascertaining the extent of drained organic soils in total and within different land use categories and soil types has been a priority in the IGLUD data sampling. In summer 2011 a project, aiming at improving the geographical identification of drained organic soils, was initiated within the IGLUD. This project involved testing of plant index and soil characters as proxies to evaluate the effectiveness of drainage. The data sampling in this project was finished in 2014, analyses of the data is pending. The results of this project are expected to improve the area estimate of drained land and of effectiveness of drainage.

A pilot study on emission from different types of wetland soils indicate some difference in emissions between wetland soil types. It is important to continue research on variability of emissions between and within different wetland soil types.

Data for dividing the drained area according to soil type drained has been collected for a part of the country. Continuation of that sampling is planned and the results used to subdivide the drained area into soil types.

Age of drainage can be an important component affecting the emissions from the drained soil, the effectiveness of the drainage can also be assumed to depend on drainage age. Therefore geographical identification of drained areas of different age is planned in near future.

The T1 emission factors for drained organic soils of Grassland have be revised since last submission. The T1 EF for C-stock changes of drained soils is comparable to new data from in country studies (Guðmundsson and Óskarsson 2014). Considering the amount of the emission from this category it is important to move to higher tier levels in general and define relevant disaggregation to land use categories and management regimes. That disaggregation is one of the main objectives of the IGLUD project and it is expected that analyses of the data already sampled will enable some steps in that direction.

In this submission a new subcategory is added i.e. "Other land converted to Natural birch shrubland" Otherwise the subdivision remains unchanged. The largest subcategory of Grassland, "Other Grassland", is still reported as one unit. Severely degraded soils are widespread in Iceland as a result of extensive erosion over a long period of time. Changes in mineral soil carbon stocks of degrading land is potentially large source of carbon emissions. The importance of this source must be emphasized since Icelandic mineral grassland soils are almost always Andosols with high carbon content (Arnalds and Óskarsson 2009). Subdivision of that category according to management, vegetation coverage and soil erosion is pending. The processing of the IGLUD field data is expected to provide information connecting degradation severity, grazing intensity and C-stocks. This data is also expected to enable relative division of area degradation and grazing intensity categories. Including areas where vegetation is improving and degradation decreasing (Magnússon et al. 2006). Processing of the IGLUD dataset is expected to give results in the next few years.

Improvements in both the sequestration rate estimates and area recording for revegetation, aim at establishing a transparent, verifiable inventory of carbon stock changes accountable according to the Kyoto Protocol. Three main improvements are planned and currently being carried out in part. The first is the improvement in activity recording, including both location (area) and description of activities and management. This is already being actively implemented and all data will be in acceptable form beginning in 2012. Data on older activities started after 1990 are currently under revision and are planned to be finished next years. Mapping of all activities since 1990 is verified by visiting points within the 1×1 km inventory grid. Recording of activities initiated before 1990 is also on-going. The second improvement is pre-activity sampling to establish a zero-activity baseline for future comparisons of SOC. This has been implemented for all new areas established in 2010 and later (Thorsson 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 confirm that areas registered as subjected 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 for revegetation, subdivided according to management regime, regions and age.

6.7 Wetland

Wetland is the third largest land use category identified by present land use mapping as described above. The total area of the Wetland category is reported as 619.37 kha. Wetlands include lakes and rivers as unmanaged land and reservoirs and intact mires and fens as managed land. The Mires and fens are included in the rangeland grazed by livestock and are grazed to some extent and accordingly included as managed land. The total area of wetland has decreased since 1990 from 642.26 kha or by 22.89 kha as new drainages exceeds land impounded by hydropower reservoirs. The net emission from the wetland category is reported as 1026.70 kt CO_2 eq.

In submissions previous to the year 2015 only emission from hydropower reservoirs were reported and biomass burning when occurring. In this year's and last year's submission emission is reported for following land use categories; "Flooded land remaining Flooded land- Mires converted to reservoirs", "Other wetlands remaining Other wetlands- Lakes and rivers converted to reservoirs", "Other wetlands remaining Other wetlands- intact mires", "Grassland converted to flooded land- Medium SOC to reservoirs", "Other land converted to flooded land- Low SOC to reservoirs", "Grassland converted to other wetlands- Refilled lakes and ponds" and "Grassland converted to other wetlands- Rewetted wetland soils".

6.7.1 Wetland remaining Wetland

The subdivision of Wetland remaining Wetland is described below. Contrary to other land use categories, except "Other land" this category contains land defined as unmanaged, i.e. Lakes and rivers which are according to AFOLU Guidelines included as unmanaged land. It can be argued that some lakes and rivers should be included as managed land as they are impacted in the sense that their emission of GHG is affected. Examples of potential impacts on lakes and rivers are urban, agricultural and industrial inputs of nutrients and organic matters. Channeling of rivers and other alteration of their paths could also potentially affect their GHG profile. Although there is no attempt made to separate potentially managed lakes and rivers from unmanaged, except the lakes used as reservoirs. For the category wetland remaining Wetland four subcategories are reported i.e. "Mires converted to reservoirs", "Lakes and rivers", "Lakes and rivers converted to reservoirs", and "Intact mires". The first "Mires converted to reservoirs" is reported as subcategory under "4.D.1.2 – Flooded land remaining Flooded land" although the land was not flooded before it was inundated by the reservoir. The other categories are reported under "4.D.1.3- Other Wetland remaining Other Wetland"

6.7.1.1 Mires converted to reservoirs

In submissions previous to 2015 this category was reported as "Grassland converted to Wetland- High SOC". The land included is defined as.

Land with high soil organic carbon content (High SOC), or higher than 50 kg C m-2. This category includes land with organic soil or complexes of peatland and upland soils. This land is classified as land converted to Wetland or as changes between wetland subcategories. The high SOC soils are in most cases organic soils of mires and fens or wetlands previously converted to Grassland or Cropland through drainage.

The total area of this category reported is 0.99 kha as in last year's submission. The area estimate is based on reservoir mapping and available data on inundated land.

6.7.1.2 Lakes and rivers

The area estimation of this category is described in chapter 6.7.2.

6.7.1.3 Lakes and rivers converted to reservoirs

This category represents the area of reservoirs previously covered by lakes or rivers. Lakes turned in to reservoirs by building a dam in their outlet without changing the water level are included here.

6.7.1.4 Intact mires

In submissions previous to 2015 this land was reported as "Other Wetlands" and no emissions reported as classified as unmanaged. In the new 2013 wetland supplement (IPCC 2014) previously unavailable guidelines are provided for estimation of emission from undrained wetlands. The decision to classify intact mires as unmanaged land had no effects on reported emissions as no T1 or higher tier methodology was available. With the available methodology for emission estimate provided by the 2013 wetland supplement (IPCC 2014) the classification of intact mires as unmanaged land was revised and the whole category included as managed land based on inclusion under land used for livestock grazing.

6.7.2 Land converted to Wetland

Four categories of land converted to wetland are identified. Two are tracked to the flooding of land by reservoirs i.e. “Grassland converted to flooded land- Medium SOC to reservoirs”, and “Other land converted to flooded land- Low SOC to reservoirs”. The remaining two are results of wetland restoration activity i.e. “Grassland converted to other wetlands- Refilled lakes and ponds”, and “Grassland converted to other wetlands- Rewetted wetland soils”.

6.7.2.1 Grassland converted to flooded land

This category contains inundated land of reservoirs with medium SOC content defined as:

> Grassland with medium soil organic content (Medium SOC). SOC 5-50 kg C m-2. This land includes most grassland, cropland and forestland soils except the drained wetland soils.

The total area of this category reported is 7.80 kha as in last year’s submission. The area estimate is based on reservoir mapping and available data on inundated land.

6.7.2.2 Other land converted to flooded land

This category contains inundated land of reservoirs with low SOC content defined as:

> Other land with low soil organic content (Low SOC). SOC less than 5 kg C m-2. This category includes land with barren soils or sparsely vegetated areas previously categorized under “Other land”.

The total area of this category reported is 18.90 kha as in last year’s submission. The area estimate is based on reservoir mapping and available data on inundated land.

6.7.2.3 Grassland converted to other wetland

This category contains all land turned to wetland through wetland restoration activities. This category is reported for the first time in this year’s submission. Most wetland restorations in Iceland hitherto have been to restore habitats rather than as act of greenhouse gas mitigation. In some cases the driver has been to get rid of unnecessary ditches even acting as traps for livestock. This category is divided to two subcategories depending on the end result of the conversion, i.e. “Refilled lakes and ponds”, which included in the map layer “Lakes and rivers”, and “Rewetted wetland soils”, which are included under map layer “Other wetlands”. The area reported for these categories is 0.12 kha and 0.50 kha for “Refilled lakes and ponds”, and “Rewetted wetland soils” respectively.

6.7.3 Carbon stock changes

The CO_2 removal due to carbon stock changes in category “Other wetlands remaining Other wetlands” is recognized as key category of level in 2014.

6.7.3.1 Carbon stock changes in living biomass and dead organic matter

No changes of C-stocks in living biomass or dead organic matter are reported. For the land converted to reservoirs changes in living biomass and dead organic matter are included in aggregate number reported as changes in C-stocks of soils. For the subcategories of “Grassland converted to other wetlands” the changes are not estimated as no data is available.

6.7.3.2 Carbon stock changes in soils

CO_2 emission from reservoirs is estimated for the three subcategories: “Mires converted to reservoir”, Medium SOC to reservoirs”, and “Low SOC to reservoirs”. In the CRF tables this emission is reported as aggregate numbers under carbon stock changes of organic and mineral soils.

The CO_2 emissions from flooded land are estimated, either on the 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). For the three new reservoirs established 2009 and one established 2007 new reservoir specific emission factors were calculated according to (Óskarsson and Guðmundsson 2008) from the estimated amount of inundated carbon. The inundated carbon of these reservoirs was estimated by (Óskarsson and Guðmundsson 2001) and (Óskarsson and Gudmundsson in prep.). Reservoir classification is based on information, from the hydro-power companies using relevant reservoir, on area and type of land flooded.

The CO_2 emission estimates of reservoirs are then converted to C-stock changes of soils and reported as such in CRF tables.

No changes in C-stocks of soils or other pools is estimated for the category “Refilled lakes and ponds”.

The changes in soils of the categories “Intact mires”, and “Rewetted wetland soils” are estimated according to T1 applying equation 3.4 in 2013 wetland supplement (IPCC 2014). The total removal reported is 712.31 kt CO_2 and 1.00 kt CO_2 respectively.

6.7.4 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

Included in this category is off-site CO_2 emission and CH_4 emission from wet organic soils.

6.7.4.1 Off-site CO_2 emission via waterborne losses from wetland soils

Off-site CO_2 emissions via waterborne losses form wet organic soils is reported for four wetland subcategories i.e. “Mires converted to reservoirs”, “Intact mires”, of Wetland remaining Wetland, and “Refilled lakes and ponds”, and “Rewetted wetland soils”, of land converted to Wetland. In all cases the emission is estimated according to T1 applying equation 3.5. in 2013 wetland supplement (IPCC 2014). The reported emission is 0.29 kt CO_2, 103.61 kt CO_2, 0.03 kt CO_2, and 0.15 kt CO_2 for these categories in the above order.

6.7.4.2 CH_4 emission and removals from wetlands

The CH_4 emissions from reservoirs is estimated for reservoirs as in previous submissions. Emissions of CH_4 from reservoirs were estimated applying a comparative method as for CO_2 emissions using either reservoir classification or a reservoir specific emission factor (Óskarsson and Guðmundsson, 2008). In cases where information was available the emissions were calculated from inundated carbon. Estimated CH_4 emission from reservoirs is 0.41 kt CH_4 (10.15 kt CO_2 eq).

In this year’s submission CH_4 emission from wet soils of three categories i.e. “Intact mires”, “Refilled lakes and ponds”, and “Rewetted organic soils”, is reported. The emission of CH4 for these categories is estimated according to T1 applying equation 3.8 in 2013 wetland supplement (IPCC 2014). The reported emission is 64.52, 0.02, and 0.09 kt CH_4 for “Intact mires”, “Refilled lakes and ponds”, and “Rewetted organic soils” respectively. This is equivalent to 1,613.00, 0.53, and 2.27 kt CO_2 eq, in the same order.

6.7.5 Other emissions

6.7.5.1 N_2O emission from wetland soils

Emission of N_2O from reservoirs is considered as not occurring. Zero emissions were measured in a recent Icelandic study on which the emission estimate of CO_2 and CH_4 for reservoirs is based (Óskarsson and Guðmundsson, 2008).

The T1 approach of 2013 wetland supplement (IPCC 2014) emission of N_2O is considered negligible for rewetted soils and the same is assumed here to apply for intact mires.

6.7.6 Biomass burning

Biomass burning on Wetland is reported. All subcategories are reported as aggregate. Only wildfires are included in the present estimate. The methodology for estimating the biomass burned and the consequent emissions is explained in chapter 6.13. The area of Wetland burned in the inventory year in wildfires is estimated from available maps of the burned area and overlays of the IGLUD land use map as 8.30 ha. The emission caused by these fires is estimated as 0.20 Mg CH_4 plus 0.02 Mg N_2O. This emission is equivalent to total 11.64 Mg CO_2.

6.7.7 Emission factors

Reservoir specific emission factors are available for one reservoir classified as High SOC, three reservoirs classified as Medium SOC and six classified as Low SOC. For those reservoirs, where specific emission factors or data to estimate them are not available, the average of emission factors for the relevant category is applied for the reservoir or part of the flooded land if information on different SOC content of the area flooded is available (Table 6.13).

Reservoirs emission factors include diffusion from surface and degassing through spillway for both CO_2 and CH_4 and also bubble emission for the latter. The emission factors of High SOC are applied for the land use category “Mires converted to reservoirs”

Selection of emission factors for other land use categories than those included as flooded land is described below.

The CO_2 emissions from C-stock changes in soil of “Intact mires” and “Rewetted wetland soils”, is calculated according to T1 using, EF= -0.55 t CO_2-C ha^{-1} yr^{-1}, as for “Boreal nutrient rich soils” from table 3.1 in 2013 wetland supplement (IPCC 2014).

Table 6.13 Emission factors applied to estimate emissions from flooded land based on (Óskarsson and Guðmundsson 2001; Óskarsson and Guðmundsson 2008; Óskarsson and Gudmundsson in prep.).

Emission factors for reservoirs in Iceland	Emission factor [kg GHG ha^{-1} d^{-1}]			
Reservoir category	**CO_2 ice free**	**CO_2 ice cover**	**CH_4 ice free**	**CH_4 ice cover**
Low SOC				
Reservoir specific	0.23	0	0.0092	0
Reservoir specific	0.106	0	0.0042	0
Reservoir specific	0.076	0	0.003	0
Reservoir specific	0	0	0	0
Reservoir specific	0.083	0	0.0033	0
Reservoir specific	0.392	0	0.0157	0
Reservoir specific	0.2472	0	0.0099	0
Average	0.162	0	0.0065	0
Medium SOC				
Reservoir specific	4.67	0	0.187	0.004
Reservoir specific	0.902	0	0.036	0.0008
Reservoir specific	0.770	0	0.031	0.0007
Average	2.114	0	0.085	0.0018
High SOC				
Reservoir specific	12.9	0	0.524	0.012

The off-site CO_2 emission via waterborne losses from “Mires converted to reservoirs”, “Intact mires”, “Refilled lakes and ponds”, and “Rewetted wetland soils” is calculated according to T1 using EF = 0.08 t CO_2-C $ha^{-1}yr^{-1}$ from table 3.2 in 2013 wetland supplement (IPCC 2014).

The CH_4 emission and removal from “Intact mires”, “Refilled lakes and ponds”, and “Rewetted wetland soils” is calculated according to T1 applying EF= 137 kg CH_4-C ha^{-1} yr^{-1} from table 3.3 in 2013 wetland supplement (IPCC 2014). The EF’s for CH_4 from reservoirs are described above.

6.7.8 Uncertainties and QA/QC

The area estimate of the category “Intact mires” is based on the IGLUD land use map plus adjustments based on other information. Both the hierarchy of the map layers used and the quality of the original mapping can affect the accuracy of the area estimate of the IGLUD land use map. The overall accuracy of the IFD mapping is estimated 76 %, and part of the area mapped is excluded by higher ranked map layers. Therefore potentially the uncertainty of the area estimate of intact mires is large. The higher ranked map layers only exclude some areas and the accuracy control of IFD mapping also revealed underestimate of wetland classes.

The main uncertainty is associated with the reservoirs 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 a reservoir flooded 15 years earlier. The information on area of flooded land is not complete and some reservoirs are still unaccounted for. This applies to reservoirs in all reported categories. The same number of days for the ice-free period is applied for all reservoirs and all years. This is a source of error in the estimate. The uncertainty of the emission factors applied is estimated as 50%, and of area as 20%.

6.7.9 Recalculations

No recalculations are done for this category in this submission. The new emission factors of 2013 Supplement (IPCC 2014) made in last year's submission and new emission components are in this also applied in this submission.

6.7.10 Planned improvements regarding Wetland

Improvements regarding information on reservoir area and type of land flooded are planned. Effort will be made to map existing reservoirs but many of them are not included in the present inventory. Introduction of reservoir specific emission factors for more reservoirs is to be expected as information on land flooded is improved. Recording and compiling information on the ice-free period for individual reservoirs or regions is planned. Information on how emission factors change with the age of reservoirs is needed but no plans have been made at present to carry out this research.

The development of IGLUD in the coming years is expected to improve area estimates for wetland and its subcategories.

Mapping of wetland restoration activity is available in printed form but digitation of those maps is pending and will be included in next compilation of IGLUD land use map.

6.8 Settlements

The area of Settlement reported is revised. In submissions previous to 2015 a buffer zone was applied on all roads representing the area administratively designated to the road. The width of the buffer zone was revised in last submission to better reflect the actual land cover of the roads rather than administrative boundaries of the roads. Time series of the basal area of all buildings in towns and villages is applied as index on changes in total area of towns and villages on one hand and all other area included as Settlements on the other hand. It is assumed that both the ratios between basal area and total area of towns and villages and basal area and other settlements have been stable since 1990. Two time series of land converted to Settlements area available, i.e. "Forest land converted to Settlements" and "Natural birch shrubland converted to Settlements". These time series explain only a small portion of the increase in Settlement area. The remaining increase in area of Settlements is for the time being assumed to be converted from the Grassland subcategory "Other grassland" and reported as such. No maps are available for these time series. No subdivision of this category is reported but the estimated total area consist of two components represented in IGLUD land use map i.e. towns and villages 15.18 kha and other settlements 12.42 kha in the inventory year. The total area reported in this submission is 27.61 kha.

6.8.1 Settlement remaining Settlement

The area of Settlement remaining Settlement is set as the total area of Settlement the year before minus the recorded conversions from Forest and birch shrubland.

6.8.2 Land converted to Settlement

6.8.2.1 Forest land converted to Settlement

The area of this category is estimated by IFR as deforestation activities. All permanent deforestation reported to the Icelandic Forest service has been converted to settlements. It is assumed that all deforestation is included in Settlements maps, although comparison of maps have not been carried out.

6.8.2.2 Grassland converted to settlements.

Time series for Natural birch shrubland converted to settlements are available but no maps have been included for this conversion. The remaining area of annual increase in Settlement extent is assumed being converted from category “Other grassland”.

6.8.3 Carbon stock changes

Carbon stock changes are estimated for three categories of “Land converted to Settlements” i.e. “Forest land converted to Settlement” 0.05 kha, “Natural birch shrubland converted to Settlement” is not reported for the year 2014 and “All other Grassland subcategories converted to Settlement”, 0.14 kha.

6.8.3.1 Carbon stock changes in living biomass

The carbon stock changes in above ground biomass of Grassland converted to Settlement based on average carbon stock of IGLUD field sampling points on land below 200 m a.s.l. categorized to the Grassland category, and the assumption that 70% of the original vegetation cover is removed in the conversion. The estimation of ratio of vegetation cover removed is based on correspondence with planning authorities of several towns in Iceland. The changes of above ground carbon stock is reported as aggregate number of changes in living biomass.

The carbon stock changes reported are -1.25 kt C or 4.59 kt CO_2 emitted from the category “all other grassland converted to Settlement”. No changes in living biomass of “Forest land converted to Settlement” is reported as no new areas were converted the inventory year.

6.8.3.2 Carbon stock changes in dead organic matter

The changes in C-stock in dead organic matter in “All other Grassland subcategories converted to Settlements” are included under changes in living biomass of the categories.

6.8.3.3 Carbon stock changes in soils

Carbon stock changes in soil are only reported for “Forest land converted to Settlement”. The methodology for the estimate of changes in soil carbon stock is described in chapter 0 above. The total changes in stock reported are -0.03 kt C causing emission of 0.11 kt CO_2.

6.8.4 Emissions and removals from drainage and rewetting and other management of organic and mineral soils

No emission from this component is reported for Settlements in this submission. There is no data on extent of organic soils or drainage within the Settlement category.

6.8.5 Other emissions

No other sinks or sources of removal/emission are recognized for the Settlement category.

6.8.6 Biomass burning

No biomass burning is recorded for this category.

6.8.7 Emission factors

The changes in living biomass of Grassland converted to Settlement is calculated according T2 applying EF= 8.88 t C ha-1 based on estimate of Grassland stock and ratio of vegetation cover removed in conversion. The calculation of EF for changes of C-stock in soil of “Forest land converted to Settlement is described in chapter 0. The EF= 5.94 for “Natural birch shrubland converted to Settlements” is calculated from NFI estimate of C stock in living biomass of Natural birch shrubland.

6.8.8 Uncertainties and QA/QC

No quantitative estimate on uncertainty of the map layers is currently available.

6.8.9 Recalculations

No recalculations are done for this category in this submission.

6.8.10 Planned improvements regarding Settlement

Overlay comparison of maps of “Forest converted to Settlement” and the IS 50 map layer for Settlement for improving estimates of both categories is planned. To refine the categorization of land converted to Settlements comparison of extent of some selected towns at different time to other land cover information is planned.

6.9 Other land

No changes in carbon stocks of “Other land remaining other land” are reported in accordance with AFOLU Guidelines. Conversion of land into the category “Other land” is not recorded. Direct human induced conversion in not known to occur. Potential processes capable of converting land to other land are, however, recognized. Among these is soil erosion, floods in glacial and other rivers, changes in river pathways and volcanic eruptions.

The area reported for “Other land” is the area estimated in IGLUD. Other land in IGLUD is recognized as the area of the map layers included in the category remaining after the compilation process. The map layers included in the category “Other land” are areas with vegetation cover < 20% or covered with mosses.

6.9.1.1 Biomass burning

No biomass burning on “Other land” is recorded for the inventory year.

6.10 The emission of N_2O from N mineralization and immobilization

Refers to mineralization/immobilization of N associated with loss of C in mineral soils and can’t be included in emissions from organic soils. For calculation of N mineralized or immobilized equation 11.8 in AFOLU guidelines should be applied. The equation request losses of C in mineral soil to be estimated.

Forest land: No losses of C from mineral soils under Forest land is reported. C –stock of several Forest land categories is to the contrary considered increasing (see above). The emission of N_2O from N mineralization/immobilization is as such not estimated in Forest land remaining Forest land or Land converted to Forest land. Components to consider could be ploughing as part of the planting, thinning of older forests. Until this is estimated the notation key is NE for those categories where C-stock of mineral soil is not reported as increasing.

Cropland: Changes in C stock of mineral soil of Cropland remaining Cropland are not estimated and likewise the associated N_2O emission should be noted as NE. Land converted to Cropland is reported as aggregate number of Grassland converted to Cropland and C-stock of mineral soils is reported as increasing. The reporting of this emission is under 3.D. 1.5 in the Agricultural sector and not requested in LULUCF CRF part.

Grassland: For the category Grassland remaining Grassland changes in C-stock of mineral soils is only reported for the subcategory “Natural birch shrubland recently expanded to Other Grassland” where increase is reported. The category “Land converted to Grassland” the overall changes in C-stock of mineral soils is an increase, owing to conversion of “Other land to Grassland” through revegetation and expansion of “Natural birch shrubland”. The category “Cropland converted to Grassland” involves loss of C of mineral soils, accordingly the N_2O emission associated with that loss should be estimated according to AFOLU equation 11.8. The N_2O emissions reported from N mineralization/immobilization for the Grassland category are in this submission the N_2O emissions from drained wetland soils as reporting those under 4(II) is not an included option in CRF-reporter (version 5.12.1) as for Forest land, in spite of EF available from table 2.5 in 2013 wetland supplement (IPCC 2014). Where to include that emission in the CRF reporting table is accordingly not obvious.

Settlement: Area estimated in Emissions and removals from N mineralization/immobilization is the area estimated as remaining vegetated. The mineralization of N of in those areas is not estimated. In the area where the vegetation “and soil” is removed all soil C stock could be estimated as lost and the N mineralized (according to Eq 11.8. AFOLU). No information are available on removed soils or its destiny.

6.11 Indirect N_2O emissions from managed soils

This components includes emissions related to “Atmospheric deposition” and “Nitrogen leaching and run-off”. The component matches completely to 3.D.2 under Agricultural sector and is reported there.

6.12 Biomass burning

Accounting for biomass burning in all land use categories is addressed commonly in this section. The Icelandic Institute of Natural History has in cooperation with regional Natural History Institutes started recently to record incidences of biomass burning categorized as wildfire. This recording includes mapping the area burned. These maps are used to classify the burned area according to IGLUD land use map. Based on this classification, biomass burning is in this submission reported for the land use categories; “Forest land remaining Forest land”, Grassland remaining Grassland, and “Land converted to Grassland”. Biomass estimate is based on biomass sampling in the IGLUD project from the relevant land use category as identified in land use map. Emission of CH_4 and N_2O is calculated on according to equation 2.27 from AFULU guidelines (IPCC 2006).

$$L_{fire} = A * M_B * C_f * G_{ef} * 10^{-3}$$

Equation 1. Equation 2.27 from AFULU guidelines (IPCC 2006): L_{fire}=tons of GHG emitted, A= area burned [ha], MB=mass of fuel available [tons/ha], C_f =combustion factor, G_{ef}= emission factor [g GHG/kg DM]

The area burned each year is according to the above described mapping and classification of the burned area to IGLUD land use mapping units. Available biomass is for each land use category is calculated from the average of IGLUD biomass samples of each mapping category weighted against the area of the relevant mapping category. The value of the C_f constant is assumed to be 0.5 for all land use categories as no applicable constants are found in table 2.6 of AFOLU guidelines. G_{ef}= is as default values of Savanna and Grassland in table 2.5 in AFOLU guidelines. No emission of CO_2 is reported as biomass is assumed to reach its pre-burning values within few years from the burning. Available biomass range from 18.7 ±3.8 to 29.9 ±1.9 tons organic matter Dw ha^{-1} the standard error for individual categories from 6-29%

Controlled burning of forest land is considered as not occurring. Controlled burning on grazing land near the farm was common practice in sheep farming in the past. 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 the local police authority is needed for safety and for birdlife protection purposes. Controlled burning of all land use categories is reported as not estimated, except for forest land where it is reported as not occurring.

6.12.1 Planned improvements regarding biomass burning

Recording of the area where controlled biomass burning is licensed is still not practiced. General awareness on the risk of controlled burning getting out of hand is presently rising and concerns are frequently expressed by municipal fire departments regarding this matter. Prohibition or stricter licenses on controlled burning can be expected in near future. This development might involve better recordkeeping on biomass burning.

6.13 Other

6.13.1 Harvested Wood products

Emissions/removals related to harvested wood products are not estimated in this year's submission. Including the HWP estimate in next year submission is planned.

6.13.2 N_2O from Grassland drained soils

The N_2O emission form drained Grassland soils is reported her because the CRF structure does not allow that emission reported under Grassland "4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils". This emission is discussed in chapter 6.6.5.1.

6.14 Key factors of no target within LULUCF

Three categories within LULUCF with land as source but no target land use category pinpointed are recognized as key categories of level 2014, i.e. CH_4 and CO_2 classified as "Emissions and removals from drainage and rewetting and other management of organic and mineral soils", N_2O classified as "Direct N_2O Emissions from N Mineralization/Immobilization". The emissions of CH_4 and N_2O of these categories are also recognized as key factors in trend 2014.

7 Waste (CRF sector 5)

7.1 Overview

This sector includes emissions from solid waste disposal on land (5.A), biological treatment of solid waste (5B), waste incineration and open burning of waste (5C), wastewater treatment and discharge (5D), and other waste treatment (5E).

For most of the 20th century solid waste disposal sites (SWDS) in Iceland were numerous, small, and located close to the locations of waste generation. Therefore waste did not have to be transported long distances for disposal. In Reykjavik, waste was landfilled in smaller SWDS before 1967. That year the waste disposal site in Gufunes was set into operation and most of the waste from the capital´s population was landfilled there.

Until the 1970s, the most common form of waste management outside the capital area was open burning of waste. In some communities, waste burning was complemented with landfills for bulky waste and ash. The existing landfill sites did not have to meet specific requirements regarding location, management, and aftercare before 1990 and were often just holes in the ground. Some communities also disposed of their waste by dropping it into the sea. Akureyri and Selfoss, two of the biggest municipalities outside the capital area, opened municipal SWDS in the 1970s and 1980s.

Before 1990, three waste incinerators were opened in Keflavík, Húsavík and Ísafjörður. In total they burned around 15,000 tonnes of waste annually. They operated at low or varying temperatures and the energy produced was not utilised. Proper waste incineration in Iceland started in 1993 with the commissioning of the incineration plant in Vestmannaeyjar, an archipelago to the south of Iceland. Six more incineration plants were commissioned until 2006. In the beginning of 2012, a total of four waste incinerators were still operating. Some of the incineration plants recovered the burning energy and used it for either public or commercial heat production. By the end of 2012 all incineration plants except one (Kalka in Reykjanesbær) had closed; therefore emissions from the single plant are reported for 2013. Open burning of waste was banned in 1999 and is non-existent today. The last place to burn waste openly was the island of Grímsey which stopped doing so during 2010.

Recycling and biological treatment of waste started on a larger scale in the beginning of the 1990s. Their share of total waste management has increased rapidly since then.

Reliable data about waste composition does not exist until recent years. In 1991 the waste management company Sorpa ltd. started serving the capital area and has gathered data on waste composition of landfilled waste since 1999. For the last few years the waste sector has had to report data for amount of waste landfilled, as well as amount incinerated, and recycled. Also, the Sorpa ltd. reports data on waste composition each year.

The special treatment of hazardous waste did not start until the 1990s, i.e. hazardous waste was landfilled or burned like non-hazardous waste. Special treatment started with the reusing of waste oil as energy source. In 1996 the Hazardous waste committee (*Spilliefnanefnd*) was founded and started a collection scheme for hazardous waste. The collection scheme included fees on hazardous substances that were refunded if the substances were delivered to hazardous waste collection sites. Hazardous substances collected include oil products, organic solvents, halogenated compounds, isocyanates, oil-based paints, printer ink, batteries, car batteries, preservatives, refrigerants, and more. After collection, these substances were destroyed, recycled, or exported for further treatment. The Hazardous waste committee was succeeded by the Icelandic recycling fund in late 2002. In 2014, 4911 tonnes of hazardous waste were landfilled, 538 tonnes were incinerated and 1555 tonnes were recycled.

Clinical waste has been incinerated in incinerators either at hospitals or at waste incineration plants. In 2014, a total of 199 tonnes of clinical waste were incinerated in Kalka, the only incineration plant In Iceland

The trend has been toward managed SWDS as municipalities have increasingly cooperated with each other on running waste collection schemes and operating joint landfill sites. This has resulted in larger SWDS and enabled the shutdown of a number of small sites. In 2014, 82% of all landfilled waste was disposed of in managed SWDS. Recycling of waste has increased due to efforts made by the government, local municipalities, recovery companies and others. Composting started in the mid-1990s and has been gradually increasing since then. Over recent years, composting has become a publically known waste treatment option and a number of composting facilities have been commissioned.

In 2014, about 38% of all waste generated was landfilled, 54% recycled or recovered, 3% incinerated, and 5% composted.

Wastewater treatment in Iceland consists mainly of basic treatment with subsequent discharge into the sea. The majority of the Icelandic population, approximately 90%, lives by the coast. The coast is a non-problem area with regard to eutrophication, as Iceland is surrounded by an open sea with strong currents and frequent storms. This leads to effective mixing. About 64% of the population lives in the greater Reykjavík area and most of the larger industries are located within the area, mostly by the coast. In recent years, more advanced wastewater treatments have been commissioned in some smaller municipalities. Their share of total wastewater treatment, however, does not exceed 2%.

Aggregated greenhouse gas emissions from the waste sector amounted to 255 kt CO_2 equivalents in 2014, which is tantamount to a 52% increase since 1990. Between 2013 and 2014, emissions from the waste sector increased by 11.6% mainly due to an increase of SWD emissions. Around 91% of all emissions from the waste sector (2014) are caused by solid waste disposal, 1.5% by composting, 3.1% by waste incineration without energy recovery, and 4.4% by wastewater treatment. The development of greenhouse gas emissions from the waste sector is shown in Figure 7.1.

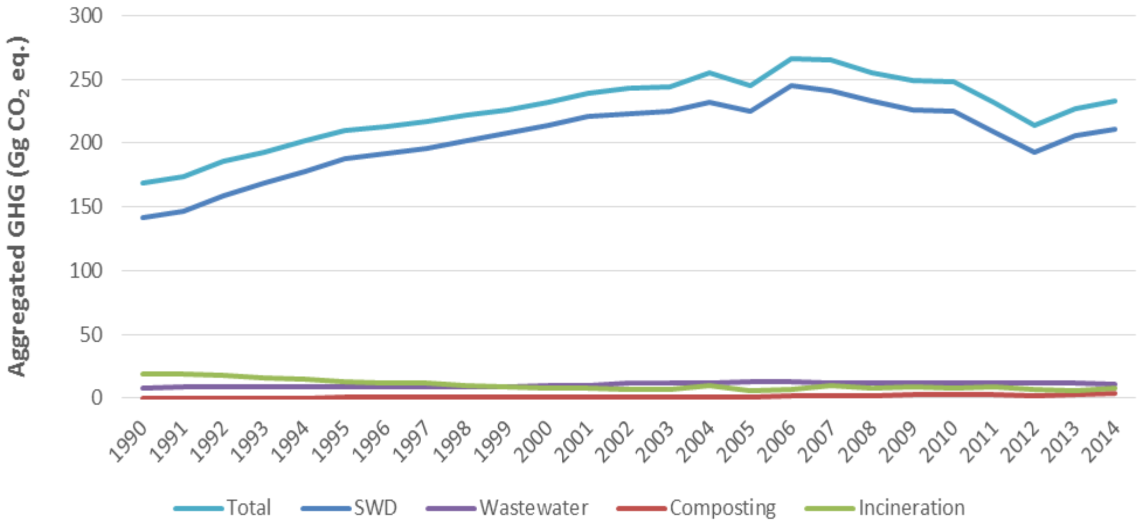

Figure 7.1 Greenhouse gas emissions from the waste sector in Iceland the year 2014 in kt CO_2 eq. CO_2, CH_4, and N_2O emissions were aggregated by calculating CO_2 equivalents for CH_4 and N_2O (factors 25 and 298, respectively).

7.1.1 Methodology

The calculation of greenhouse gas emissions from waste is based on the methodologies suggested by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 GL). Methodology for each greenhouse gas source category within the waste sector is described separately below.

7.1.2 Activity data

In recent years the data has been based on questionnaires sent to the waste industry, which returns them with weighted waste amounts landfilled, incinerated, composted, or recycled. There can be a time lag between reassessment of waste generation data and its publication and therefore, inconsistencies between older published data and newer data used in the GHG inventory. Three examples for these inconsistencies are the amount of timber burned in bonfires on New Year's Eve, the amount of landfilled manure, and waste from metal production. Until 2011 the amount of material burned annually in bonfires had been estimated to be up to 6 kt. Beginning with the year 2012 year the amount was calculated: first the material (mainly unpainted timber) that went into one of the country´s largest bonfires was weight and its mass correlated with the height and diameter of the timber pile. Then height and diameter for most of the country´s bonfires were used to calculate their weight. As a result the amount of timber burned in bonfires was estimated at 1,700 tonnes in 2014. The result was projected back in time using expert judgement.

Until the year 2011 the annual amount of landfilled manure was estimated at 10,000 tonnes. Closer inquiries revealed that the amounts actually landfilled were much smaller. The remaining amounts were so negligible that the waste category manure was suspended and allocated to the category sludge. Waste from metal production was not included because the amounts recorded by the EA are inconsistent between years. Estimation of waste from metal production started in 2002 and was assumed to be between 10 and 11 kt annually until 2007. Since 2008 data collection is more comprehensive and based on reports by the metal industry. Since then amounts are estimated to be in excess of 100 kt. Because of the data inconsistency and that the material is inert (with regard to CH_4 production) and recycled, it is left out of the data used to estimate waste generation before

1995. These are the main reasons that data reported here, deviates from data reported to, and published by, Statistics Iceland.

7.1.3 Key source analysis

The key source analysis performed for the 2016 submission revealed that in terms of total level and/or trend uncertainty the key sources in the waste sector are as follows:

Table 7.1 Key source categories for Waste (excluding LULUCF).

IPCC source category			Level 1990	Level 2014	Trend
Waste (CRF sector 5)					
5.A	Solid Waste Disposal	CH_4	✓	✓	✓

7.1.4 Completeness

Table 7.2 gives an overview of the IPCC source categories included in this chapter and presents the status of emission estimates from all greenhouse gas emission sources in the waste sector.

Table 7.2. Waste sector – completeness (E: estimated, NE: not estimated, IE: included elsewhere, NO: not occurring).

	Direct GHG			Indirect GHG		
Waste Categories	**CO_2**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**
Solid waste disposal on land (5. A)						
- **Managed (5.A.1)**	NE	E	NE	NE	NE	E
- **Unmanaged (5.A.2)**	NE	E	NE	NE	NE	E
- **Uncategorised (5.A.3)**	NE	E	NE	NE	NE	E
Biological treatment of solid waste (4.B)	NE	E	E	NE	NE	NE
Waste incineration and open burning of waste (5.C)						
- **Waste incineration (5.C.1)**	E	E	E	E[1]	E[1]	E[1]
- **Open burning (5.C.2)**	E	E	E	E[1]	E[1]	E[1]
Wastewater treatment and discharge (5.D)						
- **Domestic (5.D.1)**	NE	E	E	NE	NE	NE
- **Industrial (5.D.2)**	NE	IE[2]	IE[2]	NE	NE	NE
Other (5.E)	NO	NO	NO	NO	NO	NO

1: Data also submitted under CLRTAP; 2: included in 5D1

7.1.5 Source Specific QA/QC Procedures

The QC activities include general methods such as accuracy checks on data acquisition and calculations as well as the use of approved standardised procedures for emission calculations, estimating uncertainties, archiving information and reporting. Further information can be found in the QA/QC manual.

7.2 Solid Waste Disposal (CRF sector 5A)

7.2.1 Methodology

The methodology for calculating methane from solid waste disposal on land is according to the Tier 2 method of the 2006 IPCC Guideline and uses the First Order Decay method (FOD) for calculations. The method assumes that the degradable organic carbon (DOC) in waste decays slowly throughout the years or decades following its deposition thus producing methane and carbon dioxide emissions. The method was expanded to include additional waste categories.

7.2.2 Activity data

7.2.2.1 Waste generation

The Environment agency of Iceland (EA) has compiled data on total amounts of waste generated since 1995. This data is published by Statistics Iceland (Statistics Iceland, 2014). The data for the time period from 1995 to 2004 relies on assumptions and estimation and is less reliable than the data generated since 2005.

Waste generation before 1995 was estimated using gross domestic product (GDP) as surrogate data. Linear regression analysis for the time period from 1995-2007 resulted in a coefficient of determination of 0.54. A polynomial regression of the 2nd order had more explanation power (R^2 = 0.8) and predicted waste for GDPs closer to the reference period, i.e. from 1990 to 1994, more realistically (Figure 7.2). Therefore the polynomial regression was chosen. More recent data were not used because the economic crisis that began in 2008 had an immediate impact on GDP whereas the impact on MSW generation was delayed therefore reducing the correlation between the two. Information on GDP dates back to 1945 and is reported relative to the 2005 GDP. It was therefore used to estimate waste generation since 1950. The formula the regression analysis provided is:

$$\textbf{Waste amount generated (t)} = -22.045 * \text{GDP index}^2 + 7367 * \text{GDP index}$$

The waste amount generated was calculated for total waste and not separately for municipal and industrial waste as was done in Iceland´s 2011 and 2012 submissions to the UNFCCC. The reason behind this is that the existing data on waste amounts does not support this distinction. Waste amounts are reported to the EA as either mixed or separated waste. Though the questionnaires send to the waste industry contain the two categories mixed household and mixed production waste, the differentiation between the two on site is often neglected. Therefore they can be assumed to have similar content. The fact that all other household and production waste is reported in separated categories makes the use of the umbrella category industrial waste obsolete (more on this in Chapter 7.2.2).

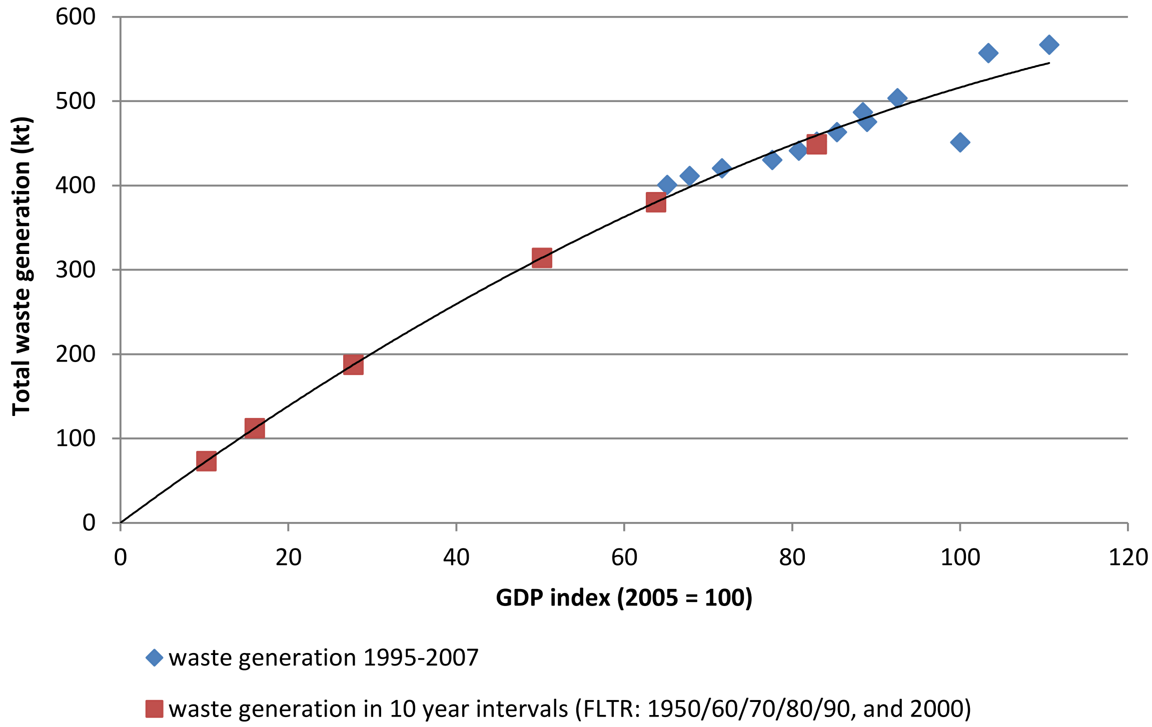

Figure 7.2 Waste generation from 1950-2007. Blue rhombuses denote waste generation between 1995 and 2007 and were used to calculate waste amounts before 1995, which are shown as red squares in 10 year intervals along the trend line.

7.2.2.2 Waste allocation

The data since 1995 described above, allocates fractions of waste generated to SWDS, incineration, recycling and composting. Recycling and composting started in 1995. For the time before 1995 the generated waste has to be allocated to either SWDS or incineration/open burning of waste. In a second step the waste landfilled has to be allocated to SWDS types and the waste incinerated to incineration forms. To this end population was used as surrogate data. It was determined that all waste in the capital area, i.e. Reykjavík plus surrounding municipalities, was landfilled since at least 1950 (expert judgement), whereas only 50% of the waste generated in the rest of the country was landfilled. The remaining 50% were burned in open pits. Calculated annual waste generation was multiplied with the respective population fractions. It is not improbable that more than half of the waste generated in the countryside was burned openly. Nevertheless, in order to not underestimate the emissions from SWDS this assumption was used until 1972. That year the SWDS in Akureyri opened and all waste generated in the town and, since 1990 in the neighbouring countryside, was landfilled there. In response to this the fraction of the population burning its waste was reduced accordingly, i.e. the 50% of waste that the population of Akureyri burned before the opening of the new landfill were allocated to SWDS. The same was done in response to the opening of another big SWDS in Selfoss in south Iceland in 1981. The waste management system fractions from 1950-2014 are shown in Figure 7.3.

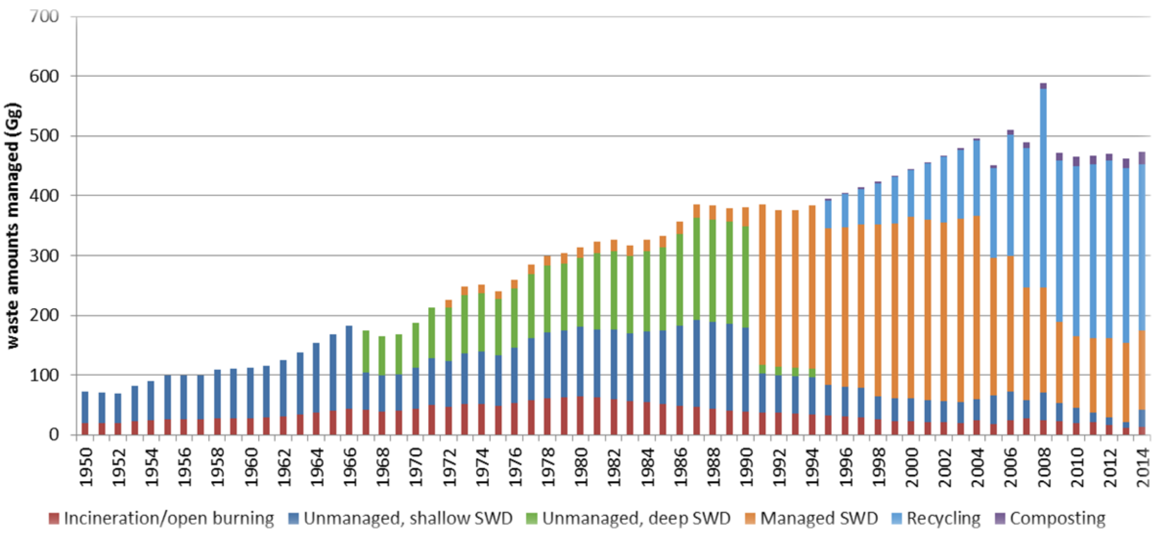

Figure 7.3 Waste amount and allocation to incineration/open burning, solid waste disposal, recycling and composting.

In accordance with the 2006 GL the amount of waste landfilled was allocated to one of three solid waste disposal site types:

Managed – anaerobic (from here on referred to as just “managed”)

Unmanaged – deep (>5 m waste, from here on sometimes referred to as just “deep”)

Unmanaged – shallow (<5 m waste, from here on sometimes referred to as just “shallow”)

From 1950 to 1966 all waste landfilled went to shallow sites. The fraction of total waste landfilled that went to shallow sites was reduced by the following events.

In 1967 the SWDS Gufunes classified as deep SWDS was commissioned to serve Reykjavík.

In 1972 the aforementioned SWDS in Akureyri was commissioned. Based on two landfill gas formation studies conducted there (Kamsma and Meyles, 2003; Júlíusson, 2011) it was classified as managed SWDS.

In 1981 the aforementioned SWDS site in Selfoss was commissioned and was classified as deep SWDS.

In 1991 Gufunes was closed down and in its place the SWDS Álfsnes was opened, now serving the capital and all surrounding municipalities. Álfsnes is the biggest SWDS in Iceland today and was classified as managed SWDS (thus reducing both shallow and deep SWDS fractions).

In 1995 a new SWDS in south Iceland was opened. It received the waste that before had gone to the SWDS Selfoss plus waste of surrounding municipalities. Based on 2006 GL criteria it was classified as managed SWDS (thus reducing both shallow and deep SWDS fractions)

In 1996 the SWDS Þernunes in eastern Iceland was opened. Based on 2006 GL criteria it was classified as managed SWDS.

In 1998 the SWDS Fíflholt in western Iceland was opened. It was classified as managed SWDS based on 2006 GL criteria and landfill gas measurements (Kamsma and Meyles, 2003; Júlíusson, 2011).

Until 2004 the fractions of waste landfilled allocated to the different SWDS types are based on surrogate data (population). From 2005 onwards actual waste amounts going to the five sites classified as managed as well as going to the remaining shallow sites have been recorded by the EA. The change in data origin explains the rise in fraction of waste landfilled going to shallow sites in 2005(Figure 7.4)i.e. shallow landfill sites receive a disproportionate amount of waste compared to the share of population they are serving.

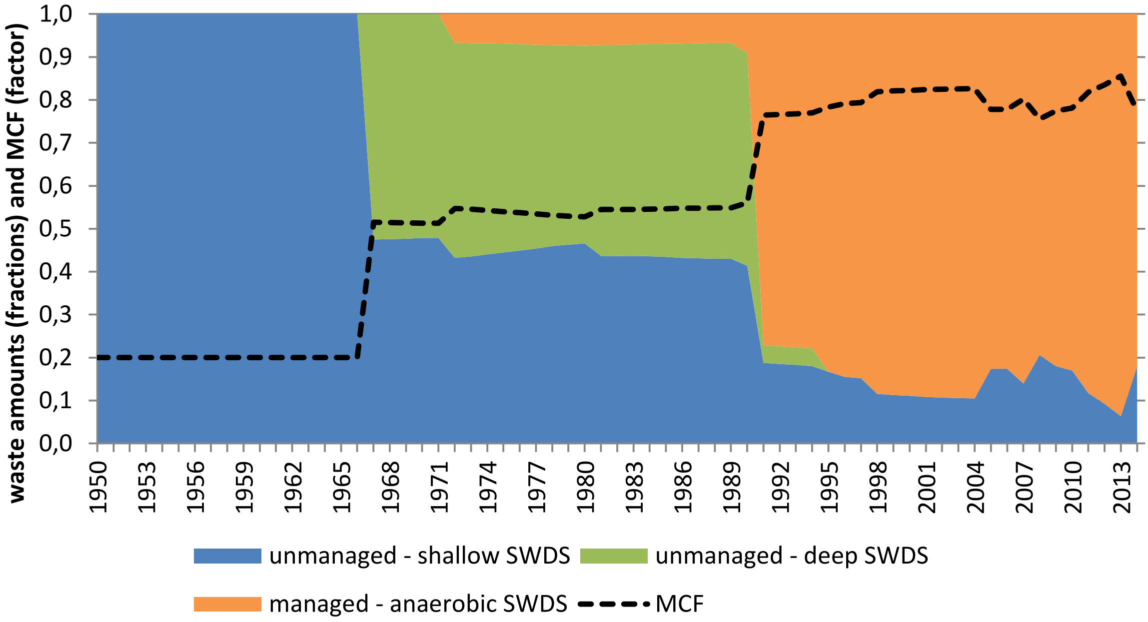

Figure 7.4 Fractions of total waste disposed of in unmanaged and managed SWDS and corresponding methane correction factor.

Waste composition

Since 2005 the EA has gathered information about annual composition of waste landfilled, burned, composted, and recycled. This data consists of separated and mixed waste categories. The separated waste categories could be allocated to one of the following waste categories:

- Food waste
- Food industry waste
- Paper/cardboard
- Textiles
- Wood
- Garden and park waste
- Nappies (disposable diapers)
- Construction and demolition waste
- Sludge
- Inert waste

The last category comprises plastics, metal, glass, and hazardous waste. The pooling of these waste categories is done in the context of methane emissions from SWDS only. For purposes other than greenhouse gas emission estimation the EA keeps these categories separated. The mixed waste categories were allocated to the categories above with the help of a study conducted by Sorpa ltd., the waste management company servicing the capital area and operating the SWDS Álfsnes. Sorpa ltd. takes random samples from the waste landfilled in Álfsnes each year, classifies and weighs them. This data was used to attribute the mixed waste categories to the ten waste categories listed above. This was done for both mixed household and mixed production waste. As mentioned above there is no real distinction between the two. A third mixed category, mixed waste from collection points, does not contain food waste. Therefore the studies´ fractions without their food waste fractions were used to attribute this category to the waste categories from the list. Thus, all waste landfilled could be attributed to one of the ten waste categories listed above with changing fractions from 2005 to 2010. The average fractions from 2005-2011 were used as starting point to estimate waste composition of the years and decades before.

Although the data gathered by Sorpa ltd. dates back to 1999, the data from 1999-2004 could not be used to represent mixed waste categories. That is because the mixed waste categories in the data gathered by the EA have undergone changes during the same time period: many categories that have been recorded separately during the last five years had been included in the mixed waste category before 2005, thus multiplying the amount recorded as mixed waste. Also, for the time period from 1995-2004 the EA data does not permit exact allocation of waste categories to waste management systems.

Therefore the average waste composition from 1990-2004 is assumed to be the same as the average waste composition from 2005-2011. For the time before 1990 the waste composition fractions were adjusted based on expert judgement and a trend deductible from the Sorpa ltd. study data, namely that the amount of food waste is increasing back in time. The adjustments that were made are shown in Table 7.3.

Table 7.3. Manipulations of waste category fractions for the time period 1950-1990.

Waste category	Adjustment	Rationale
nappies/ disposable diapers	linear reduction by 100% between 1990 and 1980	Disposable diapers were introduced to Iceland around 1980 and were not widely used until the 1990s
paper/cardboard	linear reduction by 50% between 1990 and 1950	The fraction of paper in waste was assumed to be much smaller decades ago. Also, paper was rather burned than landfilled (expert judgement)
inert waste	linear reduction by 25% between 1990 and 1980 and linear reduction by 25% between 1980 and 1950	Plastic and glass comprise around 50% of inert waste. Glass was reused during the beginning of the period. Plastic was much rarer during the beginning of the period. The amount of plastic in circulation increased in the 1980s (data from Norway), therefore the steeper decrease during that decade.
food waste	increase of fraction by amount that other categories were reduced by	Expert judgement and trend in data from study by Sorpa ltd.

These adjustments led to the waste category fractions presented for a choice of years in Table 7.4. The increase in the food waste fraction between 2010 and 2011 can be explained by a more thorough sorting process before weighing in the study by Sorpa ltd. as well as an actual increase of the fraction due to a relative decrease of other fractions due to increased recycling.

Table 7.4. Waste category fractions for selected years since 1950.

Year	Food	Food industry	Paper	Textiles	Wood	Garden	Diapers	Demolition	Sludge	Inert
1950	48.2%	18.7%	9.4%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	18.7%
1960	42.8%	21.7%	11.7%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	21.7%
1970	37.3%	24.8%	14.1%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	24.8%
1980	31.9%	27.9%	16.4%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	27.9%
1990	16.2%	37.1%	18.8%	2.5%	3.3%	3.4%	4.1%	5.7%	1.8%	37.1%
2005	15.2%	5.5%	20.9%	1.7%	4.7%	0.7%	3.6%	7.9%	0.5%	39.3%
2006	10.7%	5.2%	19.2%	1.9%	2.0%	5.5%	2.2%	9.1%	2.2%	42.0%
2007	13.0%	6.4%	18.8%	2.7%	5.9%	5.6%	3.4%	9.1%	2.2%	32.9%
2008	14.7%	8.3%	20.7%	3.3%	3.1%	4.0%	3.8%	2.1%	2.3%	37.7%
2009	19.0%	10.8%	11.2%	4.5%	3.1%	3.0%	5.8%	2.2%	2.2%	38.3%
2010	18.0%	8.6%	18.8%	1.9%	1.3%	1.7%	6.3%	1.3%	1.5%	40.5%
2011	31.0%	6.7%	19.4%	2.3%	1.9%	2.0%	6.5%	4.2%	1.6%	24.2%
2012	30.1%	8.7%	16.6%	2.1%	2.4%	3.2%	5.2%	2.0%	1.4%	28.3%
2013	38.0%	9.3%	7.1%	2.9%	2.7%	3.4%	7.2%	0.6%	1.5%	27.5%
2014	35.7%	5.8%	8.8%	2.2%	1.1%	0.5%	5.4%	3.1%	2.8%	34.4%

7.2.3 Emission factors

Methane emissions from solid waste disposal sites are calculated with equation 3.1 of the 2006 GL:

EQUATION 3.1

$$CH_4\ emissions = \left(\Sigma_x\ CH_4\ generated_{x,T} - R_t \right) * \left(1 - OX_t \right)$$

Where:

- CH_4 Emissions = CH_4 emitted in year T, kt
- T = inventory year
- x = waste category or type/material
- RT = recovered CH_4 in year T, kt
- OX_T = oxidation factor in year T, (fraction)

The IPCC default of zero was used for OX_T. The amount of methane recovered will be discussed in chapter 7.1.9. In order to calculate methane generated, the FOD method uses the emission factors and parameters shown in Table 7.5.

Table 7.5. Emission factors and parameters used to calculate methane generated.

Emission factors/parameters	values
Degradable organic carbon in the year of deposition (DOC)	Table 7.6
Fraction of DOC that can decompose (DOC_f)	0.5
Methane correction factor for aerobic decomposition (MCF)	Table 7.7
Fraction of methane in generated landfill gas (F)	0.5
Molecular weight ratio CH_4/C	16/12 (=1.33)
Methane generation rate (k)	Table 7.6
Half-life time of waste in years (y)	Table 7.6
Delay time in months	6

DOC, k, and y (which is a function of k) are defined for individual waste categories. The respective values for most of the ten categories are 2006 GL defaults, except where indicated otherwise (Table 7.6).

Table 7.6. Degradable organic carbon (fraction), methane generation rate and half-life time (years) of ten different waste categories.

cate-gory	food	food industry[1]	paper	Tex-tiles	wood	garden	diapers	demolition	sludge	inert
DOC	0.15	0.1	0.4	0.24	0.43	0.2	0.24	0.04	0.05	0
k	0.185	0.1	0.06	0.06	0.03	0.1	0.1	0.03	0.185	NA
y	4	7	12	12	23	7	7	23	4	NA

[1] country specific value aggregated for waste from fish and meat processing.

The DOC of waste going to SWDS each year was weighted by multiplying individual waste category fractions (cf. Table 7.4) with the corresponding DOC values. The multiplication of annual values for mass of waste deposited with DOC, DOC_f, and the methane correction factor results in the mass of decomposable DOC deposited annually ($DDOC_m$).

The default methane correction factors for SWDS types account for the fact that unmanaged and semi-aerobic SWDS produce less methane from a given amount of waste than managed, anaerobic SWDS. The default values suggested by the 2006 GL for the three SWDS types used are shown inTable 7.7. The default for managed, anaerobic sites however, was lowered from 1 to 0.9 by expert judgement. The rationale behind this reduction was that - although the five SWDS contained in the category managed, anaerobic classify for it by the definition used by the 2006 GL - two of them (Þernunes and Kirkjuferjuhjáleiga) have reduced CH_4 production. This was found out by the two landfill gas studies already mentioned (Kamsma and Meyles, 2003; Júlíusson, 2011). The same studies reported no methane production for several of the SWDS contained in the category unmanaged, shallow. Therefore its MCF was reduced from 0.4 to 0.2. Multiplication of MCF with respective SWDS type fractions results in a fluctuating MCF for solid waste disposal.

Table 7.7. IPCC methane correction factors and MCFs used in NIR 2016.

SWDS type	managed, anaerobic	unmanaged, deep	unmanaged, shallow
MCF (IPCC default)	1	0.8	0.4
MCF used	0.9	0.8	0.2

The FOD method is then used in order to establish both the mass of decomposable DOC accumulated and decomposed at the end of each year. To this end the k values of waste categories are used. A delay time of six months takes into account that decomposition is aerobic at first and production of methane does not start immediately after the waste deposition. Equations 3.4 and 3.5 from the 2006 GL to calculate DDOC accumulated and decomposed are shown below:

Equation 3.4
DDOC accumulated in SWDS at the end of year T

$$DDOCma_T = DDOC\ md_T + (DDOCma_{T-1} * e^{-k})$$

Equation 3.5
DDOC decomposed at the end of year T

$$DDOCm\ decomp_T = DDOCma_{T-1} * (1-e^{-k})$$

Where:

- T = inventory year
- DDOCmaT = DDOCm accumulated in the SWDS at the end of year T, kt
- DDOCmaT-1 = DDOCm accumulated in the SWDS at the end of year (T-1), kt
- DDOCmdT = DDOCm deposited into the SWDS in year T, kt
- DDOCm decompT = DDOCm decomposed in the SWDS in year T, kt
- k = reaction constant, k = ln(2)/t1/2 (y-1)
- t1/2 = half-life time (y)

Finally, generated CH_4 is calculated by multiplying decomposed DDOC with the volume fraction of CH_4 in landfill gas (= 0.5) and the molecular weight ratio of methane and carbon (16/12=1.33)

7.2.4 Emissions

7.2.4.1 Methane recovery

The only SWDS recovering landfill gas is Álfsnes which has served the capital area since 1996. Data on the amount of landfill gas recovered stems from the operator Sorpa ltd. (Hjarðar, written communication). Data for the years 1996-2004 are based on estimations whereas data since 2005 are mainly based on measurements. For the earlier time period landfill gas recovery is estimated using the known capability of the burner and the time it was in operation as proxies. For the later time period measurements exist on the amount of landfill gas recovered and the amount of methane sold. Landfill gas is converted to methane using a methane fraction of 54% which is based on regularly performed measurements. Methane volume is converted to methane mass assuming standard conditions (0.717 kg at 0 °C and 101.325 kPa) and 95% purity. From 1996 until 2001 recovered methane was combusted only. The main use between 2002 and 2006 was electricity production. The bulk of methane recovered since 2007 is sold as fuel for vehicles, e.g. cars and urban buses. Figure 7.5 gives an overview of the annual methane amounts segregated by utilization.

Recovery increased steadily between its beginning in 1996 and 2005. In 2006 the burner was damaged which led to a drop in the amount of methane recovered. Since then, amounts have oscillated but show a strong increasing trend since 2010. In 2012 the recovered amounts surpassed the 2005 level but in 2013 a decrease in methane recovery is evident. The amount incinerated dropped in 2003, 2006, and 2010 because of damage to the burner. From 2011 onwards all methane is utilized, i.e. no methane is incinerated.

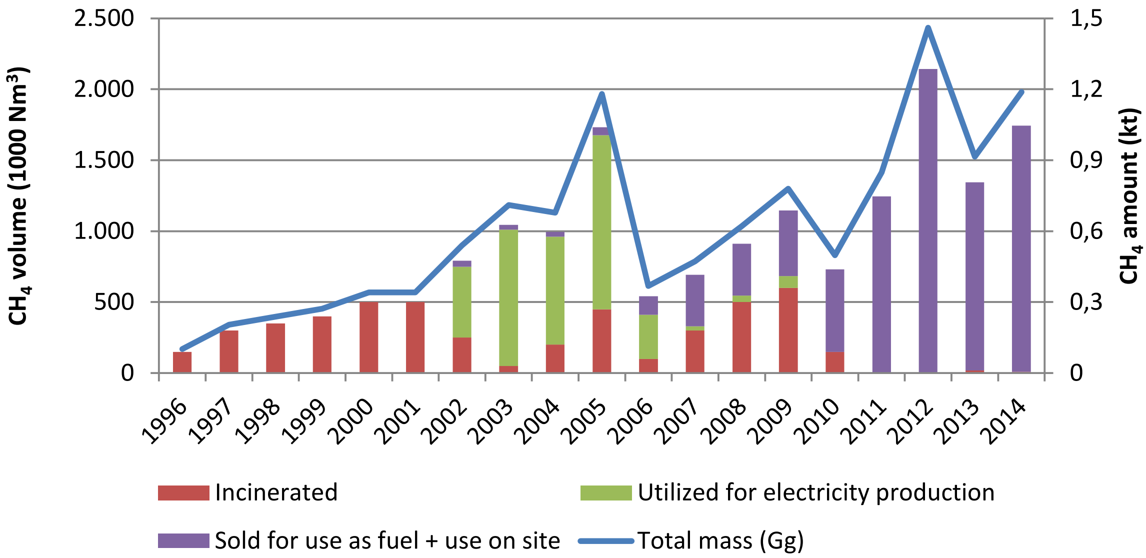

Figure 7.5 Methane recovery at Álfsnes solid waste disposal site (1000 Nm^3).

7.2.4.2 Methane emissions

In 1990 methane emissions from SWDS amounted to 5.7 kt CH_4 and increased to 9.8 kt in 2006. Since 2006 they decreased again and were estimated at 9.3 kt in 2014. This equals an increase of 63% between 1990 and 2014.

The main reason behind the increase until 2006 is a rather stable, high amount of waste disposed of in SWDS in connection with an increase of the methane correction factor caused by the close down of unmanaged SWDS in favor of managed SWDS. The shift in emissions from unmanaged to managed SWDS can be seen in Figure 7.6.

In 1990 the fraction of CH_4 emissions from managed SWDS amounted to only 11% of all SWDS emissions, whereas the fraction of emissions from unmanaged SWDS accounted for 89%. This trend has been reversed since then and in 2014 87% of SWDS emissions originated from managed SWDS. The main event underlying this development is the close down of the unmanaged SWDS Gufunes accompanied by the simultaneous opening of the managed SWDS Álfsnes, which services more than half the population of Iceland and receives corresponding waste amounts.

The reason for the decrease since 2006 can be found in the changes in waste management: since 2003 the amount of waste landfilled is decreasing rapidly and an increasing amount of waste is recycled. Because of the relatively high fraction of rapidly decreasing waste the relatively new trend away from landfilling can already be seen in emissions. Increasing recovery amounts add to this trend.

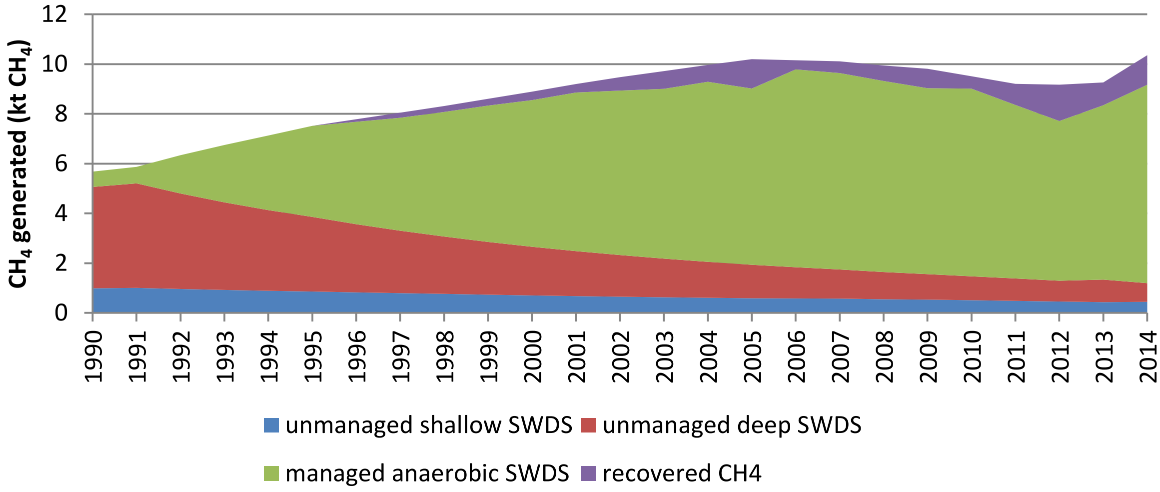

Figure 7.6 Methane generated from SWDS, separated into SWDS types. The amount of methane recovered at the managed SWDS Álfsnes is shown as purple area (reducing the size of the green area for emissions from managed SWDS).

7.2.5 Uncertainties

Uncertainty analysis for CH_4 emissions from solid waste disposal was carried out in two steps. In the first step the uncertainty of total methane generation potential was calculated independent of the year during which emissions take place. In the second step k-values are manipulated in a sensitivity analysis to determine uncertainty regarding emission distribution over the years.

Total methane generation potential can be calculated by combining equations 3.2 and 3.3 in the 2006 GL (page 3.9) as product of

- mass of waste deposited (W)
- DOC
- DOC_F
- MCF
- Fraction F of methane in generated landfill gas,
- and the molecular weight ratio CH_4/C

The total waste amount and its composition constitute the activity data in these calculations. The uncertainty range for countries where waste is weighed at SWDS is in the range of +-10% according to table 3.5 in the 2006 GL (page 3.27). Since this practice has been implemented only in recent years and since data for the years before relies on assumptions and models, the higher value for countries collecting data on waste generation on a regular basis was chosen (+-30%). Waste composition is based on periodic sampling. Therefore the guideline value of +-30% uncertainty was chosen. These two values resulted in a combined AD uncertainty of 42%.

EF uncertainty consisted of the combined uncertainties of DOC, DOC_f, MCF and F. DOC, DOC_f and F were attributed with 2006 GL default uncertainties of 20, 20, and 5%, respectively. Different MCF uncertainties were attributed to each of the three SWDS types managed, unmanaged – deep, and unmanaged – shallow. The default MCF of 1 for managed SWDS is attributed with an uncertainty of -10%. Since Iceland lowered the default MCF to 0.9 a level of uncertainty was assumed to be +-10%. The MCF for unmanaged – deep SWDS was attributed with the default uncertainty of +-20%. The uncertainty of the MCF for unmanaged – shallow SWDS, which had been lowered from 0.4 to 0.2 was estimated to be 100% in order to include the default value in the uncertainty range. This led to different combined methane generation potential EF uncertainties for the three pathways of 30% for managed, 35% for deep, and 112% for shallow, unmanaged SWDS.

In order to assign the uncertainty of emission distributions over years, k-values were manipulated in a sensitivity analysis. The first order of decay model distributes methane emissions from SWDS by applying k-values and related half times to all waste categories. These k-values were varied within the error ranges given in the 2006 GL (Table 3.3, page 3.17). To that end the model was run first with default k-values, then with the lowest values of the range for each waste category (=slowest decay) and finally with the ranges´ highest values (= fastest decay). Resulting were three distinct emission progressions over time for each of the three SWDS management types. Generally, lower k-values mean less emissions (than default k-value emissions) during the early lifetime of SWDS followed by more emissions after a certain point in time (assuming similar waste amounts deposited annually). This general development can be seen for unmanaged SWDS but not yet for managed SWDS since the waste amounts deposited there have been increasing until recently. Percentile uncertainties were quantified by dividing the highest absolute difference between the default k emissions and low/high emissions with the default emissions. Thus mean uncertainties of 19% and 13% resulted for managed and unmanaged SWDS, respectively. These uncertainties were combined with above mentioned EF uncertainties of the total methane generation potential. This increased total EF uncertainties slightly to 36% for managed SWDS and 35% and 104% for deep and shallow unmanaged SWDS, respectively. The latter two were combined by weighting them with 2014 emissions leading to a total EF uncertainties of unmanaged SWDS of 51%.

AD and EF uncertainties combined were 56% for managed SWDS and 67% for unmanaged SWDS.

7.3 Biological treatment of solid waste: composting (CRF sector 5B)

7.3.1 Overview

Composting on a noteworthy scale has been practiced in Iceland since the mid-1990s. Data collection regarding the amount of waste composted started in 1995. Composted waste mainly includes waste from slaughterhouses, garden and park waste, timber, and manure. Garden and park waste has been collected from the Reykjavík capital area and composted using windrow composting, where grass, tree crush, and horse manure is mixed together. In some municipalities there is an active composting program where most organic waste is collected and composted. Increased emphasis is placed on composting as an option in waste treatment for the future as is evident by the recent commissioning of composting facilities in Sauðárkrókur and Eyjafjörður (2009) in northern Iceland as well as of smaller facilities elsewhere in Iceland. The amount of waste composted has been increasing from 2 kt in 2002 to about 20 kt in 2014.

7.3.2 Methodology

Estimation of CH_4 and N_2O emissions from composting are calculated using the Tier 1 method of the 2006 GL.

7.3.3 Activity data

There exists data about the amount of waste composted since 1995. The amount composted is estimated to be between 2000 and 3000 tonnes annually until 2004. Since 2005 this amount has increased by roughly 2000 tonnes per year and was around 15,000 tonnes in 2010 (Figure 7.7). There exists data on the composition of waste composted since 2007. In 2014 the main waste types composted were garden and park waste, slaughterhouse waste, food waste, and wood. The Tier 1 method, however, makes no use of waste composition data.

7.3.4 Emission factors

Both CH_4 and N_2O emissions from composting are calculated by multiplying the mass of organic waste composted with the respective emission factors. The 2006 GL default emission factors are (on a wet weight basis):

- 4 g CH_4/kg waste treated
- 0.3 g N_2O/kg waste treated

7.3.5 Emissions

CH_4 emissions from composting amounted to 0.08 kt CH_4 or 2.0 kt CO_2 equivalents in 2014. N_2O emissions amounted to 0.006 kt N_2O or 2,0 kt CO_2 equivalents in 2014. This is shown in Figure 7.7.

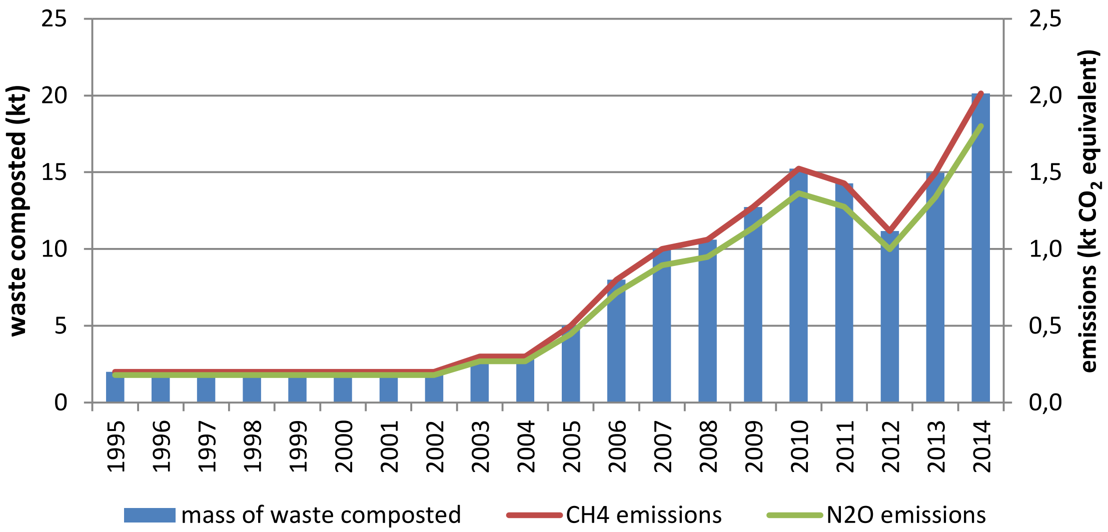

Figure 7.7 Mass of waste composted and resulting CH_4 and N_2O emissions (in kt CO_2 eq).

7.3.6 Uncertainties

Uncertainty for emissions from composting was calculated using value ranges from the 2006 GL (table 4.1, page 4.6). CH_4 emission factors from composting range from 0.03-8 g/kg wet waste treated. Thus uncertainty was calculated to be (8-4)/4 = 100%. N_2O emission factors from composting range from 0.06-0.6 g/kg wet waste treated. Thus uncertainty was calculated to be (0.6-0.3)/0.3 = 100%. Combined with AD uncertainties of 20% this resulted in combined uncertainties for both CH_4 and N_2O of 102%.

7.4 Waste incineration and open burning of waste (CRF sector 5C)

7.4.1 Overview

This chapter deals with incineration and open burning of waste. Open burning of waste includes now historic combustion in nature and open dumps as well as combustion at incineration plants that do not control the combustion air to maintain adequate temperatures and do not provide sufficient residence time for complete combustion. Proper incineration plants on the other hand are characterised by creating conditions for complete combustion. Therefore the burning of waste in historic incineration plants that did not ensure conditions for complete combustion was allocated to open burning of waste. The allocation has influence on CO_2, CH_4 and N_2O emission factors.

Open burning of waste is further divided into open burning of waste and bonfires. They differ from each other (from an emission point of view) in the composition of waste categories burned. Open burning of waste is used to incinerate a waste mix whereas bonfires contain only wood waste. Because wood does not contain any fossil carbon, CO_2 emissions from bonfires are not included in national totals.

Incineration of waste is subdivided into incineration with energy recovery (ER) and incineration without energy recovery. Emissions from incineration with ER are reported under the energy sector (1A1a and 1A4a) whereas emissions from incineration without ER are reported under the waste sector (4C).

The amount of waste burned in open pits decreased rapidly since the early 1990s, when more than 30 kilotons of waste were burned. Between 2005 and 2010 there was only one place burning waste in open pits: the island of Grímsey. It is assumed that around 45 tonnes of waste were burned there annually. The amount of material burned in bonfires has also decreased from around 4.3 kt in 1990 to 1.7 kt in 2014. Incineration of waste in incineration plants without energy recovery started in 2001 and incinerated waste amounts have been oscillating between 9 and 13 kt since 2004.

Total greenhouse gas emissions from waste incineration decreased from 18.8 kt CO_2 eq. in 1990 to 8.0 kt CO_2 eq. in 2014.

7.4.2 Methodology

The methodology for calculating carbon dioxide emissions from waste incineration is according to 2006 GL Tier 2a methodology. The methodologies for calculating methane and nitrous oxide emissions are in accordance with the 2006 GL Tier 1 methods.

Consistent with the 2006 Guidelines, only CO_2 emissions resulting from oxidation during incineration and open burning of carbon in waste of fossil origin (e.g. in plastics) are considered net emissions and therefore included in the national CO_2 emissions estimate. The CO_2 emissions from combustion of biomass materials contained in the waste (e.g. food and wood waste) are biogenic emissions and therefore not included in national total emission estimates. Other waste categories such as textiles, diapers, and rubber contain both fossil and biogenic carbon and are therefore included in CO_2 emission totals proportionally to their fossil carbon content.

CH_4, N_2O, NO_x, CO, NMVOC, and SO_2 emissions are estimated as well.

7.4.3 Activity data

Amount of waste incinerated

Methodology for activity data generation was inherited from the Icelandic submission to CLRTAP. The amount of waste burned openly is estimated using information on population in municipalities that were known to utilize open burning of waste and an assumed waste amount burned of 500 kg per head. The amount of waste burned in bonfires on New Year was calculated by weighing the wood of a sample bonfire and correlating he weight to the more readily measurable parameters pile height and diameter. These parameters were recorded for the majority of all bonfires and added up. The result was projected back in time using expert judgement. The amounts of waste incinerated are based on actual data from the incineration sites since 2004. The marginal amounts incinerated between 2001 and 2004 are based on expert judgement. The amounts of waste incinerated are shown in Figure 7.8.

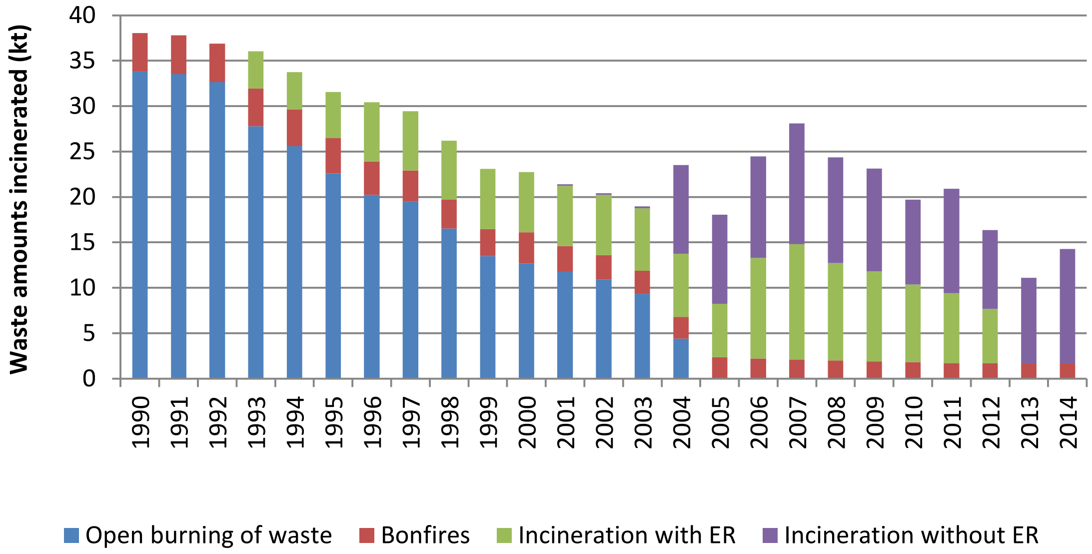

Figure 7.8 Amounts of waste incinerated with and without energy recovery, burned openly and amount of wood burned in bonfires.

Figure 7.8 shows that waste was only burned openly (here this includes waste incinerators with low/varying combustion temperatures) and in bonfires during the 1990s. A small incineration plant operated in Tálknafjörður in northwest Iceland from 2001-2004. The incineration plant Kalka in southwest Iceland, which started operation in 2004, is the biggest of its kind in Iceland. It produces energy and electricity for its own requirements and therefore rates as auto producer. Thus it is categorized as incineration plant without energy recovery.

Composition of waste incinerated

There exists data on the composition of waste incinerated since 2005. A fraction of this data is in the form of separate waste categories whereas another fraction is in the form of mixed waste categories. The mixed waste categories were divided into separate categories using the study by Sorpa ltd. for SWDS. The mixed share of waste incinerated is deemed to contain the same waste components as mixed waste landfilled, since incineration plants often took over the function of SWDS at their locations. By including the separate waste categories, however, the special function of some of the incineration plants – such as destruction of clinical and hazardous waste - are taken into account. Thus it was possible to allocate waste to one of the 11 categories shown in Figure 7.9 along with their weight fractions from 2005 to 2014. The category inert waste is defined differently here than it was defined for the SWDS chapter. In this context it excludes plastics, rubber and hazardous waste.

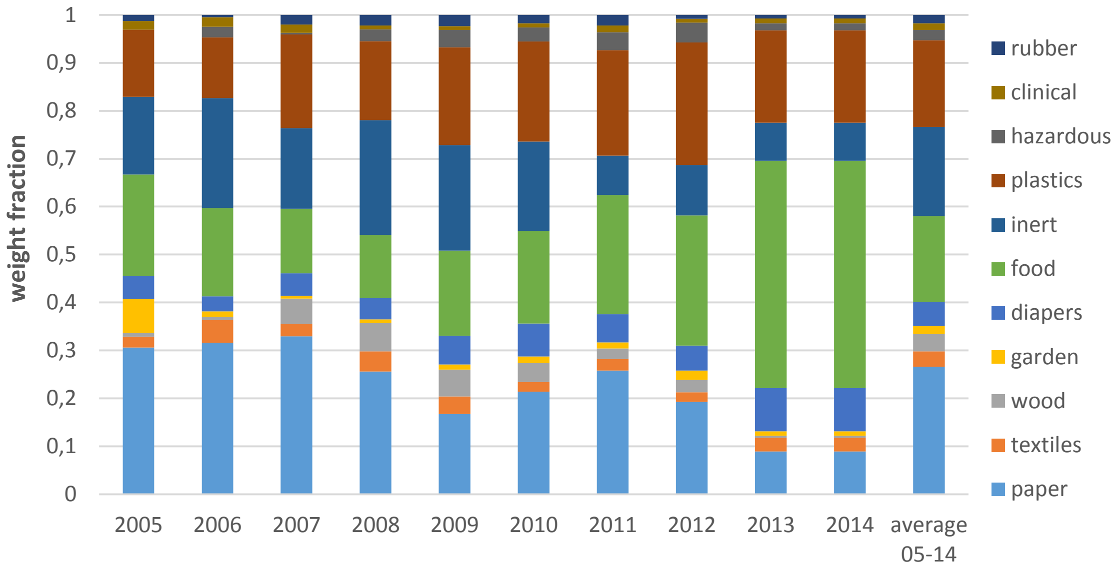

Figure 7.9 Waste categories for incineration along with weight fractions for 2005-2014 and the average weight fraction of whole period.

This data exists only for waste incineration and for the years from 2005 to 2013. For want of data from 1990-2004, weighted average fractions from 2005-2011 were applied to the period before 2005, i.e. to both incineration and open burning of waste (waste incineration plants often succeeded open burning of waste). Although the standard of living in Iceland has increased during the last two decades thus affecting waste composition, this method was deemed to yield better results than the Tier 1 method (with IPCC default waste composition).

7.4.4 Emission factors

CO_2 emission factors

CO_2 emissions were calculated using equation 5.3 from the 2006 GL (see below). As described for SWDS, there is no distinction between municipal solid and industrial waste. Therefore total waste incinerated was entered into the calculation instead of municipal solid waste.

EQUATION 5.3

$$CO_2 \text{ emissions} = MSW * \Sigma_j (WF_j * dm_j * CF_j * FCF_j * OF_j) * 44/12$$

Where:

- CO_2 Emissions = CO_2 emissions in inventory year, kt/yr
- MSW = total amount of municipal solid waste as wet weight incinerated or open-burned, kt/yr
- WFj = fraction of waste type/material of component j in the MSW (as wet weight incinerated or open-burned)
- dmj = dry matter content in the component j of the MSW incinerated or open-burned, (fraction)
- CFj = fraction of carbon in the dry matter (i.e., carbon content) of component j
- FCFj = fraction of fossil carbon in the total carbon of component j
- OFj = oxidation factor, (fraction)
- 44/12 = conversion factor from C to CO_2
- with: Σj WFj = 1
- j = component of the MSW incinerated/open-burned such as paper/cardboard, textiles, food waste, wood, garden (yard) and park waste, disposable nappies, rubber and leather, plastics, metal, glass, other inert waste.

As oxidation factors 2006 GL defaults of 1 for waste incineration (= complete oxidisation) and 0.58 for open-burning were used. The equation first calculates the amount of fossil carbon incinerated. This is shown exemplary for the year 2014 in Table 7.8.

Table 7.8. Calculation of fossil carbon amount incinerated in 2014. The column “fossil carbon (wet weight basis), fraction“ is the product of the three columns preceding it.

	Mass of incinerated waste (tonnes)	Fraction (f) of incinerated waste	(f) dry matter	(f) carbon content (dry weight basis)	(f) fossil carbon (total carbon basis)	(f) fossil carbon (wet weight basis)	fossil carbon (tonnes)
paper	836	0.09	0.90	0.46	0.01	0.004	4
textiles	273	0.03	0.80	0.50	0.20	0.080	22
wood	38	0.004	0.85	0.50	0.00	0.000	0
garden	85	0.009	0.40	0.49	0.00	0.000	0
diapers	846	0.09	0.40	0.70	0.10	0.028	24
food	4464	0.48	0.40	0.38	0.00	0.000	0
inert	742	0.08	0.90	0.03	1.00	0.027	20
plastics	1814	0.19	1.00	0.75	1.00	0.750	1360
hazardous	141	0.02	0.50	0.55	1.00	0.275	39
clinical	94	0.01	0.65	0.62	0.63	0.250	24
rubber	66	0.01	0.84	0.67	0.20	0.113	8
sum	**9397**						**1499**

1: both values generated to result in 2006 GL default fossil carbon content of 0.25.

The input for individual years from 2005 to 2011 differs from Table 7.9 in the distribution of waste category fractions and total waste amount incinerated. For the time period from 1990-2004 the weighted average waste category fractions from 2005-2011 were combined with annual amounts incinerated. The same fractions were used for open burning of waste. In bonfires only timber (packaging, pallets, etc.), which does not contain fossil carbon, is burned. Therefore no CO_2 emissions from bonfires were reported.

7.4.4.1 CH_4, N_2O, NO_x, CO, and NMVOC emission factors

In contrast to CO_2 emission factors, which are applied to the fossil carbon content of waste incinerated, the emission factors for CH_4, N_2O, NO_x, CO, NMVOC, and SO_2 are applied to the total waste amount incinerated. Emission factors for CH_4 and N_2O are taken from the 2006 GL. They differ between incineration and open burning of waste. Emission factors for NO_x, CO, and NMVOC are taken from the EMEP/EEA air pollutant emission inventory guidebook (EEA, 2009), chapter 6.C.c: Municipal waste incineration. The EMEP guidebook defaults are applied to both open burning and incineration of waste. Defaults for these greenhouse gases are shown in Table 7.9.

Table 7.9. Emission factors (EF) for incineration and open burning of waste. All values are in g/tonne wet waste except where indicated otherwise.

Greenhouse gas	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Incineration EF	237	60	1800	700	20	400
Open burning EF	6500	150[1]	1800	700	20	400

1: g/tonne dry waste

7.4.5 Emissions

GHG emissions from incineration and open burning of waste are shown in Figure 7.10. CO_2 Emissions from open burning of waste decreased from 17.9 kt in 1990 kt to 0.03 kt in 2010 thereby following the generally decreasing trend in incinerated waste amounts. CH_4 emissions from waste incineration and open burning of waste decreased more rapidly or from 6.2 kt CO_2 eq. in 1990 to 0.35 kt in 2014. The reason more this more pronounced decrease is the switch from open burning of waste to waste incineration which goes along with reduced methane EF (cf. Table 7.9). N_2O emissions decreased from 1.3 kt CO_2 eq. in 1990 to 0.3 kt in 2014. This decrease is caused by both decreasing waste amounts and a lower EF for waste incineration as opposed to open burning of waste. Aggregated HG emissions from waste incineration and open burning of waste decreased by 58% during this period.

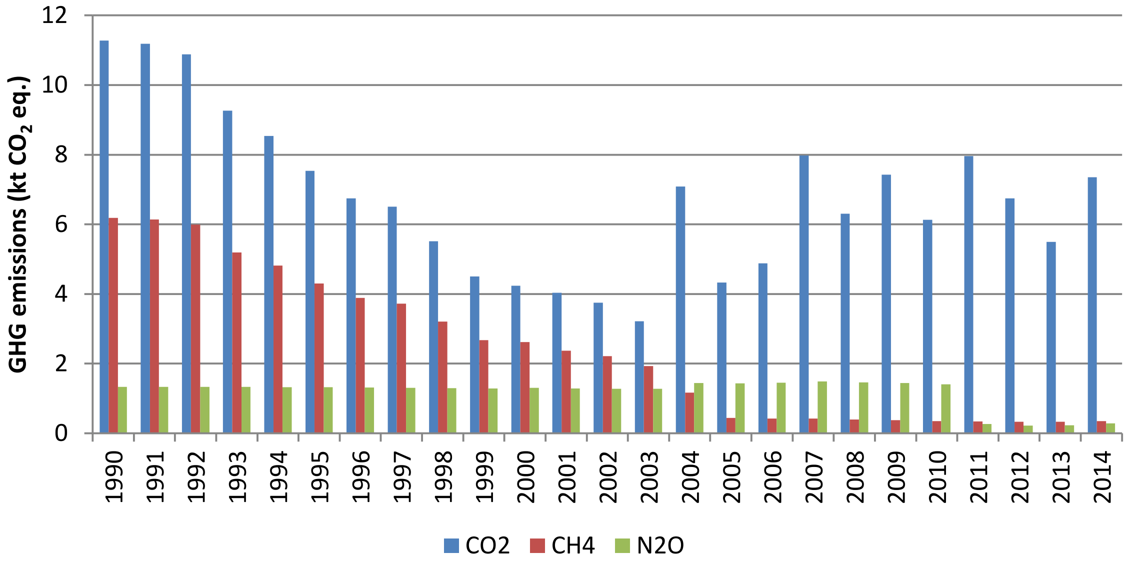

Figure 7.10 GHG emissions from incineration and open burning of waste in kt.

7.4.6 Uncertainties

AD uncertainty of CO_2 emissions from incineration and open burning of waste was estimated by propagating uncertainty estimates of each step throughout the five step calculation process of determining the fossil carbon content of each of the waste categories incinerated. This process includes estimating and combining uncertainties of the total amount of waste incinerated, of waste category fractions, dry matter fractions, total carbon fractions, and fossil carbon fractions. The uncertainty of the total amount of waste incinerated was assumed to be ±20%. Waste categorization was also assumed to be known with ±20% accuracy. That means that the amount of each waste category incinerated was assumed to be known with a 28% uncertainty (combining total waste amount and waste composition uncertainties). Dry matter fractions of all waste categories were assumed to be known with 20% accuracy (expert judgement). Each waste category was then assigned total and fossil carbon fraction uncertainties by applying the ranges for the default values given in table 2.4 on page 2.14 of the 2006 GL. All five uncertainties were combined by multiplication (equation 6.4 of the GPG) for each waste category resulting in an estimate of the uncertainty of the each category´s fossil carbon fraction. These fractions were combined by addition using equation 6.3 on page 6.12 of the GPG. The equation demands uncertain quantities. The absolute fossil carbon fractions of waste incinerated from 2005-2011 acted as uncertain quantities in the equation in order to weight waste categories due to their relative importance for the CO_2 emission estimate. The total AD uncertainty was thus estimated to be 34%.

Emission factor uncertainties for open burning were calculated by applying the EF range given in table 5.2 on page 5.18 of the 2006 GL, resulting in an EF uncertainty of 18% for open burning. Uncertainty of the oxidation factor of 1 for incineration was estimated to be 5% (expert judgement). These differing EF uncertainties were integrated over the whole period from 1990-2014 by weighting them with the sum of all years´ CO_2 emissions resulting in an EF uncertainty of 14% and a total uncertainty of CO_2 emissions from waste incineration of 37%.

Uncertainties of CH_4 and N_2O emissions were estimated by combining AD uncertainty of waste amount (=20%) with EF uncertainty (=100%) supplied by the 2006 GL (page 5.23). This resulted in combined uncertainties of 102% for both GHGs.

7.5 Wastewater Treatment and Discharge (CRF sector 5D)

7.5.1 Overview

In the 1990s almost all wastewater was discharged directly into rivers or the sea. A small percentage was collected in septic systems. The share of septic systems has increased slightly and has been fluctuating around 10% since 2002. Septic systems in Iceland are used in remote places. These include both summer houses and building sites in the highlands such as the Kárahnjúkar hydropower plant. Since 2002 the share of direct discharge of wastewater into rivers and the sea has reduced mainly in favour of collection in closed underground sewers systems with basic treatment. Basic or primary treatment includes e.g. removal of suspended solids by settlement and pumping of wastewater up to 4 km away from the coastline (capital area). Also since the year 2002, some smaller municipalities have taken up secondary treatment of wastewater. This involves aerobic treatment, secondary settlement and removal of sludge. In eastern Iceland one of these wastewater facilities is in the process of attempting to use sewage sludge as fertilizer. Therefore the removed sludge is filled into ditches for break down.

The foremost industry causing organic waste in wastewater is fish processing. Other major industries contributing organic waste are meat and dairy industries. Industrial wastewater is either discharged directly into the sea or by means of closed underground sewers and basic treatment.

Several site factors reduce methane emissions from wastewater in Icelandic, such as:

- a cold climate with mild summers
- a steep terrain with fast running streams and rivers
- an open sea with strong currents surrounding the island, and
- scarcity of population

Icelanders have a high protein intake which affects nitrous oxide emissions from the wastewater.

Total CH_4 and N_2O emissions from wastewater amounted to 11.1 kt CO_2 equivalents in 2014. Compared to 1990 emissions of 6.8 kt CO_2 equivalents this means an increase of 63%.

7.5.2 Methodology

The calculation of greenhouse gas emissions from wastewater treatment in Iceland is based on the methodologies suggested by the 2006 IPCC Guidelines and the Good Practice Guidance. Wastewater treatment is not a key source in Iceland and country-specific emissions factors are not available for key pathways. Therefore the Tier 1 method was used when estimating methane emissions from domestic and industrial wastewater. To estimate the N_2O emissions from wastewater handling the default method given by the 2006 IPCC Guidelines was used.

7.5.3 Activity data - methane emissions from wastewater

Domestic wastewater

Activity data for emissions from domestic wastewater treatment and discharge consists of the annual amount of total organics in wastewater. Total organics in wastewater (TOW) are calculated using equation 6.3 of the 2006 IPCC Guidelines. In the equation, annual amount of TOW is a product of population, kg biochemical oxygen demand (BOD) per head and year and a correction factor for additional industrial BOD discharged into sewers. The correction factor was set to zero since all methane emissions originates from domestic sewage. The default BOD_5 value for Canada, Europe, Russia and Oceania were used, 60 g per person per day (table 6.4). Between 1990 and 2014 annual TOW increased proportionally to population from 5.6 kt to 7.2 kt.

EQUATION 6.3

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

Where:

- 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 (60 g/person/day)
    - = conversion from grams BOD to kg BOD
- I = correction factor for additional industrial BOD discharge into sewers (zero since all methane emissions originates from domestic sewage)

Industrial wastewater

Industrial wastewater in Iceland is untreated and either discharged directly into rivers or the sea or by means of closed sewers. For industrial wastewater, the same MCFs as for domestic wastewater were used, i.e. zero (see rationale in chapter Emission factors. Therefore methane emissions from industrial wastewater are reported as not occurring.

7.5.4 Activity data - nitrous oxide emissions from wastewater

The activity data needed to estimate N_2O emissions is the total amount of nitrogen in the wastewater effluent ($N_{EFFLUENT}$). $N_{EFFLUENT}$ was calculated using equation 6.8 from the 2006 GL:

EQUATION 6.8

$$N_{EFFLUENT} = (P * protein * F_{NPR} * F_{NON\text{-}COM} * F_{IND\text{-}COM}) - N_{SLUDGE}$$

Where:

- NEFFLUENT = total annual amount of nitrogen in the wastewater effluent, kg N/yr
- P = human population
- Protein = annual per capita protein consumption, kg/person/yr
- FNPR = fraction of nitrogen in protein, default = 0.16, kg N/kg protein
- FNON-CON = factor for non-consumed protein added to the wastewater
- FIND-COM = factor for industrial and commercial co-discharged protein into the sewer system
- NSLUDGE = nitrogen removed with sludge, kg N/yr

Fraction of nitrogen in protein, factor for non-consumed protein added to wastewater, and factor for industrial and commercial co-discharged protein are 2006 GL defaults and are shown in Table 7.10.

Table 7.10. Default parameters used to calculate amount of nitrogen in the wastewater effluent.

Parameter	Default value	Range	Remark
F_{NPR}	0.16		
$F_{NON\text{-}CON}$	1.4	1-1.5	The default value of 1.4 for countries with garbage disposal was selected.
$F_{IND\text{-}COM}$	1.25	1-1.5	Because of significant fish processing plants the upper limit of the range (1.5) was chosen.

Other parameters influencing the nitrogen amount of wastewater is country specific. The Icelandic Directorate of Health has conducted a number of dietary surveys both for adults (Steingrímsdóttir et al., 2002; Þorgeirsdóttir et al., 2012) and for children of different ages (Þórsdóttir and Gunnarsdóttir, 2006; Gunnarsdóttir et al., 2008). The studies showed a high protein intake of Icelanders of all age classes. Adults and adolescents consumed on average 90 g per day, 9 year olds 78 g and 5 year olds 50 g. These values as well as further values for infants were integrated over the whole population resulting in an average intake of 85 g per day and Icelander regardless of age.

The amount of sludge removed was multiplied with a literature value of 2% (N content of domestic septage; McFarland, 2000). This reduced total nitrogen content of wastewater by 3.8% (average 1990-2013).

7.5.5 Emission factors

The CH_4 emission factor for wastewater treatment and discharge pathway and system is a function of the maximum CH_4 producing potential (B_o) and the methane correction factor (MCF), see Equation 6.2 of the 2006 IPCC Guidelines.

EQUATION 6.2

$$EF_j = B_0 \cdot MCF_j$$

Where:

- EFj = emission factor, kg CH_4 /kg BOD
- j = each treatment/discharge pathway or system
- B0 = maximum CH_4 production capacity, kg CH_4/kg BOD
- MCFj = methane correction factor (fraction)

The default maximum CH_4 production capacity (Bo) for domestic wastewater, 0.6 kg CH_4/kg BOD, was applied (Table 6.2 of the 2006 IPCC GL). Four wastewater discharge pathways exist in Iceland. They are shown in Table 7.11 along with respective shares of total wastewater discharge and MCFs.

Table 7.11. Wastewater discharge pathways fractions and population of Iceland from 1990 to 2014.

	Untreated systems		Treated systems		Population
discharge pathway	Flowing sewer (closed)	Sea, river and lake discharge	Centralized, aerobic treatment plant	Septic system	
1990	0.02	0.94	0.00	0.04	255,866
1995	0.04	0.90	0.00	0.06	267,958
2000	0.33	0.61	0.00	0.06	283,361
2005	0.54	0.33	0.02	0.11	299,891
2008	0.57	0.33	0.02	0.08	319,368
2012	0.57	0.33	0.02	0.08	321,857
2013	0.57	0.33	0.02	0.08	325,671
2014	0.57	0.33	0.02	0.08	321,900
MCF	0	0	0	0.5	

MCFs are in line with the 2006 GL except for the category sea, river and lake discharge. The 2006 GL propose a MCF of 0.1 and give a range of 0 – 0.2. Based on expert judgement a MCF of zero was used. The rationale behind this assessment is the cold climate in Iceland on one hand and fast running streams and rivers on the other hand. In Iceland the annual mean temperature for inhabited areas is 4 °C and the maximum temperature rises only occasionally above 15 °C, which is a threshold temperature for activity of methanogens. The geology of Iceland results in a hydrological setup with fast running streams and rivers. In combination with a low population density and therefore low organic loadings, this means that streams and rivers do not turn anaerobic. Thus, the only discharge pathway with a MCF (and emission factor) above zero is septic systems.

Total CH_4 emissions from domestic wastewater were calculated with equation 6.1 from the 2006 IPCC Guidelines.

EQUATION 6.1

$$CH_4 \text{ emissions} = \left(\Sigma \left(T_j * EF_j \right) \right) * \left(TOW - S \right) -$$

Where:

- CH_4 emissions = CH_4 emissions in 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
- T_j = degree of utilisation of treatment/discharge pathway or system, j, 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/y

The amount of sludge removed from septic systems cannot be distinguished from sludge removed during secondary treatment and was therefore set to zero. Since there is no recovery of wastewater methane, R was set to zero.

The 2006 GL emission factor for N_2O emissions from domestic wastewater is 0.005 kg N_2O-N/kg N.

7.5.6 Emissions – methane (CH_4)

Since septic tanks are the only wastewater treatment in Iceland attributed with an emission factor above zero, their fraction of total wastewater discharge determines the amount of methane emissions. This can be seen in Figure 7.11. The slight increase of TOW caused a slight increase of methane emissions during years when the share of septic tanks stayed unchanged. CH_4 emissions were highest in 2006, when they reached 0.22 kt. In recent years the share of septic systems has decreased to 8%, which caused a decrease of emissions to 0.17 kt in 2014. This is tantamount to an increase of wastewater treatment emissions of 157% since 1990. The sudden increase of emissions between 2001 and 2002 is due to an increase of septic system fraction from 6 to 11%. This increase was by the far most attribute to the setup of big septic tank system for the workforce of the Kárahnjúkar hydropower plant. The decrease of septic systems in Iceland after 2008 was caused by the completion of this same power plant.

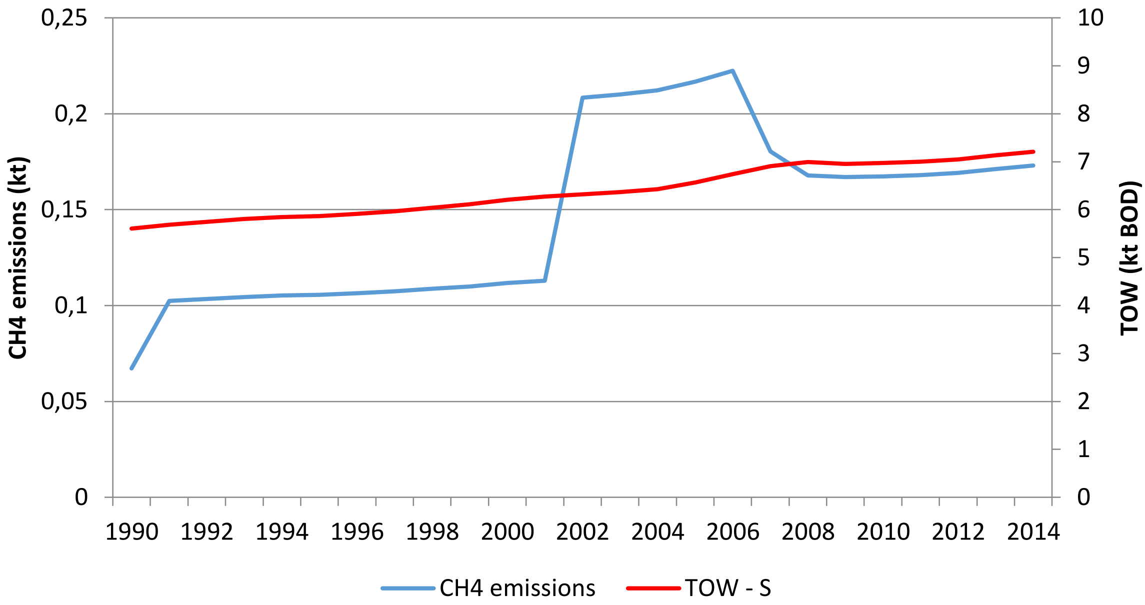

Figure 7.11 Methane emissions and total organics in wastewater in Iceland from 1990 to 2014.

7.5.7 Emissions – nitrous oxide (N_2O)

In order to estimate N_2O emissions from wastewater effluent, the nitrogen in the effluent is multiplied with the EF and then converted from N_2O-N to N_2O by multiplying it with 44/28 (molecular weight of N_2O/molecular weight of N_2). The resulting emissions are shown in Figure 7.12. Emissions rose from 0.017 kt in 1990 to 0.023 in 2014. This is tantamount to an increase of 32%. The main driver behind this development was a 29% increase of population during the same time.

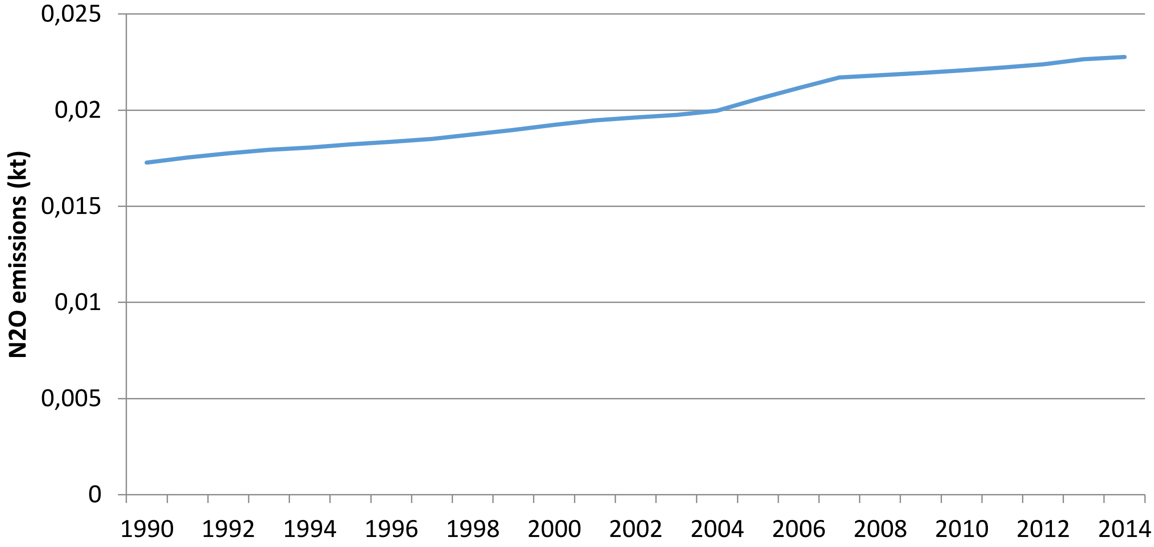

Figure 7.12 N_2O emissions from wastewater effluent between 1990 and 2014 in kt.

7.5.8 Uncertainties

AD uncertainty for N_2O emissions from wastewater were calculated by multiplying uncertainties of the five factors in the calculation of the amount of N in the wastewater effluent: population, protein content in diet, N content of protein and the two factors for additional N discharged by non-consumption and industry. Combined AD uncertainty was 46% and is not closer analysed here since it is dwarfed by an EF uncertainty of 1000% as given in table 6.11 of the 2006 GL (page 6.27), resulting in a combined uncertainty of 1001%. This can be seen in the quantitative uncertainty table in Annex II.

7.6 Recalculations and planned improvements for the waste sector

7.6.1 Recalculations

There was no recalculations in this inventory.

7.6.2 Planned improvements

For the next submission it is planned to review the division between incineration stations whether they utilize energy recovery or not. It is possible that part of the incineration stations was wrongly classified for some years.

8 Recalculations and Improvements

8.1 Overall Description of Recalculations

The Icelandic 2016 greenhouse gas emission inventory has been recalculated to a small extent (All recalculations made are calculated for the entire time series 1990-2014 and are compared to Iceland´s submission of CRF tables on November 5th of 2015. Recalculations for some components and sources have been made to account for new knowledge and/or more accurate approximation of activity data and emission factors. Detected calculation errors have been removed. The figures reported in this submission are therefore consistent throughout the whole time series.

The difference between the 2015 and the 2016 submissions are mainly in N2O emissions from the agricultural sector. The subcategories agricultural soils and manure management inhibited calculation errors and this was corrected in the 2016 submission.

Table 8.1). All recalculations made are calculated for the entire time series 1990-2014 and are compared to Iceland´s submission of CRF tables on November 5th of 2015. Recalculations for some components and sources have been made to account for new knowledge and/or more accurate approximation of activity data and emission factors. Detected calculation errors have been removed. The figures reported in this submission are therefore consistent throughout the whole time series.

The difference between the 2015 and the 2016 submissions are mainly in N_2O emissions from the agricultural sector. The subcategories agricultural soils and manure management inhibited calculation errors and this was corrected in the 2016 submission.

Table 8.1. Total recalculations in 2016 submission compared to 2015 submission (without LULUCF) in kt CO_2-equivalents.

Inventory year	2015 submission	2016 submission	Increase (kt)	Increase (%)
1990	3,849	3,634	215	5.59%
1995	3,576	3,389	187	5.23%
2000	4,175	3,963	212	5.08%
2005	4,097	3,897	200	4.88%
2010	4,948	4,730	218	4.41%
2012	4,787	4,550	237	4.95%
2013	4,731	4,535	196	4.14%

8.2 Specific description of recalculations

8.2.1 Energy

No recalculations were made for the energy sector between the 2015 and 2016 submissions.

8.2.2 Industrial Processes

There have only been minor recalculations in the Industrial Processes sector. Refilling of HFC 134A amounts leaked from reefers between 1993 and 1995 had not been dealt with in the 2013 submission. Activity data for 2013 was updated according to reports submitted according to the EU-ETS. CO emissions from industrial processes were recalculated and CO_2 emissions from Paraffin Wax Use was estimated for the 2016 submission.

8.2.3 Agriculture

No recalculations were made in this sector between the 2015 and 2016 submissions.

8.2.4 LULUCF

As described in the chapter on forest land the emission/removal estimate for forest land has been slightly revised in comparison to previous submissions. The C-stock changes are based on direct stock measurements (Tier 3) as in last year’s submission but reviewed on basis of additional data obtained and new approaches used. Time series built on direct stock measurement is calculated and reported for cultivated forest. Estimates for the natural birch forest are built on the same methodology as in last year´s submission but recalculated according to the final results of the remapping project. As a result of these recalculations the total reported removal has decreased from -267.24 kt CO_2-equivalents for the year 2012 as reported in 2014 submission to -241.94 kt CO_2-equivalents in this year’s submission or a 9.0% decrease in removal. The changes in reported emission removal of the category reflect the improvement in data, new EF’s and estimation of factors previously not estimated as well as development in the methodology applied for estimating this category.

No recalculations were done for other categories of the LULUCF in this submission.

8.2.5 Waste

There have been no recalculations between the 2015 and 2016 submissions.

8.3 Planned improvements

In the near future the following improvements for the inventory are planned:

Energy:

- Update emission factors in the energy calculations where EFs from the 1996 IPCC guidelines are still used, these EFs will be updated in accordance with the 2006 IPCC guidelines.
- Include emissions in the Energy sector from Other (1A5).
- Improvement of methodologies to estimate emissions from road transportation (use of COPERT).
- Estimate emissions from biomass fuel use in the transport sector (1A3)
- Synchronise the energy balance approach between CRF and Eurostat for sector 1A4c - fishing (reference and sectoral). Up till now fuel sold to foreign fishing vessels has not been included in CRF.
- Move estimates of emissions from aviation to the Tier 2 methodology with the use of data from EUROCONTROL.

IPPU:

- Revise the approach of calculating recovery for the category “product uses as substitutes for ozone depleting substances” in the industrial processes sector.

- Emissions from lubricant use are planned to be reported in future submissions in the industrial sector under "non-energy products from fuels and solvents use".

Agriculture:

- For the next submission it is planned to update digestible energy content of feed for both cattle and sheep in order to reflect changes in animal nutrition that have occurred since 1990. Also plans of reviewing the gross energy intake and average animal weight for all animal subcategories.
- The nitrogen excretion rate for cattle and sheep will be recalculated using data on feed and crude protein intake developed in the livestock population characterisation and default N retention rates to recalculate nitrogen intake.
- For the next submission it is planned to update the emission factor for N_2O such that the default factor will be used.
- Information gaps in data on liming and dolomite use will be addressed and estimated in case further information is not available.
- First estimations have been made for atmospheric deposition and nitrogen leaching and run-off which shows potential significance in emissions. A better estimate of these emissions will be made for future submissions.
- Sewage sludge is used in remote areas in a limited amount and accurate data on this will be available for next year's submission.

LULUCF:

- As outlined above the uncertainty of the area estimate of reported land use categories is relatively high. For other categories e.g. Natural birch forest and Natural birch shrubland new mapping effort is assumed to have decreased considerably the uncertainty of the area estimates. A survey on the drainage efficiency of the ditch network in Grassland was completed in 2014. The analyses of the data is pending and expected to enable revision of the area estimate of that category. Besides those specific improvements the land use identification is planned to be updated as new information becomes available. Generally only abandoned cropland is afforested. In next submission the category Cropland converted to Forest land will be changed to abandoned cropland converted to Forest land.
- In the chapter on forest land, data from NFI are used for the seventh time to estimate main sources of carbon stock changes in the cultivated forest where changes in carbon stock are most rapid. Sampling of soil, litter, and other vegetation than trees, is included as part of NFI and higher tier estimates of changes in the carbon stock in soil, dead organic matter and other vegetation than trees is expected in future reporting when data from re-measurement of the permanent sample plot will be available.
- New biomass functions for trees in natural birch woodland are planned to replace contemporary biomass functions used in current estimate. One can therefore expect gradually improved estimates of carbon stock and carbon stock changes regarding forest and forestry in Iceland. As mentioned before improvements in forest inventories will also improve uncertainty estimates both on area and stock changes

- In this submission as in last year's submission time series of Cropland categories were used to estimate the area of each category. Further improvements of the mapping and subdivision are still needed as e.g. revealed through the cropland mapping survey described above. The area of land converted to Cropland from other categories than Grassland or Wetland needs to be determined. Continued field controlling of mapping, improved mapping quality and division of cropland soil to soil classes and cultivated crops is planned in coming years. As the introduction of time series revealed that a considerable area of the mapping unit Cropland is abandoned cropland. Identifying the abandoned cropland within the mapping unit is considered of high importance. Information on soil carbon of mineral soil under different management and of different origin is important to be able to obtain a better estimate of the effect of land use on the SOC. Establishing reliable estimate of cropland biomass is also important and is planned.

- Considering that the CO_2 emission from both "Cropland remaining Cropland" and "Land converted to Cropland" are recognized as key sources, it is important to move to a higher tier in estimating that factor. Establishing country specific emission factors, including variability in soil classes, is already included in on-going research projects at the AUI. These studies are assumed to result in new emission factors. Data, obtained through fertilization experiments, on carbon content of cultivated soils is available at the AUI. The data is currently being processed and is expected to yield information on changes in carbon content of cultivated soils over time.

- The new emission components of offsite CO_2 emission and CH_4 emissions from Cropland have not gained much attention in Iceland. Data on that emissions and area involved is needed for Iceland e.g. the ratio of dich area. It is therefore considered important to promote the research needed and improve the estimate of relevant area.

- The total emission related to drainage of Grassland soils is a principal component in the net emission reported for the land use category. The total emission reported from drained soils of Grassland is in this submission 9,985.51 kt CO_2 eq. making that component the far largest identified anthropogenic source of GHG in Iceland. The estimation of this component is still based on T1 methodology and basically no disaggregation of the drainage area. Improvements in emission estimates for the grassland and other categories to adopt higher tiers is planned in next year's.

- Improvements in ascertaining the extent of drained organic soils in total and within different land use categories and soil types has been a priority in the IGLUD data sampling. In summer 2011 a project, aiming at improving the geographical identification of drained organic soils, was initiated within the IGLUD. This project involved testing of plant index and soil characters as proxies to evaluate the effectiveness of drainage. The data sampling in this project was finished in 2014, analyses of the data is pending. The results of this project are expected to improve the area estimate of drained land and of effectiveness of drainage.

- A pilot study on emission from different types of wetland soils indicate some difference in emissions between wetland soil types. It is important to continue research on variability of emissions between and within different wetland soil types.

- Data for dividing the drained area according to soil type drained has been collected for a part of the country. Continuation of that sampling is planned and the results used to subdivide the drained area into soil types.Age of drainage can be an important component affecting the emissions from the drained soil, the effectiveness of the drainage can also be assumed to depend on drainage age. Therefore geographical identification of drained areas of different age is planned in near future.

- The T1 emission factors for drained organic soils of Grassland have be revised since last submission. The T1 EF for C-stock changes of drained soils is comparable to new data from in country studies (Guðmundsson and Óskarsson 2014). Considering the amount of the emission from this category it is important to move to higher tier levels in general and define relevant disaggregation to land use categories and management regimes. That disaggregation is one of the main objectives of the IGLUD project and it is expected that analyses of the data already sampled will enable some steps in that direction.
- In this submission a new subcategory is added i.e. "Other land converted to Natural birch shrubland" Otherwise the subdivision remains unchanged. The largest subcategory of Grassland, "Other Grassland", is still reported as one unit. Severely degraded soils are widespread in Iceland as a result of extensive erosion over a long period of time. Changes in mineral soil carbon stocks of degrading land is potentially large source of carbon emissions. The importance of this source must be emphasized since Icelandic mineral grassland soils are almost always Andosols with high carbon content (Arnalds and Óskarsson 2009). Subdivision of that category according to management, vegetation coverage and soil erosion is pending. The processing of the IGLUD field data is expected to provide information connecting degradation severity, grazing intensity and C-stocks. This data is also expected to enable relative division of area degradation and grazing intensity categories. Including areas where vegetation is improving and degradation decreasing (Magnússon et al. 2006). Processing of the IGLUD dataset is expected to give results in the next few years.
- Improvements in both the sequestration rate estimates and area recording for revegetation, aim at establishing a transparent, verifiable inventory of carbon stock changes accountable according to the Kyoto Protocol. Three main improvements are planned and currently being carried out in part. The first is the improvement in activity recording, including both location (area) and description of activities and management. This is already being actively implemented and all data will be in acceptable form beginning in 2012. Data on older activities started after 1990 are currently under revision and are planned to be finished next years. Mapping of all activities since 1990 is verified by visiting points within the 1×1 km inventory grid. Recording of activities initiated before 1990 is also on-going. The second improvement is pre-activity sampling to establish a zero-activity baseline for future comparisons of SOC. This has been implemented for all new areas established in 2010 and later (Thorsson 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 confirm that areas registered as subjected to revegetation efforts are correctly registered and to monitor changes in carbon stocks.
- Overlay comparison of maps of "Forest converted to Settlement" and the IS 50 map layer for Settlement for improving estimates of both categories is planned. To refine the categorization of land converted to Settlements comparison of extent of some selected towns at different time to other land cover information is planned.

- Recording of the area where controlled biomass burning is licensed is still not practiced. General awareness on the risk of controlled burning getting out of hand is presently rising and concerns are frequently expressed by municipal fire departments regarding this matter. Prohibition or stricter licenses on controlled burning can be expected in near future. This development might involve better recordkeeping on biomass burning.

Waste:

- For the waste sector, it is planned to review the division between incineration stations whether they utilize energy recovery or not. It is possible that part of the incineration stations was wrongly classified for some years.

The following improvements are under consideration:

- Develop CS emission factors for fuels.
- Develop verification procedures for various data.
- Improvement of QA/QC for LULUCF.
- Revision of 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 emissions.
- Establishing country specific emission factors, including variability in soil classes, for Cropland categories
- Improvements regarding information on reservoir area and type of land Introduction of reservoir specific emission factors for more reservoirs is to be expected as information on land flooded is improved.
- The largest subcategory of Grassland, “Other Grassland”, is still reported as one unit. Severely degraded soils are widespread in Iceland as a result of extensive erosion over a long period of time. Changes in mineral soil carbon stocks are a potentially large source of carbon emissions. The importance of this source must be emphasized since Icelandic mineral grassland soils are almost always Andosols with high C content (Arnalds and Óskarsson 2009) Subdivision of that category according to management, vegetation condition and soil erosion is pending. The processing of the IGLUD field data is expected to provide information connecting degradation severity, grazing intensity and C-stocks. This data is also expected to enable relative division of area degradation and grazing intensity categories. Including areas where vegetation is improving and degradation decreasing (Magnússon et al. 2006). Processing of the IGLUD dataset is expected to give results in next years.

9 Information on Accounting of Kyoto Units

9.1 Background Information

The national registry is maintained by the Environment Agency of Iceland. The registry holds as of 31st of December 2014: 47 EU ETS accounts, thereof 5 Operator holding accounts, 32 Aircraft operator holding accounts, 8 Verifier accounts, 1 National holding account and 1 Party holding account.

Iceland's AAUs were 18,524,029 tonnes of CO_2-equivalents, on December 31st 2014. Iceland acquired 5,087 ERUs from AAUs Kyoto Protocol units in December 2013. These additional units came from Joint Implementation projects. Article 6 of the Kyoto Protocol allows an Annex I Party, with a commitment inscribed in Annex B to the Kyoto Protocol to transfer to or acquire from another Annex I Party emission reduction units (ERUs) resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks for the purpose of meeting its commitments under Article 3 of the Protocol. In addition to that, Iceland acquired 6,986 CERs from the EU in March 2014 on the basis of Ineligible CER units transferred to a national KP account in accordance with Article 58(3) of the Registry Regulation (EU) 389/2012.

In the year 2015 Iceland acquired 10,435 CERs and 10,435 ERUs from AAU from EU in January 2012 under Art.58 of the Registry Regulation (EU) 389/2013. In August 2015 861,730 RMUs (RV) and 681,031 RMUs (AR) in relation to LULUCF were added to the Party Holding Account, and 802 AAU (Deforestation) were cancelled based on the review of the 2014 inventory report of Iceland, paragraphs 94-96.[2]

102,346 AAUs were then returned to the EU in accordance with art 73.a of the delegated act amending Registry Regulation 389/2013 which leaves the total sum of AAUs in the Icelandic Party Holding account: 18,420,881.

9.2 Summary of Information reported in the SEF Tables

Article 3 in part I 'General reporting instruction', to Annex 'Standard electronic format for reporting of information on Kyoto Protocol units', of decision 14/CMP.1 says: … "each Annex I Party shall submit the SEF in the year following the calendar year in which the Party first transferred or acquired Kyoto Protocol units". Iceland submitted the SEF tables for the first time in April 2014 for the issued Kyoto Protocol units in 2013 and the 2015 SEF tables for second commitment period were submitted in March 2016. The Kyoto Protocol party holding account did not hold any units at the end of reported year 2015. No problems were found in Iceland's SEF table when performing completeness check and consistency check.

9.3 Discrepancies and Notifications

No discrepancies or notifications have occurred in relation to Iceland's accounting of Kyoto units in 2015.

[2] http://unfccc.int/resource/docs/2015/arr/isl.pdf

9.4 Publicly Accessible Information

A set of information regarding the registry and guidance on accessing registry accounts has been updated on the homepage of the Environment Agency, both in Icelandic (http://www.ust.is/atvinnulif/vidskiptakerfi-esb/skraningarkerfi/) and in English (aimed at foreign account holders in the EU-ETS - http://www.ust.is/the-environment-agency-of-iceland/eu-ets/registry/).

The website of the European Union Translation Log allows for the general public to access information, as referred to in decision 13/CMP.1, annex, paragraphs 44-48, about Iceland's national registry, as relevant. This link can be accessed on the homepage of EA: http://www.ust.is/the-environment-agency-of-iceland/eu-ets/registry/#Tab3

It can also be accessed from the website of the Union Registry:

https://ets-registry.webgate.ec.europa.eu/euregistry/IS/index.xhtml

9.5 Calculation of the Commitment Period Reserve (CPR)

The Annex to Decision 11/CMP.1 specifies that: "each Party included in Annex I shall maintain, in its national registry, a commitment period reserve which should not drop below 90% of the Party's assigned amount calculated pursuant to Article 3, paragraphs 7 and 8 of the Kyoto Protocol, or 100% of five times its most recently reviewed inventory, whichever is lowest".

Therefore, Iceland's commitment period reserve is calculated as, either:

90% of Iceland's assigned amount
= 0.9 × 18,523,847 tonnes CO_2 equivalent
= 16,671,462 tonnes CO_2 equivalent.

or,

100% of 5 × (the national total in the most recently reviewed inventory)
= 5 × 4,413,247 tonnes CO_2 equivalent
= 22,066,234 tonnes CO_2 equivalent

This means Iceland's Commitment Period Reserve is 16,671,462 tonnes CO_2-equivalent, calculated as 90% of Iceland's assigned amount.

9.6 KP-LULUCF Accounting

Iceland accounted for Article 3.3 and 3.4 LULUCF activities for the entire first commitment period. Iceland elected Revegetation under Article 3.4. Removals from Article 3.3 amounted to 103,268 tonnes CO_2 in 2008, 115,465 tonnes CO_2 in 2009, 135,426 tonnes CO_2 in 2010, 153,265 tonnes CO_2 in 2011, and 172,805 tonnes CO_2 in 2012. Removals from Article 3.4 (Net-Net accounting) amounted to 152,293 tonnes CO_2 in 2008, 159,608tonnes CO_2 in 2009, 171,719 tonnes CO_2 in 2010, 184,453 tonnes CO_2 in 2011, and 193,658 tonnes CO_2 in 2012. This allowed issuance of 1,542,761 RMUs (Table 9.1).

Table 9.1. Removals from activities under Article 3.3 and 3.4 and resulting RMUs.

	2008	2009	2010	2011	2012	CP1
Art. 73a international credits (CERs & ERUs)					102.346	102.346
Art. 73a credits returned (AAUs)					-102.346	-102.346
KP-LULUCF Art. 3.3	103.428	115.625	135.586	153.426	172.966	681.031
KP-LULUCF Art. 3.4	152.293	159.608	171.719	184.453	193.658	861.730
RMUs	**255.721**	**275.233**	**307.305**	**337.879**	**366.624**	**1.542.761**

9.7 Decision 14/CP.7 Accounting

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 carbon dioxide emissions falling under decision 14/CP.7 shall not exceed 8,000,000 tonnes. Iceland undertook the accounting with respect to Decision 14/CP.7 at the end of the commitment period.

Four projects fulfilled the provisions of Decision 14/CP.7 in 2008, 2009, 2010, 2011, and 2012. Total CO_2 emissions fulfilling the provisions of Decision 14/CP.7 amounted to 1,161 kt in 2008, to 1,205 kt in 2009, to 1,225 in 2010, to 1,209 kt in 2011 and to 1,279 kt in 2012. Total CO_2 emissions fulfilling the provisions of Decision 14/CP.7 for the first commitment period under the Kyoto Protocol therefore were 6,079 kt before the recalculation of Decision 14/CP.7, but are 5,913 kt after the recalculation as explained here below.

9.7.1 Recalculation of Decision 14/CP.7

In the report on the individual review of the annual submission of Iceland submitted in 2014[3], the ERT noted that two of the projects (Rio Tinto Alcan (aluminium) and Elkem (ferrosilicon)) include both physical expansion (installation of the new line at the Rio Tinto project and a new furnace at the Elkem project) and process improvements, which led to an increase in production at the old facilities. Thus, the ERT concluded that industrial processes CO_2 emissions from the new installations at the Rio Tinto (line 3) and Elkem (furnace 3) are eligible for the provisions of decision 14/CP.7. And industrial processes CO_2 emissions from the process improvements for line 1 and 2 at the Rio Tinto (130,345 tonnes); and furnace 1 and 2 at Elkem (36,014 tonnes) are not eligible for the provisions of decision 14/CP.7.

Therefore, the sum (166,359 tonnes) is subtracted from decision 14/CP.7 so it is now **5,912,964 tonnes** (6,079,323-166,359).Emissions from Annex A sources during CP1 were **23,356,066** tonnes CO_2-eq. **Emissions with the exeption of decision 14/CP.7: 23,356,071-5,912,964 = 17,443,107.**

[3] [3] http://unfccc.int/resource/docs/2015/arr/isl.pdf

Part of decision 14/CP.7 that is covered by Emissions from Annex A sources during CP1: 2,655,824 (20,098,931-17,443,107). **Reported seperately under decision 14/CP.7: 3,257,140** (5,912,964-2,655,824).

9.8 Summary of Kyoto accounting for the first Commitment Period – CP1

Iceland´s initial assigned amount for CP1 were 18,523,847 AAUs. Added to that are a total of 1,542,761 RMUs from Art. 3.3 and Art. 3.4 activities and 33,125 AAUs, CERs and ERUs from Joint Implementation Projects, resulting in an available assigned amount of 20,098,931 AAUs.

Emissions from Annex A sources during CP1 were 23,356,066 tonnes CO_2-eq. This means that Annex A emissions were 3,257,140 tonnes CO_2 in excess of Iceland´s available assigned amount.

Total CO_2 emissions falling under Decision 14/CP.7 during CP1 were 5,912,964 tonnes CO_2. Therefore, in order to comply with its goal for CP1, Iceland reported 3,257,140 tonnes of the CO_2 emissions falling under decision 14/CP.7 separately and not included them in national totals.

The CRF tables accompanying the 2014 NIR, however, still contain Iceland´s Annex A emissions in their entirety.

Table 9.2 and Figure 9.1 demonstrate this.

Table 9.2. Summary of Kyoto accounting for CP1.

		2008	2009	2010	2011	2012	CP1
Initial assigned amount	AAUs	3,704,769	3,704,769	3,704,769	3,704,769	3,704,769	18,523,847
Activity Deforestation Cancelation (Art.3.3)	AAUs					-802	-802
JI Projects	AAUs, CERs & ERUs					33,125	33,125
Art. 73a international credits	CERs & ERUs					102,346	102,346
Art. 73a credits returned	AAUs					-102,346	-102,346
KP-LULUCF Art. 3.3	RMUs	103,428	115,625	135,586	153,426	172,966	681,031
KP-LULUCF Art. 3.4	RMUs	152,293	159,608	171,719	184,453	193,658	861,730
Available assigned amount	AAUs	3,960,490	3,980,002	4,012,074	4,042,648	4,103,716	20,098,931
Emissions from Annex A sources	t CO_2 eq.	5,021,786	4,779,267	4,646,161	4,441,127	4,467,730	23,356,071
Difference AAU - Annex A emissions	t CO_2 eq.	1,061,296	799,265	634,087	398,479	364,014	3,257,140
Emissions falling under Decision 14/CP.7	t CO_2 eq.	1,134,704	1,178,389	1,197,398	1,184,753	1,217,720	5,912,964
Emissions falling under Decision 14/CP.7 reported under national totals	t CO_2 eq.	73,408	379,124	563,311	786,274	853,706	2,655,824
Emissions falling under Decision 14/CP.7 not reported under national totals	t CO_2 eq.	1,061,296	799,265	634,087	398,479	364,014	3,257,140

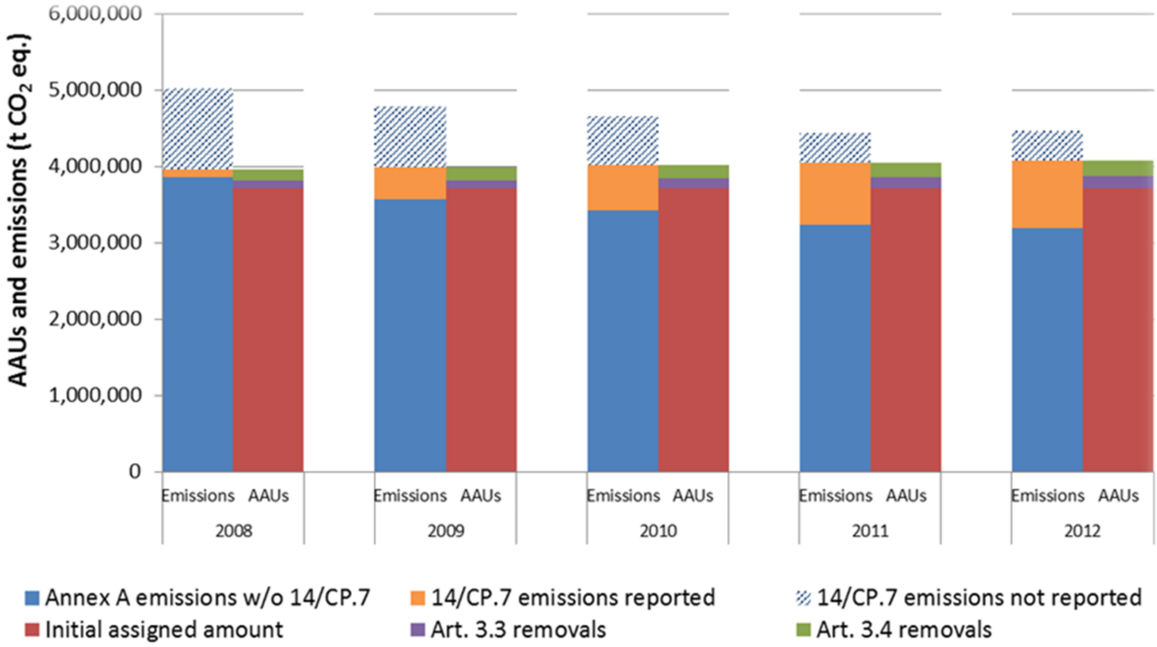

Figure 9.1 Summary of Kyoto accounting for CP1.

9.9 Second Commitment Period – CP2

The second Commitment Period started 1. January 2013 and will end 31. December 2020. Iceland is fully participating in the CP2 as it was in CP1. Iceland does not intend to account for Decision 14/CP.7 on the "Impact of single project on emissions in the commitment period" but is following the EU in CP2 commitments. No Kyoto Protocol units were requested to be carried over to the second commitment period in accordance with paragraph 49(c) of the annex to decision 13/CMP.1.

10 Kyoto Protocol – LULUCF

10.1 General Information

The Icelandic greenhouse gas emission inventory for the KP LULUCF is prepared in cooperation by IFR, AUI and SCSI. The general methods applied to estimate the sinks and sources reported are described in Chapter 6 of this report.

As this is the first time of reporting KP LULUCF for the second commitment period of the Kyoto Protocol it is for some issues not complete. Activities that will be included for reporting have not yet been formally decided by the Icelandic government. Either has decisions regarding Forest Management as about reporting of natural disturbances e.t.c. not been taken.

In the first commitment period Iceland reported the mandatory activity of Afforestation, Reforestation and Deforestation (ARD) and the elected activity of Revegetation. In this submission the mandatory activity of Forest Management (FM) is too included. Other optional activities as Cropland Management, Grassland Management and Wetland Drainage and Rewetting are not reported.

10.1.1 Definition of Forest and Any Other Criteria

Iceland's definitions of forest are identified as the following, in accordance with decision 16/CMP.1 adopted by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol.

Forest definitions are consistent with those historically reported to and subsequently published by the Food and Agriculture Organisation (FAO) of the United Nations, with the exception of tree height.

Definitions of forest as used by IFR

- Minimum value for forest area: 0.5 ha
- Minimum value for tree crown cover: 10%
- Minimum value for tree height: 2 m

In the Global Forest Resources Assessment 2005 and onward (coordinated by FAO), countries are requested to use a uniform forest definitions.

Criteria in forest definitions of the Marrakech Accord (MA), the UNEP Convention on Biological Diversity (CBD) and the Forest Resource Assessment (FAO/FRA) are listed in the Table 10.1.

Table 10.1. Criteria in forest definitions of the Marrakech Accord (MA), the UNEP Convention on Biological Diversity (CBD) and the Forest Resource Assessment (FAO/FRA).

Parameters	MA	CBD	FAO/FRA
Minimum area (ha)	0.05-1.0	0.5	0.5
Minimum height (m)	2-5	5	5
Crown cover (%)	10-30	10	10
Strip width (m)			20

Iceland uses the suggested FAO definition, but instead of the suggested 5 m height minimum, Icelandic forests are defined as being at least 2 m in height (which is the lower limit of the MA definition). That is in agreement with the general perception in Iceland and current legislative definitions. Only 10% of the natural birch woodland will reach 5 m height at maturity according National Forest Inventory (NFI) data. By widening the definition of forest, bigger portion of the natural birch woodland can be included as an ARD and FM activities under the Kyoto Protocol, hence promoting the use of native species in afforestation and prevent deforestation of the natural birch woodlands.

The functional definition of Forest land as it is applied under the KP – LULUCF is: All forested land, not belonging to Settlement, that is 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 with a minimum width of 20 m. Land which currently falls below these thresholds, but *in situ* will reach these thresholds at mature state, is included.

10.1.2 Activities under Article 3, Paragraph 4

In the first commitment period of the Kyoto Protocol Iceland elected Revegetation, defined in Paragraph 6 in the Annex to Decision 16/CMP.1 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", defined by Article 3, paragraph 4 of the Kyoto Protocol.

In the second commitment period Revegetation and FM are reported.

10.1.2.1 Interpretation of Revegetation

Revegetation is defined in Paragraph 1(e) in the Annex to Decision 16/CMP.1 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 or reforestation.
- It includes direct human-induced activities related to emissions of greenhouse gas and/or decreases in carbon stocks on sites which have been categorized as revegetation areas and do not meet the definition of deforestation.

10.1.2.2 Hierarchy among activities under Article 3.4

In accordance to the hierarchy of land use classes in UNFCCC reporting Forest Management takes precedence over Revegetation.

Iceland has elected reporting method 1 to report land areas subject to Article 3.3 and Article 3.4 activities as described in LULUCF-Good Practice Guidance, page 4.24, section 4.2.2.2. Only one stratum, Region 1 is defined covering all land areas in Iceland.

10.1.2.3 ARD and FM

Afforestation and FM is estimated in the NFI for Region 1 by systematic sampling of permanent plots (SSPP). The plots of the cultivated forest (CF) and in the natural birch forest (NBF) will be re-measured at five and ten year intervals, respectively. They were first measured in the period 2005-

2009. The second re-measurement of the CF and the first re-measurement of the NBF started in 2015. At each plot, the land use is assessed and compared to former land use. No Reforestation has been detected at the SSPP of the NFI. Although SSPP of NFI will in the future detect deforestation, special deforestation inventory aimed at deforested areas is performed together with official annual register of deforestation in accordance with the forest act (no. 3/1955) (See further description in Chapter 10.4).

Within Region 1 all CF and NBF are already mapped. Remapping of the NBF was finished in 2014. Only SSPP which are within mapped area and adjacent buffer zone are visited. The results from the NFI are used to determine the ratio of the mapped area meeting the definition of forest land. At the SSPP, data on C-pools is collected as described above (see Chapter 6). New land being afforested by cultivation is recorded annually in GIS by the IFR on basis of spatial activity data aggregated from major actors in afforestation in Iceland and consequently added to the mapped area of CF. The SSPP falling on these new area are then included in the NFI. New areas of NBF following changes in land use are considered as afforestation. Annual increase in the area of NBF is found by the difference between the old and the newly finished mapping survey. Beyond the periods between mapping survey estimates of new areas of NBF are built on extrapolation of the mean annual increase of the area between the old and the new survey.

All forest areas that are not defined as afforestation, reforestation or deforestation are defined as forest under the Forest Management activity. These are of CF afforestation areas before 1990 and plantations in the NBF. Of the NBF these are the estimated area at the end of year 1989. All expansions of NBF since 1990 are reported as afforestation in accordance to article 3.3. as described above.

10.1.2.4 Revegetation

The SCSI is responsible for the National Inventory of Revegetation Activity (NIRA). As with the NFI the whole country is defined as one region. Within Region 1 all known revegetation areas are mapped. The SSPP falling within these maps are visited in NIRA and occurrence of activity determined (see below). At selected SSPPs (see 10.1.4 below) samples to assess relevant C-pools are collected. The onset of activity is determined according to the existing records of SCSI. New areas of Revegetation activity are recorded by the SCSI and mapped. The SSPP falling within these new areas are then subsequently included in NIRA.

The SSPP will be revisited at five year intervals according to the original sampling plan. The NIRA started in 2007 and the first sampling phase ended in 2011. However, due to severe budget cuts at the SCSI, not all samples have been analysed to date and the second sampling phase, resampling older sites and sampling new sites since 2011, has not started. This delays final data submission based on the first sampling phase and concurrently restricts the submitted data to estimates based only on the available data. In the present submission the data already available from the NIRA regarding occurrence of activity at the SSPP is used to correct the activity area. Presently the sinks and sources are estimated according to Tier 2 methods described in Chapter 7.7 of this report.

The NIRA was designed to detect changes in C-pools and area of revegetation activity since 1990. The estimation of revegetation activity in the base year and of relevant sinks and sources is based on same methods as described in Chapter 7 of this report. The maps of revegetation activity before 1990 are far less accurate than the maps of activity since 1990. To secure clear separation of activities before and since 1990 the SCSI is improving these maps using both existing archives and on-ground mapping. On basis of those maps the NIRA will be extended to include the revegetation activity before 1990, albeit at a coarser scale than activities since 1990. This work is currently estimated to be concluded in 2016.

10.1.3 Description of Precedence Conditions and/or Hierarchy among Article 3.4 Activities, and how they have been Consistently Applied in Determining how Land was classified

As already stated are FM and Revegetation the activities reported under Article 3.4. In accordance to the hierarchy of land use classes in UNFCCC reporting Forest Management takes precedence over Revegetation.

Forest management include; NBF as estimated in the end of 1989. They are all defined as Forest remaining forest and not in a transitional state; CF as estimated in the end of 1989. These are of CF afforestation areas before 1990 and plantations in the NBF. Plantations in the NBF are all defined as Forest remaining forest. Afforestation areas are either defined as Forest remaining forest or Land converted to forest, depending on their age (years from plantation). The transition period in forest has been set to 50 years.

Organized revegetation and land reclamation activities date back to 1907 when the Soil Conservation Service of Iceland (SCSI) was established. Initial efforts were focused on halting accelerated erosion and serious land degradation, both directly and indirectly. Direct efforts included seeding lymegrass (*Leymus arenarius*) and erecting fences to halt sand-encroachment, but indirect efforts included excluding grazing animals by fencing off degraded lands. Recordkeeping until 1990 was fragmented, with emphasis mostly on activities but less on their spatial extent and some of the oldest records were lost in a house-fire. Activities since 1990 have better spatial documentation as aerial and satellite imagery has been used for boundary determination, and since 2002 most activities are recorded in real-time using GPS.

Data on post-1990 revegetation areas are kept in a SCSI database containing best available data on reclamation areas at any given time. One objective of initiating NIRA was to monitor changes in carbon stocks of revegetation area, using systematic sampling on predefined 1 x 1 km grid points. The grid was constructed by the Icelandic Forestry Research (IFR) from a randomly chosen point of origin, and is used for the KP LULUCF reporting (Snorrason and Kjartansson 2004).

Layers containing land reclamation areas documented as active since 1990 are overlaid with the sampling grid in a GIS to preselect potential sampling points. They are later located in the field using land-survey grade GPS units. All points that fall undoubtedly within areas where land reclamation efforts have taken place are selected as sampling points. Points falling outside are either discarded or selected as controls.

Sampling takes place within a 10 x 10 m sampling plot, using the sampling point as the SW plot corner. Five 0.5 x 0.5 m subplots are randomly selected within the sampling plot for C-stock estimation in both vegetation and soils. The KP LULUCF sampling started in 2007. During the first five years of the program, 932 sampling points have been selected as potential sampling points. 358 have been discarded after site visits or are still undetermined, (24%), 532 been sampled (57%), and 46 (5%) have been identified as controls. Points were randomly selected from all parts of the country in 2007 and 2008. Differences in numbers compared to last year's report are due to emphasis on covering as much of the remaining potential sampling points as possible before the end of this five years sampling period. A different approach was used in 2009, as emphasis was put on three key areas, each representing different a climatic zone but also having wide variety of land reclamation activities. As each of these three sites also has similar soils, they will give good information on carbon sequestration potential between activities and climate zones. Each sampling period is expected to last for five years. Re-sampling of the plots established in 2007 has yet not started due to budget cuts as explained above. Same applies to data analysis for the years subsequent to 2009.

The 1 x 1 km sampling grid is also used to add sampling points from new reclamation areas to the NIRA database, following the same methodology as described above. Quantities of pre-1990 reclamation sites remains to be determined (see information on Article 3.4 above).

10.2 Land-Related Information

10.2.1 Spatial Assessment Unit used for Determining the Area of the Units of Land under Article 3.3

Maps of cultivated forest do exist. They are made from spatial activity data aggregated from major actors in afforestation in Iceland. Although they can be used to locate forests, they are not precise and overestimate areas of the cultivated forest. Natural birch woodland (NBW) was remapped in the period 2010-2014. The new map of the NBW together with its attribute information and the old map of the NBW are used in this submission to isolate the forest part of the NBW and estimate the changes in area which turned out to increase between the old and the new mapping surveys. The area increase can be identified spatially and are defined as afforestation of the NBF. Both the map of the CF and the NBW are used with an external buffer as a population for systematic sampling of permanent plots. The permanent plots are used to estimate the area of cultivated forest. For the NBF the new map is used to estimate the total area. The area of afforestation of CF since 1990 is determined on basis of stand age within the sample plots. New afforested areas are added to the population for the SSPP annually and new sample plots falling within these areas are included in the forest inventory. The area of afforestation of natural birch forest is determined by the difference between historical mapping and current mapping. Beyond the periods between mapping survey estimates, new areas of NBF are built on extrapolation of the mean annual increase of the area between the old and the new survey (see chapter 6.7 for further description of estimation methods).

10.2.2 Methodology Used to Develop the Land Transition Matrix

Land transition matrix was prepared based on data for activity area in the years 1990, 2008-2013. Data for 2014 are built on extrapolations in the case of afforestation. They will be revised in next submission when data sampled in the NFI in 2015 have been processed. All revegetation activity involving tree planting are categorized from the beginning as Afforestation and reported as coming from “Other” than eligible KP categories of either article 3.3. or article 3.4. No conversion of land, previously reported under Revegetation, to Afforestation or Reforestation is occurring. All additions to the land included as 3.3 or 3.4 accordingly originate from the category other in the Land transition matrix.

10.2.3 Maps and/or Database to Identify the Geographical Locations, and the System of Identification codes for the Geographical Locations

Maps of CF do exist but it is not possible to isolate land subjected to ARD from these maps. The proportion of the area mapped identified as cultivated forest is determined through the inspection of the IFR on the systematic sampling plots of the NFI. Geographical locations of ARD can be partially identified by the geographical distribution of the systematic sample plots identified as ARD. Deforestation, on the other hand, is mapped separately and will be fully identifiable geographically.

The land subject to Revegetation is mapped and identified in IGLUD. The area reported as Revegetation since 1990 is larger in the present submission than the area mapped as such in IGLUD. The present area estimate of revegetation activities since 1990 is an accumulation of annual estimates for the revegetation activity. Not all of these activities have been mapped and are accordingly not included in IGLUD. The mapping of the activities recorded as Farmers Revegetate the Land (FRL) activities is particularly incomplete. Excluding the FRL activity the reported activity is all within the mapped area. The SCSI is running the NIRA based on systematic sampling of plots within the mapped areas. New results from the NIRA on total activity area are reported in this year's submission. Only mapped areas are included in the NIRA and new areas will be mapped prior to reporting.

10.3 Activity-Specific Information

10.3.1 Methods for Carbon Stock Change and GHG Emission and Removal Estimates

Description of the methodologies and the underlying assumptions used.

10.3.1.1 ARD and FM

Carbon stocks changes in living biomass in cultivated forest are based on measurements of sampling plots in the NFI. At each plot parameters to calculate aboveground and belowground biomass are determined including tree height, diameter and number of trees inside the plot area. These parameters are then used to calculate the living biomass of trees according to species specific single tree biomass functions (Snorrason and Einarsson 2006) and measured root-to-shoot ratios (Snorrason et al. 2003). Wood removal after thinning or clear cutting has not been detected in the NFI in afforestation areas since 1990. Carbon stock losses in the living woody biomass are therefore reported as not occurring.

All wood removals are on the other hand reported as FM activity whereas roundwood utilization is ongoing. Data of commercial roundwood utilization are sampled and published by the Icelandic Forestry Association (Gunnarsson 2010; Gunnarsson 2011; Gunnarsson 2012; Gunnarsson 2013, Gunnarsson 2014) and used in this submission to estimate wood removal from FM forests.

C-stock changes in dead wood are also based on measurements of sampling plots in the NFI. All dead wood meeting the minimum requirement of 10 cm in diameter and 1 m in length are measured and reported on the year of death as an increase of the dead wood stock. These stocks will in the future be a source of C when decomposing as the plots will be revisited and they will be remeasured and assessed in new decomposing class.

As already described in chapter 6, carbon stock changes of afforestation of the NBF are on the other hand estimated by a country specific removal factor built on the relation between age and woody biomass C-stock of natural birch woodland. Carbon stock changes in the NBF existing before 1990 are estimated by comparing biomass stock of the trees in two different times and use mean annual change as an estimate for the annual change in the C- stock. This method is in accordance to Equation 3.1.2 in GPG for LULUCF (page 3.16).

Changes of carbon stock in mineral soil of Grassland converted to forest land are based on Tier 2 methodology applying country specific EF. The EF is based on soil sampling from chrono-sequential research (Bjarnadóttir 2009) showing significantly increasing SOC in 0-10 cm depth layer with stand age up to 50 years old stands. No significant changes in SOC in 10-30 cm depth layer were observed. The results of this study are assumed to apply for afforestation 1-50 years old on mineral soils. For the organic soils a Tier 1 methodology is applied using a default EF. The area of organic soils is determined on basis of the NNFI sampling plots. Changes in carbon stock of litter including woody debris, twigs and fine litter is estimated applying a Tier 2 methodology and CS EF.

10.3.1.2 Revegetation

The changes in carbon stocks at revegetation sites are estimated on the basis of a country specific EF covering all carbon pools. In this submission a revised EF is used. Current, but unpublished, results from NIRA for 2007-2009 indicate considerable variation between reclamation methods and land types, as well as intrinsically lower values than previously reported. The data has not been fully analyzed, but to cover the total variability and sequestration decrease, a reduction of 10% in EF is used in this submission as suggested by SCSI. It is expected that before next submission the data will be fully analysed and new EF will be available. Built on the studies of Aradóttir et al. 2000 the EF was assumed to be divided into 10% caused by increase in living ground biomass and litter and 90% by changes in soil organic carbon.

10.3.1.3 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and Article 3.4

10.3.1.4 ARD and FM

Change in the carbon stock of other vegetation than trees is omitted in this year's submission. A research project where carbon stock in other vegetation than trees was measured on afforestation sites of different ages of larch plantations did show very low increase C-stock 50 years after afforestation although the variation inside this period where considerable (Sigurdsson et al. 2005).

Harvest Wood Products are not estimated in this year submission. Data on domestic wood utilization and production of wood products from domestic wood are not official data and the official statistical agency in Iceland (Statistics Iceland (http://www.statice.is/)) has fragmented, unverified and incomplete reporting of these data (see: http://faostat3.fao.org/download/F/FO/E). Because of this Harvest Wood Products are in this submission reported as not estimated. A future effort will be put on improving the quality and flow of data to Statistic Iceland and trace the fate of domestic roundwood and fuel wood production.

10.3.1.5 Revegetation

Losses in Revegetation are not specifically detected. The losses are assumed to be reflected as changes in the C-pool estimates of NIRA. Potential losses include losses in revegetated area, due to changes in land use. Losses in C-pools through grazing, biomass burning and erosion are also recognized as potential. These losses are expected to be detected in the NIRA, and will not be included until then.

10.3.1.6 Information on whether or not Indirect and Natural GHG Emissions and Removals have been factored out

No attempt is made to factor out indirect or natural GHG removals/emissions. This applies both for ARD, FM and Revegetation. Both AR and Revegetation have 1990 as base year. This short time window makes factoring out irrelevant.

10.3.1.7 Changes in Data and Methods since the Previous Submission (Recalculations)

The emission/removal factor and the area estimate for the Revegetation activity have been revised since last year's submission. Removals due to AR activities have not been revised.

10.3.1.8 Uncertainty Estimates

An error estimate is available for the area of afforestation of cultivated forest. The area of afforestation since 1990 is estimated at 32.25 kha (±1.69 kha 95% CL).

Uncertainty estimates for revegetation are available both for EF and area. Both are estimated with ±10% uncertainty.

10.3.1.9 Information on Other Methodological Issues

The Year of the Onset of an Activity, if after 2008: For FM 2013.

10.4 Article 3.3

10.4.1 Information that Demonstrates that Activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are Direct Human induced

The age of afforestation is estimated in field on the sample plots of the NFI. Cultivated forests are mostly plantations. A minority are direct seeded or self-seedlings originating from cultivated forests. Natural birch forests are self-seeded areas in the neighbourhood of older natural forest areas. Land use has been changed in both cases from other land use to forest with afforestation by planting and/or by total protection or drastic reduction of grazing of domestic animals. These actions are considered direct human-induced.

10.4.2 Information on how Harvesting or Forest Disturbance that is followed by the Re-Establishment of Forest is Distinguished from Deforestation

Deforestation is estimated by special inventory where the change in the area of forest where deforestation has been reported is estimated by GPS delineation of a new border between forest and the new land use which is dominantly settlements (new power lines, roads or buildings). Major forest disturbances will be detected in the NFI but local forest disturbances (wildfires etc) will be handled with special inventory as done for deforestation.

10.4.3 Information on the Size and Geographical Location of Forest Areas that have lost Forest Cover but which are not yet classified as Deforested

The only human induced forest degradation occurring is when trees have to give way for summer houses and roads to summer houses. There the forest removed is below the minimum area of 0.5 ha or 20 m with, no direct estimate of the effect of decrease of the C-stock is made. The permanent sample plot system of the NFI will, however, detect significant forest degradation.

10.5 Article 3.4

10.5.1 Information that Demonstrates that Activities under Article 3.4 have occurred since 1 January 1990 and are Human induced

All the revegetation activity included under Article 3.4 is included on the bases of SCSI activity records. No area not recorded by SCSI as revegetation activity is included.

10.5.2 Information Relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the Base Year

The removal recorded due to Revegetation in base year is estimated from SCSI archives on revegetation prior to 1990. All land revegetated before 1990 is included in the estimate. The estimate of changes in C-pools is according to Tier 2 methods as described in chapter 7.7.

10.5.3 Information Relating to Forest Management

FM consist of CF that are mostly plantations and NBF that are defined as managed forest as their existence depend on management of grazing of domestic animals.

10.6 Other Information

10.6.1 Key Category Analysis for Article 3.3 Activities and any Activities under Article 3.4

Of the three categories reported under Article 3.3 and Article 3.4 both “Revegetation” and “Afforestation and Reforestation” are larger than N_2O from manure management (CRF: 4.B), 43.29 kt CO_2 equivalents the smallest key category of level including LULUCF in the year 2012.

11 Information on Changes in National System

In June of 2012 the Icelandic Parliament passed a new law on climate change (Act 70/2012). The objectives of the Act are:

- reducing greenhouse gas emissions efficiently and effectively,
- to increase carbon sequestration from the atmosphere,
- promoting mitigation to the consequences of climate change, and
- to create conditions for the government to fulfil its international obligations in the climate of Iceland.

The law supersedes Act 65/2007 on which basis the Environment Agency made formal agreements with the necessary collaborating agencies involved in the preparation of the inventory to cover responsibilities such as data collection and methodologies, data delivery timeliness and uncertainty estimates. The data collection for this submission was based on these agreements. The articles in Act 65/2007 regarding the allocation committee still stand.

Act 70/2012 changes the form of relations between the EA and other bodies concerning data handling. Paragraph 6 of the law addresses Iceland´s greenhouse gas inventory. It states that the Environment Agency (EA) compiles Iceland´s GHG inventory in accordance with Iceland´s international obligations. The paragraph also states that the following institutions are obligated to collect data necessary for the GHG inventory and report it to the EA, further to be elaborated in regulations set by the Minister for the Environment and Natural Resources:

- Soil Conservation Service of Iceland
- Iceland Forest Service
- National Energy Authority
- Agricultural University of Iceland
- Iceland Food and Veterinary Authority
- Statistics Iceland
- The Road Traffic Directorate
- The Icelandic Recycling Fund
- Directorate of Customs

The relevant regulation regarding the manner and deadlines of said data is in preparation; a first order draft is in place. The regulation will be in place for the next inventory cycle. It is foreseen that the new law will facilitate the responsibilities, the data collection process and the timelines.

The Coordinating Team that operated from 2008 to 2012 had the function of reviewing the emissions inventory before submission to UNFCCC as described in Chapter 1.2. The Coordinating Team led to improvements in cooperation between the different institutions involved with the inventory compilation, especially with regard to the LULUCF and Agriculture sectors. Improvements proposed by the team were incorporated into the inventory. As the prospective regulation based on Act 70/2012 formalizes the cooperation and data collection process between the EA and all responsible institutions, it takes over the role of the Coordinating Team as regards the cooperation between different institutions. The role of the Coordinating Team as regards the review will be done through external review according to prioritization plan. The external review will focus on key sources and categories where methodological changes have occured. Further all chapters will be reviewed on periodic basis. Internal review within the EA, involving experts not directly involved in the preparation of the GHG inventory, will continue. The role as regards the final review before submission to the UNFCCC will be replaced by an approval meeting with the inventory team at the EA and the director of the EA, where the emission inventory is approved before submission to the UNFCCC.

12 Information on Change in National Registry

The following changes to the national registry of Iceland have occurred in 2015.

Table 12.1 Changes to national registry

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There was no change to the database structure as it pertains to KP functionality in 2015. Versions of the CSEUR released after 6.3.3.2 (the production version at the time of the last Chapter 14 submission) introduced minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model is provided in Annex VI. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex VII. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex VII). Annex H testing was carried out in February 2016 and the test report is attached in Annex VIII. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex VIII. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex VIII. Annex H testing was carried out in February 2016 and the test report is attached in Annex VIII.

13 Information on Minimization of Adverse Impacts in Accordance with Art.3 p.14

No changes have been made regarding the information of adverse impact since last submission.

Table 13.1 summary of actions specified in Decision 15/CMP.1

Actions	Implementation
The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities, in pursuit of the objective of the Convention	Planning of economic instruments in Iceland, *inter alia* for limiting emissions in the greenhouse gas emitting sectors is subject to different methodologies. These involve feasibility and efficiency and consideration of national and international circumstances.
Removing subsidies associated with the use of environmentally unsound and unsafe technologies	Subsidies associated with the use of environmentally unsound and unsafe technologies have not been identified in Iceland
Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end	Iceland does not have support activities in this field
Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort	Icelandic researchers cooperate with French and U.S. colleagues on an experimental project (CarbFix) that is under way at the Hellisheiði geothermal plant, injecting CO_2 captured in geothermal steam back into the basaltic rock underground. The aim of the Carbfix Project is to study the feasibility of sequestering the greenhouse-gas carbon dioxide into basaltic bedrock and store it there permanently as a mineral. The project's implications for the fight against global warming may be considerable, since basaltic bedrock susceptive of CO_2 injections are widely found on the planet and CO_2 capture-and-storage and mineralization in basaltic rock is not only confined to geothermal emissions or areas
Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities	The Government of Iceland has supported developing countries in the area of sustainable utilization of natural resources through its administration of the United Nations University Geothermal Training Program. The Geothermal Training Program, which started thirty-five years ago, has built up expertise in the utilization of geothermal energy by training 554 experts from 53 countries. The program provides their graduating fellows with the opportunity to enter MSc and PhD programmes with Icelandic universities. Iceland will continue its support for geothermal projects in developing countries with geothermal resources, which can be utilized to decrease their dependency on fossil fuels for economic development.
Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies	Iceland does not have support activities in this field

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Annex I. Key Categories

According to the IPCC definition, key sources are those that add up to 95% 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 lists identified key sources. Table A1 shows the level assessment of the key source analysis for 2013, Table A2 the level assessment of the key source analysis for 1990 and Table A3 the trend assessment of the key source analysis.

Key Category analysis approach 1 Level Assessment for 1990 in kt CO_2-eq, excluding LULUCF

IPCC source category		Gas	Base year (1990) Estimate Non-LULUCF	Level w/o LULUCF
1.A.4	**Other Sectors**	CO_2	817	23%
1.A.3.b	**Road Transportation**	CO_2	509	14%
2.C.3	**Aluminium Production**	PFCs	494	14%
3.A	**Enteric Fermentation**	CH_4	312	9%
3.D	**Agricultural Soils**	N_2O	229	6%
2.C.2	**Ferroalloys Production**	CO_2	207	6%
1.A.2	**Manufacturing Industries and Construction**	CO_2	149	4%
5.A	**Solid Waste Disposal**	CH_4	142	4%
2.C.3	**Aluminium Production**	CO_2	138	4%
3.D	**Agricultural Soils**	N_2O	134	4%
3.B	**Manure Management**	N_2O	62	2%
1.B.2.d	**Other emissions from energy production**	CO_2	58	2%
1.A.3.d	**Domestic Navigation**	CO_2	51	1%
1.A.2	**Manufacturing Industries and Construction**	CO_2	51	1%
3.B	**Manure Management**	CH_4	51	1%
2.A.1	**Cement Production**	CO_2	51	1%

Key category analysis approach 1 level for 2014 in kt CO2-eq, excluding LULUCF

IPCC source category		Gas	Current Year Estimate Non-LULUCF	Level w/o LULUCF
2.C.3	**Aluminium Production**	CO_2	1278	28%
1.A.3.b	**Road Transportation**	CO2	763	17%
1.A.4	**Other Sectors**	CO_2	584	13%
2.C.2	**Ferroalloys Production**	CO_2	368	8%
3.A	**Enteric Fermentation**	CH_4	294	6%
5.A	**Solid Waste Disposal**	CH_4	234	5%
3.D.1	**Agricultural Soils**	N_2O	225	5%
1.B.2.d	**Other emissions from energy production**	CO_2	184	4%
2.F.1	**Refrigeration and Air conditioning**	Aggregate F-gases	161	4%
3.D.2	**Agricultural Soils**	N_2O	138	3%
2.C.3	**Aluminium Production**	PFCs	101	2%
3.B	**Manure Management**	N2O	51	1%

Key category analysis approach 1 trend assessment in kt CO_2-eq, excluding LULUCF

IPCC Category code	IPCC Category	Gas	Base Year (1990) Estimate Non-LULUCF $E_{x,0}$	Current Year Estimate Non-LULUCF $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to Trend	Cumulative Total
2.C.3	**Aluminium Production**	CO2	139	1278	0.30	36%	36%
2.C.3	**Aluminium Production**	PFCs	495	101	0.14	17%	53%
1.A.4	**Other Sectors**	CO_2	818	584	0.12	15%	67%
2.F.1	**Refrigeration and Air conditioning**	Aggregate F-gases	NO	161	0.04	5%	73%
1.A.2	**Manufacturing Industries and Construction (liquid fuels)**	CO_2	150	23	0.05	5%	78%
1.A.3.b	**Road Transportation**	CO_2	509	763	0.03	4%	82%
1.B.2.d	**Other emissions from energy production**	CO_2	61	184	0.03	3%	85%
3.A	**Enteric Fermentation**	CH_4	314	294	0.03	3%	89%
2.C.2	**Ferroalloys Production**	CO_2	207	368	0.03	3%	92%
1.A.2	**Manufacturing Industries and Construction (solid fuels)**	CO_2	52	0	0.02	2%	94%
3.D.1	**Agricultural Soils**	N_2O	229	225	0.02	2%	96%
1.A.3.d	**Domestic Navigation**	CO_2	59	18	0.02	2%	98%
5.A	**Solid Waste Disposal**	CH_4	142	234	0.02	2%	100%
TOTAL			**3176**	**4233**	**0.85**	**100%**	

Key Category analysis approach 1 Level Assessment for 1990 in kt CO_2-eq, including LULUCF

IPCC Category code	IPCC Category	Gas	Base Year (1990) Estimate w/ LULUCF	Level assessment w/ LULUCF
4.C.1	Grassland (Grassland remaining grassland)	CO_2	3942	24%
4.C.2	Grassland (Land converted to grassland)	CO_2	2400	14%
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	2365	14%
4(III)	Direct N2O Emissions from N Mineralization/Immobilization	N_2O	1426	9%
4.B.1	Cropland	CO_2	1256	8%
1.A.4	Other Sectors (liquid fuels)	CO_2	822	5%
4.D.1.	Wetlands	CO_2	788	5%
4.B.1	Cropland	CO_2	637	4%
1.A.3.b	Road Transportation	CO_2	509	3%
2.C.3	Aluminium Production	PFCs	494	3%
3.A	Enteric Fermentation	CH_4	312	2%
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	285	2%
3.D	Agricultural Soils	N_2O	229	1%
2.C.2	Ferroalloys Production	CO_2	207	1%
1.A.2	Manufacturing Industries and Construction (liquid fuels)	CO_2	149	1%
5.A	Solid Waste Disposal	CH_4	134	1%

Key category analysis approach 1 level for 2014 in kt CO_2-eq, including LULUCF

IPCC Category code	IPCC Category	Gas	2014 Estimate w/ LULUCF	Level assessment w/ LULUCF
4.C.1	**Grassland (Grassland remaining grassland)**	CO_2	6736	36%
4(II)	**Emissions and removals from drainage and rewetting and other management of organic and mineral soils**	CH_4	2258	12%
4(III)	**Direct N2O Emissions from N Mineralization/Immobilization**	N_2O	1628	9%
4.B.1	**Cropland**	CO_2	1573	9%
2.C.3	**Aluminium Production**	CO_2	1278	7%
1.A.3.b	**Road Transportation**	CO_2	763	4%
4.D.1.	**Wetlands**	CO_2	722	4%
1.A.4	**Other Sectors (liquid fuels)**	CO_2	584	3%
2.C.2	**Ferroalloys Production**	CO_2	368	2%
4.C.2	**Grassland (Land converted to Grassland)**	CO_2	296	2%
3.A	**Enteric Fermentation**	CH_4	294	2%
4(II)	**Emissions and removals from drainage and rewetting and other management of organic and mineral soils**	CO_2	296	2%
4.A.2	**Forest land**	CO_2	259	1%
5.A	**Solid Waste Disposal**	CH_4	234	1%
3.D	**Agricultural Soils**	N_2O	225	1%
1.B.2.d	**Other emissions from energy production**	CO_2	184	1%

Key category analysis approach 1 trend assessment in kt CO2-eq, including LULUCF

IPCC Category code	IPCC Category	Gas	Base Year Estimate w/ LULUCF $E_{x,0}$	Current Year Estimate w/ LULUCF $E_{x,t}$	Trend Assessment $T_{x,t}$	% Contribution to Trend	Cumulative Total
4.C.1	**Grassland (Grassland remaining grassland)**	CO_2	3942	6735	0.14	27%	27%
4.C.2	**Grassland (Land converted to grassland)**	CO_2	2400	296	0.14	26%	53%
2.C.3	**Aluminium Production**	CO_2	139	1277	0.07	13%	66%
4.B.1	**Cropland**	CO_2	637	93	0.04	7%	73%
2.C.3	**Aluminium Production**	PFCs	494	93	0.03	5%	78%
4(II)	**Emissions and removals from drainage and rewetting and other management of organic and mineral soils**	CH_4	2365	2258	0.02	4%	82%
1.A.4	**Other Sectors**	CO_2	822	592	0.02	4%	85%
4.A.2	**Forest land**	CO_2	-27	259	0.02	3%	88%
1.A.3.b	**Road Transportation**	CO_2	509	759	0.01	2%	90%
4.B.1	**Cropland**	CO_2	1256	1573	0.01	2%	93%
2.F.1	**Refrigeration and Air conditioning**	Aggregate F-gases	NO	167	0.01	2%	94%
1.A.2	**Manufacturing Industries and Construction (liquid fuels)**	CO_2	149	19	0.01	2%	96%
2.C.2	**Ferroalloys Production**	CO_2	207	370	0.01	2%	98%
1.B.2.d	**Other emissions from energy production**	CO_2	61	185	0.01	1%	99%
5.A	**Solid Waste Disposal**	CH_4	134	241	0.01	1%	100%
TOTAL			**13089**	**14914**	**0.53**	**100%**	

Annex II. Assessment of uncertainty (Including LULUCF)

IPCC Source category	IPCC Source category	Gas	Activity data uncer-tainty	Emission factor uncer-tainty	Combined uncer-tainty	Combine uncertainty as % of total national emissions in year 2012	Type A sensi-tivity	Type B sensi-tivity	Uncer-tainty in emission trend introduced by EF uncer-tainty	Uncer-tainty in emission trend introduced by AD uncer-tainty	Uncer-tainty introdu-ced into the trend in total national emissions
1.AA.1	Public electricity and heat production	CO_2	5.0	5.0	7.1	0.010	-0.002	0.002	-0.008	0.011	0.014
1.AA.1	Public electricity and heat production	CH_4	5.0	100.0	100.1	0.001	0.000	0.000	0.000	0.000	0.001
1.AA.1	Public electricity and heat production	N_2O	5.0	150.0	150.1	0.003	0.000	0.000	0.003	0.000	0.003
1.AA.2	Manufacturing industry and construction	CO_2	5.0	5.0	7.1	0.235	-0.047	0.037	-0.237	0.258	0.351
1.AA.2	Manufacturing industry and construction	CH_4	5.0	100.0	100.1	0.003	0.000	0.000	-0.003	0.000	0.003
1.AA.2	Manufacturing industry and construction	N_2O	5.0	150.0	150.1	0.344	-0.001	0.003	-0.178	0.018	0.179
1.AA.3a/d	Transport	CO_2	5.0	5.0	7.1	0.047	-0.014	0.007	-0.069	0.052	0.087
1.AA.3a/d	Transport	CH_4	5.0	100.0	100.1	0.001	0.000	0.000	-0.002	0.000	0.002
1.AA.3a/d	Transport	N_2O	5.0	200.0	200.1	0.012	0.000	0.000	-0.023	0.000	0.023
1.AA.3b	Road transport	CO_2	5.0	5.0	7.1	1.070	0.045	0.166	0.223	1.174	1.195
1.AA.3b	Road transport	CH_4	5.0	40.0	40.3	0.011	0.000	0.000	-0.015	0.002	0.015
1.AA.3b	Road transport	N_2O	5.0	50.0	50.2	0.334	0.006	0.007	0.312	0.052	0.316
1.AA.4a/b	Residential/institutional/commercial	CO_2	5.0	5.0	7.1	0.014	-0.008	0.002	-0.039	0.015	0.042
1.AA.4a/b	Residential/institutional/commercial	CH_4	5.0	100.0	100.1	0.000	0.000	0.000	0.000	0.000	0.000
1.AA.4a/b	Residential/institutional/commercial	N_2O	5.0	150.0	150.1	0.001	0.000	0.000	-0.003	0.000	0.003
1.AA.4c	Fishing	CO_2	3.0	5.0	5.8	0.547	-0.050	0.103	-0.248	0.437	0.502

1.AA.4c	Fishing	CH_4	3.0	100.0	100.0	0.019	0.000	0.000	-0.010	0.001	0.010
1.AA.4c	Fishing	N_2O	3.0	150.0	150.0	0.118	0.000	0.001	-0.063	0.004	0.063
1.B	Fugitive emissions from fuels	CO2	10.0	1.0	10.0	0.331	0.022	0.036	0.022	0.511	0.511
1.B	Fugitive emissions from fuels	CH_4	6.0	8.0	10.0	0.005	0.000	0.001	0.003	0.005	0.006
2.A	Mineral production	CO_2	5.0	6.5	8.2	0.003	-0.012	0.000	-0.077	0.002	0.077
2.B	Chemical industry	CO_2	3.0	1.0	3.2	0.000	0.000	0.000	0.000	0.000	0.000
2.B	Chemical industry	N_2O	30.0	40.0	50.0	0.000	-0.011	0.000	-0.450	0.000	0.450
2.C	Metal production	CH_4	1.5	100.00	100.0	0.022	0.000	0.000	0.009	0.001	0.009
2.C.2	Ferroalloys	CO_2	1.5	1.0	1.8	0.142	0.038	0.086	0.038	0.183	0.187
2.C.3	Aluminium	CO_2	1.5	1.0	1.8	0.434	0.232	0.264	0.232	0.560	0.606
2.C.3	Aluminium	PFC	5.0	9.3	10.6	0.163	-0.081	0.017	-0.751	0.120	0.761
2.F	Consumption of halocarbons and SF6, refrigeration	HFC	176.0	79.6	193.2	5.383	0.031	0.031	2.432	7.611	7.991
2.F	Consumption of halocarbons and SF6, refrigeration	PFC	176.0	79.6	193.2	0.000	0.000	0.000	0.000	0.000	0.000
2.F	Consumption of halocarbons and SF6, electrical equipment	SF6	20.0	50.0	53.9	0.058	0.001	0.001	0.046	0.033	0.057
3	Solvent and other product use	N_2O	20.0	5.0	20.6	0.013	-0.001	0.001	-0.003	0.020	0.020
3	Solvent and other product use	CO_2	61.3	167.5	178.4	0.098	0.000	0.001	-0.019	0.052	0.055
4.A.1	Enteric fermentation, cattle	CH_4	17.8	20.0	26.8	0.426	-0.002	0.017	-0.033	0.441	0.442
4.A.3	Enteric fermentation, sheep	CH_4	17.2	20.0	26.4	0.666	-0.008	0.028	-0.154	0.674	0.691
4.A.4-10	Enteric fermentation, rest	CH_4	20.0	40.0	44.7	0.272	0.000	0.007	-0.006	0.189	0.189
4.B	Manure management	N_2O	55.7	100.0	114.4	0.958	-0.003	0.009	-0.293	0.723	0.780
4.B	Manure management	CH_4	50.9	126.9	136.7	1.039	-0.001	0.008	-0.158	0.601	0.621
4.D.1	Direct soil emissions	N_2O	31.1	326.1	327.6	8.636	-0.006	0.029	-1.843	1.273	2.240
4.D.2	Animal production	N_2O	55.8	100.0	114.5	1.853	-0.003	0.018	-0.314	1.401	1.436
4.D.3	Indirect soil emissions	N_2O	66.9	1,000.0	1,002.2	25.397	-0.005	0.028	-5.121	2.632	5.758
5.A.1	Forest land remaining forest land	CO_2	14.0	10.0	17.2	-0.119	-0.004	-0.008	-0.041	-0.150	0.155
5.A.2	Land converted to forest land	CO_2	5.0	10.0	11.2	-0.503	-0.043	-0.049	-0.432	-0.349	0.556

5.A	Forest land	N_2O	5.0	400.0	400.0	0.092	0.000	0.000	0.071	0.002	0.071
5.B.1	Cropland remaining Cropland	CO_2	20.0	90.0	92.2	17.886	0.035	0.213	3.144	6.021	6.793
5.B.2	Land converted to Cropland	CO_2	20.0	90.0	92.2	1.149	-0.087	0.014	-7.863	0.387	7.872
5.C.1	Wetland drained for more than 20 years	CO_2	20.0	90.0	92.2	5.142	0.022	0.061	1.953	1.731	2.609
5.C.1	All other remaining Grassland	CO_2	20.0	20.0	28.3	-0.080	-0.003	-0.003	-0.054	-0.088	0.103
5.C.2.1/2/3/4	All other conversion to Grassland	CO_2	20.0	90.0	92.2	1.393	-0.013	0.017	-1.175	0.469	1.265
5.C.2.5	Other land converted to Grassland, revegetation	CO_2	30.0	25.0	39.1	-4.101	-0.034	-0.115	-0.848	-4.889	4.962
5.D	Wetlands	CO_2	20.0	50.0	53.9	0.101	0.002	0.002	0.082	0.058	0.100
5.D	Wetlands	CH_4	20.0	50.0	53.9	0.087	0.001	0.002	0.070	0.050	0.086
5.E.2.1	Settlements	CO_2	5.0	10.0	11.2	0.000	0.000	0.000	0.000	0.000	0.000
5	LULUCF, wildfires	CH_4	10.0	70.0	70.7	0.000	0.000	0.000	0.000	0.000	0.000
5	LULUCF, wildfires	N_2O	10.0	70.0	70.7	0.000	0.000	0.000	0.000	0.000	0.000
5.G	Grassland non CO2-emissions	N_2O	20.0	25.0	32.0	0.487	0.001	0.017	0.018	0.472	0.472
6.A.1	Managed waste disposal on land	CH_4	42.4	35.9	55.6	1.448	0.026	0.029	0.918	1.716	1.946
6.A2	Unmanaged waste disposal sites	CH_4	42.4	51.4	66.7	0.350	-0.019	0.006	-0.976	0.346	1.035
6.B	Wastewater handling	CH_4	36.4	58.3	68.7	0.047	0.000	0.001	0.025	0.039	0.046
6.B	Wastewater handling	N_2O	45.7	1,000.0	1,001.0	1.556	0.000	0.002	0.256	0.110	0.279
6.C	Waste incineration	CO_2	33.9	13.8	36.6	0.048	-0.001	0.001	-0.016	0.069	0.070
6.C	Waste incineration	N_2O	20.0	100.0	102.0	0.004	0.000	0.000	-0.028	0.001	0.028
6.C	Waste incineration	CH_4	20.0	100.0	102.0	0.005	-0.001	0.000	-0.115	0.002	0.115
6.D	Other (composting)	CH_4	20.0	100.0	102.0	0.019	0.000	0.000	0.020	0.006	0.021
6.D	Other (composting)	N_2O	20.0	100.0	102.0	0.021	0.000	0.000	0.022	0.006	0.023
	Totals					**33.6**					**16.0**

Annex III. Explenation of EA's adjustment of data on fuel sales

Fuel sales (gas oil and residual fuel oil) by sectors 1A1a, 1A2 (stationary) and 1A4 (stationary) – as provided by the National Energy Authority

No.	Category	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
		Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes
Gas/Diesel Oil														
10X40	**house heating and swimming pools**	**10,623**	**8,535**	**7,625**	**4,240**	**2,417**	**2,420**	**1,546**	**1,626**	**1,637**	**1,595**	**1,745**	**1,585**	**3,109**
10X5X	**industry**	**5,072**	**1,129**	**10,253**	**22,177**	**23,751**	**14,852**	**8,553**	**9,849**	**9,391**	**4,919**	**5,412**	**7,575**	**4,571**
10X60	**energy industries**	**1,300**	**1,091**	**1,065**	**21**	**1,349**	**1,109**	**1,436**	**760**	**1,012**	**683**	**955**	**1,090**	**1,423**
10X90	**other**	**0**	**458**	**1,386**	**8,928**	**8,296**	**2,033**	**1,336**	**1,499**	**2,728**	**1,136**	**260**	**768**	**214**
Residual Fuel Oil														
10840	**house heating and swimming pools**	**2,989**	**3,079**	**122**	**195**	**76**	**86**	**63**	**78**	**0**	**0**	**0**	**0**	**191**
1085X	**industry**	**55,934**	**56,224**	**46,213**	**25,005**	**23,635**	**22,839**	**20,475**	**17,646**	**16,546**	**17,294**	**17,839**	**13,789**	**3,806**
10860	**energy industries**	**0**	**0**	**0**	**0**	**5**	**4,498**	**0**	**0**	**0**	**0**	**135**	**125**	**0**
10890	**other**	**39**	**52**	**67**	**0**	**0**	**45**	**913**	**0**	**1,629**	**780**	**0**	**0**	**0**

ADJUSTMENTS

For gas oil:

First fuel consumption needed for the known electricity production with fuels is calculated (**1A1a** – electricity production), assuming 34% efficiency, the values calculated are compared with the fuel sales for the category 10X60 Energy industries.

- In years where there is less fuel sale to energy industries as would be needed for the electricity production, the fuel needed is taken from the category 10X90 Other and when that is not sufficient from the category 10X40 House heating and swimming pools.
- In years where there is surplus the extra fuel is added to the category 10X40 House heating and swimming pools.

NEA has estimated the fuel use by swimming pools (**1A4a**). These values are subtracted from the adjusted 10X40 category. The rest of the category is then **1A4c** – Residential.

For years when there is still fuel in the category 10X90 Other, this is added to the 10X5X Industry. This is the fuel use in **1A2** – Industry.

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Swimming pools	1800	1600	1600	1000	300	300	300	300	300	300	300	300	300

For Residual Fuel Oil:

The sectors 10840 and 10860 are added together. This is the fuel use by **1A1a** - public heat plants, In year 1997 four tonnes are subtracted from this category as the category 10890 has minus four tonnes, leaving category 10890 with 0 in 1997. The categories 1085X Industry and 10890 Other are added together, this is the fuel use in **1A2** – industry.

Annex IIII. CRF Table Summary 2 for 1990-2014.

1990

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

Inventory 1990
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	9799.62	2896.14	1937.71	NO,NA	494.64	1.10		NO	15129.21
1. Energy	1695.11	6.70	36.27						1738.08
A. Fuel combustion (sectoral approach)	1633.75	5.89	36.27						1675.92
1. Energy industries	13.79	0.01	0.02						13.82
2. Manufacturing industries and construction	201.97	0.12	0.51						202.59
3. Transport	599.54	3.93	15.53						618.99
4. Other sectors	818.46	1.84	20.21						840.51
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	61.36	0.81	NO,NA						62.17
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	61.36	0.81	NA,NO						62.17
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	399.59	0.73	52.25	NO	494.64	1.10		NO	948.31
A. Mineral industry	52.28								52.28
B. Chemical industry	0.36	NO,NE	46.49	NO	NO	NO		NO	46.85
C. Metal industry	346.63	0.73	NA		494.64	NO,NA			842.00
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				NO	NO				NO
G. Other product manufacture and use	NE	NE	5.77			1.10			6.86
H. Other									
3. Agriculture	0.06	364.49	415.03						779.58
A. Enteric fermentation		313.83							313.83
B. Manure management		50.66	50.01						100.67
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	365.02						365.02
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7693.59	2374.38	1427.67						11495.65
A. Forest land	-45.16	0.11	0.93						-44.11
B. Cropland	1919.45	94.83	NA,NE,IE						2014.28
C. Grassland	6483.33	477.67	1426.74						8387.74
D. Wetlands	-677.22	1801.77	NO,NA,NE						1124.55
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	11.27	149.83	6.48						167.59
A. Solid waste disposal	NE,NA	141.97							141.97
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	11.27	6.18	1.34						18.79
D. Waste water treatment and discharge		1.68	5.15						6.83
E. Other	NA	NO	NO						NO,NA
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	316.25	0.27	2.63						319.15
Aviation	217.25	0.04	1.83						219.11
Navigation	99.00	0.23	0.80						100.03
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	NO,NA								NO,NA
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3633.56
Total CO_2 equivalent emissions with land use, land-use change and forestry	15129.21
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3633.56
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15129.21

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for
(2) See footnote 7 to table Summary 1.A.
(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1991

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

Inventory 1991
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	9737.14	2892.99	1922.35	NO,NA	410.61	1.24		NO	14964.32
1. Energy	1666.10	6.73	36.15						1708.98
A. Fuel combustion (sectoral approach)	1596.15	6.02	36.15						1638.32
1. Energy industries	15.39	0.01	0.02						15.42
2. Manufacturing industries and construction	138.10	0.08	0.39						138.56
3. Transport	610.87	4.04	16.03						630.94
4. Other sectors	831.79	1.89	19.71						853.39
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	69.95	0.72	NO,NA						70.67
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	69.95	0.72	NA,NO						70.67
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	365.60	0.60	50.26	NO	410.61	1.24		NO	828.32
A. Mineral industry	48.65								48.65
B. Chemical industry	0.31	NO,NE	45.00	NO	NO	NO		NO	45.31
C. Metal industry	316.32	0.60	NA		410.61	NO,NA			727.54
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				NO	NO				NO
G. Other product manufacture and use	NE	NE	5.27			1.24			6.51
H. Other									
3. Agriculture	0.06	353.86	399.06						752.97
A. Enteric fermentation		304.17							304.17
B. Manure management		49.68	46.46						96.15
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	352.60						352.60
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7694.20	2376.36	1430.32						11500.88
A. Forest land	-46.75	0.15	1.22						-45.38
B. Cropland	1910.44	94.32	NA,NE,IE						2004.76
C. Grassland	6487.40	478.46	1429.10						8394.96
D. Wetlands	-670.08	1803.44	NO,NA,NE						1133.36
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	11.18	155.43	6.55						173.17
A. Solid waste disposal	NE,NA	146.73							146.73
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	11.18	6.14	1.33						18.65
D. Waste water treatment and discharge		2.56	5.23						7.79
E. Other	NA	NO	NO						NO,NA
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	256.92	0.13	2.15						259.20
Aviation	219.55	0.04	1.85						221.44
Navigation	37.37	0.09	0.30						37.76
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	NO,NA								NO,NA
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3463.44
Total CO_2 equivalent emissions with land use, land-use change and forestry	14964.32
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3463.44
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	14964.32

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1992

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

Inventory 1992
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	9855.85	2897.39	1895.37	NO,NA	183.04	1.24		NO	14832.89
1. Energy	1793.07	7.04	36.10						1836.20
A. Fuel combustion (sectoral approach)	1725.45	6.29	36.10						1767.83
1. Energy industries	13.83	0.01	0.02						13.86
2. Manufacturing industries and construction	205.42	0.13	0.46						206.01
3. Transport	621.01	4.15	16.40						641.56
4. Other sectors	885.19	2.00	19.21						906.41
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	67.62	0.75	NO,NA						68.37
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	67.62	0.75	NA,NO						68.37
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	368.61	0.63	44.91	NO	183.04	1.24		NO	598.43
A. Mineral industry	45.69								45.69
B. Chemical industry	0.25	NO,NE	40.23	NO	NO	NO		NO	40.48
C. Metal industry	322.36	0.63	NA		183.04	NO,NA			506.02
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				NO	NO				NO
G. Other product manufacture and use	NE	NE	4.68			1.24			5.93
H. Other									
3. Agriculture	0.06	348.12	374.66						722.83
A. Enteric fermentation		299.58							299.58
B. Manure management		48.53	41.39						89.92
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	333.27						333.27
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7683.23	2374.55	1433.12						11490.90
A. Forest land	-51.24	0.20	1.66						-49.38
B. Cropland	1900.69	93.81	NA,NE,IE						1994.50
C. Grassland	6489.86	479.24	1431.47						8400.57
D. Wetlands	-669.27	1801.29	NO,NA,NE						1132.02
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	10.88	167.06	6.59						184.52
A. Solid waste disposal	NE,NA	158.48							158.48
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	10.88	5.99	1.29						18.17
D. Waste water treatment and discharge		2.59	5.29						7.88
E. Other	NA	NO	NO						NO,NA
6. Other ***(as specified in summary 1.A)***	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	260.90	0.18	2.18						263.26
Aviation	201.39	0.04	1.70						203.12
Navigation	59.51	0.14	0.48						60.14
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	NO,NA								NO,NA
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3341.99
Total CO_2 equivalent emissions with land use, land-use change and forestry	14832.89
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3341.99
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	14832.89

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1993

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

Inventory 1993
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	9967.16	2906.23	1910.23	1.46	88.24	1.24		NO	14874.57
1. Energy	1868.15	7.21	39.75						1915.11
A. Fuel combustion (sectoral approach)	1782.78	6.44	39.75						1828.96
1. Energy industries	12.92	0.01	0.02						12.95
2. Manufacturing industries and construction	224.51	0.14	0.51						225.16
3. Transport	621.61	4.12	16.30						642.03
4. Other sectors	923.73	2.17	22.92						948.82
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	85.38	0.77	NO,NA						86.15
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	85.38	0.77	NA,NO						86.15
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	417.03	0.72	46.88	1.46	88.24	1.24		NO	555.57
A. Mineral industry	39.68								39.68
B. Chemical industry	0.24	NO,NE	42.32	NO	NO	NO		NO	42.56
C. Metal industry	376.80	0.72	NA		88.24	NO,NA			465.75
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				1.46	NO				1.46
G. Other product manufacture and use	NE	NE	4.57			1.24			5.81
H. Other									
3. Agriculture	0.06	348.00	381.57						729.63
A. Enteric fermentation		299.59							299.59
B. Manure management		48.41	42.05						90.46
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	339.52						339.52
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7672.66	2373.78	1435.57						11482.01
A. Forest land	-56.43	0.21	1.74						-54.48
B. Cropland	1890.88	93.30	NA,NE,IE						1984.18
C. Grassland	6493.89	480.03	1433.83						8407.75
D. Wetlands	-668.87	1800.24	NO,NA,NE						1131.38
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	9.27	176.52	6.47						192.25
A. Solid waste disposal	NE,NA	168.71							168.71
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	9.27	5.19	1.12						15.58
D. Waste water treatment and discharge		2.61	5.35						7.96
E. Other	NA	NO	NO						NO,NA
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	290.17	0.26	2.41						292.85
Aviation	193.50	0.03	1.63						195.16
Navigation	96.67	0.23	0.78						97.69
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.31								0.31
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								
Total CO_2 equivalent emissions without land use, land-use change and forestry									3392.56
Total CO_2 equivalent emissions with land use, land-use change and forestry									14874.57
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									3392.56
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									14874.57

[(1)] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[(2)] See footnote 7 to table Summary 1.A.

[(3)] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1994

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

Inventory 1994
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	9919.35	2916.37	1918.49	2.34	52.53	1.24		NO	14810.32
1. Energy	1821.54	7.12	39.90						1868.55
A. Fuel combustion (sectoral approach)	1751.42	6.34	39.90						1797.65
1. Energy industries	12.60	0.01	0.02						12.62
2. Manufacturing industries and construction	210.36	0.13	0.48						210.97
3. Transport	624.17	4.16	16.46						644.79
4. Other sectors	904.28	2.04	22.95						929.27
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	70.12	0.78	NO,NA						70.90
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	70.12	0.78	NA,NO						70.90
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	418.23	0.68	46.78	2.34	52.53	1.24		NO	521.81
A. Mineral industry	37.37								37.37
B. Chemical industry	0.35	NO,NE	42.61	NO	NO	NO		NO	42.97
C. Metal industry	380.20	0.68	NA		52.53	NO,NA			433.41
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				2.34	NO				2.34
G. Other product manufacture and use	NE	NE	4.16			1.24			5.41
H. Other									
3. Agriculture	0.06	349.94	387.35						737.35
A. Enteric fermentation		301.60							301.60
B. Manure management		48.34	42.08						90.42
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	345.27						345.27
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7670.98	2372.93	1438.04						11481.95
A. Forest land	-59.17	0.22	1.85						-57.10
B. Cropland	1881.04	92.79	NA,NE,IE						1973.83
C. Grassland	6496.73	480.81	1436.19						8413.74
D. Wetlands	-668.43	1799.10	NO,NA,NE						1130.67
E. Settlements	20.81	NE	NE,IE						20.81
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	8.54	185.70	6.42						200.66
A. Solid waste disposal	NE,NA	178.25							178.25
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	8.54	4.82	1.04						14.40
D. Waste water treatment and discharge		2.63	5.38						8.01
E. Other	NA	NO	NO						NO,NA
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	304.15	0.26	2.53						306.94
Aviation	211.28	0.04	1.78						213.09
Navigation	92.87	0.22	0.75						93.84
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.31								0.31
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3328.37
Total CO_2 equivalent emissions with land use, land-use change and forestry	14810.32
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3328.37
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	14810.32

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1995

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

Inventory 1995
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	9946.50	2910.48	1910.83	10.23	69.36	1.24		NO	14848.65
1. Energy	1857.01	6.60	47.42						1911.03
A. Fuel combustion (sectoral approach)	1774.78	5.72	47.42						1827.92
1. Energy industries	16.38	0.01	0.03						16.42
2. Manufacturing industries and construction	215.00	0.13	0.46						215.59
3. Transport	599.91	3.47	20.19						623.56
4. Other sectors	943.50	2.11	26.75						972.35
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	82.23	0.88	NO,NA						83.11
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	82.23	0.88	NA,NO						83.11
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	435.01	0.70	44.66	10.23	69.36	1.24		NO	561.20
A. Mineral industry	37.87								37.87
B. Chemical industry	0.46	NO,NE	40.53	NO	NO	NO		NO	40.98
C. Metal industry	396.37	0.70	NA		69.36	NO,NA			466.44
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				10.23	NO				10.23
G. Other product manufacture and use	NE	NE	4.13			1.24			5.37
H. Other									
3. Agriculture	0.06	337.63	369.91						707.60
A. Enteric fermentation		290.03							290.03
B. Manure management		47.60	39.44						87.04
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	330.47						330.47
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7646.89	2370.45	1442.31						11459.65
A. Forest land	-68.67	0.26	2.13						-66.28
B. Cropland	1871.22	92.28	NA,NE,IE						1963.50
C. Grassland	6505.29	482.14	1440.18						8427.62
D. Wetlands	-667.18	1795.78	NO,NA,NE						1128.60
E. Settlements	6.22	NE	NE,IE						6.22
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	7.53	195.09	6.54						209.17
A. Solid waste disposal	NE,NA	187.95							187.95
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	7.53	4.30	0.93						12.76
D. Waste water treatment and discharge		2.64	5.43						8.07
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	376.61	0.38	3.13						380.12
Aviation	233.56	0.04	1.97						235.57
Navigation	143.05	0.34	1.16						144.55
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.31								0.31
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3389.00
Total CO_2 equivalent emissions with land use, land-use change and forestry	14848.65
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3389.00
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	14848.65

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1996

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

Inventory 1996
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	10033.21	2918.77	1934.39	18.59	29.64	1.24		NO	14935.86
1. Energy	1944.72	6.75	47.37						1998.85
A. Fuel combustion (sectoral approach)	1863.45	5.92	47.37						1916.74
1. Energy industries	8.23	0.00	0.01						8.24
2. Manufacturing industries and construction	260.07	0.17	0.51						260.75
3. Transport	590.23	3.50	20.16						613.88
4. Other sectors	1004.92	2.25	26.69						1033.86
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	81.27	0.84	NO,NA						82.10
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	81.27	0.84	NA,NO						82.10
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	434.38	0.68	51.88	18.59	29.64	1.24		NO	536.43
A. Mineral industry	41.78								41.78
B. Chemical industry	0.40	NO,NE	47.38	NO	NO	NO		NO	47.78
C. Metal industry	391.89	0.68	NA		29.64	NO,NA			422.22
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				18.59	NO				18.59
G. Other product manufacture and use	NE	NE	4.50			1.24			5.74
H. Other									
3. Agriculture	0.07	342.15	382.68						724.90
A. Enteric fermentation		294.06							294.06
B. Manure management		48.09	40.39						88.48
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	342.29						342.29
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.07								0.07
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7647.30	2370.41	1445.97						11463.68
A. Forest land	-72.97	0.27	2.24						-70.45
B. Cropland	1861.43	91.77	NA,NE,IE						1953.20
C. Grassland	6512.79	483.32	1443.73						8439.83
D. Wetlands	-664.66	1795.05	NO,NA,NE						1130.39
E. Settlements	10.71	NE	NE,IE						10.71
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	6.75	198.78	6.49						212.01
A. Solid waste disposal	NE,NA	192.03							192.03
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	6.75	3.89	0.84						11.48
D. Waste water treatment and discharge		2.66	5.47						8.13
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	391.67	0.34	3.26						395.27
Aviation	268.53	0.05	2.26						270.84
Navigation	123.14	0.29	1.00						124.43
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.31								0.31
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3472.18
Total CO_2 equivalent emissions with land use, land-use change and forestry	14935.86
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3472.18
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	14935.86

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1997

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

Inventory 1997
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	10102.71	2915.24	1937.27	28.76	97.08	1.24		NO	15082.30
1. Energy	1949.95	6.34	55.32						2011.61
A. Fuel combustion (sectoral approach)	1886.10	5.28	55.32						1946.70
1. Energy industries	4.74	0.00	0.01						4.75
2. Manufacturing industries and construction	275.62	0.17	0.57						276.37
3. Transport	601.32	2.87	24.62						628.81
4. Other sectors	1004.41	2.23	30.12						1036.77
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	63.85	1.06	NO,NA						64.91
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	63.85	1.06	NA,NO						64.91
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	493.73	0.72	44.04	28.76	97.08	1.24		NO	665.58
A. Mineral industry	46.55								46.55
B. Chemical industry	0.44	NO,NE	39.51	NO	NO	NO		NO	39.95
C. Metal industry	446.44	0.72	NA		97.08	NO,NA			544.24
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				28.76	NO				28.76
G. Other product manufacture and use	NE	NE	4.53			1.24			5.77
H. Other									
3. Agriculture	0.06	338.74	379.17						717.98
A. Enteric fermentation		291.40							291.40
B. Manure management		47.34	40.98						88.32
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	338.19						338.19
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7652.47	2366.75	1452.22						11471.44
A. Forest land	-79.84	0.30	2.44						-77.11
B. Cropland	1851.56	91.25	NA,NE,IE						1942.82
C. Grassland	6531.34	485.34	1449.79						8466.47
D. Wetlands	-662.67	1789.86	NO,NA,NE						1127.19
E. Settlements	12.08	NE	NE,IE						12.08
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	6.50	202.69	6.50						215.69
A. Solid waste disposal	NE,NA	196.08							196.08
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	6.50	3.73	0.81						11.04
D. Waste water treatment and discharge		2.68	5.52						8.20
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	436.71	0.40	3.63						440.74
Aviation	288.91	0.05	2.43						291.40
Navigation	147.80	0.35	1.19						149.34
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.31								0.31
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3610.86
Total CO_2 equivalent emissions with land use, land-use change and forestry	15082.30
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3610.86
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15082.30

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1998

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

Inventory 1998
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	10116.00	2922.11	1947.86	43.21	212.33	1.24		NO	15242.76
1. Energy	1923.02	6.57	55.92						1985.51
A. Fuel combustion (sectoral approach)	1839.32	5.26	55.92						1900.50
1. Energy industries	7.71	0.01	0.01						7.73
2. Manufacturing industries and construction	241.36	0.15	0.55						242.06
3. Transport	605.02	2.93	25.22						633.16
4. Other sectors	985.23	2.18	30.14						1017.55
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	83.70	1.31	NO,NA						85.01
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	83.70	1.31	NA,NO						85.01
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	521.63	0.53	39.09	43.21	212.33	1.24		NO	818.03
A. Mineral industry	54.39								54.39
B. Chemical industry	0.40	NO,NE	34.45	NO	NO	NO		NO	34.85
C. Metal industry	466.53	0.53	NA		212.33	NO,NA			679.39
D. Non-energy products from fuels and solvent use	0.31	NE	NE						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				43.21	NO				43.21
G. Other product manufacture and use	NE	NE	4.64			1.24			5.88
H. Other									
3. Agriculture	0.08	345.73	385.43						731.24
A. Enteric fermentation		296.96							296.96
B. Manure management		48.77	41.94						90.71
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	343.49						343.49
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.08								0.08
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7665.77	2361.25	1460.96						11487.99
A. Forest land	-88.26	0.34	2.75						-85.17
B. Cropland	1841.71	90.74	NA,NE,IE						1932.45
C. Grassland	6558.99	488.16	1458.22						8505.37
D. Wetlands	-659.52	1782.02	NO,NA,NE						1122.49
E. Settlements	12.85	NE	NE,IE						12.85
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	5.51	208.03	6.46						220.00
A. Solid waste disposal	NE,NA	201.91							201.91
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	5.51	3.20	0.69						9.41
D. Waste water treatment and discharge		2.72	5.58						8.30
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	510.01	0.47	4.23						514.71
Aviation	334.42	0.06	2.82						337.29
Navigation	175.59	0.42	1.42						177.42
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.31								0.31
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3754.77
Total CO_2 equivalent emissions with land use, land-use change and forestry	15242.76
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3754.77
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15242.76

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

1999

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

Inventory 1999
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	10340.27	2921.47	1975.64	48.83	204.17	1.24		NO	15491.62
1. Energy	1980.10	6.40	64.66						2051.15
A. Fuel combustion (sectoral approach)	1868.82	4.51	64.66						1937.99
1. Energy industries	4.79	0.01	0.01						4.81
2. Manufacturing industries and construction	251.35	0.15	0.57						252.08
3. Transport	625.94	2.17	31.29						659.40
4. Other sectors	986.73	2.19	32.79						1021.71
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	111.27	1.89	NO,NA						113.16
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	111.27	1.89	NA,NO						113.16
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	670.72	0.80	39.41	48.83	204.17	1.24		NO	965.18
A. Mineral industry	61.43								61.43
B. Chemical industry	0.43	NO,NE	34.78	NO	NO	NO		NO	35.21
C. Metal industry	608.55	0.80	NA		204.17	NO,NA			813.52
D. Non-energy products from fuels and solvent use	0.31	NE,NO	NE,NO						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				48.83	NO				48.83
G. Other product manufacture and use	NE	NE	4.63			1.24			5.88
H. Other									
3. Agriculture	0.07	344.87	394.71						739.65
A. Enteric fermentation		296.31							296.31
B. Manure management		48.56	42.03						90.60
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	352.68						352.68
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.07								0.07
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7684.87	2355.45	1470.44						11510.77
A. Forest land	-94.63	0.36	2.91						-91.37
B. Cropland	1831.74	90.23	NA,NE,IE						1921.97
C. Grassland	6591.04	491.27	1467.54						8549.84
D. Wetlands	-656.34	1773.59	NO,NA,NE						1117.25
E. Settlements	13.07	NE	NE,IE						13.07
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	4.51	213.95	6.41						224.87
A. Solid waste disposal	NE,NA	208.32							208.32
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	4.51	2.68	0.58						7.77
D. Waste water treatment and discharge		2.75	5.65						8.40
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	522.10	0.45	4.35						526.90
Aviation	359.38	0.06	3.03						362.47
Navigation	162.72	0.39	1.32						164.43
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.40								0.40
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3980.85
Total CO_2 equivalent emissions with land use, land-use change and forestry	15491.62
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3980.85
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15491.62

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2000

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

Inventory 2000
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	10448.78	2904.79	1964.04	43.24	149.89	1.31		NO	15512.06
1. Energy	1931.77	6.46	64.51						2002.74
A. Fuel combustion (sectoral approach)	1778.62	4.35	64.51						1847.49
1. Energy industries	3.78	0.01	0.01						3.79
2. Manufacturing industries and construction	207.31	0.12	0.50						207.94
3. Transport	628.99	2.15	31.08						662.22
4. Other sectors	938.54	2.08	32.92						973.54
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	153.15	2.11	NO,NA						155.26
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	153.15	2.11	NA,NO						155.26
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	792.86	1.12	22.35	43.24	149.89	1.31		NO	1010.78
A. Mineral industry	65.48								65.48
B. Chemical industry	0.41	NO,NE	17.91	NO	NO	NO		NO	18.32
C. Metal industry	726.67	1.12	NA		149.89	NO,NA			877.69
D. Non-energy products from fuels and solvent use	0.31	NE,NO	NE,NO						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				43.24	NO				43.24
G. Other product manufacture and use	NE	NE	4.44			1.31			5.75
H. Other									
3. Agriculture	0.07	331.85	387.20						719.12
A. Enteric fermentation		284.76							284.76
B. Manure management		47.09	41.45						88.54
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	345.74						345.74
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.07								0.07
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7719.84	2345.95	1483.50						11549.29
A. Forest land	-104.46	0.44	3.69						-100.33
B. Cropland	1821.81	89.72	NA,NE,IE						1911.53
C. Grassland	6638.94	495.38	1479.82						8614.14
D. Wetlands	-651.37	1760.41	NO,NA,NE						1109.04
E. Settlements	14.91	NE	NE,IE						14.91
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	4.24	219.41	6.48						230.13
A. Solid waste disposal	NE,NA	213.80							213.80
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	4.24	2.62	0.57						7.42
D. Waste water treatment and discharge		2.79	5.73						8.53
E. Other	NA	NO	NO						NA,NO
6. Other ***(as specified in summary 1.A)***	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	620.47	0.59	5.15						626.21
Aviation	403.26	0.07	3.40						406.73
Navigation	217.21	0.52	1.76						219.48
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.40								0.40
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3962.77
Total CO_2 equivalent emissions with land use, land-use change and forestry	15512.06
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3962.77
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15512.06

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2001

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

Inventory 2001
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	10452.12	2910.53	1965.39	48.64	108.05	1.31		NO	15486.05
1. Energy	1879.13	6.39	63.71						1949.24
A. Fuel combustion (sectoral approach)	1735.36	4.21	63.71						1803.28
1. Energy industries	3.09	0.00	0.01						3.10
2. Manufacturing industries and construction	241.59	0.15	0.58						242.32
3. Transport	639.69	2.18	31.38						673.25
4. Other sectors	850.99	1.88	31.75						884.61
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	143.77	2.19	NO,NA						145.96
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	143.77	2.19	NA,NO						145.96
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	827.05	1.08	19.66	48.64	108.05	1.31		NO	1005.80
A. Mineral industry	58.69								58.69
B. Chemical industry	0.49	NO,NE	15.53	NO	NO	NO		NO	16.02
C. Metal industry	767.56	1.08	NA		108.04	NO,NA			876.68
D. Non-energy products from fuels and solvent use	0.31	NE,NO	NE,NO						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				48.64	0.01				48.65
G. Other product manufacture and use	NE	NE	4.14			1.31			5.45
H. Other									
3. Agriculture	0.08	335.75	383.10						718.93
A. Enteric fermentation		287.08							287.08
B. Manure management		48.67	40.07						88.74
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	343.03						343.03
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.08								0.08
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7741.83	2340.45	1492.42						11574.70
A. Forest land	-110.11	0.47	3.87						-105.76
B. Cropland	1811.76	89.21	NA,NE,IE						1900.96
C. Grassland	6673.77	498.29	1488.54						8660.61
D. Wetlands	-648.22	1752.48	NO,NA,NE						1104.26
E. Settlements	14.63	NE	NE,IE						14.63
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	4.03	226.85	6.50						237.38
A. Solid waste disposal	NE,NA	221.45							221.45
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	4.03	2.37	0.52						6.93
D. Waste water treatment and discharge		2.82	5.80						8.63
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	493.28	0.41	4.11						497.80
Aviation	345.29	0.06	2.91						348.26
Navigation	147.98	0.35	1.20						149.54
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.40								0.40
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3911.35
Total CO_2 equivalent emissions with land use, land-use change and forestry	15486.05
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3911.35
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15486.05

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2002

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

Inventory 2002
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	10573.08	2899.21	1946.06	46.08	85.51	1.31		NO	15551.25
1. Energy	1950.86	6.57	63.05						2020.48
A. Fuel combustion (sectoral approach)	1803.30	4.38	63.05						1870.73
1. Energy industries	5.06	0.01	0.01						5.08
2. Manufacturing industries and construction	253.52	0.16	0.56						254.25
3. Transport	643.32	2.20	31.69						677.21
4. Other sectors	901.39	2.01	30.78						934.19
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	147.57	2.19	NO,NA						149.75
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	147.57	2.19	NA,NO						149.75
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	841.21	1.15	3.89	46.08	85.51	1.31		NO	979.16
A. Mineral industry	39.34								39.34
B. Chemical industry	0.45	NO,NE	NO	NO	NO	NO		NO	0.45
C. Metal industry	801.11	1.15	NA		85.50	NO,NA			887.77
D. Non-energy products from fuels and solvent use	0.31	NE,NO	NE,NO						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				46.08	0.01				46.08
G. Other product manufacture and use	NE	NE	3.89			1.31			5.20
H. Other									
3. Agriculture	0.08	328.01	367.92						696.01
A. Enteric fermentation		281.15							281.15
B. Manure management		46.86	40.15						87.00
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	327.77						327.77
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.08								0.08
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7777.17	2332.50	1504.68						11614.35
A. Forest land	-118.77	0.50	4.15						-114.12
B. Cropland	1801.68	88.69	NA,NE,IE						1890.37
C. Grassland	6723.69	502.30	1500.53						8726.52
D. Wetlands	-643.89	1741.00	NO,NA,NE						1097.11
E. Settlements	14.46	NE	NE,IE						14.46
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	3.75	230.99	6.51						241.25
A. Solid waste disposal	NE,NA	223.36							223.36
B. Biological treatment of solid waste		0.20	0.18						0.38
C. Incineration and open burning of waste	3.75	2.21	0.48						6.45
D. Waste water treatment and discharge		5.21	5.85						11.06
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	512.29	0.54	4.25						517.09
Aviation	306.45	0.05	2.58						309.08
Navigation	205.85	0.49	1.67						208.01
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.40								0.40
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3936.90
Total CO_2 equivalent emissions with land use, land-use change and forestry	15551.25
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3936.90
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15551.25

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2003

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

Inventory 2003
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	10578.58	2891.94	1945.51	56.74	70.47	1.31		NO	15544.56
1. Energy	1948.75	6.59	63.91						2019.25
A. Fuel combustion (sectoral approach)	1812.24	4.46	63.91						1880.61
1. Energy industries	4.32	0.01	0.01						4.34
2. Manufacturing industries and construction	224.44	0.16	0.48						225.08
3. Transport	737.96	2.35	33.35						773.65
4. Other sectors	845.52	1.95	30.08						877.54
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	136.51	2.13	NO,NA						138.64
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	136.51	2.13	NA,NO						138.64
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	840.67	1.12	3.74	56.74	70.47	1.31		NO	974.05
A. Mineral industry	33.00								33.00
B. Chemical industry	0.48	NO,NE	NO	NO	NO	NO		NO	0.48
C. Metal industry	806.88	1.12	NA		70.47	NO,NA			878.48
D. Non-energy products from fuels and solvent use	0.31	NE	NE,NO						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				56.74	0.00				56.74
G. Other product manufacture and use	NE	NE	3.74			1.31			5.05
H. Other									
3. Agriculture	0.08	323.98	358.81						682.87
A. Enteric fermentation		278.07							278.07
B. Manure management		45.90	39.83						85.73
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	318.98						318.98
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.08								0.08
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7785.86	2327.63	1512.48						11625.97
A. Forest land	-129.51	0.53	4.41						-124.57
B. Cropland	1791.59	88.18	NA,NE,IE						1879.77
C. Grassland	6746.89	504.82	1508.07						8759.78
D. Wetlands	-641.28	1734.10	NO,NA,NE						1092.81
E. Settlements	18.17	NE	NE,IE						18.17
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	3.22	232.63	6.58						242.42
A. Solid waste disposal	NE,NA	225.15							225.15
B. Biological treatment of solid waste		0.30	0.27						0.57
C. Incineration and open burning of waste	3.22	1.93	0.42						5.57
D. Waste water treatment and discharge		5.25	5.89						11.14
E. Other	NA	NO	NO						NA,NO
6. Other ***(as specified in summary 1.A)***	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	472.14	0.40	3.93						476.47
Aviation	329.34	0.06	2.77						332.17
Navigation	142.80	0.34	1.16						144.29
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.59								0.59
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3918.59
Total CO_2 equivalent emissions with land use, land-use change and forestry	15544.56
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3918.59
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15544.56

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2004

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

Inventory 2004
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	10625.85	2889.08	1950.42	60.25	45.48	1.31		NO	15572.39
1. Energy	1965.95	6.81	68.59						2041.35
A. Fuel combustion (sectoral approach)	1843.05	4.51	68.59						1916.15
1. Energy industries	3.88	0.01	0.01						3.90
2. Manufacturing industries and construction	197.69	0.13	0.48						198.30
3. Transport	789.77	2.47	34.76						827.00
4. Other sectors	851.71	1.91	33.34						886.96
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	122.90	2.30	NO,NA						125.20
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	122.90	2.30	NA,NO						125.20
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	863.91	1.14	3.52	60.25	45.48	1.31		NO	975.62
A. Mineral industry	50.84								50.84
B. Chemical industry	0.39	NO,NE	NO	NO	NO	NO		NO	0.39
C. Metal industry	812.37	1.14	NA		45.47	NO,NA			858.99
D. Non-energy products from fuels and solvent use	0.31	NE	NE,NO						0.31
E. Electronic Industry									
F. Product uses as ODS substitutes				60.25	0.00				60.25
G. Other product manufacture and use	NE	NE	3.52			1.31			4.84
H. Other									
3. Agriculture	0.08	319.15	351.23						670.45
A. Enteric fermentation		273.99							273.99
B. Manure management		45.15	39.66						84.81
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	311.57						311.57
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.08								0.08
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7788.82	2323.01	1520.44						11632.27
A. Forest land	-135.78	0.55	4.52						-130.71
B. Cropland	1781.56	87.67	NA,NE,IE						1869.22
C. Grassland	6766.50	507.44	1515.92						8789.86
D. Wetlands	-638.74	1727.35	NO,NA,NE						1088.62
E. Settlements	15.28	NE	NE,IE						15.28
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	7.09	238.98	6.64						252.70
A. Solid waste disposal	NE,NA	232.21							232.21
B. Biological treatment of solid waste		0.30	0.27						0.57
C. Incineration and open burning of waste	7.09	1.16	0.42						8.67
D. Waste water treatment and discharge		5.30	5.95						11.25
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
Memo items:[(2)]									
International bunkers	570.72	0.53	4.74						575.99
Aviation	375.83	0.07	3.16						379.06
Navigation	194.89	0.46	1.58						196.93
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.52								0.52
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3940.12
Total CO_2 equivalent emissions with land use, land-use change and forestry	15572.39
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3940.12
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15572.39

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2005

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

Inventory 2005
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	10602.22	2877.88	1966.74	69.98	30.76	2.52		NO	15550.11
1. Energy	1946.11	6.53	73.10						2025.73
A. Fuel combustion (sectoral approach)	1827.95	4.04	73.10						1905.08
1. Energy industries	6.88	0.01	0.02						6.90
2. Manufacturing industries and construction	171.19	0.11	0.37						171.67
3. Transport	795.17	2.07	38.60						835.84
4. Other sectors	854.71	1.86	34.11						890.68
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	118.16	2.49	NO,NA						120.65
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	118.16	2.49	NA,NO						120.65
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	846.80	1.15	3.33	69.98	30.76	2.52		NO	954.55
A. Mineral industry	55.01								55.01
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	791.47	1.15	NA		30.76	NO,NA			823.38
D. Non-energy products from fuels and solvent use	0.32	NE	NE						0.32
E. Electronic Industry									
F. Product uses as ODS substitutes				69.98	0.00				69.99
G. Other product manufacture and use	NE	NE	3.33			2.52			5.85
H. Other									
3. Agriculture	0.07	322.32	352.04						674.43
A. Enteric fermentation		276.03							276.03
B. Manure management		46.29	40.12						86.41
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	311.92						311.92
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.00								0.00
H. Urea application	0.07								0.07
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7804.91	2316.08	1531.44						11652.42
A. Forest land	-155.29	0.57	4.71						-150.01
B. Cropland	1771.40	87.15	NA,NE,IE						1858.55
C. Grassland	6803.80	511.05	1526.72						8841.57
D. Wetlands	-634.94	1717.30	NO,NA,NE						1082.36
E. Settlements	19.95	NE	NE,IE						19.95
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	4.33	231.81	6.85						242.98
A. Solid waste disposal	NE,NA	225.45							225.45
B. Biological treatment of solid waste		0.50	0.45						0.95
C. Incineration and open burning of waste	4.33	0.44	0.26						5.03
D. Waste water treatment and discharge		5.42	6.14						11.55
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	527.40	0.33	4.40						532.13
Aviation	417.01	0.07	3.51						420.60
Navigation	110.38	0.26	0.89						111.53
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.39								0.39
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	3897.69
Total CO_2 equivalent emissions with land use, land-use change and forestry	15550.11
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	3897.69
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	15550.11

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2006

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

Inventory 2006
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	10814.57	2898.38	2015.17	70.27	392.79	2.52		NO	16193.69
1. Energy	1979.67	7.78	72.46						2059.92
A. Fuel combustion (sectoral approach)	1843.03	4.18	72.46						1919.66
1. Energy industries	3.92	0.01	0.01						3.93
2. Manufacturing industries and construction	147.45	0.08	0.36						147.90
3. Transport	938.41	2.44	40.87						981.72
4. Other sectors	753.25	1.65	31.22						786.12
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	136.65	3.61	NO,NA						140.25
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	136.65	3.61	NA,NO						140.25
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	954.65	1.18	3.16	70.27	392.79	2.52		NO	1424.57
A. Mineral industry	62.20								62.20
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	892.13	1.18	NA		392.79	NO,NA			1286.10
D. Non-energy products from fuels and solvent use	0.32	NE	NE						0.32
E. Electronic Industry									
F. Product uses as ODS substitutes				70.27	0.00				70.27
G. Other product manufacture and use	NE	NE	3.16			2.52			5.68
H. Other									
3. Agriculture	0.08	328.65	377.21						705.94
A. Enteric fermentation		280.11							280.11
B. Manure management		48.54	40.08						88.63
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	337.13						337.13
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.08								0.08
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7875.29	2309.33	1555.03						11739.65
A. Forest land	-161.27	0.59	4.90						-155.78
B. Cropland	1761.18	86.65	0.02						1847.84
C. Grassland	6875.35	521.04	1548.98						8945.38
D. Wetlands	-628.41	1701.04	1.13						1073.75
E. Settlements	28.45	NE	NE,IE						28.45
F. Other land	NA,NE	0.01	0.01						0.01
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	4.88	251.43	7.30						263.61
A. Solid waste disposal	NE,NA	244.64							244.64
B. Biological treatment of solid waste		0.80	0.72						1.52
C. Incineration and open burning of waste	4.88	0.43	0.28						5.59
D. Waste water treatment and discharge		5.56	6.30						11.86
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	630.95	0.41	5.26						636.62
Aviation	494.41	0.09	4.16						498.66
Navigation	136.54	0.32	1.10						137.96
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.40								0.40
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4454.03
Total CO_2 equivalent emissions with land use, land-use change and forestry	16193.69
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4454.03
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16193.69

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2007

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

Inventory 2007
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	11182.88	2884.16	2046.33	74.05	331.39	2.86		NO	16521.66
1. Energy	2075.38	9.07	73.68						2158.13
A. Fuel combustion (sectoral approach)	1928.01	4.36	73.68						2006.05
1. Energy industries	16.83	0.01	0.02						16.86
2. Manufacturing industries and construction	166.09	0.10	0.47						166.66
3. Transport	974.15	2.56	41.01						1017.71
4. Other sectors	770.95	1.70	32.17						804.83
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	147.37	4.71	NO,NA						152.08
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	147.37	4.71	NA,NO						152.08
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1153.41	1.23	3.58	74.05	331.39	2.86		NO	1566.52
A. Mineral industry	64.36								64.36
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1088.71	1.23	NA		331.38	NO,NA			1421.33
D. Non-energy products from fuels and solvent use	0.33	NE	NE						0.33
E. Electronic Industry									
F. Product uses as ODS substitutes				74.05	0.00				74.05
G. Other product manufacture and use	NE	NE	3.58			2.86			6.44
H. Other									
3. Agriculture	0.13	333.95	393.53						727.61
A. Enteric fermentation		284.13							284.13
B. Manure management		49.82	40.83						90.65
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	352.70						352.70
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.13								0.13
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7945.98	2293.00	1567.86						11806.84
A. Forest land	-168.70	0.60	5.02						-163.07
B. Cropland	1750.91	86.12	NA,IE						1837.04
C. Grassland	6952.11	523.14	1562.84						9038.09
D. Wetlands	-621.37	1683.13	NO,NA,NE						1061.76
E. Settlements	33.02	NE	NE,IE						33.02
F. Other land	NO,NA,NE	NO	NO,NA						NO,NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	7.98	246.90	7.68						262.56
A. Solid waste disposal	NE,NA	240.97							240.97
B. Biological treatment of solid waste		1.00	0.89						1.89
C. Incineration and open burning of waste	7.98	0.42	0.32						8.72
D. Waste water treatment and discharge		4.51	6.47						10.98
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	712.06	0.57	5.91						718.55
Aviation	505.92	0.09	4.26						510.27
Navigation	206.14	0.49	1.65						208.28
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.54								0.54
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4714.82
Total CO_2 equivalent emissions with land use, land-use change and forestry	16521.66
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4714.82
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16521.66

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2008

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

Inventory 2008
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) (1)	11573.03	2868.91	2071.88	85.01	411.38	3.01		NO	17013.22
1. Energy	1964.59	9.31	68.87						2042.77
A. Fuel combustion (sectoral approach)	1779.62	4.13	68.87						1852.62
1. Energy industries	2.33	0.00	0.01						2.34
2. Manufacturing industries and construction	143.09	0.08	0.41						143.59
3. Transport	919.82	2.50	39.28						961.60
4. Other sectors	714.37	1.54	29.17						745.09
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	184.97	5.18	NO,NA						190.16
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	184.97	5.18	NA,NO						190.16
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1596.16	1.05	3.54	85.01	411.38	3.01		NO	2100.15
A. Mineral industry	61.84								61.84
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1534.02	1.05	NA		411.38	NO,NA			1946.46
D. Non-energy products from fuels and solvent use	0.30	NE	NE						0.30
E. Electronic Industry									
F. Product uses as ODS substitutes				85.01	0.00				85.01
G. Other product manufacture and use	NE	NE	3.54			3.01			6.55
H. Other									
3. Agriculture	0.15	337.57	406.98						744.70
A. Enteric fermentation		287.61							287.61
B. Manure management		49.96	39.84						89.80
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	367.14						367.14
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.15								0.15
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry (1)	8005.82	2282.30	1584.76						11872.88
A. Forest land	-172.67	0.62	5.10						-166.95
B. Cropland	1740.59	85.61	NA,IE						1826.20
C. Grassland	7021.30	528.79	1579.63						9129.73
D. Wetlands	-615.38	1667.28	0.02						1051.92
E. Settlements	31.97	NE	NE,IE						31.97
F. Other land	NA,NE	0.00	0.00						0.00
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	6.31	238.68	7.73						252.72
A. Solid waste disposal	NE,NA	233.02							233.02
B. Biological treatment of solid waste		1.06	0.95						2.01
C. Incineration and open burning of waste	6.31	0.40	0.28						6.99
D. Waste water treatment and discharge		4.20	6.50						10.70
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: (2)									
International bunkers	651.25	0.61	5.38						657.23
Aviation	423.13	0.07	3.56						426.77
Navigation	228.12	0.53	1.81						230.47
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.28								0.28
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 (3)	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	5140.34
Total CO_2 equivalent emissions with land use, land-use change and forestry	17013.22
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	5140.34
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	17013.22

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2009

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

Inventory 2009
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	11549.03	2856.97	2051.85	114.16	180.05	3.02		NO	16755.09
1. Energy	1905.26	9.92	61.88						1977.07
A. Fuel combustion (sectoral approach)	1736.81	4.17	61.88						1802.86
1. Energy industries	2.59	0.00	0.01						2.60
2. Manufacturing industries and construction	92.73	0.06	0.24						93.03
3. Transport	893.25	2.46	39.17						934.88
4. Other sectors	748.24	1.65	22.46						772.35
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	168.45	5.75	NO,NA						174.21
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	168.45	5.75	NA,NO						174.21
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1609.04	1.09	3.06	114.16	180.05	3.02		NO	1910.42
A. Mineral industry	28.70								28.70
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1580.06	1.09	NA		180.05	NO,NA			1761.20
D. Non-energy products from fuels and solvent use	0.27	NE	NE						0.27
E. Electronic Industry									
F. Product uses as ODS substitutes				114.16	0.00				114.16
G. Other product manufacture and use	NE	NE	3.06			3.02			6.08
H. Other									
3. Agriculture	0.16	340.75	380.41						721.31
A. Enteric fermentation		290.92							290.92
B. Manure management		49.83	41.27						91.10
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	339.14						339.14
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NE								NE
H. Urea application	0.16								0.16
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	8027.14	2273.63	1598.55						11899.31
A. Forest land	-186.35	0.63	5.22						-180.50
B. Cropland	1730.21	85.09	NA,IE						1815.31
C. Grassland	7077.65	533.33	1593.33						9204.31
D. Wetlands	-610.42	1654.57	NO,NA,NE						1044.15
E. Settlements	16.05	NE	NE,IE						16.05
F. Other land	NA,NE	0.00	0.00						0.00
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	7.43	231.59	7.95						246.97
A. Solid waste disposal	NE,NA	225.76							225.76
B. Biological treatment of solid waste		1.27	1.14						2.41
C. Incineration and open burning of waste	7.43	0.38	0.27						8.08
D. Waste water treatment and discharge		4.17	6.54						10.71
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	494.79	0.44	4.09						499.32
Aviation	330.21	0.06	2.78						333.05
Navigation	164.58	0.38	1.31						166.27
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.21								0.21
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4855.77
Total CO_2 equivalent emissions with land use, land-use change and forestry	16755.09
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4855.77
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16755.09

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2010

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

Inventory 2010
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	11366.33	2856.14	2039.50	148.74	171.67	4.66		NO	16587.04
1. Energy	1761.21	8.81	56.12						1826.14
A. Fuel combustion (sectoral approach)	1571.62	3.89	56.12						1631.63
1. Energy industries	1.35	0.00	0.00						1.36
2. Manufacturing industries and construction	70.83	0.05	0.16						71.03
3. Transport	849.83	2.38	37.31						889.53
4. Other sectors	649.60	1.46	18.65						669.71
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	189.60	4.92	NO,NA						194.51
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	189.60	4.92	NA,NO						194.51
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1616.08	1.07	3.25	148.74	171.67	4.66		NO	1945.48
A. Mineral industry	10.42								10.42
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1605.40	1.07	NA		171.66	NO,NA			1778.13
D. Non-energy products from fuels and solvent use	0.26	NE	NE						0.26
E. Electronic Industry									
F. Product uses as ODS substitutes				148.74	0.01				148.75
G. Other product manufacture and use	NE	NE	3.25			4.66			7.92
H. Other									
3. Agriculture	0.13	342.46	370.45						713.04
A. Enteric fermentation		293.14							293.14
B. Manure management		49.32	41.26						90.59
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	329.18						329.18
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.00								0.00
H. Urea application	0.13								0.13
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7982.77	2272.42	1601.50						11856.69
A. Forest land	-209.40	0.65	5.35						-203.39
B. Cropland	1719.81	84.58	NA,IE						1804.39
C. Grassland	7076.67	534.27	1596.15						9207.08
D. Wetlands	-609.80	1652.92	0.00						1043.12
E. Settlements	5.50	NE	NE,IE						5.50
F. Other land	NO,NA,NE	NO	NO,NA						NO,NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	6.13	231.39	8.18						245.69
A. Solid waste disposal	NE,NA	225.33							225.33
B. Biological treatment of solid waste		1.52	1.36						2.89
C. Incineration and open burning of waste	6.13	0.35	0.24						6.72
D. Waste water treatment and discharge		4.18	6.58						10.76
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	555.19	0.49	4.59						560.27
Aviation	373.12	0.07	3.14						376.32
Navigation	182.07	0.43	1.45						183.94
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.22								0.22
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4730.35
Total CO_2 equivalent emissions with land use, land-use change and forestry	16587.04
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4730.35
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16587.04

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2011

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

Inventory 2011
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	11268.85	2833.86	2041.47	146.14	74.52	3.05		NO	16367.87
1. Energy	1680.28	7.71	52.07						1740.06
A. Fuel combustion (sectoral approach)	1501.50	3.70	52.07						1557.27
1. Energy industries	1.68	0.00	0.00						1.69
2. Manufacturing industries and construction	81.21	0.05	0.20						81.46
3. Transport	815.24	2.30	35.96						853.50
4. Other sectors	603.37	1.34	15.91						620.62
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	178.78	4.01	NO,NA						182.79
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	178.78	4.01	NA,NO						182.79
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1610.15	1.04	3.40	146.14	74.52	3.05		NO	1838.29
A. Mineral industry	20.16								20.16
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1589.70	1.04	NA		74.52	NO,NA			1665.26
D. Non-energy products from fuels and solvent use	0.28	NE,NO	NE,NO						0.28
E. Electronic Industry									
F. Product uses as ODS substitutes				146.14	0.00				146.14
G. Other product manufacture and use	NE	NE	3.40			3.05			6.45
H. Other									
3. Agriculture	0.18	342.19	368.47						710.83
A. Enteric fermentation		292.28							292.28
B. Manure management		49.90	42.05						91.95
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	326.42						326.42
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.03								0.03
H. Urea application	0.15								0.15
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7970.28	2268.02	1609.36						11847.65
A. Forest land	-237.36	0.65	5.38						-231.33
B. Cropland	1709.40	84.06	NA,IE						1793.46
C. Grassland	7100.88	536.89	1603.97						9241.74
D. Wetlands	-607.32	1646.42	NO,NA,NE						1039.10
E. Settlements	4.68	NE	NE,IE						4.68
F. Other land	NO,NA,NE	NO	NO,NA						NO,NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	7.96	214.91	8.17						231.03
A. Solid waste disposal	NE,NA	208.94							208.94
B. Biological treatment of solid waste		1.43	1.28						2.70
C. Incineration and open burning of waste	7.96	0.34	0.27						8.57
D. Waste water treatment and discharge		4.20	6.62						10.82
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	615.72	0.54	5.09						621.35
Aviation	417.30	0.07	3.51						420.88
Navigation	198.43	0.46	1.57						200.46
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.15								0.15
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4520.22
Total CO_2 equivalent emissions with land use, land-use change and forestry	16367.87
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4520.22
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16367.87

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2012

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

Inventory 2012
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	11276.21	2808.81	2059.51	173.36	94.00	5.32		NO	16417.21
1. Energy	1630.67	6.82	51.09						1688.58
A. Fuel combustion (sectoral approach)	1460.48	3.62	51.09						1515.19
1. Energy industries	2.70	0.00	0.01						2.70
2. Manufacturing industries and construction	66.56	0.05	0.11						66.73
3. Transport	806.60	2.26	34.82						843.69
4. Other sectors	584.62	1.30	16.15						602.07
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	170.18	3.20	NO,NA						173.39
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	170.18	3.20	NA,NO						173.39
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1652.96	1.33	3.27	173.36	94.00	5.32		NO	1930.24
A. Mineral industry	0.53								0.53
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1652.15	1.33	NA		94.00	NO,NA			1747.48
D. Non-energy products from fuels and solvent use	0.28	NE,NO	NE,NO						0.28
E. Electronic Industry									
F. Product uses as ODS substitutes				173.36	0.00				173.37
G. Other product manufacture and use	NE	NE	3.27			5.32			8.59
H. Other									
3. Agriculture	0.21	339.37	378.90						718.48
A. Enteric fermentation		289.93							289.93
B. Manure management		49.43	41.61						91.05
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	337.29						337.29
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.04								0.04
H. Urea application	0.17								0.17
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7985.63	2262.82	1618.36						11866.81
A. Forest land	-247.96	0.65	5.36						-241.95
B. Cropland	1698.99	83.55	NA,IE						1782.53
C. Grassland	7134.31	539.92	1613.00						9287.23
D. Wetlands	-604.41	1638.71	NO,NA,NE						1034.29
E. Settlements	4.70	NE	NE,IE						4.70
F. Other land	NA,NE	0.00	0.00						0.00
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	6.74	198.47	7.89						213.11
A. Solid waste disposal	NE,NA	192.80							192.80
B. Biological treatment of solid waste		1.12	1.00						2.12
C. Incineration and open burning of waste	6.74	0.33	0.22						7.29
D. Waste water treatment and discharge		4.23	6.67						10.90
E. Other	NA	NO	NO						NA,NO
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA

Memo items:[(2)]									
International bunkers	619.05	0.50	5.13						624.67
Aviation	437.30	0.08	3.68						441.06
Navigation	181.75	0.43	1.45						183.62
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	0.11								0.11
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4550.40
Total CO_2 equivalent emissions with land use, land-use change and forestry	16417.21
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4550.40
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16417.21

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2013

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

Inventory 2013
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	11288.75	2804.17	2052.70	169.60	88.16	3.20		NO	16406.58
1. Energy	1617.45	7.64	49.35						1674.45
A. Fuel combustion (sectoral approach)	1444.99	3.57	49.35						1497.91
1. Energy industries	2.59	0.00	0.01						2.60
2. Manufacturing industries and construction	49.30	0.04	0.08						49.42
3. Transport	822.22	2.28	34.72						859.22
4. Other sectors	570.88	1.24	14.54						586.67
5. Other	NO,NA	NO,NA	NO,NA						NO,NA
B. Fugitive emissions from fuels	172.46	4.07	NO,NA						176.54
1. Solid fuels	NO,NA	NO,NA	NO,NA						NO,NA
2. Oil and natural gas	172.46	4.07	NA,NO						176.54
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1678.59	1.40	2.87	169.60	88.16	3.20		NO	1943.81
A. Mineral industry	0.58								0.58
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1677.73	1.40	NA		88.16	NO,NA			1767.28
D. Non-energy products from fuels and solvent use	0.28	NE,NO	NE,NO						0.28
E. Electronic Industry									
F. Product uses as ODS substitutes				169.60	0.00				169.60
G. Other product manufacture and use	NE	NE	2.87			3.20			6.07
H. Other									
3. Agriculture	0.26	322.51	365.03						687.80
A. Enteric fermentation		276.13							276.13
B. Manure management		46.38	41.28						87.65
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	323.75						323.75
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.05								0.05
H. Urea application	0.21								0.21
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7986.95	2257.84	1627.13						11871.92
A. Forest land	-271.47	0.66	5.39						-265.42
B. Cropland	1688.57	83.03	NA,IE						1771.60
C. Grassland	7166.87	542.85	1621.74						9331.47
D. Wetlands	-601.62	1631.30	NO,NA,NE						1029.68
E. Settlements	4.60	NE	NE,IE						4.60
F. Other land	NA,NE	NA	NA						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	5.50	214.78	8.32						228.60
A. Solid waste disposal	NE,NA	208.67							208.67
B. Biological treatment of solid waste		1.50	1.34						2.83
C. Incineration and open burning of waste	5.50	0.33	0.23						6.06
D. Waste water treatment and discharge		4.28	6.75						11.03
E. Other	NA	NO	NO						NO,NA
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	702.66	0.58	5.75						708.99
Aviation	493.58	0.09	4.16						497.83
Navigation	209.08	0.49	1.60						211.16
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	NO,NA								NO,NA
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4534.66
Total CO_2 equivalent emissions with land use, land-use change and forestry	16406.58
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4534.66
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16406.58

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

2014

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

Inventory 2014
Submission 2016 v1
ICELAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [(1)]	11252.26	2846.92	2101.94	162.92	99.03	2.22		NO	16465.30
1. Energy	1618.30	8.17	53.36						1679.84
A. Fuel combustion (sectoral approach)	1436.24	3.54	53.36						1493.15
1. Energy industries	2.52	0.00	0.01						2.53
2. Manufacturing industries and construction	25.19	0.02	0.05						25.26
3. Transport	824.68	2.30	34.08						861.07
4. Other sectors	583.85	1.22	19.23						604.31
5. Other									
B. Fugitive emissions from fuels	182.06	4.63	NA,NO						186.69
1. Solid fuels	NA,NO	NA,NO	NA,NO						NA,NO
2. Oil and natural gas	182.06	4.63	NA,NO						186.69
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	1646.19	1.30	2.51	162.92	99.03	2.22		NO	1914.16
A. Mineral industry	0.57								0.57
B. Chemical industry	NE,NA,NO	NE,NO	NO	NO	NO	NO		NO	NE,NA,NO
C. Metal industry	1645.36	1.30	NA		99.03	NA			1745.68
D. Non-energy products from fuels and solvent use	0.25	NE,NO	NE,NO						0.25
E. Electronic Industry									
F. Product uses as ODS substitutes				162.92	0.01				162.93
G. Other product manufacture and use	NE	NE	2.51			2.22			4.72
H. Other									
3. Agriculture	0.37	344.07	403.23						747.67
A. Enteric fermentation		294.19							294.19
B. Manure management		49.88	42.32						92.20
C. Rice cultivation		NO							NO
D. Agricultural soils		NA,NE,NO	360.90						360.90
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO	NO						NO
G. Liming	0.03								0.03
H. Urea application	0.35								0.35
I. Other carbon-containing fertilizers									
J. Other									
4. Land use, land-use change and forestry [(1)]	7980.06	2254.43	1633.96						11868.45
A. Forest land	-295.99	0.66	5.41						-289.92
B. Cropland	1678.14	82.51	NA,IE						1760.66
C. Grassland	7192.47	545.29	1628.55						9366.30
D. Wetlands	-599.27	1625.97	0.01						1026.70
E. Settlements	4.70	NE	NE,IE						4.70
F. Other land	NA,NE	NA	NA						NA,NE
G. Harvested wood products	NE								NE
H. Other	NO	NO	NO						NO
5. Waste	7.35	238.95	8.88						255.18
A. Solid waste disposal	NE,NA	232.26							232.26
B. Biological treatment of solid waste		2.01	1.80						3.81
C. Incineration and open burning of waste	7.35	0.35	0.29						7.99
D. Waste water treatment and discharge		4.32	6.79						11.11
E. Other	NA	NO	NO						NA,NO
6. Other ***(as specified in summary 1.A)***									
Memo items: [(2)]									
International bunkers	782.74	0.63	6.48						789.85
Aviation	553.99	0.10	4.66						558.75
Navigation	228.75	0.53	1.82						231.10
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	NA,NO								NA,NO
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NO								NO
Indirect N_2O			NE						
Indirect CO_2 [(3)]	NE								

Total CO_2 equivalent emissions without land use, land-use change and forestry	4596.85
Total CO_2 equivalent emissions with land use, land-use change and forestry	16465.30
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	4596.85
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	16465.30

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

Annex V. Values used in Calculation of Digestible Energy of Cattle and Sheep Feed

a) Mature Dairy Cattle

1. Dairy cattle, stallfed, lactation period[4,5]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
Hay	10.0	72.0	7.0
Barley	3.0	86.0	3.0
pulp	0.7	67.0	4.0
concentrate	2.5	85.0	8.0
sum	16.2		
average		76.4	6.3
2. Dairy cattle, stallfed, non-lactation [1,2]	**amount/day (kg dm)**	**dry matter digestibility (%)**	**ash (%)**
Hay	12.0	68.0	8.0
SUM	12.0		
Average		68.0	8.0
3. Dairy cattle, pasture, lactation period[1,2]	**amount/day (kg dm)**	**dry matter digestibility (%)**	**ash (%)**
Pasture	12.0	70.0	8.0
Concentrate	3.0	85.0	8.0
SUM	15.0		
average		73.0	8.0
4. Dairy cattle, pasture, non-lactation[1,2]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
pasture	14.0	70.0	8.0
sum	14.0		
average		70.0	8.0
Duration of periods[1,2]	**days for periods**	**dry matter digestibility (%)**	**ash (%)**
1. Dairy cattle, stallfed, lactation period	230.0		
2. Dairy cattle, stallfed, non-lactation	35.0		
3. Dairy cattle, pasture, lactation period	75.0		
4. Dairy cattle, pasture, non-lactation	25.0		
annual average	15.4	74.4	6.9

[4] Jóhannes Sveinbjörnsson og Grétar H. Harðarson, 2008. Þungi og átgeta íslenskra mjólkurkúa. Fræðaþing landbúnaðarins: 336-344

[5] Harald Volden (ed.), 2011. Norfor- the Nordic feed evaluation system. EAAP publication no. 130. Wageningen Academic Publishers

b) Cows Used for Producing Meat

1. Cows used for prod. meat, stallfed[6]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
hay	10.0	70.0	7.0
sum	10.0		
average		70.0	7.0
2. Cows used for prod. meat, pasture[3]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
hay	4.0	70.0	7.0
pasture	6.0	80.0	7.0
sum	10.0		
average		76.0	7.0
Duration of periods	days for periods	dry matter digestibility (%)	ash (%)
1. Cows used for prod. meat, stallfed	100.0		
2. Cows used for prod. meat, pasture	265.0		
annual average	10.0	74.4	7.0

c) Heifers

1. Heifers, stallfed[3,7]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
Hay	5.0	70.0	7.0
Concentrate	1.0	85.0	8.0
Sum	6.0		
Average		72.5	7.2
2. Heifers, pasture	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
Hay	1.0	70.0	7.0
Pasture	5.0	80.0	7.0
Sum	6.0		
Average		78.3	7.0
Duration of periods	days for periods	dry matter digestibility (%)	ash (%)
1. Heifers, stallfed	245.0		
2. Heifers, pasture	120.0		

[6] Jóhannes Sveinbjörnsson og Bragi L. Ólafsson, 1999. Orkuþarfir sauðfjár og nautgripa í vexti með hliðsjón af mjólkurfóðureiningakerfi. Ráðunautafundur 1999: 204-217.

[7] Harald Volden (ed.), 2011. Norfor- the Nordic feed evaluation system. EAAP publication no. 130. Wageningen Academic Publishers

annual average	6.0	74.4	7.1

d) Steers

1. Steers[8,9]	**amount/day (kg dm)**	**dry matter digestibility (%)**	**ash (%)**
Hay	5.0	70.0	7.0
Concentrate	1.0	85.0	8.0
Sum	6.0		
Average		72.5	7.2
Duration of periods	**days for periods**	**dry matter digestibility (%)**	**ash (%)**
1. Steers	365.0		
annual average	6.0	72.5	7.2

e) Calves

1. Calves, first 90 days[10]	**amount/day (kg dm)**	**dry matter digestibility (%)**	**ash (%)**
milk/formula	1.0	93.0	9.0
Concentrate	0.2	82.0	8.0
Hay	0.1	75.0	7.0
Sum	1.3		
Average		89.9	8.7
2. Calves, days 91-365[5]	**amount/day (kg dm)**	**dry matter digestibility (%)**	**ash (%)**
Hay	2.0	75.0	7.0
Concentrate	0.5	82.0	8.0
Sum	2.5		
Average		76.4	7.2
Duration of periods	**days for periods**	**dry matter digestibility (%)**	**ash (%)**
1. Calves, first 90 days	90.0		
2. Calves, days 91-365	275.0		
annual average	2.2	79.7	7.6

[8] Jóhannes Sveinbjörnsson og Bragi L. Ólafsson, 1999. Orkuþarfir sauðfjár og nautgripa í vexti með hliðsjón af mjólkurfóðureiningakerfi. Ráðunautafundur 1999: 204-217.

[9] Harald Volden (ed.), 2011. Norfor- the Nordic feed evaluation system. EAAP publication no. 130. Wageningen Academic Publishers

[10] Grétar H. Harðarson, Eiríkur Þórkelsson og Jóhannes Sveinbjörnsson, 2007. Uppeldi kálfa: Áhrif kjarnfóðurs með mismiklu tréni á vöxt og heilbrigði kálfa. Fræðaþing landbúnaðarins 2007: 234-239

f) Sheep

1. Sheep, stallfed[11]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
Hay	1.6	68.0	7.0
Concentrate	0.0	85.0	8.0
Sum	1.6		
Average		68.2	7.0
2. Sheep, pasture[12]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
Pasture	1.5	80.0	7.0
Hay	0.5	75.0	7.0
Sum	2.0		
Average		78.8	7.0
3. Sheep, range[13]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
gras/vegetation	1.8	70.0	7.0
Sum	1.8		
Average		70.0	7.0
Duration of periods	days for periods	dry matter digestibility (%)	ash (%)
1. Sheep, stallfed	200.0		
2. Sheep, pasture	60.0		
3. Sheep, range	105.0		
annual average	1.7	70.5	7.0

[11] Jóhannes Sveinbjörnsson, 2013: Fóðrun og fóðurþarfir sauðfjár. Kafli 4 í: Sauðfjárrækt á Íslandi. Útg. Uppheimar, 2013.

[12] Jóhannes Sveinbjörnsson, 2013: Fóðuröflun og beit á ræktað land. Kafli 5 í: Sauðfjárrækt á Íslandi. Útg. Uppheimar, 2013.

[13] Ólafur Guðmundsson, 1987: Átgeta búfjár og nýting beitar. Ráðunautafundur 1987: 181-192

g) Lambs

1. Lambs, pre-weaning[14,15]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
gras/vegetation	0.4	70.0	7.0
milk	0.3	95.0	5.1
sum	0.7		
average		79.9	6.2
2. Lambs, after-weaning[16,12]	amount/day (kg dm)	dry matter digestibility (%)	ash (%)
gras/vegetation	0.5	75.0	8.0
rape/rye grass etc.	0.3	83.0	9.0
milk	0.2	95.0	5.1
sum	1.0		
average		81.1	7.8
Duration of periods	days for periods	dry matter digestibility (%)	ash (%)
1. Lambs, pre-weaning	60.0		
2. Lambs, after-weaning	80.0		
annual average	0.3	83.5	7.4

h) Conversion of DMD into DE

	dry matter digestibility	organic matter digestibility	metabolisable energy	metabo-lizality	Net energy for lactation	Net energy of 1 kg barley	Digestible energy
	DMD	OMD	BO	q	NO_m	FE_m	DE
	%	g/kg	kJ/kg dm		kj/kg		%
Calculations	cf. A-G	(0.98*DMD-4.8)*10	15*OMD	BO/18500*100	0.6*(1+0.004* (q-57))*09752*BO	NO_m/6900	OMD*15 / 0.81/18.5/10
Mature dairy cows	74.4	681.6	10,224	55.3	5,941	0.861	68.2
Cows used for producing meat	74.4	680.7	10,210	55.2	5,931	0.860	68.1
Heifers	74.4	681.3	10,219	55.2	5,937	0.861	68.2

14 Ólafur Guðmundsson, 1987: Átgeta búfjár og nýting beitar. Ráðunautafundur 1987: 181-192

15 Stefán Sch. Thorsteinsson og Sigurgeir Thorgeirsson, 1989: Winterfeeding, housing and management. P. 113-145 í: Reproduction, nutrition and growth in sheep. Dr. Halldór Pálsson memorial publication. (Eds. Ólafur R. Dýrmundsson and Sigurgeir Thorgeirsson). Agricultural Research Institute and Agricultural Society, Iceland)

16 Jóhannes Sveinbjörnsson, 2013: Fóðuröflun og beit á ræktað land. Kafli 5 í: Sauðfjárrækt á Íslandi. Útg. Uppheimar, 2013.

Steers used principally for producing meat	72.5	662.5	9,938	53.7	5,738	0.832	66.3
young cattle	79.7	733.4	11,001	59.5	6,500	0.942	73.4
sheep	70.5	642.5	9,637	52.1	5,528	0.801	64.3
lambs	83.5	770.7	11,561	62.5	6,913	1.002	77.2

Annex VI. EU ETS in Iceland and comparison to the national inventory

Installations subject to the EU ETS in 2014	Number of operators
Aluminium production	3
Ferroalloys production	1
Fishmeal production	1
Total	**5**

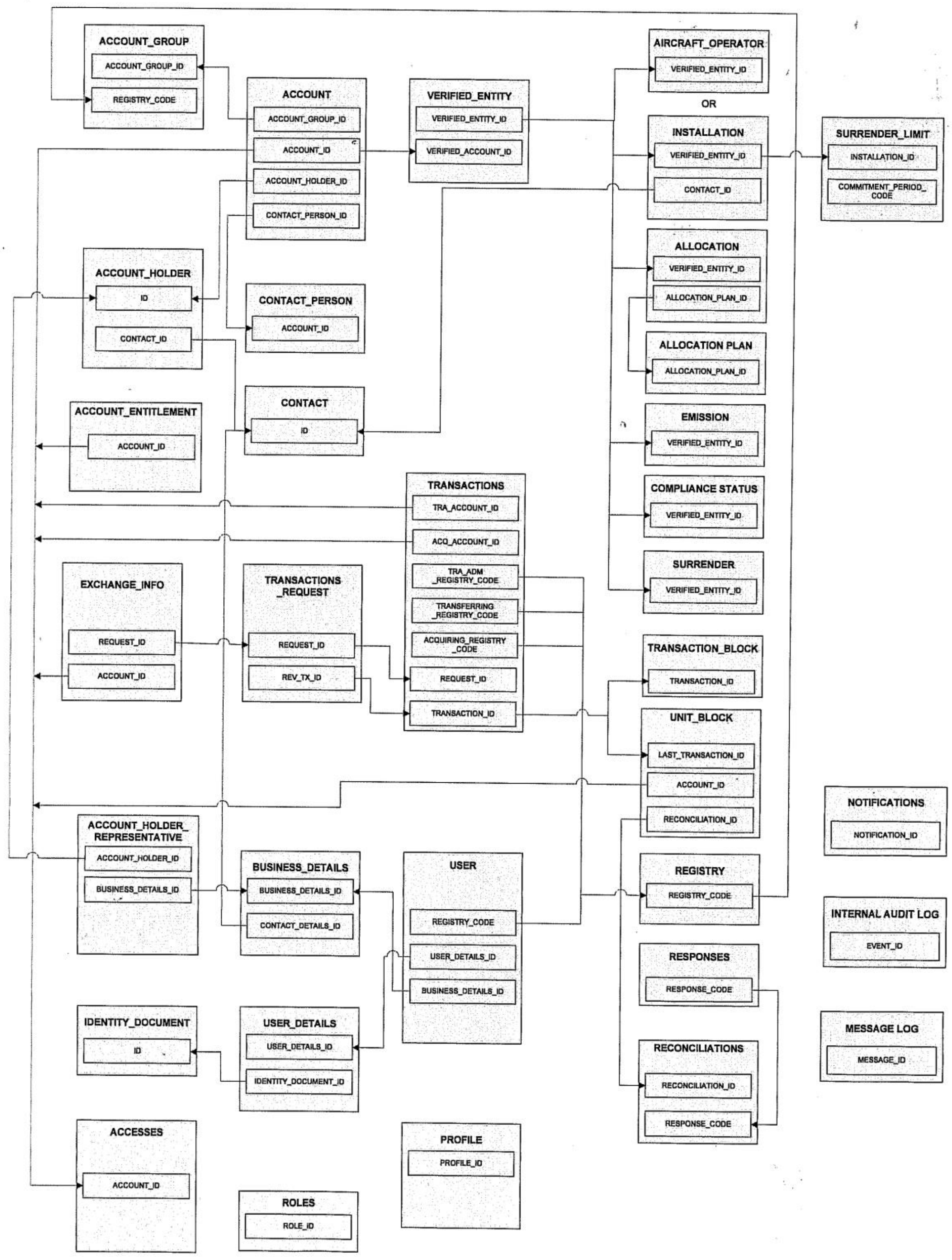
	Greenhouse gas inventory emissions [kt CO_2eq]	Verified emissions under Directive 2003/87/EC [kt CO_2eq]	Ratio %
Greenhouse gas emissions (total emissions without LULUCF for GHG inventory and without emissions from 1A3a Civil aviation, total emissions from installations under Article 3h of Directive 2003/87/EC)	4,556.53	1,754.95	38.52
CO_2 emissions (total CO_2 emissions without LULUCF for GHG inventory and without emissions from 1A3a Civil aviation, total emissions from installations under Article 3h of Directive 2003/87/EC)	3,232.27	1,653.35	51.15

Category	CO_2 emissions		
	Greenhouse gas inventory emissions [kt]	Verified emissions under Directive 2003/87/EC [kt]	Ratio %
1. Energy	24.95	7.99	32.02
1.A.2.a Iron and steel	0.93	0.93	100
1.A.2.b Non-Ferrous Metals	10.95	6.36	58.11
1.A.2.e Food processing, beverages and tobacco	13.07	0.70	5.37
2. Industrial Processes	1,645.36	1,645.36	100
2.C.2 Ferroalloys production	365.85	365.85	100
2.C.3 Aluminium production	1,279.50	1,279.50	100
Total	**1,670.30**	**1,653.35**	**98.98**

Category	PFC emissions		
	Greenhouse gas inventory emissions [kt]	Verified emissions under Directive 2003/87/EC [kt]	Ratio %
2.C.3 Aluminium production	99.03	99.03	100

Annex VII. CSEUR Database Structure

Annex A: CSEUR Database structure



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Annex VIII. Test results of changes introduced in version 6.7.3

FEATURE	DESCRIPTION	TEST CASES	SAT Status
A series of technical test cases, ensuring YLE and PRD are handled and checked by EUTL correctly, even in the case when EUCR screen mechanisms are bypassed	*(EUTL) Edit YLE and Permit Revocation Date*		PASSED
-	Modify Check 7028	1. Connect as NA and update the PRD of an installation to a past date; approve the update as another NA 2. Navigate to an account in the TAL of the account whose installation is the installation affected in step [1] 3. Propose a transfer to the account whose installation is the installation affected in step [1] 4. Approve the transfer 5. Ensure the transaction is COMPLETED	PASSED
-	Create Check 7175	Scenario 1: Test YLE cannot get < VE year via EUCR 1. Locate an account with VE for 2011, 2012, 2013, 2014 2. Update installation and set YLE = 2013 3. Ensure the following message appears: "There are Verified Emissions introduced in years after to the proposed Last Year of Verification." 4. The update cannot be submitted. Scenario 2: Test YLE cannot get < VE year via EUCR 1. Locate an account with VE for 2011, 2012, 2013, 2014 2. Update in EUTL database the record in VERIFIED_EMISSION table to 2016 so that an artificial VE record exists in EUTL for 2016. 3. Update YLE for this installation via EUCR screen 4. Approve the request 5. Locate the state of the installation update request via: select * from installation_update_req where request_id = <<request_id>>; select * from request_state where request_state_id = <<request_state_id from previous query>>; select * from response where request_id =	PASSED

		<<request_id>>; Ensure the request is REJECTED with response code 7175.	
-	Add Check 7174	Scenario #1: Change YLE in EUTL 1. Create a request for change of YLE to 2014, and Permit Revocation Date to a date in 2014. Grab the RequestId. 2. Manually change the YLE of the request to 2016. update verified_entity set end_year = '2016' where verified_entity_id = (select NEW_INSTALLATION_ID from INSTALLATION_UPDATE_REQ where request_id = XXXXX); commit 3. In the Task List, verify that the data of the Request have changed. 4. Approve the Request 5. Verify that the Request gets Rejected from EUTL with code 7174. (select * from response where request_id = XXXXXXX) Scenario #2: Change PRD in EUTL Follow the steps of scenario #1 but set permit_revocation_date to a date before YLE. The closure request must be rejected with code 7174.	PASSED

-	Set allocations to 0 for years > YLE	1. Login as NA of a registry 2. Select an OHA account without allocations. 3. At the "Installation" tab of the account check the YLE. 4. Go to EU ETS - Allocation Tables Phase 3 and upload a valid NAT xml up to the YLE of the account. 5. Check the Details table and ensure that the NAT xml has been uploaded successfully 5. Login to to EUTL. 6. Go to "Registry Mgt" and upload the same valid xml 7. Go to ETS - Installation Mgt and search for the account 8. Click on "Installation Number" link and ensure that the NAT xml has been uploaded successfully. 9. Go to EUCR to Accounts and search for the account 10. Go to "Installation" tab of the account and change the YLE to a previous value. Submit and approve the new update. 11. Go to to EU ETS - Allocation Tables Phase 3 and at the "Details' table search for the specific account 12. Ensure that NAT allocations set to zero (0) for year> YLE. 13. Login to EUTL and go to ETS - Installation Mgt and search for the account 14. Click on "Installation Number" link and ensure that the NAT allocations set to zero (0) for year> YLE. 15. Repeat the above test for AOHA and upload a NAAT xml file	PASSED
-	Setting permit status after permit revocation date has passed	1. Set an installation in EUTL database to PRD = 2/2/1902 and permit active via the query: update installation set permit_revocation_date = '2/2/1902', installation_status_code = 1 where installation_id = <<installation_identifier>>; 2. Wait 10 minutes 3. Perform the query: select permit_revocation_date, installation_status_code from installation where installation_id = <<installation_identifier>>; and ensure the installation_status_code is now set to 2.	PASSED

-	YLE, PRD should not be updated in RequestAccountClosure, RejectAccountClosure	1. Update an installation and set YLE=2016 and PRD=1/1/2016 2. Approve the update 3. Request closure of the account 4. Reject the closure request 5. Ensure the account in EUTL has unaffected YLE and PRD via the query: select * from installation where installation_identifier = <<installation_id>> and registry_code = <<registry_code>>;	PASSED
-	modify Check 7168	1. Connect as NA and locate an OHA 2. Submit a close account request 3. In EUTL, via the database: 4. update yle to be less than yfe 5. Approve the account closure request 6. Ensure via the database that the request is terminated with error code 7168 (at least this code) 7. Restore the EUTL installation record to its former state Repeat the above steps but replace step 4 with the following alternatives: * delete PRD for installation * delete YLE	PASSED
-	Modify UpdatedInstallation class	1. Connect as NA in ETS, Finnish registry 2. Locate an OHA and update YLE to 2013 and PRD to 1/1/2013 3. Query in EUTL database the following: select * from installation where installation_identifier = <<installation_identifier>> and registry_code = 'FI'; 4. Ensure YLE and PRD are as entered in step [2].	PASSED
-	Modify compliance calculation query	1. Set the YLE to an installation to 2020 and approve the request 2. Delete record from COMPLIANCE_STATUS_BL for that installation for last period_year. Installation ID can be found via the query in EUTL: select * from installation where installation_identifier = <<verified_entity.identifier>> and registry_code = <<MS of the installation>>; The connected record must have been deleted from COMPLIANCE_STATUS_HISTORY. 3. Run Compliance Calculation Job - a record should be inserted for that installation in COMPLIANCE_STATUS_BL.	PASSED

Tests for EUCR screens, to handle YLE and PRD requirements	*Edit YLE and Permit Revocation Date*		PASSED
-	Account closure request creation modifications	Scenario 1 1. Login as NA of a registry 2. Search for an OHA account with no values at the fields YLE and PRD 3. Click on "Close" link. 4. Ensure that the system displays the error message: "The Operator Holding Account cannot be closed as long as the Permit Revocation Date and the Last Year of Verification are not filled in; they can be entered by the National Administrator from the Installation tab of the Account Details". Below the error message you can see a table with Permit Revocation Date and Last Year of Verification with no data 5. Repeat the above test with an AR of the account Scenario 2 1. Login as NA of a registry 2. Search for an OHA account with no values only at the field YLE 3. Click on "Close" link. 4. Ensure that the system displays the error message: "The Operator Holding Account cannot be closed as long as the Permit Revocation Date and the Last Year of Verification are not filled in; they can be entered by the National Administrator from the Installation tab of the Account Details". Below the error message you can see a table. At the "Permit Revocation Date" field you can see the date and the "Last Year of Verification" field is without data 5. Repeat the above test with an AR of the account Scenario 3 1. Login as NA of a registry 2. Search for an OHA account with no values only at the field PRD 3. Click on "Close" link. 4. Ensure that the system displays the error message: "The Operator Holding Account cannot be closed as long as the Permit Revocation Date and the Last Year of Verification are not filled in; they can be entered by the National Administrator from the Installation tab of the Account Details". Below the error message you can see a table. At the "Last Year of Verification" field you can see the year and the "Permit Revocation Date" field is without data 5. Repeat the above test with an AR of the account	PASSED

		Scenario 4 1. Login as NA of a registry 2. Search for an OHA account with values at the fields YLE and PRD 3. Click on "Close" link. 4. Ensure that the system displays the confirmation message: "Do you wish to close the account with identifier xxxxx". Below the message you can see a table with Permit Revocation Date and Last Year of Verification with data 5. Repeat the above test with an AR of the account Scenario 5 1. Login as NA of a registry 2. Search for an OHA account with no values at the fields YLE 3. Click on "Close" link. 4. Ensure that the system displays the error message: "The Aircraft Operator Holding Account cannot be closed as long as the Last Year of Verification is not filled in; it can be entered by the National Administrator from the Aircraft Operator tab of the Account Details". Below the error message you can see a table with the "Last Year of Verification" field is without data 5. Repeat the above test with an AR of the account Scenario 6 1. Login as NA of a registry 2. Search for an AOHA account with values at the field YLE 3. Click on "Close" link. 4. Ensure that the system displays the confirmation message: "Do you wish to close the account with identifier xxxxx". Below the message you can see a table. At the "Last Year of Verification" field you can see the year. 5. Repeat the above test with an AR of the account	

-	Allocation Screen - Allocation Job - modify for V1.40 doc	1. Login to ESD registry and select an OHA account with YLE & PRD = 2020 2. Upload a valid NAT xml for years 2013 - 2020 3. Go to "Allocation Phase 3" and search for the specify account 4. If current year is 2016 you can see Allocation data for the specific account up to 2016. (if Current year 2014, system displays Allocation data = 2014) 5. Go to the account at the "Installation" tab and change the YLE< of current year (for example 2013). Submit and approve the changes 6. Go to "Allocation Phase 3" and search for the specify account 7. Ensure that can see values up to 2013 for the specific account. 8. Go to the account at the "Installation" tab. Delete the value at YLE and change the PRD < of current year (for example 31/12/2013). Submit and approve the changes 6. Go to "Allocation Phase 3" and search for the specify account. 7. Ensure that can see values up to 2013 for the specific account. 9. Repeat the above test for AOHA only for YLE.	PASSED

-	Installation/Aircraft Tab - If user NA, add "Edit YLE" functionality	Scenario 1 1. Login as NA of a registry 2. Select an OHA without LYV and PRD and FYV<= 2013 3. Go to "Installation" tab and click on "Update" button 4. Ensure that you can see the fields : "Permit Revocation Date", "First Year of Verification" and "Last Year of Verification" 5. Delete the data at FYV field and click on "Submit" button 6. System displays the error message : "First Year of Verification: Validation Error: Value is required." 7. Enter a value at LYV<FYV 8. System displays the error message: "The Last Year of Verification must be greater or equal to the First Year of Verification. 9. Enter a value at PRD and click on "Submit" button 10. System displays the information message: "Your request to update installation information has been submitted under identifier xxxxx" 11. Login as an other NA and approve the test. 12. Ensure that the account has been updated with the new data. 13. Enter a data at LYE and click on "Submit" button. 14. System displays the information message: "Your request to update installation information has been submitted under identifier xxxxx" 15. Login as an other NA and approve the test. 16. Ensure that the account has been updated with the new data. 17. Delete the values at PRD and LYE and click on "Submit" button. 18.System displays the information message: "Your request to update installation information has been submitted under identifier xxxxx" 19. Login as an other NA and approve the test. 20. Ensure that the account has been updated with the new data. 21. Enter LYE> PRD and click on "Submit" button 22. System displays the error message: "The Year of the Permit Revocation Date must be greater or equal to the Last Year of Verification." 23. Enter LYE< PRD and click on "Submit" button 24. Next to the field of PRD System displays the warning message: "Warning: Last year of verification is earlier than the year of	PASSED

		Permit Revocation Date". Click on "Submit" button 25. System displays the information message: "Your request to update installation information has been submitted under identifier xxxxx" 26. Login as an other NA and approve the test. 27. Ensure that the account has been updated with the new data. 28. Enter a date at PRD < of current date. Click on "Submit" button 29. Login as an other NA and approve the test. 30. Ensure that the account has been updated with the new data, and that the "Permit Status " has been REVOKED Scenario 2 1. Repeat the above test for AOHA. (only for LYE field) 2. Enter FYV < LYV 3. System displays the error message: " The Last Year of Verification must be greater or equal to the First Year of Verification." 4. Delete data from the LYV field and click on "Submit" button . 5. System displays the information message: "Your request to update an aircraft operator has been submitted under identifier xxxxx." 6. Login as an other NA and approve the test. 7. Ensure that the account has been updated with the new data. 8. Enter a valid date at LYV field and click on "Submit" button . 9. System displays the information message: "Your request to update an aircraft operator has been submitted under identifier xxxxx." 10. Login as an other NA and approve the test. 11. Ensure that the account has been updated with the new data. Scenario 3 1. Login as NA of a registry 2. Select an OHA account without allocations. 3. At the "Installation" tab of the account check the YLE. 4. Go to EU ETS - Allocation Tables Phase 3 and upload a valid NAT xml up to the YLE of the account. 5. Check the Details table and ensure that the NAT xml has been uploaded successfully 5. Login to EUTL. 6. Go to "Registry Mgt" and upload the same	

		valid xml 7. Go to ETS - Installation Mgt and search for the account 8. Click on "Installation Number" link and ensure that the NAT xml has been uploaded successfully. 9. Go to EUCR to Accounts and search for the account 10. Go to "Installation" tab of the account and change the YLE to a previous value. Submit and approve the new update. 11. Go to EU ETS - Allocation Tables Phase 3 and at the "Details' table search for the specific account 12. Ensure that NAT allocations set to zero (0) for year> YLE. 13. Login to EUTL and go to ETS - Installation Mgt and search for the account 14. Click on "Installation Number" link and ensure that the NAT allocations set to zero (0) for year> YLE. 15. Repeat the above test for AOHA and upload a NAAT xml file	

-	NAT/NAVAT allocations set to zero (0) for year > YLE	1. Login as NA of a registry 2. Select an OHA account without allocations. 3. At the "Installation" tab of the account check the YLE. 4. Go to EU ETS - Allocation Tables Phase 3 and upload a valid NAT xml up to the YLE of the account. 5. Check the Details table and ensure that the NAT xml has been uploaded successfully 5. Login to EUTL. 6. Go to "Registry Mgt" and upload the same valid xml 7. Go to ETS - Installation Mgt and search for the account 8. Click on "Installation Number" link and ensure that the NAT xml has been uploaded successfully. 9. Go to EUCR to Accounts and search for the account 10. Go to "Installation" tab of the account and change the YLE to a previous value. Submit and approve the new update. 11. Go to EU ETS - Allocation Tables Phase 3 and at the "Details' table search for the specific account 12. Ensure that NAT allocations set to zero (0) for year> YLE. 13. Login to EUTL and go to ETS - Installation Mgt and search for the account 14. Click on "Installation Number" link and ensure that the NAT allocations set to zero (0) for year> YLE. 15. Repeat the above test for AOHA and upload a NAAT xml file	PASSED
-	OHA Account - Compliance Tab - Enter/Edit emissions between YFE & YLE	1. Login as NA of a registry and select an OHA without emissions. 2. Go to "Installation" tab and check the dates at the YFE and YLE. 3. Go to "Compliance" tab and ensure that you are able to enter emissions between YFE & YLE. 4. Go to Installation" tab again and change the dates at YFE and YLE. 5. Go to "Compliance" tab and ensure that you are able to enter emissions between YFE & YLE. 6. Ensure that as NA you can see the "Save" button. 7. Login as another appropriate user of the account. 8. Ensure that you can enter appropriate user and that you cannot see the "Save" button. 9. Repeat the above test for AOHA 10. Repeat the above test for accounts with emissions and ensure that you are able to edit emissions. Edit emissions should be	PASSED

		handled like the account was excluded (i.e. if a verified emissions exist, it is possible to change the value etc)	
-	PRD Quartz Trigger	Scenario 1 1. Login as NA of a registry and select an OHA in Open or Blocked status. 2. Go to "Installation" tab and ensure that the Permit Status =ACTIVE 3. Enter/ Change the Permit Revocation Date to a date in the future (for example enter tomorrow's date) and approve the task 4. At the date of Permit Revocation Date check the account. 5. Ensure that the Permit Status = REVOKED. Scenario 2 1. Login as NA of a registry and select an OHA in Open or Blocked status. 2. Go to "Installation" tab and ensure that the Permit Status =ACTIVE 3. Enter/ Change the Permit Revocation Date to a date in the past and approve the task 4. Check the account. 5. Ensure that the Permit Status = REVOKED. Scenario 3 1. Select an OHA in Suspended or Closed status and go to "Installation" tab. 2. Ensure that the "Update" button is not available	PASSED

-	Rejection of Account Closure Request	Scenario 1 1. Login as NA of a registry 2. Search for an OHA account with values at fields YLE & PRD 3. Click on "Close" or "Force Close" link of the account 4. Go to task list and reject the account closure task. 5. Go back to the account and ensure that the fields YLE & PRD have not changed values. 6. Repeat the above test with an AR of the account. As NA of the registry reject the task. 7. Go back to the account and ensure that the fields YLE & PRD have not changed values. Scenario 2 1. Login as NA of a registry 2. Search for an AOHA account with values at field "Expiry Date" 3. Click on "Close" link of the account 4. Go to task list and reject the account closure task. 5. Go back to the account and ensure that the field "Expiry Date" has the correct value 6. Repeat the above test with an AR of the account. As NA of the registry reject the task. 7. Go back to the account and ensure that the field "Expiry Date" has the correct value	PASSED
-	Sum of Verified Emissions - Compliance Status/Entitlements	Scenario 1 1. Select an OHA and go to "Compliance" tab 2. Ensure that you have enter emissions for year 2013 3. At the "Compliance" table check the value at "Cumulative Verified Emissions" field. 4. Ensure that you can see correct data 5. Tick on the Exclude box for year 2013 and click on "Save" button 6. System displays the information message: "Compliance data are being recalculated" 7. When the process completed, check again at the "Compliance" table the value at "Cumulative Verified Emissions" field. 8. Ensure that you can see correct data 9. Repeat the above test for AOHA (year 2013 is excluded by default for AOHAs. To be able to perform the above test should not apply the parameters of "exclusion") Scenario 2 Run the following script to check if entitlements updated correctly: select ve_cp2 from account_entitlement_extras ae, account a	PASSED

		where a.account_id = ae.account_id and a.identifier = :p_account_identifier;	
-	Update YLE-PRD Screen - Show warning with js	1. Login as NA of a registry 2. Select an OHA account and go to "Installation" tab 3. Click on "Update" button 4. At the field "Permit Revocation Date" enter a date > than the year at the field "Last Year of Verification" 5. Ensure that the system displays the warning message: "Warning: Last year of verification is earlier than the year of Permit Revocation Date" next to the field of PRD 6. Click on "Submit" button 7. Ensure that the request to update installation information has been submitted	PASSED
Allocation delivery settings conformation has a useless checkbox	Allocation delivery settings conformation has a useless checkbox	1. Log in to MS as NA 2. Go to Allocation Phase 3, select Aircraft Operators tab and choose 2014 form the list. 3. Tick the allocation that you want and click on "Submit" button 4. At the "Approve Transaction Request" pop up, ensure that there isn't a checkbox next to the titles "Free" and "Special Reserve"	PASSED
Allocations to disabled aircraft operators sometimes appeared as allowed; this is now fixed.	Allocations for disabled Aircraft Operator	1. Log in to MS as NA 2. Go to Allocation Phase 3, select Aircraft Operators tab and choose 2014 form the list 3, Make sure that at check box for least one Aircraft Operator is disabled (grey with question mark icon) 4. Click "Free" checkbox 5. Ensure that all positions except disabled ones are checked	PASSED

Fix account block mechanism so that OHA are correctly blocked	Block Accounts Job - Count non excluded years for OHA ignore excluded 2013	1. Create a new account with YFE=YLE=2013 2. Approve the account creation 3. Exclude year 2013 for this account 4. Run BlockAccountsTrigger by modifying its next fire time, e.g. via the query: update qrtz_cron_triggers set cron_expression = '0 0/10 * 1/1 * ? *' where trigger_name = 'BlockAccountsTrigger'; 5. Wait ten minutes. 6. Ensure the account is still OPEN	PASSED
Issued amount for ESD appeared double for the first issuance only; this is now fixed.	CLONE - Double value for ESD Issuance - first issuance time	1. Remove the existing ESD TQA via the query in EUCR: (update account set status = 'REMOVED' where eu_account_type = 'AEA_TOTAL_QUANTITY_ACCOUNT' ; commit;) 2. Create a new ESD TQA via ESD account management screens 3. Perform an issuance of AEA units, and approve the issuance request. 4. Navigate to ESD accounts list; verify that the balance of the ESD TQA is the one that you issued during step [3].	PASSED
CP1 credits ineligible after 31 March 2015	CP1 credits ineligible after 31 March 2015	1. Set system date to a date after 31/3/2015 (OR SET PARAMETER ZZZZZ) 2. Locate an account with ICH eligible CER units with OP=AP=1 3. Transfer one of these units to JP-100-999 account; the transfer can be proposed 4. Transfer one of these units to an ETS account; the transfer cannot be submitted; error message: "80706: The acquiring account is not allowed to hold CP1 units after a specified date"	PASSED
Cannot search ESD entitlements transactions by account identifier	Cannot search ESD entitlements transactions by account identifier	1. Log in to ESD 2. Go to ESD Entitlements Transactions page 3. Enter account identifier either to "Transferring Account ID" or "Acquiring Account ID" and click search. 4. Ensure that you can see correct data	PASSED
Translation issue	Change of labels in EN	1. Propose a transaction reversal; ensure the approval task description is: "The following Reversal Transaction needs approval prior to launching the Transaction workflow" 2. Propose a transaction; ensure the approval task description is: "The following Transaction needs approval prior to launching the Transaction workflow."	PASSED

Correction in EUTL check	Check 7864 for Post Compliance Transfers should check Transferring Account	For each of the following transaction types: ESD Post Compliance Transfers ESD Delete after OverAllocation ESD AEA Transfer ESD Entitlement Transferred do the following: 1. Propose a new transaction 2. Update the end_of_validity of the transferring account of the transaction in EUTL to 1/1/1999 3. Approve the transaction request 4. Ensure the transaction is terminated with error code 7864 5. Update the value updated during step [2] to 1/1/9999 6. Repeat the same transaction 7. Ensure the transaction is completed	PASSED
Compliance Status figure C is not calculating	Compliance Status figure C is not calculating	1. Connect as ESD-CA and locate an ESD compliance account with zero emissions and zero balance for the active year 2. Execute balance job for the active year 3. Ensure an entry is entered in esd compliance as follows: select * from esd_compliance_history where account_id = (select account_id from account where identifier = <<acc_identifier>>); All values must be null except the balance, which is zero 4. Execute compliance status job for the active year 5. Perform the same query and ensure the compl. status of this account is C.	PASSED
Condition if an installation appears in the allocation list should not contain Expiry Date	Condition if an installation appears in the allocation list should not contain Expiry Date	1. Connect as NA and navigate to Allocation screen. 2. Ensure the rules for an installation/aircraft operator to appear in this screen are as follows: Account Status NOT CLOSED AND The state of the NAT/NAAT is ACTIVE (not deleted) AND Remaining quantity is greater than 0 AND For Installations: (Year of allocation <= year of Permit Revocation if this exists) AND (Year of allocation <= YLE if this exists) For Aircrafts operators: Year of allocation <= YLE	PASSED

ESD : AR and AAR addition	ESD : AR and AAR addition	Scenario 1 1. Login to ESD registry as an AR of an account 2. Go to "ESD ARs" tab and add a new AR to the account. Submit the task 3. Login as ESD CA and go to task list to approve the task 4. Repeat the above test for "ESD AARs" tab and add a new AAR to the account 5. Ensure that the new AR / AAR has been added to the account Scenario 2 1. Login to ESD registry as an AAR of an account 2. Go to "ESD ARs" tab 3. Ensure that you cannot see the "Add ESD AR" button Scenario 3 1. Login to ESD registry as an AR of an account 2. Go to "ESD ARs" tab and select an AR 3. Click on replace button and select a new AR. Submit the task 4. Login as ESD CA and go to task list to approve the task 5. Repeat the above test for "ESD AARs" tab and replace an AAR 5. Ensure that the new AR / AAR has been replaced to the account Scenario 4 1. Login to ESD registry as an AAR of an account 2. Go to "ESD ARs" tab 3. Ensure that you cannot see the "Replace" button	PASSED
ESD AR user can see details of suspended account as well as suspension reason	ESD AR user can see details of suspended account as well as suspension reason	1. Log in as ESD CA and suspend an account 2. As ESD CA ensure that you can see the links "View Details", "Restore" and "Suspension reason" 3. Log in as AR/AAR of suspended account and display Account list 4. Ensure that you cannot see the links "View Details", "Restore" and "Suspension reason"	PASSED

ESD Compliance Dashboard - Account Identifier should not be a link for SUSPENDED account and user is AR/AAR	ESD Compliance Dashboard - Account Identifier should not be a link for SUSPENDED account and user is AR/AAR	Scenario 1 1. Login as ESD CA to ESD registry and find a suspended account or select to suspend an account 2. Go to ESD Compliance dashboard 3. Ensure that at the suspended account's identifier there is a link 4. Click on the link of suspended account and ensure it is active Scenario 2 As AR/AAR of the suspended account: 1. Login to ESD registry as an ESD AR of the suspended account 2. Go to ESD Compliance dashboard 3. Ensure that at the suspended account's identifier there is NOT a link. 4. Repeat the above test as an AAR of the suspended account	PASSED
ESD Entitlements - Propose transaction from account with NO AAR, AAR is supposed to sign ??	ESD Entitlements - Propose transaction from account with NO AAR, AAR is supposed to sign ??	1. Login as ESD AR and go to ESD Entitlements screen 2. Ensure that you can Propose Transaction 3. Select an ESD account of the MS and Suspend all ESD AARs of the account 4. As ESD AR go again to ESD Entitlements screen 5. Ensure that the proposal link is not visible when the user is an AR of the account and the account does not have any enrolled AARs.	PASSED
ESD Entitlements - Transaction Proposal enabled for user who is not AR/CA of account + Red screen when transaction proposed	ESD Entitlements - Transaction Proposal enabled for user who is not AR/CA of account + Red screen when transaction proposed	1. Ensure that in a MS you have the same ESD AR in two accounts (for example BG 2013 and BG 2017) 2. Login as the ESD AR and go to ESD Entitlements Screen. 3. Ensure that you can see all accounts of the same MS but the "Propose Transaction" link only to the account that you are as ESD AR 4. As ESD CA suspend an account of the ESD AR 5. Login as the ESD AR and go to ESD Entitlements Screen. 6. Ensure that you can not see the "Propose Transaction" link of the suspended account 7. Restore the suspended account. 8. Ensure that the ESD AR is able to see the "Propose Transaction" link at ESD Entitlements Screen. 9. Select to suspend the ESD AR of an account 10. Login as the ESD AR and go to ESD Entitlements Screen. 11. Ensure that you can not see the "Propose Transaction" link of account that the ESD AR has been suspended 12. Restore the suspended ESD AR. 13. Ensure that the ESD AR is able to see	PASSED

		the "Propose Transaction" link at ESD Entitlements Screen.	
Corrections in ESD Parameters page	ESD Parameters - there is no way to change EU_PARTY_ACC_IDENTIFIER_FOR_NON_KP_MS value via GUI	Regression incoming CER from KP PHA to ESD 1. I setup EU-296 as (incoming) PHA for MT 2. I give 100 limit1 to MT-2014 account for ESD 3. I set dates so that we are now between balance date and compliance status date 4. I connect as NA to EU and navigate to 296 PHA 5. The transaction type "Transfer to ESD" appears 6. I enter a KP transfer and approve as another CA 7. Transfer is completed and target account balance is increased; Limit1 is decreased. Please also refer to tab "ESD Parameters regression tests"	PASSED

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ESD Parameters - user cannot set European Union value as KP Party Holding Account Registry parameter	ESD Parameters - user cannot set European Union value as KP Party Holding Account Registry parameter	1. Connect as ESD-CA and navigate to "Modify ESD Parameters" 2. Select MS = 'CY' and provide KP PHA Registry = "European Union" and KP PHA identifier = 12 3. Click Save 4. Execute the query "select * from esd_parameter where esd_member_state = 'CY';" and ensure the provided values are persisted. Repeat the same steps for FR, MT, GR.	PASSED
ESD Task List for ESD-AR: shows submitted transfer AEA but not submitted transfer entitlement	ESD Task List for ESD-AR: shows submitted transfer AEA but not submitted transfer entitlement	1. Ensure that ESD-ARs have the permissions : "ERM_ESD_TR_ENT_APPROVE" & "PERM_ESD_AEA_TRANSFER_APPROVE" 2. Connect as ESD-AR of an ESD account. 3. Go to "Holdings" tab and submit one transfer AEA 4. Go to ESD- ESD Entitlements and submit one transfer entitlement 5. Go to task list -as the initiator AR- and ensure that you can see and reject the tasks "Approve Transaction Request" for transfer AEA & "Approve ESD Entitlements Transaction Request" for transfer entitlement 6. Login as an other ESD AR of the account and go to task list. Ensure that you can only see the tasks.	PASSED

ESD parameters page gets locked when empty Abatement Factor (and others) is saved	ESD parameters page gets locked when empty Abatement Factor (and others) is saved	Flow #1 1.1. Log in to ESD as NA 1.2. Go to ESD Parameters 1.3. Remove value from Abatement Factor field 1.4. Click [Save] 1.5 Ensure an error message appears forbidding saving with null abatement factor Flow #2 2.1. Log in to ESD as NA 2.2. Go to ESD Parameters 2.3. Choose member state which has "Carry-forward AEA limit" and "Transfer AEA limit" values set 2.4. Remove value from "Carry-forward AEA limit" field 2.5. Change value in "Transfer AEA limit" field 2.6. Click [Save] 2.7 Ensure saving is forbidden without a value in "Carry-forward AEA limit" and in "Transfer AEA limit".	PASSED
ETS account management: "View suspension reason" should only be visible to roles that have permission PERM_ACC_SUSP_REST	ETS account management: "View suspension reason" should only be visible to roles that have permission PERM_ACC_SUSP_REST	<<all permissions of account search screen should be regressed>> Scenario 1 1. Login as NA of a registry 2. Ensure that only NA and SD Agent have the role "Suspend or unsuspend account (PERM_ACC_SUSP_REST)' 3. Search for a suspended account or suspend an account and enter Suspension reason. 4. Ensure that NA is able to see and click on the "Suspension reason" link. 5. Repeat the above test for SD Agent. 6. Ensure that SD Agent is able to see and click on the "Suspension reason" link. Scenario 2 1. Log in as one of the ARs for that account (making sure you do not have any admin privileges) 2. Ensure that you cannot see the "Suspension reason" link. 3. Repeat the above test as AAR of the suspended account 4. Ensure that you cannot see the "Suspension reason" link.	PASSED

EUTL - CP1 credits ineligible after 31 March 2015	EUTL - CP1 credits ineligible after 31 March 2015	1. Set the parameter ets.last.allowed.date.cp1 to a future date; this is in eucr-configuration.properties 2. Set in EUTL database table EUTL_PARAMETERS, parameter name "cp1_inelligible_date" to a past date 3. Connect as NA in ETS and locate an account with CER or ERU in CP1 4. Propose a transfer of CP1 units towards ETS; approve it 5. Ensure that transaction is TERMINATED with response code "7657: CP1 units are no more eligible" 6. Propose a transfer of CP1 units towards Japan. Approve it. Ensure it remains in status PROPOSED (this is normal, expecting for an approval from Japan) 7. Propose a transfer of CP1 units towards another PHA. Approve it. Ensure the check 7657 is not generated.	PASSED
EUTL Public - If VE are missing for an unexcluded year and Compliance Status is C, Emissions should be shown as "Not Reported" and Cumulative Emissions should be "Not Calculated"	EUTL Public - If VE are missing for an unexcluded year and Compliance Status is C, Emissions should be shown as "Not Reported" and Cumulative Emissions should be "Not Calculated"	1. Select an OHA or AOHA without VE and Compliance Status = C. 2. Login to EUTL Public 3. Go to ETS - Operator Holding Accounts and search for the account 4. Click on "Details - Current Period " link. 5. Ensure that you can see at "Verified Emissions " column the value " Not Reported" at the "Total verified emissions*** " column the value "Not Calculated" 6. Press History. 7. Ensure that under the column "Cumulative Verified Emissions" the value "Not Calculated" is displayed 1. Link to EUTL public 2. From ETS - Operator Holding Accounts search for an OHA or AOHA with Compliance Status = C. 3. Go to ETS-Allocation Compliance. Select Registry of OHA/AOHA of step 2 and Second Commitment period. 4. Click on the proper year link 5. Enter the installation identifier of OHA/AOHA from step 2. 6. Ensure the value "Not Calculated " is shown under column "Total verified emissions"	PASSED
Enable retirement from an AAU deposit account	Enable retirement from an AAU deposit account	1. Select a registry with balance at the ETS AAU deposit account. 2. Click on "View Details" link and go to "Holdings" tab 3. Click on "Propose a transaction" button 4. Ensure that at the "Transaction selection" screen you can see the "Retirement" link. 5. Make sure that the Retirement link is active.	PASSED

Entitlement Transfer to Closed Account	Entitlement Transfer to Closed Account	Scenario 1 1. Login to ESD registry and search for an account in status "Closed" 2. Go to ESD Entitlements and select to Propose Transaction for a different account than the account with "Closed" status 3. At the "Credit Entitlement Transaction" screen select "Transfer" and search for the account in "Closed" status. 4. Ensure that the data of "Closed" account does not appear for selection 5. Repeat the above test for Transaction type: Carry-over Scenario 2. 1. Login to ESD registry and search for an account in status "Blocked" or "Open" (for ex. GR 2015) 2. Go to ESD Entitlements and select to Propose Transaction for a different account than the account with "Blocked" status (For ex. FR 2013) 3. At the "Credit Entitlement Transaction" screen, select "Transfer" to the previous account in "Blocked" or "Open"status. 4. Enter a quantity to transfer and click on "Next" button 5. System displays the information message: "Your ESD Entitlements transfer proposal has been recorded and assigned the identifier EDxxx. The transaction request with id xxxxx has been submitted for approval." 6. Do not approve the task. 7. Go to Accounts and search for the Blocked account (GR 2015) 8. Close the account and approve the account closure task 9. Ensure that the account (GR 2015) is in closed status. 10. Go to task list and approve the previous "Approve ESD Entitlements Transaction Request". 11. Go to ESD -ESD Entitlement Transaction and search for the request 12. Ensure that ESD Entitlements Transfer is in status "5-Terminated" . 13. Click on Transaction Id link and go to "Response Codes" tab. 14. Ensure that you can see the Response code : "7833 Acquiring account should not be CLOSED" 15. Repeat the above test for Transaction type: Carry-over 16. Ensure that the ESD Entitlements Carry Over Terminated with response code: "7833 Acquiring account should not be CLOSED"	PASSED

ITL does not reply back to the registries if the transactions sent are more than 3.000 unit blocks. For this one we should implement an EUCR check to prevent the initiation of such transaction.	ITL does not reply back to the registries if the transactions sent are more than 3.000 unit blocks. For this one we should implement an EUCR check to prevent the initiation of such transaction.	Scenario #1: More than ITL limit across one unit type 1. Set the configuration parameter itlIntegrationSettings.maxTransactionUnitBlocks = 10 2. Locate an account with more than 10 unit blocks via the query: select account_id, unit_type, count(*) , sum(end_ - start_ + 1) quantity from unit_block group by account_id, unit_type order by 3 desc, 1, 2; 2. Connect as NA and locate this account 3. Propose a transfer of units for a quantity spanning more than 10 unit blocks 4. Click on "Submit" 5. Sign in via ECAS 5. The system presents a message: "Check 80002: The amount requested exceeds the maximum number of blocks (10) accepted by ITL in a single transaction." 6. Ensure the message presents quantities whose total quantities sum up to the quantity entered in step [3]. Scenario #2: Equal to ITL limit across many unit types 1. Set the configuration parameter itlIntegrationSettings.maxTransactionUnitBlocks = 3 2. Locate an account with 3 unit types (e.g. CER, RMU, ICER) 3. Enter a transfer of 1+1+1 units across each of the types 4. Ensure the proposal is successfully submitted. 5. Ensure the proposal can be approved and completed normally Scenario #3: Less than ITL limit across many unit types 1. Repeat scenario #2 but enter 1+1 units across two unit types 2. Ensure the proposal is successfully proposed and completed Scenario #4: More than ITL limit across many unit types 1. Repeat scenario #2 but enter 1+1+1+1 units across four unit types 2. Ensure the error message "Check 80002: The amount requested exceeds the maximum number of blocks (3) accepted by ITL in a single transaction." appears after signature, along with valid transaction requests. Scenario #5: Less than ITL limit across one unit type	PASSED

		1. Repeat scenario #1 entering quantity in step 3 less than 10. 2. Ensure the request is submitted normally and, after approval, is completed. NOTICE: All transaction types that go through ITL must be tested. As a rule consider any transaction that: * is NOT internal (10-xx), * is NOT any Issuance of Allowances, * or is between different account types.	
Implement solution that links the KP account to which ESD accounts transfer KP units to MS, not to Year and MS	Implement solution that links the KP account to which ESD accounts transfer KP units to MS, not to Year and MS	1. Connect to ESD as ESD-CA 2. Navigate to Modify ESD parameters 3. Select MS='CZ' 4. Set values for KP Party Holding Account Registry and KP Party Holding Account Identifier 5. Save the values 6. Execute the query: select * from esd_parameter where esd_member_state = 'CZ'; 7. Ensure that for parameters: COMPL_PARTY_ACC_HOST_REG EU_PARTY_ACC_IDENTIFIER_FOR_NON_KP_MS COMPL_PARTY_ACC_IDENTIFIER the value of ESD_YEAR is 9999. 8. Ensure that for other parameters the value of ESD_YEAR is not 9999. Repeat for MT, CY, IT, FR.	PASSED

Incorrect tool tip for excluded Aircraft Operator in Allocation Phase 3 list	Incorrect tool tip for excluded Aircraft Operator in Allocation Phase 3 list	1. Login as NA of a registry 2. Go to EU ETS - Allocation Phase 3 3. Go to Aircraft Operators tab 4. Check the text in tool tip for excluded Aircraft Operator 5. Ensure that you can see the text "Allocation disabled because aircraft operator is excluded for year (YYYY)". Where YYYY is the allocation year	PASSED
Installation Details empty on Account Opening request	Installation Details empty on Account Opening request	1. Request Account Opening for OHA & AOHA 2. In the Task List verify that the Installation tab is not empty	PASSED
Lack of order with displaying "Transfer to year" drop-down list while Transferring AEA units	Lack of order with displaying "Transfer to year" drop-down list while Transferring AEA units	1. Login to ESD registry as ESD CA 2. Propose creating account for one MS, from 2013 up to 2020. 3. While approving, pick random order like: 2018, 2014, 2020, 2015, 2017, 2016.. etc.. 4. From other account with balance propose AEA transfer to MS, open drop-down list: "Transfer to year" 5. Make sure the years are ordered correctly	PASSED
Modify ESD Parameters - fix validation message for the various fields	Modify ESD Parameters - fix validation message for the various fields	1. Login as CA in ESD registry 2. Go to ESD- Modify ESD parameters 3. At the "Abatement Factor" field enter letters and symbols 4. System displays the error message: "the value provided must be numeric." 5. Enter more that two fractional digits 6. System displays the error message: "Only two fractional digits are allowed in abatement factor"	PASSED
New Check for Allocations against YLE/PRD	New Check for Allocations against YLE/PRD	Scenario #1: Submit allocation and change YLE from EUCR screen 1. Prepare and upload an allocation XML; upload in EUCR and EUTL 2. Tick allocation for an included installation; approve the allocation 3. Update via account=>installation screen the YLE to a value earlier than the allocation year of step [2]. 4. At next job execution: Ensure a transaction request is not generated because it is stopped by EUCR Scenario #2: Submit allocation and change YLE from EUTL database 1. Repeat step 1 of scenario #1 2. Repeat step 2 of scenario #1 3. Update the YLE in EUTL via the query: update installation set year_of_last_emissions = 2013 where installation_identifier = <<installation_identifier>> and registry_code = 'FI'; 4. Ensure that at the next job invocation, the allocation transaction towards the specific account is generated, by logging in EU Registry.	PASSED

		5. Ensure the transaction is TERMINATED with error code 7229.	
This is partial implementation of TST-619, which will be completed in the next EUCR release.	replace ESD eligibility icons with text	1. Ensure that in ESD registry the Current Phase within Compliance Cycle is "Between Balance Calculation and Compliance Status Calculation" 2. Login to a registry and search for a Party HA relates to ESD MS 3. Click on "View Details" link 4. Go to "Holdings" tab. 5. Ensure that at the table of the screen the iconic representation like "moon" has been removed and that at the "ESD Eligibility' column you can see the values "Limit 1"and / or "Limit 2" and /or "Limit 1 + "Limit 2". 6. Click on "Propose a transaction" button 7. At the Transaction selection screen "Transfer of ERU, CER, ICER and tCER to ESD Compliance Account" 8. At the Transfer credits to ESD compliance account screen ensure that at the column "Eligible for ESD" you can see the values "Limit 1"and / or "Limit 2" and /or "Limit 1 + "Limit 2". 9. Enter a quantity to transfer and click on "Next" button 10. Ensure that at the "Transfer Confirmation" pop up you can see the values "Limit 1"and / or "Limit 2" and /or "Limit 1 + "Limit 2".	PASSED

Problem with actions in Modify ESD Parameter page	Problem with actions in Modify ESD Parameter page	1. Connect to ESD as ESD-CA 2. Navigate to "Modify ESD Parameters" 3. Click "Save" without changing anything 4. Ensure the message "There is no change on your submit request" appears 5. Change abatement factor to "1.99" and click "Save" 6. Ensure the messages "There exists a pending request for modifying the ESD Parameters, page in view only mode" and "Updated values have been submitted to EUTL for approval" appears at the top of the screen 7. After 2 minutes re-visit the page and ensure the messages do not appear any more 8. Perform the following query in EUTL and ensure the value "1.99" appears: 'select * from esd_parameters where name like 'ABAT%'; 9. Set MS = "AT", KP PHA Registry = "Bulgaria", KP PHA Identifier = "999" and click Save. 10. Ensure the message "KP Party Holding Account Identifier values have been saved." appears 11. Select MS = "AT" and check the other values entered during step [9] appear on the screen. 12. Select MS = "AT" and year = 2020 and set Carry-forward limit = 2 and Transfer AEA limit = 2 and click 'Save'. 13. Ensure the messages "There exists a pending request for modifying the ESD Parameters, page in view only mode" and "Updated values have been submitted to EUTL for approval" appear. 14. After 2 minutes re-visit the page and ensure the messages do not appear any more 15. Perform the following query in EUTL and ensure the entered values during step [13] have been stored: select * from esd_parameters where esd_registry='AT'; 16. Select MS: CY, KP Party Holding Account Registry: European Union, KP Party Holding Account Identifier: 5000280. Click [Save] button. Ensure the messages "KP Party Holding Account Identifier values have been saved" appears 17. Select a MS with data in all fields. At the field "KP Party Holding Account Registry" select "--Select a country--" and click on save button. Ensure that the field "KP Party Holding Account Identifier" become empty and then system displays the message: "KP Party Holding Account Identifier values have been saved." 18. Select a MS and Set Abatement Factor	PASSED

		value to 0.99 Click "Save". The system displays the error message: "The value of Abatement Factor should be greater or equal to: 1.00." Set Abatement Factor value to 1.99 Click "Save". The system displays the message: "Updated values have been submitted to EUTL for approval" <<TO ATTACH LARGE EXCEL WITH 100 TEST CASES>>	
Red Box error while clicking Save button in ESD Parameter Page with no data selected	Red Box error while clicking Save button in ESD Parameter Page with no data selected	1. Login as CA in ESD registry 2. Go to ESD- Modify ESD parameters 3. Click on "Save" button without selecting or entering a value 4. Ensure that system displays the message: "There is no change on your submit request." 5. If there is a value at "Abatement Factor" field delete it and click on "Save" button 6. Ensure that system displays the message: "Abatement Factor: Validation Error: Value is required."	PASSED
Refresh button in ESD Compliance Dates page is not working - for ESD SDAgent user	Refresh button in ESD Compliance Dates page is not working - for ESD SDAgent user	1. Login as user with ESD SD Agent role to ESD registry 2. Go to ESD Compliance Dates page 3. Ensure that Refresh button is available and works properly when clicking on it.	PASSED

Open/blocked status not-recalculated when excluding accounts.	Open/blocked status not-recalculated when excluding accounts.	1. Find an OHA with YFE 2013 but no 2013 emissions and check it is blocked 2. Go to the Compliance page 3. Tick the "Exclude" box for 2013 4.Go back to the Account Search and look for the account again. 5. Ensure that the status of the account is "Open" 6. Un-exclude 2013 and click on "Save" button 7. Ensure that the status of the account is "Blocked"	PASSED
Alignment between Dynamic Compliance Status and Account Status in EUCR	Alignment between Dynamic Compliance Status and Account Status in EUCR	Detailed excel of Test Cases is attached in SDB-2680 1. An account does not have emissions for a year it should => becomes C => becomes blocked 2. An account has all emissions but less surrenders => becomes B => becomes open 3.An account has all emissions but equal or more surrenders => becomes A => becomes open Test exclude-unexlude Test YFE, YLE	PASSED
Show Unit Block management screen for ESD and add details	Show Unit Block management screen for ESD and add details	Scenario #1: Test unit block management page in ESD 1. Connect as ESD-CA and navigate to administration=>unit blocks; ensure columns ESD used and ESD eligibility columns are added as rightmost columns. 2. Ensure the presented data correspond to the rows returned from the query: select * from unit_block where account_id in (select account_id from account where registry_code='ED'); 3. Test search functionality by searching for unit types, ranges and other screen fields. 4. Test export functionality via the same fields. 5. Test sorting functionality by clicking on all columns. 6. Click on a unit block record and edit/suspend/restore the record. Scenario #2: Test unit block management page in IT 1. Connect as NA in Italian registry 2. Repeat all steps of scenario #1 for Italian registry	PASSED

Suspended user can see account details and gets unrecoverable error on transaction proposal	Suspended user can see account details and gets unrecoverable error on transaction proposal	1. Login to ESD as AR of an account. Do not leave the page. 2. From an other browser login to ESD as CA and suspend the above AR user in his account 3. Go to the browser that you have login as ESD AR and search for the account for which this user was suspended (clicking on "Search" button) 4. Ensure that suspended ESD AR cannot see the account at the ESD Compliance Accounts list. After the AR/AAR gets suspended he'll loose access to the particular account almost instantly (which might lead to a 404 error on his next click)	PASSED
There is no displayed Transaction ID in ESD Task List for Entitlement Transactions	There is no displayed Transaction ID in ESD Task List for Entitlement Transactions	1. Login to ESD registry as ESD CA or ESD AR and Propose an Entitlement transaction 2. Go to task list and search for the "Approve ESD Entitlements Transaction Request" task 3. At the "Filter results" table ensure that at the column "Transaction Id" you can see the correct value.	PASSED
Task - user who approved/rejected a task disappears	Task - user who approved/rejected a task disappears	1. Log in as AR 2. Claim and approve a task; note the request Id 3. Submit an un-enrolment request as this user 4. Connect as NA 5. Navigate to Task History 6. Navigate to the request with Id as noted in step 2 7. Ensure the task claimant on this request remains the user from step 1	PASSED
Task List - Search & Export - Wrong description	Task List - Search & Export - Wrong description	1. Login as NA of a registry 2. Go to task list at "Exclusive Task List" and click on "Search & Export" button 3. Check the description. 4. Ensure that you can see correct data 5. Go to "General Task List" tab and click on "Search & Export" button 6. Check the description. 7. Ensure that you can see correct data 8. Go to "History" tab and click on "Search & Export" button 9. Check the description. 10. Ensure that you can see correct data 11. Login as AR or/and as AAR 12. Go to Task list and click on "Filter & Export" button 13.Check the description. 14. Ensure that you can see correct data 15. Go to "History" tab and click on "Search & Export" button 16. Check the description. 17. Ensure that you can see correct data	PASSED

The amendment table should not appear for the NAT Tab of allocation tables phase 3	The amendment table should not appear for the NAT Tab of allocation tables phase 3	1. Login as NA of a registry 2. Go to EU ETS - Allocation Tables Phase 3 3. Go to "National Allocation Table" 4. Ensure that you cannot see the table "Amendments". 5. Go to "National Aviation Allocation Table" 6. Ensure that you can see the table "Amendments" at the end of the screen.	PASSED
Unrecoverable error while trying to do KP transfer to non-existing account	Unrecoverable error while trying to do KP transfer to non-existing account	1. Log in to MS as NA 2. Display PHA account with eligible KP units 3. Propose KP transfer to non-existing account (but with valid account number; you can accomplish this by temporarily changing account identifier of another account to 9999 in EUCR and EUTL, and send the transaction to that account) 4. System displays an error message: 7020: The specified account identification does not exist in the acquiring registry 5. Restore back the change to the account identifier described in step [2]. 6. Propose a transfer to that account 7. Ensure the transfer is properly proposed, approved and respective transaction is completed.	PASSED
View Details link not working	View Details link not working	1. Login as NA to a registry 2. Search for AOHA accounts 3. Click the ">|" button to navigate to the last page of the results 4. Click on the "<<" button to go to the previous page 5. Click the "View Details" link of any account on that page 6. Ensure that you can see the details of the AOHA account 7. Repeat the above test for OHAs account	PASSED
Wrong number of "rows found" displayed in NAT an NAAT	Wrong number of "rows found" displayed in NAT an NAAT	1. Log in to a MS as NA 2. Go to Allocation Table Phase 3 3. At National Allocation Table tab check that you can see correct number at "rows found" field 4. Repeat the above test for National Aviation Allocation Table tab 5. Ensure that system displays correct number at "rows found" field	PASSED

NAs cannot complete "Send Enrolment Keys Task"	Three NAs were needed in order to approve/enrol a user and send enrolment keys; this is now fixed and two NAs are needed for such processes.	Scenario A: Add user as AR - NA1 sends keys A1. Connect as NA and locate the URID of a REGISTERED user A2. Navigate to an OPEN OHA and add the user of step [A1] A3. Connect as NA1 and approve the task A4. Ensure that after 1 minute NA1 has a "Send enrolment keys" task for the specific user. A5. Ensure NA1 can claim and approve the task A6. Ensure the registered user of step A1 is now VALIDATED A7. Ensure the user is indeed added on the specific account Scenario B: Add user as AR - NA sends keys B1. Repeat steps A1-A4. B2. Ensure that after 5 minutes NA1 has a "Send enrolment keys" task for the specific user. B3. Connect as another NA. Ensure NA can claim and approve the task B4. Ensure the registered user of step A1 is now VALIDATED. B5. Ensure the user is indeed added in the specific account Scenario C: Open account and appoint user C1. Create a new account and appoint as AR one REGISTERED user C2. Approve the account opening as NA C3. As the same NA ensure a task "Send enrolment keys' is created C4. Claim and approve the task C5. Ensure the account is created and the user is in VALIDATED status Repeat the above scenarios for adding AAR. Repeat the above scenarios for replacement of existing AR/AAR with another user who is REGISTERED. Ensure the user is finally VALIDATED and the user indeed replaced the appropriate user on the account.	PASSED
Revision of the Czech translation	Translation issue		PASSED

Empty Error after adding closed account to TAL list	When attempting to add a CLOSED account to a TAL, an empty error box appeared; this is now fixed	A. Add CLOSED account to another account's TAL A1. Get Account number of holding account which is CLOSED A2. Go to another OPEN holding account A3. Add closed account into TAL list of holding account A4. Ensure the message "80207: The account EU-100-320-0-80 is closed." appears and the TAL addition cannot be submitted. Repeat for BLOCKED account in step A2. B. Attempt to add non existing account Repeat scenario A but enter a non-existing account Ensure the message "80206: The specified account number EU-100-655454545-0-89 does not exist in the registry." and the TAL addition cannot be submitted. C. Attempt the add account with wrong check digits Repeat scenario A but enter a existing account and wrong check digits Ensure the message "80203: The account number is invalid with respect to its check digits. Check digits cannot be provided for non-ETS accounts." D. Negative scenario - TAL addition works normally for adding OPEN account Repeat scenario A but choose an OPEN account to add. Ensure account is added normally to the TAL.	PASSED
ESD Entitlements Transactions: Transferring ESD Account Year and Acquiring ESD Account Year cleared after search is performed	Search presentation issue in ESD transactions	1. Log to ESD as CA 2. Go to ESD - ESD Entitlements Transactions 3. Select values for Transferring ESD Account Year and Acquiring ESD Account Year 4. Click "Search" button 5. Ensure that you can see correct data at the "ESD Entitlements Transactions" table. At filters "Transferring ESD Account Year" and "Acquiring ESD Account Year" , system displays the pre-selected values	PASSED

No user names in Representative drop down list when creating account for existing holder	Account opening presentation issue, enriching screen objects with account representative names.	1. Log in to MS as NA 2. Go to Accounts - Account request 3. Choose "Account Holder is already recorded in the registry" 4. Provide Account Holder ID (NA must NOT be related to this holder) 5. Click Next 6. At the "Account Opening - Authorised Representative Information" choose the option " Representative is already related to the Account Holder" 7. At the field "Representative" open the drop down list. 8. Ensure that you can see the URIDs and the names of the Representatives 9. Choose Authorised Representatives and go to "Account Opening - Additional Authorised Representative Information" 10. Choose the option " Representative is already related to the Account Holder" 11. At the field "Representative" open the drop down list. 12. Ensure that you can see the URIDs and the names of the Representatives	PASSED
Incorrect warnings when saving ESD parameters	Incorrect warnings when saving ESD parameters	Log in to ESD as CA and go to ESD/Modify ESD parameters Scenario 1 1.1 Select any MS and any Year. 1.2 Remove value from "Transfer AEA limit" field and click [Save] 1.3 System displays the error message: "Transfer AEA limit: Validation Error: Value is required." Scenario 2 2.1 Type value 3333.00 in "Abatement Factor" field and click [Save] 2.2 System displays the error message: "Abatement factor must be a decimal number with up to 3 digits as integer part and up to 2 digits as fractional part." Scenario 3 3.1 Select any MS and any "KP Party Holding Account Registry" 3.2 At the "KP Party Holding Account Identifier" try to type a value > of 15 digits. 3.3 Ensure that system doesn't allow you to type more than 15 digits. Scenario 4 4.1 Select any MS and any Year. 4.2 Type 0 in "Carry-forward AEA limit" field and click [Save] 4.3 System displays the error message: "Carry-forward AEA limit must be a positive integer up to 7 digits long. 4.4 Repeat steps for "Transfer AEA limit"	PASSED

		4.5 System displays the error message: "Transfer AEA limit must be a positive integer up to 7 digits long."	
Contents of Administration menu are not scaled properly under Chrome	Graphical issue, concerning Administration menu under Chrome browser	1. Clear browser cache 2. Log in as NA 3. Navigate to "Administration" menu 4. Try to move the browser window in various positions and sizes 5. Ensure the vertical scroll-bar does not appear in the "Administration" menu	PASSED
There is no "Approve ESD Entitlements Transaction Reversal Request" in Task name filter	There was no "Approve ESD Entitlements Transaction Reversal Request" in Task name filter; this is now fixed	1. Log in to ESD as CA 2. Make sure there is at lease one "Approve ESD Entitlements Transaction Reversal Request" task pending approval 3. Go to Task list / Exclusive Task List 4. At the field "Task name" open the drop down list and ensure that you can see the option "Approve ESD Entitlements Transaction Reversal Request". 5. Select the option "Approve ESD Entitlements Transaction Reversal Request" and click on "Search" button 6. Ensure that the system displays correct data	PASSED

No possibility to filter Unit Blocks in ESD by Holding Account Type	Searching of unit blocks is optimised under ESD to included holding account type.	1. Login to ESD as CA. 2. Go to Administration - Unit Blocks. 3. At the Search Criteria go to "Holding account Type" field and open the drop down list 4. Ensure that you can see the options: EU AEA Total Quantity Account ESD Deletion Account ESD Compliance Account 5. Try to filter Unit Blocks by Holding Account Type 6. Ensure that you can see correct data.	PASSED
Problem with filtering Unit blocks in ETS-EUCR by Holding Account Type	Searching of unit blocks is optimised under ETS to included holding account type.	1. Login as NA of a registry 2. Go to "Administration" -"Unit Blocks" 3. Click on Search button and check how many results are displayed 4. At the field "Holding account Type" open the drop-down list and select "None". Consult number of results displayed (ensure that the number of rows are < 500) 5. From the above drop down list select KP accounts. Consult number of results displayed for each KP account. 6. Ensure that the sum of rows of all KP accounts is equal to rows of "None"	PASSED
CP1 units are not marked red after "last allowed date"	All CP1 KP units are considered as ineligible after a specified date.	1. Connect as NA. 2. Set the parameter ets.last.allowed.date.cp1 equal to 31/5/2020 3. Locate an account with CP1 CERs. 4. Ensure that the projects of the CERs of step [3] are in no list. 5. Ensure the holdings of account of step [3] all show red in holdings screen; attempt a proposal of transfer of KP units and ensure these are summed in red colour (ineligible). 6. Add some projects of step 3 in Art58(1) Negative list 7. Ensure the holdings of account of step [3] all show red in holdings screen; attempt a proposal of transfer of KP units and ensure these are summed in red colour (ineligible). 8. Remove projects from Art581(1) Negative list and add them in a positive list 9. Ensure the units appear green/eligible in holdings and propose KP transfer screens. 10. Set the parameter ets.last.allowed.date.cp1 is equal to 31/5/2013 11. Ensure the units appear red/ineligible in holdings and propose KP transfer screens.	PASSED

red box when uploading auction tables	Under a specific sequence, when uploading auction tables a red screen error appeared; this is now fixed.	Scenario 1: Upload a valid Auction xml file in EUCR 1.1 Login as CA to EU registry 1.2 Go EU ETS - Auction Tables 1.3 Select a valid Auction xml file (General and / or Aviation Allowance) and click on "Import" button 1.4 At the "Auction table changes confirmation" pop up check the data and click on "Confirm" button. 1.5 System displays the information message: "The auction table has been imported." 1.6 Check the "Details" table and ensure that you can see correct data. 1.7 Repeat the above test for Update and Delete valid Auction xml Scenario 2 Negative: Click on “Import” button without selecting xml file 2.1 Login as CA to EU registry 2.2 Go EU ETS - Auction Tables 2.3 Click on "Import" button without selected a xml file 2.4 System displays the error message: "A file is required" Scenario 3 Negative: Cancel the import of an Auction Table 3.1 Login as CA to EU registry 3.2 Go EU ETS - Auction Tables 3.3 Select a valid Auction xml file (General and / or Aviation Allowance) and click on "Import" button 3.4 At the "Auction table changes confirmation" pop up check the data and click on "Cancel" button. 3.4 Ensure that the Auction xml file has not been imported 3.5 Repeat the above test for Update and Delete xml files Scenario 4 Negative: Attempt to upload an Auction xml file with Invalid content 4.1 Login as CA to EU registry 4.2 Go EU ETS - Auction Tables 4.3 Select an Auction xml file (General and / or Aviation Allowance) with Invalid content and click on "Import" button 4.4 System displays the error message: "The content of the XML file is invalid" Scenario 5 Negative: Attempt to upload an Auction xml file with Invalid format 5.1 Login as CA to EU registry 5.2 Go EU ETS - Auction Tables 5.3 Select an Auction xml file (General and / or Aviation Allowance) with Invalid format	PASSED

		and click on "Import" button 5.4 System displays the error message: "The uploaded file is invalid." Scenario 6 Negative: Attempt to upload an Auction xml file with wrong extension 6.1 Login as CA to EU registry 6.2 Go EU ETS - Auction Tables 6.3 Select an Auction xml file (General and / or Aviation Allowance) with wrong extension and click on "Import" button 6.4 System displays the error message: “The uploaded file is not of the appropriate content type (text/xml).” Scenario 7 Negative: Attempt to upload an Auction xml file with wrong first characters in xml file 7.1 Login as CA to EU registry 7.2 Go EU ETS - Auction Tables 7.3 Select an Auction xml file (General and / or Aviation Allowance) with wrong first characters in xml file and click on "Import" button 7.4 System displays the error message: "The uploaded file is invalid. Its type does not match its extension."	
Filtering Auction Tables by Auction Platform Name is not entirely working	Optimisation of auction tables search	1. Login as CA in EU registry 2. Go to EU ETS - Auction Tables 3. At the "Auction Platform" field enter an existed Platform name and click on "Filter" button 4. Ensure that you can see correct data 5. At the "Auction Platform" field enter a wrong Platform name and click on "Filter" button 6. Ensure that the system does not display data 7. At the "Auction Platform" field enter a part of an existed Platform name with a * at the end and click on "Filter" button 8. Ensure that you can see correct data 9. Click on "Filter & Export" button 10. Ensure that you can see correct data	PASSED

Auction Delivery - Search is no clearing filter criteria	Optimisation of auction delivery search	1. Login as CA in EU registry 2. Go EU ETS - Auction Delivery 3. In Auction Delivery in results table there are displayed records with the years for 2013, 2014, 2015. (Filter by all years) 4. Click one of the records and ensure that the radio button is selected 5. Click on "Search" button and ensure that the radio button has been deselected. 6. Click on "Submit" button without selected a new record 7. System displays the error message: "No Entry SelectedPlease select an entry in the auction delivery list". 8. Repeat the above test by selecting values to filter "Year " for example select 2015 9. Click one of the records and ensure that the radio button is selected 10. Click on "Search" button and ensure that the radio button has been deselected, or select an other year and then click on "Search" button 11. Click on "Submit" button without selected a new record 12. System displays the error message: "No Entry SelectedPlease select an entry in the auction delivery list".	PASSED
Typo in Modify ESD Parameters page	Typo in Modify ESD Parameters page; this is now fixed	1. Visit "Modify ESD Parameters" page 2. Select CY 3. Verify that the text is corrected as "KP Party Holding Account Identifier (incoming)"	PASSED
Red Box error while searching records in JI Project page	Red Box error while searching records in JI Project page; this is now fixed	1. Navigate to JI Projects 2. Perform Search by Track and Unit Type 3. Verify that the search is performed without errors. 4. With the results verify that the data for Unit Type is shown as "ERU from AAU" instead of "ERU_FROM_AAU" and "ERU from RMU" instead of "ERU_FROM_RMU". 5. With the results verify that the data for Track are displayed properly, i.e. "Track 1" instead of "Track_1", and so on.	PASSED
Surrender of Allowances - Period to be changed to Phase	Screen change in surrender allowance screen	From any OHA or AOHA that has some available Allowances: 1. Go to Holdings tab 2. Click Propose Transaction 3. Select Surrender of allowances Expected result: In the surrender of allowances screen, in the compliance information section the 3rd figure on the left column should be labelled: "Carry-Over from previous phase"	PASSED

Allow Emissions for year Y when YLE = Y	Compliance issue, for allowing emissions submission for current year	TEST CASE 1 1. Update Installation, change PRD and YLE to a date in current year Y 2. Approve the Request 3. Verify that the link Propose (emissions) is available for current year. 4. Propose Emissions for current Y. 5. Verify that EUTL approved them TEST CASE 2 1. Update Installation, change PRD and YLE to a date in current year Y 2. Approve the Request 3. Submit a request for Account Closure for the account 4. Verify that the link Propose (emissions) is available for current year. 5. Propose Emissions for current Y. 6. Verify that EUTL approved them TEST CASE 3 1. Locate an installation without a YLE. 2. Verify that the link Propose (emissions) is not available for current year. TEST CASE 4 1. Locate an installation with YLE = any future year up to 2020. 2. Verify that the link Propose (emissions) is not available for current year. Repeat all scenarios for AOHA	PASSED
When there is a pending request for Account Closure, the system should not allow new requests of Installation Information update	When there is a pending request for Account Closure, the system should not allow new requests of Installation Information update; this is now enforced	1. Login as NA of a registry 2. Select an OHA in Open (without balance) or Blocked status 3. Click on "View Details" link and go to "Installation" tab 4. Ensure that the button "Update" is active 5. Click on "Close" or " Force Close' button. 6. Ensure that the "Account Closure" task has been created at the task list 7. Click on "View Details" link and go to "Installation" tab 8. Ensure that you cannot see the "Update" button 9. Repeat the above test for AOHA and "Aircraft Operator" tab	PASSED

CP1 Eligibility in transaction details page	CP1 Eligibility is added in transaction details page	Test Case 1. Change CP1 Eligibility parameter (eucr-configuration) to expire after current date 2. Perform a transaction of CP1 CERs units than belong to a White list 3. Transactions page > Locate the performed transaction and check on Summary tab that units are displayed as eligible. Test Case 2 1. Change CP1 Eligibility parameter (eucr-configuration) to expire BEFORE current date 2. Perform a transaction of CP1 CERs units than belong to a White list 3. Transactions page > Locate the performed transaction and check on Summary tab that units are displayed as ineligible.	PASSED
Account Claim > Cannot Approve task	Account claim request could not be approved under certain conditions; this is now fixed	Scenario A: Release and claim account A1. Connect as NA, locate an OHA and release it A2. Claim the account and assign another account holder and representatives A3. Submit the task A4. Connect as another NA and approve the task A5. Ensure the task appears in history list and in list of account requests mentioning the included account holder and representatives. Scenario B (regression test): Release and reject claim Repeat steps A1-A3 B2. Connect as another NA and reject the claim request B3. Ensure the account still belongs to the original account holder	PASSED
Approved "Allocation Delivery Settings" request displays all allocations not only approved one.	Column sorting on "Approve Allocation Settings Delivery" task is disabled to avoid presentation of wrong data.	Scenario A: Task details approval task hides sorting symbols A1. Navigate to NA's tasklist and locate a "Approve Allocation Settings Delivery" task A2. View the details of this task A3. Ensure the column heading do not show sorting symbols Ensure that both tasks pertaining to installations and to aircraft operators behave as described. Scenario B: Allocation screen uses sorting symbols B1. Navigate to EUETS=>Allocation Phase 3. B2. Ensure that sorting via clicking column headers works normally for both installations	PASSED

		and aircrafts, by clicking on the respective tabs.	
Eligibility Flag does not reflect CP1 eligibility in all views	In some screens, units considered ineligible as per CP1 end date are erroneously displayed as eligible. This is now fixed.	**Scenario A: Test CP1 date affects eligibility (screens #067, #076, #077, #062)** A1. Set ets.last.allowed.date.cp1 to 1/1/2023 A2. Locate a PHA with CP1 CER units A3. Add these CER units in General Positive List A4. Ensure the units are shown as eligible in the account's holdings screen . A5. Propose a KP transfer and ensure the units are shown as eligible A6. Ensure these units can be transferred to an OHA and approve the transaction request as another NA. A7. Ensure the units are shown as eligible in Cancellation proposal screen and its confirmation; approve the transaction request as another NA. A8. Ensure the units are shown as eligible in Cancellation Against Deletion proposal screen and its confirmation; approve the transaction request as another NA. A9. Set ets.last.allowed.date.cp1 to 1/1/2013 A10. Repeat steps 4-8 but ensure units are shown as ineligible because they are past CP1 end date. A11. Lookup all completed transactions and ensure their transaction PDF show eligible/ineligible units as this is shown in the transaction details screen; ensure the eligible/ineligible flags in the transaction details screen are correct. **Scenario B: Test CP1 date affects eligibility in exchange screen (screen #522)** B1. Repeat the steps A1-A5 but choose an OHA with 100 entitlements. B2. Ensure 10 eligible units can be exchanged. B3. Ensure any ineligible unit cannot be exchanged.	PASSED

		Scenario C: Test unit block search screen (screen #110) C1. Connect as NA and navigate to unit block search screen C2. Set ets.last.allowed.date.cp1 to 1/1/2023 C3. Locate a unit block of type CER which is in no list C4. Ensure it is shown as ineligible C5. Add the unit block to General Positive List C6. Ensure it is shown as eligible C7. Set ets.last.allowed.date.cp1 to 1/1/2013 C8. Ensure it is shown as ineligible **Scenario D: Test 3000 unit blocks check screen (screen #063)** D1. Set itlIntegrationSettings.maxTransactionUnitBlocks to 0 (so that all ITL-routed transactions are stopped) D2. Set ets.last.allowed.date.cp1 to 1/1/2023 (so that all CP1 units are eligible) D3. Attempt a transaction from PT PHA to GB PHA of CP1 CERs D4. Ensure the transaction is stopped via Check 80002 and alternative transactions are presented; the unit blocks of this CER are shown as eligible D5. Set ets.last.allowed.date.cp1 to 1/1/2013 (so that all CP1 units are ineligible) D6. Repeat steps D3-D6; ensure the proposed transactions show the CER unit blocks as ineligible. **Scenario E: Regression tests (screen #152)** For regression, repeat the tests of SDB-2672 (EUCR-1500).	
Change of error message	Addition of translation for all registries	Ensure the error message of error check 7175 is as proposed.	PASSED
[SI - SLOVENIA] Registry administrators could not view details of AO account	Addition of Slovenian translation	1. As NA login to SI registry 2. Change the UI Language to SLOVENIAN 3. Search for AOHA accounts 4. Open the details of any AOHA from the results 5. The page should be displayed normally	PASSED

System doesn't reject CO2 only emission upload when opt-ins are enabled	System should demand explicit values (zeros are acceptable) for CO2, N2O and PFC for all year of Phase 3.	Set up system configuration for all registries opt-in PFC and opt-in N2O starting with 2013, as follows:
		# GHG Gases Opt-in defaults
		registryConfig.ALL.OPT_IN_N2O = true
		registryConfig.ALL.OPT_IN_N2O_YEAR = 2013
		registryConfig.ALL.OPT_IN_PFC = true
		registryConfig.ALL.OPT_IN_PFC_YEAR = 2013
		
		Perform the following tests for any year of Phase 3.
		-- 	
		
		A1. Ensure XML containing all three gases uploads correctly via EUETS=> Emissions Upload (refer to XML 1)
		A2. Ensure emissions screen demands all gases
		
		B1. Ensure XML containing no gases does not upload via EUETS=> Emissions Upload (refer to XML 2)
		B2. Ensure emissions screen cannot accept empty gases fields
		
		C1. Ensure XML omitting values for any of the three gases does not upload via EUETS=> Emissions Upload (refer to XML 3)
		C2. Ensure emissions screen does not accept anything less than the three gases.
		
		D. Ensure an account with some null emissions value is updated correctly
		1. Locate an account with emissions CO2=5, PFC=null, N20=null
		2. Edit the emissions of the account
		3. Ensure that a positive or zero value is demanded for all three gases.
		4. Ensure the cumulative emissions quantity is calculated adding the values of CO2, PFC, N2O.
		
		Ensure that emissions figures are always positive integer or zero.
		Strings are not accepted.
		Decimals are not accepted.
		Negative numbers are not accepted.
		
		List of XML files:
		----------------------- 	
		1. Legitimate XML file
		------------------------------ 	
		<?xml version="1.0" encoding="UTF-8"?>
		<ns1:emissions registry="AT"
			PASSED

		xmlns:ns1="urn:eu:europa:ec:clima:ets:1.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="urn:eu:europa:ec:clima:ets:1.0 emissions.xsd "> <ns1:installation identifier="XXXXXX"> <ns1:stationaryEmissions verified="true" year="2014"> <ns1:CO2>1</ns1:CO2> <ns1:N2O>1</ns1:N2O> <ns1:PFC>1</ns1:PFC> </ns1:stationaryEmissions> </ns1:installation> </ns1:emissions> 2. XML file with missing values --- <?xml version="1.0" encoding="UTF-8"?> <ns1:emissions registry="AT" xmlns:ns1="urn:eu:europa:ec:clima:ets:1.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="urn:eu:europa:ec:clima:ets:1.0 emissions.xsd "> <ns1:installation identifier="XXXXXX"> <ns1:stationaryEmissions verified="true" year="2014"> <ns1:CO2></ns1:CO2> <ns1:N2O></ns1:N2O> <ns1:PFC></ns1:PFC> </ns1:stationaryEmissions> </ns1:installation> </ns1:emissions> 3. XML file with missing mandatory elements --- <?xml version="1.0" encoding="UTF-8"?> <ns1:emissions registry="AT" xmlns:ns1="urn:eu:europa:ec:clima:ets:1.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="urn:eu:europa:ec:clima:ets:1.0 emissions.xsd "> <ns1:installation identifier="XXXXXX"> <ns1:stationaryEmissions verified="true" year="2014"> <ns1:CO2>1</ns1:CO2> <ns1:N2O>1</ns1:N2O> </ns1:stationaryEmissions> </ns1:installation> </ns1:emissions>	

Entitlement values are not calculated correctly in EUCR	Entitlement values of accounts should be re-calculated at emission verification and at exclusion/unexclusion of account.	Preliminary step: Upload the following ICE XML for an installation: <?xml version="1.0" encoding="UTF-8" standalone="no"?> <entitlements registryCode="<<registry>>" xmlns="urn:eu:europa:ec:clima:ets:1.0"> <installation identifier="<<installation_id>>"> <action>A</action> <flag>2</flag> <ice>5</ice> </installation> </entitlements> A. Ensure ICE value is recalculated for all DCS by uploading emissions and excluding/unexcluding years A1. Exclude all years for an installation, so that DCS=BLANK A2. Upload a new ICE XML with a large ICE value and ensure this appears in the installation's entitlement value B1. Unexclude a year and enter emissions and equal surrenders. B2. Ensure DCS=A B3. Update emissions to 1 B4. Ensure entitlements are re-calculated to the max of 4.5% of VE and the value provided in the ICE XML C1. Update emissions to a larger value C2. Ensure DCS=B. C3. Ensure entitlement value is recalculated to 4,5% of the VE value D1. Via the database delete all emissions of this installation and update the COMPLIANCE_STATUS of this installation for CP2 to VE=0 and cumulative surrenders = 0. D2. Un-exclude two years to force recalculation of DCS. D3. Ensure DCS=C D4. Provide emissions for one of the excluded years D5. Ensure the entitlement is recalculated. E1. Repeat steps D1-D5 via uploading VE XML with APPROVED flag E2. Ensure entitlement is recalculated F1. Repeat steps D1-D5 via uploading VE XML with NOT APPROVED flag F2. Approve the emissions F3. Ensure entitlement is recalculated General check:	PASSED

		Ensure that in all calculations, VE corresponding to excluded years are not considered in calculated ICE values.	

Initially blocked AOHA account doesn't get unblocked when its DCS becomes A	AOHA account status should be updated when Dynamic Compliance Status gets to A, B, C or BLANK, according to a defined set of rules.	1. AOHA which is OPEN, has not been compliant and gets DCS=BLANK should become OPEN. 2. AOHA which is OPEN, has been compliant and gets DCS=BLANK should become OPEN. 3. AOHA which is BLOCKED, has not been compliant and gets DCS=BLANK should become BLOCKED. 4. AOHA which is BLOCKED, has been compliant and gets DCS=BLANK should become OPEN. 5. AOHA which is BLOCKED, has not been compliant and gets DCS=OPEN should become OPEN. 6. AOHA which is BLOCKED, has been compliant and gets DCS=A should become OPEN. 7. AOHA which is OPEN, has not been compliant and gets DCS=A should become OPEN. 8. AOHA which is OPEN, has been compliant and gets DCS=A should become OPEN. 9. AOHA which is OPEN, has not been compliant and gets DCS=B should become BLOCKED. 10. AOHA which is OPEN, has been compliant and gets DCS=B should become OPEN. 11. AOHA which is BLOCKED, has not been compliant and gets DCS=B should become BLOCKED. 12. AOHA which is BLOCKED, has been compliant and gets DCS=B should become OPEN. 13. AOHA which gets DCS = C should become BLOCKED.	PASSED

Task list: I un-claim one task -> many tasks get unclaimed	Due to a bug, unclaiming one task resulted in unclaiming multiple tasks; this is now fixed.	A. Unclaim only the checked tasks 1. Log in as NA 2. Go to Exclusive tasklist 3. Claim 10 tasks 4. Click one task and click "Unclaim" 5. Only the clicked task becomes unclaimed; the other 9 remain claimed. B. Regression - Unlaim between two users 1. Connect as a user (A) that has tasks visible in his task-list 2. Claim any number of tasks (more than 1) 3. Connect as another user (B) that also has tasks visible in his task-list 4. Claim any number of tasks (more than 1) 5. As NA user propose the un-enrolment of user (A) (no need to Approve it) 6. Ensure the tasks previously claimed by user (A) are now unclaimed 7. Ensure the tasks previously claimed by user (B) remain claimed C. Regression - Task history of un-enrolled user is unaffected 1. As an NA that has tasks visible in his task-list 2. Claim and approve a task 3. Verify that the approved task in the task-history shows the user as claimant 4. Connect as another NA user and propose the un-enrolment of the NA of step 1 (no need to Approve it) 5. Ensure that the tasklist history still presents the same information as shown in step 3.	PASSED
Transaction View - Request details wrong info for reversals	Reversals did not present correctly the corresponding actors; this is now fixed.	1. Login to EUCR as NA of a Registry 2. Go to "Transactions" and search for Allocation Allowances transaction (or create a new one) 3. Click on "Transaction Id" link 4. Click on "Reverse" button and ender your ECAS Signature 5. Login as an other NA of the registry and go to Task List 6. Approve the Transaction Request and ender your ECAS Signature 7. Login as CA and go to Task List 8. Approve the Transaction Request and ender your ECAS Signature 9. Login as NA and go to the "Transactions" 10. Search for the reversal transaction and Click on "Transaction Id" link 11. Click on "Request Details" tab 12. Ensure that you can see correct data.	PASSED

CLONE - SMS of credit entitlements transaction capitalization	The SMS of credit entitlements transaction is modified.	1. Propose an ESD Entitlement transaction 2. Ensure the SMS states "Confirm the ESD Credit Entitlements transaction proposal..." Note that this can be tested via technical means, by checking the ECAS log for the exact SMS message generated.	PASSED
Red error encountered when clicking on transaction	Certain old transactions which did not have some attributes produced an error screen when clicked; this is now fixed.	Scenario 1: Manually modify the transferring account of a transaction 1. Connect as NA and navigate to Accounts=>Transactions screen 2. Locate a transaction identifier 3. Update the transaction details in the database as follows: update transactions set tra_account_id = 9999, tra_acc_identifier_full = 'ZZZZZ' where transaction_identifier = <<located_transaction_identifier>>; 4. Log-out and re-connect to the same screen. 5. Locate the transaction and click on its identifier 6. Ensure the transaction details screen appears correctly. Note: Clicking on the imaginary transferring account hyperlink will lead to the 404-Invalid screen of EUETS.	PASSED

YFE should be able to override existing VE years, if VE=0	It should be able to set YFE to a year higher than those for provided emissions, if the provided emissions for the lower years are zero.	**Scenario A: YFE can be set to a larger year having zero emissions** 1. Login as NA1 2. Find OHA with YFE=2013 3. Make sure the VE for 2013=0 4. Go to "Installation" tab of the account and update First Year of Verification = 2014 5. As NA2 approve the "Update of Installation Information" task 6. Check that the account has been updated. Repeat for AOHA **Scenario B: YFE can be set to a larger year having zero emissions, with some excluded years** 1. Login as NA1 2. Find OHA with YFE=2013 3. From the Compliance tab mark year 2013 as excluded. 4. Set VE emissions for 2014=0 5. Login as NA2 and approve the emissions update 8. As NA1 go to "Installation" tab of the account and update First Year of Verification = 2015 9. As NA2 approve the "Update of Installation Information" task 6. Check that the account has been updated. Repeat for AOHA **Scenario C (regression): YFE cannot be set to a larger year when having non-zero emissions** 1. Login as NA1 2. Find OHA with YFE=2013 3. Make sure the VE for 2013>0 4. Go to "Installation" tab of the account and update First Year of Verification = 2014 5. The error “There are Verified Emissions introduced in years prior to the proposed Year of First Emissions.” appears. Repeat for AOHA **Scenario D (regression): YFE can be set to a larger year when having null emissions** 1. Login as NA1 2. Find OHA with YFE=2013 3. Make sure the VE for 2013 are not set 4. Go to "Installation" tab of the account and update First Year of Verification = 2014 5. As NA2 approve the "Update of Installation Information" task (“Update of Aircraft Operator Information” in case of AOHA) 6. Check that the account has been	PASSED

		updated. Repeat for AOHA	

User appears twice in the AR list	Under a series of actions, users attached on accounts appeared twice in the account screen. This is now fixed.	**Scenario A: Add AR to two accounts concurrently** 1. Locate an account (ACC1) and a user (USER1) who is not connected to the account. Ensure the corresponding account holder has at least one more account (ACC2). The accounts to which an account's holder is connected to are returned via the following query: select identifier from account where account_holder_id = (select account_holder_id from account where identifier = <<account_identifier>>); 2. Ensure the user is not connected to any account of this account holder; run this query and ensure it returns no results: select * from account_holder_representative where URID = '<<URID>>' and account_holder_id = (select account_holder_id from account where identifier = <<account_identifier>>) 3. Propose to add USER1 to ACC1 (user is not yet connected to the account holder). Do not approve it yet. 4. Propose to add USER1 to ACC2 (user is now connected to the account holder). Do not approve it yet. 5. Reject the request of step 3. 6. Repeat step 3 and approve request for USER1. 7. Approve the request of step 4. 8. Ensure USER1 appears only once in ACC1 and ACC2 in EUCR (Accounts->View Details->Authorised Representatives) and EUTL (Account Mgt->Details). **Scenario B: Replace AR from two accounts concurrently** Repeat scenario A but replace an AR with another AR who is not yet connected to the account holder. **Scenario C: Add AR in three accounts concurrently** Repeat scenario A but use three accounts. Reject the addition request of two account and repeat it. Ensure the added AR appears once in each of the three accounts. **Scenario D: Repeat scenario A and**	PASSED

		combine with a concurrent user details update Repeat scenario A but combine with a request for personal details update of the AR to be added. Ensure the AR appears once in each of the two accounts. **Scenario E: Create a new account for existing AH adding a new AR not already connected to AH** Ensure the new AR appears only once in the account. **Scenario F: Create two new accounts for existing AH adding a new AR not already connected to AH** Ensure the new AR appears only once in each account.	

Emissions entered for year 2014 are rejected by EUTL	Submission of emissions to EUTL needed a certain configuration; this is no longer needed, as EUTL gets the current year automatically.	**Scenario A: Ensure EUTL accepts emissions even when database setting is equal to a year in the past** 1. Update in EUTL database the parameter param_value3 with a year in the past UPDATE system_parameter SET param_value3 = 2014 WHERE system_parameter_id = 1; 2. As NA1 go to OHA account with no YLE and no emissions for 2014 3. Go to "Compliance" tab and enter emissions for year 2014 (Approve Emissions task is generated) 4. As NA2 approve task "Approve Emissions" 5. Check the OHA in EUCR (account->compliance screen) and confirm that the emissions have been updated 6. Check the OHA in EUTL (account mgt->installation) and confirm that the emissions have been updated 7. Check EUTL log and confirm that there is no error "FINE: Check7119 [Correlation ID: xxxxx]: The verified emission year [2014] for installation [yyyyyy] must be before the current year [2014] since no year of last emissions has been provided for the installation." Repeat for AOHA.	PASSED

Task claimed by NA can be claimed by AR/AAR	It was possible for an AR/AAR to claim a task already claimed by an NA; this is now fixed.	Create a task for testing: 1. Login as AAR 2. Go to an OHA account with configured ARs and AARs, in the holdings tab 3. Click propose a transaction 4. Choose deletion of allowances 5. Enter a quantity to delete and click next 6. Click confirm 7. Complete the signature procedure **Scenario 1. Claimant is AAR; NA and AR attempt to claim the task** 1. Login as AAR and claim the "Approve transaction request" task but do NOT proceed to approve it. 2. Login as AR and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 3. As AR try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user." 4. Login as NA and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 5. As NA try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user." **Scenario 2. Claimant is AR; NA and AAR attempt to claim the task** 1. Login as AAR and unclaim the task 2. Login as AR and claim the task but do not proceed to approve it 3. Login as AAR and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 4. As AAR try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user." 5. Login as NA and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 6. As NA try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected	PASSED

		user." **Scenario 3. Claimant is NA1; AR, AAR and NA2 attempt to claim the task** 1. Login as AR and unclaim the task 2. Login as NA1 and claim the task but do not proceed to approve it 3. Login as AAR and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 4. As AAR try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user." 5. Login as AR and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 6. As AR try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user." 7. Login as an other NA and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 8. As an other NA try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user." 9. Login as NA1 and unclaim the task. Ensure the task can be unclaimed **Scenario 4. Claimant is NA; Verifier attempts to claim the task** 1. Login as NA and claim an "Approve emissions" task but do not proceed to approve it 2. Login as Verifier and try to claim the task. You should get "Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status." 3. As Verifier try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user." **Scenario 5. Claimant is Verifier; NA attempts to claim the task** 1. Login as Verifier and claim an "Approve emissions" task but do not proceed to	

		approve it 2. Login as NA and try to claim the task. You should get “Claim task item error: One or more task items cannot be claimed, because they are not in unclaimed status.” 3. As NA try to unclaim the task. You should get "Unclaim task item error: One or more task items cannot be unclaimed, because the claimant is not the currently connected user."	

Condition if an installation appears in the allocation list should not contain Expiry Date	Installations appearing in the "Allocation" screen should appear irrespectively of the value of Expiry Date.	A. Ensure setting PerExpDate to a past or future date does not affect appearance of the respective account in the allocation screen A1. Connect as NA and navigate to EUETS => Allocation Phase 3 screen. A2. Choose year = 2014 and locate an installation whose record appears on screen. A3. Update PerExpDdate = 1/1/2013 and approve the change A4. Ensure the installation appears in the allocation screen for year = 2014 A5. Update PerExpDdate = 1/1/2014 and approve the change A6. Ensure the installation appears in the allocation screen for year = 2014 A7. Update PerExpDdate = 1/1/2015 and approve the change A8. Ensure the installation appears in the allocation screen for year = 2014 B. Ensure closing an account hides it from the allocation screen B1. Repeat steps A1 and A2 B2. Update the account status to 'CLOSED' B3. Ensure the installation does not appear in the allocation screen B4. Update the account status to 'OPEN' B5. Ensure the installation appears in the allocation screen B6. Update the account status to 'BLOCKED' B7. Ensure the installation appears in the allocation screen Repeat scenario for aircraft operator C. Ensure allocated installations do not appear in the allocation screen C1. Repeat steps A1 and A2 C2. Allocate to this installation C3. Ensure after allocation the specific entry does not appear in the allocation screen Repeat scenario for aircraft operator D. Ensure setting PerRevDate = Y hides the installation when allocating to any year > Y D1. Locate an installation with entries for year 2013, 2014, 2015, 2016 D2. Set PerRevDate = 2013 and approve the change D3. Ensure the installation appears for allocation year 2013 D4. Ensure the installation does not appear for years 2014, 2015, 2016	PASSED

Check 80211 - Upload NAT fails for some cases when Return of Excess allocation exist in another year	It was impossible to increase NAT if a "Return for Excess Allocation" existed for the installation for any year; this is now changed. NAT increases are now allowed for years later than the "Return of Excess Allocation"	REA = Return of Excess Allocation Scenario A: Allocation for future years after REA is allowed 1. Upload NAT 2. Allocate 2015 with values for 2015, 2016, 2017 3. Upload new NAT with less value for 2015 4. Return exc.alloc for 2015 5. Upload new NAT with higher values for 2016 and 2017 6. Ensure NAT upload succeeds 7. Allocate next years for this installation (2016 and 2017) 8. Ensure allocation for 2016 and 2017 succeeds Scenario B (negative): NAT upload fails for year of REA Execute steps 1 to 4 of scenario A. 2. Upload new NAT with higher values for 2015 3. Ensure NAT upload fails with error code: "80211: The installation 102 has returned allocation. It is not permitted to increase any of allocation, transitional allocation, reserve for year 2015" Scenario C (regression): Allocation succeeds for installation without REA 1. Upload NAT with values for 2015, 2016, 2017 for an installation without REA 2. Allocate for 2015, 2016, 2017 3. Ensure the allocation completes correctly. Repeat for aircraft operator (note: aircraft operators do not have REA).	PASSED

Auction Delivery -> Search -> Null Pointer Exception	Issues with auction delivery screen are now fixed.	Scenario A: Check search criteria 1. Login to EU Registry as CA 2. Go to EU ETS - Auction Delivery 3. Make a search 4. Ensure that you can see correct data 5. Click on "Search and Export" button 6. Ensure that you can see correct data Note1: The search criteria must contain any one and any combination of the filters below: * Auction delivery account ID - Numeric search returns a correct results - Non-numeric characters return an error (validation error appears) - Numeric characters plus non-numeric characters return an error (validation error appears) - Wildcards are not supported for this field (validation error appears) - Negative or decimal numeric values return an validation error * Year (2012-2020 years are possible entries) * Allowance (General/Aviation are possible entries) Scenario B: Check "Show past deliveries" B1. Repeat Scenario A without checking the checkbox "Show past deliveries" B2. Ensure the results do not contain records where Volume of Auction = Auctioned Volume B3. Repeat Scenario A after checking the checkbox "Show past deliveries" B2. Ensure the results contain records where Volume of Auction = Auctioned Volume Note2: The checkbox "Show past deliveries" should be named "Show completed deliveries" Note3: Note the following bug: C1. Search via delivery date and set "delivery date from" = "delivery date to" = "10/05/2014" where this date is a date of an existing record, the search will return nothing. C2. Search via delivery date and set delivery date from = "10/05/2014"; set delivery date to = "11/05/2014"; the search will return the appropriate results pertaining to 10/05/2014.	PASSED

Transaction delays are present where they should not be	Transfer from Trading account towards TAL which were approved on weekends are executed on next working day Start Of Business.	Set the parameter registryConfig.ALL.WORKING_HOURS_START = 08:00 Scenario A: Approve a transfer from TRADING->TAL on weekday 1. Locate an OPEN trading account with allowances 2. Propose a transfer towards a TAL account 3. Approve the transfer on weekday 4. Ensure the transaction execution date is immediate Scenario B: Approve a transfer from TRADING->TAL on weekend 1. Locate an OPEN trading account with allowances 2. Propose a transfer towards a TAL account 3. Approve the transfer on Sunday 4. Ensure the transaction execution date is on the next working day at 08:00	PASSED
Clean-up job for stuck returns of excess allocation	Returns of Excess Allocation which are not properly approved via ECAS are cleared-down automatically.	1. Propose a return for excess allocation and do not approve it 2. Wait at least 35 minutes 3. Ensure no pending returns of excess allocations exists. The following query should return no results: SELECT tr.request_id, tr.transaction_type FROM transaction_request tr JOIN request_state rs ON rs.request_state_id = tr.request_state_id WHERE transaction_type IN ('ReturnOfExcessAllocation') AND state = 'SUBMITTED_NOT_YET_APPROVED' AND tr.datetime < SYSDATE - 35 / (24 * 60)	PASSED

Account Statements - Wrong Information	Correction in the generation of account statements.	Scenario 1: Generate account statement 1. Login to a registry as NA 2. Click accounts then click search 3. Click "View Details" of account "A" 4. Go to "Account statement" tab 5. Enter start and end dates and hit Refresh. 6. Note the results 7. Click transactions, then search 8. Click on the hyperlink of a different account "B" 9. Go to "Account Statements" tab 10. Enter the same start and end dates as in step 5 and hit Refresh. 11. Confirm that the results are not the same. Scenario 2 (regression): Generate account statement with wrong dates 1. Login to a registry as NA 2. Click accounts then click search 3. Click "View Details" of account "A" 4. Go to "Account statement" tab 5. Enter start and end dates that are more than 30 days apart and click Refresh. 6. Confirm that there is error "The selected period should not be longer than a month." 7. Enter start and end dates more than 3 years in the past 8. Confirm that there is error "Cannot select a date more than 3 years back." Scenario 3: Generate account statement in PDF and CSV 1. Login to a registry as NA 2. Click accounts then click search 3. Click "View Details" of account "A" 4. Go to "Account statement" tab 5. Enter start and end dates and click Refresh. 6. Click "Account Statement PDF" 7. Confirm that a pdf file is created with the account statement data. 8. Click "Account Statement CSV" 9. Confirm that a csv file is created with the account statement data	PASSED

SEF XML exported from Union Registry has 'NA' instead of 'NO' for table 5a	SEF XML exported from Union Registry has 'NA' instead of 'NO' for table 5a; this is now fixed.	1. Export a SEF report for any registry/year. 2. Ensure the following five instances of UnitQty element have the value "NA". <Table5a numbering="5a" description="Summary information on additions and subtractions"> <SubTotal> <Additions> <UnitQty type="RMU">NA</UnitQty> <UnitQty type="tCER">NA</UnitQty> <UnitQty type="lCER">NA</UnitQty> </Additions> <Subtractions> <UnitQty type="tCER">NA</UnitQty> <UnitQty type="lCER">NA</UnitQty> </Subtractions> </SubTotal>	PASSED
Initially blocked AOHA account doesn't get unblocked when its DCS becomes A	AOHA attaining DCS equal to A are now automatically set to OPEN.	1. AOHA which is OPEN, has not been compliant and gets DCS=BLANK should become OPEN. 2. AOHA which is OPEN, has been compliant and gets DCS=BLANK should become OPEN. 3. AOHA which is BLOCKED, has not been compliant and gets DCS=BLANK should become BLOCKED. 4. AOHA which is BLOCKED, has been compliant and gets DCS=BLANK should become OPEN. 5. AOHA which is BLOCKED, has not been compliant and gets DCS=OPEN should become OPEN. 6. AOHA which is BLOCKED, has been compliant and gets DCS=A should become OPEN. 7. AOHA which is OPEN, has not been compliant and gets DCS=A should become OPEN. 8. AOHA which is OPEN, has been compliant and gets DCS=A should become OPEN. 9. AOHA which is OPEN, has not been compliant and gets DCS=B should become BLOCKED. 10. AOHA which is OPEN, has been compliant and gets DCS=B should become OPEN. 11. AOHA which is BLOCKED, has not been compliant and gets DCS=B should become BLOCKED. 12. AOHA which is BLOCKED, has been compliant and gets DCS=B should become OPEN. 13. AOHA which gets DCS = C should become BLOCKED.	PASSED

Entitlement values are not calculated correctly in EUCR	Available entitlement values are re-calculated at emission upload and at exclusion/unexclusion of years.	Preliminary step: Upload the following ICE XML for an installation: <?xml version="1.0" encoding="UTF-8" standalone="no"?> <entitlements registryCode="FI" xmlns="urn:eu:europa:ec:clima:ets:1.0"> <installation identifier="101"> <action>A</action> <flag>2</flag> <ice>5</ice> </installation> </entitlements> A. Ensure ICE value is recalculated for all DCS by uploading emissions and excluding/unexcluding years A1. Exclude all years for an installation, so that DCS=BLANK A2. Upload a new ICE XML with a large ICE value and ensure this appears in the installation's entitlement value B1. Unexclude a year and enter emissions and equal surrenders. B2. Ensure DCS=A B3. Update emissions to 1 B4. Ensure entitlements are re-calculated to the max of 4.5% of VE and the value provided in the ICE XML C1. Update emissions to a larger value C2. Ensure DCS=B. C3. Ensure entitlement value is recalculated to 4,5% of the VE value D1. Via the database delete all emissions of this installation and update the COMPLIANCE_STATUS of this installation for CP2 to VE=0 and cumulative surrenders = 0. D2. Un-exclude two years to force recalculation of DCS. D3. Ensure DCS=C D4. Provide emissions for one of the excluded years D5. Ensure the entitlement is recalculated. E1. Repeat steps D1-D5 via uploading VE XML with APPROVED flag E2. Ensure entitlement is recalculated F1. Repeat steps D1-D5 via uploading VE XML with NOT APPROVED flag F2. Approve the emissions F3. Ensure entitlement is recalculated General check:	PASSED

		Ensure that in all calculations, VE corresponding to excluded years are not considered in calculated ICE values.	

one parameter for ECAS signature	All authorisation mechanisms of EUCR are harmonised so as to use or bypass ECAS via a single parameter.	Before performing the following scenarios, set registryConfig.ALL.ECAS_SIGNATURE_ENABLED in eucr-configuration.properties to true Scenario No. 1 Signature during pre-allocation 1. Login as CA into registry EU 2. On the left side menu click "EU ETS" 3. Choose "Pre-Allocations" 4. Choose "Credit of Allocation Account prior to allocations" and fill in the "Quantity of Allowances to transfer" 5. Click on "Submit" 6. The ECAS signature page appears Scenario No. 2 Trusted Account Addition 1. Login as NA1 2. Go to Accounts 3. Choose an OHA 4. On the "Trusted Accounts" tab click "Add" 5. Enter an account and a description and click "Save' 6. Click Confirm 7. The ECAS Signature Page appears. Repeat for AOHA Scenario No. 3 Trusted Account addition approval 1. Login as NA2 2. On the left side menu click "Task List" 3. Click on the tab "General Task List" 4. Select on field "Task Name:" the choice "Addition of account to Trusted Account List" 5. Click on "Search" 6. Check on the request initiated by NA1 and click "Claim" 7. Click on the name of the request 8. At the bottom of the page click on the Request id hyperlink 9. Click on "Approve" 10. The system asks for confirmation, click 'Confirm' 11. The ECAS signature page appears Scenario No. 4 Trusted Account Deletion 1. Login As NA1 2. On the left side menu click "Accounts" 3. Click on "Search". 4. Click on "View Details" of an OHA account. 5. Click on tab "Trusted Accounts" 6. click "Delete" on an account with status "Trusted" 7. Click on "Confirm" 8. The ECAS signature page appears. Repeat for AOHA	PASSED

		Scenario No. 5 Trusted Account deletion approval 1. Login as NA2 2. On the left side menu click “Task List” 3. Click on the tab “General Task List” 4. Select on field “Task Name:” the choice “Deletion of account to Trusted Account List” 5. Click on “Search” 6. Check on the request initiated by NA1 and click “Claim” 7. Click on the name of the request 8. At the bottom of the page click on the Request id hyperlink 9. Click on “Approve” 10. The system asks for confirmation, click ‘Confirm’ 11. The ECAS signature page appears Scenario No.6 Role Update 1. Login as NA1 2. On the left side menu click “Administration” 3. Choose “Users” 4. Click on “Search” 5. Click on a User’s “URID” 6. On “Administration Roles” tab click “Edit” 7. Select roles and click on “Next“ 8. Click on “Submit” 9. The ECAS signature page appears. Scenario No. 7 Role Update approval 1. Login as NA2 2. On the left side menu click “Task List” 3. Click on the tab “General Task List” 4. Select on field “Task Name:” the choice “Administration Roles Update” 5. Click on “Search” 6. Check on the request initiated by NA1 and click “Claim” 7. Click on the name of the request 8. At the bottom of the page click on the Request id hyperlink 9. Click on “Approve” 10. The system asks for confirmation, click ‘Confirm’ 11. The ECAS signature page appears Scenario No. 8 Roles Permissions Changes 1. Login as NA1 2. On the left side menu click “Administration” 3. Choose “Roles and Permissions” 4. Check the permissions you want to add or remove. 5. At the end of the page click on “Next” 6. Click on “Save” 7. The ECAS signature page appears Scenario No. 9 Approve Roles/Permissions	

		Changes 12. Login as NA2 13. On the left side menu click “Task List” 14. Click on the tab “General Task List” 15. Select on field “Task Name:” the choice “Approve Roles/Permissions Changes” 16. Click on “Search” 17. Check on the request initiated by NA1 and click “Claim” 18. Click on the name of the request 19. At the bottom of the page click on the Request id hyperlink 20. Click on “Approve” 21. The system asks for confirmation, click ‘Confirm’ 22. The ECAS signature page appears Scenario No.10 ESD ARs/ ESD AARs Suspend 1. Login as NA1 2. Open registry ESD 3. On the left side menu click ESD 4. Click accounts 5. Click “View details” on an account 6. Click on the “ESD ARs” tab 7. Click on ‘Suspend’ for a specific AR or AAR 8. The system asks for confirmation, click ‘Confirm’ 9. The ECAS signature page appears Repeat for AAR from the “ESD AARs” tab Scenario No.11 ESD ARs/ ESD AARs Restore 1. Login as NA1 2. Open registry ESD 3. On the left side menu click ESD 4. Click accounts 5. Click “View details” on an account 6. Click on the “ESD ARs” tab 7. Click on ‘Restore’ for a specific AR or AAR 8. The system asks for confirmation, click ‘Confirm’ 9. The ECAS signature page appears Repeat for AAR from the “ESD AARs” tab Scenario No.12 Propose transaction 1. Login as NA1 2. From Accounts click “View Details” on an OHA 3. Go to the “Holdings” tab 4. Click “Propose a transaction” 5. Choose Deletion of Allowances 6. Enter a quantity and click “Next” 7. Click Confirm 8. The ECAS signature page appears Repeat for AOHA	

		Set registryConfig.ALL.ECAS_SIGNATURE_ENABLED in eucr-configuration.properties to false and repeat all scenarios. Confirm that the ECAS signature page does not appear.	
ESD SDAgent have no access to Unit Blocks menu item	ESD SDAgent have no access to Unit Blocks menu item; this is now fixed.	1. Login as an ESD SD Agent 2. Go to "Administration" - " Unit Blocks" 3. Verify that you have access to Unit Blocks menu 4. Ensure that the buttons "Add", "Delete" and "Suspend/Restore" at the button of the "Unit Block Search Result" table are not visible	PASSED
Task list date range filter return zero results	When searching for tasks, date ranges did not filter correctly; this is now fixed.	1. Login to EUCR as NA of a Registry and go to Task List 2. Enter a date range for example 01/10/2014 and 31/12/2014 in the Start Date "From" and "To" fields to "Exclusive Task List", "General Task List" and "History" tabs 3. Click on Search Button 4. Ensure that you can see correct data 5. Click on "Search and Export" button and verify that you can see correct data 6. Repeat the above test as AR, AAR and CA	PASSED

Task list: I un-claim one task -> many tasks get unclaimed	Unclaiming one task triggered the unclaim of all tasks of the specific role; this is now fixed.	**A. Unclaim only the checked tasks** 1. Log in as NA 2. Go to Exclusive tasklist 3. Claim 10 tasks 4. Click one task and click "Unclaim" 5. Only the clicked task becomes unclaimed; the other 9 remain claimed. **B. Regression - Unclaim between two users** 1. Connect as a user (A) that has tasks visible in his task-list 2. Claim any number of tasks (more than 1) 3. Connect as another user (B) that also has tasks visible in his task-list 4. Claim any number of tasks (more than 1) 5. As NA user propose the un-enrolment of user (A) (no need to Approve it) 6. Ensure the tasks previously claimed by user (A) are now unclaimed 7. Ensure the tasks previously claimed by user (B) remain claimed **C. Regression - Task history of un-enrolled user is unaffected** 1. As an NA that has tasks visible in his task-list 2. Claim and approve a task 3. Verify that the approved task in the task-history shows the user as claimant 4. Connect as another NA user and propose the un-enrolment of the NA of step 1 (no need to Approve it) 5. Ensure that the tasklist history still presents the same information as shown in step 3.	PASSED
ESD - ENTITLEMENTS Transaction View - Request details wrong info for reversals	Reversals of ESD entitlement transactions did not present correctly the actors; this is now fixed.	1. Connect as ESD-CA 2. Navigate to ESD->ESD Entitlements Transactions 3. Search for entitlements reversals transactions and locate one which has been proposed by an ESD-AR (so that three users are involved for its approval in total) 4. Click on a COMPLETED reversal and navigate to the tab "Request Details" 5. Ensure three distinct users appear as actors of the reversal.	PASSED

Allocation process - wrong summary information	The summary at the top of the allocation approval screen is corrected and enriched.	**Scenario A. Check adding allocations** 1. Login as NA of a Registry 2. Go to "Allocation Phase 3" 3. Select a year and tick three tick boxes of allocations of type "FREE" 4. Submit the task 5. Login as an other NA and go to "Task list" 6. Search for the "Approve Allocation Settings Delivery" task, claim it and click on the "Request" link 7. Verify that at the confirmation page the three ticked boxes are green and their total appears at the top: Total of allocations to be delivered: <<total of free>> (<<total of free>> free, 0 transitional, 0 from the NER) Total of allocations to be removed: 0 (0 free, 0 transitional, 0 from the NER) Repeat adding Transitional and NER allocation types and ensure that their subtotal appears. Confirm the allocation job executes and creates the approved allocations. **Scenario B. Check removing allocations** Execute Scenario A and approve the allocation 2. Before execution of the job go to "Allocation Phase 3" and un-tick two checkboxes of type "FREE" 3. Submit the task 4. Login as an other NA and go to "Task list" 5. Search for the "Approve Allocation Settings Delivery" task, claim it and click on the "Request" link 6. Verify that at the confirmation page the two un-ticked boxes are red and their total appears at the top: Total of allocations to be delivered: 0 (0 free, 0 transitional, 0 from the NER) Total of allocations to be removed: <<total of unticked checkboxes>> (<<total of unticked checkboxes>> free, 0 transitional, 0 from the NER) Repeat un-ticking transitional and NER and ensure their subtotal appears. Confirm the allocation job executes and creates the approved allocations. **Scenario C. Check adding and removing allocation** Execute Scenario B and approve the allocation but tick some tick boxes and un-tick some other tick boxes. 2. Submit the task 3. Login as an other NA and go to "Task list" 4. Search for the "Approve Allocation Settings Delivery" task, claim it and click on the "Request" link	PASSED

		5. Verify that at the confirmation page the un-ticked boxes are red and the ticked boxes appear green and their totals appears correctly at the top of the screen. Repeat for all types of allocation. Confirm the allocation job executes and creates the approved allocations.	
Glitch in Holdings screen of Party Holding Account	The holdings "Total;" is not aligned to the "Balance" column; this is now fixed.	1. Connect as NA and navigate to a Party Holding Account, "Holdings" tab. 2. Ensure that the "Total" figure is aligned to the "Balance" column. Repeat with all other account types.	PASSED

Under a certain sequence of actions, an AR does appear correctly in an account	AR not displayed in OHA account	1. Locate USER1 and AccountHolder to which this user is NOT related 2. Submit AccountRequest_1 and use USER1 as AR (fill in the data manually) 3. Submit AccountRequest_2 and use USER1 as AR (choose the user from the list) 4. Reject AccountRequest_1 5. Approve AccountRequest_2 6. USER1 will not be displayed as AR for new account Description There is a user that is not related to account holder. For this account holder two account requests are submitted that will have this user as AR. When first request is rejected and second approved - this user will not be displayed as AR for new account (however the user will see it in his account list and will be able to act as AR). Attachments	PASSED
Change of message on NAT upload after return of excess allocation	Change in Documentation and message: Unable to modify NAT after REA	The error produced by the system: "80211: The installation 102 has returned allocation. It is not permitted to increase any of allocation, transitional allocation, reserve for year 2015" Is correct and refers to any returned allocation, pending or completed. The description of check 80211 in the documentation is wrong and will be corrected to the following text: "If there exists -pending- transaction of type "Return of Excess Allocation", it is not allowed to increase any values of allocation, transitional, reserve" Let us know if you prefer a different approach.	PASSED
An update of YFE should be allowed if emissions exist, and they are zero	YFE cannot override existing VE years, if VE=0	It should be able to set YFE to a year higher than those for provided emissions, if the provided emissions for the lower years are zero. Installation update requests are rejected by EUTL with "7173 Check if change of YFE of an Installation is valid (*new)"	PASSED
Label change	Not renamed label for Past Deliveries	Open EUCR with MS=EU Go to Auction Delivery menu and consult the label next to the checkbox. It should be "Show completed deliveries"	PASSED

Ineligible units of incoming transaction (either CP1 or Blacklisted) show as eligible in transaction details.	1. Request CP1 units form ITL 2. Verify if in incoming transaction details units are marked as ineligible If CP1 units are received from ITL CDM account in Summary tab of such Transaction details units are marked as eligible whereas. In subsequent transactions of these units, they are properly marked as ineligible so it seam to pertain only to the first transaction which transfers the units to registry.	Scenario 1: Test incoming transaction from Japan -> KP account in CP1 and in ICH General Negative list 1. Perform a transaction from Japan -> KP account, whose units are in CP1 and in ICH General Negative list 2. Ensure the transaction completes and the units appear as ineligible in Transaction Details tab 3. Ensure the units appear as "CP1 Expired Unit" in Administration->Unit Blocks screen, column Reason, when searching via acquiring account identifier 4. Ensure the units appear as "CP1 Expired Unit" when being exported via the Export CSV functionality of the Administration->Unit Blocks screen. Scenario 2: Test incoming transaction from Japan -> KP account in CP1 and in ICH General Positive list 1. Repeat scenario 1 but with units in ICH General Positive list. Scenario 3: Test incoming transaction from Japan -> KP account in CP2 and in ICH General Negative list 1. Repeat scenario 1 but with units in CP2 and in ICH General Negative list. 2. In this case the unit blocks should be marked in the screen and in the exported CSV as "Ineligible, General Negative List", columns Flag - Reason. Scenario 4: Test incoming transaction from Japan -> KP account in CP2 and in ICH General Positive list 1. Repeat scenario 1 but with units in CP2 and in ICH General Positive list. 2. Ensure the transaction completes and the units appear as eligible in Transaction Details and as "Eligible, General Positive List" in Unit Blocks screen, columns Flag - Reason and in the exported CSV.	PASSED

KP Public Reports Page - Last update is in 12h clock without am/pm	When updating the last modified date of the KP public reports to a time after pm (i.e. 18:30) the time is displayed using a 12h clock format without am/pm indication so 18:30 is displayed as 06:30. To fix this, we need to change the display format to 24h clock.	1) Update the "Last Update" of the KP public reports to any date and a time in "AM" 2) Visit the KP public Reports page and verify that the last update at the bottom of the page shows the correct date and time. 3) Update the "Last Update" of the KP public reports to any date and a time in "PM" 4) Visit the KP public Reports page and verify that the last update at the bottom of the page shows the correct date and time.	PASSED
CLONE - Problem with incoming transactions details	When clicking transaction details, for example CDM31006 or CH19830, the webpage with red error code appears and the details can't be seen. The error applies to all transactions (External Transfer Kyoto Unit) from other Kyoto registries.	A) Test Scenario: 1. Locate a transaction of type 03-00 (External Transfer Kyoto Unit) in the database. 2. Update ACQ_ACCOUNT_IDENTIFIER to null 3. Commit. 4. Navigate to “Transactions”. 2. Search for the same transaction you updated in (1) 3. Click on transaction ID. 4. No error should be thrown. B) Repeat (A) but this time update the column TR_ACCOUNT_IDENTIFIER to null in step (2) C) Repeat (A) but this time update both ACQ_ACCOUNT_IDENTIFIER & TR_ACCOUNT_IDENTIFIER to null in step (2) Regression Test: In ESD registry ensure that ESD transaction details include: - Transferring MS - Acquiring MS - Transferring Year - Acquiring Year	PASSED

Mistake in error message	The following error message should read: error.message.check.7 119 = 7119: Verified emissions must be entered for a year equal to or after the year of first emissions, and either before the current year (if no year of last emissions has been set) or up to the year of last emissions. instead of error.message.check.7 119 = 7119: Verified emissions must be equal or after the year of first emissions, and either before the current year (if no year of last emissions has been set) or up to the year of last emissions.	Ensure the message is corrected as specified.	PASSED
Mistake in error message	Error message 7662 should read: error.message.check.7 662 = 7662: Return of Excess Allocation transaction is allowed only if Allocation amount is less than the already Allocated amount minus any Returned amount. instead of error.message.check.7 662 = 7662: Return of Excess Allocation transaction is allowed only if Allocation amount is less that the already Allocated amount minus any Returned amount.	Ensure the message is corrected as specified.	PASSED

Transaction ID link in "Completed Transactions" points to wrong transaction; this is now fixed	Transaction ID link in "Completed Transactions" points to wrong transaction		PASSED
"Rejection details" link is not re-enabled after closing "Rejection Information" window; this is now fixed	"Rejection details" link is not re-enabled after closing "Rejection Information" window	1. Log in to registry 2. Go to the "List of Account requests" and search for rejected requests 3. Click on "Rejection details" 4. Close "Rejection Information" window 5. Ensure the "Rejection Details" hyperlink clicked in step [3] is still enabled.	PASSED
Confirmation buttons for Task assignment stay disabled; this is now fixed	Confirmation buttons for Task assignment stay disabled	1. Log in to registry as NA 2. Go to Task list and search for tasks 3. Select the task and click [Assign] button 4. Select the user and clock [Save] 5. Click [Confirm] or [Cancel] or [Close pop up window] 6. Ensure all buttons are enabled and repeat steps 3-5	PASSED
"Return to search" in Transaction details doesn't work under FF; this is now fixed	"Return to search" in Transaction details doesn't work under FF	1. Log in to registry using FF 2. Go to Transactions, search for transactions 3. Click on a transaction identifier and display transaction details 3. Click on "Return to search" 4. Ensure the screen presented is the screen of step [2]	PASSED
Unrecoverable error in Conversion of AAU screen when following a certain sequence of actions; this is now fixed	Unrecoverable error in Conversion of AAU screen	1. Log in to registry 2. Go to account that holds AAU (e.g. BG-100-5009554-0-88 in TEST environment) 3. Propose "Conversion of AAU or RMU to ERU" transaction 4. Change commitment period to First commitment period; ensure holdings appear normally and no runtime error occurs. 5. Change commitment period to Second commitment period; ensure holdings appear normally and no runtime error occurs.	PASSED

Error on creating account statement; this is now fixed	NullPointerException on creating account statement	*Scenario 1: Ensure missing dates do not crash the system* 1. Log in to any registry 2. Open account details and go to "Account Statements" tab 3. Without specifying start and end date click on [Account Statement PDF]; ensure the error message "Start date should be set" appears. 4. Repeat the same for button [Account Statement CSV]; ensure the error message "Start date should be set" appears. 5. Repeat steps 3-4 by providing start date; ensure the error message "End date should be set" appears. *Scenario 2 (regression): Ensure that by providing start and end dates the system operates normally* 1. Locate an account's latest transaction in CER units. 2. Repeat scenario 1 for the account of step [2]; provide start and end dates as before and after the transaction's execution date, respectively. 2. Ensure the system presents modified balances for CER units on screen, PDF and CSV account statement formats. Repeat for general and aviation allowances. Do not test AAU units because of issue ETS-8773 which is not fixed.	PASSED
Installation link in "Allocation Phase 3" page points to wrong installation; this is now fixed	Installation link in "Allocation Phase 3" page points to wrong installation	1. Log in EUCR 2. Go to "Allocation Phase 3" or "Allocation Tables Phase 3" 3. Click on the Installation ID link for any installation. 4. Ensure the next screen is the account pertaining to the clicked installation (click to Installation tab and ensure the shown Installation Id is the one clicked in step 3)	PASSED
Unrecoverable error in Task list; this is now fixed	Unrecoverable error in Task list	1. Log into any EUCR registry e.g. BG 2. Go to Task list 3. Enter 'aaa' into Account Identifier field and press Enter 4. Ensure an orange pop-up box appears at the top of the screen with the error message "ERROR CODE:10100 The account number must contain 1 to 15 digits."	PASSED
Wrong default action in Task list; this is now fixed	Wrong default action in Task list	1. Log into any EUCR registry e.g. BG 2. Go to Task list 3. Enter '123' into Account Identifier field and press Enter 4. Ensure a tasklist search is performed and not an export of data.	PASSED

Validation error is not displayed in ESD Compliance screen; this is now fixed	Validation error is not displayed in ESD Compliance screen	1. Log in to ESD 2. Go to "ESD Compliance Dashboard" search page 3. From HTML level modify "Member State" and "Year" fields to use invalid values e.g. X and 201 respectively 4. Click [Search] button 5. Ensure the error message "The value entered for Member State is not a valid Member State The value entered for Year is not a valid Year" appears at the top of the screen	PASSED
Message added for validation rule 7869	EUCR-2162 Add message for Check 7869	This is a technical issue. Ensure that in messages.properties the code 7869 corresponds to the message "Exchanged Units are not eligible for ESD".	PASSED
Correction in ESD Entitlements transaction type validation	ClassCastException when validating ESD Entitlements Transaction Type	1. Log in to ESD 2. Go to "ESD Entitlements Transaction" search page 3. From HTML level modify "ESD Entitlements Transaction Type" search field to use ESD_ENTTRANSFER value 4. Click [Search] button 5. Ensure the error message "The value entered for ESD Entitlements Transaction Type is not a valid" appears in an orange box.	PASSED
Return to Search (account details) link disappears after double click; this is now fixed	Return to Search (account details) link disappears after double click	1. Go to EUCR 2. Go to Accounts->Accounts screen and perform a search which returns some accounts 3. Click on an "account details" hyperlink and navigate to an account's details 4. Double click on "Return to Search" link 5. Ensure the next screen is the originating search screen of step [2].	PASSED

Validation error when creating new ESD account; this is now fixed	Validation error on using URID filter when creating new ESD account	1. Log in to ESD as ESDCA 2. Click on [Account request] 3. Select type, MS and year 4. Click [Add] button to add new AR 5. Enter valid URID in URID filter and click [Apply Filter(s)] button 6. Ensure the corresponding AR was located in the results list. 7. Select ARs and additional ARs for this account creation request and submit the request 8. Approve the request as another ESDCA 9. Navigate to ESD->Accounts and ensure the new ESD compliance accounts exists and has the ARs/AARs specified in steps 4 and 7. *Technical explanation:* After implementing TST-896 / EUCR-2072 URID filter cannot be used anymore when creating new ESD account. This is probably related to error in implemented validation pattern which is Validator.Urid=^[A-Z]{2}\d{12}$ (there should be double escape before d{12}). In this situation using proper URID for search such as ED818239191418 leads to an error: "The value entered for URID is not a valid URID"	PASSED

KP2 requirement: Ensure exchanged units retain exchanged property when split	Ensure exchanged units retain exchanged property when split	Scenario 1: When manually split, exchanged units retain exchanged property 1. Locate an exchanged unit by searching Administration->Unit Blocks screen by an IC account identifier. <<Normally all unit blocks held by this account should have value 'No (exchanged)' in ESD Eligibility column >> 2. Click "edit" and split the unit block. 3. Locate the split unit blocks by searching Administration->Unit Blocks screen by an IC account identifier. 4. Ensure the split unit blocks retain "No (exchanged)" value by checking the "ESD Eligibility" column. *Scenario 2: Split unit blocks by loading ICH list and ensure exchanged property is preserved* 1. Connect as CA in EU registry 2. Navigate to ICH Lists and upload an ICH Application Procedure Positive List, mentioning half a unit block which is exchanged (exchanged unit block details can be located as described in Scenario 1). 3. Use the Administration->Unit Blocks screen to locate the specific unit block and ensure its value "No (exchanged)" for "ESD Eligibility" column; also, the other half of the split unit block should also have as value "No (exchanged)". *Scenario 3: Transfer a part of an exchanged unit block* 1. Locate an exchanged unit block in an IC Account. 2. Transfer a sub-set of the unit block in another PHA. 3. Ensure that both part of the unit block are exchanged by visiting the first and the second PHA screen and checking the "ESD Eligibility" column of both accounts. *Note*: A method in order to prioritize larger unit blocks to be picked by a transaction is to set the smaller unit blocks to reconciliation mode, e.g. update unit_block set blocked_by_recon = 999 where ID in (IDs of smaller unit blocks); After the end of the test, reinstate the unit blocks by update unit_block set blocked_by_recon = null where ID in (IDs of smaller unit blocks);	PASSED

Implementation of KP2-DA67-REQ-12	[KP2-DA67-REQ-12] Allow external transfers from NaHA	Scenario 1: Ensure transfer from NaHA completes successfully 1. Repeat scenario EUCR-2161 but use NaHA as transferring account and KP account as acquiring account. 2. Ensure the transaction completes successfully and the units are transferred to acquiring account. Repeat with OHA as acquiring account, using CP2 units (because CP1 units cannot enter ETS accounts).	PASSED
Implementation of KP2-DA67-REQ-8	[KP2-DA67-REQ-8] Allow external transfers of AAUs from MS KP accounts to EU KP accounts	Scenario 1: Ensure external transfers of AAUs from MS KP accounts to EU KP accounts are allowed. 1. Repeat scenario EUCR-2161 but use as transferring account a KP account hosted by a member-state and as acquiring account KP account hosted by EU. 2. Ensure the transaction completes normally and the units are transferred to the acquiring account.	PASSED
Implementation of KP2-DA67-REQ-9	[KP2-DA67-REQ-9] Allow external transfers from AAU Deposit account -> EU KP account	Scenario 1: Ensure transfer from AAU Deposit account -> KP account completes successfully. 1. Repeat scenario of EUCR-2161 but use AAU Deposit account as transferring and a KP account hosted in EU Registry 2. Ensure the transaction completes and the units are transferred to the destination account.	PASSED
Implementation of KP2-DA67-REQ-4	[KP2-DA67-REQ-4] Exchanged units are ineligible for ETS	Scenario 1: Ensure exchanged units cannot enter ETS accounts 1. Locate a PHA account with exchanged units. 2. Choose to transfer the specific units and choose an OHA as destination account 3. Ensure the error core <<80706: The acquiring account is not allowed to hold CP1 units after a specified date>> appears and the transaction is not permitted. Repeat for CER, ERU units. Note: This issue is checked indirectly; CER/ERU units cannot enter ETS accounts not only because they are exchanged, but because they are CP1. Nevertheless, the business rule is enforced. CER or ERU units of CP2 are not envisaged to exist beyond IC accounts, so this scenario is not tested. Scenario 2 (regression): Ensure exchanged units can enter KP accounts Repeat scenario 1 but choose a KP account as destination account. Ensure the transaction completes normally.	PASSED

Implementation of KP2-DA67-REQ-7	[KP2-DA67-REQ-7]: Precedence of ESD eligibility	Scenario 1: Ensure "Exchanged" flag precedes ESD eligibility flagging 1. Navigate to a KP PHA holdings screen 2. Locate a 'No (exchanged)' unit block 3. Add this unit block to General Positive list by the following actions: 4. Connect as ESD-CA in ESD Registry and navigate to ESD->ESD Eligibility Lists 5. Add the Project, Country, Unit Type to General Positive List 6. Return to the KP PHA holdings screen of step 1 and ensure the unit block is still marked as "No (exchanged)" 7. Navigate to Administration -> Unit Blocks and locate this unit block and ensure it is marked as "No (exchanged)" Repeat for CER, ERU Repeat for General Positive List, General Negative List. *Scenario 2 (regression): Ensure non-exchanged units show correct ESD eligibility flags* 1. Navigate to a KP PHA holdings screen 2. Locate a unit block which has <<null>> value in ESD Eligibility column 3. Add the unit block in General Positive list as described in steps 1.4-1.5 4. Return to the KP PHA holdings screen of step 1 and ensure the unit block is marked as Limit1. 5. Navigate to Administration -> Unit Blocks and locate this unit block and ensure it is marked as Limit1. 6. Remove the unit block from General Positive list. 7. Repeat steps 4 and 5 and ensure the unit block is no longer marked as Limit1. Repeat for CER, ERU Repeat for General Positive List, General Negative List.	PASSED

Implementation of KP2-DA67-REQ-6	[KP2-DA67-REQ-6]: Exchanged units re-entering ETS remain exchanged	Scenario 1: Transfer exchanged units from IC account to KP account 1. Locate IC account(general) 2. Transfer exchanged units to a KP account 3. Ensure the transaction completes normally Repeat for a destination of PHA and person HA. Repeat for IC account (aviation) Repeat for CER, ERU units. Repeat only for CP1 units; CP2 units will not be transferred out of IC account (general/aviation) in the near future. *Scenario 2: Transfer exchanged units from PHA to Japan* 1. Locate exchanged units to a PHA 2. Transfer exchanged units to an account in Japan 3. Ensure the transaction ends in "Proposed" state (a Japanese registry is needed for further advance) *Scenario 3 (regression scenario of existing functionality): Ensure transfer exchanged units from Japan to ETS fails* 1. Transfer CP1 exchanged units from Japan to an ETS account; exchanged unit blocks can be found in EUTL by the query: select * from exchanged_unit_block; 2. Ensure the transaction is terminated with code 7657 *Scenario 4: Ensure transfer exchanged units from Japan to PHA completes* 1. Transfer exchanged units from Japan to a PHA 2. Ensure the transaction is completed 3. Navigate to the holdings of the PHA and ensure the transacted units are denoted with "NO (exchanged)" in the ESD Eligibility column. Repeat for CER, ERU units. Repeat for a subset of a transferred unit block; (e.g. if the unit block was 1-100, transfer back to PHA units 20-30. Repeat steps 1-2 for a personal holding account.	PASSED

Implementation of KP2-DA67-REQ-5, REQ-11 and REQ-10	[KP2-DA67-REQ-5] [REQ-11] [REQ-10]: Exchanged units are ineligible for ESD	Scenario 1: Ensure exchanged units cannot be transferred to ESD 1. Locate a PHA with exchanged units and not any non-exchanged units 2. Navigate to its account holdings 3. Ensure the exchanged units are flagged with ESD eligibility-> "No (exchanged)" 4. Ensure the transaction type "Transfer to ESD" is not available OR this transaction type is available and when clicked, the exchanged units are not able to be chosen for ESD transfer Repeat for CER, ERU units. Scenario 2 (regression): Ensure non-exchanged units can be transferred to ESD 1. Locate a PHA with non-exchanged units. 2. Navigate to its account holdings 3. Ensure the transaction type "Transfer to ESD" is available. 4. Propose a "Transfer to ESD" and choose non-exchanged units. 5. Ensure the "Transfer to ESD" transaction completes normally. Repeat for CER, ERU units Scenario 3: Ensure exchanged units cannot be transferred to ESD even if chosen along with non-exchanged units 1. Locate a PHA with exchanged and non-exchanged units 2. Navigate to its account holdings; ensure the exchanged and non-exchanged units are in different lines in the account holdings screen and are denoted as follows. -- Non-exchanged have in column ESD Eligibility: "Limit1", "Limit2", "Limit1+Limit2" or null -- Exchanged units have in column ESD Eligibility: "No (Exchanged)" 3. Ensure the transaction type "Transfer to ESD" is available; initiate a "Transfer to ESD" transaction. Ensure that only the non-exchanged units appear in the unit selection screen; the exchanged units appearing in step [2] of this scenario do not appear in the unit selection screen. 4. Choose non-exchanged units; ensure exchanged units cannot be selected; click "Next". Repeat for CER, ERU units. Repeat for 1 unit being exchanged only.	PASSED

Implementation of KP2-DA67-REQ-1, REQ-2 and REQ-3	[KP2-DA67-REQ-1] & [REQ-2] & [REQ-3]: Allow transfers out of IC account (General/Aviation)	Scenario 1: Ensure external transfer from IC account (general/aviation) is possible 1. Connect as a user assigned as AR to an IC account (general) in Account Search screen. 2. Search for IC account (general) and navigate to account holdings and propose an external transfer towards a PHA. 3. Choose CP1 CER units. 4. Approve the transaction as AAR assigned on the account. 5. Ensure the transfer completes and the units are transferred to the destination account. 6. Navigate to the destination PHA and ensure the transferred units in column "ESD Eligibility" state "No (exchanged)". Repeat for ERU units. Repeat for IC account (aviation). Repeat with NA user assigned as AR on the account; the transaction must be approved by another NA assigned to the account. Note that it is not in the scope of ETS 6.7.1 to transfer CP2 units out of IC account (general/aviation). Therefore this is not tested.	PASSED
When proposing a transfer, only 10 unit types-commitment period combinations appeared; this is now fixed	Only 10 unit types displayed on transfer proposal screen	1. Locate a KP account with unit_types/original period/applicable period combinations counting more than 10. 2. Navigate to its account holdings and propose a KP transfer 3. Ensure all possible combinations of unittypes/original period/applicable period appear, and they are more than 10 4. Propose a transfer to another KP account 5. Submit and approve the transfer 6. Ensure the transfer completes successfully	PASSED

Uploading an ESD eligibility list now ignores exchanged units	ESD limit marking of exchanged KP units that returned to ETS	*Scenario 1: ESD Limit XML upload omits the exchanged units.* 1. Locate the IC Accounts and select in EUCR the corresponding units blocks. This is achieved via the following query: select ub.* from account acc, unit_block ub where acc.ACCOUNT_ID = ub.ACCOUNT_ID and identifier = 10000344 and registry_code = 'EU' order by 2; 2. Ensure column IS_EXCHANGED is set to 1, since all units in IC Accounts are exchanged. 3. Update manually these blocks so that they belong to no ESD list. This can be accomplished by setting ESD_ELIG1 and ESD_ELIG2 of the unit blocks of step 1 to null. 4. Delete from table EUCR.esd_sg_list and from EUTL.Esd_List_Project the record(s) pertaining to the specific project and country. Upload an ESD limits XML for LIMIT1 (ESD General List) referencing the project, unit type and country used in step 1. 5. Ensure that the units of step 1.1 were not marked as belonging to the limit of the XML, so their column ESD_ELIG1 is null. Repeat for ESD_ELIG2 and (ESD Special List). *Scenario 2: ESD Limit entry via EUCR screen omits exchanged units.* 1. Locate a project, country and unit type contained in the IC Account, for example: project=1, country=RO, unit_type=CER 2. Ensure this set of values does not exist in ESD General list. 3. Add it in ESD General list via ESD->View ESD Eligibility Lists-> Insert 4. Wait until the change is propagated to EUTL. 5. Ensure the exchanged units are not marked in Limit1 but non-exchanged units are marked; this can be accomplished via the query of step 1.1. 6. Update the project value from 1 to 2; ensure the unit blocks pertaining to project=1, country=RO, unit_type=CER are now unmarked in EUTL. 7. Update the project value from 2 back to 1. 8. Delete the list value <<project=1, country=RO, unit_type=CER>> via ESD->View ESD Eligibility Lists>Search->Delete 9. Ensure all the units in EUTL which were marked by <<project=1, country=RO,	PASSED

		unit_type=CER>> are now un-marked. Repeat for ESD_ELIG2 and (ESD Special List). Note: The notation "step 1.3" refers to scenario 1 step 3.	
There is no possibility to choose a project when sending KP units to ESD; this is now fixed	There is no possibility to choose a project when sending KP units to ESD	1. Connect as NA and locate a PHA with units in Limit1, for a member-state with enough entitlement in ESD account of current year. 2. Navigate to account holdings and propose a transaction of type "transfer to ESD compliance account" 3. Ensure the next screen "Transfer credits to ESD compliance account" contains a Project ID. 4. Choose one project from the drop-down list and submit the transaction request. 5. Approve the transaction request as another NA 6. Ensure the transaction completes and the transaction blocks of the completed transaction contain only units of the project chosen in step [4].	PASSED

Proposed transfer to ESD increases displayed balance for exchanged units; this is now fixed	Proposed transfer to ESD increases displayed balance for exchanged units	1. Connect as NA and navigate to a PHA which contains some exchanged units and which has limit 1 in ESD for the current year. 2. Propose a transfer to ESD and enter a quantity to transfer. 3. After proposal, return to account holdings 4. Ensure in account holdings screen only the "Reserved for Transaction" column has been increased for the rows pertaining to the quantities reserved in step [2]. 5. Cancel the transaction request and ensure the account holdings return to the same quantities as in step [2].	PASSED
The message pertaining to rule 80000 was wrong; this is now fixed	Wrong label substituted instead "Aviation Allowance"	Since the error check for rule 80000 is the same throughout the application and since auction deliveries may not exist in the test system, the following scenario can test this functionality: 1. Login ETS as NA 2. Search for AOHA and select one with aviation allowances 3. Navigate to account holdings and propose a transfer or allowances 4. Propose a transfer to an account in TAL 5. Enter more aviation allowances than available and click "submit" 6. Ensure the following error message appears: "80000: The amount <<qty entered>> of Aviation Allowance is not available in the account: <<account identifier>>"	PASSED

Uploading an ESD eligibility list now ignores exchanged units	ESD limit marking of exchanged KP units that returned to ETS	Scenario 1: ESD Limit XML upload omits the exchanged units. 1. Locate the IC Accounts and select in EUTL the corresponding units blocks, pertaining to a specific project, country and unit type. This is achieved via the following query: select ub.* from account acc, account_holding ah, unit_block ub, unit_type_code utc where acc.ACCOUNT_ID = ah.ACCOUNT_ID and ah.BLOCK_ID = ub.BLOCK_ID and account_identifier = <<acct_identifier>> and registry_code = 'EU' and ub.UNIT_TYPE_CODE = utc.UNIT_TYPE_CODE and ub.unit_type_code = <<unit_type>> and originating_country_code = <<country>> and project_id = <<project>> order by 2; 2. Ensure column IS_EXCHANGED is set to 1, since all units in IC Accounts are exchanged. 3. Update manually these blocks so that they belong to no ESD list. This can be accomplished by setting ESD_ELIG1 and ESD_ELIG2 of the unit blocks of step 1 to null. 4. Upload an ESD limits XML for LIMIT1 (ESD General List) referencing the project, unit type and country used in step 1. 5. Ensure that the units of step 1.1 were not marked as belonging to the limit of the XML, so their column ESD_ELIG1 is null. Repeat for ESD_ELIG2 and (ESD Special List). Scenario 2: ESD Limit entry via EUCR screen omits exchhanged units. 1. Locate a project, country and unit type contained in the IC Account, for example: project=1, country=RO, unit_type=CER 2. Ensure this set of values does not exist in ESD General list. 3. Add it in ESD General list via ESD->View ESD Eligibility Lists-> Insert 4. Wait until the change is propagated to EUTL. 5. Ensure the exchanged units are not marked in Limit1 but non-exchanged units are marked; this can be accomplished via the query of step 1.1. 6. Update the project value from 1 to 2; ensure the unit blocks pertaining to project=1, country=RO, unit_type=CER are now unmarked in EUTL. 7. Update the project value from 2 back to 1. 8. Delete the list value <<project=1,	PASSED

		country=RO, unit_type=CER>> via ESD->View ESD Eligibility Lists>Search->Delete 9. Ensure all the units in EUTL which were marked by <<project=1, country=RO, unit_type=CER>> are now un-marked. Repeat for ESD_ELIG2 and (ESD Special List). Note: The notation "step 1.3" refers to scenario 1 step 3.	

Using Internet Explorer to access the site, for certain downloads an unrecoverable error is generated.	Unrecoverable error on downloads in Internet Explorer.	**Scenario A**: Functionality tests using Internet Explorer. 1. Log in to Registry using Internet Explorer (checked on IE 9.0.8112) . 2. Navigate to Accounts -> Transactions -> Search and locate a transaction -> Click on the transaction Identifier -> Click on "Transaction PDF". Ensure no error is generated and the PDF file appears correctly. 3. Navigate to Accounts -> Accounts -> Search and locate an account -> Click on "Account Statements" -> Enter Start Date and End Date and click on "Account Statement PDF" -> Ensure no error is generated and the PDF file appears correctly. 4. Click on Administration -> View ICH Lists -> Click on Export XML and Export CSV; ensure no error is generated and the XML/CSV files appear correctly. 5. Click on EU ETS-> Entitlements -> Click on Search -> Click on Export XML and Export CSV; ensure no error is generated and the XML/CSV files appear correctly. **Scenario B**: Regression tests using Firefox. Repeat the tests of Scenario A using Firefox. **Scenario C**: Regression tests using Chrome. Repeat the tests of Scenario A using Chrome.	PASSED

Annex VIIII. Test Results EU

Annex H testing was carried out in February 2016 and following is the test report.

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Prepared by	:	Prasantha Annamreddy 03rd March 2016

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03/03/2016	1.0	Created	Prasantha Annamreddy

Table of Contents

1 Introduction

The tests were conducted on 22nd to 23rd February 2016. The environments used were ITL REG, EUTL and CSEUR ACC.

1.1 Overview

This is the test report for the ‘EU custom Annex’. LV and LT are the registries used in this test.

This test is follows the test plan produced by the UNFCCC and distributed in advance to all test participants

To set up the ITL REGISTRY environment for this testing, CGI App Support uploaded the provided government accounts, set the registries test limits and created the projects

1.2 References

Reference	Identifier	Title
01	DES	Technical Specifications for Data Exchange, version 2.0.1 draft 5 17 August 2015
02	Test Plan	EC Custom Annex H - Feb 2016 - Detailed Test Plan - v0.1

2 Test Configuration

2.1 Registries

Following registries are used

ZZ	XX	YY	QQ	RR
LV	LT	--NA--	--NA--	--NA--

2.2 Additional Results

At the end of each scenario the relevant ITL logs were captured.

A WebEx session is used for communication during the testing. This will be captured at the end of each day.

3 TEST RESULTS

Ref	*Description*	*Pass/Fail Time*	*Notes*
1.1	*Successful AAU issuance in CP1*	*PASS*	
1.2	*Successful RMU issuance, LULUCF activity 1 in CP1*	*PASS*	
1.3	*Reconciliation*	*PASS*	
2.1	*Successful AAU conversion*	*PASS*	
2.2	*Successful RMU conversion*	*PASS*	
3.1	*Successful voluntary cancellation of CP1 AAUs*	*PASS*	
3.2	*Successful mandatory cancellation of CP1 AAUs*	*NA*	*Not performed because the EC indicated that this type of transaction and account are not enabled in their current software version*
3.3	*Cancellation to fulfil net source cancellation notification in CP1*	*PASS*	
3.4	*Cancellation to fulfil non-compliance cancellation notification in CP1*	*PASS*	
3.5	*Reconciliation*	*PASS*	
4.1	*External transfer attempt of CP1 units*	*PASS*	
4.2	*Receive CP1 and CP2 CERs, tCERs, lCERs and other units*	*PASS*	*We had an issue with the data set up in ITL; hence transactions were not successful initially. We have sorted out the issue and set the data correctly. Post this change transactions were successful*
4.3	*Reconciliation*	*NA*	*Skipped reconciliation, because the test 4.1 'External transfer' had to take one hour to complete.*

Ref	*Description*	*Pass/Fail*	*Notes*
5.1	***Retirement of AAUs, ERUs, CERs, and lCERs***	***PASS***	
5.2	***Reconciliation***	***PASS***	
1.1bis	***Successful AAU issuance in CP2***	***PASS***	
1.2bis	***Successful RMU issuance, LULUCF activity 1 in CP2***	***PASS***	
3.1bis	***Successful voluntary cancellation of CP2 AAUs***	***PASS***	
3.2bis	***Successful mandatory cancellation of CP2 AAUs***	***NA***	***Not Performed***
3.5bis	***Reconciliation***	***PASS***	
4.1bis	***External transfer of CP2 units***	***PASS***	
5.1bis	***Successful retirement of CP2 AAUs***	***PASS***	
5.3bis	***Unsuccessful attempt for Retirement of CP2 CERs***	***PASS***	***It took several attempts to get it to work as expected (unsuccessful transaction). The key was to re-enable the check in ITL REG and to restart the apps server***
5.3ter	***Successful Retirement of CP2 CERs***	***PASS***	
5.2bis	***Reconciliation***	***PASS***	