UMHVERFISSTOFNUN

NATIONAL INVENTORY REPORT 2015

Submitted under the United Nations Framework Convention on Climate Change

Emissions of greenhouse gases in Iceland from 1990 to 2013

Thee **Environment Agency of Iceland**

Telephone +354 591 20000, fax +354 591 2020
E-mail: ust@ust.is
Address: Suðurlandsbraut 24, 108 Reykjavik, Iceland
Website: www.ust.is

Authors:
Arnór Snorrason, Icelandic Forest Research
Jóhann Þórsson, Soil Conservation Service of Iceland
Jón Guðmundsson, Agricultural University of Iceland
Kristján Andrésson, Environment Agency of Iceland
Páll Valdimar Kolka Jónsson, Environment Agency of Iceland
Stefán Einarsson, Ministry for the Environment and Natural Resources
Vanda Úlfrún L. Hellsing, Environment Agency of Iceland

UST-2014-1, October 2015

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 2015. 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 and the Kyoto Protocol, and covers emissions and removals in the period 1990 – 2013.

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).

Contact information:

Vanda Úlfrún L. Hellsing

vanda.hellsing@ust.is

+354-5912000

TABLE OF CONTENTS

Index of figures

Index of tables

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

Gigagrams (Gg) are repeatedly used in the inventory and are equal to 10^9 grams or 1,000 tonnes.

GLOBAL WARMING POTENTIALS (GWP) OF GREENHOUSE GASES

Greenhouse gas	Chemical formula	1995 IPCC GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Sulphur hexafluoride	SF_6	23,900
Perfluorocarbons (PFCs)		
Tetrafluoromethane	CF_4	6,500
Hexafluoroethane	C_2F_6	9,200
Octafluoropropane	C_3F_8	7,000
Hydrofluorocarbons		
HFC-23	CHF_3	11,700
HFC-32	CH_2F_2	650
HFC-125	C_2HF_5	2,800
HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1,300
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3,800
HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	140
HFC-227ea	C_3HF_7	2,900

Source: FCCC/CP/2002/8, p.15

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

EXECUTIVE SUMMARY

ES.1. Background information

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 during the first commitment period. Iceland's obligations according to the Kyoto Protocol are as follows:

- For the first commitment period, from 2008 to 2012, the greenhouse gas emissions shall not increase more than 10% from the level of emissions in 1990. Iceland AAU's for the first commitment period amount to 18,523,847 tonnes of CO_2-equivalents.
- Decision 14/CP.7 on the "Impact of single projects on emissions in the commitment period" allows Iceland to report certain industrial process carbon dioxide emissions separately and not include them in national totals to the extent they would cause Iceland to exceed its assigned amount. For the first commitment period, from 2008 to 2012, the carbon dioxide emissions falling under decision 14/CP.7 shall not exceed 8,000,000 tonnes.

ES.2. Summary of national emission and removal-related trends

In 1990, the total emissions of greenhouse gases (excluding LULUCF) in Iceland were 3,696 Gg of CO_2-equivalents. In 2013, total emissions were 4,536 Gg CO_2-equivalents. This is an increase of 22.7% over the time period.

A summary of the Icelandic national emissions for 1990, 2005, 2012 and 2013 is presented in Table ES 1 (without LULUCF).

Table ES 1 Emissions of greenhouse gases 1990, 2005, 2012 and 2013 in Gg CO2-equivalents (excluding LULUCF).

	1990	2005	2012	2013	Changes ´90-´13	Changes ´12-´13
CO_2	2,163	2,839	3,309	3,322	53.62%	0.4%
CH_4	528	573	522	541	2.55%	-1.94%
N_2O	514	414	426	414	-19.45%	2.58%
PFCs	495	31	94	88	-82.3%	-6.7%
HFCs	NO	69	172	171	NA	-0.4%
SF_6	1	3	5	3	178.0%	-42.6%
Total emissions	3,699	3,929	4,558	4,539	22.7%	-0.42%

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

The largest contributor of greenhouse gas emissions in Iceland in 2013 were Industrial Processes, followed by the Energy sector, then Agriculture, Waste, and Solvent and other Product Use (Table ES 2). From 1990 to 2013, the contribution of Industrial Processes increased from 25% to 43%, emissions from the Energy sector decreased from 50% to 37% during the same period.

Table ES 2 Total emissions of greenhouse gases by source 1990, 2005, 2012 and 2013 in Gg CO_2-eqivalents.

	1990	2005	2012	2013	Changes ´90-´13	Changes ´12-´13
Energy	1,800	2,052	1,693	1,688	-6.22%	-0.29%
Industrial Processes	948	953	1,927	1,937	104.32%	0.52%
Emissions fulfilling 14/CP.7			1,279			
Solvent and Other Product Use	4.4	5.1	4.5	4.4	0%	-2.22%
Agriculture	779	675	719	684	-12.19%	-4.87%
LULUCF	11,496	11,652	11,867	11,872	-3,27%	-0,04%
Waste	168	244	214	226	34.52%	5.61%
Total emissions w/o LULUCF	3,699	3,929	4,558	4,539	22.71%	-0.42%
Removals from KP 3.3 and 3.4			338			

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 2013 is shown in Figure ES 1. Emissions from the Energy sector account for 39% (fuel combustion 34.6% and geothermal energy 3.9%) of the national total emissions, industrial processes account for 42.2% and agriculture for 15.2%. The Waste sector accounts for 4.1%, and Solvent and other Product Use for 0.1%.

Figure ES 1. Emissions of greenhouse gases by UNFCCC sector in 2013.

ES.4. Other information – Kyoto Accounting

Iceland's initial AAUs for the first commitment period amount to 18,523,847 tonnes of CO_2-equivalents for the period or 3,704,769 tonnes per year on average. Added to that are a total of 1,541,960 RMUs from Art. 3.3 and Art. 3.4 activities resulting in an available assigned amount of 20,065,807 AAUs.

Emissions from Annex A sources during CP1 were 23,356,066 tonnes CO_2-eq. This means that Annex A emissions were 3,290,264 tonnes CO_2 in excess of Iceland´s available assigned amount.

Total CO_2 emissions falling under Decision 14/CP.7 during CP1 were 6,079,323 tonnes CO_2. Therefore, in order to comply with its goal for CP1, Iceland reported 3,290,264 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 1 demonstrate this.

The CRF tables accompanying the 2014 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

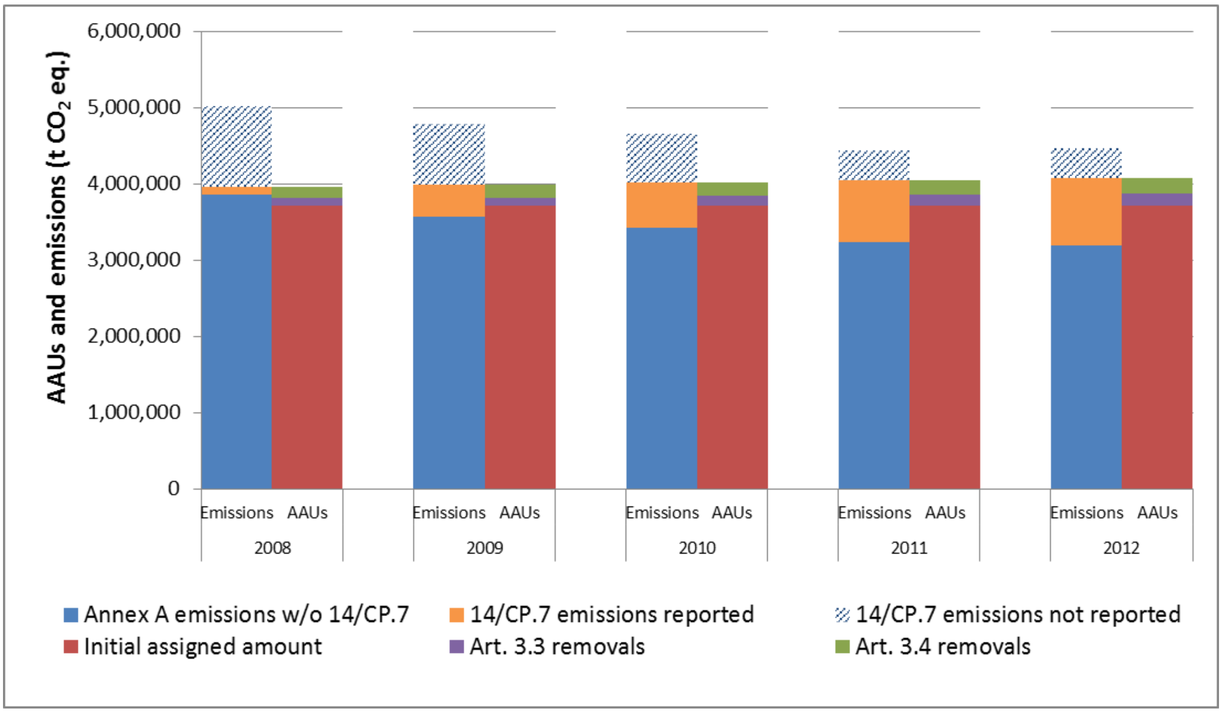


Figure ES 1 Summary of Kyoto accounting for CP1.

As part of its submission to UNFCCC Iceland submits SEF tables for the Kyoto Protocol units issued in 2013. 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.

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 in the first commitment period. Iceland's obligations according to the Kyoto Protocol are as follows:

- For the first commitment period, from 2008 to 2012, the greenhouse gas emissions shall not increase more than 10% from the level of emissions in 1990. Iceland AAUs for the first commitment period were decided in Iceland's Initial Report under the Kyoto Protocol and amount to 18,523,847 tonnes of CO_2-equivalents.
- Decision 14/CP.7 on the "Impact of single project on emissions in the commitment period" allows Iceland to report certain industrial process carbon dioxide emissions separately and not include them in national totals; to the extent they would cause Iceland to exceed its assigned amount. For the first commitment period, from 2008 to 2012, the carbon dioxide emissions falling under decision 14/CP.7 shall not exceed 8,000,000 tonnes.

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 the 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 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 will undertake 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 1990-2013. 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 2013. 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 (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). Emissions of the precursors NOx, NMVOC and CO as well as SO2 are also included, in compliance with the reporting guidelines.

1.2. National System for Estimation of Greenhouse Gases

1.1.1.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.

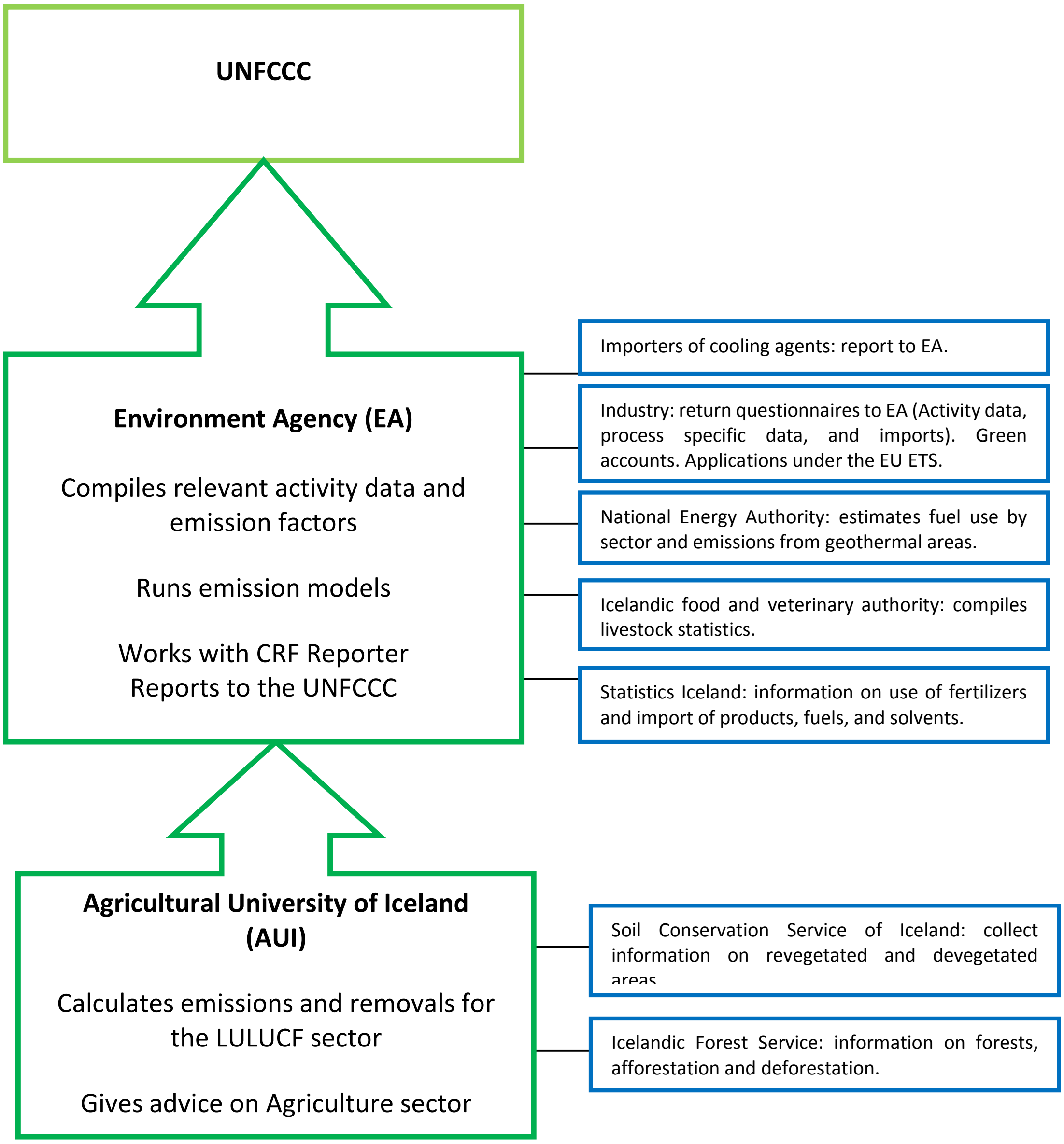


Figure 1.1 Information flow and distributionof responsibilities in the Icelandic emission inventory system for reporting to the UNFCCC.

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.

1.1.2. *Act No. 70 from 2012*

In June 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 regarding climate change.

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 is based on these agreements. Articles 7 to 15 of Act 65/2007 regarding the allocation of allowances in the period 2008 to 2012 still stands. Regulation 244/2009, put forward on basis of Act 65/2007 further elaborates on the reporting of information from the industrial plants falling under that part of Act 65/2007. Based on Act 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 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.

Paragraph 6 of Act 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 70/2012 changes the form of relations between the EA and other bodies concerning data handling. The law 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 (SCSI)
- 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 said data had been drafted by the EA and sent to the Ministry for Environment and Natural Resources. From next year 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 law will facilitate the responsibilities, the data collection process and the timeliness.

As the prospective regulation on data collection, 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 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.

1.1.3. Green Accounts

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 Preperation

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 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.

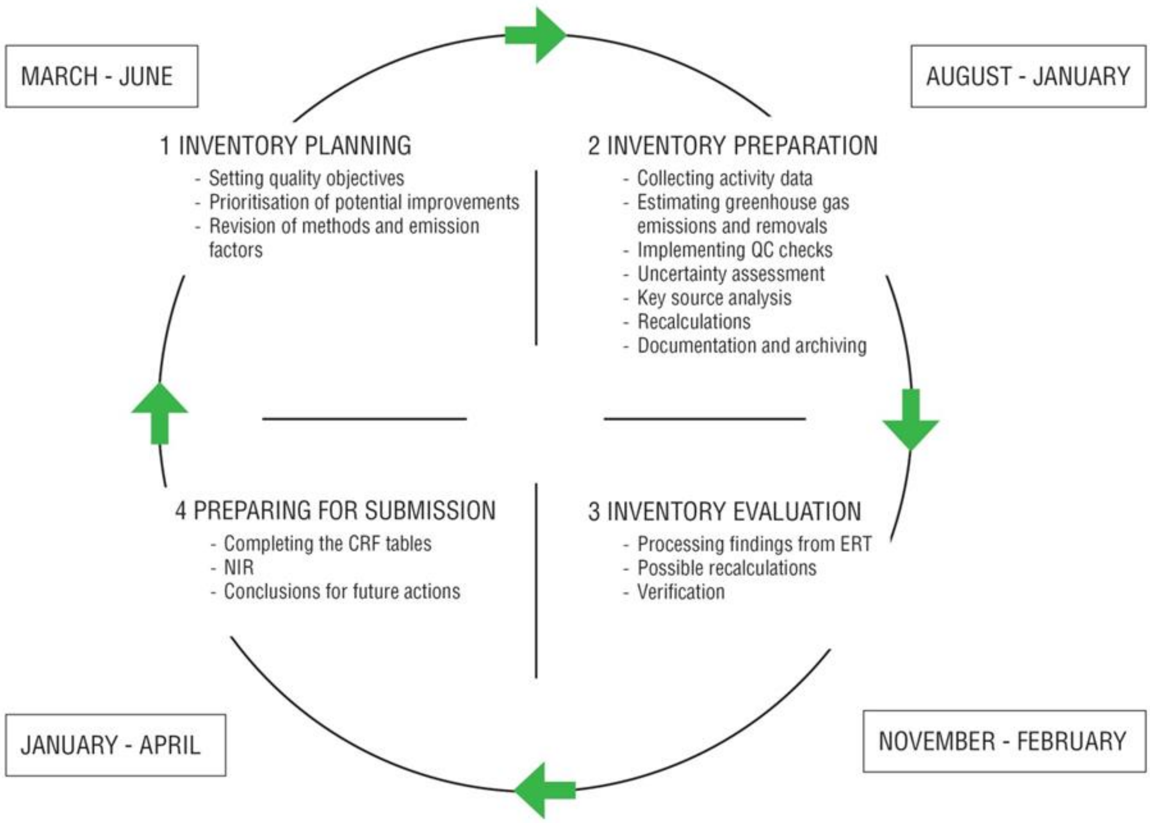


Figure 1.2 The annual inventory cycle.

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 and Data Sources

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

The general emission model is based on the equation:

Emission (E) = Activity level (A) · Emission Factor (EF)

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

Methodologies and data sources for LULUCF are described in Chapter 6.

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 2015 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 2015 GHG inventory. ✓= Key source category (✓) = Only key source category when LULUCF is excluded.

IPCC source category			Level 1990	Level 2013	Trend
Energy (CRF sector 1)					
1.AA.1	Public electricity and heat production	CH_4			
1.AA.1	Public electricity and heat production	CO_2			
1.AA.1	Public electricity and heat production	N_2O			
1.AA.2	Manufacturing industry and construction	CH_4			
1.AA.2	Manufacturing industry and construction	CO_2	✓	✓	✓
1.AA.2	Manufacturing industry and construction	N_2O			
1.AA.3a/d	Transport	CH_4			
1.AA.3a/d	Transport	CO_2	✓		✓
1.AA.3a/d	Transport	N_2O			
1.AA.3b	Road transport	CH_4			
1.AA.3b	Road transport	CO_2	✓	✓	✓
1.AA.3b	Road transport	N_2O			✓
1.AA.4a/b	Residential/institutional/commercial	CH_4			
1.AA.4a/b	Residential/institutional/commercial	CO_2	(✓)		✓
1.AA.4a/b	Residential/institutional/commercial	N_2O			
1.AA.4c	Fishing	CH_4			
1.AA.4c	Fishing	CO_2	✓	✓	✓
1.AA.4c	Fishing	N_2O			
1.B	Fugitive emissions from fuels	CH_4			
1.B	Fugitive emissions from fuels	CO_2	✓	✓	✓
2. Industrial Processes					
2.A	Mineral production	CO_2	✓		✓
2.B	Chemical industry	CO_2			

2.B	Chemical industry	N_2O	✓		
2.C	Metal production	CH_4			
2.C.2	Ferroalloys	CO_2	✓	✓	✓
2.C.3	Aluminium	CO_2	✓	✓	✓
2.C.3	Aluminium	PFC	✓	✓	✓
2.F	Consumption of halocarbons and SF6, refrigeration	HFC		✓	✓
2.F	Consumption of halocarbons and SF6, refrigeration	PFC			
2.F	Consumption of halocarbons and SF6, electrical	SF_6			
	3. Solvents and Other Product Use				
3	Solvent and other product use	CO_2			
3	Solvent and other product use	N_2O			

Table 1.1. continued

IPCC source category			Level	Level	Trend
4.A.4-10	Enteric fermentation, rest	CH_4			
4.B	Manure management	CH_4		(✓)	
4.B	Manure management	N_2O	✓	✓	
4.D.1	Direct soil emissions	N_2O	✓	✓	
4.D.2	Animal production	N_2O	✓	✓	
4.D.3	Indirect soil emissions	N_2O	✓	✓	
	5. Land use, Land use change and Forestry				
5	LULUCF – Biomass burning	CH_4			
5	LULUCF – Biomass burning	N_2O			
5.A.1	Forest Land – Forest Land remaining Forest Land	CO_2			
5.A.2	Forest land – Land converted to Forest Land	CO_2		✓	✓
5.A.2	Forest land – Land converted to Forest Land	N_2O			
5.B.1	Cropland remaining Cropland	CO_2	✓	✓	✓
5.B.2	Land converted to Cropland	CO_2	✓	✓	✓
5.C.1	Wetlands drained for more than 20 years	CO_2	✓	✓	✓
5.C.1	All other remaining Grassland	CO_2			
5.C.2.2/3	All other conversion to Grassland	CO_2	✓	✓	✓
5.C.2.5	Other land converted to Grassland, revegetation	CO_2	✓	✓	✓
5.D	Wetlands	CH_4			
5.D	Wetlands	CO_2			
5.D	Wetlands	N_2O			
5.E	Settlements	CO_2			
5.G	Grassland non CO2-emissions	N_2O	✓	✓	
	6. Waste				
6.A.1	Managed waste disposal on land	CH_4		✓	✓
6.A.2	Unmanaged waste disposal sites	CH_4	✓		✓
6.B	Wastewater handling	CH_4			
6.B	Wastewater handling	N_2O			
6.C	Waste incineration	CH_4			
6.C	Waste incineration	CO_2			
6.C	Waste incineration	N_2O			

6.D	Other (composting)	CH_4			
6.D	Other (composting)	N_2O			

1.7. Quality Assurance and Quality Control (QA/QC)

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 at 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 (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 the Completeness

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

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

In the case of temporal coverage, CRF tables are reported for the whole time series from 1990 to 2013.

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 (2A6).
- 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

Several improvements have been made since last submission. The main changes include:

- Improved reporting on projects falling under Decision 14/CP.7
- Country specific values for digestible energy content of cattle and sheep feed were determined and used in the calculation of methane emissions from livestock
- Revision of area of many landuse categories
- Inclusion of biomass burning under LULUCF

In the near future the following improvements for the inventory are planned:

- Preparation of a national energy balance. The NEA should prepare a national energy balance annually and submit to the EA. Work has already been initiated by the NEA, with the aim of producing the national energy balance within two years. The obligation of the NEA to provide national energy balance will be further elaborated in a regulation, to be set on basis of Act no 70/2012.
- Improvement of methodologies to estimate emissions from road transportation (use of COPERT).
- Move estimates of emissions from aviation to the Tier 2 methodology.
- Improvement of methodologies to estimate N_2O emissions from manure management.
- Developing a time series for the enhanced livestock population characterisation
- The division of land use into subcategories and improved time and spatial resolution of the land use information is an on-going task of the AUI.

- Repeated land classification based on new satellite images through remote sensing, updating and improving GIS-maps and continuing field surveys is included in the IGLUD project.
- Definition of baseline map that helps separating actual land use changes from seeming land use changes brought on by improved mapping and data management
- Improving the area estimate of drained land and of the effectiveness of drainage
- Revision of EF for drained organic soils
- Improving identification of former cropland categories and destination of abandoned cropland.
- Higher tier estimates of changes regarding the carbon stock in soil, dead organic material and other vegetation than trees on forest Land is expected in future reporting when data from re-measurement of the permanent sample plot will be available.
- Increase the accuracy of the new area estimate of the natural birch woodland and the changes in area with time
- 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. When implemented, these improvements will provide more accurate area and removal factor estimates for revegetation, subdivided according to management regime, regions and age.
- Improve area estimate of Settlement area and Other land
- Further improvement of the time series already presented.
- The provision of missing Annexes.

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.
- Division of „Other Grassland“ into subcategories that reflect differences in management, vegetation condition and soil erosion is pending.

2. TRENDS IN GREENHOUSE GAS EMISSIONS

2.1. Emission Trends in Aggregated Greenhouse Gas Emissions Emission Trends in Aggregated Greenhouse Gas Emissions

Total amounts of greenhouse gases emitted in Iceland during the period 1990-2013 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, 2012 and 2013 expressed in Gg CO_2-equivalents along with percentage changes for both time periods 1990-2013 and 2012-2013. Table 2.2 presents emission figures for all greenhouse gases by gas in 1990, 2005, 2012, and 2013 expressed in Gg CO_2-equivalents along with percentage changes for both time periods 1990-2013 and 2012-2013.

Table 2.1 Emissions of greenhouse gases by sector in Iceland during the period 1990-2013 in Gg CO_2-equivalents.

	1990	2005	2012	2013	Changes ´90-´13	Changes ´12-´13
1. Energy	1,800	2,052	1,693	1,688	-6.22%	-0.29%
1.A Fuel combustion	1,738	1,931	1,520	1,512	-13.00%	-0.53%
1.B Geothermal	62	121	173	176	183.87%	1.73%
2. Industrial Processes	948	953	1,927	1,937	104.32%	0.52%
2.S. Solvent and Other Product Use	4.4	5.1	4.5	4.4	0%	-2.22%
3. Agriculture	779	675	719	684	-12.19%	-4.87%
4. Land Use, Land Use Change and Forestry	11,496	11,652	11,867	11,872	3.2%	0,0%
5. Waste	168	244	214	226	34.52%	5.61%
Total emissions without LULUCF	3,699	3,929	4,558	4,539	22.71%	-0.42%

Table 2.2 Emissions of greenhouse gases by gas in Iceland during the period 1990-2013 (without LULUCF) in Gg CO_2-equivalents.

	1990	2005	2012	2013	Changes ´90-´13	Changes ´12-´13
CO_2	2,163	2,839	3,309	3,322	53.62%	0.4%
CH_4	528	573	522	541	2.55%	-1.94%
N_2O	514	414	426	414	-19.45%	2.58%
PFCs	495	31	94	88	-82.3%	-6.7%
HFCs	NO	69	172	171	NA	-0.4%
SF_6	1	3	5	3	178.0%	-42.6%
Total emissions	3,699	3,929	4,558	4,539	22.7%	-0.42%

In 1990 total GHG emissions (excluding LULUCF) in Iceland were 3,699 Gg CO_2-equivalents. In 2013 total emissions were 4,539 Gg CO_2-equivalents. This is tantamount to an increase of 22% 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 0.42% between 2012 and 2013.

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 2013, 840,975 tonnes of aluminium were produced in three aluminium plants. Parallel investments in increased power capacity were needed to accommodate for this 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 27% from 1990 to 2013. 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 decrease has slowed down and was only 0.5% between 2012 and 2013. The total decrease from 2007 to 2013 is therefore 23%. 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 stopped 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 2013 total emissions from the aluminium sector were 16% 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 2.1 Distribution of emissions of GHG by gas in 2013

, the largest contributor by far to total GHG emissions is CO_2 (73%), followed by CH_4 (12%), N_2O (9%) and fluorinated gases (PFCs, HFCs, and SF_6, 6%). In the year 2013, the changes in gas emissions compared to 1990 levels for CO_2, CH_4, N_2O, and fluorinated gasses were 54%, 3%, -19%, and -47%, respectively (cf. Table 2.2 and Figure 2.2).

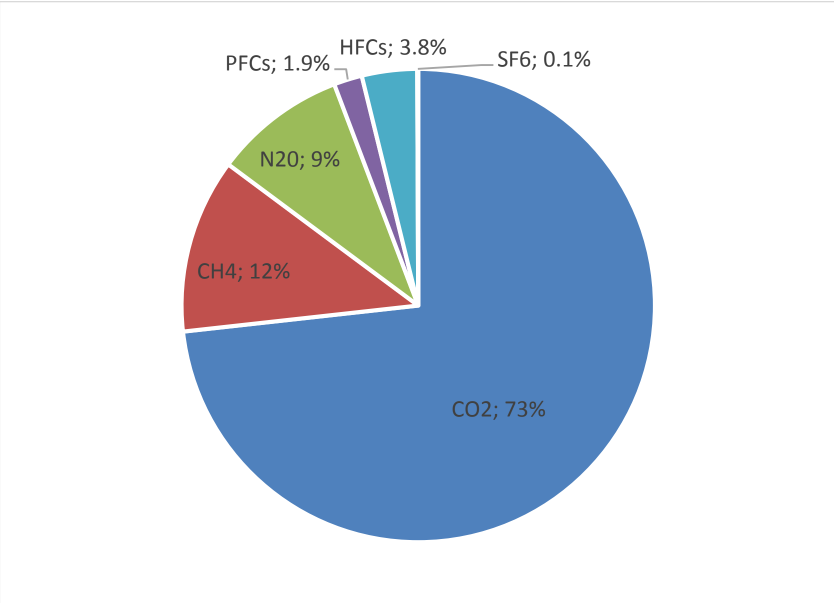


Figure 2.1 Distribution of emissions of GHG by gas in 2013

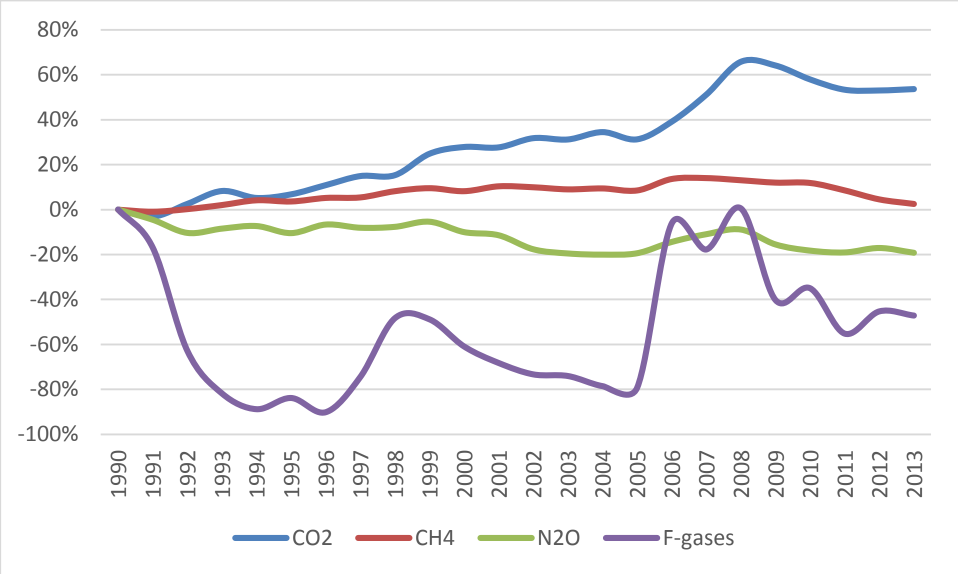


Figure 2.2 Percentage changes in emissions of GHG by gas 1990-2013, compared to 1990 levels.

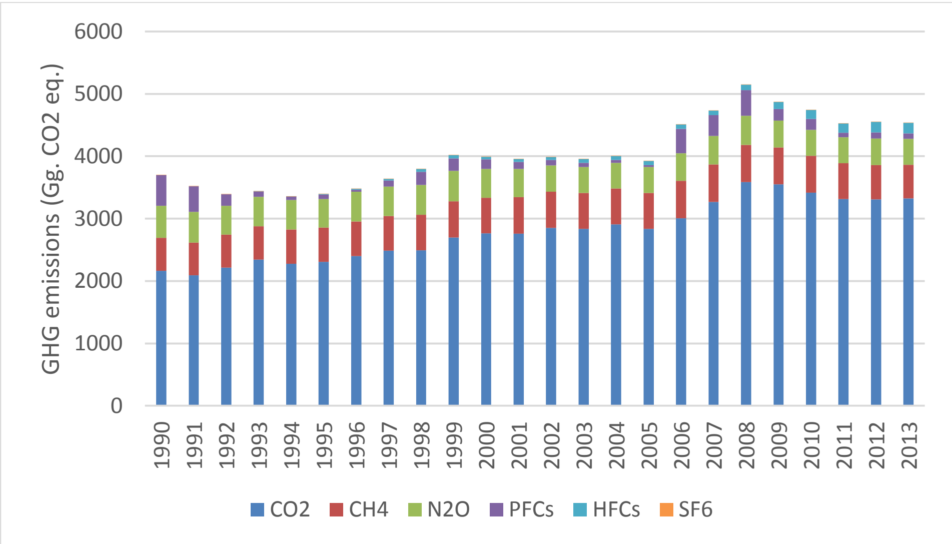


Figure 2.3 Emissions of greenhouse gases by gas, 1990-2013.

2.1.1. *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 1990-2013.

Table 2.3 Emissions of CO_2 by sector 1990-2013 in Gg.

	1990	2005	2010	2011	2012	2013
Fishing	655	626	535	500	485	475
Road vehicles	509	747	794	776	772	787
Stationary combustion, liquid fuels	243	208	101	98	84	70
Industrial processes	399	846	1,616	1,610	1,653	1,671
Construction	120	214	102	87	92	87
Geothermal	61	118	189	179	170	172
Other	148	71	73	59	47	54
Total CO_2 emissions	2,068	2,827	3,407	3,306	3,299	3,315

In 2013, Iceland´s total CO_2 emissions were 3,315 Gg. This is tantamount to an increase of 60% from 1990 levels and an increase of 0.4% from the preceding year. CO_2 emissions from Industrial Processes increased by 1.1% from 2012 to 2013 due to more emissions from metal production. Emissions from geothermal energy exploitation increased by 1.2% between 2012 and 2013. Emissions from road vehicles peaked in 2007 but have decreased by 12% 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 economic 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 16.7% from 2012 to 2013. Emissions from construction decreased by 5% and emissions from other sources increased by 14.9% during the same time period.

The increase in CO_2 emissions between 1990 and 2013 can be explained by increased emissions from industrial processes (318%), road transport (54%), and geothermal energy utilisation (181%). Total CO_2 emissions from the commercial fishing and construction sectors, on the other hand, declined by 27% and 27%, respectively.

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 2013, a total of 840,975 tonnes of aluminium were produced in these three aluminium plants, slightly more than in 2012.

CO_2 emissions from road transport have increased by 54% 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 76%. Emissions from both domestic flights and navigation have declined since 1990.

Emissions from geothermal energy exploitation have increased by 181% since 1990. Electricity production using geothermal energy has increased from 283 GWh in 1990 to 5,245 GWh in 2013, or more than 18-fold.

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 2013, the emissions were 27% below the 1990 levels and 2% below the 2013 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 which led to a further decrease of other CO_2 emissions of 32% between 2011 and 2013.

2.1.2. Methane (CH_4)

Agriculture and waste treatment have been the main sources of methane emissions since 1990. In 2013 they comprised 58% and 39% of total methane emissions, respectively (Table 2.4 and Figure 2.4). 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 90% of sector methane emissions.

Methane emissions from agriculture decreased by 13% between 1990 and 2013 due to a decrease in livestock population. Emissions from waste, on the other hand, increased by 43% 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 Gg 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 14% is due to a decrease in the amount of waste landfilled since 2005 (Figure 2.5).

Table 2.4 Emissions of CH_4 by sector 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Agriculture	364	338	332	322	342	340	315
Waste	149	194	219	231	231	198	212
Other	14	15	20	19	17	13	14
Total	527	547	571	572	590	551	541

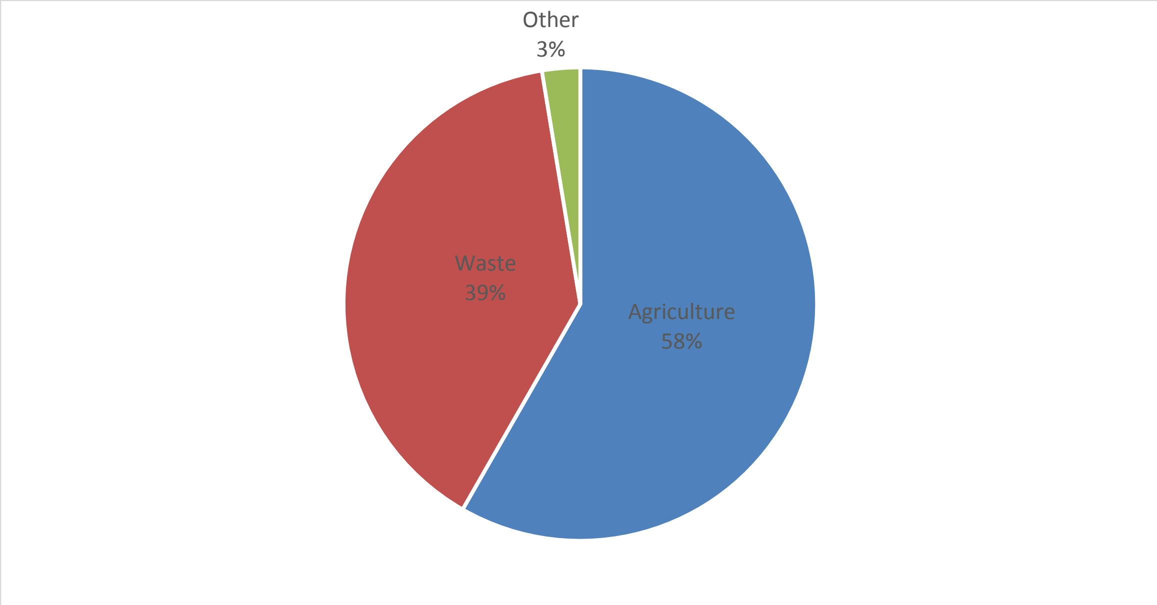


Figure 2.4 Distribution of CH4 emissions by source in 2013.

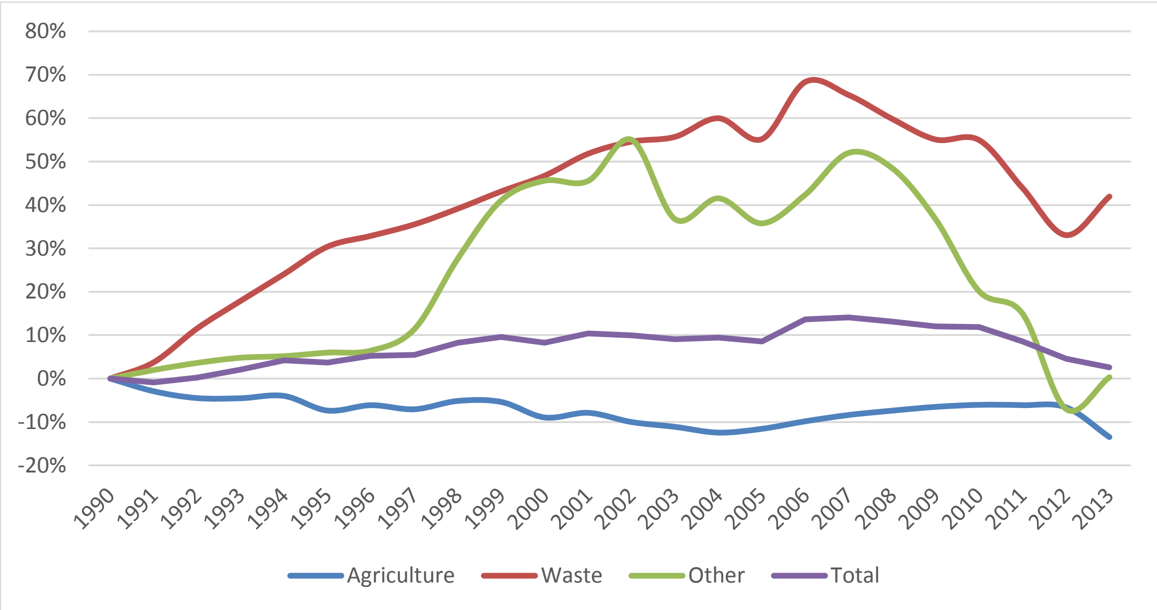


Figure 2.5 Percentage changes in emissions of CH_4 by major sources 1990-2013, compared to 1990 levels.

2.1.3. Nitrous Oxide (N_2O)

Agriculture has been the main source of N_2O emissions in Iceland and accounted for 88% of nitrous oxide emissions in 2013 (Table 2.5and Figure 2.6). 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 N2O, 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. N2O is a by-product of NOx reduction in catalytic converters. Total nitrous oxide emissions have decreased by 17% since 1990.

Table 2.5 Emissions of N_2O by sector 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Agriculture	415	370	387	352	370	379	374
Road transport	15	16	17	20	20	19	19
Other fuel combustion	21	24	30	31	17	15	14
Chemical industry	47	41	18	NO	NO	NO	NO
Other	17	16	17	16	17	17	17
Total	514	467	468	419	425	430	425

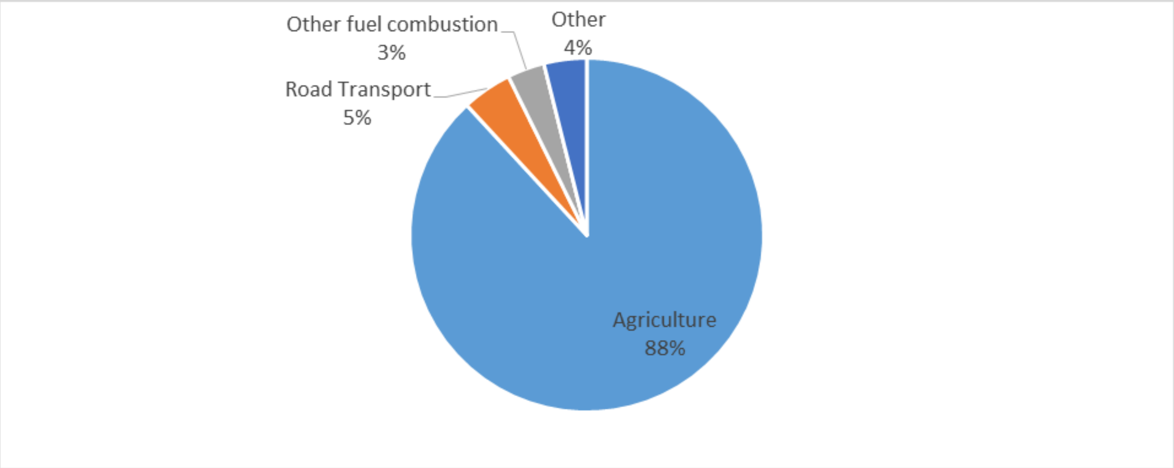


Figure 2.6 Distribution of N2O emissions by source in 2013.

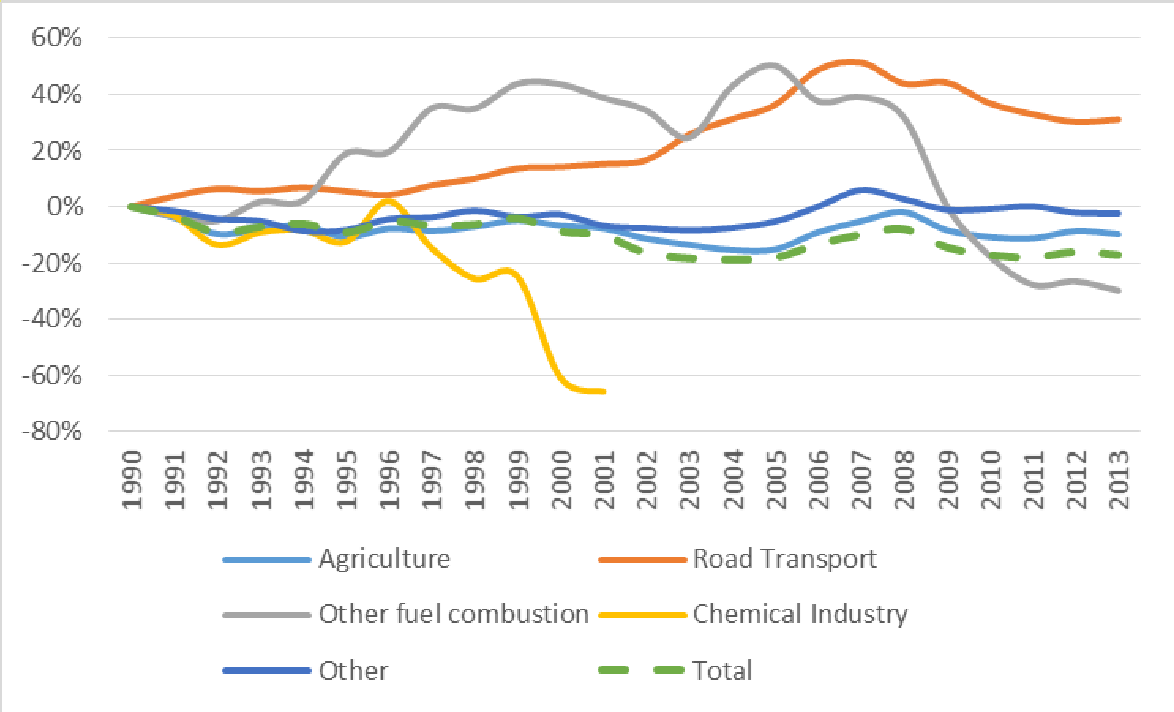


Figure 2.7. Changes in N_2O emission for major sources between 1990 and 2013.

2.1.4. *Perfluorocarbons (PFCs)*

The emissions of the perfluorocarbons, i.e. tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) from the aluminium industry were 73.11 and 14.6 Gg CO_2-equivalents respectively in 2013, or roughly 88 Gg CO_2-equivalents in total. Emissions of PFCs (PFC 116 and PFC 218) from consumption of halocarbons in refrigeration and air conditioning equipment were 0.003 Gg CO_2-equivalents in 2013 (Table 2.6).

Total PFC emissions decreased by 82% in the period of 1990-2013. The emissions decreased steadily from 1990 to 1996 with the exception of 1995, as can be seen from Figure 2.8.

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 0.003 Gg 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 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2011	2012	2013
CF4	412	58	125	26	143	62	78	73
C_2F_6	82	12	25	5	29	12	16	15
C_3F_8	NO	NO	NO	NO	0.007	0.005	0.004	0.003
Total	495	69	150	31	172	75	94	88

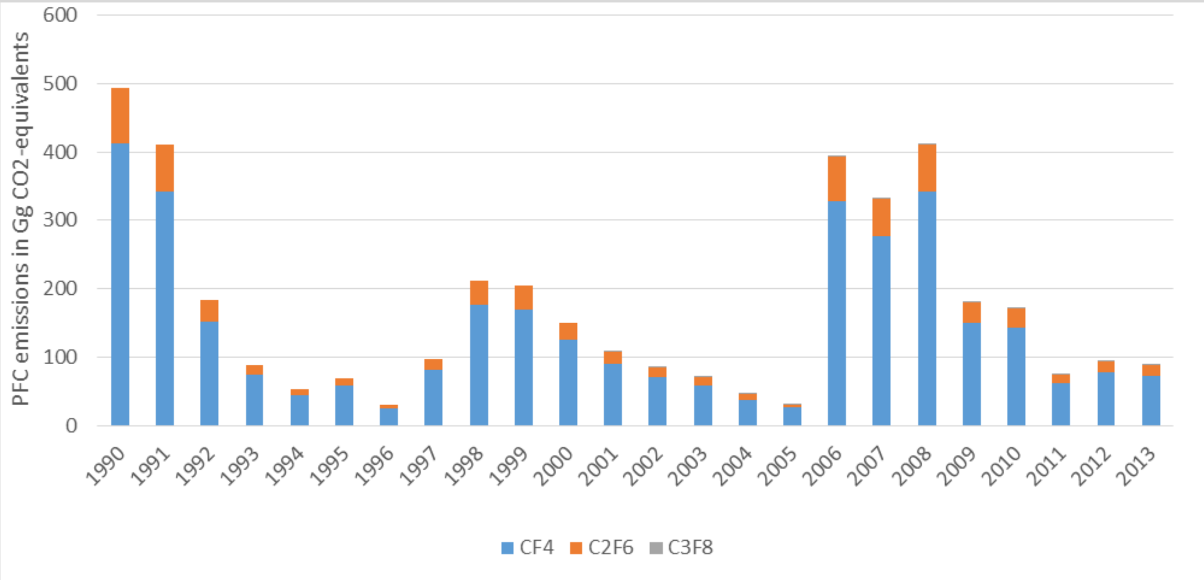


Figure 2.8. Emissions of PFCs from 1990 to 2013, Gg CO_2-equivalents.

2.1.5. Hydrofluorocarbons (HFCs)

Total actual emissions of HFCs, used as substitutes for ozone depleting substances (ODS), amounted to 171 Gg CO_2-equivalents in 2013 (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 2.9). Between 2008 and 2010 the import of HFCs had increased more than twofold. Total HFC emissions amounted to to 171 Gg in 2013 which is similar compared to 2012.

Table 2.7. Emissions of HFCs 1990-2013(Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
HFC-23	NO	NO	NO	0.02	0.02	0.01	0.01
HFC-32a	NO	NO	0.01	0.03	0.05	0.09	0.17
HFC-125	NO	5.08	17.49	25.4	53.43	64.71	63.10
HFC-134a	NO	1.91	7.49	13.17	21.49	22.99	22.74
HFC-143	NO	2.46	17.46	30.52	70.73	83.86	82.75
HFC152a	NO	0.04	0.07	0.05	0.02	0.01	0.01
HFC-227ea	NO	NO	NO	0.08	0.03	0.05	0.28
Total	NO	9.50	42.52	69.26	145.77	171.73	169.1

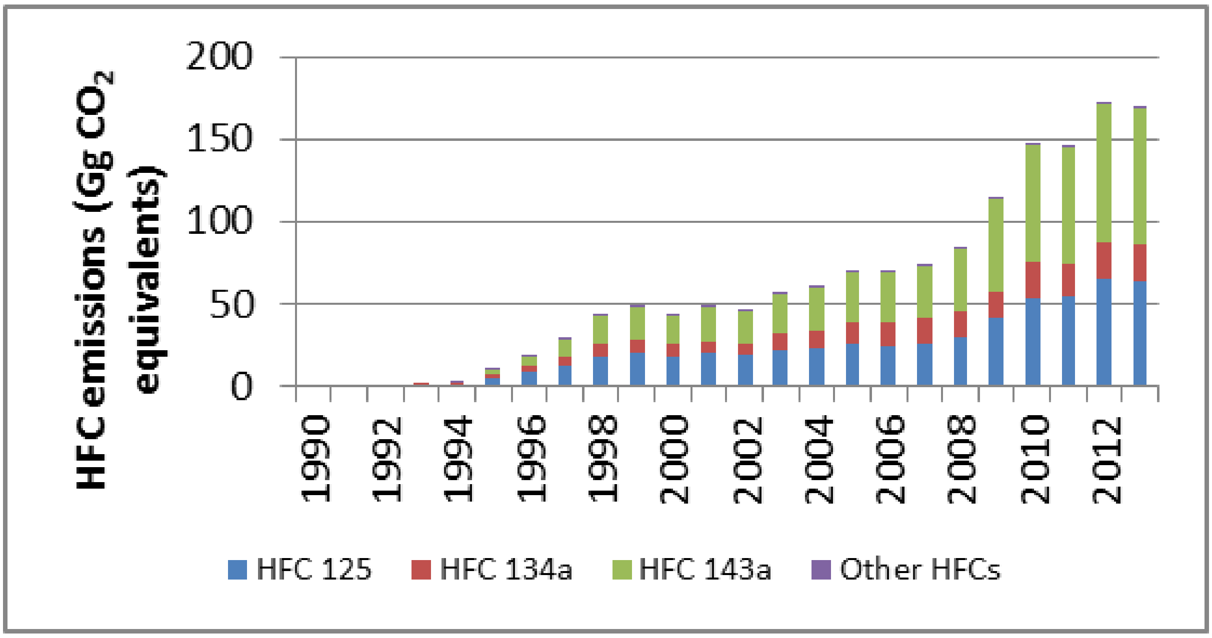


Figure 2.9. Emissions of HFCs 1990-2013, Gg CO_2-equivalents (HFC-23, HFC-32, HFC-152 and HFC-227 cannot be seen in figure due to proportionally low levels compared to three major HFCs).

2.1.6. Sulphur Hexafluoride (SF_6)

The sole source of SF_6 emissions in Iceland is leakage from electrical equipment. Total emissions in 2013 were 133 kg SF_6 which is tantamount to 3.1 Gg CO_2-equivalents. Emissions have increased by 178% 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 2.10). The emission peak in 2012 was caused by increased leakage in the transmission grid of Landsnet LLC.

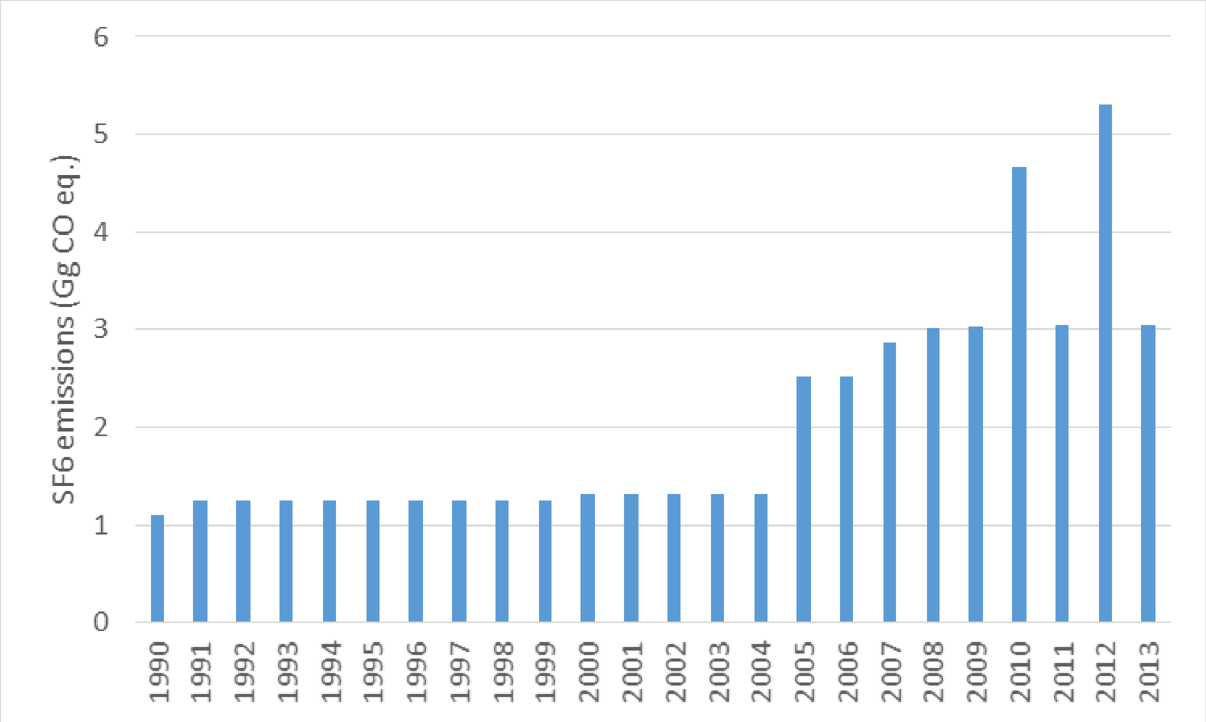


Figure 2.10. Emissions of SF_6 from 1990 to 2012 in Gg CO2-eq.

2.3. 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 42% in 2013. The contribution of the Energy sector decreased from 51% in 1990 to 38% in 2013. Agriculture and the Waste sector accounted for 15% and 4% of 2013 emissions, respectively (cf. Table 2.1, Table 2.2 and Figure *2.11* to Figure 2.13).

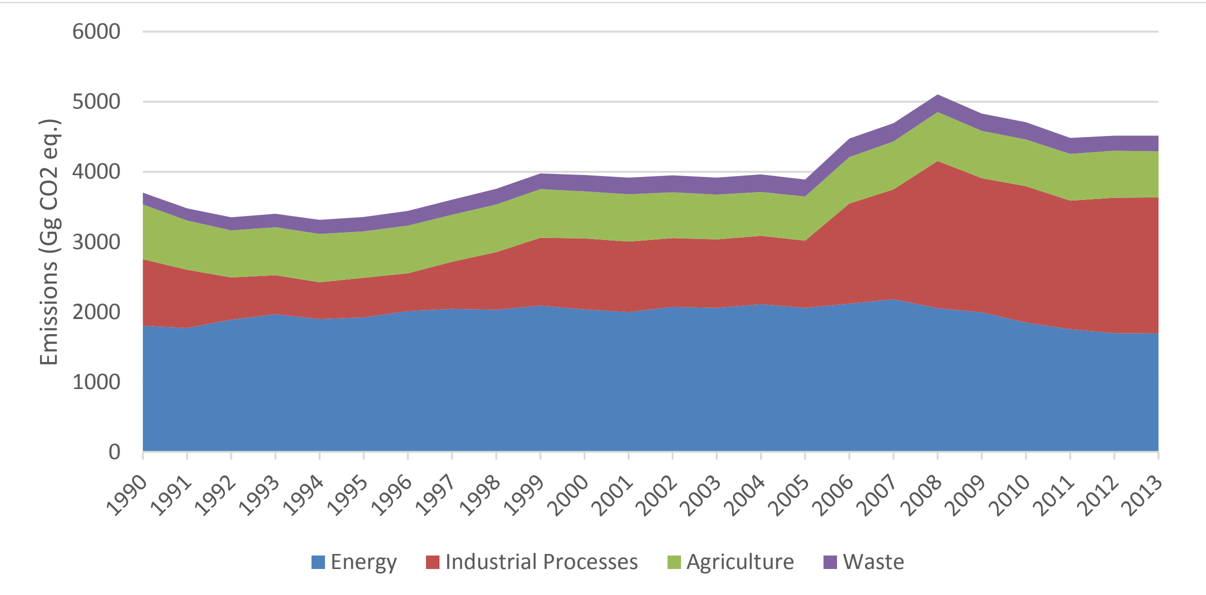


Figure 2.11. Emissions of GHG by sector, without LULUCF, from 1990 to 2013 in CO2-equivalents.

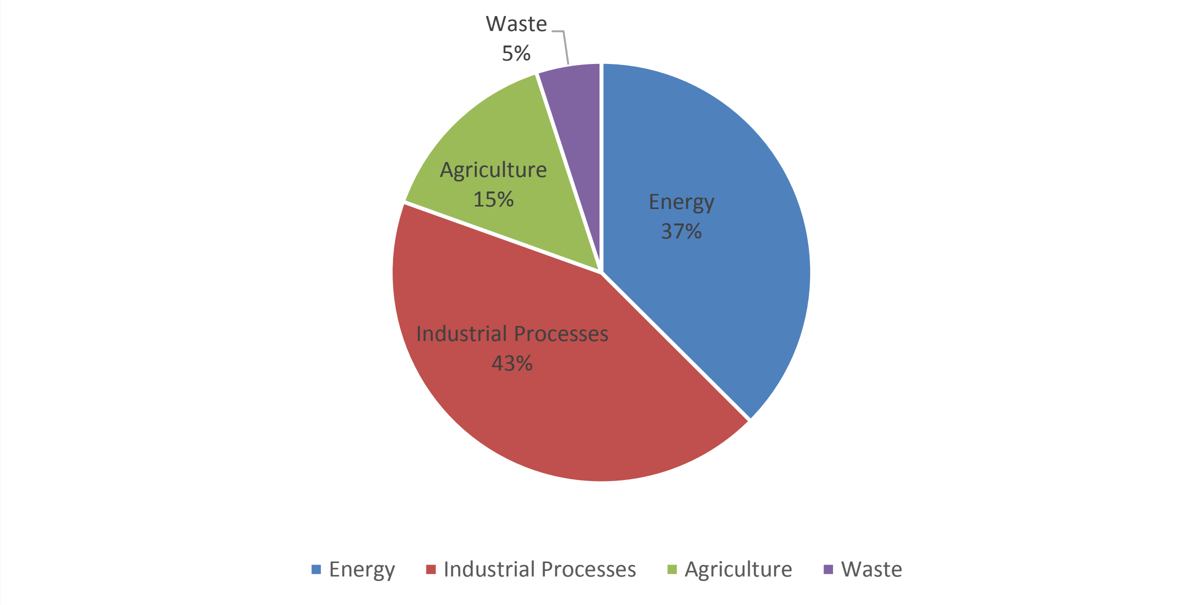


Figure 2.12. Emissions of greenhouse gases by UNFCCC sector in 2013.

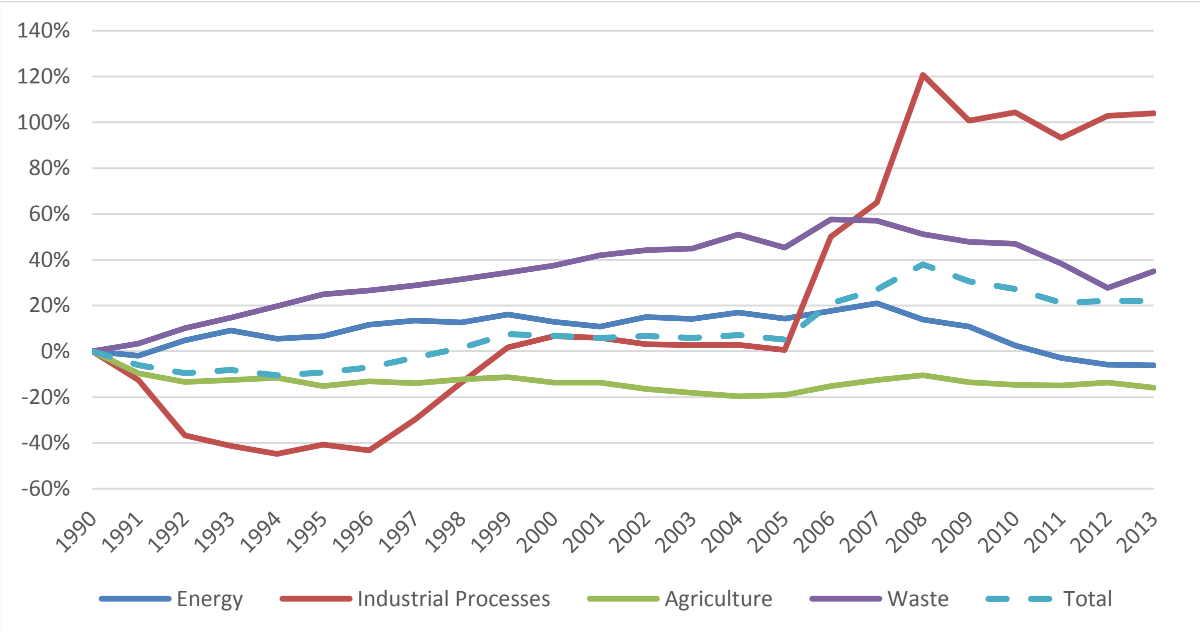


Figure 2.13. Percentage changes in emissions of total greenhouse gas emissions by UNFCCC source categories during the period 1990-2013, compared to 1990 levels.

2.1.7. 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 786 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 80% of the total electricity produced in Iceland in 2013. Iceland relies heavily on its geothermal energy sources for space heating (over 90% of all homes) and electricity production (27% of the electricity) and on hydropower for electricity production (73% 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.

Fuel Combustion

The total emissions of greenhouse gases from fuel combustion in the Energy sector over the period 1990 to 2013 are listed in Table 2.8. Emissions from fuel combustion in the Energy sector accounted for 38% of the total greenhouse gas emissions in Iceland in 2013.

Figure 2.14 shows the distribution of emissions in 2013 by different source categories. The percentage change in the various source categories in the Energy sector between 1990 and 2013, compared with 1990, are illustrated in Figure 2.15.

Table 2.8. Total emissions of GHG from the fuel combustion in the Energy sector in 1990-2013(CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Energy industries	14	19	7	9	7	7	2
Manufacturing industry and construction	377	378	450	447	213	184	170
Transport	621	628	674	849	900	853	850
Road	529	561	633	800	844	818	811
Other	92	67	41	49	57	35	39
Other sectors	705	808	756	651	556	500	493
Fishing	662	780	728	633	540	490	478
Residential/ commercial	43	28	29	19	16	10	15
Total	1,717	1,833	1,887	1,957	1,676	1,545	1,515

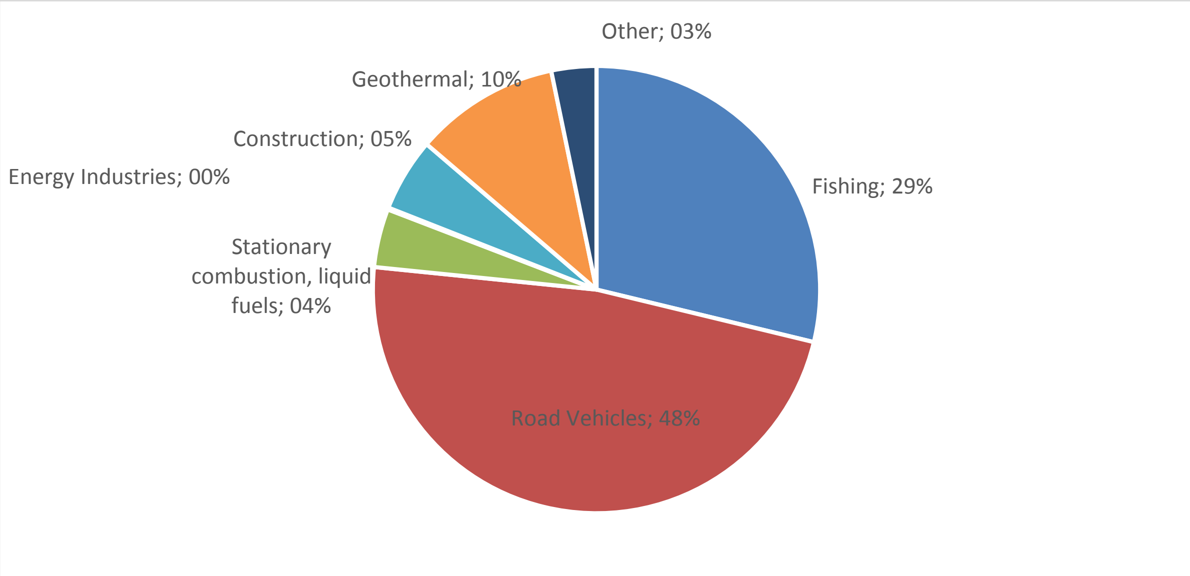


Figure 2.14. Greenhouse gas emissions in the Energy sector 2013, distributed by source categories.

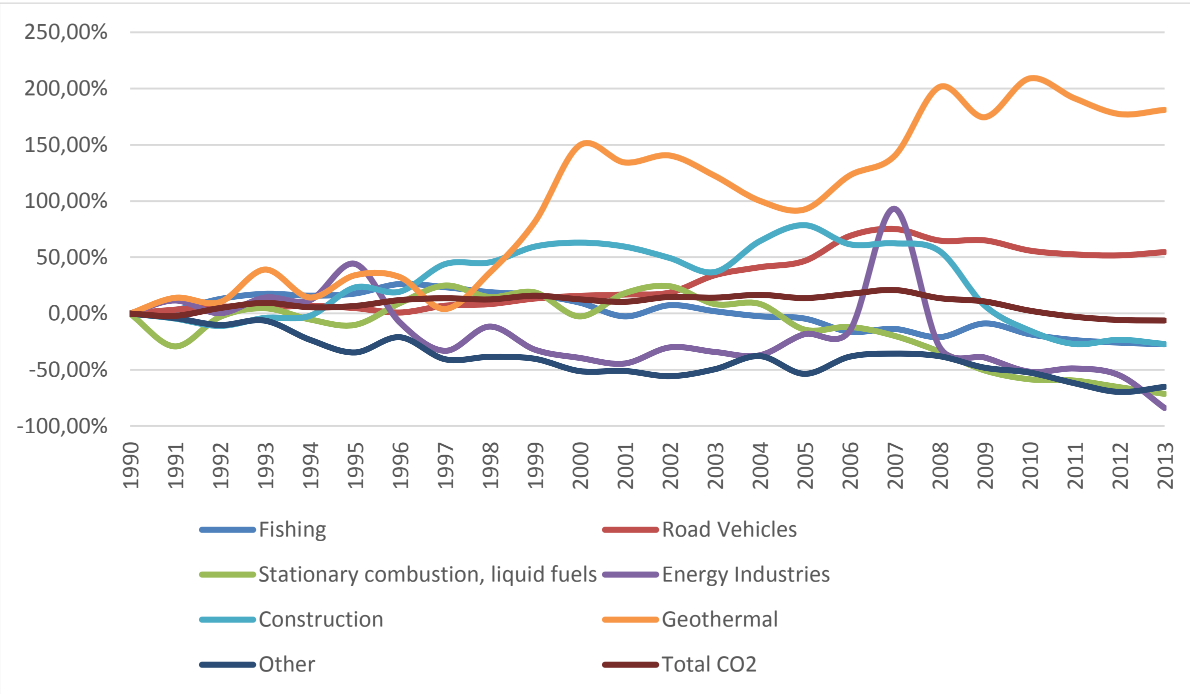


Figure 2.15. Percentage changes in emissions in various source categories in the Energy sector during the period 1990-2013, compared to 1990.

Table 2.8 and Figure 2.15 show that emissions from transport have increased by 59% since 1990 as emissions from other sectors (dominated by fishing) have decreased by 27%. Emissions from energy industries are 84% below 1990 levels and emissions from manufacturing industries and construction are 54% 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 0.4% of the sector's total and 0.2% 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 unfavourable 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 2013. Emissions from road transport have increased by 55% 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 76%. Also, the Icelandic population has grown by 26% from 1990 to 2013. Emissions from road vehicles peaked in 2007 and have decreased by 12% 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 2010-2013. 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 2013 emissions were 27% below the 1990 level and 2% below the 2012 level. Annual changes are inherent to the nature of fisheries.

Geothermal Energy

Emissions from geothermal energy utilization accounts for 4% of the total greenhouse gas emissions in Iceland in 2012. 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 2012. Electricity production using geothermal power increased more than 16-fold during this period from 283 to 5,210 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 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Geothermal energy	62	83	154	118	193	173	176

Distribution of oil products

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

2.1.8. 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 2.16* 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 2013, emissions from the industrial processes sector were 104% above the 1990 level.

Table 2.10. Emissions from industrial processes 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Mineral products	52	38	66	56	11	1	1
Chemical industry	49	43	19	NO	NO	NO	NO
Metal production	767	456	855	818	1,752	1,732	1,760
- Ferroalloys	208	243	374	375	369	408	404
- Aluminium	559	213	480	443	1,383	1,324	1,356
o Aluminium CO_2	139	154	353	417	1,238	1,244	1,268
o Aluminium PFC	420	59	127	26	146	80	88
Consumption of HFCs and SF_6	1	9	37	61	127	150	174
Total	869	546	976	935	1,890	1,883	1,942

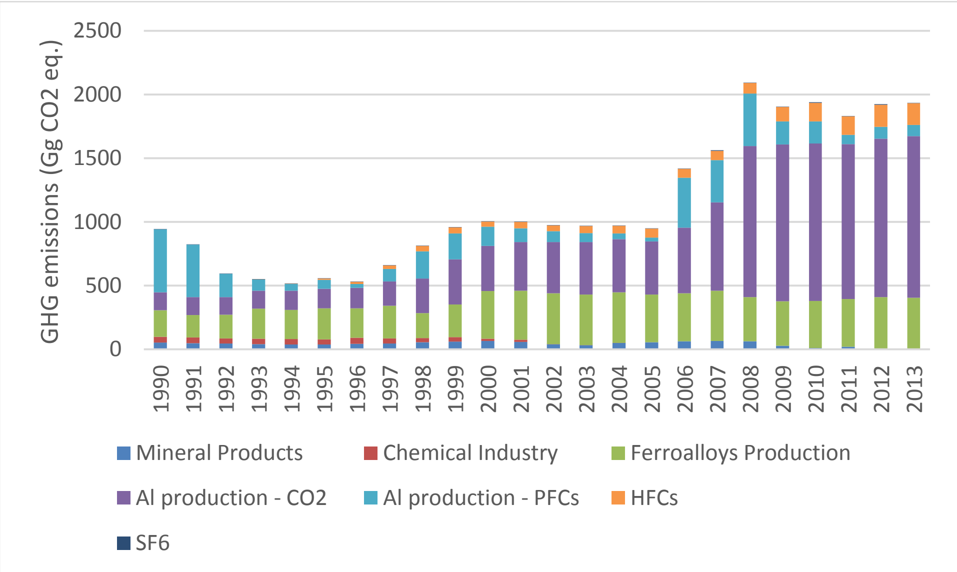


Figure 2.16. Total greenhouse gas emissions in the Industrial Process sector during the period from 1990-2013 (Gg CO_2-equivlalents).

The most significant category within the Industrial Processes sector is metal production, which accounted for 88% of the sector's emissions in 1990 and 90% in 2013. Aluminium production is the main source within the metal production category, accounting for 70% 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 0.1 tonnes CO_2-equivalents per tonne aluminium in 2013.

Production of ferroalloys is another major source of emissions, accounting for 20% of Industrial Processes emissions in 2013. 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 80% since 1990. Emissions in 2013 were 3% higher than in 2012.

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 (Gg-CO_2 equivalents).

	1990	1995	2000	2005	2010	2012	2013
HFCs (refrigeration)	0.0	9.5	42.5	69.2	145.7	171.7	171.1
SF6 (electrical equipment)	1.1	1.3	1.4	2.6	4.9	5.6	3.0

2.1.9. 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. 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 7.2 Gg CO_2-equivalents in 2013 (less than 0.1% of total GHG emissions), which was 28% below the 1990 level and 1% above the 2013 level. This development was mainly due to a decrease in paint application. Emissions from N_2O use decreased by 49% between 1990 and 2013 due to decreasing imports for medical purposes (anaesthesia).

2.1.10.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 2.18).

Since 2005 emissions from agriculture have increased by 4% due to an increase in livestock population size but still remain 15% 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 11,800 tonnes in 2013. 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 2013 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 54% of total agriculture emissions (Figure 2.17). The remaining 46% 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).

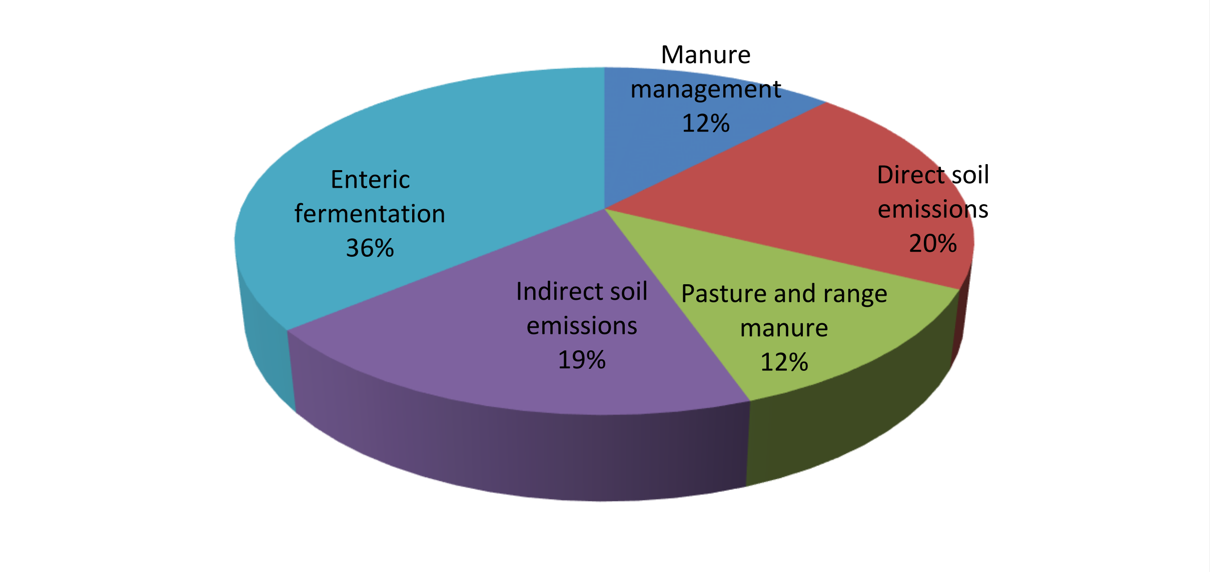


Figure 2.17. Greenhouse gas emissions from the agriculture sector 2013, distributed by source categories.

Table 2.12. Total greenhouse gas emissions from agriculture in 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Manure management	93	80	81	79	82	83	84
Direct soil emissions	149	135	143	124	131	136	129
Pasture and range manure	90	82	82	81	84	84	79
Indirect soil emissions	141	127	134	119	127	131	124
Enteric fermentation	264	244	239	232	246	244	240
Total emissions	737	667	680	635	671	678	656

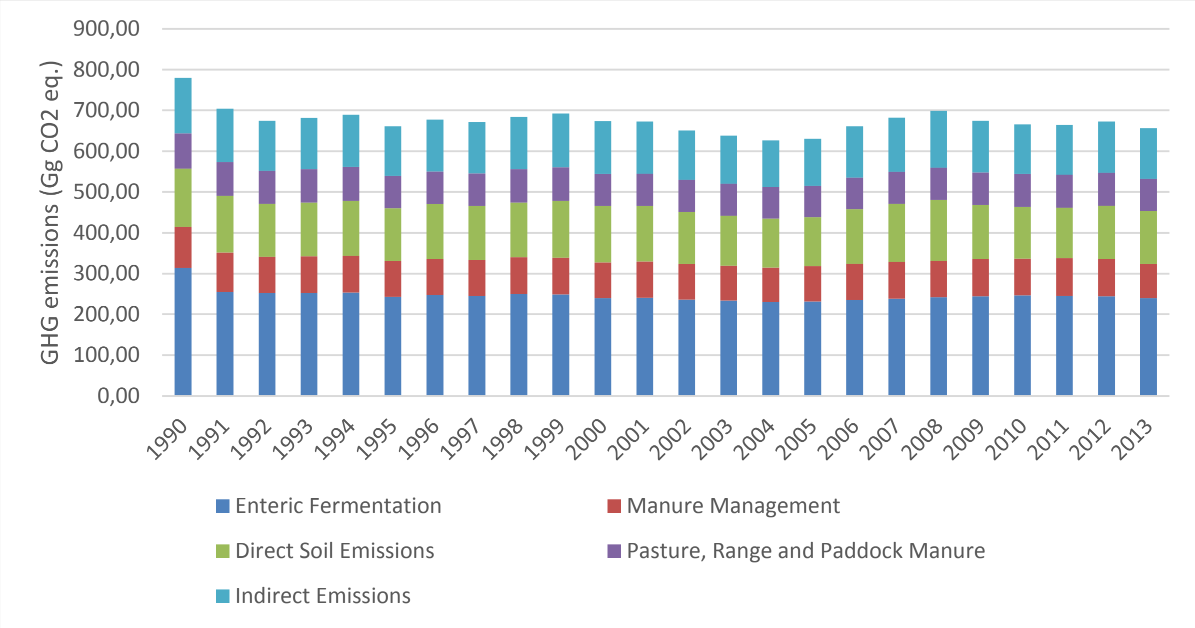


Figure 2.18. Total greenhouse gas emissions from agriculture 1990-2013, (Gg CO2-equivalents).

2.1.11. Land Use, Land-Use Change and Forestry (LULUCF)

2013 LULUCF chapter is missing, therefore the following chapter is from the 2014 submission.

Net emissions from the LULUCF sector in Iceland are high; the sector had the highest net emission 1990-2013. A large part of the absolute value of emissions from the sector in 2013 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. Emissions from the LULUCF sector from 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Forest Land	-44	-66	-100	-150	-203	-242	-265
Cropland	2,014	1,963	1,912	1,859	1,804	1,783	1,772
Grassland	8,388	8,428	8,614	8,842	9,207	9,287	9,331
Wetlands	1,125	1,129	1,109	1,082	1,043	1,034	1,030
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	11,867	11,872

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.

2.1.12. Waste

Emissions from the Waste sector accounted for 5% of total GHG emissions in 2013. About 91% of these emissions were methane emissions from solid waste disposal on land. 5,3% were CH_4 and N_2O emissions from wastewater treatment and 2,4% were CO_2, CH_4 and N_2O emissions from waste incineration. The remaining 1% 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 2.19*). 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 2013 amounted to 45%.

Table 2.14. Total emissions from the Waste sector from 1990-2013 (Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2011	2012	2013
Solid waste disposal	142	188	214	225	225	209	193	206
Wastewater	8	9	9	12	11	12	12	12
Incineration	18	12	7	5	7	9	7	5
Composting	NO	0.4	0.4	0.9	2.9	2.7	2.1	2.8
Total emissions	167	209	230	243	246	232	214	226

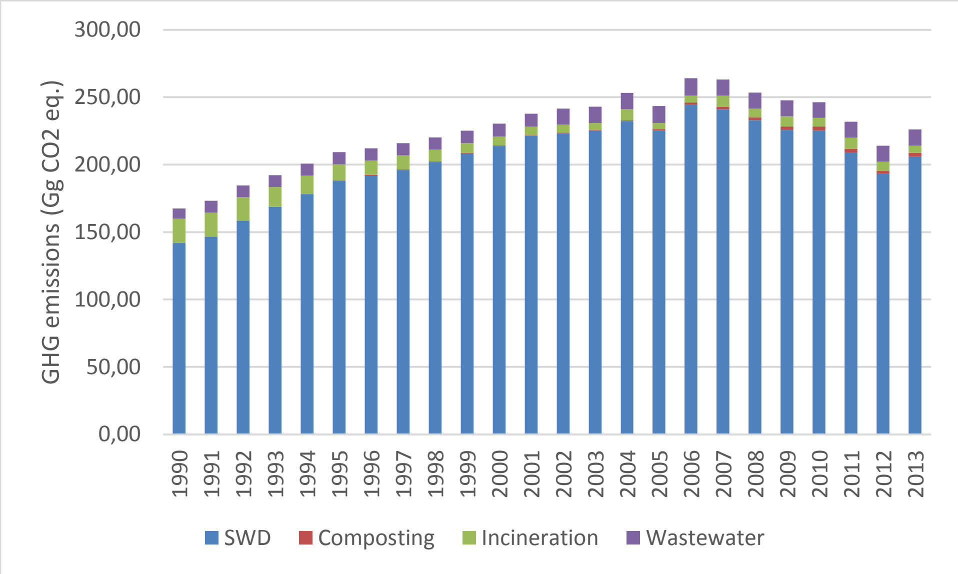


Figure 2.19. Aggregated GHG emissions of the Waste sector 1990-2013 (Gg CO_2-equivalents).

Total wastewater handling emissions increased by 52% 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 70% between 1990 and 2013 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 2.20*).

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.

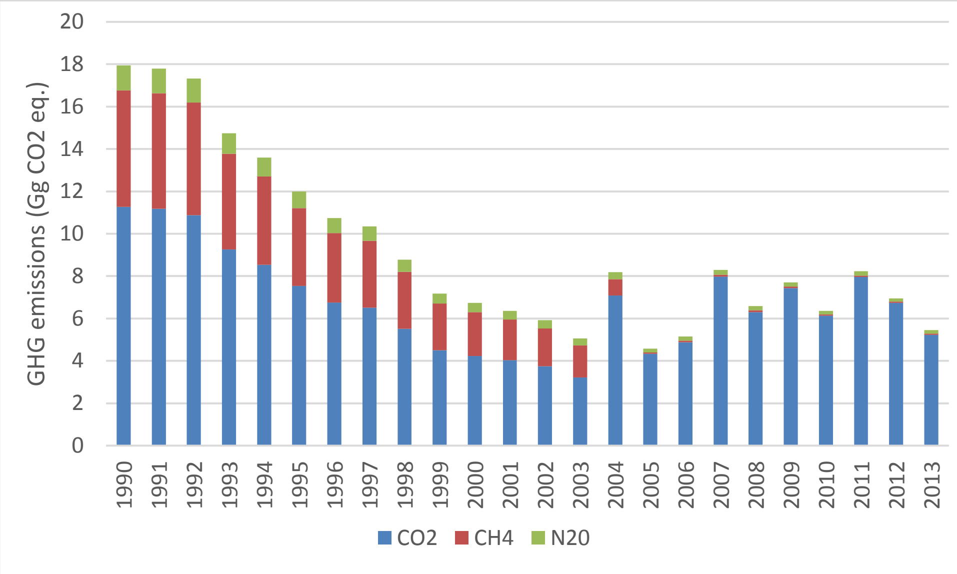


Figure 2.20. Emissions from inciniration and open burning of waste 1990-2013 (Gg CO_2-equivalents).

Emissions from composting have been steadily increasing between 1995 when composting started and 2010. Between 2010 and 2013 composting emissions decreased by 3.7% due to decreasing amounts of waste composted.

2.1.13. 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 2013, greenhouse gas emissions from ships and aircrafts in international traffic bunkered in Iceland amounted to a total of 681 Gg CO_2-equivalents, which corresponds to about 15% of the total Icelandic greenhouse gas emissions. Greenhouse gas emissions from marine and aviation bunkers increased by 111% from 1990 to 2013; with a 8% increase between 2012 and 2013.

Looking at these two categories separately, it can be seen that greenhouse gas emissions from international marine bunkers increased by 73% from 1990 to 2013, while emissions from aircrafts increased by 129% during the same period. Between 2012 and 2013 emissions from marine bunkers decreased by 6% while emissions from aviation bunkers increased by 14%. 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. Greenhouse gas emissions from international aviation and marine bunkers 1990-2013(Gg CO_2-equivalents).

	1990	1995	2000	2005	2010	2012	2013
Aviation	222	238	411	425	381	446	508
Marine	100	146	221	112	184	184	173
Total	322	384	632	538	565	630	681

2.4. 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.

2.1.14. 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 2.21. 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 2013 were 25% 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 20%) after the use of catalytic converters in all new vehicles became obligatory in 1995, despite the fact that fuel consumption has increased by 50%. 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 2013 emissions from manufacturing industry and construction were 42% 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 2012 were 23% below the 1990 level.

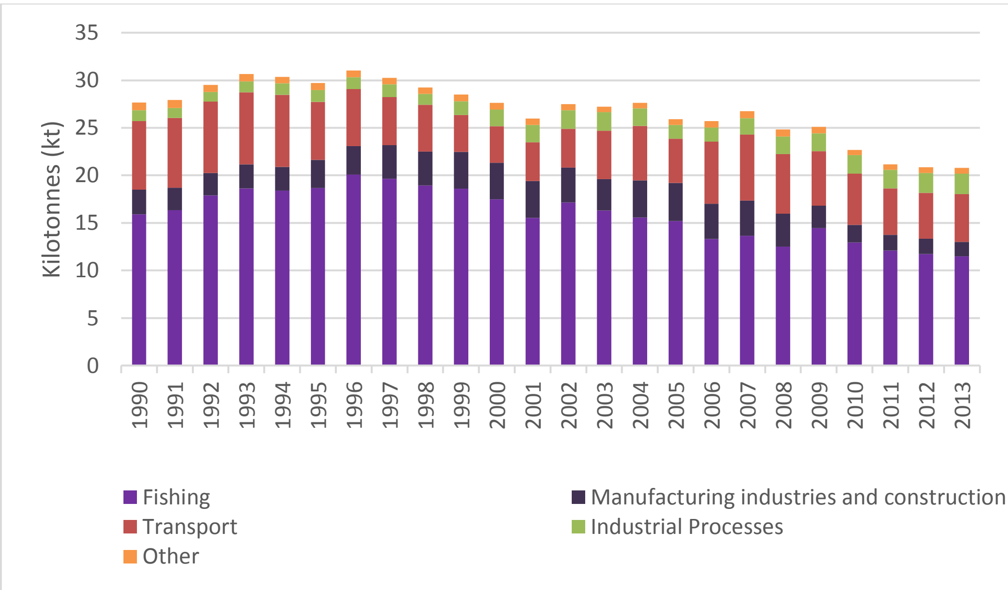


Figure 2.21. Emissions of NO_x by sector 1990-2013 in Gg.

2.1.15. 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 2.22. 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 Gg 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 2013. The emissions in 2013 were 55% below the 1990 level.

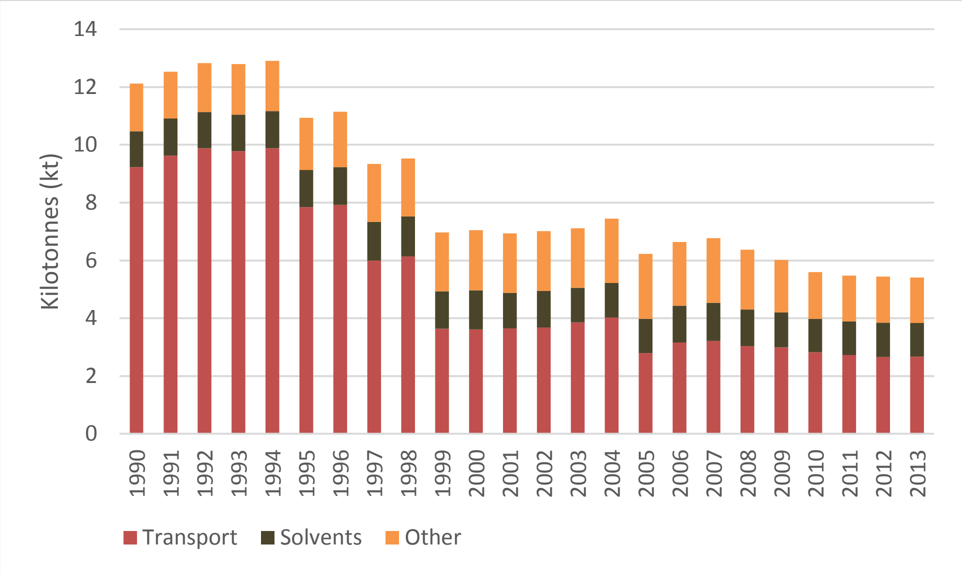


Figure 2.22. Emissions of NMVOC by sector 1990-2013 in Gg.

2.1.16. Carbon Monoxide (CO)

Transport is the most prominent contributor to CO emissions in Iceland, as can be seen in Figure 2.23. Emissions from transport are dominated by road transport. These emissions have decreased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995. Total CO emissions show, like the emissions from transport, a rapid decrease after 1990. The emissions in 2013 were 65% below the 1990 level.

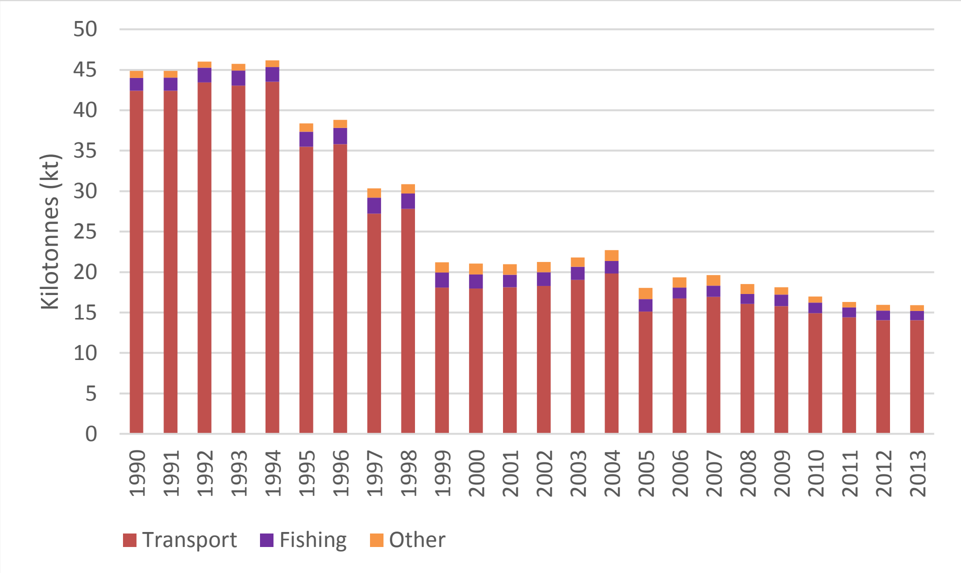


Figure 2.23. Emissions of CO by sector 1990-2013 in Gg.

2.1.17. 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 294% since 1990 due to increased activity in this field, as electricity production at geothermal power plants has increased more than 17-fold since 1990. Other significant sources of sulphur dioxide in Iceland are industrial processes, manufacturing industry and construction, as can be seen in Figure 2.24.

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 2013 840,975 tonnes of aluminium were produced at three plants and 119,609 tonnes of ferroalloys were produced at one plant. This led to increased emissions of sulphur dioxide (388% 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 77% below the 1990 level in 2013.

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 2013 were about the same as the 1990 level although fuel consumption was 27% less.

In 2013 total sulphur emissions in Iceland, calculated as SO_2, were in 237% above the 1990 level, but 163% when excluding emissions from geothermal power plants.

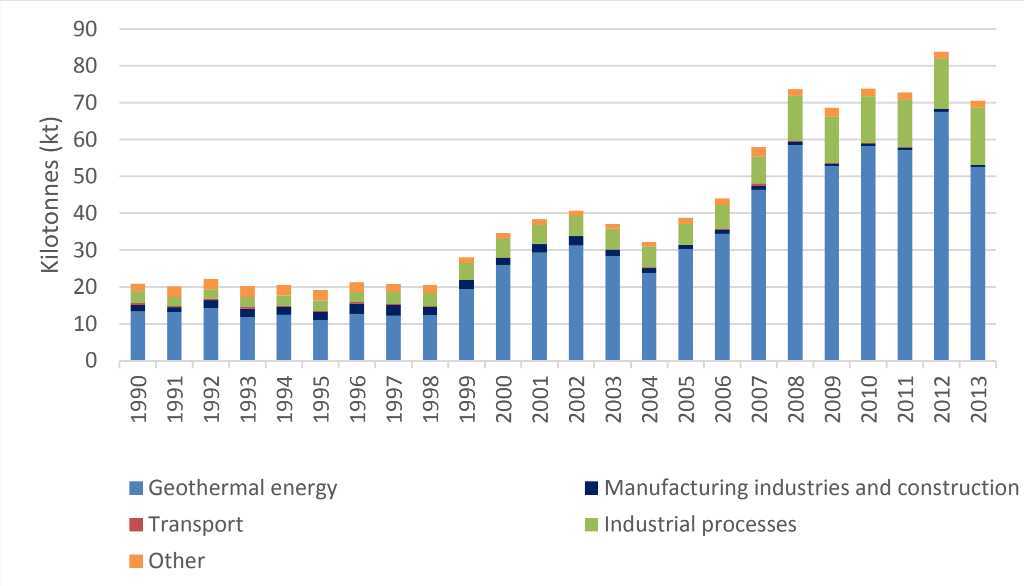


Figure 2.24. Emissions of S (sulphur) by sector 1990-2013 (Gg SO_2-equivalents).

In 2010 the volcano Eyjafjallajökull started eruption. The eruption lasted from 14th of April until 23rd of May. During that time 127 Gg of SO_2 were emitted or 71% more than total man made emissions in 2010. In 2011 the volcano Grímsvötn started erupting. The eruption lasted from 21st until 28th of May. During that time around 1000 Gg 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 2013 was around 786 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 2013. 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 0.016% of the electricity in 2013 was produced with fossil fuels.

The Energy sector accounts for 37.5% (fuel combustion 33.6%, geothermal energy 3.9%, fugitive emissions from fuels 0%) of the GHG emissions in Iceland. Total energy related emissions decreased by 6% from 1990 to 2013. Emissions from fuel combustion decreased by 12.8% from 1990 to 2013 while emissions from geothermal energy increased by 181.1%. From 2012 to 2013 the emissions from fuel combustion decreased by 0.72%, while emissions from geothermal energy increased by 1%. Total emissions related to energy decreased by 0.5% from 2012 to 2013. 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, apart from updating the Global Warming Potentials in accordance to the Fourth Assessment Report (AR4).

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 (1,090 tonnes in 2013), as would be needed for the electricity production (691 tonnes in 2013), 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 2013 there was a surplus in the energy industries category, so 399

tonnes were added to the category 10X40 House heating and swimming pools. So now the category 10X40 has 1984 tonnes in 2013 (1585+399).

- 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 2013. These values are subtracted from the adjusted 10X40 category, leaving 1684 tonnes in the category in 2013 (1984-300). This rest is then 1A4c – Residential.
- For years where there is still fuel in the category 10X90 Other (768 tonnes were left in that category in 2013), this is added to the 10X5X Industry (originally with 6807 tonnes in 2013). This is the fuel use in 1A2 – Industry (6807+768=7575 tonnes in 2013).

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 2013 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:

- Manufacturing Industries and Construction – CO_2 (1A2)
  - » This is a key source in level (1990) and trend
- Road Transport – CO_2 (1A3b)
  - » This is a key source in level (1990, 2013) and trend
- Non-Road Transport – CO_2 (1A3a/d)
  - » This is a key source in level (1990) and trend
- Residential/institutional/commercial – CO2 (1A4a/b)
  - » This is a key source in level (1990) and trend
- Fishing – CO_2 (1A4c)
  - » This is a key source in level (1990, 2013) and trend
- Fugitive emissions from fuels – CO_2 (1B)
  - » This is a key source in level (1990, 2013) and trend

3.1.3. Completeness

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

Table 3.1. 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)

3.1.5. *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 0.13% of the energy industry total and 0.05% of the total GHG emissions in Iceland in 2013.

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 3.4 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 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 0.016% 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.

3.1.6. *Main Activity Electricity and Heat Production (CRF 1A1a)*

Electricity Generation

Electricity was produced from hydropower, geothermal energy and fuel combustion in 2013 (Table 3.2) with hydropower as the main source of electricity (Orkustofnun, 2013). 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.

Table 3.2. Electricity production in Iceland (GWh).

	1990	1995	2000	2005	2010	2013
Hydropower	4,159	4,678	6,352	7,014	12,592	12,863
Geothermal	283	288	1,323	1,658	4,465	5,245
Fuel combustion	5.6	8.4	4.4	7.8	1.7	2.8
Total	**4,447**	**4,977**	**7,679**	**8,680**	**17,059**	**18,116**

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 2013 only 0.015% of the electricity in Iceland is produced with fuel combustion. Activity data for fuel combustion and the resulting emissions are given in Table 3.3.

Table 3.3. Fuel use (kt) and resulting emissions (GHG total in Gg CO_2-equivalents) from electricity production

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

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 3.4 along with sulphur content of the fuels.

Table 3.4. 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 800 g of CO_2 per kWh.

Emissions from hydropower reservoirs amounted to 18 Gg of CO_2-equivalents and emissions from geothermal power plants to 176 Gg of CO_2-equivalents, in 2013. The resulting emissions of GHG per kWh amount to 1.4 g CO_2-equivalents/kWh for hydropower plants and to 33 g CO_2-equivalents/kWh for geothermal energy. The weighted average GHG emissions from electricity production in Iceland in 2013 were thus 11 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.

Heat Plants

Geothermal energy was the main source of heat production in 2013. 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 3.5. No fuel consumption for heat production was reported by the NEA for 2010, 2011 and 2013.

Table 3.5. Fuel use (kt) and resulting emissions (GHG total in Gg CO_2-equvalents) from heat production.

	1990	1995	2000	2005	2007	2008	2009	2010	2011	2012	2013
Residual fuel oil	3.0	3.1	0.1	0.2	4.5	0.1	0.1	-	-	0.1	-
Gas/Diesel oil	-	-	-	-	-	-	-	-	-	-	-
Solid waste	-	4.7	6.1	5.4	12.0	10.3	9.5	8.2	7.5	5.8	9.4
Emissions (GHG)	**9.2**	**12.3**	**3.8**	**3.1**	**21.3**	**6.0**	**6.7**	**5.5**	**5.3**	**5.1**	

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 3.6 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 8.4.3).

Table 3.6: 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	40.19	21.10	0.99	3.08	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 sector 1A2)

Emissions from the Manufacturing Industries and Construction account for 10.1% of the Energy sector's total and 3.77% of total GHG emissions in Iceland in 2013. Mobile Combustion in the Construction sector accounts for 57.2% of the total emissions from Manufacturing Industries and the Construction sector.

3.1.7. Manufacturing Industries, Stationary Combustion

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 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 2013 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). 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 3.7 and Table 3.8). Emissions from fuel use in the ferroalloys production is reported under 1A2a, Iron and Steel.

Table 3.7. Fuel use (kt) and emissions (GHG total in Gg CO_2-equivalents) from stationary combustion in the manufacturing industry.

	1990	1995	2000	2005	2010	2011	2012	2013
Gas/Diesel oil	5.1	1.1	10.3	22.2	9.4	4.9	5.4	7.3
Residual fuel oil	55.9	56.2	46.2	25.0	16.5	17.3	17.8	13.8
LPG	0.5	0.4	0.9	0.9	1.0	1.0	1.8	0.8
Electrodes (residue)	0.8	0.3	1.5	-	0.4	-	-	-
Steam Coal	18.6	8.6	13.3	9.9	3.6	7.8	-	-
Petroleum coke	-	-	-	8.1	-	-	-	-
Waste oil	-	5.0	6.0	1.8	1.4	1.2	1.2	0
Total Emissions	**241**	**210**	**228**	**205**	**97**	**94**	**80**	**68.8**

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 3.8 along with sulphur content of the fuels.

Table 3.8. 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	18.5	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*
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

***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 3.9 gives an overview of the EFs used.

Table 3.9. 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

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.

3.1.8. Manufacturing Industries, Mobile Combustion

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 3.10.

Table 3.10. Fuel use (kt) and resulting emissions (GHG total in Gg CO_2-equivalents) from mobile combustion in the construction industry.

	1990	1995	2000	2005	2010	2012	2013
Gas/Diesel oil	38	47	62	68	32	29	27.6
Emissions	**136**	**167**	**222**	**243**	**115**	**104**	**97**

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 3.11.

Table 3.11. 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

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 47.9% of the Energy sector's total and 17.9% of the total GHG emissions in Iceland in 2013. Road Transport accounts for 95.3% of the emissions in the transport sector.

3.1.9. Civil Aviation (CRF 1A3a)

Text missing

3.1.10. 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.

Activity Data

Total use of diesel oil and gasoline are based on the NEA's annual sales statistics for fossil fuels (Table 3.12).

Table 3.12. Fuel use (kt) and resulting emissions (GHG total in Gg CO_2-equivalents) from road transport.

	1990	1995	2000	2005	2010	2011	2012	2013
Gasoline	127.812	135.601	142.599	156.730	148.214	142.688	136.84	134.941
Diesel oil	36.567	36.862	47.463	83.478	106.433	106.293	110.54	117.052
Emissions	**527**	**553**	**610**	**772**	**819**	**801**	**796**	**811**

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 2013 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 2013 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.

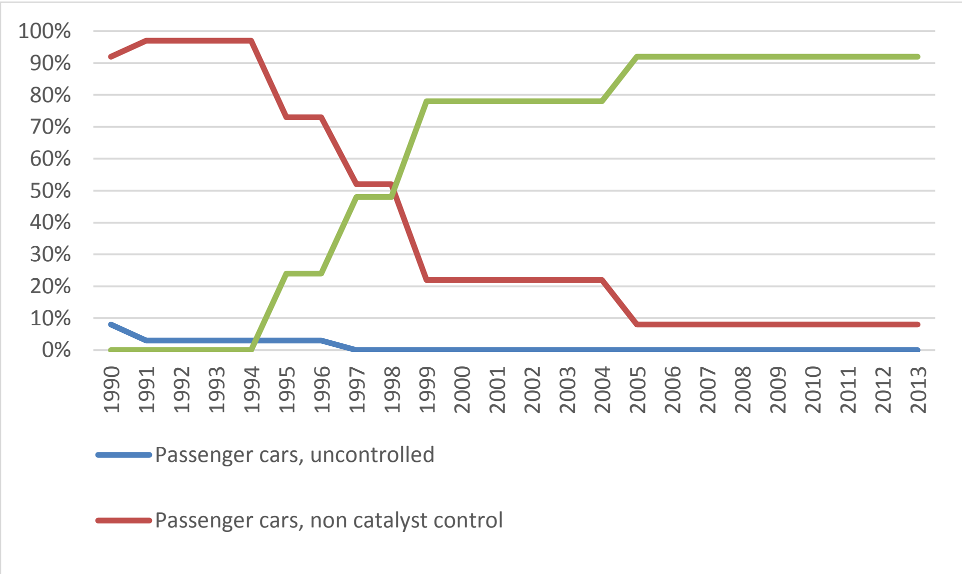


Figure 3.1. Passenger cars by emission control technology.

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 3.13.

Table 3.13. 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

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.

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 2016 submission.

3.1.11. Water-born Navigation (CRF 1A3d)

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

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 3.14.

Table 3.14. Fuel use (kt) and resulting emissions (GHG total in Gg CO_2-equivalents) from national navigation.

	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**
Gas/Diesel oil	11.749	7.043	3.425	6.199	8.464	5.526	4.142	3.725
Residual fuel oil	7.170	4.755	0.542	0.881	2.612	0.330	0.181	1.236
Emissions	**60**	**37**	**13**	**23**	**35**	**19**	**14**	**16**

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 3.15.

Table 3.15. 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	40.19	21.10	0.99	3.08	2	0.084	7	0.28

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.

3.1.12. International Bunker Fuels (1A3di)

Emissions from international aviation and marine bunker fuels are excluded from national totals as is outlined in the IPCC Guidelines.

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.

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 3.15 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 29.1 of the Energy sector's total and for 11.0% of total GHG emissions in Iceland 2013. Fishing accounted for 97% of the Other sector's total.

3.1.13. Commercial, Institutional, and Residential Fuel Combustion

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

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 3.16.

Table 3.16. Fuel use (kt) and resulting emissions (GHG total in Gg CO_2-equivalents) from the commercial/institutional sector.

	1990	1995	2000	2005	2010	2011	2012	2013
Gas/Diesel oil	1.8	1.6	1.6	1.0	0.3	0.3	0.3	0.3
Waste oil	3.3	-	-	-	-	-	-	-
LPG	0.3	0.3	0.5	0.5	0.2	0.2	0.5	0.5
Solid waste	-	0.5	0.6	0.5	0.4	0.2	0.2	0.2
Emissions	**12.3**	**6.3**	**6.8**	**4.9**	**1.7**	**1.6**	**2.5**	**2.4**

Activity data for fuel combustion in the Residential sector and the resulting emissions are given in Table 3.17. 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 utilisation 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 CO2 tax, despite the fact that it is not good for the engine. Since 2012 the CO2 tax also covers kerosene and the use decreased rapidly again.

Table 3.17. Fuel use (kt) and resulting emissions (GHG total in Gg CO_2-equivalents) from the residential sector.

	1990	1995	2000	2005	2010	2011	2012	2013
Gas/Diesel oil	8.8	6.4	6.0	3.2	1.9	1.4	1.7	1.7
LPG	0.4	0.5	0.7	0.9	1.4	0.7	0.6	1.2
Kerosene	0.5	0.2	0.1	0.2	1.2	3.2	0.1	0.2
Emissions	**30.6**	**22.1**	**21.8**	**13.6**	**14.2**	**16.6**	**7.5**	**9.5**

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 3.8 along with sulphur content of the fuels. Emissions of SO2 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 3.18 gives an overview of the used EFs.

Table 3.18. 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 8.4.3). 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.

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.

3.1.14. 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.

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 3.19.

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

	1990	1995	2000	2005	2010	2011	2012	2013
Gas/Diesel oil	174.9	191.3	211.1	171.7	128.2	120.1	116.2	112.8
Residual fuel oil	32.4	53.4	16.0	26.3	41.4	38.5	37.7	38.2
Emissions	**662.3**	**779.8**	**727.5**	**632.9**	**540.2**	**505.3**	**490.3**	**474.7**

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 3.15 above.

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

3.1.15. 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.

3.1.16. 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)

3.1.17. 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 Gg per 1000 m^3 and the CH_4 EF is 2.5E-05 Gg 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 3.20.

Table 3.20. Fuel use (kt) and resulting emissions from distribution of oil products.

	1990	1995	2000	2005	2010	2011	2012	2013
Gasoline	129.35	132.19	153.42	164.17	144.53	145.00	138.44	132.81
Jet Kerosene	78.70	72.28	146.55	139.37	120.36	141.80	148.58	167.11
Other Kerosene	0.03	0.02	0.00	0.01	0.00	0.01	0.03	0.12
Gas/Diesel oil	335.78	309.35	427.92	418.23	292.31	300.32	278.51	273.19
Residual Fuel Oil	105.96	151.92	64.08	62.90	93.05	88.71	105.92	108.85
LPG	1.29	1.32	1.68	2.46	2.62	2.51	2.59	3.07
Emissions	**0.49**	**0.50**	**0.60**	**0.60**	**0.49**	**0.51**	**0.51**	**0.52**

3.1.18. Geothermal Energy (CRF 1B2d)

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 2012). 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 et al., 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.

Key Source Analysis

The key source analysis performed for 2013 has revealed that geothermal energy is a key source in terms of both level and trend, as indicated in Table 1.1.

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 3.21 shows the electricity production with geothermal energy and the total CO_2, CH_4 and sulphur emissions (calculated as SO_2).

Table 3.21. Electricity production and emissions from geothermal energy in Iceland.

	1990	1995	2000	2005	2010	2012	2013
Electricity production (GWh)	283	288	1323	1658	4465	5210	5245
Carbon dioxide emissions (Gg)	61	82	153	116	189	170	172
Methane emissions (Gg CO_2 eq)	0.3	0.3	1.5	1.9	4.4	2.7	3.6
Sulphur emissions (as SO_2, Gg)	13	11	26	30	58	68	53

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 AND PRODUCT USE (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 2013. By 2013, emissions from the industrial processes sector were 120% 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 91% of the sector's emissions in 2013. Figure 4.1 Location of major industrial sites in Iceland shows the location of major industrial plants in Iceland.

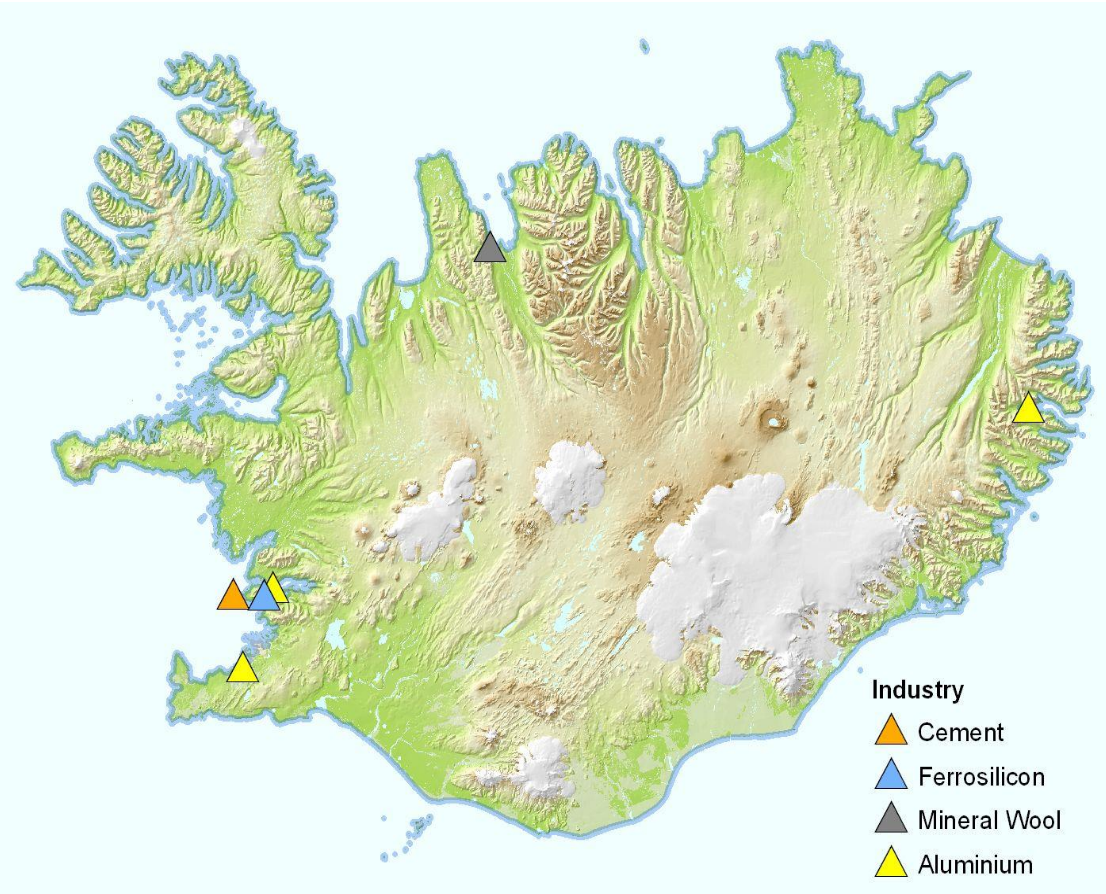


Figure 4.1 Location of major industrial sites in Iceland

Methodology

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

Key Source Analysis

The key source analysis performed for 2013 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).

- Emissions from Mineral industry – CO_2 (2A)
  - This is a key source in level (1990).
- Emissions from Chemical industry – N_2O (2B)
  - This is a key source in level (1990).
- Emissions from Ferroalloys – CO_2 (2C2)
  - This is a key source in level (1990, 2013) and trend.
- Emissions from Aluminium Production – CO_2 (2C3)
  - This is a key source in level (1990, 2013) and trend.
- Emissions from Aluminium Production – PFCs (2C3)
  - This is a key source in level (1990, 2013) and trend
- Emissions from Consumption of halocarbons and SF_6 – HFCs (2F)
  - This is a key source in level (2013) and trend

Completeness

Table 4.1 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.

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

		Greenhouse gases						Other gases			
Sector		CO_2	CH_4	N_2O	HFC	PFC	SF_6	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	Other Process Uses of Carbonates	NOT OCCURRING									
2A5	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 (IE)[2]	E	NA	NA	NA	NA	NA	NA	NA	NA	NA
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 OCCURRING									
2D2	Paraffin Wax Use	NOT OCCURRING									
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										
2F1a	Refrigeration and Stationary Air Conditioning	NA	NA	NA	E	NO	E	NA	NA	NA	NA
2F2b	Mobil 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	E	NO	E	NA	NA	NA	NA
2G2	SF_6 and PFCs from Other Product Uses	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.

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 Industy (CRF sector 2A)

4.1.1. 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 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; $EF_{cl} = 0.785 \times$ CaO content

CF_{ckd} = emissions correction factor for non-recycled cement kiln dust, dimensionless

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 4.2 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	-	-	-	-	-	-
2013	-	-	-	-	-	-

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 (EF_{cl}) 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 (CF_{ckd}) was 107.5% for all years from 1990 to 2004, 110% from 2005 - 2008 and 108% in 2009 and 2010. In 2011 the CF_{ckd} correction factor was 110%.

Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO_2 emissions from Cement Production is 8% (with an activity data uncertainty of 5% and emission factor uncertainty of 6.5%). This can be seen in the quantitative uncertainty table in Annex II.

4.1.2. 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 information from the plant for other years).

4.3. Chemical Industry (CRF sector 2B)

Other (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 Industry (CRF sector 2C)

4.1.3. Ferroalloys (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. The consumption of limestone is collected from Elkem Iceland by EA through an electronic reporting form. The emission factor is 440 kg CO_2 per tonne limestone, assuming the fractional purity of the limestone is 1.

Activity Data

The consumption of reducing agents and electrodes are collected from Elkem Iceland by EA through an electronic reporting form. Activity data for raw materials, products and the resulting emissions are given in Table 4.3.

Table 4.3. Raw materials (kt), production (kt) and resulting emissions (GHG total in Gg CO_2-equivalents) from Elkem.

	1990	1995	2000	2005	2008	2012	2013
Electrodes	3.8	3.9	6.0	6.0	4.9	5.1	5.2
Coking coal	45.1	52.4	88.0	86.9	86.7	105.1	111.0
Coke oven coke	24.9	30.1	35.8	42.6	31.8	35.4	33.7
Char coal	-	-	-	2.1	0.2	-	-
Waste wood	16.7	7.7	16.2	15.6	14.2	23.3	26.4
Limestone	-	-	0.5	1.6	2.3	2.4	2.3
Production (FeSi)	62.8	71.4	108.4	111.0	96.4	118.4	119.6
Coarse Microsilica	0.9	1.0	1.4	1.6	1.3	1.3	1.4
Fine Microsilica	13.2	15.0	21.4	24.3	19.8	20.9	23.7
Emissions	**207**	**242**	**374**	**374**	**346**	**407**	**403**

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 and 2013. 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 4.4. 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 3.60 tonne CO_2 per tonne Ferrosilicon in 2010.

Emission factors for CH_4, NO_x, and NMVOC are taken from Tables 1.7, 1.9, and 1.11 in the IPCC Guidelines Reference Manual. 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.

Table 4.4.Carbon content of raw material and products at Elkem

	1990	1995	2000	2005	2008	2012	2013
Electrodes	94%	94%	94%	94%	94%	94%	94%
Coking coal	74.8%	74.8%	79.0%	75.5%	74.6%	75.2%	72.62%
Coke oven coke	78.8%	78.8%	76.6%	73.8%	80.9%	78.7%	74.64%
Char coal	-	-	-	80.9%	84.3%	-	-
Waste wood	48.7%	48.7%	48.7%	48.7%	48.7%	48.7%	50.00%

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%

Uncertainties

The estimate of quantitative uncertainty has revealed that the uncertainty of CO2 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 CH4 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.

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.

4.1.4. Aluminum 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 (Figure 4.1 Location of major industrial sites in Iceland). 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**
- **ECF4 = SCF4 · AEM · MP**
- **and**
- **EC2F6 = ECF4 · 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

Activity Data

The EA collects annual process specific data from the aluminium plants, through electronic reporting forms. Activity data and the resulting emissions can be found in Table 4.5.

Table 4.5. Aluminium production, CO_2 emissions, PFC emissions and IEF for CO_2 and PFC from 1990-2013

Year	Aluminium production [kt]	CO_2 emissions [Gg]	PFC emissions [Gg 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	1268.3	87.7	1.51	0.10

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 2013. 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_2F_6/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.

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.

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 sector 2D)

4.1.5. Solvent use (CRF 2D3)

Overview

This chapter 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 Non-Energy Products from Fuel and Solvent Use was 4.43 Gg CO_2 equivalents. Emissions decreased by 1.6 % between 1990 and 2013 and were 4.36 Gg CO_2 equivalents in 2013 accounting for roughly 0.1% of the total greenhouse gas emissions of Iceland in 2013.

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

Key source analysis

The key source analysis performed for 2013 has revealed that the sector Non-Energy Products from Fuels and Solvent Use is neither a key source category in level nor in trend.

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.

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, 2013) and on domestic production of paint since 1998 (Icelandic recycling fund, 2013). 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 in Figure 4.2.

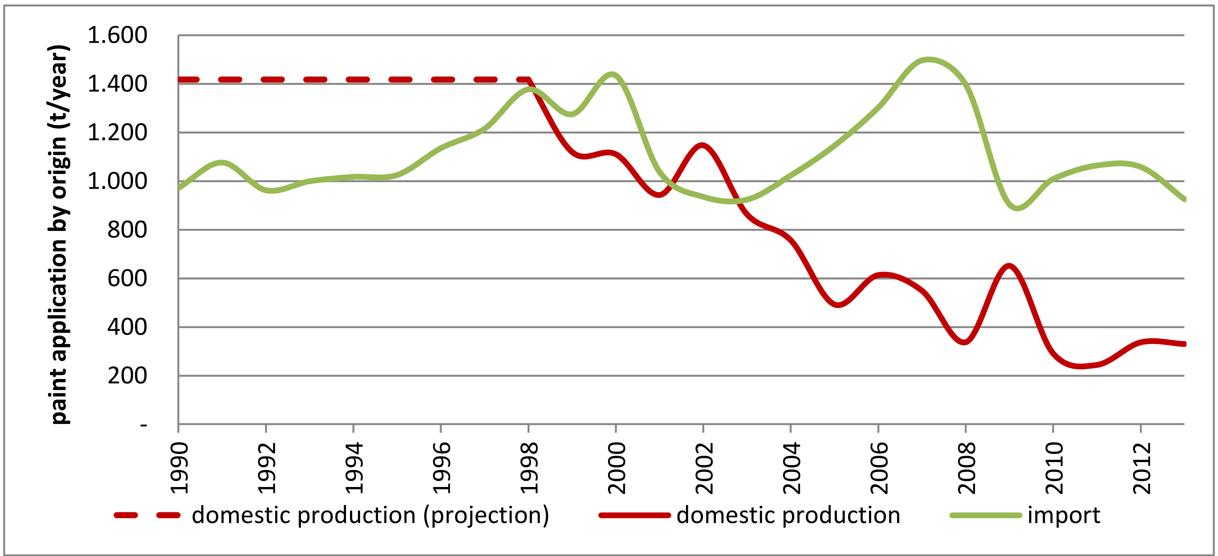


Figure 4.2 Amounts of imported solvent based paints and procduced domestically 1990-2013

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:

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

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

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.

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, 2013).

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, 2013).

Emissions

Figure 4.3 shows NMVOC emissions from the sector from 1990-2013. NMVOC emissions were around one Gg from 1990 to 1995. Between 1996 and 2008 emissions oscillated between 1.1 and 1.3 Gg. The decrease of emissions during the last four years is mainly due to decreasing emissions from paint application, printing and organic wood preservatives.

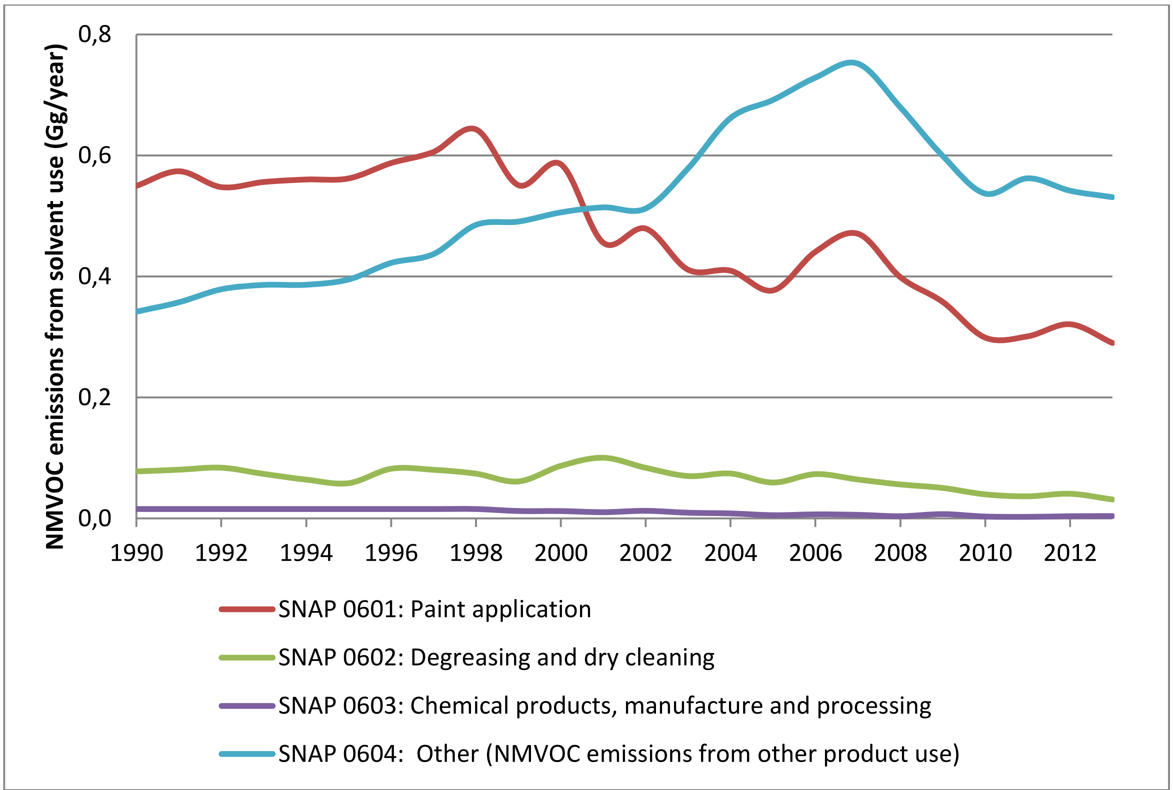


Figure 4.3. NMVOC emissions from solvent and other product use (Gg/year) from 1990-2013

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

- **Emissions from NMVOCs in CO_2-equivalents**
- **CO_2 equivalents = 0.85 • $NMVOC_t$ • 44/12**

Where:

0.85 = Carbon content fraction of NMVOC

$NMVOC_t$ = Total NMVOC emissions in the year t

44/12 = Conversion factor

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 CO_2 emission from the sector. Table 4.6 shows the uncertainties for the subsectors and the respective references.

Table 4.6. 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	50[a]	108[b]

A = expert judgement; B = EMEP GB

4.1.6. Other: Road Paving with Asphalt (CRF 2D4)

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 are taken from Table 3.1, in chapter 2.A.6 in the EMEP/EEA emission inventory guidebook (2009). 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.

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

4.1.7. 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 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 4.7. Use of HFCs in other sub-source categories is not occurring.

Table 4.7. Source category structure of product uses as substitutes for ozone depleting substances

GHG source category	GHG sub-source category		Further specification
2F1 Refrigeration and Air Conditioning	Refrigeration and Stationary Air Condition (2F1a)	Domestic Refrigeration	
		Commercial Refrigeration	Combination of stand-alone and medium & large commercial refrigeration
		Transport Refrigeration	Reefers
			Fishing vessels
		Industrial Refrigeration	Food industries such as fish farming, meat processing, and vegetable production
		Residential and Commercial AC, including heat pumps	
	2F1b Mobile Air Conditioning (MAC) (2F1b)		Passenger cars
			Trucks
			Coaches

2F4 Aerosols	Metered Dose Inhalers (MDI)

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.

4.1.8. *Refrigeration and Air Conditioning (CRF 2F1)*

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.

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 2012 and the sum of all sub-source emissions until 2012 and the amount allocated to the sub-sources 2013 stock. This difference had to be zero.

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 is the EA aware that this method simplifies the sector. Figure 4.4 shows the quantity of HFCs introduced to Iceland in bulk between 1993 and 2013.

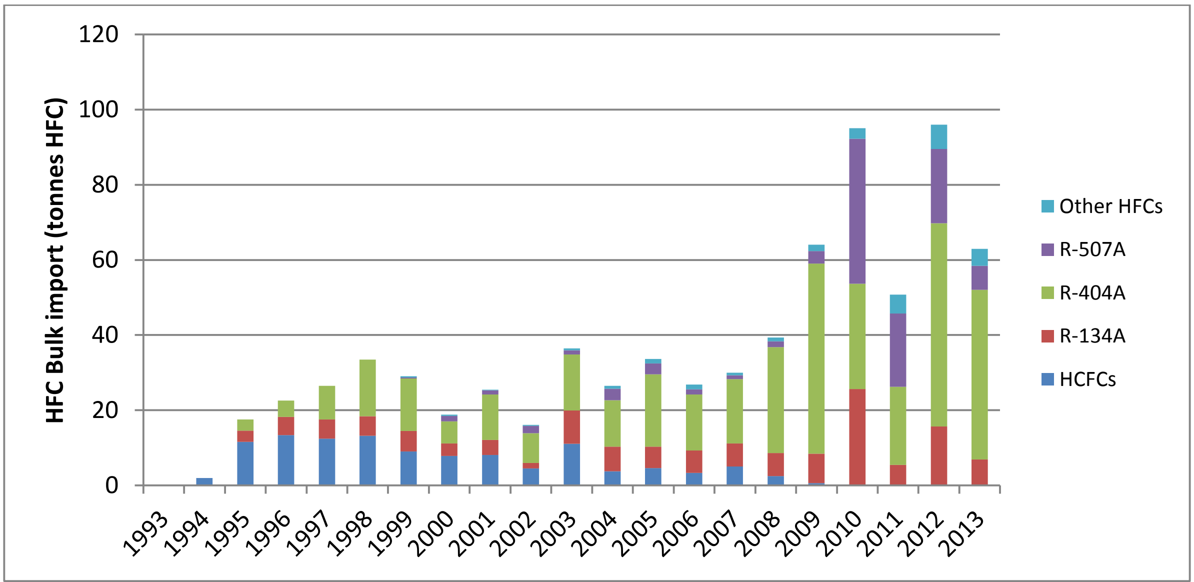


Figure 4.4. Quantity of HFCs imported in bulk to Iceland between 1993 and 2013.

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).

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 4.13.

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 4.8.

The calculation of disposal emissions requires information on the average lifetime n of equipment. 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 4.8.

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 4.8. *Values used for charge, lifetime and emission factors for stationary refrigeration equipment and mobile air conditioning. Sources for the majority of values are taken for the 2006 IPCC Guideline, Tables 7.9 pages 7.52.*

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.

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 Gg in 2013 which is 0.4% decrease compared to 2012 emissions (Figure 4.5).

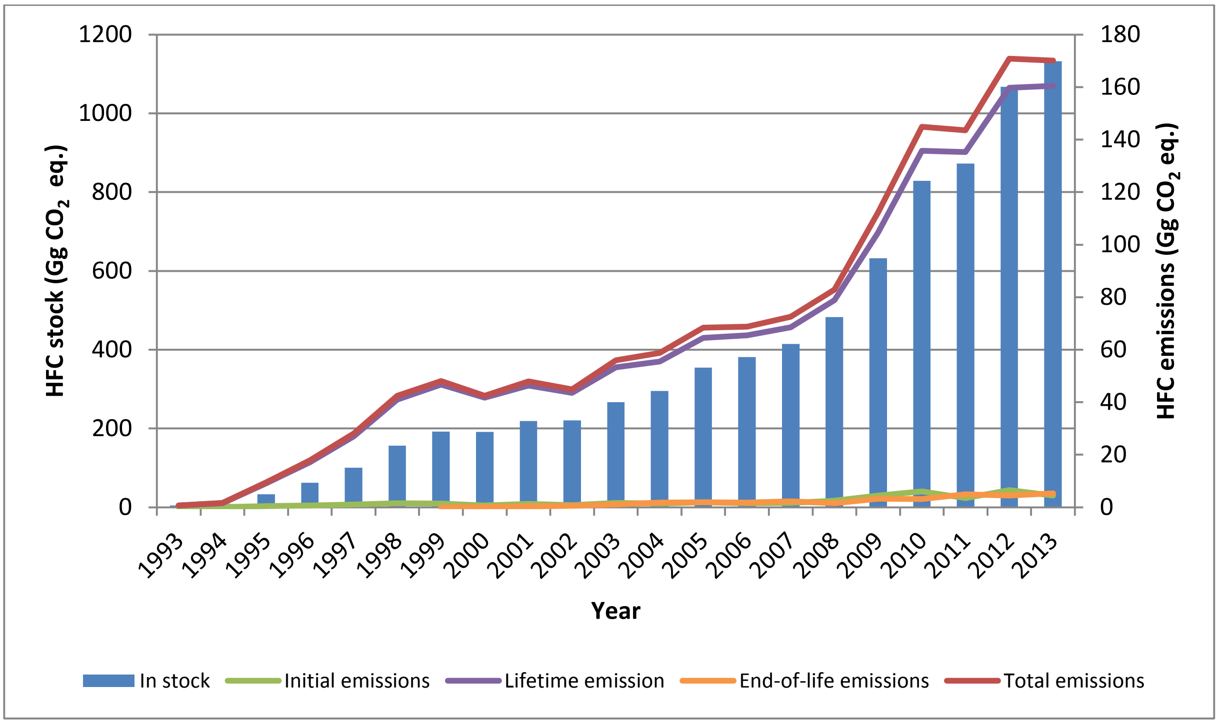


Figure 4.5. HFC stock (primary y-axis) and emissions (secondary y-axis) from refrigeration and air conditioning equipment. Included are domestic refrigeration, commercial refrigeration, industrial refrigeration (fishing vessels and reefers), residential ACs and MACs.

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 emissions stem from refrigeration systems on fishing vessels. Total transport refrigeration emissions, i.e. including reefers, account for 66.5% of all HFC emissions. Other important sectors are industrial refrigeration (16.4%), commercial refrigeration (12.6%), and MACs (4.2%). 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).

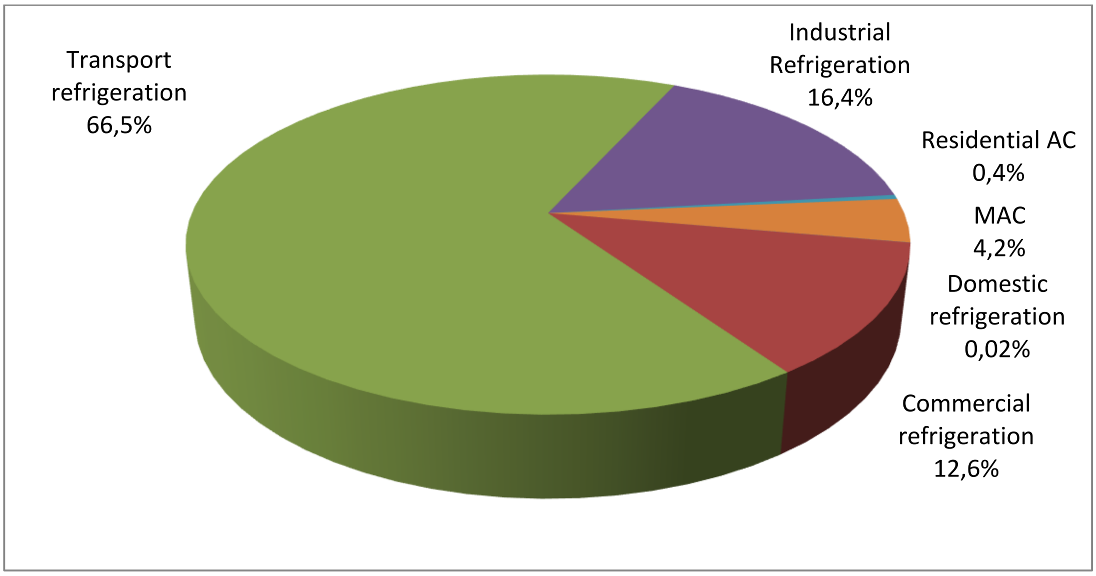


Figure 4.6. 2013 emission distributions of refrigeration and AC sub-source categories

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 2012 and 2013 (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.

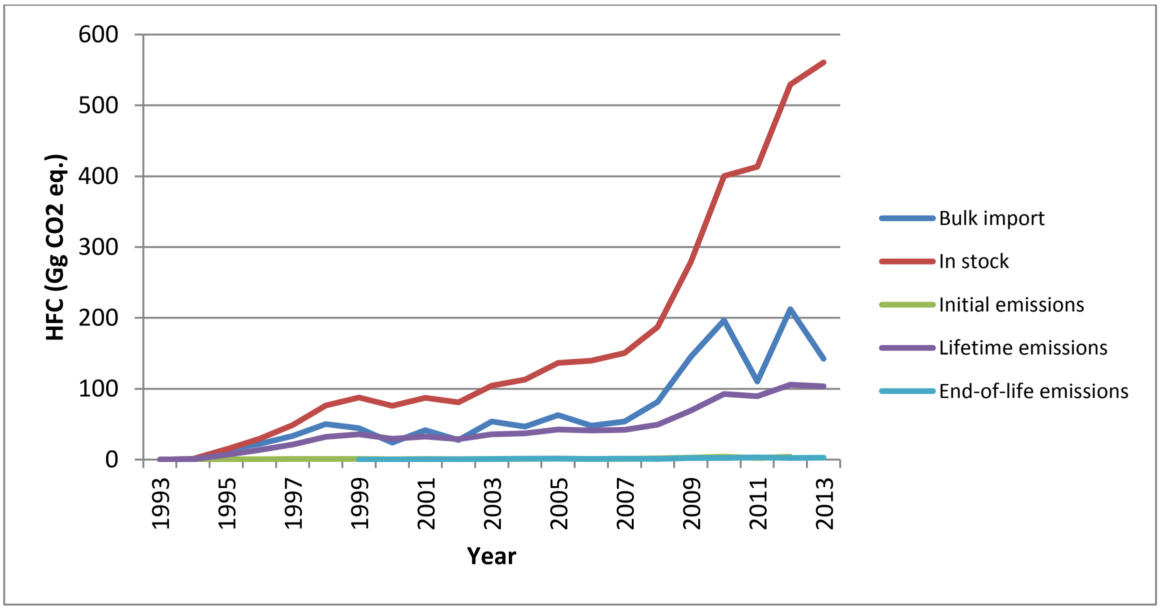


Figure 4.7. Import, stock development and emissions from refrigeration systems on fishing vessels between 1993 and 2013.

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.

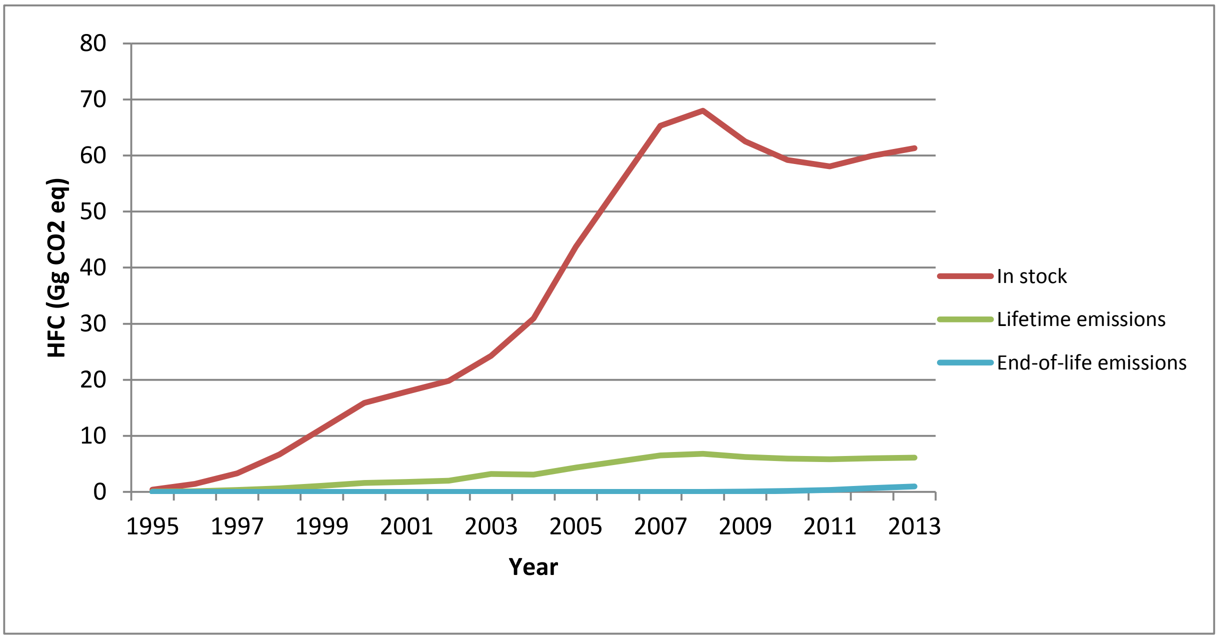


Figure 4.8. Emissions from mobile air conditionings

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 4.9.

Table 4.9. Lifetime EFs used along with EF ranges given in the GPG; calculated EF uncertainties and estimated AD uncertainties as well as 2012 emission shares used to weight uncertainties.

Value ranges (Lifetime EF)	EF, lower bound	EF, upper bound	Lifetime EF used	EF uncertainty (%)	AD uncertainty (%)	2013 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

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 2013 and 2014 submissions. Refilling of HFC amounts leaked from reefers between 1993 and 1995 had not been dealt with in the 2013 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 Gg CO2 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 Gg CO_2 eq.

4.1.9. 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).

Methodology

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

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.

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.

Emissions

Emissions from MDIs in 2013 were 0.83 Gg CO_2 eq. which equals the 2012 emissions.

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)

4.1.10. Electrical Equipment (CRF 2G1)

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 SF6 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

SF6 emissions amounted to 123.3 kg in 2013 which is tantamount to 4.0 Gg CO2 eq. or less than 0.2% of Iceland´s total GHG emissions in 2013. Emissions increased by 138% since 1990. However, this increase is slightly less than proportional compared to the net increase in SF_6 nameplate capacity since 1990.

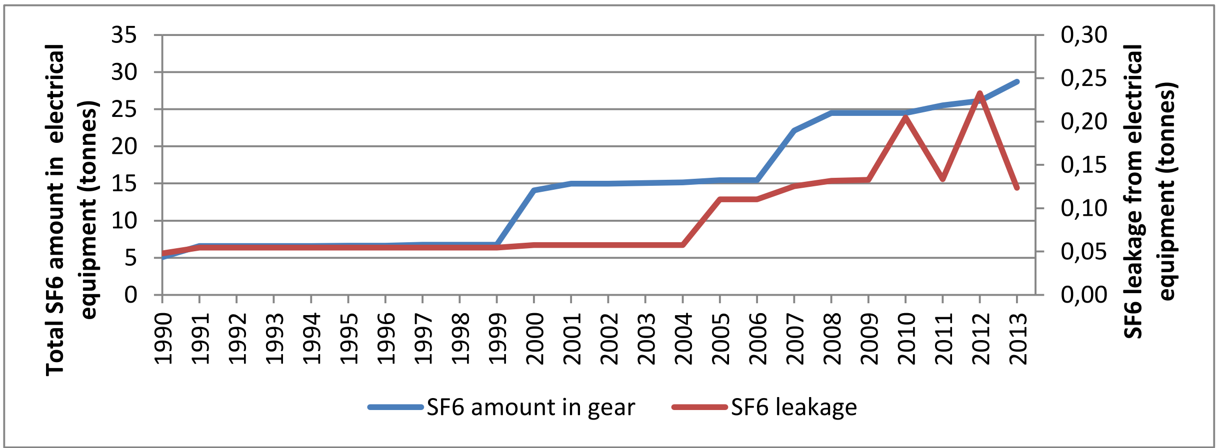


Figure 4.9 shows both nameplate capacity development and emissions between 1990 and 2013. The spike in 2010 is caused by two unrelated incidents during which switchgear was destroyed and SF_6 emitted. The spike in 2012 is caused by an increase of emissions from Landsnet LLC.

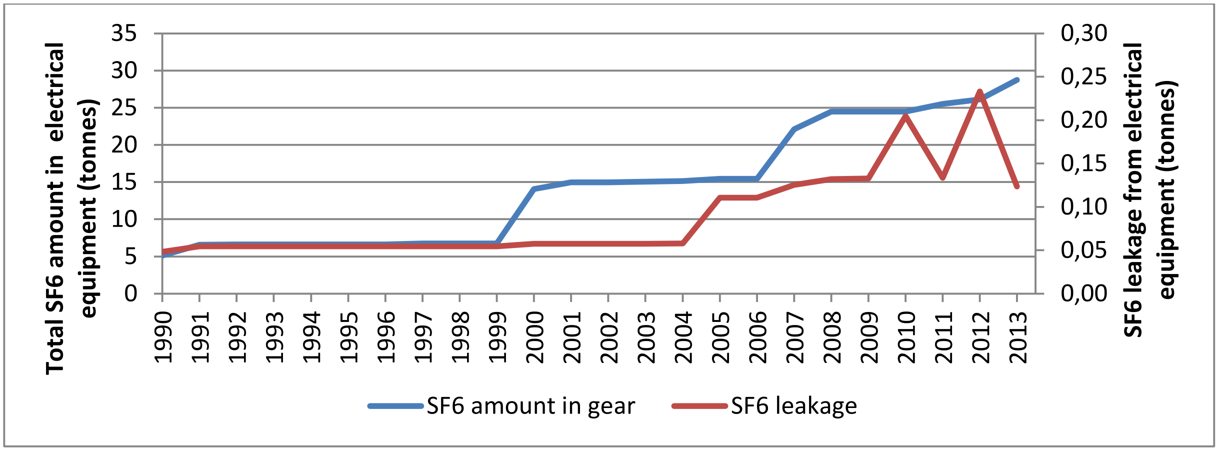


Figure 4.9. Total SF_6 amounts contained in and SF_6 leakage from electrical equipment (tonnes).

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 2012 and 2014 submissions.

4.1.11. N_2O from Product Use (CRF 2G3)

Medical Applications (2G3a)

Other(2G3c)

N_2O 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**
- **EN2O (t) = Σi { [0.5 • Ai(t) + 0.5 • Ai(t-1)] • 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 8.6 tonnes N_2O in 2013.

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%.

4.1.12. Other: Tobacco combustion (CRF 2G4)

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

4.8. Other (CRF sector 2H)

4.1.13. Food and Beverages Industry (CRF 2H2)

Other production in Iceland is the Food and Beverages Industry. NMVOC emissions from this sector are estimated. Production statistics were obtained from Statistics Iceland for beer, fish, meat and poultry for the whole time series (Figure 4.10). Production of bread, cakes and biscuits was estimated from consumption figures (Þorgeirsdóttir et al., 2012). Emission factor for NMVOC were taken from the EMEP/EEA air pollutant emission inventory guidebook (EMAP/EEA, 2013).

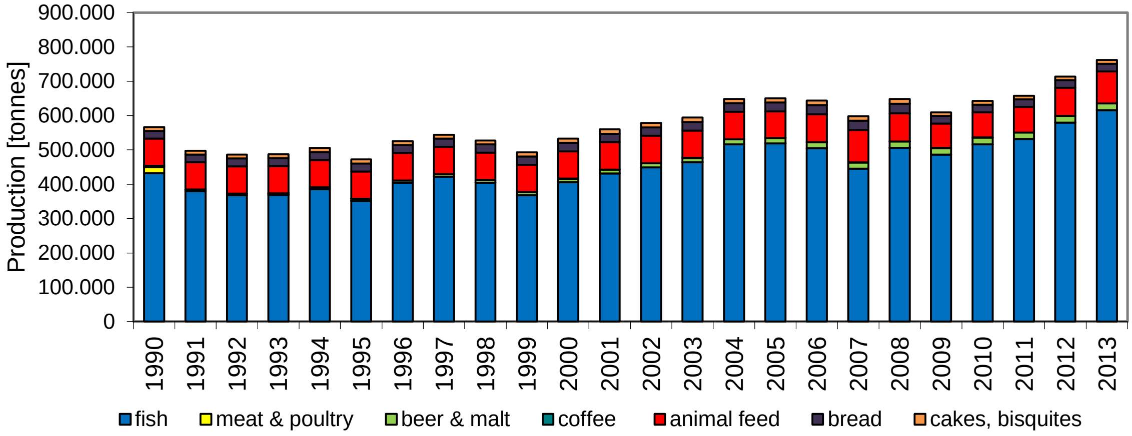


Figure 4.10. Food and beverages production in Iceland.

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.

Total methane emissions from agriculture amounted to 12.61 Gg in 2013; total nitrous oxide emissions to 0.89Gg. Thus combined CH4 and N2O emissions amounted to 648 Gg CO_2-eq. in 2013. Aggregated agriculture emissions were 779.53 Gg CO_2-eq. in 1990. The 17% decrease 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. 88% of CH_4 emissions were caused by enteric fermentation, the rest by manure management. 77% 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 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 GPG. 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 2013 (Table 1.1) revealed the following greenhouse gas source categories from the agriculture sector to be key sources in terms of total level and/or trend:

- Emissions from Enteric Fermentation, Cattle – CH_4 (3A1a)
  This is a key source in level (1990 and 2013)
- Emissions from Enteric Fermentation, Sheep – CH_4 (3A1c)
  This is a key source in level (1990 and 2013) and trend
- Emissions from Manure Management – N_2O (3A2)
  This is a key source in level (1990 and 2013) and trend
- Direct Emissions from Agricultural Soils – N_2O (3C4)
  This is a key source in level (1990 and 2013) and trend

- Pasture, Range, and Paddock Manure – N_2O (3C6)
  This is a key source in level (1990 and 2013)
- Indirect Emissions from Agricultural Soils – N_2O (3C5)
  This is a key source in level (1990 and 2013)

5.1.3. *Completeness*

Table 5.1 gives an overview of the IPCC source categories included in this chapter and presents the status of emission estimates from all sub-sources in the Agricultural sector.

Table 5.1. Agriculture – completeness (E: estimated, NE: not estimated, NA: not applicable, NO: not occurring).

Sources	CO_2	CH_4	N_2O
Enteric Fermentation (3A1)	NA	E	NA
Manure Management (3A2)	NA	E	E
Rice Cultivation (3C7)	Not Occurring		
Agricultural Soils (3C4,5)			
Direct Emissions	NA	NA	E
Animal Production	NA	NA	E
Indirect Emissions	NA	NA	E
Other	Not Occurring		
Prescribed burning of Savannas (3B)	Not Occurring		
Field burning of Agricultural Residues (4F)	Not Occurring		
Other (4G)	Not Occurring		

5.2. Activity data

5.1.4. *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 (3% in 2013), they are considerably higher for sheep and poultry (56 and 117%, respectively). Number of swine, however, is eleven times higher in the NIR than in the national census. The national census was incomplete for the year 2013 due to lack of participation from farmers. In the cases where the census was incomplete, mainly poultry and horses trend projection were used to estimate population data.

5.1.5. 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 5.2 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 5.2. 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 replacement1	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 5.3 shows national parameters that were used to calculate gross energy intake for cattle in 2013. Not all parameters have been constant over the last two decades. The ones that have changed during that time period are listed with the range for the respective parameter (see: chapter 5.1.7).

Table 5.3. Animal performance data used in calculation of gross energy intake for cattle in 2012. Where time dependent data is used, the range of data is shown in brackets below the 2010 value (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	8.7 (9 - 8.7)	1	8.1	10.91	12
Months on pasture	3.3 (3 – 3.3)	11	3.9	1.1	0
Mature body weight (kg)	430	500	430	5152	5152
Daily weight gain (kg)	NO	NO	0.5	0.53	0.5
Kg milk per day	14.9 (11.3 – 15)	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 5.4 shows national parameters that were used to calculate gross energy intake for sheep in 2013.

Table 5.4. Animal performance data used in calculation of gross energy intake for sheep from 1990-2010 (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	6.6	6.6	6.6	0
Months on flat pasture	2	2	2	1.1
Months on hilly pasture	3.4	3.4	3.4	3.4
Body weight at weaning (kg)	22	22	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	0.1851	NA	0.551	NA
Double birth fraction	0.721	NA	0.141	NA
Triple birth fraction	0.061	NA	NO	NA
Annual wool production (kg)	3	2.5	1.5	1.5
Digestible energy (in % of gross energy)	69	69	69	69

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.

5.1.6. Feed characteristics and gross energy intake

In preparation of the 2015 submission characteristics of cattle and sheep feed were revised. They now built on information 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 5.5 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 2015 submission.

Table 5.5. Dry matter digestibility, digestible energy and ash content of cattle and sheep feed.

	DMD (%)	DE (%)	Ash in feed (%)
mature dairy cows	74.4	68.2	6.9
cows used for producing meat	74.4	68.1	7.0
heifers	74.4	68.2	7.1
steers used principally for producing meat	72.5	66.3	7.2
young cattle	79.7	73.4	7.6
mature ewes	70.5	64.3	7.0
other mature sheep	70.5	64.3	7.0
animals for replacement	70.5	64.3	7.0
lambs	83.5	77.2	7.4

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: chapter 5.1.7). The GE of mature dairy cattle has increased from 200 MJ/day in 1990 to 236 MJ/day in 2012. 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 5.6 t in 2013.

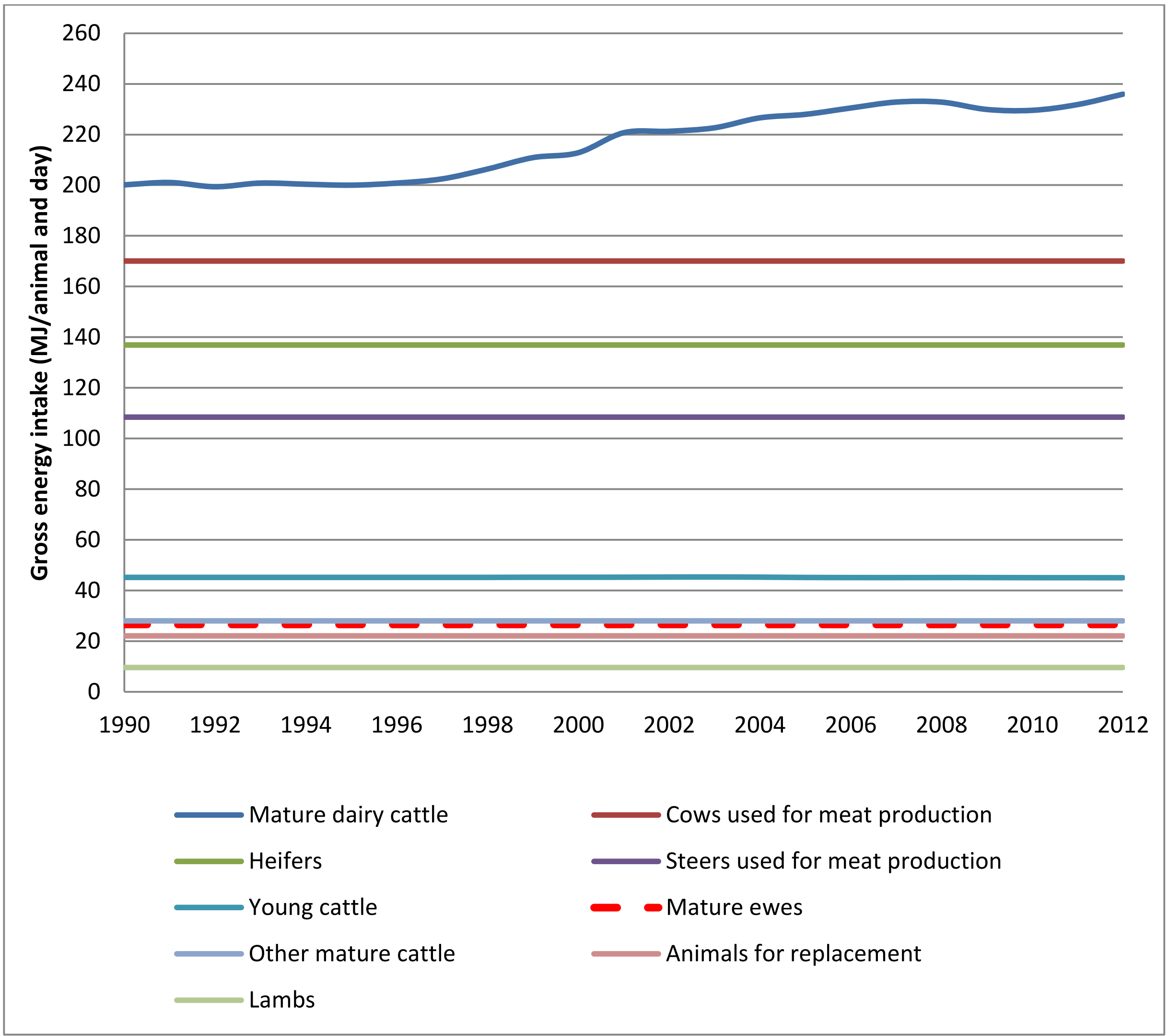


Figure 5.1. Gross energy intake (MJ/day) for cattle and sheep subcategories from 1990-2012.

5.1.7. Planned improvements

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.

5.3. CH_4 emissions from enteric fermentation in domestic livestock (4A)

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).

5.1.8. 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:

- **Equation 10.21**
- **Emission factor development**
- **EF = (GE * Y_m * 365 days/yr) / (55.65 MJ/kg CH_4)**

Where:

EF = emission factor, kg CH4/head/yr

GE = gross energy intake, MJ/head/day

Ym = 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 5.6).

Table 5.6. Methane conversion rates for cattle and sheep (IPCC, 2006).

Category/subcategory	Cattle	Mature sheep	Lambs (<1 year old)
Ym	0.065	0.065	0.045

For pseudo-ruminant and mono-gastric animal species methane emission factors were taken from the 2006 Guidelines. Dvalues 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.

5.1.9. 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 5.7 are solely based on fluctuations in population size. The population size of mature dairy cattle has decreased by 23% between 1990 and 2013. Methane emissions, however, have only decreased by 11.7% from 2.6 Gg to 2.3 Gg 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 17% between 1990 and 2013 (from 4.4 to 3.6 Gg). 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 Gg methane in 1990 to 1.41 Gg methane in 2013 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 Gg in 1990 to 11.6 Gg in 2011, or by 7.3% (Table 5.7).

Table 5.7. Methane emissions from enteric fermentation from agricultural animals for years 1990, 1995, 2000, 2005 and 2011-2013 in t methane.

livestock category	1990	1995	2000	2005	2011	2012	2013
mature dairy cattle	2,540	2,395	2,267	2,201	2,341	2,299	2,284
cows used for producing meat	0	49	64	91	110	115	115
heifers	247	689	343	362	352	365	373
steers used for producing meat	766	656	847	650	801	789	731
young cattle	358	247	319	322	358	351	333
mature ewes	5,437	4,541	4,553	4,397	4,558	4,578	4,512
other mature sheep	171	159	156	144	150	146	149
animals for replacement	651	535	582	604	649	650	648
lambs	987	823	831	808	841	844	833
swine	44	47	48	57	65	66	46
horses	1,332	1,447	1,364	1,382	1,442	1,408	1,021
goats	2	2	3	3	5	6	6
fur animals	5	4	4	4	4	4	6
poultry	13	7	11	15	16	16	16
total methane emissions	12,553	11,601	11,390	11,041	11,691	11,635	11,062
emission reduction (year-base year)/base year		-7.6%	-9.3%	-12.0%	-6.9%	-7.3%	-11.9%

5.1.10. Recalculations

5.1.11. 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 (3A)

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).

5.1.12. 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. chapter 6.2.3). Equation 4.16 from the GPG was used.

- **Equation 10.24**
- **Volatile solid excretion rates**
- **VS = GE * (1 kg-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.

- **Equation 10.23**
- **Emission factor from manure management**
- **$EF_i = VS_i * 365 \text{ days/year} * B_{oi} * 0.67 \text{ kg/m}^3 * \Sigma(j) MCF_j * MS_{ij}$**

Where:

EFi = annual emission factor for defined livestock population i, in kg

VSi = daily VS excreted for an animal within defined population i, in kg

Boi = maximum CH_4 producing capacity for manure produced by an animal within defined

population i, m^3/kg of VS

MCFj = CH_4 conversion factors for each manure management system j

MSij = 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 5.8. 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

5.1.13. 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 5.9).

Table 5.9. 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 5.10.

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

livestock category	emission factor 2013	emission factor range 1990-2013	source
	(kg CH4/head year)	(kg CH4/head year)	
mature dairy cattle	28.00	24.4-28.0	LPS
cows used for producing meat	2.65		LPS
heifers	10.70		LPS
steers used for producing meat	11.84		LPS
young cattle	4.24	4.24-4.27	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	1.56		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

5.1.14. Emissions

As can be seen in Table 5.10 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 emissions from manure management are 23% lower in 2013 compared to 2012. This decrease may be due the lack of good population data for 2013 but a decrease in livestock population of horses, sheep and cows play a part.

Table 5.11. Methane emissions from manure management in tons.

livestock category	1990	1995	2000	2005	2011	2012	2013
mature dairy cattle	793	742	696	671	706	693	689
cows used for producing meat	0.0	2.0	2.5	3.6	4.3	4.6	4.6
heifers	49	137	68	72	70	72	74
steers used for producing meat	213	182	235	180	222	219	219
young cattle	86	59	76	77	86	84	80
mature ewes	439	367	368	355	368	370	370
other mature sheep	14	13	13	12	12	12	12
animals for replacement	74	60	66	68	73	73	73
lambs	16	13	14	13	14	14	13
swine	89	93	97		262	262	183
horses	103	112	106	107	112	109	
goats	0.1	0.1	0.1	0.1	0.1	0.2	
fur animals (minks and foxes)	32	26	28	25	28	27	
rabbits	0.1	0.0	0.1	0.0	0.0	0.0	
poultry	53	28	43	60	63	61	
total methane from manure management	1960	1836	1810	1760	1890	1872	
emission reduction (year-base year)/base year		-6.4%	-7.7%	-10.2%	-3.6%	-4.5%	

5.1.15. Recalculations

5.1.16. 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

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

5.1.17. 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).

- **EQUATION 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 5.1.12. 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 5.9.

Average annual nitrogen excretion rates were calculated using 2006 GL default values (Table 5.12). 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 2000-2013. 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 5.12. 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			4.6
foxes			12.1
rabbits			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.

5.1.18. 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.

5.1.19. Emissions

N_2O emissions from the manure management systems liquid/slurry and solid storage amounted to 134 tonnes N_2O in 2013 and 168 tonnes in 1990 (-20%).

Emissions from liquid systems make up only a small part of total emissions from managed systems or only 8% of total emissions from manure management systems in 2013. 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 2013, followed by solid storage of poultry manure (11.5%), horse manure (6.8%), and fur animal manure (4.2%).

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 2013 N_2O emissions from manure spread on pasture by livestock amounted to 270 tonnes or almost twice as much as aggregated emissions from liquid systems and solid storage. Emissions from sheep manure were 181 tonnes, emissions from horse manure were 60 tonnes, and emissions from cattle manure amounted to 28.5 tonnes N_2O.

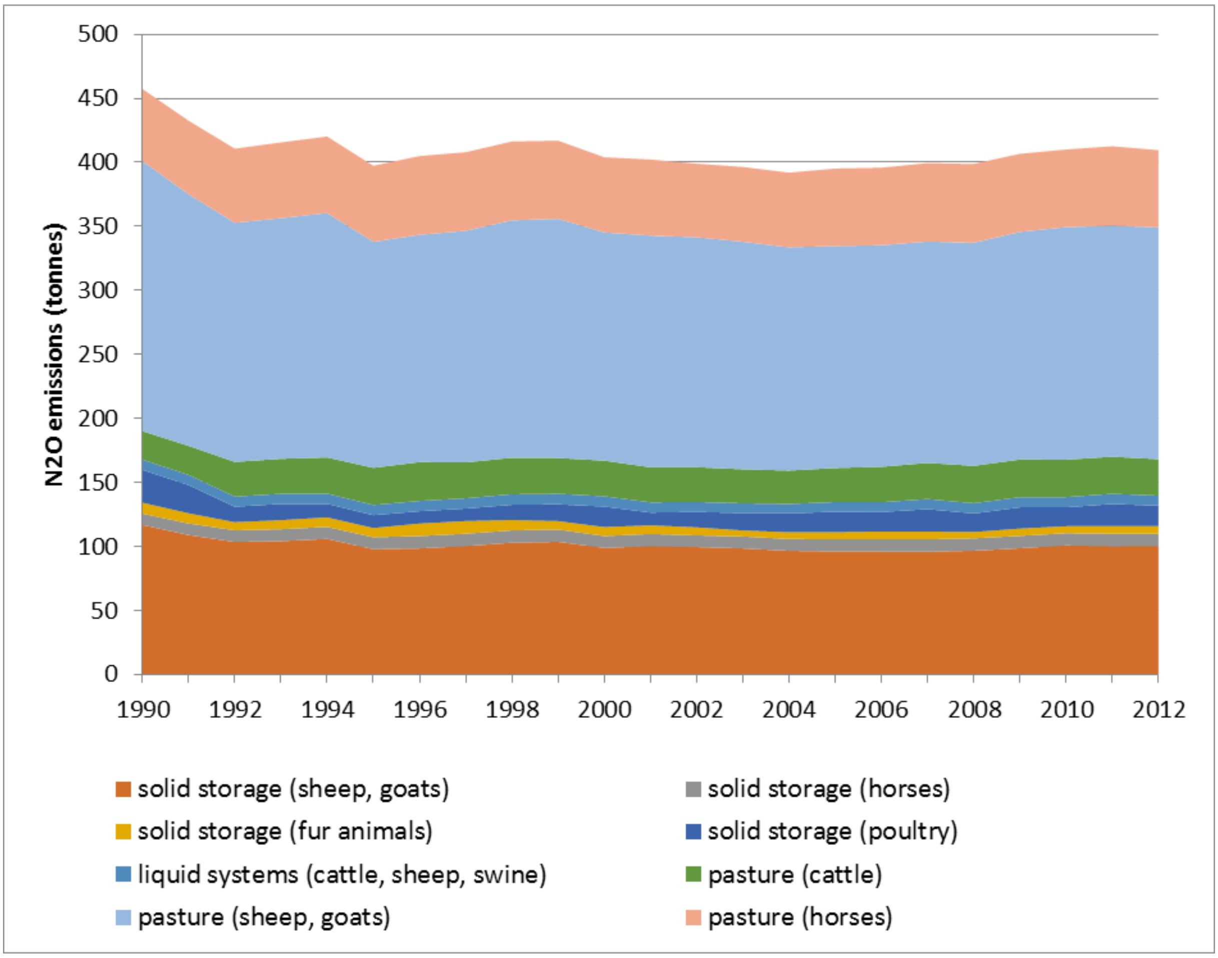


Figure 5.2. N_2O emissions from manure management in Gg N_2O.

5.1.20. *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%.

5.1.21. 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

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 N2O emitted. The emissions of N2O 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 NH3 and NOx and subsequent redeposition and through leaching and runoff (IPCC, 2006). Direct N2O emissions from agricultural soils are described here, indirect emissions in chapter 5.7.

5.1.22. 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

- **EQUATION 11.2**
- **DIRECT N_2O EMISSIONS FROM AGRICULTURAL SOILS (TIER 1a)**
- $N_2O_{Direct}-N = [(F_{SN} + F_{AM} + F_{BN} + F_{CR}) \bullet EF_1] + (F_{OS} \bullet EF_2)$
- 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)

5.1.23. 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 NH3 and NOx. The IPCC default for volatilization of synthetic fertilizer N is 0.1.

5.1.24.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: 5.1.18). The amounts have to be adjusted for N that volatilizes as NH3 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.

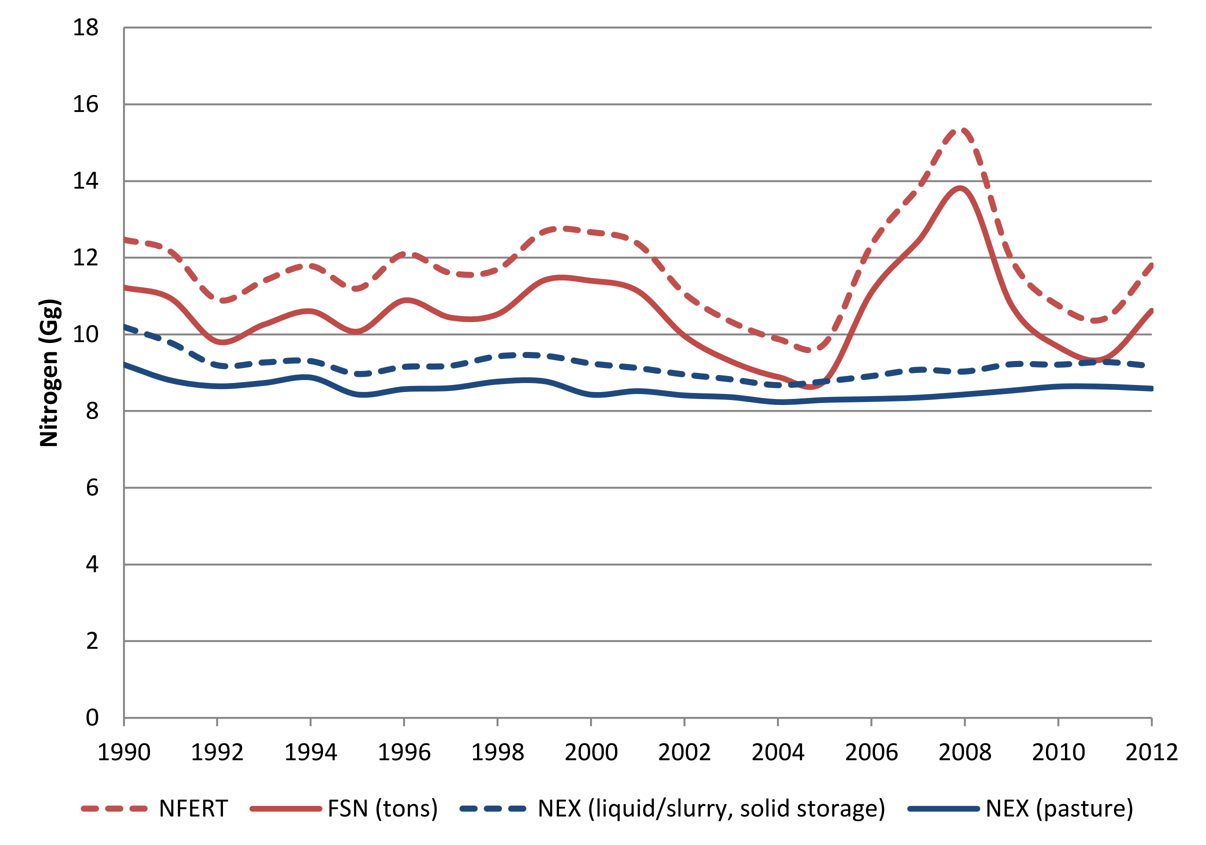


Figure 5.3. Amounts of nitrogen from synthetic fertilizer and animal manure application. Solid lines show nitrogen amounts adjusted for volatilization. Total N amounts are shown in dashed lines of same colour.

5.1.25.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:

- Amount of produce * residue/crop product ratio * dry matter fraction * nitrogen fraction * (1 – fraction of residue used as fodder)

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).

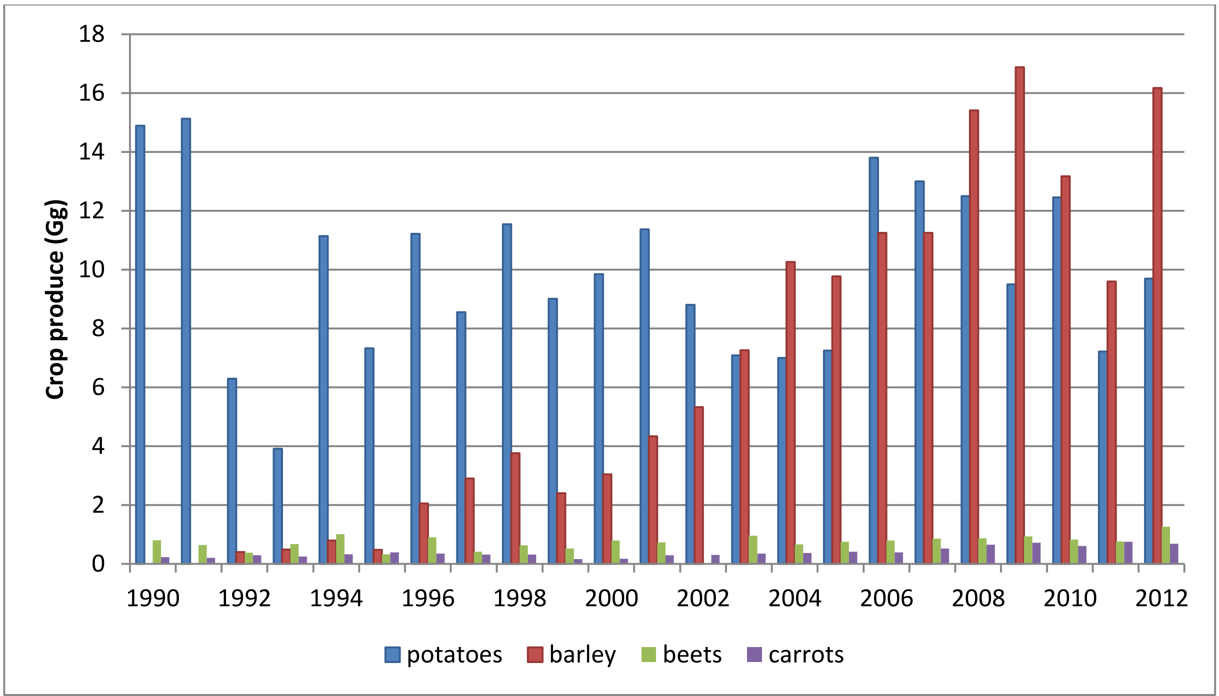


Figure 5.4. Crop produce in kilotonnes for 1990-2013.

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.

5.1.26.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 57.4 kha in 2013.

5.1.27.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).

5.1.28. 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 440 tonnes N_2O in 2010, which meant a decrease of 8% in comparison to 1990 emissions. Drivers behind the decrease were decreasing amounts of synthetic fertilizer and animal manure applied to soils as well as the decrease in the total area of cultivated soils. 47% of 2013 emissions originated from synthetic fertilizer application, 33% from animal manure application and 20% 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).

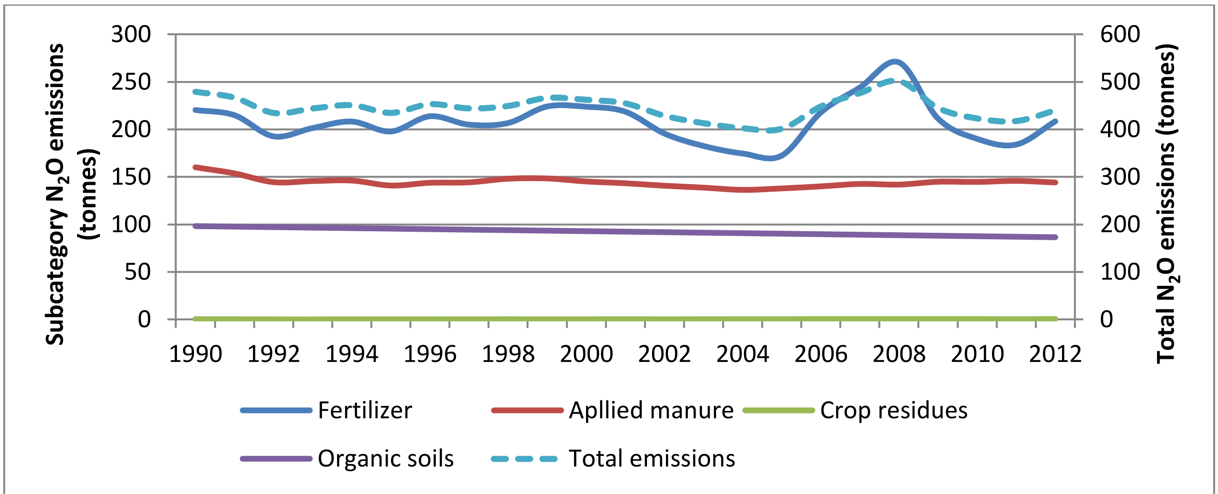


Figure 5.5. Direct N_2O emissions from soils (Gg).

5.1.29. 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%.

5.7. Indirect N_2O emissions from nitrogen used in agriculture

5.1.30. *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.

N2O 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:

- $N_2O(G)$ = N_2O produced from atmospheric deposition of N, kg N/yr
- N_{FERT} = total amount of synthetic nitrogen fertiliser applied to soils, kg N/yr 20
- $\Sigma T(N_{(T)} \bullet Nex_{(T)})$ = total amount of animal manure nitrogen excreted in a country, kg N/yr
- $Frac_{GASF}$ = fraction of synthetic N fertiliser that volatilises as NH_3 and NO_x, kg NH_3-N and NO_x-N/kg of N input

- $Frac_{GASM}$ = fraction of animal manure N that volatilises as NH_3 and NO_x, kg NH_3-N and NO_x-N/kg of N excreted

N2O 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.

5.1.31. Emissions

The development of indirect N_2O emissions from 1990-2013 - after conversion from nitrogen to nitrous oxide - is shown in

Figure 5.6. N_2O emissions amounted to 419 tonnes N_2O in 2013, which meant a 9% decrease 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.

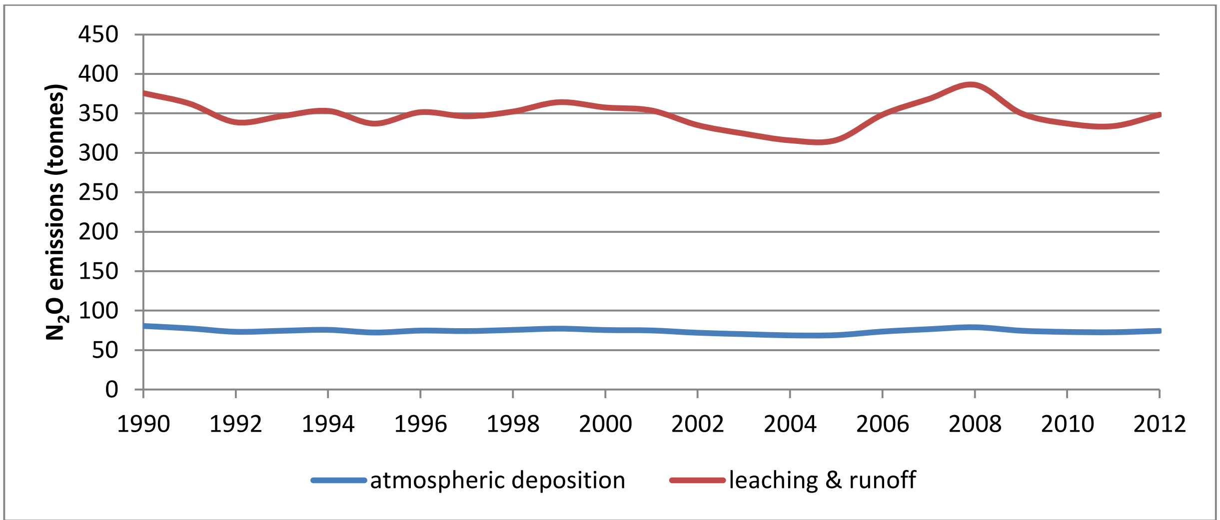


Figure 5.6. Indirect N2O emissions from agricultural soils.

5.1.32. 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

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). 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.

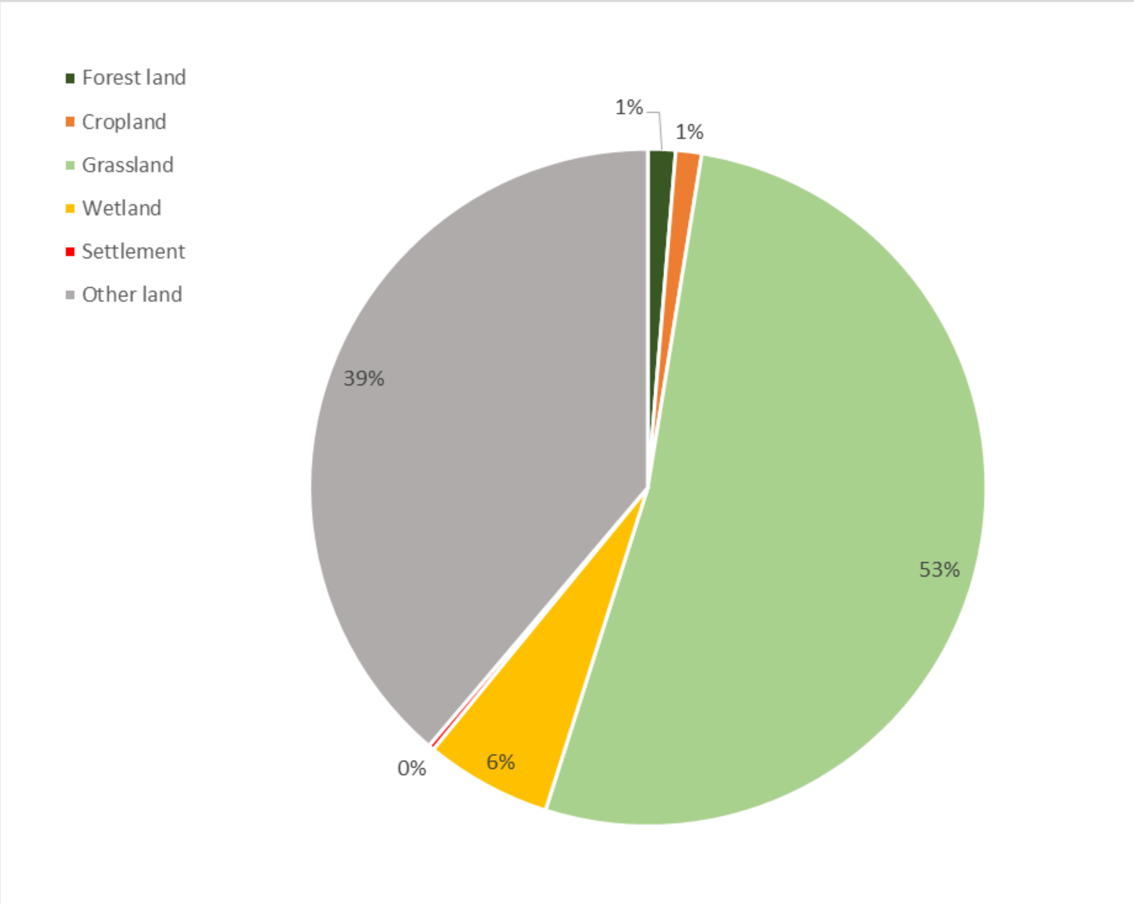


Figure 6-1 Relative size of land use categories in Iceland according to IGLUD land use map 2013

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.

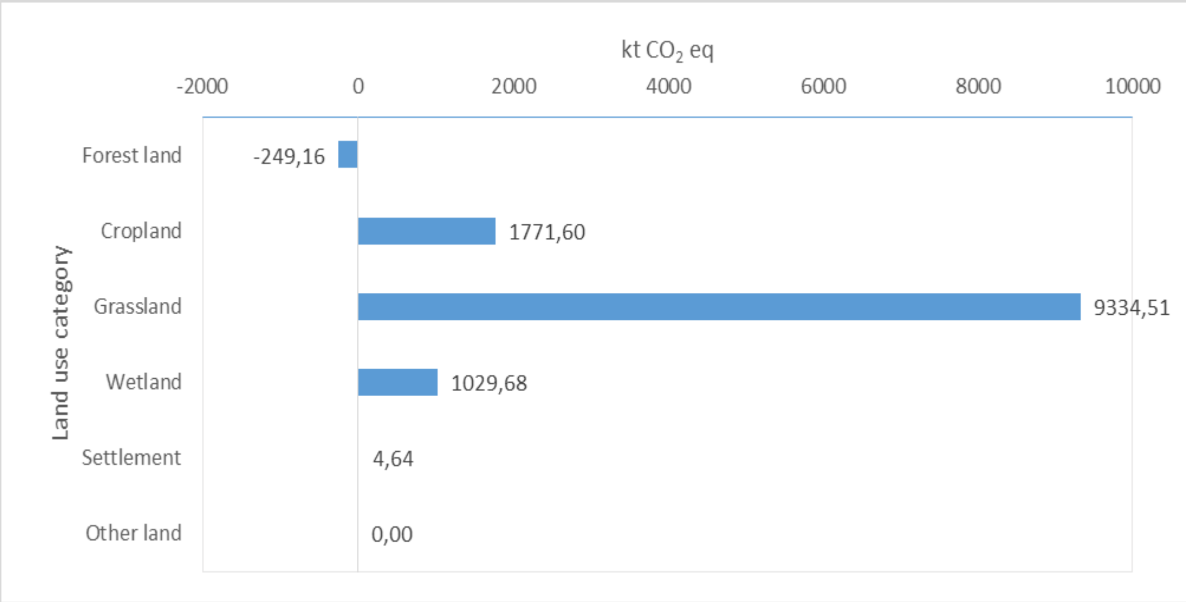


Figure 6-2. The net emission/removals of land use categories in kt CO_2 equivalents, according to this submission

The sum of all emissions reported is 13,474 kt CO_2 eq, and is dominated 86.9% by 11,713 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 12.1% or 1,631 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, 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 44.9 % or 710 kt CO_2 eq, to biomass and SOC in revegetation 34.9 % or 552 kt CO_2 eq, to biomass and SOC in forest 16.5 % or 262 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 increased greatly or from 706 kt CO_2 eq to 11,891 kt CO_2 eq. The reported emission for the year 2012 is 11,883 kt CO_2 eq in this submission showing the effects of recalculations. The increased emission reported is explained both by revised emission factors and estimation of components previously not estimated. New components estimated in this submission include methane emission from drained and wet organic soils, off-site CO_2 emission from waterborne dissolved organic compounds (DOC) from organic soils. The CO_2 removal of un-drained and rewetted organic soils is included in this year's submission for the first time.

The CRF tables are prepared through new version of the CRF reporter (version 5.10.1). The structure of the information is changed considerably from last submission in line with the different structure in the CRF- reporter. "Emissions and removals from drainage and rewetting and other management of organic and mineral soils" is a new structural component included in the new CRF for the land use categories; Forest land, Cropland, Grassland and Wetland. The CH_4 emissions from drained and wet soils and off-site CO_2 emission from waterborne carbon loss from organic soils is reported under this category whereas the C-stock changes in drained areas is reported as in previous submissions under C-stock changes of land remaining in category and land converted to a category. The N_2O emission associated with the drainage, was in previous submissions reported for Forest land under "*5(II) Non-CO2 emissions from drainage of soils and wetlands*", for Cropland under "*Agricultural sector – Cultivation of Histosol*" and for Grassland under "*Other as Grassland Non-CO_2 emissions from drainage* *of soils and wetlands*" in now 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 N2O emissions from N Mineralization/Immobilization"* with the notation that emission reported is of drained soils. Other changes in structure of the information will be explained in subsequent chapters on the relevant land use category.

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 6-9) 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 forests.

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 grazing areas. This maximum in sheep number was followed by rapid decline in number until 1990 when present winterfeed stock size level was reached (Figure 6-3). 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 also the time spent on highland grazing area is better managed than before affecting the overall grazing pressure.

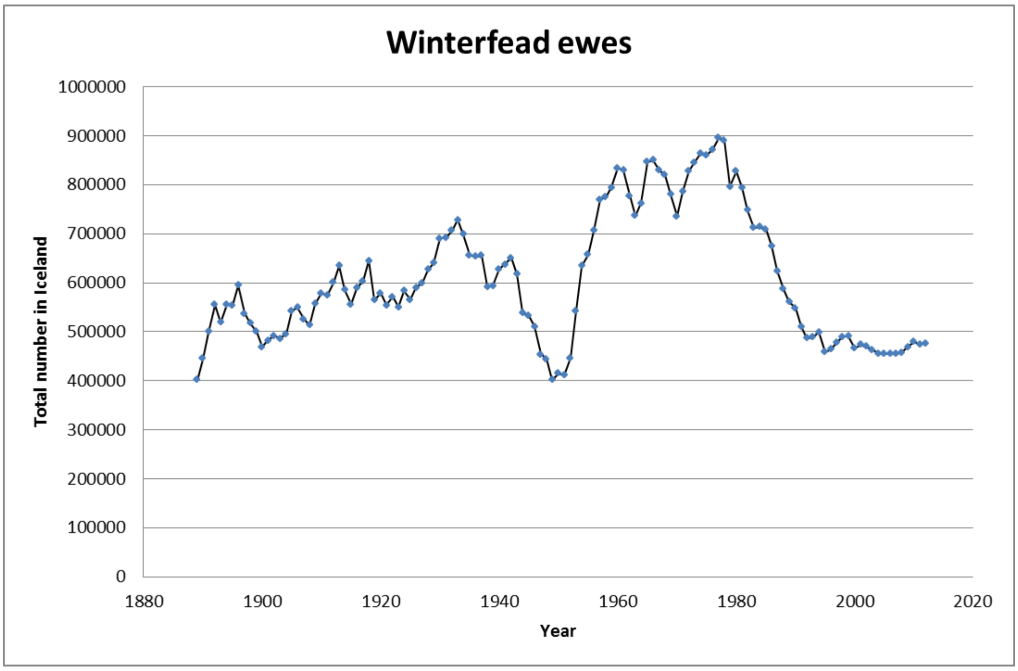


Figure 6-3 Changes in number of winterfed sheep as officially recorded (Statistic Iceland website 2014)

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 Westford'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 is has been described elsewhere (Gudmundsson, Brink et al. 2013). For some 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 is e.g. the case for 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 smaller than the mapped area. As the 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 in different 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. 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 only be relative and not geographically identifiable or it can be geographically identifiable at various resolutions. The relative division can thus 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 prepared for this 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".

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

Table 6-1. List of map layers used in compiling the IGLUD map showing the categorization of layers and order of compilation.

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 covering 60% of the country a whole country map layer of this classification is available. This work is presently 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 this submission the buffer zone applied in last submission is 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. 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 6.3.5). 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 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 last year's 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

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

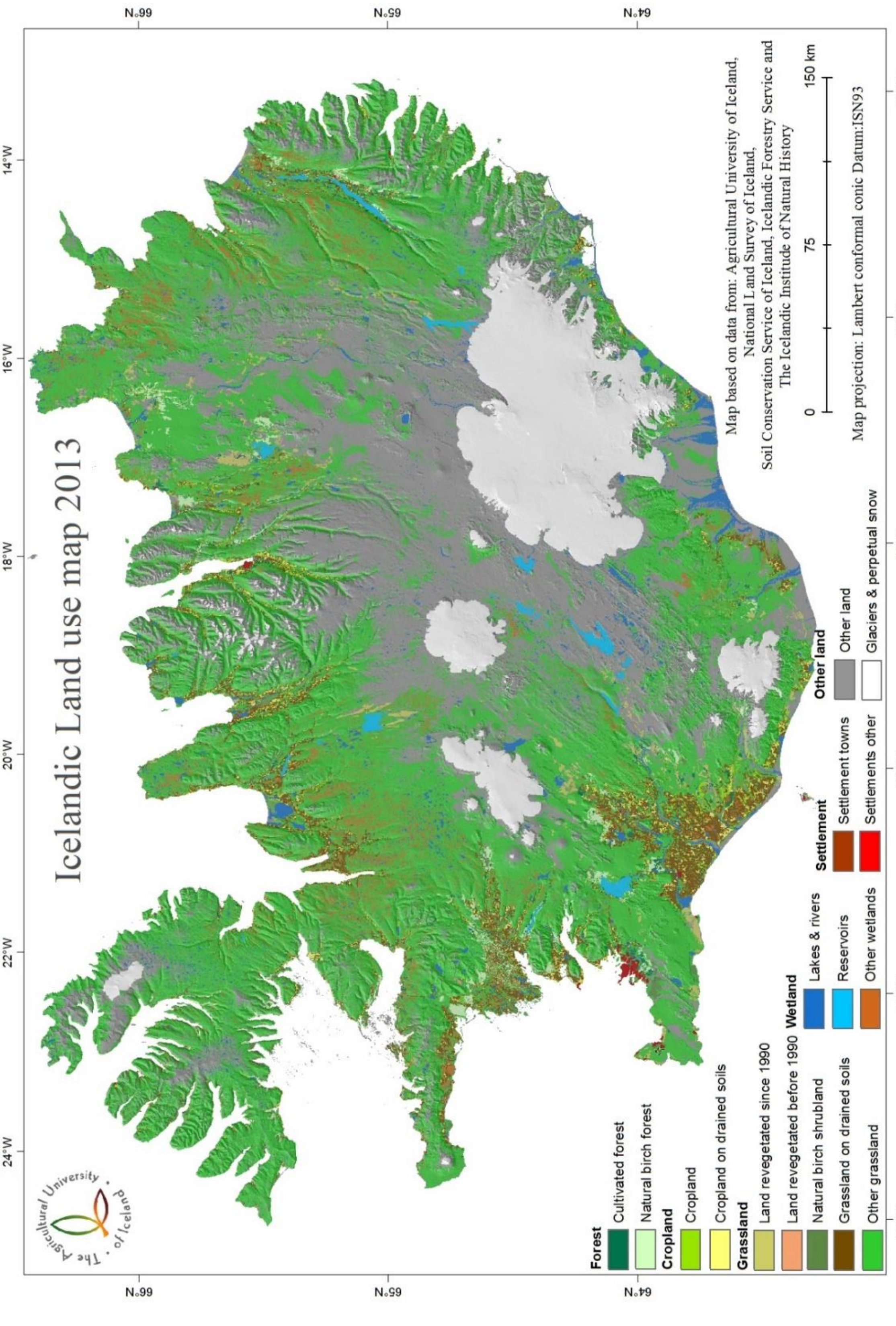


Figure 6-4. The land use map of IGLUD for the year 2013

Figure 6-5. Enlargement of land use map emphasizing the different Forest land subcategories

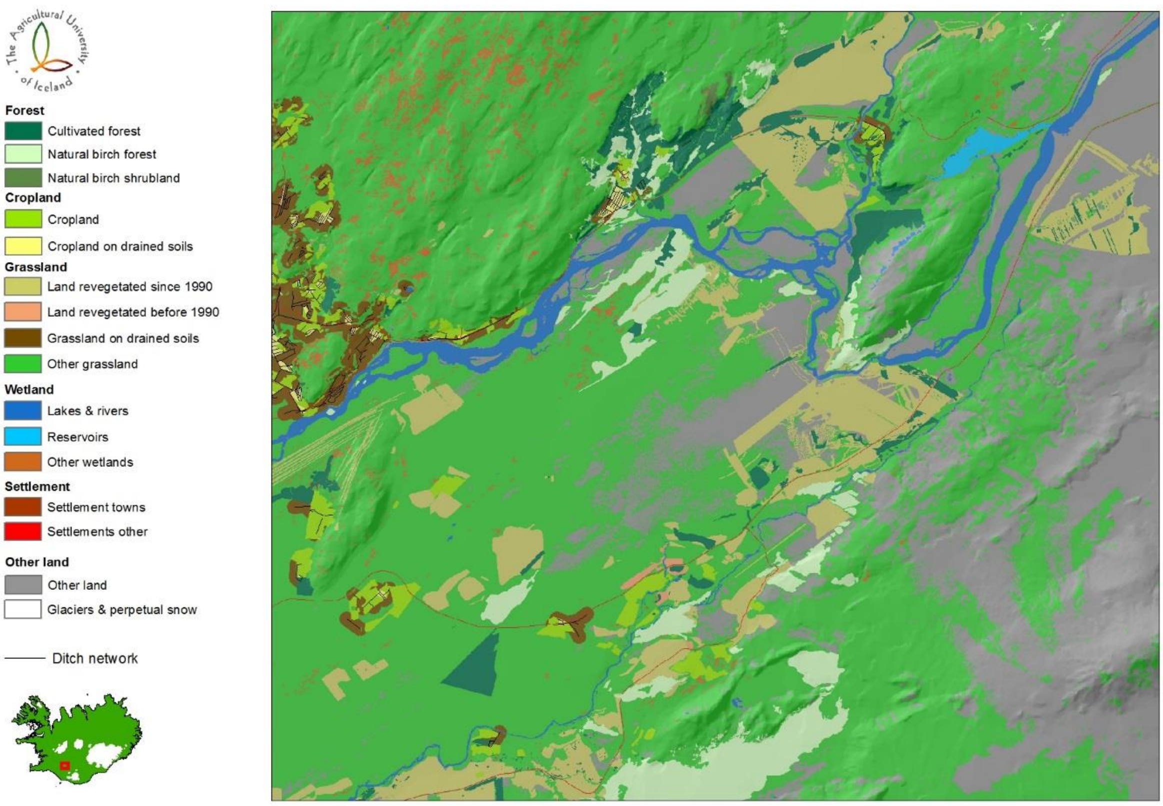


Figure 6-6. Enlargement of land use map emphasizing the Revegetation area mapped

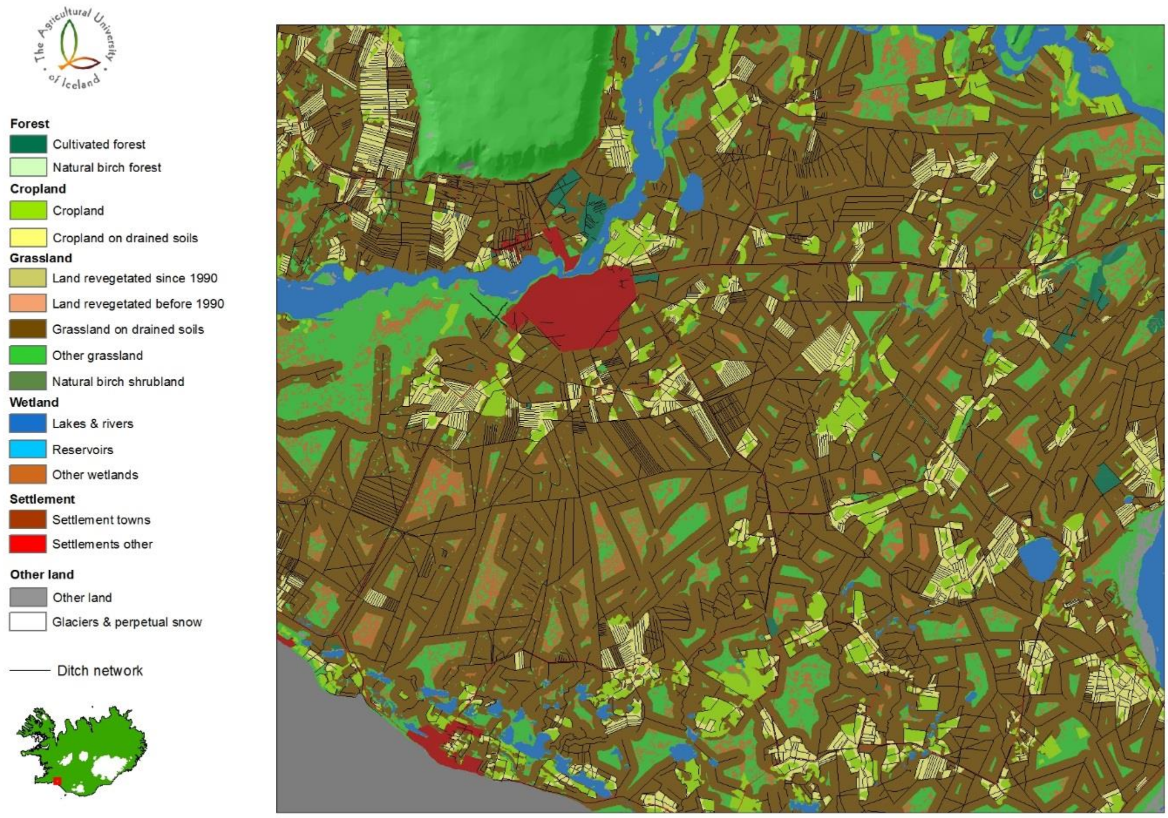


Figure 6-7. Enlargement of land use map emphasizing the subcategory Grassland on drained soils.

6.3.2. Changes in land use map

Most of the map layers applied in last year's submission are applied unchanged in this submission with few exceptions. The most important of these deviations is the revision of the map layers of natural birch forest and natural birch shrubland. Also map layers for cultivated forest and revegetation have been revised and updated. As described above the buffer zone applied on roads from the IS50v2013 was narrowed. Changes in these map layers are propagated to other map layers lower in the hierarchy.

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 minor part 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). 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 year 2013. 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 recognisable 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. 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 digitised 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 2013.

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	OL	Other
FL C								8,382				
FL NB												
CL				15,468				30,036				
GL. drained									498	8		
GL. Nb. shrub												
RV before. “90												
RV since. “90								1,341			1,341	
O.GL		429			546	161,574						
WL.O				6,763								
WL. L&R												
OL												
Other												
Other estimate	39,047	96,332	127,079	363,568	54,735	165,356	101,244			207,109		
Map area	47,429	95,903	172,583	341,843	54,189	3,782	103,927	4,811,805	361,195	207,101	2,896,546	1,171,984
Difference	8,382	-429	45,504	-21,725	-546	-161,574	2,683			-8		
Corrected area	39,047	96,332	127,079	363,568	54,735	165,356	101,244	4,689,014	354,930	207,109	2,897,888	1,171,984
Total area [ha]												**10,268,286**

FL C: Cultivated forest.	GL Nb. shrub: Natural birch shrubland	WL. O: other wetlands
FL NB: Natural birch forest.	RV b. “90: Revegetation initiated before 1990	WL. L&R: Lakes and rivers
CL: Cropland	RV s. “90: Revegetation initiated since 1990	OL: other land
GL. Drained: Grassland on drained soils	O.GL: other Grassland	Other: all other land use map units

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.

The area of the land use map units; “Settlements towns”, “Settlements other”, “Reservoirs” and “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. 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 5.10.1 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.

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)(2)	89.61	NO	NO	NO	NO	NO	NO	0.05	NO	NO	89.66
Forest land (unmanaged)(2)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Cropland(2)	0.92	NO	121.82	23.46	NO	NO	NO	IE	NO	NO	146.19
Grassland (managed)(2)	35.31	NO	2.53	5,053.33	NO	7.57	NO	0.14	NO	NO	5,098.89
Grassland (unmanaged)(2)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Wetlands (managed)(2)	IE	NO	2.73	32.26	NO	386.90	NO	IE	NO	NO	421.89
Wetlands (unmanaged)(2)	NO	NO	NO	NO	NO	31.48	206.99	NO	NO	NO	238.47
Settlements(2)	NO	NO	NO	NO	NO	NO	NO	27.28	NO	NO	27.28
Other land(2)	9.54	NO	IE	265.48	NO	NO	NO	IE	3,984.50	NO	4,259.53
Total unmanaged land (3)	IE	NO	IE	IE	NO	IE	NO	IE	NO	IE	IE,NO
Final area	135.38	NO	127.08	5,374.53	NO	425.95	206.99	27.47	3,984.50	IE,NO	10,281.91
Net change(4)	45.72	NO	-19.11	275.64	NO	4.06	-31.48	0.19	-275.02	IE,NO	0.00

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.

6.4. 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 analysing 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.

6.5. 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 Abandoned cropland converted to Forest land.

6.6. 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, CH_4 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	135.38			-273.03
Forest Land remaining Forest Land	89.61			-33.27
Afforestation older than 50 years	0.82			-7.57
Living biomass		T3		-7.63
Dead wood		IE		
Litter		NE		
Mineral soil	0.78	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			-9.70
Living biomass		T3		-9.70
Dead wood		IE		
Litter		NE		
Mineral soil		NE		
Organic soil		NO		
Land converted to Forest Land	45.77			-239.76
Cropland converted to Forest Land	0.92			-3.58
Afforestation 1-50 years old - Cultivated forest	0.92			
Living biomass		T3		-2,49
Dead wood		IE		
Litter		T2	CS	-0.46
Mineral soil	0.69	T2	CS	-0.92
Organic soil	0.23	T1	D	0.31
Grassland converted to Forest Land	35.31			-195.03
Afforestation Natural birch forest 1 - 50 years old	6.57			-17.05
Living biomass		T2	CS	-6.13
Dead wood		IE		
Litter		T2	CS	-3.19
Mineral soil	6.17	T2	CS	-8.27
Organic soil	0.40	T1	D	0.54
Afforestation 1-50 years old - Cultivated forest	28.74			-177.97
Living biomass		T3	CS	-132.15
Dead wood		NO		
Litter		T3	CS	-14.86
Mineral soil	25.94	T2	CS	-34.76
Organic soil	2.80	T1	D	3.79
Other land converted to Forest land				

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Afforestation 1-50 years old - Cultivated forest				
Living biomass		T3	CS	-16.24
Dead wood		IE		
Litter		T2	CS	-3.88
Mineral soil	7.50	T2	CS	-14.11
Organic soil	NO			
Natural birch forest 1-50 years old	2.04			-6.91
Living biomass		T2	CS	-2.03
Dead wood		NE		
Litter		T2	CS	-1.05
Mineral soil	2.04	T2	CS	-3.83
Organic soil	NO			
Off-site emission via waterborne carbon losses from drained soils	3.56			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	127.08			1,688.57
Cropland remaining Cropland	121.81			1,572.53
Living biomass		T1		NO
Dead organic matter		T1		NO
Mineral soil	67.53	NE		NE
Organic soil	54.29	T1	D	1,572.53
Land converted to Cropland	5.26			90.95
Grassland converted to Cropland	2.53			3.95
Living biomass		T1	CS	4.91
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
Off-site emission via waterborne carbon losses from drained soils				25.09
CL remaining CL	54.29	T1	D	23.89
WL converted to CL	2.73	T1	D	1.20

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Grassland	5,374.53			7,166.87
Grassland remaining Grassland	5,053.33			6,724.88
Cropland abandoned for > 20 years	21.72			116.52
Living biomass		NO		
Dead organic matter		NO		
Mineral soil	16.14	NO		
Organic soil	5.58	T1	D	116.52
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	3.42			-6.62
Living biomass		T2	CS	-3.41
Dead organic matter		T2	CS	-1.77
Mineral soil	3.28	T2	CS	-4.40
Organic soil	0.14	T1	D	2.96
Other Grassland	4,659.20	NE		
Re-vegetated land older than 60 years	2.59	NO		
Wetland drained for > 20 years	316.56			6,616.20
Living biomass		NE		
Dead organic matter		NO		
Mineral soil		NO		
Organic soil	316.56	T1	D	6,616.20
Land converted to Grassland	321.20			281.64
Cropland converted to Grassland	23.46			164.13
Living biomass		T1	CS	-45.51
Dead organic matter		IE		
Mineral soil	13.67	T2	CS	5.22
Organic soil	9.78	T1	D	204.42
Wetlands converted to Grassland	32.26			674.28
Living biomass		NO		
Dead organic matter		NO		
Mineral soil	NO	NA		
Organic soil	32.26	T1	D	674.28
Other Land converted to Grassland	265.48			-556.78
Other land converted to natural birch shrubland	1.47			-4.99
Living biomass		T2	CS	-1.46
Dead organic matter		T2	CS	-0.76
Mineral soil		T2	CS	-2.77
Organic soil	NO			
Revegetation before 1990	162.77			-340.18
Living biomass		T2	CS	-34.01

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Dead organic matter		IE		
Mineral soil	162.77	T2	CS	-306.16
Organic soil	NO			
Revegetation since 1990	101.24			-211.60
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	89.98			-188.81
Living biomass		T2	CS	-18.81
Dead organic matter		IE		
Mineral soil		T2	CS	-169.26
Organic soil	NO			
Off-site emission via waterborne carbon losses from drained soils				160.35
Drained soils				
GL remaining GL Abandoned CL	21.72	T1	D	2.45
GL remaining GL Natural birch forest old	0.11	T1	D	0.05
GL remaining GL Natural birch forest recently expanded to oGL	0.14	T1	D	0.06
GL remaining GL WL drained for more than 20 years	316.56	T1	D	139.29
CL converted to GL	9.78	T1	D	4.30
WL converted to GL	32.26	T1	D	14.20
Wetland	616.94			-601.62
Wetlands remaining Wetlands	593.89			-712.03
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	31.47	NA		
Other wetlands- intact mires	354.43			-714.77
Living biomass		NO		
Dead organic matter		IE		
Mineral soil		IE		
Organic soil		T1	D	-714.77
Lakes and rivers	206.99	NA		
Land converted to Wetlands	26.04			5.97
Grassland converted to Wetlands	7.57			5.08

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Grassland converted to Reservoirs - Medium SOC	6.96	RA/T2	CS	6.09
Living biomass		IE		
Dead organic matter		IE		
Mineral soil		RA/T2	CS	6.09
Organic soil		NO		
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	18.48			0.89
Low SOC CO2	18.48	RA/T2	CS	0.89
Living biomass		IE		
Dead organic matter		IE		
Mineral soil		RA/T2	CS	0.89
Organic soil		NO		
Off-site emission via waterborne carbon losses from wet soils				104.44
Mires converted to Reservoirs –High SOC	0.99	T1	D	0.29
Other wetlands- intact mires	354.43	T1	D	103.97
Refilled lakes and ponds	0.12	T1	D	0.03
Rewetted wetland soils	0.50	T1	D	0.15
Settlement	27.47			4.60
Settlements remaining Settlements	27.28	NA		
Land converted to Settlement	0.19			4.60
Forest land converted to Settlement	0.05			0.11
Living biomass		T3	CS	
Dead organic matter		T3	CS	
Mineral soil	0.05	T2	CS	0.11
Organic soil		NO		
Grassland converted to Settlement	0.14			4.49
Natural birch shrubland to Settlement	0.01			0.12
Living biomass		T2	CS	0.12
Dead organic matter		NE		
Mineral soil		NE		
Organic soil		NO		
All other grassland to Settlement	0.13			4.37
Living biomass		T2	CS	4.37
Dead organic matter		IE		

Table 6.5 continued				
Source/sink	Area (kha)	Method	EF	kt CO_2 Emission(+) /Removal (-)
Mineral soil		NE		
Organic soil		NE		
Other Land remaining Other Land	3,984.50	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.

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	0.01
Land converted to Forest land				0.03	0.63
Cropland converted to Forest land	0.23	T1	D	0.00	0.04
Grassland converted to Natural birch forest	0.40	T1	D	0.00	0.07
Grassland converted to Cultivated forest	2.80	T1	D	0.02	0.52
Biomass burning- wildfire	0.00	T2	CS,D	0.00	0.00
Cropland				3.32	83.03
Drained soils	57.02			3.32	83.03
Cropland remaining Cropland	54.28	T1	D	3.16	79.06
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	542.84
Drained soils of				21.71	542.82
Grassland remaining Grassland				19.21	480.20
Cropland abandoned for more than 2 years	5.58	T1	D	0.33	8.30
Natural birch shrubland old	0.11	T1	D	0.01	0.16
Natural birch shrubland recently expanded	0.14	T1	D	0.01	0.21
Wetlands drained for more than 20 years	316.56	T1	D	18.86	471.52
Land converted to Grassland				2.50	62.62
Cropland converted to Grassland	9.78	T1	D	0.58	14.57
Wetland converted to Grassland	32.26	T1	D	1.92	48.05
Biomass burning	0.04	T2	CS,D	0.00	0.01
Wetland					
Wetland remaining Wetland					
Intact mires	354.43	T1	D	64.74	1,618.57
Flooded land- Mires converted to reservoirs	0.99	RA/T2	CS	0.11	2.83
Land converted to wetland					
Grassland converted to reservoirs	6.95	RA/T2	CS	0.04	0.90
Other land converted to reservoirs	18.48	RA/T2	CS	0.25	6.18
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	NO				
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 N2O emission calculations.

Source/sink	Area kha	Method	EF	kt Emission / Removal (-)	kt CO2 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	0.00	T2	CS,D	0.00	0.30
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	0.07
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	0.40	T1	D	0.00	0.60
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					
Direct N_2O emission from N mineralization / immobilization[1)]	322.39	T1	D	4.81	1,434.23
Biomass burning- wildfire	0.00	T2	CS,D	0.00	0.02
Land converted to Grassland					
Cropland converted to Grassland					
Direct N_2O emission from N mineralization / immobilization[2)]	23.45	T1,T2	D,CS	0.15	43.96
Biomass burning- wildfire	0.00	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				

Continuation of table 6.7					
Source/sink	Area kha	Method	EF	kt Emission / Removal (-)	kt CO2 eq
Biomass burning- controlled burning	NE				
Biomass burning- wildfire	NO				
Flooded land					
Mires converted to reservoirs	0.99	RA/T2	CS	NO	
Grassland converted to reservoirs	6.96	RA/T2	CS	NO	
Other land converted to reservoirs	18.48	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 (5.8.14) does not include N2O emission from Grassland on drained soils.*

6.7. 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 m^2 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 analysing 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 categorising 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.

6.7.1. 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.

6.7.1.1. 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 analysed.

6.7.1.2. 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 analysed.

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.

6.7.1.3. 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 CO_2 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.

6.7.2. 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 CH_4 from drained soils.

6.7.2.1. 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.

6.7.2.2. 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 CH_4 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.

6.7.2.3. 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 N_2O or 5.33 kt CO_2 eq.

6.7.2.4. 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 recognised and the relevant categories of 4(II) reported with notation key NO.

6.7.3. Other Emissions (4(I), 4(III))

Direct N_2O emission from use of N fertilisers is reported for Land converted to Forest Land since fertilisation 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. N_2O emissions from drainage of organic soils are also reported separately for forest land. Direct N_2O 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.

6.7.4. 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 categorise is unavailable.

6.7.5. 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 6.7.1(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.

6.7.6. 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 6.9.7). 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 N_2O-N ha^{-1} yr^{-1}. (Table 2.5 in the “2013 Supplement”). For CH_4 emission compound factor of 7.375 kg CH_4 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 tonnes 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 tonnes C ha^{-1}, for fully vegetated areas with thick developed andosol layers it was 72.9 tonnes 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 tonnes ha^{-1} on poor and fully vegetated sites, respectively. Weighted C-stock of treeless land is then 66.9 tonnes 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.

6.7.7. 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.

6.7.8. 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.

6.7.9. 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.

6.8. 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 127.08 kha, whereof 57.02 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.

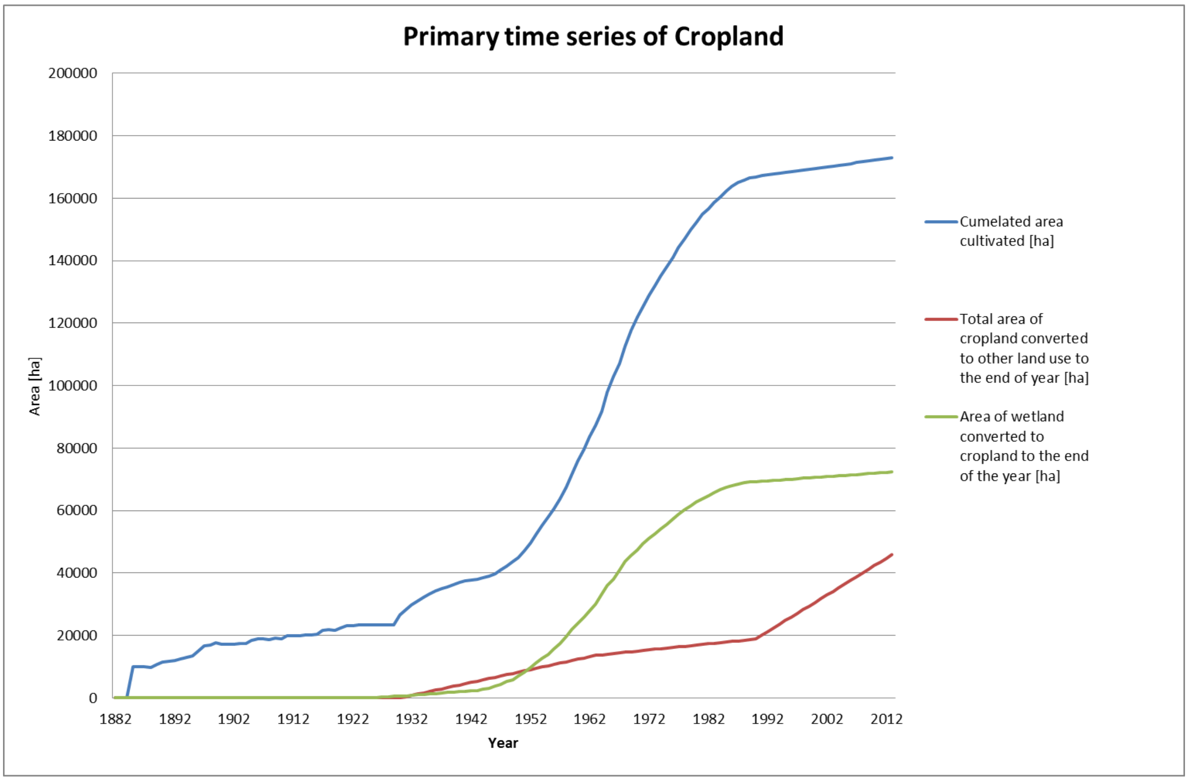


Figure 6-8. Primary time series of Cropland area: Cumulated area represents all land that has been cultivated to that time. Area of wetland converted to cropland represents the part of that area on organic soil. Total area converted to other land use represents the estimated area of abandoned Cropland.

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).

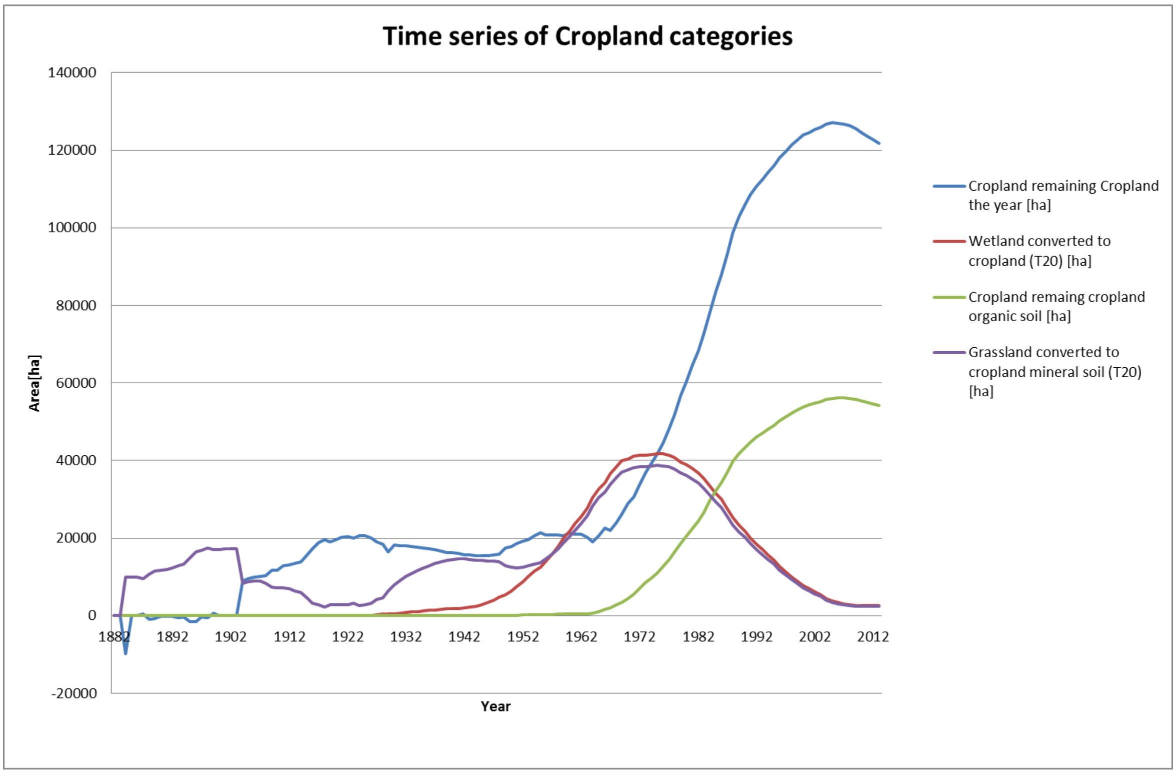


Figure 6-9. Time series of Cropland as reported. Area in hectares as estimated at the end of the year.

The area of Cropland organic soils is estimated through the time series available as described above (chapter 6.3.3). 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.

6.8.1. Carbon stock changes

6.8.1.1. Carbon stock changes in living biomass

As no perennial woody crops are cultivated in Iceland, no biomass changes need to be reported. Shelterbelts, not 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 CO_2 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.

6.8.1.2. 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 recognised 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.

6.8.1.3. 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” F_{LU} = 0.93 was selected based on the descriptions in Table 5.5 as best describing the hayfields in Iceland. For management and input, F_{MG} =1.10 no tillage- temperate boreal -dry and F_I =1.00 medium input, were selected. The SOC_{REF}, 90.5 tC 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 SOC_0 = 90.5 t C ha^{-1} * 0.93*1.10*1.00 = 92.6 t C ha^{-1}. For the 20 year conversion period the annual change in $\Delta C_{Mineral}$ = 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 0.95 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 54.29 kha and 2.53 kha respectively. These organic soils are estimated to annually lose 428.87 kt C and 21.56 kt C in the same order. The consequent emission is estimated as 1572.53 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.

6.8.2. 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.

6.8.3. 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.

6.8.3.1. 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 23.88 kt CO_2 for organic soils of Cropland remaining Cropland and 1.20 kt CO_2 for soils of Wetland converted to Cropland.

6.8.3.2. 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 3.16 kt CH_4 or 79.06 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.

6.8.3.3. 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 recognised and the relevant categories of 4(II) reported with notation key NO.

6.8.4. Other emissions

6.8.4.1. 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.

6.8.5. 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.

6.8.6. 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 $ha^{-1}yr^{-1}$ 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 $ha^{-1}yr^{-1}$ 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 $\Delta C_{Mineral}$ = 0.10 t C ha^{-1} for Grassland converted to Cropland.

The CH_4 emission and removal from drained cropland is calculated according to T1 applying EF_{CH4_land} = 0 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.

6.8.7. 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 172.9 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%.

6.8.8. Recalculations

The onsite emission of CO_2 from Cropland organic soils is recalculated according to revised T1 emission factors in the new 2013 wetland supplement (IPCC 2014). Also emission components of off-site CO_2 and of CH_4 from drained Cropland not included in previous submissions are for the first time reported. The emission reported in this submission for the year 2012 from C stock changes in Cropland organic soils is 1,661.8 kt CO_2 compared to 1,051.8 kt CO_2 reported for the same component in last year's submission. The total emission reported for the year 2012 in this submission is 1,782.5 kt CO_2 eq compared to 1,067.7 kt CO_2 eq in last year's submission. Of the difference 714.8 kt CO_2 eq is explained by new EF for CO_2-C for C-stock (610 kt CO_2 eq). The new components off-site CO_2 and CH_4 estimated for the first time added 25.2 kt CO_2 eq and 83.5 kt CO_2 eq or totally 108.7 kt CO_2 eq. Increase in revised and new components is thus 718.7 kt CO_2 eq or 3.9 kt CO_2 eq larger than actual difference in reported emissions. Of this difference 4.0 kt CO_2 eq is explained by liming of Cropland not included under LULUCF in this submission.

6.8.9. 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.

6.9. 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 5,374.53 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 instead of ten in last year´s submission. The category of "Other land converted to Grassland –Revegetation since 1990" is now divided to two categories i.e. areas "protected from grazing" and areas with "limited grazing allowed". Also under "Other land converted to Grassland" a new category is added i.e. "Other land converted to natural birch shrubland".

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.

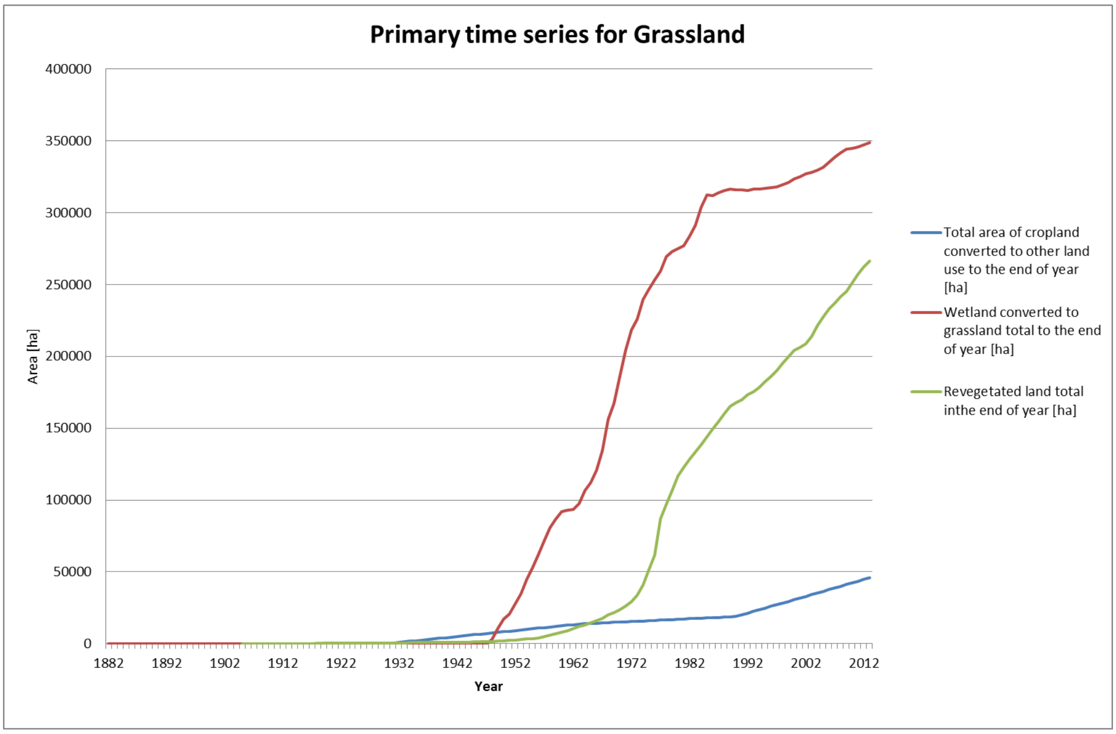


Figure 6-10 Primary time series for Grassland: Total area of Cropland converted to other land uses at the end of the year, Wetland converted to Grassland at the end of the year, Revegetated land at the end of the year. All graphs showing cumulative area at the end of the year from the beginning of time series.

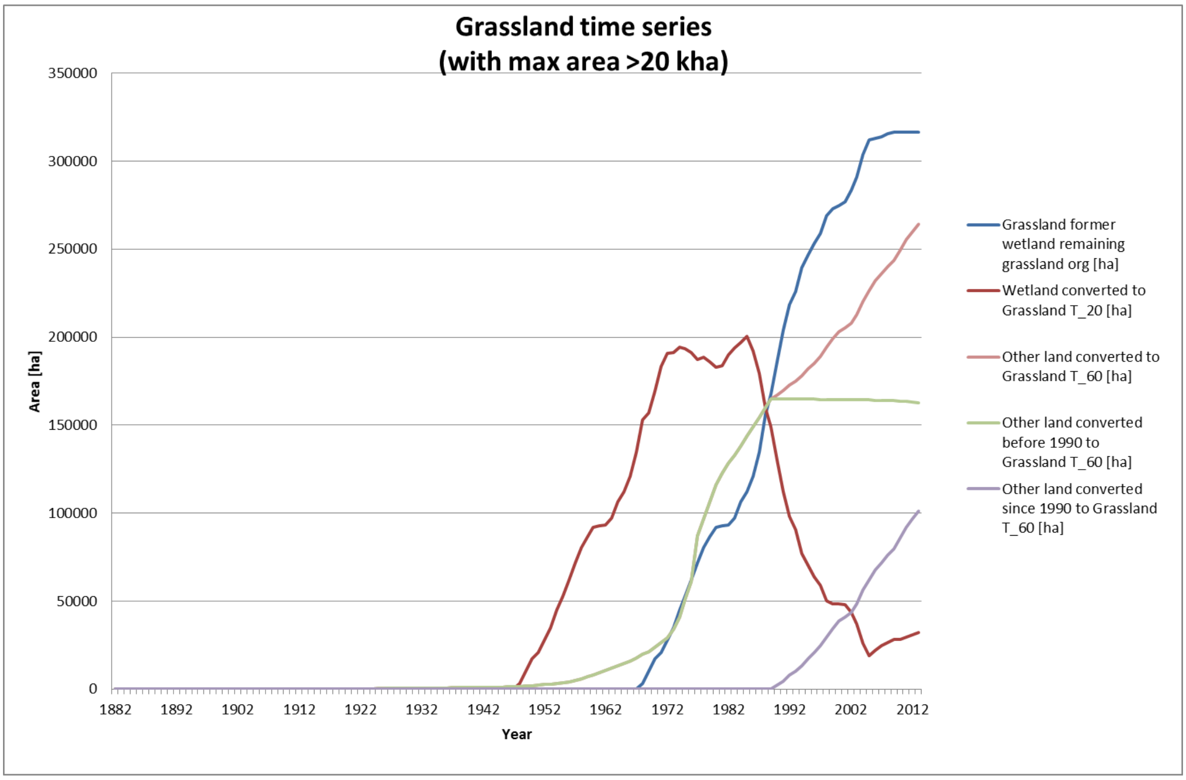


Figure 6-11. Time series of reported Grassland categories with max area >20 kha: Grassland former Wetland remaining Grassland organic soil, Wetland converted to Grassland T_20, Other land converted to Grassland T_60, Other land converted to Grassland before 1990 T_60, Other land converted to Grassland since 1990 T_60. All graphs showing the area in hectares at the end of the year.

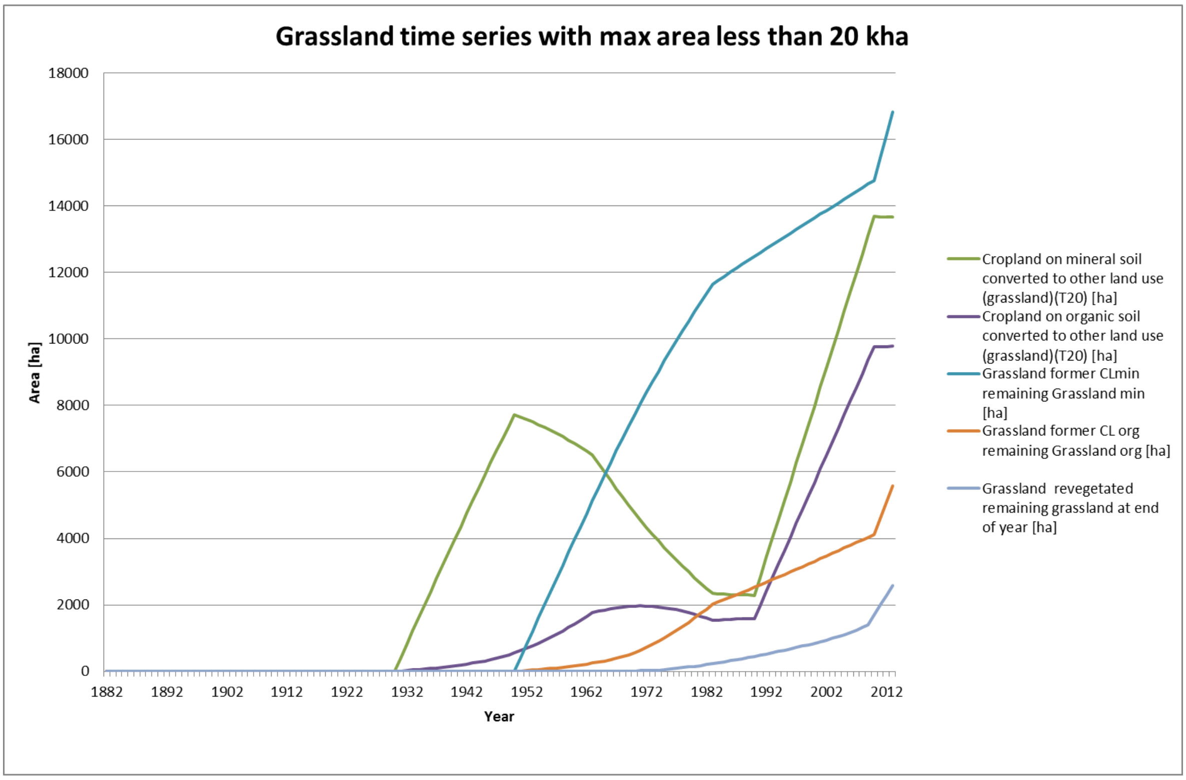


Figure 6-12. Time series of reported Grassland categories with max area <20 kha: Cropland on mineral soil converted to Grassland T_20, Cropland on organic soil converted to Grassland T_20, Grassland former Cropland remaining Grassland mineral soil, Grassland former Cropland remaining Grassland organic soil, Grassland former revegetated Other land remaining Grassland. All graphs showing the area in hectares at the end of the year.

6.9.1. 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.

6.9.1.1. 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 21.72 kha whereof 5.58 kha is organic soil.

6.9.1.2. 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 6.9.2.3)

6.9.1.3. 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 (

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

Table 6-1), 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 6.3.5) and the time series prepared as described above. The total area reported in this year's submission for this category is 4,659.20 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 60-250×10^3 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 present increasing both in vigour and continuity (Magnússon et al. 2006). In these areas, the annual carbon budget might be positive at present with C being sequestered from the atmosphere. Whether these changes in vegetation are related to changes in climate, management or a combination of both is not clear.

The subdivision of Grassland, according to land degradation 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.

6.9.1.4. 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 2.59 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 Maps of Land being re-vegetated).

6.9.1.5. 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 316.56 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 drained. The preparation of that mapping unit is described in (chapter).

6.9.2. *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.

6.9.2.1. 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.

6.9.2.2. 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 32.26 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.

6.9.2.3. 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 2013 is kha compared to 96.80 kha reported for the year 2012 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)

6.9.2.4. 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 1.47 kha.

6.9.3. *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 2013

6.9.3.1. 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 0.93 kt C respectively removing 3.51 kt CO_2 and 3.41 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 6.8.6). 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 9.28 kt C, 5.13 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 34.02 kt CO_2, 18.81 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 0.4 kt C removing 1.46 kt CO_2 from the atmosphere.

6.9.3.2. 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 0.48 kt C for "Natural birch shrubland-recently expanded into Other Grassland" and 0.21 kt C for "Other land converted to Natural birch shrubland" in the year 2013 and accordingly removing 1.77 kt CO_2 and 0.76 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 6.8.6). 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.

6.9.3.3. 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 1.20 kt C in the year 2013 and thereby removing a total of 4.40 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 6.8.6). 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 83.50 kt C, 46.16 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 306.16, 169.26, 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 0.76 kt C and to have removed 2.77 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 1,709.49 kt C in the inventory year emitting 7,616.67 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	322.39	-1837.64	6737.97
Cropland abandoned for more than 20 years	5.58	-31.78	116.52
Natural birch shrubland (N.b.s)- old	0.11	-0.63	2.29
N.b.s.- recently expanded into Other Grassland	0.14	-0.81	2.96
Wetland drained for more than 20 years	316.56	-1804.42	6616.20
Land converted to Grassland	42.04	128.15	878.7
Cropland converted to Grassland	9.78	-55.75	204.42
Wetland converted to Grassland	32.26	183.90	674.28
Total	364.43	-1709.49	7616.67

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

The emissions and removals included under this component are reported for first time in this year's submission.

6.9.4.1. 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 160.35 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	322.39	141.85
Cropland abandoned for more than 20 years	5.58	2.45
Natural birch shrubland (N.b.s)- old	0.11	0.05
N.b.s.- recently expanded into Other Grassland	0.14	0.06
Wetland drained for more than 20 years	316.56	139.29
Land converted to Grassland	42.04	18.5
Cropland converted to Grassland	9.78	4.30
Wetland converted to Grassland	32.26	14.20
Total	364.43	160.35

6.9.4.2. 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 21.71 kt CH_4 or 542.82 kt CO_2 eq. Of this emission 21.23 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 in Table 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	322.39	0.43	18.78	19.21	480,20
Cropland abandoned for more than 20 years	5.58	0.01	0.32	0.33	8,30
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	0.14	0.00	0.01	0.01	0,21
Wetland drained for more than 20 years	316.56	0.42	18.44	18.86	471,52
Land converted to Grassland	42.04	0.06	2.45	2.50	62,62
Cropland converted to Grassland	9.78	0.01	0.57	0.58	14,57
Wetland converted to Grassland	32.26	0.04	1.88	1.92	48,05
Total	364.43	0.48	21.23	21.71	542,82

6.9.4.3. 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 recognised and the relevant categories of 4(II) reported with notation key NO.

6.9.5. Other emissions

6.9.5.1. N_2O emission from drained inland soils

The emission of N_2O form drained Grassland soil is in CRF reported in tables for 4(III) Direct N2O emissions from N mineralization/immobilization both under Grassland remaining Grassland and Land converted to Grassland. In the latter category the emission is divided to two subcategories i.e. “Cropland converted to Grassland” and “Wetland converted to Grassland”. No subdivision of 4(III) is allowed in the CRF Reporter (v5.10.1) for Grassland remaining Grassland, and the emissions of all subcategories including drained soils is reported as aggregate number. The emissions are calculated according to T1 applying equation 2.7 in the 2013 wetland supplement (IPCC 2014). The total emission of N2O reported under 4(III) is 5.44 kt N_2O or 1621.26 kt CO_2 eq. The disaggregation of this emission to subcategories is shown in Table 6-12.

Table 6-12 Drained soils, estimated N_2Oemission from drained soils of Grassland categories/subcategories

Category/subcategory	Drained “organic” soils [kha]	Direct N_2O from N min/immob.	
		[kt N_2O]	[kt CO2 eq]
Grassland remaining Grassland	322,39	4,81	1434,22
Cropland abandoned for more than 20 years	5,58	0,08	24,80
Natural birch shrubland (N.b.s)- old	0,11	0,00	0,49
N.b.s.- recently expanded into Other Grassland	0,14	0,00	0,63
Wetland drained for more than 20 years	316,56	4,73	1408,30
Land converted to Grassland	42,04	0,63	187,04
Cropland converted to Grassland	9,78	0,15	43,51
Wetland converted to Grassland	32,26	0,48	143,53
Total	364,43	5,44	1621,26

6.9.6. Biomass burning

Biomass burning on Grassland is reported both for Grassland remaining Grassland and land converted to 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 22.2 ha of Grassland remaining Grassland and 17.84 ha of Land converted to Grassland. The emission caused by these fires is estimated as 0.57 Mg CH_4 plus 0.05 Mg N_2O and 0.61 Mg CH_4 plus 0.06 Mg N_2O for Grassland remaining Grassland and Land converted to Grassland respectively. This emission is equivalent to total 29.9 Mg CO_2 and 32.0 Mg CO_2 respectively for Grassland remaining Grassland and Land converted to Grassland.

6.9.7. 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 6.8.6) 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 CH_4 emission and removal from drained Grassland is calculated according to T1 applying EF_{CH4_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).

6.9.8. 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 analysed, 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 CH_4 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 CH_4 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.

6.9.9. Recalculations

The reported emissions from the land uses category Grassland increases significantly from last year´s submission. The accumulated emission/removal from the Grassland category in last year's submission was -191.15 kt CO_2 eq reported under the Grassland category (5C) plus 78.66 kt CO_2 eq from N_2O emission of drained land reported under the category Other (5G). The net removal of the Grassland category in last year's submission was accordingly -112.49 kt CO_2 eq. The total emission from the Grassland category in this year's submission is 9,331.47 kt CO_2 eq. The emission for the year 2012 in this year's submission is 9,287.23 kt CO_2 eq reflecting the recalculation effect. The increase for the year 2012 is 8,350% whereof 699.24 kt CO_2 eq are caused by new emission components not estimated in previous submissions.

6.9.10. 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 9,941.12 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.

6.10. 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 619.94 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 22.32 kha as new drainages exceeds land impounded by hydropower reservoirs. The net emission from the wetland category is reported as 1029.68 kt CO_2 eq.

In previous submissions only emission from hydropower reservoirs have been reported and biomass burning when occurring. In this 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". Of these the four categories of area added to reservoirs were included in last year's submission.

6.10.1. 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. Channelling 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"

6.10.1.1. Mires converted to reservoirs

In previous submissions 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.

6.10.1.2. Lakes and rivers

The area estimation of this category is described in chapter 6.3.5.

6.10.1.3. 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.

6.10.1.4. Intact mires

In previous submissions this land has been 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.

6.10.2. 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".

6.10.2.1. 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 6.96 kha as in last year's submission. The area estimate is based on reservoir mapping and available data on inundated land.

6.10.2.2. 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 18.48 kha as in last year's submission. The area estimate is based on reservoir mapping and available data on inundated land.

6.10.2.3. 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.

6.10.3. Carbon stock changes

The CO_2 removal due to carbon stock changes in category “Other wetlands remaining Other wetlands” is recognised as key category of level in 2013.

6.10.3.1. 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.

6.10.3.2. 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 714.77 kt CO_2 and 1.00 kt CO_2 respectively.

6.10.4. 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

6.10.4.1. Off-site CO_2 emission via waterborne losses from wetland soils

Off-site CO2 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, 103.97 kt CO_2, 0.03 kt CO_2, and 0.15 kt CO_2 for these categories in the above order.

6.10.4.2. CH_4 emission and removals from wetlands

The CH4 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 0.40 kt CH_4 (9.91 kt CO_2 eq) the same as in last year's submission.

For the first time 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 CH_4 for these categories is estimated according to T1 applying equation 3.8. in 2013 wetland supplement (IPCC 2014). The reported emission is 64.74, 0.02, and 0.09 kt CH_4 for "Intact mires", "Refilled lakes and ponds", and "Rewetted organic soils" respectively. This is equivalent to 1,618.57, 0.53, and 2.27 kt CO_2 eq, in the same order.

6.10.5. Other emissions

6.10.5.1. 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 N2O is considered negligible for rewetted soils and the same is assumed here to apply for intact mires.

6.10.6. Biomass burning

No biomass burning of wetland is reported in this year's submission. The methodology for estimating the biomass burned and the consequent emissions is explained in chapter 6.13.

6.10.7. 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.

6.10.8. 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 (see chapter 6.3.5). 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%.

6.10.9. Recalculations

The estimate of emission/removals of GHG by wetlands is extended from previous estimates as many new components are estimated for the first time in this year's submission. These new components are also estimated for the previously submitted inventory years. For the year 2012 the total emission reported for the wetland category was 18.05 kt CO_2 eq in last year's submission (19.64 kt CO_2 eq applying same warming potential of CH_4 as in this year's submission). In this year's submission the total emission of the wetland category is reported as 1,029.68 kt CO_2 eq, reflecting the recalculation effect.

6.10.10. 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.

6.11. Settlements

The area of Settlement reported is revised. In previous submissions a buffer zone was applied on all roads representing the area administratively designated to the road. The width of the buffer zone is revised in this submission to better reflect the actual land cover of the roads rather than administrative boundaries of the roads (see chapter). 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 (The land use map of IGLUD for the year 2013

) i.e. towns and villages 15.04 kha and other settlements 12.43 kha in the inventory year. The total area reported in this submission is 27.47 kha compared to 51.46 kha in last year's submission. The difference explained by revised buffer zone.

6.11.1. 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.

6.11.2. Land converted to Settlement

6.11.2.1. 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.

6.11.2.2. 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”

6.11.3. 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” 0.01 kha and “All other Grassland subcategories converted to Settlement”, 0.13 kha.

6.11.3.1. Carbon stock changes in living biomass

Carbon stock changes in living biomass of “Natural birch shrubland converted to Settlements” are estimated according to T3 estimate of its 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 -0.03 kt C and -1.19 kt C or 0.12 kt CO_2, and 4.37 kt CO_2 emitted from “Natural birch shrubland converted to Settlements” and “all other grassland converted to Settlement” respectively.

6.11.3.2. Carbon stock changes in dead organic matter

C-stock in dead organic matter of “Natural birch shrubland converted to Settlement” is not estimated but the changes in “All other Grassland subcategories converted to Settlements” are included under changes in living biomass of the categories.

6.11.3.3. 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 6.7.5 above. The total changes in stock reported are -0.03 kt C causing emission of 0.11 kt CO_2.

6.11.4. 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.

6.11.5. Other emissions

No other sinks or sources of removal/emission are recognized for the Settlement category.

6.11.6. Biomass burning

No biomass burning is recorded for this category

6.11.7. 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 6.7.6. 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.

6.11.8. Uncertainties and QA/QC

The revision of buffer zone on mapped roads is considered to have improved the area estimate of the category. No quantitative estimate on uncertainty of the map layers is currently available.

6.11.9. Recalculations

As new estimates for changes in Settlement area and Land converted to Settlement is applied and the emission related to majority of land converted is estimated for the first time in this submission, the emission estimates of previous submissions is recalculated. For the year 2012 the total emission of the category reported is 4.60 kt CO_2 eq in this year's submission compared to 0.11 kt CO_2 eq in last year's submission reflecting the effects of the recalculations.

6.11.10. Planned improvements regarding Settlement

The improvements in estimate of Settlement area reported as planned in last year's submission have now been implemented. 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.

6.12. 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 (see

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

Table 6-1). The map layers included in the category "Other land" are areas with vegetation cover < 20% or covered with mosses.

6.12.1. Biomass burning

No biomass burning on "Other land" is recorded for the inventory year.

6.13. The emission of N_2O from N mineralization/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 a included option in CRF-reporter (version 5.10.199 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.

6.14. Indirect N2O 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.

6.15. 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 categorised 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 6.1: Equation 2.27 from AFULU guidelines (IPCC 2006): L_{fire}=tonnes of GHG emitted, A= area burned [ha], M_B=mass of fuel available [tonnes/ha], C_f =combustion factor, G_{ef}= emission factor [gGHG/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 tonnes 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.

6.15.1. Planned improvements regarding biomass burning

Recording of the area where controlled biomass burning is licenced 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 licences on controlled burning can be expected in near future. This development might involve better recordkeeping on biomass burning.

6.16. Other

6.16.1. 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.

6.17. Key factors of no target within LULUCF

Three categories within LULUCF with land as source but no target land use category pinpointed are recognised as key categories of level 2013, 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 N2O Emissions from N Mineralization/Immobilization”. The emissions of CH_4 and N_2O of these categories are also recognized as key factors in trend 2013

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 2013, 85 tonnes of hazardous waste were landfilled, 426 tonnes were incinerated, 6,091 tonnes were recycled, and 122 tonnes of acid were neutralized.

Clinical waste has been incinerated in incinerators either at hospitals or at waste incineration plants. In 2013, a total of 94 tonnes of clinical waste were incinerated in Icelandic incineration plants.

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 2013, more than 90% 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 2013, about 44% of all waste generated was landfilled, 48% recycled or recovered, 4% 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 226 Gg CO_2 equivalents in 2013, which is tantamount to a 35% increase since 1990. Between 2012 and 2013, emissions from the waste sector increased by 5.7% mainly due to an increase of SWD emissions. Around 91% of all emissions from the waste sector (2013) are caused by solid waste disposal, 1.3% by composting, 2.4% by waste incineration without energy recovery, and 5.3% by wastewater treatment. The development of greenhouse gas emissions from the waste sector is shown in Figure 7.1.

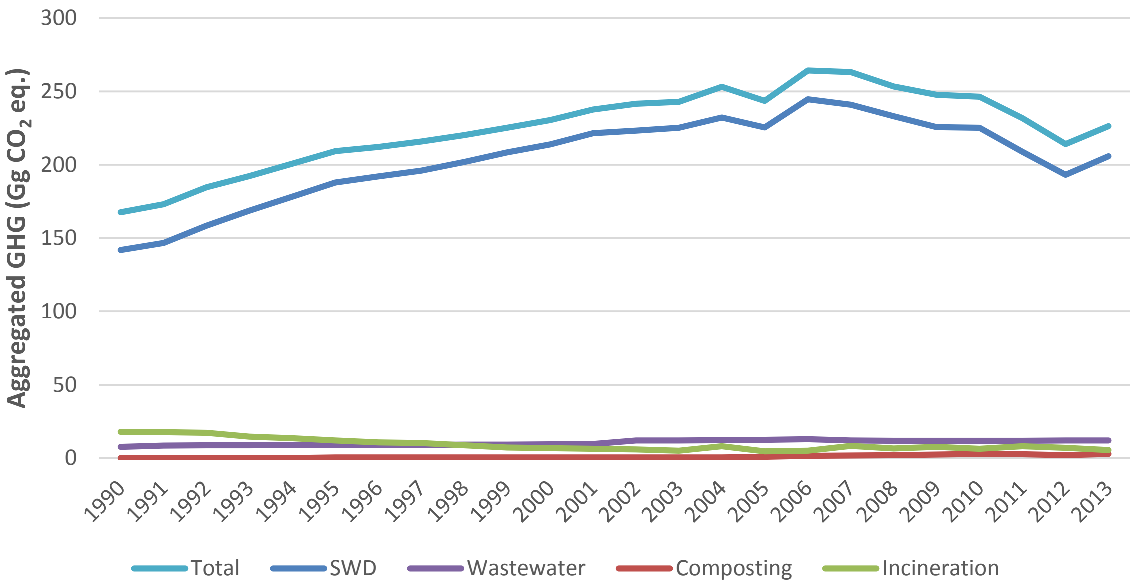


Figure 7.1 Greenhouse gas emissions from the waste sector in Iceland the year 2013 in Gg CO_2 eq. CO_2, CH_4, and N_2O emissions were aggregated by calculating CO_2 equivalents for CH_4 and N_2O (factors 25 and 298, respectively).

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 Gg. 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 2013. The result was projected back in time using expert judgement. Until last year 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 2015 submission revealed that in terms of total level and/or trend uncertainty the key sources in the waste sector are as follows:

- Managed waste disposal on land – CH_4 (4A1)
  - This is a key source in level (2013) and trend
- Unmanaged waste disposal on land – CH_4 (4A2)
  - This is a key source in level (1990) and trend
- Incineration and open burning of waste – N_2O (4C)
  - This is a key source in trend

7.1.4. Completeness

Table 7.1 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 7.1. 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 (4A)						
- **Managed (4A1)**	NE	E	NE	NE	NE	E
- **Unmanaged (4A2)**	NE	E	NE	NE	NE	E
- **Uncategorised (4A3)**	NE	E	NE	NE	NE	E
Biological treatment of solid waste (4B)	NE	E	E	NE	NE	NE
Waste incineration and open burning of waste (4C)						
- **Waste incineration (4C1)**	E	E	E	E[1]	E[1]	E[1]
- **Open burning (4C2)**	E	E	E	E[1]	E[1]	E[1]
Wastewater treatment and discharge (4D)						
- **Domestic (4D1)**	NE	E	E	NE	NE	NE
- **Industrial (4D2)**	NE	IE[2]	IE[2]	NE	NE	NE
Other (4E)	NO	NO	NO	NO	NO	NO

1: Data also submitted under CLRTAP; 2: included in 4D1

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

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, 2013). 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 2011and 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).

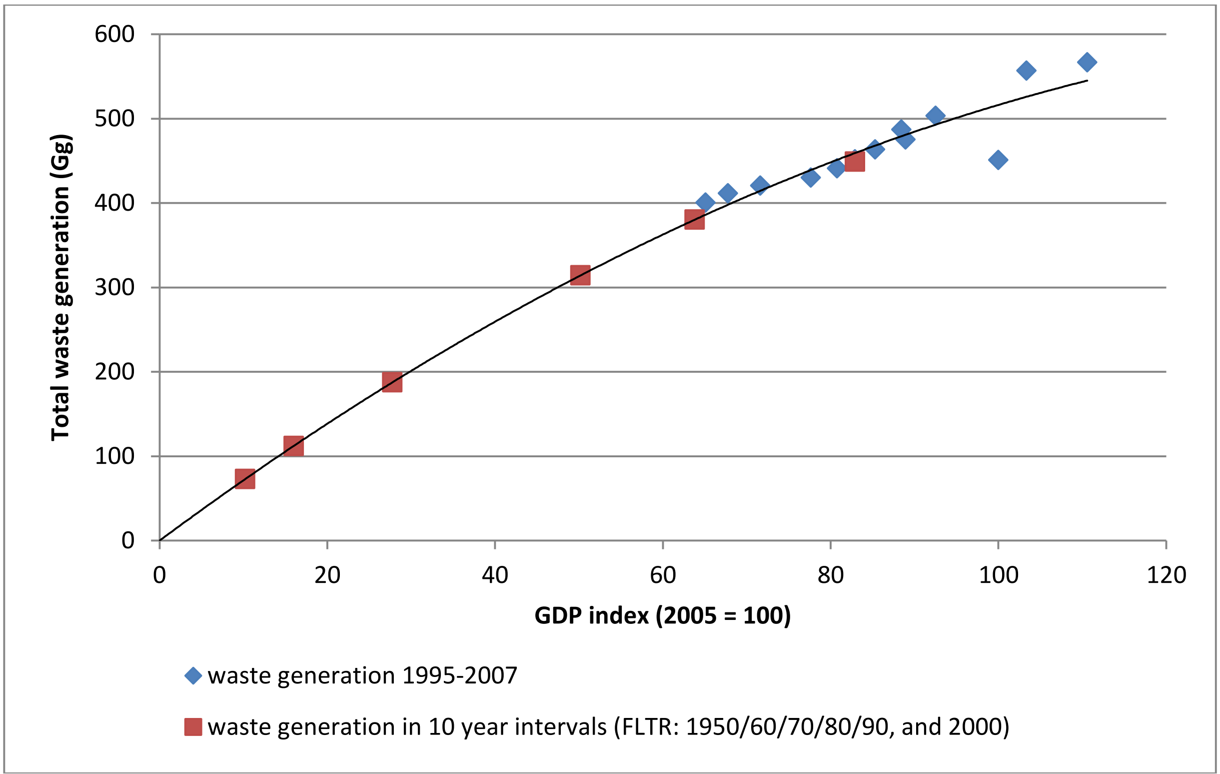


Figure 7.2. Waste generation from 1950-2007. Blue rhombuses denote waste generation between 1995 and 2007 and were used to calculate waste amounts before 1995, which are shown as red squares in 10 year intervals along the trend line.

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 1950-2012 are shown in Figure 7.3.

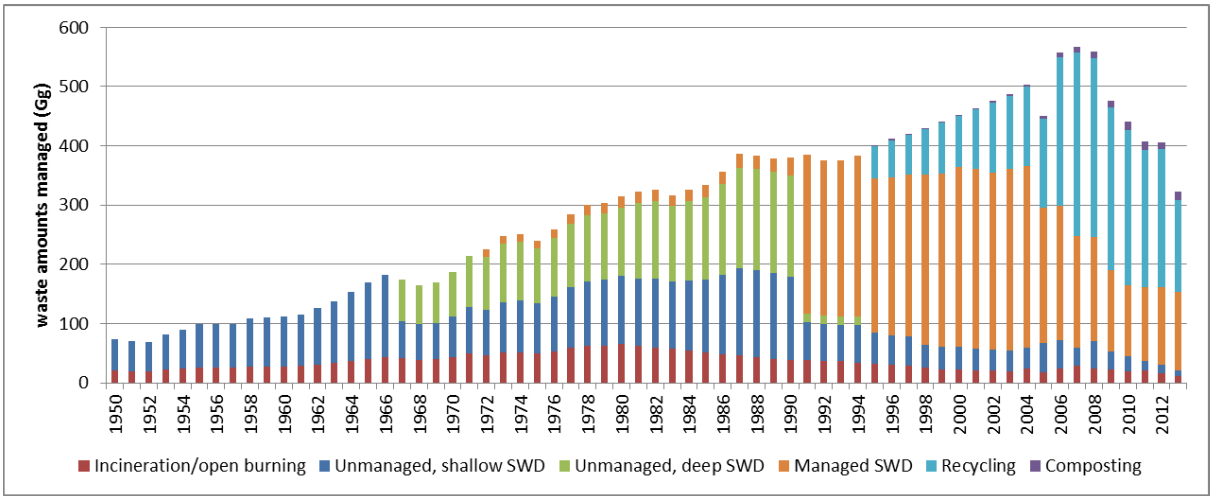


Figure 7.3. Waste amount and allocation to incineration/open burning, solid waste disposal, recycling and composting.

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.

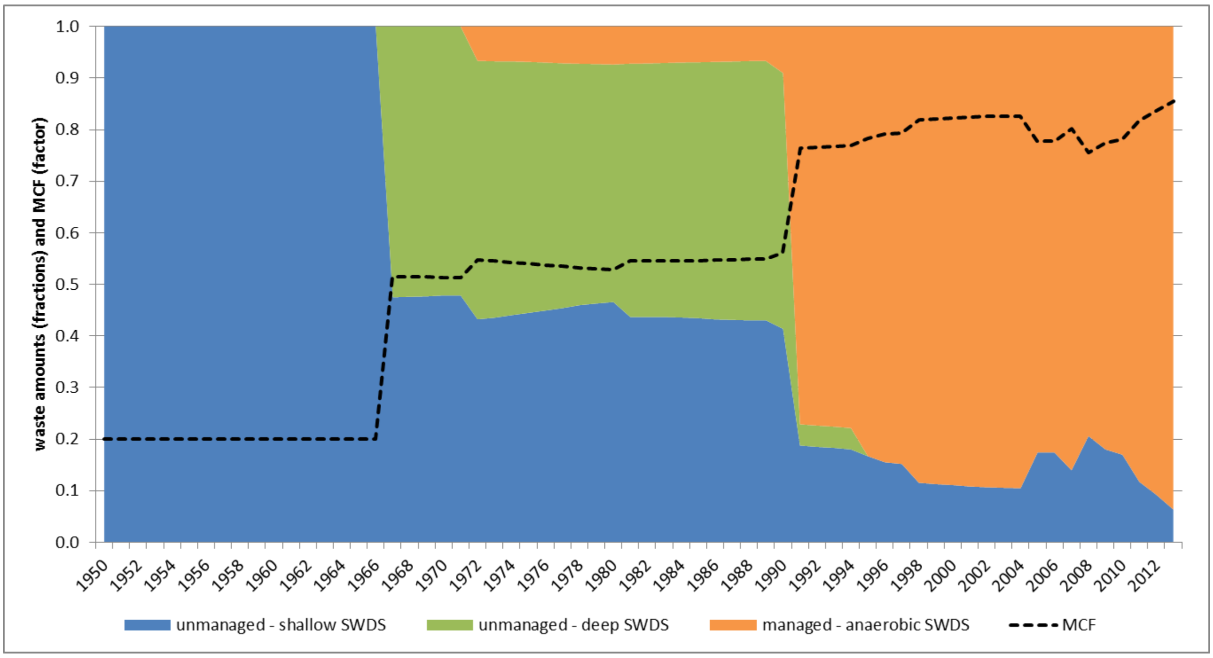


Figure 7.4. Fractions of total waste disposed of in unmanaged and managed SWDS and corresponding methane correction factor

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 7.2.

Table 7.2. 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 7.3. 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 7.3. Waste category fractions for selected years since 1950.

	food	food industry	paper	textiles	wood	garden	diapers	demolition	sludge	inert
1950	48.2%	7.0%	9.4%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	18.7%
1960	42.8%	7.0%	11.7%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	21.7%
1970	37.3%	7.0%	14.1%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	24.8%
1980	31.9%	7.0%	16.4%	2.5%	3.3%	3.4%	0.0%	5.7%	1.8%	27.9%
1990	16.2%	7.0%	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	30.4%	8.7%	16.6%	2.1%	2.4%	3.2%	5.2%	2.0%	1.4%	28.1%
2013	38,0%	9,3%	7,1%	2,9%	2,7%	3,4%	7,2%	0,6%	1,5%	27,5%

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 = (Σ_x CH_4 generated$_{x,T}$ - R_t) * (1 – OX_t)**

Where:

CH_4 Emissions = CH_4 emitted in year T, Gg

T = inventory year

x = waste category or type/material

RT = recovered CH_4 in year T, Gg

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 7.4.

Table 7.4. Emission factors and parameters used to calculate methane generated.

Emission factors/parameters	values
Degradable organic carbon in the year of deposition (DOC)	Table 7.5
Fraction of DOC that can decompose (DOC_f)	0.5
Methane correction factor for aerobic decomposition (MCF)	Table 7.6
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 7.5
Half-life time of waste in years (y)	Table 7.5
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 7.5).

Table 7.5. 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 7.3) 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 in Table 7.6. 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 (cf.

).

Table 7.6. IPCC methane correction factors and MCFs used in NIR 2015.

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**
- **$DDOCma_T = DDOC\ md_T + (DDOCmaT\text{-}1 * e^{-k})$**
- **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, Gg

DDOCmaT-1 = DDOCm accumulated in the SWDS at the end of year (T-1), Gg

DDOCmdT = DDOCm deposited into the SWDS in year T, Gg

DDOCm decompT = DDOCm decomposed in the SWDS in year T, Gg

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

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.

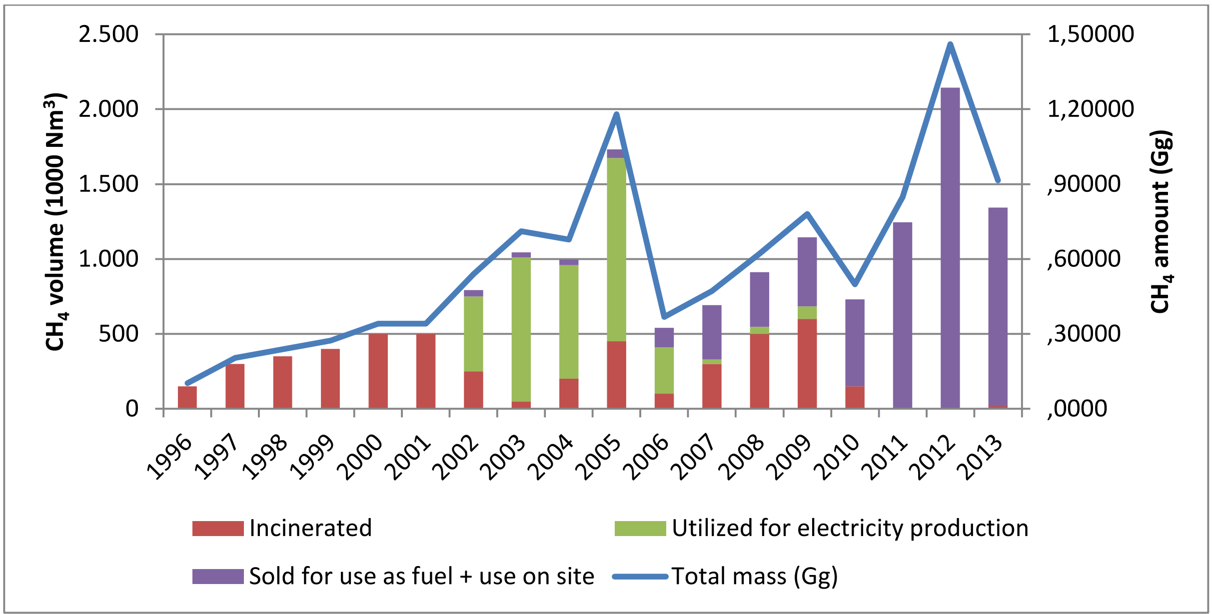


Figure 7.5. Methane recovery at Álfsnes solid waste disposal site (1000 Nm³).

Methane emissions

In 1990 methane emissions from SWDS amounted to 5.7 Gg CH_4 and increased to 9.8 Gg in 2006. Since 2006 they decreased again and were estimated at 8.2 Gg in 2013. This equals an increase of 45% between 1990 and 2013.

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 2013 83% 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.

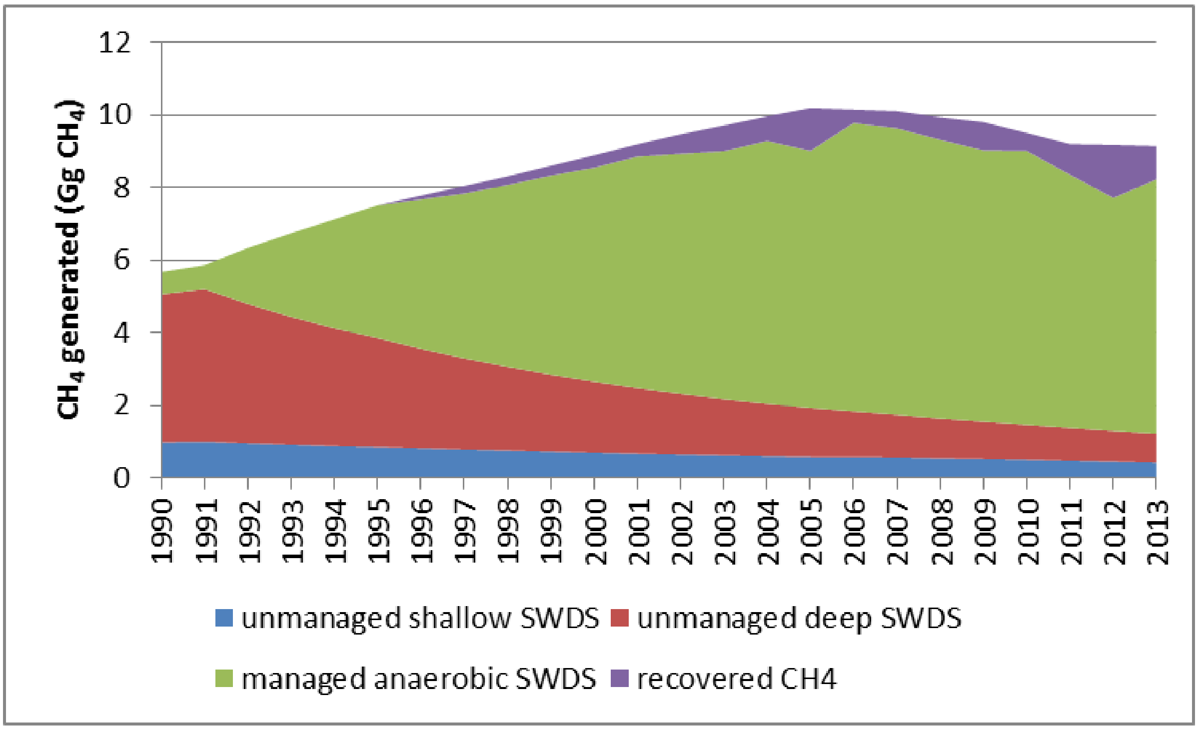


Figure 7.6. Methane generated from SWDS, separated into SWDS types. The amount of methane recovered at the managed SWDS Álfsnes is shown as purple area (reducing the size of the green area for emissions from managed SWDS).

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 2013 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 almost 15 kt in 2013.

Methodology

Estimation of CH_4 and N_2O emissions from composting are calculated using the Tier 1 method of the 2006 GL.

7.3.2. 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 2013 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.

7.3.3. 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

7.3.4. Emissions

CH_4 emissions from composting amounted to 0.06 Gg CH_4 or 1.5 Gg CO_2 equivalents in 2013. N_2O emissions amounted to 0.005 Gg N_2O or 1.34 Gg CO_2 equivalents in 2013. This is shown in Figure 7.7.

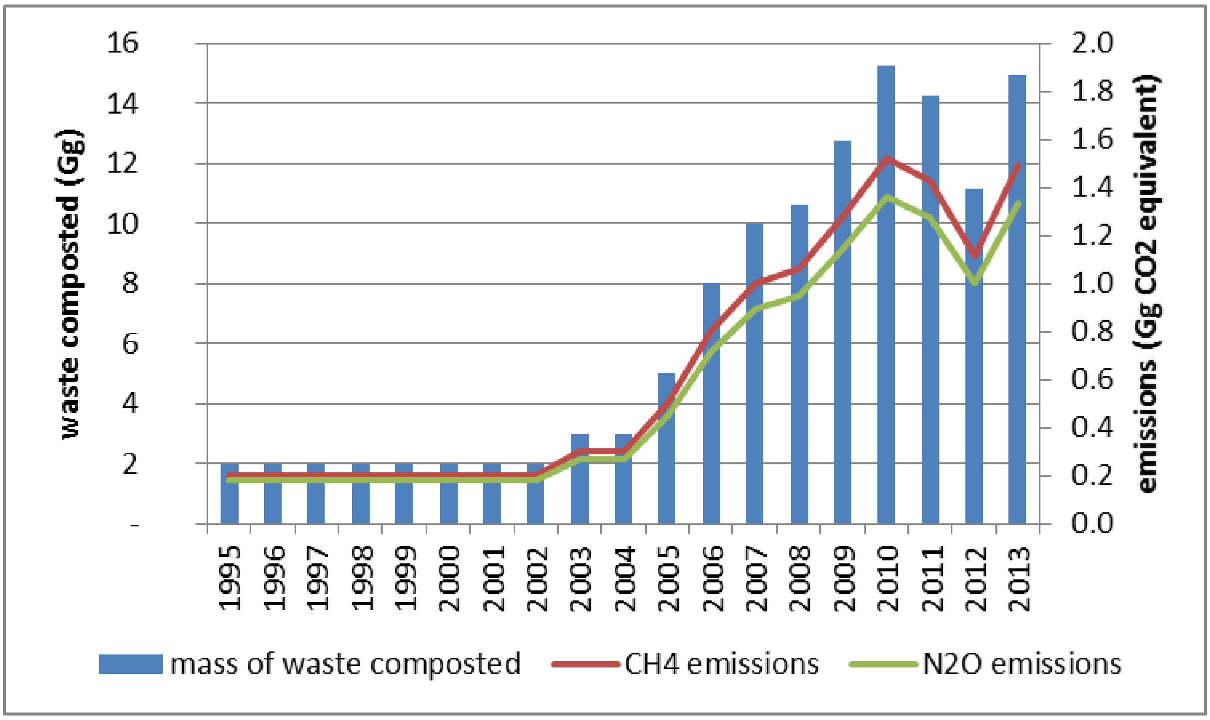


Figure 7.7. Mass of waste composted and resulting CH_4 and N_2O emissions (in Gg CO_2 eq).

7.3.5. 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 2013. 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 17.9 Gg CO_2 eq. in 1990 to 5.5 Gg CO_2 eq. in 2013.

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.

7.4.2. 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 the 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.

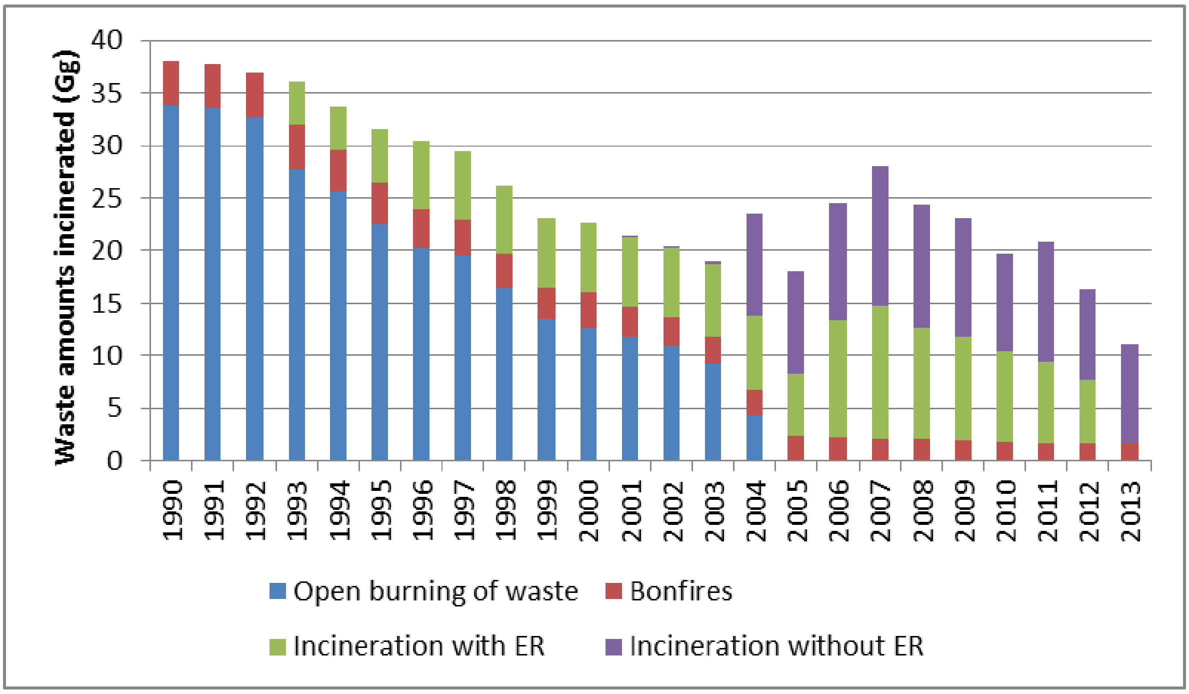


Figure 7.8. Amounts of waste incinerated without energy recovery, burned openly and amount of woodburned in bonfires.

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 2013. 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.

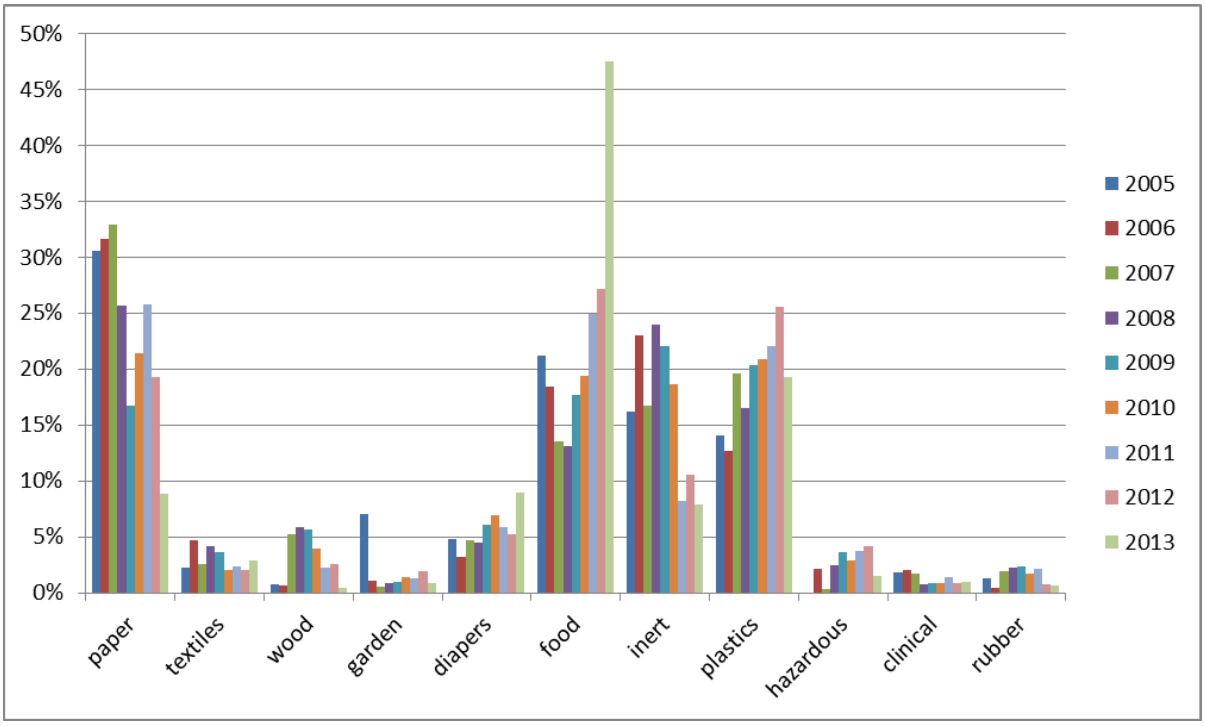


Figure 7.9. Waste categories for incineration along with weight fractions for 2005-2013 and the average weight fraction of whole period.

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).

7.4.3. 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 emissions = MSW * Σ_j (WF_j * dm_j * CF_j * FCF_j * OF_j) * 44/12**

Where:

CO_2 Emissions = CO_2 emissions in inventory year, Gg/yr

MSW = total amount of municipal solid waste as wet weight incinerated or open-burned, Gg/yr

WFj = fraction of waste type/material of component j in the MSW (as wet weight incinerated or openburned)

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 2013 in Table 7.7.

Table 7.7. Calculation of fossil carbon amount incinerated in 2013. The column "fossil carbon (wet weight basis), fraction" is the product of the three columns preceding it.

	waste category	**waste category**	**dry matter**	**carbon content (dry weight basis)**	**fossil carbon (total carbon basis)**	**fossil carbon (wet weight basis)**	**fossil carbon**

tonnes/fractions	weight	fraction	fraction	fraction	fraction	fraction	weight
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 7.8 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.

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 7.8.

Table 7.8. 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

7.4.4. 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 Gg in 1990 Gg to 0.03 Gg 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 5.5 Gg CO_2 eq. in 1990 to 0.06 Gg in 2012.

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 7.8). N_2O emissions decreased from 1.2 Gg CO_2 eq. in 1990 to 0.2 Gg in 2013. This decrease is caused by both decreasing waste amounts and a lower EF for waste incineration as opposed to open burning of waste. Aggregated GHG emissions from waste incineration and open burning of waste decreased by 59% during this period.

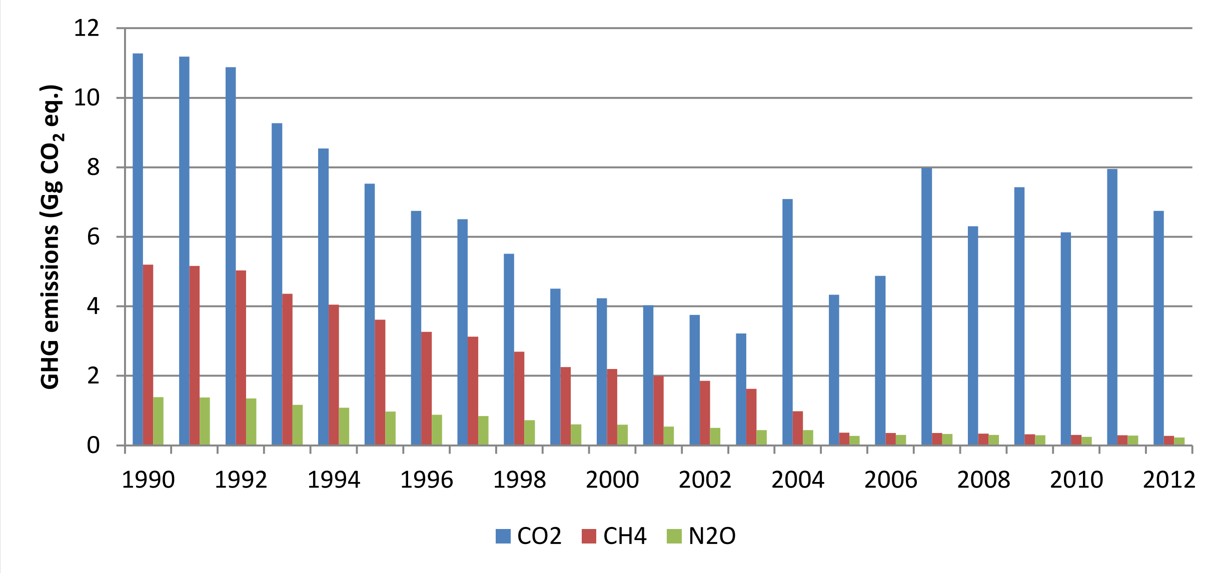


Figure 7.10. CO_2 emissions from incineration and open burning of waste in Gg.

7.4.5. 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 1990-2013 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 12.1 Gg CO_2 equivalents in 2013. Compared to 1990 emissions of 7.7 Gg CO_2 equivalents this means an increase of 57%.

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 2013 annual TOW increased proportionally to population from 5.6 Gg to 7.1 Gg.

- **Equation 6.3**
- **TOW = P · BOD · 0.001 · I · 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)

0.01 = 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 7.9.

Table 7.9. Default parameters used to calculate amount of nitrogen in the wastewater effluent.

Parameter	Default value	Range	Remark
F_{NPR}	0.16		
$F_{NON-CON}$	1.4	1-1.5	The default value of 1.4 for countries with garbage disposal was selected.
$F_{IND-COM}$	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 CH4 /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 7.10 along with respective shares of total wastewater discharge and MCFs.

Table 7.10. Wastewater discharge pathways fractions and population of Iceland from 1990 to 2013.

	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
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 CH4 emissions from domestic wastewater were calculated with equation 6.1 from the 2006 IPCC Guidelines.

- **Equation 6.1**
- **CH_4 emissions = $(\Sigma (T_j * EF_j)) * (TOW - S) - R$**

Where:

CH4 emissions = CH4 emissions in inventory year, kg CH4/yr

TOW = total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr

Tj = degree of utilisation of treatment/discharge pathway or system, j, in inventory year

j = each treatment/discharge pathway or system

EFj = emission factor, kg CH4 / 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. The sudden increase of emissions between 2001 and 2002 is due to an increase of septic system fraction from 6 to 11%. CH_4 emissions were highest in 2006, when they reached 0.22 Gg. In recent years the share of septic systems has decreased to 8%, which caused a decrease of emissions to 0.17 Gg in 2013. This is tantamount to an increase of wastewater treatment emissions of 155% since 1990. The decrease of septic systems in Iceland after 2008 was caused by the completion of the Kárahnjúkar hydropower plant where the wastewater of the workforce had been collected in septic tanks.

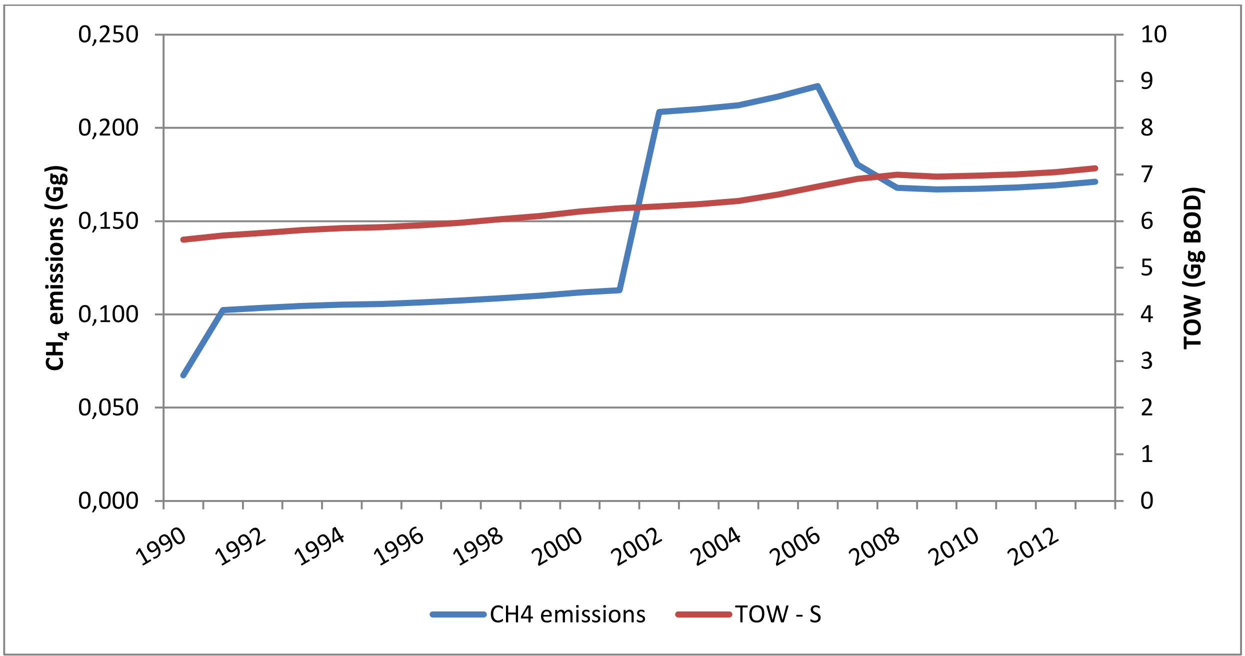


Figure 7.11. Methane emissions and total organics in wastewater in Iceland from 1990 to 2013.

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 0.020 Gg in 1990 to 0.026 in 2013. This is tantamount to an increase of 31%. The main driver behind this development was a 27% increase of population during the same time.

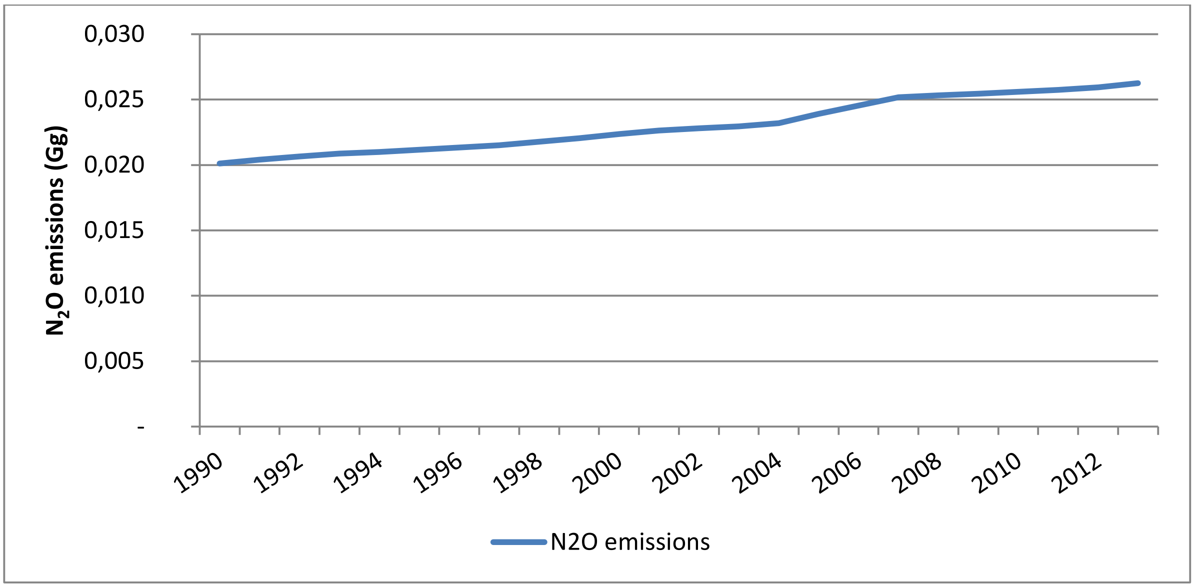


Figure 7.12. N_2O emissions from wastewater effluent between 1990 and 2013 in Gg.

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.

8. INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

9. RECALCULATIONS AND IMPROVEMENTS

10. INFORMATION ON ACCOUNTING OF KYOTO UNITS

10.1. Background Information

The national registry is maintained by the Environment Agency of Iceland. The registry holds as of 7th of April 2014: 46 EU ETS accounts, thereof 5 Operator holding accounts, 32 Aircraft operator holding accounts, 7 Verifier accounts, 1 National holding account and 1 Party holding account.

Iceland's AAUs, 18,523,847 tonnes of CO_2-equivalents, for the first commitment period were issued in the Icelandic Registry in September 2013. In addition, 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.

10.2. 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 will submit the SEF tables for the first time in April 2014 for the issued Kyoto Protocol units in 2013. In accordance with decision 13/CMP.1, annex, under paragraph 47, annual external transactions consisted of additional 182 AAUs from SE (account ID 926) issued on the basis of the assigned amount pursuant to Article 3 and 5,087 ERUs from EU (account ID 5017348) issued on the basis of Article 6 projects, 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. No problems were found in Iceland's SEF table when performing completeness check and consistency check.

10.3. Discrepancies and Notifications

No discrepancies or notifications have occurred in relation to Iceland's accounting of Kyoto units in 2013.

10.4. 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

10.5. 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 CO2 equivalent, calculated as 90% of Iceland's assigned amount.

10.6. KP-LULUCF Accounting

Iceland intends to account for Article 3.3 and 3.4 LULUCF activities for the entire commitment period. Iceland has 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 would allow issuance of 1,541,960 RMUs (Table 10.1).

Table 10.1. Removals from activities under Article 3.3 and 3.4 and resulting RMUs.

	2008	2009	2010	2011	2012	Total
Article 3.3 (t CO_2)	103,268	115,465	135,426	153,265	172,805	680,229
Article 3.4 (t CO_2)	152,293	159,608	171,719	184,453	193,658	861,730
RMUs	**255,561**	**275,073**	**307,145**	**337,718**	**366,463**	**1,541,960**

10.7. 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 will undertake 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 Gg in 2008, to 1,205 Gg in 2009, to 1,225 in 2010, to 1,209 Gg in 2011 and to 1,279 Gg in 2012. Total CO_2 emissions fulfilling the provisions of Decision 14/CP.7 for the first commitment period under the Kyoto Protocol therefore are 6,079 Gg.

10.8. Summary of Kyoto accounting for the 1. Commitment Period

Iceland´s initial assigned amount for CP1 were 18,523,847 AAUs. Added to that are a total of 1,541,960 RMUs from Art. 3.3 and Art. 3.4 activities resulting in an available assigned amount of 20,065,807 AAUs.

Emissions from Annex A sources during CP1 were 23,356,066 tonnes CO_2-eq. This means that Annex A emissions were 3,290,264 tonnes CO_2 in excess of Iceland´s available assigned amount.

Total CO_2 emissions falling under Decision 14CP.7 during CP1 were 6,079,323 tonnes CO_2. Therefore, in order to comply with its goal for CP1, would Iceland report 3,290,264 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, stll contain Iceland´s Annex A emissions in their entirety.

Table 12.2 and Figure 12.1 demonstrate this.

Table 10.2. 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
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

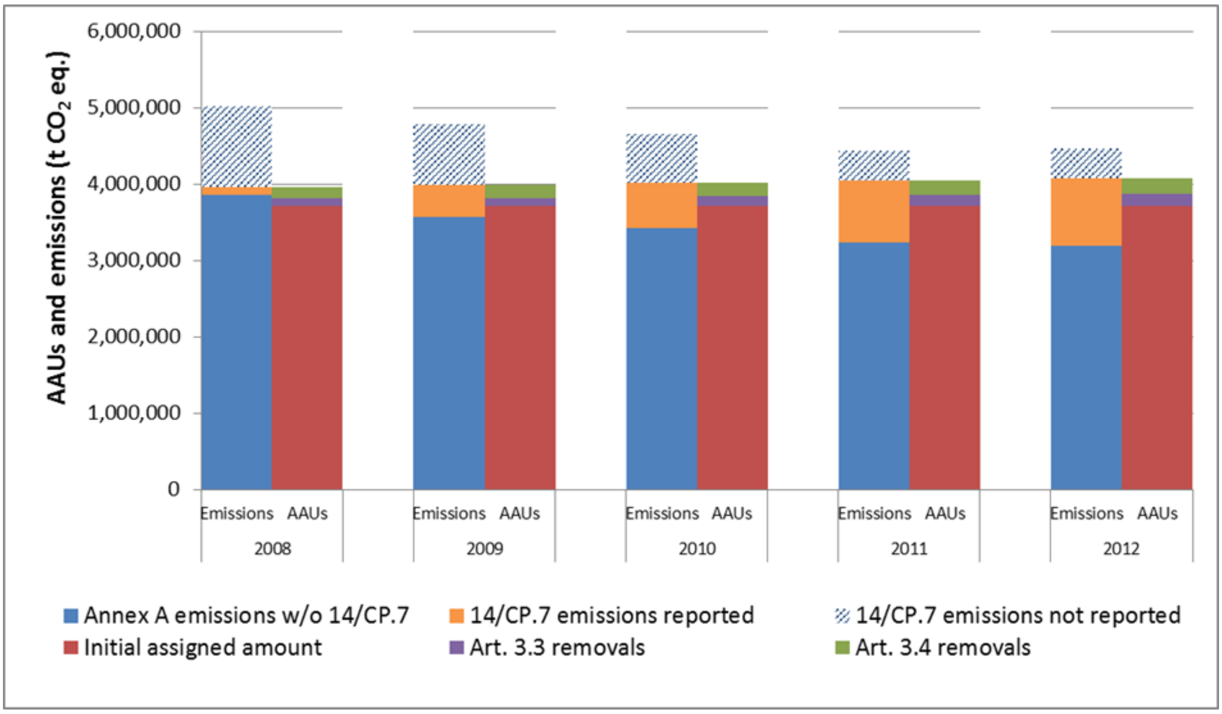


Figure 10.1. Summary of Kyoto accounting for CP1.

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 CHANGES IN NATIONAL REGISTRY

The national registry is maintained by the Environment Agency of Iceland as before.

The following changes to the national registry of Iceland have therefore occurred in 2014.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	Registry System Administrators: Kristján Andrésson - (kristjan@registry.ust.is) Margrét Helga Guðmundsdóttir(margret.gudmundsdottir@ust.is) Vanda Hellsing - (vanda@registry.ust.is)
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	An updated diagram of the database structure is attached as Annex A. Versions of the CSEUR released after 6.1.7.1 (the production version at the time of the last Chapter 14 submission) introduced 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. 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 6.1.7.1 of the national registry were limited and only affected EU ETS functionality. However, 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 B). Annex H testing was carried out in February 2015 and the test report is provided as part of this submission. No other change in the registry's conformance to the technical standards occurred for the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
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 6.1.7.1 of the national registry were limited and only affected EU ETS functionality. 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 B. Annex H testing was carried out in February 2015 and the test report is provided as part of this submission.

13. INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

REFRENCES

Alþingi (2007). Lög um losun gróðurhúsalofttegunda nr. 65. Lagasafn. Íslensk lög 15. maí 2009. Útgáfa 136 p. (in Icelandic).

Aradóttir, Á. L., Svavarsdóttir, K., Jónsson, T. H., and Guðbergsson, G. (2000). Carbon accumulation in vegetation and soils by reclamation of degraded areas. Icelandic Agricultural Sciences 13: 99-113.

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

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

Arnalds, Ó., Orradottir, B. and Aradottir, A.L. 2013 Carbon accumulation in Icelandic desert Andosols during early stages of restoration. *Geoderma*, 193–194, 172-179.

Arnalds, Ó. and Óskarsson H. (2009). Íslenskt Jarðvegskort. Náttúrufræðingurinn, 78 (3-4): 107-121 (in Icelandic)

Arnalds, Ó., Óskarsson, H., Gísladóttir, F. O. and Grétarsson, E. (2009). Íslenskt Jarðvegskort Landbúnaðarháskóli Íslands.

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

ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers). (2007). Designation and Safety Classification of Refrigerants. Online at www.ashrae.org

Auðunsson, G.A. (2002). Hegðun og samsetning fráveituvatns í Skolpu 2000-2001. Icelandic Fisheries Laboratories Report Summary 27/03/2002 (in Icelandic).

Ármannsson, H., Friðriksson, Þ., Kristjánsson, B. (2005). CO_2 emissions from geothermal power plants and natural geothermal activity in Iceland. Geothermics 34:286-296.

Baldvinsson, Í, Þórisdóttir, Þ. H., Ketilsson, J. (2011). Gaslosun jarðvarmavirkjana á Íslandi 1970-2009. OS 2011/02, 33 p. (in Icelandic)

Bjarnadóttir, B. (2009). Carbon stocks and fluxes in a young Siberian larch (Larix sibirica) plantation in Iceland. Department of Physical Geography and Ecosystem Analysis. Lund, Lund University. Ph.D: 171 p.

Bossard, M., Feranec, J., and Otahel, J.(2000). CORINE land cover technical guide – Addendum 2000, European Environment Agency, Copenhagen No 40, 10.

Bændasamtök-Íslands (2010). Hagtölur landbúaðarins, Bændasamtök Íslands. (in Icelandic)

Climate and Pollution Agency of Norway (2011). National Inventory Report. Greenhouse Gas Emissions 1990-2009. 256 p.

Dämmgen, U., Amon, B., Gyldenkærne, S., Hutchings, N. J., Kleine Hausing, H. Haenel, H.-D., Rösemann, C. (2011). Reassessment of the calculation procedure for the volatile solid excretion rates of cattle and pigs in the Austrian, Danish and German agricultural emission inventories. Landbauforschung – vTI Agricutlure and Forestry Research 2 2011 (61), p. 115-126.

EA (2002). Starfsreglur um góða búskaparhætti (Codes of good agricultural practice). Starfshópur um meðferð úrgangs frá landbúnaði: 17 http://ust.is/library/Skrar/utgefid-efni/Annad/buskaparhaettir.pdf (in Icelandic)

EA (2003). Landfill Gas Formation in Iceland. A study on Landill Gas Formation in landfills in Iceland, in relation to the implementation of the Landfill Directive into the national act.

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

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

EA (2007). Quality Assurance and Quality Control Plan for the Icelandic Greenhouse Gas Inventory. http://www.ust.is/library/Skrar/Atvinnulif/Loftslagsbreytingar/Iceland_QAQC_plan.pdf

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

Hjarðar, G. Bjarni, Á. Personal communication on March 14th 2013.

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

Friðriksson et al. (2006). CO_2 emissions and heat flow through soil, fumaroles, and steam heated mud pools at the Reykjanes geothermal area, SW Iceland. Applied Geochemistry. 21(9): 1551-1569.

Gísladóttir, F. Ó., Metúsalemsson, S., and Óskarsson, H. (2007). Áhrifasvæði skurða: Greining með fjarkönnunaraðferðum. Fræðaþing landbúnaðarins 2007, Reykjavík, 371-376, (in Icelandic)

Gísladóttir, F., Gudmundsson, J. and Áskelsdóttir, S. (2009). Íslenskt skurðakort og greining á þéttleika skurða. Fræðaþing Landbúnaðarins 2009.

Gísladóttir, F., Gudmundsson, J. and Áskelsdóttir, S. (2010). Mapping and density analyses of drainage ditches in Iceland. Mapping and monitoring of Nordic Vegetation and landscapes. Hveragerði, Norsk Insitute for Skog og landskap.

Grétarsdóttir, J. and J. Guðmundsson (2007). Skammtímaáhrif sinubruna á Mýrum 2006 á gróðurfar og uppskeru. Fræðaþing landbúnaðarins 2007, Reykjavík. (In Icelandic)

Guðmundsson, J. (2009). Vísinda og tæknileg lokaskýrsla: Verkefni: Losun hláturgass og annarra gróðurhúsaloftteguanda úr lífrænum jarðvegi við mismunandi landnotkun. Lbhi: 11 (in Icelandic)

Gudmundsson, J., S. H. Brink and F. Gísladóttir (2013). Preparation of a LULUCF land-use map for Iceland: Development of the Grassland layer and subcategories Grassland. Science in Europe 13.

Guðmundsson, J., Gísladóttir, F., Brink S. H. and Óskarsson, H. (2010). The Icelandic Geographic Land Use Database (IGLUD). Mapping and monitoring of Nordic Vegetation and landscapes. Hveragerði, Norsk Insitute for Skog og landskap.

Guðmundsson, J., Gísladóttir, F. Ó. and Brink, S.H. (in prep). Description of methods and definitions of land use classes used in the Icelandic Land Use Database. Unpublished results,

Guðmundsson, J. and Óskarsson, H. (2013). Carbon dioxide emission from drained organic soils in West-Iceland. Unpublished results

Gudmundsson, J. and H. Óskarsson (2014). Carbon dioxide emission from drained organic soils in West-Iceland. Soil carbon sequestration: for climate, food security and ecosystem services. Proceedings of the International Conference 27-29 May 2013, Reykjavík, Iceland. JRC Scientific and Policy Reports. European Union. In press. G. Halldórsson, F. Bampa, A. B. Þorsteinsdóttiret al.

Guðmundsson, Ó. And Eiríksson, T. (1995) Breyting á orkumatskerfi fyrir jórturdýr (Ráðunautafundur, 1995) (in Icelandic)

Gunnarsdóttir, I., Eysteinsdóttir, T. & Þórsdóttir, I. (2008).Hvað borða íslensk born á leikskólaaldri? Könnun á mataræði 3ja og 5 ára barna 2007. Online at: http://www.landlaeknir.is/servlet/file/store93/item14897/version2/3ja_og_5_ara_skyrsla_181208.pdf. (in Icelandic)

Gunnarsson, E. (2009). Skógræktarárið 2008. Skógræktaritið 2009 (2): 90-95. (in Icelandic)

Gunnarsson, E. (2010). Skógræktarárið 2009. Skógræktarritið 2010 (2): 90-95. (in Icelandic)

Gunnarsson E. (2011). Skógræktarárið 2010. Skógræktarritið 2011. 2. tbl. bls. 96-101. (in Icelandic)

Gunnarsson E. (2012). Skógræktarárið 2011. Skógræktarritið 2012. 2. tbl. bls. 90-95. (in Icelandic)

Gunnarsson E. (2013). Skógræktarárið 2012. Skógræktarritið 2013. 2. tbl. bls. 84-89. (in Icelandic)

Halldórsson, G., Agustdottir, A. M., Bau, A., Thorarenssen J., Thorsson, J. & Svavarsdóttir K (2009) (in prep.). A national inventory of carbon stocks in revegatation areas in Iceland.Unpublished results

Hermannsson, J. (1993). Kornrækt á Íslandi. Ráðunautafundur 1993, Reykjavík, RALA (in Icelandic)

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

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

http://www.orkuvefsja.is/vefsja/orkuvefsja.html

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

Ívarsson, Á., Ingólfsson, F., Ólafsson G. (2011). Mat á metanmyndun í Glerárdal – Afkastamælingar. Confidential project report.

International Aluminium Institute (2010). Results of the 2009 anode effect survey. Report on the Aluminium Industry’s Global Perfluorocarbon Gasses Emission Reduction Programme, 1-47.

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

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

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

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

Jóhannesson, B. (1988). Íslenskur jarðvegur. Reykjavík, Rannsóknastofnun landbúnaðarins. (in Icelandic)

Jónmundson, J. V. and E. Eyþórsdóttir (2013). Erfðir og kynbætur sauðfjár. Sauðfjárrækt á Íslandi. R. Sigurðardóttir. Reykjavík, Uppheimar. (in Icelandic)

Jónsson, J. (1968). Ræktun landsins. Bættir eru bænda hættir: landbúnaðurinn, saga hans og þróun. Bókaútgáfan Þorri: 30-50. (in Icelandic)

Jónsson T.H. 2004. *Annals of Botany* 94: 753–762. doi:10.1093/aob/mch200, available online at www.aob.oupjournals.org

Júlíusson, A. G. (2011). Hauggasrannsóknir á Urðunarstöðum á Íslandi. M. Sc. Thesis, Umhverfis- og byggingarverfræðideild, University of Iceland, 123 p. (in Icelandic)

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

Ketilsdóttir, S. Ó and Sveinsson, Þ. (2010). Efnainnihald kúamykju og mælingar in situ á þurrefni, NH4-N og P með Agros Nova mælibúnaði. Fræðaþing landbúnaðarins 2010, s 207-215. (in Icelandic)

Ketilsdóttir, S. Ó and Sveinsson, Þ. (2010). Gashæfni kúamykju og möguleikar metanvinnslu í Eyjafirði. Fræðaþing landbúnaðarins 2010, s 18-26 (in Icelandic)

Kolka-Jónsson, P.V. 2011 CarbBirch (Kolbjörk): Carbon sequestration and soil development under mountain birch (Betula pubescens) in rehabilitated areas in southern Iceland. MS, The Ohio State University.

Landmælingar_Íslands (1943). Herforingjaráðskort.

Landsvirkjun, Landsvirkjun´s history. http://www.landsvirkjun.is/Fyrirtaekid/Saga/

Magnússon, B. ó., Barkarson B. H., Guðleifsson B. E., Maronsson B. P., Heiðmarsson S., Guðmundsson G. A., Magnússon S. H. and Jónsdóttir S. r. (2006). Vöktun á ástandi og líffræðilegri fjölbreytni úthaga 2005. Fræðaþing Landbúnaðarins, Reykjavík (in Icelandic)

Maljanen, M., Sigurdsson, B. D., Gudmundsson, J., Óskarsson, H., Huttunen, J. T. and Martikainen, P. J. (2010). "Greenhouse gas balances of managed peatlands in the Nordic countries – present knowledge and gaps." Biogeosciences 7(9): 2711-2738.

McFarland, M. (2000). Biosolids Engineering. McGraw-Hill Professional. 800 p.

Ministry for the Environment (2007). Climate Change Strategy. http://eng.umhverfisraduneyti.is/media/PDF_skrar/Stefnumorkun_i_loftslagsmalum_en.pdf

Ministry for the Environment, I. (2007). Vernd og endurheimt íslenskra birkiskóga, Skýrsla og tillögur nefndar. Protection and restoration of Icelandic birch forests, Ministry for the Environment, Iceland (in Icelandic).

Ministry for the Environment (2010). Aðgerðaáætlun í loftslagsmálum (Climate Change Action Plan). Ministry for the Environment, Reykjavík, 40 pp.

National Energy Forecast Committee (2009). Eldsneytisnotkun Íslendinga eftir notkunarflokkum, innlend notkun. Fuel use in Iceland per type, domestic use. (Available on the committee's website: http://orkuspa.is/eldsneyti/Innlend.PDF)

Nielsen, O.-K., Mikkelsen, M.H., Hoffmann, L., Gyldenkærne, S., Winther, M., Nielsen, M., Fauser, P., Thomsen, M., Plejdrup, M.S., Albrektsen, R., Hjelgaard, K., Bruun, H.G., Johannsen, V.K., Nord-Larsen, T., Bastrup-Birk, A., Vesterdal, L., Møller, I.S., Rasmussen, E., Arfaoui, K., Baunbæk, L. & Hansen, M.G. (2012). Denmark's National Inventory Report 2012. Emission Inventories 1990-2010 - Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. Aarhus University, DCE – Danish Centre for Environment and Energy, 1168 pp. Scientific

Report from DCE – Danish Centre for Environment and Energy No. 19 http://www.dmu.dk/Pub/SR19.pdf

Nordisk Ministerrad (1997): BAT Best available technology I fiskeindustrien. TemaNord 1997: 580. 107 p. (in Norwegian)

Norwegian Pollution Control Authority (2007). Revised National Inventory Report 2007.

Norwegian Pollution Control Authority (2009). National Inventory Report 2009.

Norwegian Pollution Control Authority (2011). National Inventory Report 2011.

Orkustofnun (2011). Orkutölur 2011. http://www.os.is/gogn/os-onnur-rit/orkutolur_2011-islenska.pdf

Ólafsdóttir, K. L. and Steinarsdóttir, S. S. (2006). Gamlir urðunarstaðir í Reykjavík. Report of the city of Reykjavík: UHR 3-2006 (in Icelandic)

Óskarsson, H. and Guðmundsson, J. (in prep). Magn kolefnis i lónstæðum Hraunaveitu og áætluð losun gróðurhúsalofttegunda úr þeim. Landsvirkjun. Umpublished results.

Óskarsson, H. and Guðmundsson, J. (2001). Mat á gróðurhúsaáhrifum fyrirhugaðs Hálslóns. Reykjavík. Rala, Landsvirkjun: 31 (in Icelandic).

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

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

Óskarsson, M. and Eggertsson, M. (1991). Áburðafræði (Fertilisers). Búnaðarfélag Íslands: 135 (in Icelandic)

Poulsen H. G. (2009). Normtal for husdyrgödning. http://www.agrsci.dk/var/agrsci/storage/original/application/6ad0435ef70c7cb3b7c30f15b406c0e3 (in Danish)

Reykjavíkurborg (2008). Áætluð losun gróðurhúsalofttegunda frá bílaumferð í Reykjavík. Samantekt fyrir árin 1999-2007 með samanburði við 1990. (in Icelandic)

Road Traffic directorate (2009). http//www.us.is

Dr. Winfried Schwarz, Barbara Gschrey, Dr. André Leisewitz (Öko-Recherche GmbH), Anke Herold, Sabine Gores (Öko-Institut e.V.), Irene Papst, Jürgen Usinger, Dietram Oppelt, Igor Croiset (HEAT International GmbH), Per Henrik Pedersen (Danish Technological Institute), Dr. Daniel Colbourne (Re-phridge), Prof. Dr. Michael Kauffeld (Karlsruhe University of Applied Sciences), Kristina Kaar (Estonian Environmental Research Centre), Anders Lindborg (Ammonia Partnership), 2012.

Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases.

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

Sigurdsson, B. D., Magnusson, B., Elmarsdottir A. and Bjarnadottir, B. (2005). Biomass and composition of understory vegetation and the forest floor carbon stock across Siberian larch and mountain birch chronosequences in Iceland. Annals of Forest Science 62(8): 881-888.

Sigurðsson, B. D. and Snorrason, A. (2000). Carbon sequestration by afforestation and revegetation as a means of limiting net-CO_2 emissions in Iceland. Biotechnol. Agron. Soc. Environ. 4(4): 303-307.

Sigurðsson, B. D., Elmarsdóttir, Á., Bjarnadóttir, B. and Magnússson, B. Ó. (2008). Mælingar á kolefnisbindingu mismunandi skógargerða. Fræðaþing landbúnaðarins (in Icelandic).

Sigurðsson, H. M. (2002). Vatnsaflsvirkjanir á Íslandi, Verkfræðistofa Sigurðar Thoroddssen (in Icelandic)

Skógrækt ríkisins, S. (2008). Skógrækt í skipulagsáætlunum sveitarfélaga (in Icelandic)

Snorrason, A. (2010a). Global Forest Resources Assessment 2010, Country Report, Iceland, Food and Agriculture Organization of the United Nations. Forestry Department, p. 67.

Snorrason, A. (2010b). Iceland. National Forest Inventories - Pathways for Common Reporting. E. Tomppo, T. Gschwantner, M. Lawrence and R. E. McRoberts, Springer: 612.

Snorrason, A. (in prep). Methodology of carbon accounting and other data analysis and aggregations concerning forest and woodland in Iceland for the reporting year of 2007 and 2008 Rit Mógilsár Rannsóknastöðvar skógræktar. Nr. 23/2010.

Snorrason A., Jónsson T.H., Traustason B. & Eggertsson Ó. (in manuscript). Natural birch woodland in Iceland – changes in area and biomass over the last two decades.

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

Snorrason, A. and Kjartansson B. T. (2004). Towards a general woodland and forestry inventory for Iceland: 6.

Snorrason, A. and Einarsson, S. F. (2006). Single-tree biomass and stem volume functions for eleven tree species used in Icelandic forestry. Icelandic Agricultural Science 19: 15-25.

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

Snorrason, A., O. Jónsson, H., Svavarsdóttir, K., Guðbergsson, G. (2000). Rannsóknir á kolefnisbindingu ræktaðra skóga á Íslandi. Skógræktarritið (1): 71-89 (in Icelandic).

Statistical Yearbook of Iceland, 2007 (Statistics Iceland).

Statitstics Iceland, 2011. Landshagir - Statistical yearbook of Iceland, 2011. Online at: http://www.statice.is/lisalib/getfile.aspx?itemid=13543.

Steingrímsdóttir L., Þorgeirsdóttir, H, Ólafsdóttir, A. S. (2002). Hvað borða Íslendingar? Könnun á mataræði Íslendinga. Icelandic Directorate of health report, 103 p. (in Icelandic)

Sveinbjörnsson, J. and Ólafsson, B.J. (1999). Orkuþarfir sauðfjár og nautgripa í vexti með hliðsjón af mjólkurfóðureiningakerfi. Ráðunautafundur: 204-217 (in Icelandic)

Sveinsson, Th. (1998). Næringarefnabókhald fyrir kúabú. Ráðunautafundur: 124-140 (in Icelandic).

The Environment Agency of Iceland (2007). Grænt bókhald, http://ust.is/einstaklingar/mengandi-starfsemi/graent-bokhald/.

Thorsson, J., Halldórsson G., Ágústsdóttir, A. M. and Bau, A. (in prep). Monitoring carbon sequestration in reclaimed lands. Unpublished results.

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

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

UNFCCC (2010). Report of the individual review of the annual submission of Iceland. Submitted in 2009. FCCC/ARR/2009/ISL, UNFCCC.

UNFCCC secretariat (2009). Report of the individual review of the greenhouse gas inventory of Iceland. Submitted in the year 2009 (in-country review).

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

UNFCCC/WEB/IRI/2004/ISL (available on the secretariat web site http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600005115#beg

United Nations (2002), Report of the Conference of the Parties on its Seventh Session, Held at Marrakesh From 29 October to 10 November 2001. Addendum. Part two: Action Taken by the Conference of the Parties. Volume I: 68.

Þorgeirsdóttir, H. Valgeirsdóttir, H., Gunnarsdóttir, I. et al. (2012). Hvað borða Íslendingar? Könnun á mataræði Íslendinga 2010-2011. Report of the Icelandic directorate of Health, 130 p. (in Icelandic)

Þorvaldsson, G. (1994). Gróðurfar og nýting túna. Fjölrit Rala, Agricultural research institute Iceland: 32.

Þórarinsson (1974). "Þjóðin lifði en skógurinn dó." Ársrit Skógræktarfélags Íslands 41: 13 (in Icelandic)

Arnalds, Ó. , Orradottir, B. and Aradottir, A.L. 2013 Carbon accumulation in Icelandic desert Andosols during early stages of restoration. Geoderma, 193–194, 172-179.

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

Bjarnadóttir, B. (2009). Carbon stocks and fluxes in a young Siberian larch (Larix sibirica) plantation in Iceland. Department of Physical Geography and Ecosystem Analysis. Lund, Lund University. Ph.D: 171 p.

Bossard, M., J. Feranec and J. Otahel (2000). CORINE land cover technical guide – Addendum 2000. Technical report. Copenhagen, European Environment Agency**:** 105.

Dugmore, A. J., G. Gisladottir, I. A. Simpson and A. Newton (2009). "Conceptual Models of 1200 Years of Icelandic Soil Erosion Reconstructed Using Tephrochronology." Journal of the North Atlantic: 1-18.

Gísladóttir, F., J. Gudmundsson and S. Áskelsdóttir (2010). Mapping and density analyses of drainage ditches in Iceland. Mapping and monitoring of Nordic Vegetation and landscapes, Hveragerði, Norsk Insitute for Skog og landskap.

Gísladóttir, F. Ó., S. Brink and Ó. Arnalds (2014). Nytjaland. Rit Lbhí, Landbúnaðar háskóli Íslands.

Gísladóttir, F. Ó., S. Metúsalemsson and H. Óskarsson (2007). Áhrifasvæði skurða: Greining með fjarkönnunaraðferðum. Fræðaþing landbúnaðarins, Reykjavík.

Gudmundsson, J., S. H. Brink and F. Gísladóttir (2013). Preparation of a LULUCF land-use map for Iceland: Development of the Grassland layer and subcategories Grassland Science in Europe 13.

Gudmundsson, J., F. Gísladóttir, S. H. Brink and H. Óskarsson (2010). The Icelandic Geographic Land Use Database (IGLUD). Mapping and monitoring of Nordic Vegetation and landscapes, Hveragerði, Norsk Insitute for Skog og landskap.

Guðmundsson, J. and H. Óskarsson (2014). Carbon dioxide emission from drained organic soils in West-Iceland. Soil carbon sequestration for climate food security and ecosystem services, Reykjavík Iceland, JRC science and policy report.

Gunnarsson, E. (2010). Skógræktarárið 2009. Skógræktarritið 2010 (2): 90-95. (in Icelandic)

Gunnarsson E. (2011). Skógræktarárið 2010. Skógræktarritið 2011. 2. tbl. bls. 96-101. (in Icelandic)

Gunnarsson E. (2012). Skógræktarárið 2011. Skógræktarritið 2012. 2. tbl. bls. 90-95. (in Icelandic)

Gunnarsson E. (2013). Skógræktarárið 2012. Skógræktarritið 2013. 2. tbl. bls. 84-89. (in Icelandic)

Gunnarsson E. (2014). Skógræktarárið 2012. Skógræktarritið 2014. 2. tbl. bls. 89-94 (in Icelandic)

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

IPCC (2014). 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. T. Hiraishi, Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G., IPCC, Switzerland.

Jónmundson, J. V. and E. Eyþórsdóttir (2013). Erfðir og kynbætur sauðfjár. Sauðfjárrækt á Íslandi. R. Sigurðardóttir. Reykjavík, Uppheimar.

Jónsson T.H. 2004. Annals of Botany 94: 753–762. doi:10.1093/aob/mch200, available online at www.aob.oupjournals.org

Kolka-Jónsson, P.V. 2011 CarbBirch (Kolbjörk): Carbon sequestration and soil development under mountain birch (Betula pubescens) in rehabilitated areas in southern Iceland. MS, The Ohio State University.

Ministry for the Environment, I. (2007). Vernd og endurheimt íslenskra birkiskóga, Skýrsla og tillögur nefndar. Protection and restoration of Icelandic birch forests, Ministry for the Environment, Iceland (in Icelandic).

Sigurðsson, H. M. (2002). Vatnsaflsvirkjanir á Íslandi, Verkfræðistofa Sigurðar Thoroddssen.

Sigurdsson, B. D., Magnusson, B., Elmarsdottir A. and Bjarnadottir, B. (2005). Biomass and composition of understory vegetation and the forest floor carbon stock across Siberian larch and mountain birch chronosequences in Iceland. Annals of Forest Science 62(8): 881-888.
Sigurðsson, B. D. and Snorrason, A. (2000). Carbon sequestration by afforestation and revegetation as a means of limiting net-CO2 emissions in Iceland. Biotechnol. Agron. Soc. Environ. 4(4): 303-307.

Sigurðsson, B. D., Elmarsdóttir, Á., Bjarnadóttir, B. and Magnússson, B. Ó. (2008). Mælingar á kolefnisbindingu mismunandi skógargerða. Fræðaþing landbúnaðarins (in Icelandic).

Snorrason, A. (2010). Iceland. National Forest Inventories - Pathways for Common Reporting. E. Tomppo, T. Gschwantner, M. Lawrence and R. E. McRoberts, Springer: 612.

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

Snorrason, A., O. Jónsson, H., Svavarsdóttir, K., Guðbergsson, G. (2000). Rannsóknir á kolefnisbindingu ræktaðra skóga á Íslandi. Skógræktarritið (1): 71-89 (in Icelandic).

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

Wöll, C., B. S. Hallsdóttir, J. Guðmundsson, A. Snorrason, J. Þórsson, P. V. K. Jónsson, K. Andrésson and S. Einarsson (2014). Emissions of greenhouse gases in Iceland from 1990 to 2012. National Inventory Report 2014; Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol: , UST**:** 372.

Þorvaldsson, G. (1994). Gróðurfar og nýting túna. Fjölrit Rala, Agricultural research institute Iceland**:** 32.

Þórarinsson (1974). "Þjóðin lifði en skógurinn dó.
." Ársrit Skógræktarfélags Íslands **41**: 13.

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.

TABLE A1: KEY SOURCE ANALYSIS – 2013 LEVEL ASSESSMENT.

Category	Classification	Gas	Level w/ LULUCF	Trend w/ LULUCF	Level w/o LULUCF	Cumulative Total of Column to left	Trend w/o LULUCF
Aluminium Production	no classification	CO2	7%	0.066	27%	27%	0.285
Road Transportation	Fossil fuels	CO2	4%	0.014	17%	44%	0.042
Other Sectors	Liquid Fuels	CO2	3%	0.018	12%	56%	0.112
Ferroalloys Production	no classification	CO2	2%	0.01	9%	64%	0.038
Agricultural Soils	Direct N2O Emissior	N2O	2%	0.004	8%	72%	0.033
Enteric Fermentation	Farming	CH4	1%	0.004	6%	78%	0.027
Solid Waste Disposal	Waste	CH4	1%	0.003	4%	82%	0.008
Refrigeration and Air conditioning	no classification	Aggregat	1%	0.01	4%	86%	0.044
Other emissions from energy production	Operation	CO2	1%	0.006	4%	89%	0.025
Agricultural Soils	Farming	N2O	1%	0.001	3%	92%	0.011
Manure Management	Farming	N2O	1%	0.002	3%	94%	0.014
Aluminium Production	no classification	PFCs	1%	0.026	2%	96%	0.135
Incineration and Open Burning of Waste	Waste	N2O	0%	0.003	1%	97%	0.013
Manufacturing Industries and Construction	Liquid Fuels	CO2	0%	0.007	1%	98%	0.037
Road Transportation	Fuels	N2O	0%	0	0%	99%	0.001
Domestic Navigation	Liquid Fuels	CO2	0%	0.003	0%	99%	0.015
Other Sectors	Liquid Fuels	N2O	0%	0	0%	99%	0.003
Wastewater Treatment and Discharge	Wastewater	N2O	0%	0	0%	100%	0
Other emissions from energy production	Operation	CH4	0%	0	0%	100%	0.001
Road Transportation	Fuels	CH4	0%	0	0%	100%	0
Wastewater Treatment and Discharge	Wastewater	CH4	0%	0	0%	100%	0.001
Incineration and Open Burning of Waste	Waste	CO2	0%	0	0%	100%	0.002
Manure Management	Farming	CH4	0%	0.001	0%	100%	0.004
Ammonia Production	no classification	N2O	0%	0	0%	100%	0
Adipic Acid Production	no classification	CO2	0%	0	0%	100%	0
Other Applications	no classification	Aggregat	0%	0	0%	100%	0
Domestic Navigation	Gaseous Fuels	N2O	0%	0	0%	100%	0
Cement Production	no classification	CO2	0%	0	0%	100%	0
Other Product Manufacture and Use	no classification	CH4	0%	0	0%	100%	0
Liming	Farming	CO2	0%	0	0%	100%	0
Solid Fuels	Operation	CO2	0%	0	0%	100%	0
Foam Blowing Agents	no classification	Aggregat	0%	0	0%	100%	0
Other Other Sectors	Gaseous Fuels	CH4	0%	0	0%	100%	0
Non-energy Products from Fuels and Solvent Use	no classification	CO2	0%	0	0%	100%	0
Other Sectors	Biomass	CH4	0%	0	0%	100%	0
Field Burning of Agricultural Residues	Farming	N2O	0%	0	0%	100%	0
Energy Industries	Solid Fuels	N2O	0%	0	0%	100%	0
Wetlands	Carbon stock chang	CO2	0%	0	0%	100%	0
Manufacturing Industries and Construction	Solid Fuels	CH4	0	0	0%	100%	0

TABLE A2: KEY SOURCE ANALYSIS – 1990 LEVEL ASSESSMENT.

Category	Classification	Gas	Level w/ LULUCF	Level w/o LULUCF	Cumulative Total of Column to left
Other Sectors	Liquid Fuels	CO2	5%	21%	21%
Road Transportation	Fossil fuels	CO2	3%	13%	35%
Aluminium Production	no classification	PFCs	3%	13%	47%
Agricultural Soils	Direct N2O Emissions Fr	N2O	2%	11%	58%
Enteric Fermentation	Farming	CH4	2%	8%	66%
Ferroalloys Production	no classification	CO2	1%	5%	71%
Manufacturing Industries and Construction	Liquid Fuels	CO2	1%	4%	75%
Solid Waste Disposal	Waste	CH4	1%	4%	79%
Manure Management	Farming	N2O	1%	4%	83%
Aluminium Production	no classification	CO2	1%	4%	86%
Agricultural Soils	Farming	N2O	1%	4%	90%
Other emissions from energy production	Operation	CO2	0%	2%	91%
Domestic Navigation	Liquid Fuels	CO2	0%	2%	93%
Manufacturing Industries and Construction	Solid Fuels	CO2	0%	1%	94%
Cement Production	no classification	CO2	0%	1%	95%
Other chemical industry	no classification	N2O	0%	1%	97%
Domestic Aviation	Fossil fuels	CO2	0%	1%	97%
Other Sectors	Liquid Fuels	N2O	0%	1%	98%
Manure Management	Farming	CH4	0%	0%	98%
Energy Industries	Liquid Fuels	CO2	0%	0%	99%
Road Transportation	Fuels	N2O	0%	0%	99%
Incineration and Open Burning of Waste	Waste	CO2	0%	0%	99%
Incineration and Open Burning of Waste	Waste	CH4	0%	0%	100%
Wastewater Treatment and Discharge	Wastewater	N2O	0%	0%	100%
Road Transportation	Fuels	CH4	0%	0%	100%
Ammonia Production	no classification	N2O	0%	0%	100%
Domestic Navigation	Gaseous Fuels	N2O	0%	0%	100%
Refrigeration and Air conditioning	no classification	Aggreg	0%	0%	100%
Other Product Manufacture and Use	no classification	CH4	0%	0%	100%
Liming	Farming	CO2	0%	0%	100%
Solid Fuels	Operation	CO2	0%	0%	100%
Foam Blowing Agents	no classification	Aggreg	0%	0%	100%
Other Other Sectors	Gaseous Fuels	CH4	0%	0%	100%
Non-energy Products from Fuels and Solvent Use	no classification	CO2	0%	0%	100%
Other Sectors	Biomass	CH4	0%	0%	100%
Field Burning of Agricultural Residues	Farming	N2O	0%	0%	100%
Energy Industries	Solid Fuels	N2O	0%	0%	100%
Wetlands	Carbon stock change	CO2	0%	0%	100%
Manufacturing Industries and Construction	Solid Fuels	CH4	0%	0%	100%

TABLE A3: KEY SOURCE ANALYSIS – TREND ASSESSMENT**.**

ANNEX II. ASSESSMENT OF UNCERTAINTY (INCLU DING LULUCF)

IPCC Source category	Gas	Base year emis-sions (1990)	Year t emissions (2013)	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	U ta e int
c electricity and heat uction	CO2	13.6	7.2	5.0	5.0	7.1	0.010	-0.002	0.002	-0.008	
c electricity and heat uction	CH4	0.0	0.0	5.0	100.0	100.1	0.001	0.000	0.000	0.000	
c electricity and heat uction	N2O	0.0	0.1	5.0	150.0	150.1	0.003	0.000	0.000	0.003	
ufacturing industry and truction	CO2	360.8	172.0	5.0	5.0	7.1	0.235	-0.047	0.037	-0.237	
ufacturing industry and truction	CH4	0.3	0.1	5.0	100.0	100.1	0.003	0.000	0.000	-0.003	
ufacturing industry and truction	N2O	15.9	11.9	5.0	150.0	150.1	0.344	-0.001	0.003	-0.178	
sport	CO2	91.1	34.6	5.0	5.0	7.1	0.047	-0.014	0.007	-0.069	
sport	CH4	0.1	0.0	5.0	100.0	100.1	0.001	0.000	0.000	-0.002	
sport	N2O	0.8	0.3	5.0	200.0	200.1	0.012	0.000	0.000	-0.023	
transport	CO2	521.3	782.2	5.0	5.0	7.1	1.070	0.045	0.166	0.223	
transport	CH4	3.0	1.5	5.0	40.0	40.3	0.011	0.000	0.000	-0.015	
transport	N2O	4.5	34.4	5.0	50.0	50.2	0.334	0.006	0.007	0.312	
ential/institutional/commercial	CO2	42.8	10.0	5.0	5.0	7.1	0.014	-0.008	0.002	-0.039	
ential/institutional/commercial	CH4	0.0	0.0	5.0	100.0	100.1	0.000	0.000	0.000	0.000	
ential/institutional/commercial	N2O	0.1	0.0	5.0	150.0	150.1	0.001	0.000	0.000	-0.003	
ng	CO2	655.5	485.3	3.0	5.0	5.8	0.547	-0.050	0.103	-0.248	
ng	CH4	1.3	1.0	3.0	100.0	100.0	0.019	0.000	0.000	-0.010	
ng	N2O	5.5	4.1	3.0	150.0	150.0	0.118	0.000	0.001	-0.063	
ive emissions from fuels	CO2	61.4	170.2	10.0	1.0	10.0	0.331	0.022	0.036	0.022	
ive emissions from fuels	CH4	0.7	2.7	6.0	8.0	10.0	0.005	0.000	0.001	0.003	
ral production	CO2	52.3	1.6	5.0	6.5	8.2	0.003	-0.012	0.000	-0.077	
ical industry	CO2	0.4	0.0	3.0	1.0	3.2	0.000	0.000	0.000	0.000	
ical industry	N2O	48.4	0.0	30.0	40.0	50.0	0.000	-0.011	0.000	-0.450	
l production	CH4	0.6	1.1	1.5	100.00	100.0	0.022	0.000	0.000	0.009	
alloys	CO2	207.4	406.9	1.5	1.0	1.8	0.142	0.038	0.086	0.038	
inium	CO2	139.2	1,244.2	1.5	1.0	1.8	0.434	0.232	0.264	0.232	
inium	PFC	419.6	79.7	5.0	9.3	10.6	0.163	-0.081	0.017	-0.751	
umption of halocarbons and refrigeration	HFC		144.1	176.0	79.6	193.2	5.383	0.031	0.031	2.432	

umption of halocarbons and refrigeration	PFC		0.0	176.0	79.6	193.2	0.000	0.000	0.000	0.000	
umption of halocarbons and electrical equipment	SF6	1.1	5.6	20.0	50.0	53.9	0.058	0.001	0.001	0.046	
nt and other product use	N2O	6.0	3.3	20.0	5.0	20.6	0.013	-0.001	0.001	-0.003	
nt and other product use	CO2	3.1	2.8	61.3	167.5	178.4	0.098	0.000	0.001	-0.019	
ic fermentation, cattle	CH4	82.1	82.3	17.8	20.0	26.8	0.426	-0.002	0.017	-0.033	
ic fermentation, sheep	CH4	152.1	130.6	17.2	20.0	26.4	0.666	-0.008	0.028	-0.154	
ic fermentation, rest	CH4	29.3	31.5	20.0	40.0	44.7	0.272	0.000	0.007	-0.006	
ure management	N2O	52.0	43.3	55.7	100.0	114.4	0.958	-0.003	0.009	-0.293	
ure management	CH4	41.2	39.3	50.9	126.9	136.7	1.039	-0.001	0.008	-0.158	
t soil emissions	N2O	148.5	136.3	31.1	326.1	327.6	8.636	-0.006	0.029	-1.843	
al production	N2O	89.7	83.7	55.8	100.0	114.5	1.853	-0.003	0.018	-0.314	
ect soil emissions	N2O	141.4	131.0	66.9	1,000.0	1,002.2	25.397	-0.005	0.028	-5.121	
t land remaining forest land	CO2	-14.8	-35.6	14.0	10.0	17.2	-0.119	-0.004	-0.008	-0.041	
converted to forest land	CO2	-26.6	-232.8	5.0	10.0	11.2	-0.503	-0.043	-0.049	-0.432	
t land	N2O	0.3	1.2	5.0	400.0	400.0	0.092	0.000	0.000	0.071	
and remaining Cropland	CO2	764.0	1,003.3	20.0	90.0	92.2	17.886	0.035	0.213	3.144	
converted to Cropland	CO2	434.3	64.4	20.0	90.0	92.2	1.149	-0.087	0.014	-7.863	
and drained for more than 20	CO2	169.6	288.4	20.0	90.0	92.2	5.142	0.022	0.061	1.953	
her remaining Grassland	CO2	-1.7	-14.6	20.0	20.0	28.3	-0.080	-0.003	-0.003	-0.054	
her conversion to Grassland	CO2	127.3	78.1	20.0	90.0	92.2	1.393	-0.013	0.017	-1.175	
r land converted to Grassland, getation	CO2	-349.5	-543.1	30.0	25.0	39.1	-4.101	-0.034	-0.115	-0.848	
ands	CO2	1.9	9.7	20.0	50.0	53.9	0.101	0.002	0.002	0.082	
ands	CH4	1.6	8.3	20.0	50.0	53.9	0.087	0.001	0.002	0.070	
ements	CO2		0.1	5.0	10.0	11.2	0.000	0.000	0.000	0.000	
CF, wildfires	CH4		0.0	10.0	70.0	70.7	0.000	0.000	0.000	0.000	
CF, wildfires	N2O		0.0	10.0	70.0	70.7	0.000	0.000	0.000	0.000	
land non CO2-emissions	N2O	68.6	78.7	20.0	25.0	32.0	0.487	0.001	0.017	0.018	
aged waste disposal on land	CH4	13.0	134.8	42.4	35.9	55.6	1.448	0.026	0.029	0.918	
anaged waste disposal sites	CH4	106.3	27.1	42.4	51.4	66.7	0.350	-0.019	0.006	-0.976	
ewater handling	CH4	1.4	3.6	36.4	58.3	68.7	0.047	0.000	0.001	0.025	
ewater handling	N2O	6.2	8.0	45.7	1,000.0	1,001.0	1.556	0.000	0.002	0.256	
e incineration	CO2	11.3	6.7	33.9	13.8	36.6	0.048	-0.001	0.001	-0.016	
e incineration	N2O	1.4	0.2	20.0	100.0	102.0	0.004	0.000	0.000	-0.028	
e incineration	CH4	5.2	0.3	20.0	100.0	102.0	0.005	-0.001	0.000	-0.115	
r (composting)	CH4		0.9	20.0	100.0	102.0	0.019	0.000	0.000	0.020	
r (composting)	N2O		1.0	20.0	100.0	102.0	0.021	0.000	0.000	0.022	
s		**4,713.1**	**5,171.6**				**33.6**				

ANNEX III. EXPLENATION OF EAI'S ADJUSTMENT OF DATAON 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 Tonnes	1995 Tonnes	2000 Tonnes	2005 Tonnes	2006 Tonnes	2007 Tonnes	2008 Tonnes	2009 Tonnes	2010 Tonnes	2011 Tonnes	2012 Tonnes	2013 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
10X5X	**industry**	5.072	1.129	8.920	15.196	15.455	12.819	7.217	9.100	6.663	3.783	5.152	6.807
10X60	**energy industries**	1.300	1.091	1.065	21	1.349	1.109	1.436	760	1.012	683	955	1.090
10X90	**other**	0	458	1.386	8.928	8.296	2.033	1.336	1.499	2.728	1.136	260	768
Residual Fuel Oil													
10840	**house heating and swimming pools**	2.989	3.079	122	195	76	86	63	78	0	0	0	0
1085X	**industry**	55.895	56.172	46.146	25.005	23.635	22.708	19.562	17.646	14.917	16.514	17.839	13.789
10860	**energy industries**	0	0	-53	0	5	4.498	0	0	0	0	0	0
10890	**other**	39	52	67	0	0	131	913	0	1.629	780	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.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013
Swimming pools	1800	1600	1600	1000	300	300	300	300	300	300	300	300

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.

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 IV. CRF TABLE SUMMARY 2 FOR 1990-2013

1990

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

Inventory 1990
Submission 2015 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)]	9,798.61	2,848.23	2,202.40	NO,NA	494.64	1.10			15,344.98
1. Energy	1,695.17	6.58	34.70						1,736.46
A. Fuel combustion (sectoral approach)	1,633.82	5.77	34.70						1,674.29
1. Energy industries	13.79	0.01	0.02						13.82
2. Manufacturing industries and construction	201.85	0.12	0.51						202.48
3. Transport	599.71	3.80	14.76						618.27
4. Other sectors	818.46	1.85	19.41						839.73
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	398.56	0.73	46.49	NO	494.64	1.10			941.51
A. Mineral industry	51.56								51.56
B. Chemical industry	0.36	NO,NE	46.49	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				NO	NO				NO
G. Other product manufacture and use						1.10			1.10
H. Other									
3. Agriculture	0.02	316.71	686.21						1,002.93
A. Enteric fermentation		299.81							299.81
B. Manure management		16.89	138.61						155.51
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	547.60						547.60
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7,693.59	2,374.38	1,427.67						11,495.65
A. Forest land	-45.16	0.11	0.93						-44.11
B. Cropland	1,919.45	94.83	NA,NE,IE						2,014.28
C. Grassland	6,483.33	477.67	1,426.74						8,387.74
D. Wetlands	-677.22	1,801.77	NO,NA,NE						1,124.55
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	11.27	149.83	7.33						168.43
A. Solid waste disposal	NE,NA	141.97							141.97
B. Biological treatment of solid waste		NA,NO	NA,NO						NA,NO
C. Incineration and open burning of waste	11.27	6.18	1.34						18.79
D. Waste water treatment and discharge		1.68	5.99						7.67
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	2.65						319.17
Aviation	217.25	0.04	1.85						219.13
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,849.34**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,344.98**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,849.34**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,344.98**

(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 2015 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)]	9,736.19	2,846.24	2,180.27	NO,NA	410.61	1.24			15,174.57
1. Energy	1,666.18	6.80	34.21						1,707.19
A. Fuel combustion (sectoral approach)	1,596.23	6.09	34.21						1,636.53
1. Energy industries	15.39	0.01	0.02						15.42
2. Manufacturing industries and construction	138.02	0.08	0.39						138.48
3. Transport	611.04	4.10	14.84						629.98
4. Other sectors	831.79	1.90	18.96						852.65
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	364.62	0.60	45.00	NO	410.61	1.24			822.07
A. Mineral industry	47.98								47.98
B. Chemical industry	0.31	NO,NE	45.00	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				NO	NO				NO
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	307.04	663.34						970.39
A. Enteric fermentation		291.17							291.17
B. Manure management		15.87	131.06						146.93
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	532.28						532.28
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7,694.20	2,376.36	1,430.32						11,500.88
A. Forest land	-46.75	0.15	1.22						-45.38
B. Cropland	1,910.44	94.32	NA,NE,IE						2,004.76
C. Grassland	6,487.40	478.46	1,429.10						8,394.96
D. Wetlands	-670.08	1,803.44	NO,NA,NE						1,133.36
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	11.18	155.43	7.41						174.02
A. Solid waste disposal	NE,NA	146.73							146.73
B. Biological treatment of solid waste		NA,NO	NA,NO						NA,NO
C. Incineration and open burning of waste	11.18	6.14	1.33						18.65
D. Waste water treatment and discharge		2.56	6.08						8.64
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	2.17						259.22
Aviation	219.55	0.04	1.87						221.46
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									

Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,673.68**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,174.57**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,673.68**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,174.57**

(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.

1992

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

Inventory 1992
Submission 2015 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)]	9,854.96	2,850.71	2,128.98	NO,NA	183.04	1.24			15,018.93
1. Energy	1,793.12	7.02	36.82						1,836.96
A. Fuel combustion (sectoral approach)	1,725.50	6.26	36.82						1,768.59
1. Energy industries	13.83	0.01	0.02						13.86
2. Manufacturing industries and construction	205.34	0.13	0.46						205.93
3. Transport	621.14	4.12	17.84						643.11
4. Other sectors	885.19	2.01	18.49						905.70
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	367.71	0.63	40.23	NO	183.04	1.24			592.85
A. Mineral industry	45.10								45.10
B. Chemical industry	0.25	NO,NE	40.23	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				NO	NO				NO
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	301.47	611.35						912.84
A. Enteric fermentation		286.55							286.55
B. Manure management		14.92	124.07						138.99
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	487.28						487.28
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7,683.23	2,374.55	1,433.12						11,490.90
A. Forest land	-51.24	0.20	1.66						-49.38
B. Cropland	1,900.69	93.81	NA,NE,IE						1,994.50
C. Grassland	6,489.86	479.24	1,431.47						8,400.57
D. Wetlands	-669.27	1,801.29	NO,NA,NE						1,132.02
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	10.88	167.06	7.45						185.39
A. Solid waste disposal	NE,NA	158.48							158.48
B. Biological treatment of solid waste		NA,NO	NA,NO						NA,NO
C. Incineration and open burning of waste	10.88	5.99	1.29						18.17
D. Waste water treatment and discharge		2.59	6.15						8.74
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	2.20						263.27
Aviation	201.39	0.04	1.71						203.14
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,528.03**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,018.93**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,528.03**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,018.93**

(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 2015 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)]	9,966.23	2,860.23	2,151.97	0.74	88.24	1.24			15,068.65
1. Energy	1,868.20	7.13	37.59						1,912.92
A. Fuel combustion (sectoral approach)	1,782.83	6.36	37.59						1,826.77
1. Energy industries	12.92	0.01	0.02						12.95
2. Manufacturing industries and construction	224.44	0.14	0.51						225.09
3. Transport	621.74	4.03	14.92						640.68
4. Other sectors	923.73	2.18	22.15						948.06
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	416.09	0.72	42.32	0.74	88.24	1.24			549.35
A. Mineral industry	39.05								39.05
B. Chemical industry	0.24	NO,NE	42.32	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				0.74	NO				0.74
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	302.08	629.15						931.25
A. Enteric fermentation		287.04							287.04
B. Manure management		15.04	125.73						140.76
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	503.43						503.43
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7,672.66	2,373.78	1,435.57						11,482.01
A. Forest land	-56.43	0.21	1.74						-54.48
B. Cropland	1,890.88	93.30	NA,NE,IE						1,984.18
C. Grassland	6,493.89	480.03	1,433.83						8,407.75
D. Wetlands	-668.87	1,800.24	NO,NA,NE						1,131.38
E. Settlements	13.19	NE	NE,IE						13.19
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	9.27	176.52	7.34						193.12
A. Solid waste disposal	NE,NA	168.71							168.71
B. Biological treatment of solid waste		NA,NO	NA,NO						NA,NO
C. Incineration and open burning of waste	9.27	5.19	1.12						15.58
D. Waste water treatment and discharge		2.61	6.22						8.83
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	290.17	0.26	2.43						292.87
Aviation	193.50	0.03	1.65						195.18
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,586.65**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,068.65**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,586.65**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,068.65**

(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.

1994

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

Inventory 1994
Submission 2015 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)]	9,918.20	2,869.59	2,171.92	1.61	52.53	1.24			15,015.10
1. Energy	1,821.59	7.10	40.57						1,869.25
A. Fuel combustion (sectoral approach)	1,751.47	6.32	40.57						1,798.35
1. Energy industries	12.60	0.01	0.02						12.62
2. Manufacturing industries and construction	210.27	0.13	0.48						210.88
3. Transport	624.31	4.13	17.91						646.35
4. Other sectors	904.28	2.05	22.17						928.50
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	417.09	0.68	42.61	1.61	52.53	1.24			515.78
A. Mineral industry	36.54								36.54
B. Chemical industry	0.35	NO,NE	42.61	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				1.61	NO				1.61
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	303.18	643.39						946.59
A. Enteric fermentation		287.95							287.95
B. Manure management		15.23	127.22						142.45
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	516.17						516.17
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7,670.98	2,372.93	1,438.04						11,481.95
A. Forest land	-59.17	0.22	1.85						-57.10
B. Cropland	1,881.04	92.79	NA,NE,IE						1,973.83
C. Grassland	6,496.73	480.81	1,436.19						8,413.74
D. Wetlands	-668.43	1,799.10	NO,NA,NE						1,130.67
E. Settlements	20.81	NE	NE,IE						20.81
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	8.54	185.70	7.30						201.54
A. Solid waste disposal	NE,NA	178.25							178.25
B. Biological treatment of solid waste		NA,NO	NA,NO						NA,NO
C. Incineration and open burning of waste	8.54	4.82	1.04						14.40
D. Waste water treatment and discharge		2.63	6.26						8.89
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	2.55						306.96
Aviation	211.28	0.04	1.80						213.11
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,533.16**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,015.10**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,533.16**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,015.10**

(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 2015 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)]	9,945.21	2,866.41	2,144.50	9.50	69.36	1.24			15,036.23
1. Energy	1,857.12	7.21	40.94						1,905.27
A. Fuel combustion (sectoral approach)	1,774.88	6.33	40.94						1,822.15
1. Energy industries	16.38	0.01	0.03						16.42
2. Manufacturing industries and construction	214.89	0.13	0.46						215.48
3. Transport	600.12	4.07	14.68						618.87
4. Other sectors	943.50	2.12	25.78						971.39
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	433.66	0.70	40.53	9.50	69.36	1.24			555.00
A. Mineral industry	36.84								36.84
B. Chemical industry	0.46	NO,NE	40.53	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				9.50	NO				9.50
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	292.74	613.12						905.88
A. Enteric fermentation		278.51							278.51
B. Manure management		14.23	120.32						134.55
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	492.80						492.80
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,646.89	2,370.45	1,442.31						11,459.65
A. Forest land	-68.67	0.26	2.13						-66.28
B. Cropland	1,871.22	92.28	NA,NE,IE						1,963.50
C. Grassland	6,505.29	482.14	1,440.18						8,427.62
D. Wetlands	-667.18	1,795.78	NO,NA,NE						1,128.60
E. Settlements	6.22	NE	NE,IE						6.22
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	7.53	195.29	7.60						210.43
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	6.31						8.95
E. Other	NA	0.20	0.18						0.38
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA

Memo items: [(2)]									
International bunkers	376.61	0.38	3.15						380.14
Aviation	233.56	0.04	1.99						235.59
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,576.58**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,036.23**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,576.58**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,036.23**

(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 2015 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)]	10,031.99	2,873.14	2,190.61	17.87	29.64	1.24			15,144.49
1. Energy	1,944.81	7.32	43.58						1,995.71
A. Fuel combustion (sectoral approach)	1,863.55	6.48	43.58						1,913.60
1. Energy industries	8.23	0.00	0.01						8.24
2. Manufacturing industries and construction	259.98	0.17	0.51						260.66
3. Transport	590.42	4.05	17.32						611.79
4. Other sectors	1,004.92	2.26	25.73						1,032.91
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	433.11	0.68	47.38	17.87	29.64	1.24			529.93
A. Mineral industry	40.82								40.82
B. Chemical industry	0.40	NO,NE	47.38	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				17.87	NO				17.87
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	295.76	646.12						941.90
A. Enteric fermentation		281.43							281.43
B. Manure management		14.33	123.33						137.66
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	522.79						522.79
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,647.30	2,370.41	1,445.97						11,463.68
A. Forest land	-72.97	0.27	2.24						-70.45
B. Cropland	1,861.43	91.77	NA,NE,IE						1,953.20
C. Grassland	6,512.79	483.32	1,443.73						8,439.83
D. Wetlands	-664.66	1,795.05	NO,NA,NE						1,130.39
E. Settlements	10.71	NE	NE,IE						10.71
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	6.75	198.98	7.56						213.28
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	6.36						9.02
E. Other	NA	0.20	0.18						0.38
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA

Memo items: [(2)]									
International bunkers	391.67	0.34	3.28						395.29
Aviation	268.53	0.05	2.29						270.86
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									

Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,680.82**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,144.49**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,680.82**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,144.49**

(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 2015 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)	10,101.44	2,869.66	2,178.42	28.04	97.08	1.24			15,275.88
1. Energy	1,950.10	7.53	47.21						2,004.83
A. Fuel combustion (sectoral approach)	1,886.25	6.46	47.21						1,939.92
1. Energy industries	4.74	0.00	0.01						4.75
2. Manufacturing industries and construction	275.53	0.17	0.57						276.27
3. Transport	601.57	4.04	17.63						623.25
4. Other sectors	1,004.41	2.25	28.99						1,035.65
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	492.35	0.72	39.51	28.04	97.08	1.24			658.94
A. Mineral industry	45.47								45.47
B. Chemical industry	0.44	NO,NE	39.51	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				28.04	NO				28.04
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	291.78	631.90						923.69
A. Enteric fermentation		277.12							277.12
B. Manure management		14.66	124.26						138.92
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	507.64						507.64
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry(1)	7,652.47	2,366.75	1,452.22						11,471.44
A. Forest land	-79.84	0.30	2.44						-77.11
B. Cropland	1,851.56	91.25	NA,NE,IE						1,942.82
C. Grassland	6,531.34	485.34	1,449.79						8,466.47
D. Wetlands	-662.67	1,789.86	NO,NA,NE						1,127.19
E. Settlements	12.08	NE	NE,IE						12.08
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	6.50	202.89	7.58						216.97
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	6.41						9.10
E. Other	NA	0.20	0.18						0.38
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	436.71	0.40	3.65						440.76
Aviation	288.91	0.05	2.46						291.42
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									
Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,804.43**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,275.88**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,804.43**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,275.88**

(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 2015 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)]	10,114.60	2,875.11	2,189.74	42.49	212.33	1.24			15,435.51
1. Energy	1,923.18	7.93	47.07						1,978.18
A. Fuel combustion (sectoral approach)	1,839.49	6.62	47.07						1,893.17
1. Energy industries	7.71	0.01	0.01						7.73
2. Manufacturing industries and construction	241.26	0.15	0.55						241.96
3. Transport	605.28	4.28	17.52						627.08
4. Other sectors	985.23	2.19	28.98						1,016.40
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	520.11	0.53	34.45	42.49	212.33	1.24			811.15
A. Mineral industry	53.18								53.18
B. Chemical industry	0.40	NO,NE	34.45	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	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				42.49	NO				42.49
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture	0.02	297.17	639.71						936.91
A. Enteric fermentation		282.01							282.01
B. Manure management		15.16	126.19						141.35
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	513.53						513.53
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,665.77	2,361.25	1,460.96						11,487.99
A. Forest land	-88.26	0.34	2.75						-85.17
B. Cropland	1,841.71	90.74	NA,NE,IE						1,932.45
C. Grassland	6,558.99	488.16	1,458.22						8,505.37
D. Wetlands	-659.52	1,782.02	NO,NA,NE						1,122.49
E. Settlements	12.85	NE	NE,IE						12.85
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	5.51	208.23	7.54						221.29
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	6.49						9.21
E. Other	NA	0.20	0.18						0.38
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	510.01	0.48	4.26						514.74
Aviation	334.42	0.06	2.85						337.33
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**3,947.52**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,435.51**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**3,947.52**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,435.51**

(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 2015 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)	10,339.01	2,876.45	2,232.32	48.10	204.17	1.24			15,701.31
1. Energy	1,980.28	8.37	49.85						2,038.51
A. Fuel combustion (sectoral approach)	1,869.01	6.49	49.85						1,925.35
1. Energy industries	4.79	0.01	0.01						4.81
2. Manufacturing industries and construction	251.24	0.15	0.57						251.96
3. Transport	626.25	4.13	17.76						648.14
4. Other sectors	986.73	2.20	31.51						1,020.44
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	669.35	0.80	34.78	48.10	204.17	1.24			958.45
A. Mineral industry	60.39								60.39
B. Chemical industry	0.43	NO,NE	34.78	NO	NO	NO			35.21
C. Metal industry	608.52	0.80	NA		204.17	NO,NA			813.50
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				48.10	NO				48.10
G. Other product manufacture and use						1.24			1.24
H. Other									
3. Agriculture		297.68	669.74						967.42
A. Enteric fermentation		282.39							282.39
B. Manure management		15.29	125.91						141.20
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	543.83						543.83
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application									
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry(1)	7,684.87	2,355.45	1,470.44						11,510.77
A. Forest land	-94.63	0.36	2.91						-91.37
B. Cropland	1,831.74	90.23	NA,NE,IE						1,921.97
C. Grassland	6,591.04	491.27	1,467.54						8,549.84
D. Wetlands	-656.34	1,773.59	NO,NA,NE						1,117.25
E. Settlements	13.07	NE	NE,IE						13.07
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	4.51	214.15	7.51						226.16
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	6.57						9.32
E. Other	NA	0.20	0.18						0.38
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:(2)									
International bunkers	522.10	0.45	4.38						526.93
Aviation	359.38	0.06	3.06						362.50
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									
Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,190.54**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,701.31**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,190.54**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,701.31**

(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 2015 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)	10,447.33	2,862.15	2,221.19	42.52	149.89	1.31			15,724.39
1. Energy	1,931.92	8.63	50.11						1,990.65
A. Fuel combustion (sectoral approach)	1,778.77	6.52	50.11						1,835.40
1. Energy industries	3.78	0.01	0.01						3.79
2. Manufacturing industries and construction	207.21	0.12	0.50						207.83
3. Transport	629.25	4.30	17.98						651.52
4. Other sectors	938.54	2.09	31.63						972.26
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	791.31	1.12	17.91	42.52	149.89	1.31			1,004.07
A. Mineral industry	64.44								64.44
B. Chemical industry	0.41	NO,NE	17.91	NO	NO	NO			18.32
C. Metal industry	726.46	1.12	NA		149.89	NO,NA			877.48
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				42.52	NO				42.52
G. Other product manufacture and use						1.31			1.31
H. Other									
3. Agriculture	0.02	286.84	662.07						948.93
A. Enteric fermentation		272.22							272.22
B. Manure management		14.62	122.23						136.85
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	539.84						539.84
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry(1)	7,719.84	2,345.95	1,483.50						11,549.29
A. Forest land	-104.46	0.44	3.69						-100.33
B. Cropland	1,821.81	89.72	NA,NE,IE						1,911.53
C. Grassland	6,638.94	495.38	1,479.82						8,614.14
D. Wetlands	-651.37	1,760.41	NO,NA,NE						1,109.04
E. Settlements	14.91	NE	NE,IE						14.91
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	4.24	219.61	7.59						231.44
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	6.67						9.46
E. Other	NA	0.20	0.18						0.38
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:(2)									
International bunkers	620.47	0.59	5.19						626.25
Aviation	403.26	0.07	3.43						406.77
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									
Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,175.10**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,724.39**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,175.10**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,724.39**

(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.

2001

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

Inventory 2001
Submission 2015 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)]	10,450.54	2,865.64	2,217.06	47.92	108.05	1.31			15,690.53
1. Energy	1,879.22	8.55	49.11						1,936.88
A. Fuel combustion (sectoral approach)	1,735.46	6.36	49.11						1,790.93
1. Energy industries	3.09	0.00	0.01						3.10
2. Manufacturing industries and construction	241.49	0.15	0.58						242.22
3. Transport	639.89	4.32	18.06						662.27
4. Other sectors	850.99	1.89	30.47						883.34
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	825.44	1.08	15.53	47.92	108.05	1.31			999.32
A. Mineral industry	57.69								57.69
B. Chemical industry	0.49	NO,NE	15.53	NO	NO	NO			16.02
C. Metal industry	767.26	1.08	NA		108.04	NO,NA			876.38
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				47.92	0.01				47.93
G. Other product manufacture and use						1.31			1.31
H. Other									
3. Agriculture	0.02	288.51	651.41						939.95
A. Enteric fermentation		273.85							273.85
B. Manure management		14.66	121.57						136.23
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	529.85						529.85
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,741.83	2,340.45	1,492.42						11,574.70
A. Forest land	-110.11	0.47	3.87						-105.76
B. Cropland	1,811.76	89.21	NA,NE,IE						1,900.96
C. Grassland	6,673.77	498.29	1,488.54						8,660.61
D. Wetlands	-648.22	1,752.48	NO,NA,NE						1,104.26
E. Settlements	14.63	NE	NE,IE						14.63
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	4.03	227.05	8.59						239.68
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	1.49						7.89
D. Waste water treatment and discharge		2.82	6.75						9.57
E. Other	NA	0.20	0.18						0.38
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	493.28	0.41	4.14						497.83
Aviation	345.29	0.06	2.94						348.29
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,115.83**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,690.53**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,115.83**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,690.53**

(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 2015 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)	10,571.30	2,856.50	2,169.64	44.94	85.51	1.31			15,729.21
1. Energy	1,950.95	8.59	48.26						2,007.80
A. Fuel combustion (sectoral approach)	1,803.38	6.41	48.26						1,858.05
1. Energy industries	5.06	0.01	0.01						5.08
2. Manufacturing industries and construction	253.43	0.16	0.56						254.16
3. Transport	643.49	4.21	18.09						665.79
4. Other sectors	901.39	2.03	29.60						933.02
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	839.41	1.15	NO,NA,NE	44.94	85.51	1.31			972.32
A. Mineral industry	38.27								38.27
B. Chemical industry	0.45	NO,NE	NO,NE	NO	NO	NO			0.45
C. Metal industry	800.68	1.15	NA		85.50	NO,NA			887.34
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				44.94	0.01				44.95
G. Other product manufacture and use						1.31			1.31
H. Other									
3. Agriculture	0.02	283.06	608.09						891.18
A. Enteric fermentation		268.43							268.43
B. Manure management		14.63	120.48						135.11
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	487.61						487.61
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry(1)	7,777.17	2,332.50	1,504.68						11,614.35
A. Forest land	-118.77	0.50	4.15						-114.12
B. Cropland	1,801.68	88.69	NA,NE,IE						1,890.37
C. Grassland	6,723.69	502.30	1,500.53						8,726.52
D. Wetlands	-643.89	1,741.00	NO,NA,NE						1,097.11
E. Settlements	14.46	NE	NE,IE						14.46
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	3.75	231.19	8.61						243.55
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	1.45						7.42
D. Waste water treatment and discharge		5.21	6.80						12.01
E. Other	NA	0.20	0.18						0.38
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:(2)									
International bunkers	512.29	0.55	4.28						517.12
Aviation	306.45	0.05	2.61						309.11
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									
Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,114.85**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,729.21**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,114.85**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,729.21**

(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.

2003

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

Inventory 2003
Submission 2015 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)	10,576.96	2,850.94	2,153.79	55.23	70.47	1.31			15,708.71
1. Energy	1,948.87	8.70	49.94						2,007.50
A. Fuel combustion (sectoral approach)	1,812.36	6.57	49.94						1,868.87
1. Energy industries	4.32	0.01	0.01						4.34
2. Manufacturing industries and construction	224.35	0.16	0.48						224.99
3. Transport	738.17	4.45	20.46						763.07
4. Other sectors	845.52	1.96	28.99						876.47
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	839.00	1.12	NO,NA,NE	55.23	70.47	1.31			967.13
A. Mineral industry	32.11								32.11
B. Chemical industry	0.48	NO,NE	NO,NE	NO	NO	NO			0.48
C. Metal industry	806.41	1.12	NA		70.47	NO,NA			878.00
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				55.23	0.00				55.23
G. Other product manufacture and use						1.31			1.31
H. Other									
3. Agriculture	0.02	280.56	582.60						863.19
A. Enteric fermentation		265.97							265.97
B. Manure management		14.59	119.29						133.88
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	463.31						463.31
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry(1)	7,785.86	2,327.63	1,512.48						11,625.97
A. Forest land	-129.51	0.53	4.41						-124.57
B. Cropland	1,791.59	88.18	NA,NE,IE						1,879.77
C. Grassland	6,746.89	504.82	1,508.07						8,759.78
D. Wetlands	-641.28	1,734.10	NO,NA,NE						1,092.81
E. Settlements	18.17	NE	NE,IE						18.17
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	3.22	232.93	8.77						244.92
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	1.39						6.54
D. Waste water treatment and discharge		5.25	6.84						12.09
E. Other	NA	0.30	0.27						0.57
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA

Memo items:(2)									
International bunkers	472.14	0.40	3.96						476.50
Aviation	329.34	0.06	2.80						332.21
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									

Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,082.74**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,708.71**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,082.74**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,708.71**

(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 2015 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)]	10,623.94	2,848.68	2,199.09	58.75	45.48	1.32			15,777.26
1. Energy	1,966.07	8.94	53.27						2,028.29
A. Fuel combustion (sectoral approach)	1,843.17	6.64	53.27						1,903.09
1. Energy industries	3.88	0.01	0.01						3.90
2. Manufacturing industries and construction	197.61	0.13	0.48						198.22
3. Transport	789.97	4.59	20.74						815.30
4. Other sectors	851.71	1.92	32.04						885.67
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	861.94	1.14	NO,NA,NE	58.75	45.48	1.32			968.63
A. Mineral industry	49.79								49.79
B. Chemical industry	0.39	NO,NE	NO,NE	NO	NO	NO			0.39
C. Metal industry	811.76	1.14	NA		45.47	NO,NA			858.38
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				58.75	0.00				58.76
G. Other product manufacture and use						1.32			1.32
H. Other									
3. Agriculture	0.02	276.31	565.56						841.90
A. Enteric fermentation		261.66							261.66
B. Manure management		14.65	118.13						132.78
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	447.44						447.44
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,788.82	2,323.01	1,520.44						11,632.27
A. Forest land	-135.78	0.55	4.52						-130.71
B. Cropland	1,781.56	87.67	NA,NE,IE						1,869.22
C. Grassland	6,766.50	507.44	1,515.92						8,789.86
D. Wetlands	-638.74	1,727.35	NO,NA,NE						1,088.62
E. Settlements	15.28	NE	NE,IE						15.28
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	7.09	239.28	59.81						306.17
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	52.35						60.60
D. Waste water treatment and discharge		5.30	6.92						12.22
E. Other	NA	0.30	0.27						0.57
6. Other ***(as specified in summary 1.A)***	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	570.72	0.53	4.78						576.03
Aviation	375.83	0.07	3.20						379.09
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,144.99**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,777.26**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,144.99**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,777.26**

(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 2015 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)]	10,600.31	2,836.49	2,210.84	68.45	30.76	2.52			15,749.37
1. Energy	1,946.35	9.14	55.23						2,010.71
A. Fuel combustion (sectoral approach)	1,828.19	6.65	55.23						1,890.07
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	795.41	4.66	22.13						822.21
4. Other sectors	854.71	1.87	32.70						889.29
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	844.71	1.15	NE,NA,NO	68.45	30.76	2.52			947.59
A. Mineral industry	53.95								53.95
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	790.76	1.15	NA		30.76	NO,NA			822.67
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				68.45	0.00				68.45
G. Other product manufacture and use						2.52			2.52
H. Other									
3. Agriculture	0.02	277.81	563.76						841.59
A. Enteric fermentation		263.01							263.01
B. Manure management		14.80	119.12						133.92
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	444.63						444.63
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	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,804.91	2,316.08	1,531.44						11,652.42
A. Forest land	-155.29	0.57	4.71						-150.01
B. Cropland	1,771.40	87.15	NA,NE,IE						1,858.55
C. Grassland	6,803.80	511.05	1,526.72						8,841.57
D. Wetlands	-634.94	1,717.30	NO,NA,NE						1,082.36
E. Settlements	19.95	NE	NE,IE						19.95
F. Other land	NA,NE	NE	NA,NE						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	4.33	232.31	60.42						297.06
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	52.41						57.18
D. Waste water treatment and discharge		5.42	7.12						12.54
E. Other	NA	0.50	0.45						0.95
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	527.40	0.34	4.44						532.17
Aviation	417.01	0.07	3.55						420.64
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,096.95**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**15,749.37**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,096.95**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**15,749.37**

(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 2015 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)]	10,812.70	2,854.91	2,320.82	68.72	392.79	2.52			16,452.46
1. Energy	1,979.85	10.63	53.12						2,043.60
A. Fuel combustion (sectoral approach)	1,843.20	7.02	53.12						1,903.35
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	938.58	5.27	22.82						966.68
4. Other sectors	753.25	1.66	29.93						784.84
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	952.66	1.18	NE,NA,NO	68.72	392.79	2.52			1,417.88
A. Mineral industry	61.05								61.05
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	891.62	1.18	NA		392.79	NO,NA			1,285.59
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				68.72	0.00				68.73
G. Other product manufacture and use						2.52			2.52
H. Other									
3. Agriculture	0.02	281.54	644.39						925.95
A. Enteric fermentation		266.72							266.72
B. Manure management		14.82	119.48						134.30
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	524.91						524.91
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.02								0.02
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7,875.29	2,309.33	1,555.03						11,739.65
A. Forest land	-161.27	0.59	4.90						-155.78
B. Cropland	1,761.18	86.65	0.02						1,847.84
C. Grassland	6,875.35	521.04	1,548.98						8,945.38
D. Wetlands	-628.41	1,701.04	1.13						1,073.75
E. Settlements	28.45	NE	NE,IE						28.45
F. Other land	NA,NE	0.01	0.01						0.01
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	4.88	252.23	68.28						325.38
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	59.53						64.84
D. Waste water treatment and discharge		5.56	7.32						12.88
E. Other	NA	0.80	0.72						1.52
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:[(2)]									
International bunkers	630.95	0.41	5.31						636.67
Aviation	494.41	0.09	4.21						498.71
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,712.81**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**16,452.46**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,712.81**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**16,452.46**

(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 2015 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)	11,181.08	2,839.73	2,392.05	72.50	331.39	2.86			16,819.59
1. Energy	2,075.35	11.60	51.44						2,138.40
A. Fuel combustion (sectoral approach)	1,927.98	6.90	51.44						1,986.32
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	974.12	5.07	20.07						999.26
4. Other sectors	770.95	1.72	30.88						803.54
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	1,151.73	1.23	NE,NA,NO	72.50	331.39	2.86			1,559.70
A. Mineral industry	63.17								63.17
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	1,088.56	1.23	NA		331.38	NO,NA			1,421.18
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				72.50	0.00				72.50
G. Other product manufacture and use						2.86			2.86
H. Other									
3. Agriculture	0.04	285.98	692.68						978.70
A. Enteric fermentation		270.81							270.81
B. Manure management		15.17	120.51						135.68
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	572.18						572.18
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.04								0.04
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry(1)	7,945.98	2,293.00	1,567.86						11,806.84
A. Forest land	-168.70	0.60	5.02						-163.07
B. Cropland	1,750.91	86.12	NA,IE						1,837.04
C. Grassland	6,952.11	523.14	1,562.84						9,038.09
D. Wetlands	-621.37	1,683.13	NO,NA,NE						1,061.76
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									
H. Other	NO	NO	NO						NO
5. Waste	7.98	247.90	80.06						335.94
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	70.77						79.16
D. Waste water treatment and discharge		4.51	7.51						12.01
E. Other	NA	1.00	0.89						1.89
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items:(2)									
International bunkers	712.06	0.58	5.96						718.60
Aviation	505.92	0.09	4.31						510.32
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									
Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**5,012.75**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**16,819.59**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**5,012.75**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**16,819.59**

(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 2015 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)]	11,570.79	2,824.24	2,445.78	82.93	411.38	3.01			17,338.13
1. Energy	1,964.79	11.90	51.43						2,028.12
A. Fuel combustion (sectoral approach)	1,779.82	6.72	51.43						1,837.97
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	920.03	5.08	23.06						948.17
4. Other sectors	714.37	1.55	27.94						743.87
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	1,593.83	1.05	NE,NA,NO	82.93	411.38	3.01			2,092.20
A. Mineral industry	60.83								60.83
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	1,533.00	1.05	NA		411.38	NO,NA			1,945.43
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				82.93	0.00				82.93
G. Other product manufacture and use						3.01			3.01
H. Other									
3. Agriculture	0.04	289.25	737.99						1,027.28
A. Enteric fermentation		274.37							274.37
B. Manure management		14.88	119.95						134.83
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	618.04						618.04
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.04								0.04
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	8,005.82	2,282.30	1,584.76						11,872.88
A. Forest land	-172.67	0.62	5.10						-166.95
B. Cropland	1,740.59	85.61	NA,IE						1,826.20
C. Grassland	7,021.30	528.79	1,579.63						9,129.73
D. Wetlands	-615.38	1,667.28	0.02						1,051.92
E. Settlements	31.97	NE	NE,IE						31.97
F. Other land	NA,NE	0.00	0.00						0.00
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	6.31	239.74	71.61						317.65
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	62.16						68.86
D. Waste water treatment and discharge		4.20	7.55						11.75
E. Other	NA	1.06	0.95						2.01
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	651.25	0.61	5.42						657.27
Aviation	423.13	0.08	3.60						426.81
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**5,465.25**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**17,338.13**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**5,465.25**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**17,338.13**

(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 2015 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)	11,546.84	2,811.61	2,352.89	112.27	180.05	3.03			17,006.69
1. Energy	1,905.42	12.24	44.60						1,962.25
A. Fuel combustion (sectoral approach)	1,736.96	6.49	44.60						1,788.05
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	893.41	4.77	22.74						920.91
4. Other sectors	748.24	1.66	21.61						771.50
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	1,606.81	1.09	NE,NA,NO	112.27	180.05	3.03			1,903.25
A. Mineral industry	28.10								28.10
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	1,578.72	1.09	NA		180.05	NO,NA			1,759.85
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				112.27	0.00				112.27
G. Other product manufacture and use						3.03			3.03
H. Other									
3. Agriculture	0.04	291.80	639.55						931.39
A. Enteric fermentation		276.60							276.60
B. Manure management		15.20	122.54						137.74
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	517.01						517.01
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming									
H. Urea application	0.04								0.04
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry(1)	8,027.14	2,273.63	1,598.55						11,899.31
A. Forest land	-186.35	0.63	5.22						-180.50
B. Cropland	1,730.21	85.09	NA,IE						1,815.31
C. Grassland	7,077.65	533.33	1,593.33						9,204.31
D. Wetlands	-610.42	1,654.57	NO,NA,NE						1,044.15
E. Settlements	16.05	NE	NE,IE						16.05
F. Other land	NA,NE	0.00	0.00						0.00
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	7.43	232.86	70.20						310.49
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	60.34						68.14
D. Waste water treatment and discharge		4.17	7.58						11.76
E. Other	NA	1.27	1.14						2.41
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	494.79	0.44	4.12						499.35
Aviation	330.21	0.06	2.81						333.08
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									
Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**5,107.38**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**17,006.69**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**5,107.38**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**17,006.69**

(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.

2010

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

Inventory 2010
Submission 2015 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
	CO2 equivalent (kt)								
Total (net emissions) [(1)]	11,365.43	2,811.46	2,306.15	144.93	171.67	4.66			16,804.30
1. Energy	1,761.38	11.20	40.85						1,813.43
A. Fuel combustion (sectoral approach)	1,571.79	6.28	40.85						1,618.92
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	850.01	4.76	22.72						877.49
4. Other sectors	649.60	1.47	17.96						669.03
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	1,615.11	1.07	NE,NA,NO	144.93	171.67	4.66			1,937.44
A. Mineral industry	9.92								9.92
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	1,605.18	1.07	NA		171.66	NO,NA			1,777.92
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				144.93	0.01				144.94
G. Other product manufacture and use						4.66			4.66
H. Other									
3. Agriculture	0.04	293.86	603.54						897.44
A. Enteric fermentation		278.51							278.51
B. Manure management		15.35	123.45						138.80
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	480.09						480.09
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	0.03								0.03
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,982.77	2,272.42	1,601.50						11,856.69
A. Forest land	-209.40	0.65	5.35						-203.39
B. Cropland	1,719.81	84.58	NA,IE						1,804.39
C. Grassland	7,076.67	534.27	1,596.15						9,207.08
D. Wetlands	-609.80	1,652.92	0.00						1,043.12
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									
H. Other	NO	NO	NO						NO
5. Waste	6.13	232.91	60.26						299.30
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	49.91						56.39
D. Waste water treatment and discharge		4.18	7.62						11.81
E. Other	NA	1.52	1.36						2.89
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: [(2)]									
International bunkers	555.19	0.49	4.62						560.30
Aviation	373.12	0.07	3.18						376.36
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,947.61**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**16,804.30**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,947.61**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**16,804.30**

(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.

2011

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

Inventory 2011
Submission 2015 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)]	11,259.18	2,790.90	2,310.48	143.60	74.52	3.05			16,581.73
1. Energy	1,680.49	10.14	35.13						1,725.76
A. Fuel combustion (sectoral approach)	1,501.71	6.13	35.13						1,542.96
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	815.45	4.73	19.59						839.77
4. Other sectors	603.37	1.35	15.33						620.04
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	1,608.37	1.04	NE,NA,NO	143.60	74.52	3.05			1,830.57
A. Mineral industry	19.65								19.65
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	1,588.72	1.04	NA		74.52	NO,NA			1,664.27
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				143.60	0.00				143.60
G. Other product manufacture and use						3.05			3.05
H. Other									
3. Agriculture	0.05	293.73	594.37						888.15
A. Enteric fermentation		278.30							278.30
B. Manure management		15.43	124.34						139.77
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	470.02						470.02
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.01								0.01
H. Urea application	0.04								0.04
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry [(1)]	7,970.28	2,268.02	1,609.36						11,847.65
A. Forest land	-237.36	0.65	5.38						-231.33
B. Cropland	1,709.40	84.06	NA,IE						1,793.46
C. Grassland	7,100.88	536.89	1,603.97						9,241.74
D. Wetlands	-607.32	1,646.42	NO,NA,NE						1,039.10
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									
H. Other	NO	NO	NO						NO
5. Waste	0.00	217.97	71.63						289.61
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	0.00	1.98	61.40						63.39
D. Waste water treatment and discharge		4.20	7.67						11.87
E. Other	NA	1.43	1.28						2.70
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	615.72	0.54	5.13						621.39
Aviation	417.30	0.07	3.55						420.92
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,734.08**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**16,581.73**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,734.08**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**16,581.73**

(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 2015 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)	11,274.58	2,765.28	2,344.21	170.81	94.00	5.31			16,654.19
1. Energy	1,631.06	9.04	35.25						1,675.35
A. Fuel combustion (sectoral approach)	1,460.87	5.84	35.25						1,501.96
1. Energy industries	2.70	0.00	0.01						2.70
2. Manufacturing industries and construction	66.74	0.05	0.11						66.91
3. Transport	806.82	4.48	19.57						830.87
4. Other sectors	584.62	1.31	15.56						601.48
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	1,651.09	1.33	NE,NA,NO	170.81	94.00	5.31			1,922.54
A. Mineral industry	NO								NO
B. Chemical industry	NO,NA	NO	NO	NO	NO	NO			NO,NA
C. Metal industry	1,651.09	1.33	NA		94.00	NO,NA			1,746.41
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				170.81	0.00				170.82
G. Other product manufacture and use						5.31			5.31
H. Other									
3. Agriculture	0.06	292.26	634.73						927.05
A. Enteric fermentation		276.88							276.88
B. Manure management		15.38	123.37						138.75
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	511.36						511.36
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.01								0.01
H. Urea application	0.05								0.05
I. Other carbon-containing fertilizers									
J. Other		NA	NA						NA
4. Land use, land-use change and forestry (1)	7,985.63	2,262.82	1,618.36						11,866.81
A. Forest land	-247.96	0.65	5.36						-241.95
B. Cropland	1,698.99	83.55	NA,IE						1,782.53
C. Grassland	7,134.31	539.92	1,613.00						9,287.23
D. Wetlands	-604.41	1,638.71	NO,NA,NE						1,034.29
E. Settlements	4.70	NE	NE,IE						4.70
F. Other land	NA,NE	0.00	0.00						0.00
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	6.74	199.83	55.87						262.45
A. Solid waste disposal	NE,NA	193.04							193.04
B. Biological treatment of solid waste		1.12	1.00						2.12
C. Incineration and open burning of waste	6.74	0.33	46.14						53.22
D. Waste water treatment and discharge		4.23	7.73						11.96
E. Other	NA	1.12	1.00						2.12
6. Other *(as specified in summary 1.A)*	NA	NA	NA	NA	NA	NA			NA
Memo items: (2)									
International bunkers	619.05	0.50	5.17						624.72
Aviation	437.30	0.08	3.72						441.10
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									
Indirect CO_2 (3)									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,787.38**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**16,654.19**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,787.38**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**16,654.19**

(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 2015 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)]	11,256.28	2,748.08	2,339.47	168.15	87.71	3.05			16,602.75
1. Energy	1,593.24	9.84	33.48						1,636.57
A. Fuel combustion (sectoral approach)	1,420.78	5.77	33.48						1,460.03
1. Energy industries	2.20	0.00	0.01						2.21
2. Manufacturing industries and construction	43.16	0.03	0.08						43.27
3. Transport	802.79	4.48	19.44						826.71
4. Other sectors	572.63	1.25	13.96						587.84
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	1,670.79	1.40	NO,NA,NE	168.15	87.71	3.05			1,931.10
A. Mineral industry	NO								NO
B. Chemical industry	NO,NA	NO,NE	NO,NE	NO	NO	NO			NO,NA,NE
C. Metal industry	1,670.79	1.40	NA		87.71	NO,NA			1,759.90
D. Non-energy products from fuels and solvent use	NE,NO	NE,NO	NE,NO						NE,NO
E. Electronic Industry									
F. Product uses as ODS substitutes				168.15	0.00				168.15
G. Other product manufacture and use						3.05			3.05
H. Other									
3. Agriculture	0.07	267.04	619.57						886.68
A. Enteric fermentation		262.59							262.59
B. Manure management		4.46	116.35						120.80
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NE,NA,NO	503.22						503.22
E. Prescribed burning of savannas									
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	0.01								0.01
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)]	7,986.95	2,257.84	1,627.13						11,871.92
A. Forest land	-271.47	0.66	5.39						-265.42
B. Cropland	1,688.57	83.03	NA,IE						1,771.60
C. Grassland	7,166.87	542.85	1,621.74						9,331.47
D. Wetlands	-601.62	1,631.30	NO,NA,NE						1,029.68
E. Settlements	4.60	NE	NE,IE						4.60
F. Other land	NA,NE	NA	NA						NA,NE
G. Harvested wood products									
H. Other	NO	NO	NO						NO
5. Waste	5.22	211.96	59.29						276.48
A. Solid waste disposal	NE,NA	205.85							205.85
B. Biological treatment of solid waste		1.50	1.34						2.83
C. Incineration and open burning of waste	5.22	0.33	50.13						55.69
D. Waste water treatment and discharge		4.28	7.82						12.10
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	675.88	0.49	4.28						680.65
Aviation	503.20	0.09	2.98						506.27
Navigation	172.68	0.40	1.30						174.38
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									
Indirect CO_2 [(3)]									

Total CO_2 equivalent emissions without land use, land-use change and forestry	**4,730.83**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**16,602.75**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**4,730.83**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**16,602.75**

(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[1,2]	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		

[1] Jóhannes Sveinbjörnsson og Grétar H. Harðarson, 2008. Þungi og átgeta íslenskra mjólkurkúa. Fræðaþing landbúnaðarins: 336-344

[2] Harald Volden (ed.), 2011. Norfor- the Nordic feed evaluation system. EAAP publication no. 130. Wageningen Academic Publishers

annual average	15.4	74.4	6.9

B) COWS USED FOR PRODUCING MEAT

1. Cows used for prod. meat, stallfed[3]	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[3,4]	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 (%)

[3] Jóhannes Sveinbjörnsson og Bragi L. Ólafsson, 1999. Orkuþarfir sauðfjár og nautgripa í vexti með hliðsjón af mjólkurfóðureiningakerfi. Ráðunautafundur 1999: 204-217.

[4] Harald Volden (ed.), 2011. Norfor- the Nordic feed evaluation system. EAAP publication no. 130. Wageningen Academic Publishers

1. Heifers, stallfed	245.0		
2. Heifers, pasture	120.0		
annual average	6.0	74.4	7.1

D) STEERS

1. Steers[5,6]	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[7]	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

[5] Jóhannes Sveinbjörnsson og Bragi L. Ólafsson, 1999. Orkuþarfir sauðfjár og nautgripa í vexti með hliðsjón af mjólkurfóðureiningakerfi. Ráðunautafundur 1999: 204-217.

[6] Harald Volden (ed.), 2011. Norfor- the Nordic feed evaluation system. EAAP publication no. 130. Wageningen Academic Publishers

[7] 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

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

F) SHEEP

1. Sheep, stallfed[8]	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[9]	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[10]	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

[8] Jóhannes Sveinbjörnsson, 2013: Fóðrun og fóðurþarfir sauðfjár. Kafli 4 í: Sauðfjárrækt á Íslandi. Útg. Uppheimar, 2013.

[9] Jóhannes Sveinbjörnsson, 2013: Fóðuröflun og beit á ræktað land. Kafli 5 í: Sauðfjárrækt á Íslandi. Útg. Uppheimar, 2013.

[10] Ólafur Guðmundsson, 1987: Átgeta búfjár og nýting beitar. Ráðunautafundur 1987: 181-192

G) LAMBS

1. Lambs, pre-weaning[11,12]	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[13,12]	**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

[11] Ólafur Guðmundsson, 1987: Átgeta búfjár og nýting beitar. Ráðunautafundur 1987: 181-192

[12] 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)

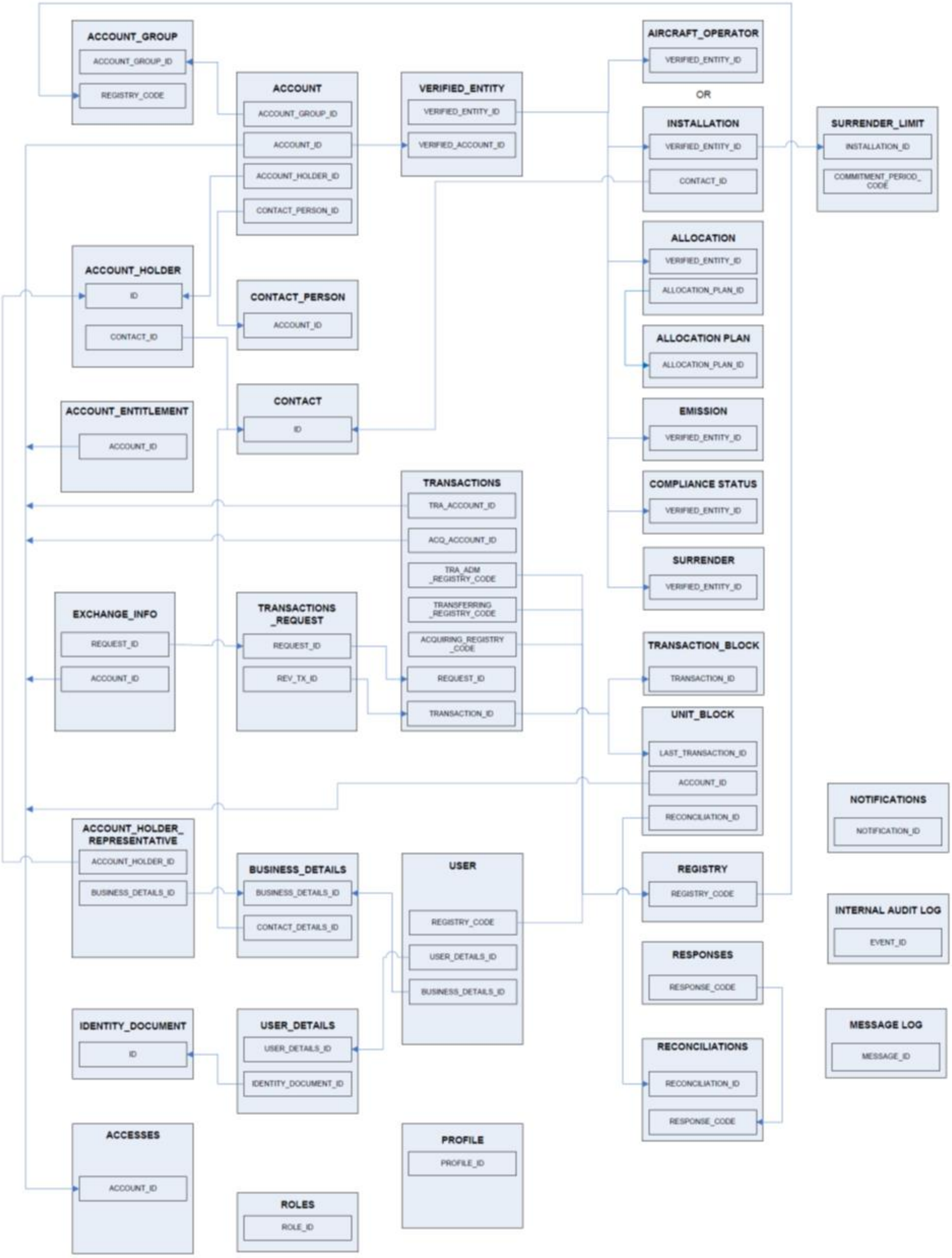
[13] Jóhannes Sveinbjörnsson, 2013: Fóðuröflun og beit á ræktað land. Kafli 5 í: Sauðfjárrækt á Íslandi. Útg. Uppheimar, 2013.

H) CONVERSION OF DMD INTO DE[14]

	dry matter digestibility	organic matter digestibility	metabo-lisable 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
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

[14] Guðmundsson, Ó. And Eiríksson, T. (1995) Breyting á orkumatskerfi fyrir jórturdýr (Ráðunautafundur, 1995)

ANNEX VI. CSEUR DATABESE STRUCTURE



ANNEX VI. TEST RESULTS OF CHANGES INTRODUCED IN V6.2.1

FEATURE	DESCRIPTION	TEST CASES
ETS-4251: Delete Trusted Account appears twice in task list filter	The option "Delete Trustred Account" appears twice in the drop-down lists which selects task type	1. Select "Task List" 2. Click the arrow next to "Task Name" to expand the drop-down list. 3. Pull down the drop down list and Ensure that the "Deletion of addition to Tr text does not appear twice.
ETS-3534: Button 'ADD' visible next to Trusted Accounts List	An account cannot be added on the TAL of a closed account	1.Select an OHA or AOHA with status "Closed" 2. Click on "View details" of the closed account 3. Select the tab "Trusted Accounts" 4. Ensure that the button "Add" at the end of the page is inactive (or has disap
ETS-2838: Verifier AR can see the full names of all national Admins	While assigning an emission approval task, the verifier should not have as an option the names of the NAs. On the contrary, when NAs assign emission approval tasks, they should retain the ability to assing the task to another NA.	1. Log in as an AR of an OHA with verifier account 2. Go to "Compliance" and enter verified emissions. 3. Log in as the AR Verifier 4. Go to "task list " and click assign task by AR of the appointed verifier 5. Make sure that the drop-down list doesnot contains the NAs. 6. Log in as NA and go to task list. Click assign task. 7. Make sure that the drop-down list contains the NAs.
ETS-1922: Account identifier incomplete in transaction list in case of 3-0 external transfer	A transaction towards a Registry beyond ETS has an "-0" suffix so that all four elements are full.	1. Choose"Transactions". 2.Click the arrow next to "Transaction Type" to expand the drop-down list and External Transfer Kyoto Units" and then "Search". 3. Ensure that the account identifier in the transaction list for accounts outside registry have and the 4th element.
ETS-1661: Include decimal separators in the "Reserved for transaction" column on Holdings	In Holding screen, all numbers have thousands separators.	1. Go into Accounts 2. Select an OHA or AOHA. 3. Click on "View details" of the account 4. Select the tab "Holdings" 5. Ensure that there are thousands separators in the "Balance" and in the "Res Transcation" columns.
ETS-1115: Filter page not reset when filter criteria changed	Ensure that when switching account types, the page is restarted at 1.	1. Go into Accounts 2. Select Operator Holding Accounts from the Account Type drop down 3. Click on "Filter" button 4. Select "Next page" several times e.g. to page 3 5. Change the Account Type to Person Holding Accounts 3. Click on "Filter" button 7. Ensure that new results start from page 1.

ETS-798: It is possible to submit duplicate Account Holder Updates	Exact identical account holder updates are treated correctly and show the correct *before* and *after* values.	1.Select an Account 2. Go to the Account Holder Details and Update something (e.g. the City) 3. Submit the request 4. Go back into the Account and make exactly the same change 5. Log in as NA and go to the "Transactions" 6. Approve the first Account Holder Details change from the Task List. Ensure t "Account Holder - Non Updatable Details" you can not see the field "CITY" and "Account Holder - Updated Details" the fields "After" and "Before" contain the for before and after the update. 7. Approve the task 8. When the change has completed pick up the second task from the task list. 9. At the field "Account Holder - Non Updatable Details" you CAN see the field update change. At the field "Account Holder - Updated Details" the fields "Afte empty.
SDB-424: Active Account Group Deleted	Ensure an active account group cannot be deleted.	Negative testing 1. Go to "Administrator" - "List Account Groups" 2.Click on an active account Group. 3. Click on the Delete button and click on Confirm. The system will display the e account group cannot be removed:This account group is in use."
SDB-486: Closed OHA still on Verifier List	When an account is closed, it is removed from the list of accounts of the Verifier, so that the Verifier does not see its identifier any more.	Negative testing 1. select a closed account (A)OHA and see the verifier 2. Log in as the verifier 3. Make sure that the clodsed account does not appear on the verifier's list
TST-169: Error message not user friendly when adding AR or AAR	When adding an AR/AAR on an account without specifying the type of connection to account holder, the error message became user-friendly.	Negative testing 1. Select an account 2. Click on AR or AAR tab and click on add AR or add AAR 4. Click next directly without selecting a radio button 5. The sytems message is: "Authorised Representative Addition: Validation Erro required" for ARs and "Additional Authorised Representative Addition: Validati required." for AARs.
TST-173: Message not user friendly when forgetting to select an external platform	When delegating an account to external platform, and a platform is not selected, the error message became user-friendly.	Negative testing 1. Select an account (OHA or AOHA) 2. Click on Delegate link on the right 3. Click on Next without selecting an external platform. 4. The system message is "External Platform: Validation Error: Value is requirec
SDB-1820: Europe - Allocation Phase 3 page locked displaying the incorrect locking user	Correct the information message which informs allocation page is locked by another user - this message erroneously informed the locking person is the current user. This message now correctly identifies the locking person	1. Log in as CA1 and Select EU ETS- Allocation Phase 3 2. From an other PC log in as CA2. 3. Make sure that the error message is saying page is locked by CA1 (The alloca is locked by another session from user CA1.)
TST-216: Account statements balance differentiation	Account statements PDF for a single account is enriched, so as to contain information for the eligibility of the units contained in the account.	1. Select an (A) OHA account 2. Go to "View Details" and click on "Account Statements" tab. 3. Enter a valid period and click on "Refresh" button. 4. Ensure that the balance shown is differentiated per unit type, and per eligibi AAU" and "CER" . The eligilbe units are marked with green color and the Inelig red color.

TST-208: Account Statements - Acquiring Account is KP account - requests Tab. The account type is "???account_type???"	In account statements, in case the acquiring account is KP account, its type does not appear correctly. This is now fixed.	1. Select an (A) OHA account 2. Go to "View Details" and click on "Account Statements" tab. 3. Enter a valid period and click on "Refresh" button. 4. Ensure that if the Aquiring Account is KP account then the information in the Type" field appears correctly as KP account.
SDB-2100: Full details of account holder details changes not shown	When account holder details are submitted for approval by NA, the details do not appear thoroughly in "Before" and "After" columns. This issue ensures the changed attributes appear in "Before" and "After" columns.	1. Log in as an AR 2. In your account holder details enter for example a new postcode 3. Submit the change 4. Log in as NA and review the Account Holder Details task 5. Ensure that the fields "Before" and "After" have the appropriate data, befor proposed update.
SDB-2102: Mobile phone number not mandatory field	When adding a user in the system the mobile phone number is not mandatory; this is changed so that it becomes mandatory.	1. Go to "Administration" - "Users" 2.Click on an URID of a user. 3. At the tab "Personal Details" click "Edit". 4. Ensure that the field "Mobile phone number" is mandatory. If you do not er number the systems displays the error message: "Mobile phone number: Valid required."
SDB-2054: Return to search loses sort order	When reviewing a transaction and clicking the "Return to Search" link, the transaction screen to which the user returns to should maintain sorting and paging, as appropriate.	1. Go to "Transactions" screen 2. Enter some search criteria 3. Sort the results (e.g. by Transaction Id) 4. Select one of the transactions, click on the hyperlink and look at the details 5. Click "Return to search" link 6. Ensure that you are returned to the list of results as it was after step 3.
SDB-2081: Transaction confirmation not cleared from screen	When entering a successful transaction, the approval message is sometimes maintained and re-appears at the following transaction, when an information message needs to appear.	1. Select an account (OHA or AOHA) 2. Click on "Holdings" tab. 3.Click On "Propose a transaction". Make sure you have an account with some credits, some ineligible project credits and some AAUs in it. 2. Propose a transfer of some of the eligible project credits to an EU- account 3. When returned to the holdings tab immediately propose another transactio some AAUs in it 4. When the error message saying that the transfer is not allowed make sure th message from the sucessful submission of the last transaction has disappeared
TST-185: During the creation of a project without selecting a country the error message displayed is not user friendly	When entering a new project in an ICH list, if a country is not provided, the error message is not user-friendly.	Nagative testing 1. Go to Administration - View ICH Lists 2. Select a List Name and click on "Insert" button 3. Into the new screen add a project but do not choose a country 4. Click on "Insert". Ensure that the error message is "Country: Validation Error
SDB-1834: AR of OHA can see URID of Verifier Account's ARs	The representative of an account should not be able to see the URID of the representative of the respective verifier account.	1. Select an OHA or AOHA 2. View Details 3. Select Verifier tab 4. Make sure that the URID of the VA's ARs is not shown
SDB-1866: Forbidden screen appears if AAR tries to propose emissions	Prohibit the AAR from proposing emissions for an account. The AAR cannot even click on the "Propose emissions" link, because it has been hidden.	1. Log in as an AAR of an account 2. Go to "Compliance" tab 3. Select First Commitment Period and click on "Refresh" Button 4. Make sure that the hyperlinks are not shown against the years for which Ver requied.

SDB-1607: Release already Released AOHA re-enables Account History radio buttons	An account can currently be released twice, leading to unforeseen behaviour; this is now corrected; an account cannot be released without having been claimed in advance.	1. Select on open AOHA 2. Go to "Release Account" and release the account 3. Make sure that the account is in "Transfer Pending" status 4. Go to "Release Account" and release the same account 5. Make sure that the system displays the error message: "Only account in acti Blocked, Inactive) should be eligible to be released" and the the radio buttons transfer of account history are not displayed.
SDB-1736: Suspended account not allowed to receive units	Currently, a suspended account cannot receive units; this is corrected, so that a suspended account can acquire units.	1. Select to suspend an OHA or AOHA account or choose an account in status " 2. Go to an other OHA or AOHA and make sure that the suspended account inc List 3. Go to "Holgings" tab and click on "Propose a transaction" 4. Select to transfer units. 5. in the field "Acquiring account identification code", select from trusted acco account. 6. Edit valid data in fields, and click on "Next" Button and then click on "Confirr 7. To sign the transaction, enter the ECAS password 8. Log in as an AAR of the account 9. Go to task List and approve the transaction. 10. Go to "Transaction" and make sure that the transfer is in status "Completec
SDB-363: Transaction details - no information on user who performed transfer	The transaction details screen is enriched with the user who performed the transaction. This information is not available for incoming transactions from JP, AU, CA, CH etc.	1. Go to "Transactions" 2. Select a transfer transaction, and click on the Transaction Identifier. 3. Make sure that : * The user who performed the transfer appears in "Request Details" tab in the This is not available in case where the transaction is incoming from JP, AU, CA, * Blocks details appear in the "Blocks" tab in the transaction details. * The respective accounts appear as clickable link in the transaction list. *Response codes (if such were generated for this transaction) appear in "Resp
SDB-1494: The revamp of the Task List has to be revisited - Critical Showstopper	The task list is redesigned so that NAs can opt between tasks assigned explicitly to them ("exclusive tasks") and tasks which can be approved by other users as well ("general tasks").	Test scenario 1: NA 1. Log in as NA 2. Go to "Task List" 3. Make sure that at the top of the page you can see the radio buttons " Exclus "General Task List". 4. Select " Exclusive Task List " and click on "Filter" button. Ensure that the res can be executed by NA only. 5. Select "General Task List" and click on "Filter" button. Ensure that the result executed by NA and other roles as well. 6. Ensure that the Fields "Account Identifier" and "Requester URID" are active. Test scenario 2: AR/AAR 1. Log in as AR or AAR 2. Go to "Task List" 3. Make sure that you can see the contents of the exclusive task list only .The b Task List", "General Task List", "Account Identifier" and "Requester URID" are r

SDB-2123: Commitment Period in transfer summary	The transaction confirmation screen by AR (before the initial signature), the commitment period and eligibility of the contained units are added.	1. Go to "Accounts". 2. Select an (A)OHA account. 3. Click on tab "Holdings" and "Propose a trasaction" 4. Propose a transfer transaction 5. In the summary of a transaction, just before you sign it, make sure that you c columns: Unit Type -Quantity to transfer -Eligibility- Applicable Commitment Pe
SDB-2122: Error message needs to be added	If a transfer is proposed and units to transfer are chosen from a project which has as Authorised Quantity inadequate quantity, the error message should become more detailed.	1. Go to "Accounts". 2. Select an (A)OHA account. 3. Click on tab "Holdings" and "Propose a trasaction" 4. Propose a transaction of Kyoto Units 5. Choose one project, and then type in a quantity greater than the one allowe project. Make sure that the error is <<Validation error 80000>> The amount << <<unit type>> is not available in the account <<account_identifier>> for the ch examble 80000: The amount 10000 of CER is not available in the account: 379 f project
SDB-2121: Holdings List - Order of Columns	In holdings screen, the columns "Eligible for ICH" and "Pending / Ineligible for ICH" are moved just before the column "Balance".	1. Go to "Accounts". 2. Select an (A)OHA account. 3. Click on tab "Holdings". Make sure that the columns "Eligible for ICH" and "P for ICH" are just before the column "Balance".
SDB-2126: Change the banking transactions from Chapter 2 , Chapter 3 to Aviation allowances and General Allowances	Banking transactions were renamed to more friendly names.	1. Go to "Transactions" 2. At the field "Transaction Type" open the drop down list. Make sure that you DeletionAviationAllowancesBanking DeletionGeneralAllowancesBanking IssuanceAviationAllowancesBanking IssuanceGeneralAllowancesBanking
SDB-1179: Need to see Account Name and Account Holder Name on AR approval task	Three account-related fields added in tasks approval screens.	1. Go to "Task List". Search for (A)ARs approval tasks 2. Select a task. At the end of the page at the field "Details: <<name of task>>" "Request" link. 3. Make sure that at the section "Account Details" the following fields are adde * Account Name * Account Holder Name * Account ID .
SDB-598: Task list should show the name of the person that requested the task	Describe addition of requester information in task list.	1. Go to "Task List". Click on "Filter" button. 2. Make sure that into the column "Initiator" you can see the name of the pers the task, and when hovering you can see the user's URID.
SDB-828: Task Accept/Reject not shown in task list history	In task history, "Outcome" criterion is added. Additional columns appear in the results list.	1. Go to "Task List" and click on "History" tab. 2. Ensure that the search criterion "Outcome" is added, with possible values: A User Approval Pending. 2. Click on "Search" button and make sure that you can see the columns Name Description -Initiator- Request ID- Start date-Due date- Outcome- Status

TST-214: Eligibility not shown in transaction details	Transaction details screen shows eligibility of the contained units.	1. Log in as NA 2. Go to "Transactions" and click on "Search" button. 3. Click on a Trasaction ID. 4. At the tab "Summary" make sure that there are the columns "Eligible for ICH Ineligible for ICH".
SDB-1610: No way to set up a Readonly AR on Account Claim	When releasing/claiming an accoun to another account holder, allow for specifying Ars as read-only.	1. Locate an account and release it. 2. Claim the account 3. Select "Account Holder already exists" 4. Select your first AR from ARs already related to the Account Holder. Ensure t make the AR readonly 5. Select your second AR by adding an AR that is not already related to the Acc there is option to make the AR readonly.
SDB-1513: Verifier that introduced Verified Emissions cannot approve them	If a Verifier of an OHA has introduced emissions for the OHA, the same Verifier can also approve it.	1. Log in as a an authorised representative of a verifier account of an OHA 2. Submit VE for the installation. 3. Go to the Task List to approve VE . 3. Make sure that the AR of the verifier account, that indroduce the VE is able t reject the task.
SDB-318: Technical error message give when alpha characters put in amount field on transfer	Clarify the error messages returned when entering invalid quantities for a transfer	Negative scenario 1. Go into Accounts 2. Select an OHA or AOHA. 3. Click on "View details" of the account 4. Select the tab "Holdings" and click "Propose a transaction". 5. select "Transfer of allowances' or "Transfer of AAU, RMU, ERU, CER, lCER and tCER" 6. Choose an account from the TAL and enter a date. 7. enter invalid data into the field "Quantity to transfer" * Leave the field empty ( ) The system will display an error message: At least o transfer must be a positive integer. * (0, -4) The system will display an error message: "The amount should be a po number." * (1.4) The system will display an error message: "Quantity to transfer: the valu numeric".
SDB-985: NA Auditor cannot see Task List	NA Auditors are allowed view-only access to the tasklist screen	1. Log in as NA Auditor 2. Click on "Task List" 3. Make sure that you can see all the tasks but you cannot claim or a assign any

SDB-2064: Account type wording incorrect when reviewing an account release prior to submission	When claiming an OHA, correct the account type shown on screen	1. Release an Operator Holding Account 2. Claim the account 3. Enter all the details of (A)ARs etc. 4. Review the final result prior to submission. Ensure that the Account Type is: Account. - Operator Holding. " Repeat with an Aircraft Operator Holding Account and ensure that the ccount Holding Account. - Aircraft Operator."
TST-132: When searching on Account holder in the Claim Account section, error message displayed is not user friendly	When claiming an account and not specifying account holder linked to the user, make the error message user-friendly	Negative senario 1. Select an account with status "Transfer Pending" 2.Go to Claim Account 3. Ender the identifier of the (aircraft) operator holding account your account claim, and click on "Next" 4. Select the "Account Holder is already linked to the user" . A drop down --Sel - appears 5. Click on Search without selecting anything. Make sure that the system displa message: "An account holder should be selected."
SDB-804: More details are needed on Account Approval	When approving an account creation request, for each account representative included in the request, specify if the AR operates for the same or different account holder.	1. Go to "Task List" and search Task name "Account Opening". Click on "Filter" 2. Click on the task. At the end of the page at the field "Details: Account Openi "Request" link. 3. Click on tab "Authorised Representative". For each Authorise Representative you can see the Fields User's States - Operates for the Same Account Holder - Operates for another Account Holder
SDB-229: Country information would be useful on transfer details	In transaction details screen, show the countries of the transfering and acquiring registries	1. Log in as NA 2. Go to "Transactions" and click on "Search" button. 3. Click on a Trasaction ID. 4. at the "Transaction details" field" make sure that next to Transferring Regist Registry there are countrycodes. For examble Acquiring Registry:EU(GR) Repeat as an AR, and make sure that you cannot see the countrycodes. For exa Registry:EU
ETS-4668: ICH lists export not possible	Exporting ICH lists in XML/CSV form is corrected to include all properties	1. Go to Administration and select "View ICH Lists" 2. At the field "List Names" select a list name from the drop-down list 3. Ensure the list can be exported in XML/CSV form respectively from buttons E Export CSV
ETS-3095: Transaction Search displays results outside criteria	Transaction search mechanism is corrected to return records inside criteria.	1. Go to "Transactions" 2. Enter a date into the field "From- To" end click on "Search" button. 3. Change display of results (e.g. from 10 to 50) 4. Make sure that the Transaction Search doesn't display transactions outside
ETS-3644: Transaction searching criteria do not work properly	Transaction search mechanism is corrected to return correct records if start and end date are equal.	1. Go to "Transactions" 2. Enter the same date into the field "From- To" end click on "Search" button. 3. make sure that the systems displays the correct results

SDB-1417: Inconsistent pre-population of country drop-down when creating new accounts	Modify the country drop-down list during account creation to contain correct countries	1. Select Account Request 2. Fill in the Account & Account Holder Details 3. For first AR select is not related to account holder" and enter a URID. The co business details is defaulted (to UK in my case) 4. Add the AR 5. When the screen to add the second AR is displayed select "is not related to t 6. Make sure that the country drop down is pre-populated as it was for the firs
TST-233: The "logout" link should start with a capital letter	Change "logout" link to start with a capital letter	Make sure that the The "Logout" link starts with a capital letter.
ETS-4740: Error screen on user search	Correct the user search mechanism when changing users states and paging	1. log in as CA, and go to Administration - Users 2. In the search criteria, choose status "Enrolled" and press "Search" button. 3. In results page, go to next page. 4. In the search criteria, change the status to "Validated" and press "Search" bu
SDB-1296: Claim account does not check number of (A)ARs added	When claiming an account, the number of ARs is not respected; this is corrected to respect the maximum allowed per Registry.	1. Limit the system to, say, 2 AARs 2. Select an account to Release and Release it 3. Start an Account Claim 4. Add the limit of AARs 5. Add another one 6. The system displays the error message: "The number of representatives can maximum allowable limit <<maximum number of ARs specified for the specific
SDB-795: Monitoring Plan & Verification Year of 2011 accepted	Minimum number of first year of verificaiton for AOHA set to 2012	1. Go to "Account Request" 2. Open an "Aircraft operator holding account" 3. Entry the data in the screen "Account Opening- Aircraft Operator Informatio Year of verification" enter a value >2012. The system will display an error mess Verification: Validation Error: Value is less than allowable minimum of '2012'"
SDB-2010: Verifier Account opening requests new Account Holder	Allow verifier to connect to account holder with the methods an account representative can connect to an account holder.	1. Go to Account request 2. Select to open a Verifier Account and enter a name. Click "Next" 3. at the screen "Account Opening Account Holder Information" ensure that yo following options: *Account Holder is already linked to the user *Account Holder is already recorded in the registry *Account Holder is new
SDB-600: Task description/header should be shown when going into the details	Fix task headers so that they depict the exact task selected.	1. Go to "Task List". Click on "Task List" (or on "History") tab and clic "Filter" bu 2. Select a task. At the end of the page at the field "Details: ......" click on the "R 3. Make sure that you can see the title of the task.
SDB-665: Account number should be displayed in the account detail	Add a descriptive header to all tabs of the account screen, so that account information are evident.	1. Go to "Accounts". 2. Select an account and Click in all tabs of the account, Make sure that in all ta ID (Full Account Number) - Account Holder Name -Account Name- Account St
TST-214: Eligibility not shown in transaction details	On transaction details screen, show the eiligibility of transacted units, at the time of transaction finalisation	1. Log in as NA 2. Go to "Transactions" and click on "Search" button. 3. Click on a Trasaction ID. 4. At the tab "Summary" make sure that there are the columns "Eligible for ICH Ineligible for ICH".

TST-222: Commitment Period in transfer summary	On transaction signature, the AAR needs to see Commitment Period and eligibility of transacted units; this information is now added.	This issue duplicates: SDB-2123 Commitment Period in transfer summary (Included in version 6.2) 1. Go to "Accounts". 2. Select an (A)OHA account. 3. Click on tab "Holdings" and "Propose a trasaction" 4. Propose a transfer transaction 5. In the summary of the transaction, just before you sign it, make sure that yo columns: Unit Type -Quantity to transfer -Eligibility- Applicable Commitment P
SDB-1444: No way back to account from List of Trusted Accounts	Add functionality to return from list of trusted accounts back to the transferring accounts	1. Log in as an NA or AR 2. Select an account (A)OHA in open status 3. Select "View details" and Click on Holdings tab 4. Select Propose Transaction 5. Select the link to select the destination from your list of trusted accounts 6. Make sure that there is a "Back" button
SDB-1663: Add Trusted Account button available on Closed Account	The functionality to add an account in the Trusted Account List of a closed account is removed.	This issue duplicates: ETS-3534 Button 'ADD' visible next to Trusted Accounts L version 6.2), ETS-4512 Add a account to the trusted account list, although the a 1. Select an account (A)OHA in closed status 2. Select "View details" and click on "Trusted Accounts" 3. make sure that there is no "Add" button
SDB-1841: Limit/Remaing column appears on non-compliance accounts	In account holdings tab, the "Limit/Remaining" column should not exist for non-OHA/AOHA accounts, as it is not relevant.	1. select a Party holding account in open status 2. Select "View details" and Click on Holdings tab 3. make sure that the column "Limit / Remaining" is not visible.
SDB-2034: Still allowed into Surrender Allowances even if you have no Phase 3 Allowances in your account	A surrender transaction should not even be clickable if the account does not have Phase 3 allowances.	1. Select an account (A)OHA with no balance in open status. 2. Select "View details" and Click on Holdings tab 3. Make sure that the button "Propose Transaction" is inactive.
SDB-1049: Task list history - table should display the outcome of the task (approved/ rejected) and not the status completed	Task list history is modified so as to show the outcome of the respective task, an not always the status "COMPLETED".	This issue duplicates: SDB-828 Task Accept/Reject not shown in task list history version 6.2) 1. Go to "Task List" and click on "History" tab. 2. Ensure that the search criterion "Outcome" is added 2. Click on "Search" button and make sure that you can see the columns Name Description -Initiator- Request ID- Start date-Due date- Outcome- Status
SDB-1373: Account closed with non-zero balance	The system is modified so as to prohibit accounts holding units from closing.	This issue duplicates: SDB-1704 Account close is possible even though units are (Included in version 6.2) 1.Select an Account (A)OHA with units in open status 2. Ensure that the button "Close" is not visible 1.Select an Account OHA with units in blocked status 2. Ensure that the button "Force Close" is active 3. Click on "Force Close", enter valid data and click on "Confirm Account Closur 4. Make sure that the account has the new status "Closed" 1. Select an Account AOHA with units in blocked status 2. Make sure that the button "Close" and "Force Close" are not visible.

SDB-1862: Account Closed with Positive Balance	The system is modified so as to prohibit accounts holding units from closing.	same as SDB-1373 This issue duplicates: SDB-1704 Account close is possible even though units are (Included in version 6.2), SDB-1373,
SDB-2196: Allocation page locked - wrong info	Allocation page is corrected so as to present correctly the details of the other user who is blocking access to this page.	This issue duplicates: SDB-1820 Europe - Allocation Phase 3 page locked displa locking user (Included in version 6.2) 1. Log in as User 1 (for examble nadmin1) and Select EU ETS- Allocation Phase 2. From an other PC log in as User2 (For examble na). 3. make sure that the error message is saying page is locked by User 1 (The all page is locked by another session from user na - GR National Administrator.The locked by another session from user na - GR National Administrator.
ETS-2789: Deletion without AAR	Ensure that a deletion of allowances is approved by another AR, when an AAR is missing on the account.	similar problem with issue:ETS-2332 1. Select an (A)OHA with no or with invalid AAR 2. Click as AR of the account on "View details" and click on "Holdings" tab. 3. Click on "Propose a transaction" and select "Deletion of allowances" 4. Enter Quantity to transfer and click on "Next". 5. Log in as an other AR of the account to approve the task.
ETS-2898: Transaction Terminated with incorrect Response Code	Ensure that a transaction to a suspended account is not prohibited by validation rules.	This issue duplicates: SDB-1736 Suspended account not allowed to receive uni version 6.2), ETS-3725, ETS-4805 1. Select to suspend an OHA or AOHA account or choose an account in status " 2. Go to an other OHA or AOHA and make sure that the suspended account inc List 3. Go to "Holgings" tab and click on "Propose a transaction" 4. Select to transfer units. 5. in the field "Acquiring account identification code", select from trusted acco account. 6. Edit valid data in fields, and click on "Next" Button and then click on "Confir 7. To sign the transaction, enter the ECAS password 8. Log in as an AAR of the account 9. Go to task List and approve the transaction. 10. Go to "Transaction" and make sure that the transfer is in status "Complete
ETS-3725: Account statuses which prevent transactions to be executed	Ensure that a transaction to a suspended account is not prohibited by validation rules.	This issue duplicates: SDB-1736 Suspended account not allowed to receive uni version 6.2), same as ETS-2898, ETS-4805
ETS-4512: Add a account to the trusted account list, although the account is closed.	Ensure that a closed account does not allow for additions of accounts in its TAL	same as SDB-1663 This issue duplicates: ETS-3534 Button 'ADD' visible next to Trusted Accounts L version 6.2), SDB-1663
ETS-4557: Unable to change the status of an Inactive Aircraft Operator Account	Allow a SUSPENDED account to become EXCLUDED.	1. go to Accounts and select Type "AOHA" in status Open or Blocked. 2. looking at the accounts in Account List you can see the options for an accou View Details || Suspend || Delegate || Block || Exclude and for an account wh View Details || Suspend || Delegate || Unblock || Exclude 3. Click on "Exclude" button. Make sure that the account is in status "Excluded

ETS-4805: France - Transaction EU131368 terminated with 2 response codes	Ensure that a transaction to a suspended account is not prohibited by validation rules.	This issue duplicates: SDB-1736 Suspended account not allowed to receive unit version 6.2), ETS-2898, ETS-3725
SDB-1308: Account Transaction History not withheld from new AR	When releasing an account and specifying that its history will not be available to new operators of the account, the history was shown. This issue is now fixed and history is not shown.	1. Find an account with at least one transaction in its history 2. Release the Account and specify that the account history is not to be availab Account Holder 3. Claim the Account 4. Approve the Claim task 5. Check the transactions whilst logged in as NA. Make sure that all transaction account are visible. 6. Log is as one of the new ARs. Check the transactions. Make sure that the tra out on the account are not visible.
ETS-2179: Voluntary cancellation not in accordance with Regulation	When a cancellation is proposed and the account does not have AAR, the cancellation can be approved by another AR	1. Log in as an AR or NA. 2. Select an account without an AAR. 3. Click on "View details"- "Holdings"- "Propose a transaction"- "Voluntary canc RMU, CER, lCER and tCER". 4. Enter valid data and click "Next" button. 5. Log in as an other AR of the account. Go to "Task List" and make sure that yo task.
ETS-2051: No option to close Person Account National Registry	Allow AR with permissions PERM_ACC_ADM_CLS_REQUEST and PERM_ACC_REP_CLS_REQUEST to be able to close Person account on National registry	1.Make sure that the permissions: PERM_ACC_ADM_CLS_REQUEST and PERM_ACC_REP_CLS_REQUEST are selected for Authorised Representative. 2. Log in as an Authorised Representative of a Person holding account or of a P National Registry. 3. Make sure that the "Close" Button is active for accounts without balance.
SDB-435: Administrator cannot see pending Verifier Appointments	NA is fixed via the permission PERM_ACCEPT_APPOINT_VERIFIER so that NA is able to see tasks appointed to verifiers.	The permission PERM_ACCEPT_APPOINT_VERIFIER needs to be added to NA. 1. Appoint a Verifier into an account 2. Log in as a NA and go to "Task List". Click "General Task List" Button, and ma see and you can only Reject the tasks of the verifier.
SDB-702: Rejection reason not shown on Account Requests	NA can review rejection reasons on account creation requests.	1. Go to "Accounts" - "List of account request". 2. Search for Rejected Account Creation. 3. Click on Rejection Details
ETS-2183: Not possible for natural person to open verififer account	Natural person is modified so that being able to open a verifier account.	This issue relates to: ETS-1037 1. Go to "Account Request". 2. Select to open a Verifier account. 3. At the screen "Account Opening Account Holder Information" enter all the n choose the radio button "Person". Complete the account opening.
SDB-1704: Account close is possible even though units are held on that account	Forbid account closure when the account possesses units.	1.Select an Account (A)OHA with units in open status 2. Ensure that the button "Close" is not visible 1.Select an Account OHA with units in blocked status 2. Ensure that the button "Force Close" is active 3. Click on "Force Close", enter valid data and click on "Confirm Account Closur 4. Make sure that the account has the new status "Closed" 1. Select an Account AOHA with units in blocked status 2. Make sure that the button "Close" and "Force Close" are not visible.

SDB-1087: Lost access to OHA as Verifier	An AR of a verifier account is modified so that the AR cannot be also an AR on an account being verified by the specific verifier account.	Senario 1 1. Create an OHA 2. Create a Verifer account and make sure one of the ARs is an AR on the OHA 3. Go to the account. Select the "Verifier" and click on "Appoint Verifier". 4. Make sure that the Verifier account with the same AR with the account isnot list. Senario 2 1. Appoint a Verifier account to a account. 2. Check the AR of the Verifier account. 3. Go to account and try to add or replace an (A)AR with the AR of the Verifier 4. The sytem displays the following message: "A relationship with the account with URID GR900000......."
SDB-2035: Incorrect text in Verifier Account Creation Summary	Modification of the text of the account creation summery when a verifier account is being created	Account Creation Summary e-mailed out when a Verifier Account was created following account characterisation: Kyoto Account Type: Non-holding
TST-171: Add AAR button is still displayed even after having 10 AAR	Addition of AAR was possible beyond the limit allowed per registry. This is now fixed and the "add AAR" button is no longer visible when that limit is reached.	1. Go into an (A)OHA account 2. Add the maximum number of AARs. 3. make sure that the button "Add AAR" is not anymore visible.
TST-160: Release account still accessible by AR through transaction	An AR of an account can still access account details after the account has been released.	1. Select an account as an AR of the account 2. Complete a transaction (for exmple a transfer) 3.Release the account. 4. Check that the account is in status 'Transfer Pending' 5. Check that the account is not more accessible through the menu 'Accounts' 6. Open the menu 'Transactions' and search for the transferring/acquiring acc released 7. Ensure that the link to the account is not active
SDB-1504: Inconsistent use of dual Task List	The task list of the NA is modified via new permissions: PERM_TR_SURR_APPROVE PERM_TR_DEL_APPROVE PERM_TR_CANCELLATION_APPROVE so as to include the tasks assigned to AAR.	NAs must have the permissions: PERM_TR_SURR_APPROVE PERM_TR_DEL_APPROVE PERM_TR_CANCELLATION_APPROVE 1. Log in as AR 2. Submit a transaction (surrender or deletion or cancellation) 3.Log in as NA and go to "Task List" 4. NA is able to see/query the above transactions waiting for AAR approval.
ETS-1995: Acquiring account details missing on transaction details for migrated transactions	Migrated transactions are missing acquiring account ID. This has been manually inserted.	Manual addition of data in Production

ETS-2436: Set Kyoto Unit Holdings per Account Type	Each MS can specify if each of the unit types: AAU, CER, ERU_from_AAU, tCER, lCER, RMU, ERU_from_RMU can be held on each of the KYTO account types: Person Holding Accounts and Former Operator Holding Accounts. This specification is performed on a configuration file (eucr-configuration.properties).	1. Connect in PL registry. 2. Confirm all KYOTO unit types can be transferred to Person Holding Accounts 3. Confirm all KYOTO unit types can be transferred to Former Operator Holding 4. Connect to DK registry. 5. Confirm that all KYOTO unit types except tCER, lCER, can be transferred to P Accounts 6. Confirm that all KYOTO unit types except tCER, lCER, can be transferred to F Holding Accounts Repeat for all registries included in the provided list.
SDB-2133: Implement or extend ain the Union Registry and in the EUTL the ITL check 5112	Implement check 5112, which fires when CP2 CER, lCER, tCER are transferred incoming from a country not included in a defined country list.	1. Connect to ITL as JP registry (JP is not contained in the country list) 2. Send 100 CER on an account in EUETS. 3. Confirm the validation rule 5112 is returned from EUTL to ITL. 4. Connect to ITL as CH registry (CH is not contained in the country list) 5. Send 100 CER on an account in EUETS. 6. Confirm the transaction succeeds
SDB-2134: Implement or extend ain the Union Registry and in the EUTL the ITL check 5257 referring to the retirement of CERs, lCERs, tCERs valid for the second KP period	Implement check 5257, which blocks CP2 CER, lCER, tCER from retirement, if before a definable date. The date is defined in configuration file (Kyoto_app.properties=>retirement.cp2.validFrom)	1. Set the CP2 retirement date to a past date 2. Perform retirement of CP2 units. 3. Set the CP2 retirement date to a future date 4. Ensure CP2 units cannot be retired.
TST-236: Include Colour Code Legend in NAT screen	In NAT screen, a new footer is added explaining all used colours	1. Navigate to EUCR=>EUETS=>Allocation Tables Phase 3 2. On the bottom left corner of the screen a footer explaining the colours appe
TST-238: Confirmation message and error message on the same screen	When uploading a NAT.XML double messages are removed	1. Navigate to EUETS=>Allocation Tables Phase 3 2. Upload an XML 3. Ensure only one confirmation message appears
TST-240: Task name should be changed	When approving the upload of a ICE XML the task name should be "Approve upload of ICE Table".	1. Upload an ICE XML as an NA 2. Connect as second NA to approve the upload 3. Confirm the name of the message is: "Approve upload of ICE Table"
TST-241: Calculation Method search criteria in ICE table screen not functional	When searching entitlements via calculation method, results are erroneous	1. Navigate to EUETS=>Entitlements 2. Select calculation method "0" 3. Click "Search" 4. Ensure results correspond to method "0" Repeat for 1,2,3
All roles and permissions should be shown in the roles and permissions matrix		1. Select "Roles and permissions" 2. Ensure that you can see all the roles and permissions. Also Ensure that all pe names with some sort of information as to what this permission is all about.
Europe - Not possible to submit a surrender when a previous one was rejected by EUTL		1.Make sure that the EUTL will reject surrender transactions (e.g. by setting U of all unit blocks of the account to 1, so that they are marked as being included 2. Select an Account and submit a surrender transaction. Make sure that the tr rejected from the EUTL. 3. Make sure that the EUTL will approve surrender transactions (by un-doing th step 1) 3. Select the previous account and submit a new surrender transaction 4. Make sure that the transaction is completed

Verifier AR can see the full names of all national Admins	While assigning an emission approval task, the verifier should not have as an option the names of the NAs. On the contrary, when NAs assign emission approval tasks, they should retain the ability to assign the task to another NA.	1. Log in as an AR of an OHA with verifier account 2. Go to "Compliance" and enter verified emissions. 3. Log in as the AR Verifier 4. Go to "task list " and click assign task by AR of the appointed verifier 5. Make sure that the drop-down list does not contain the NAs. 6. Log in as NA and go to task list. Click assign task. 7. Make sure that the drop-down list contains the NAs. Repeat the test with a user who has both roles of NA and CA
It is possible to submit duplicate Account Holder Updates	Exact identical account holder updates are treated correctly and show the correct *before* and *after* values.	1. Select an Account 2. go to the Account Holder Details and Update something (for ex. The city) 3. Submit the task 4. Select the same account (or select any account that has the same Holder wit and try to make a new change in the details of the account Holder. The system error message: "This account holder has already a pending update request."
Active Account Group Deleted	Ensure an active account group cannot be deleted.	1. Go to "Administrator" - "List Account Groups" 2.Click on an active account Group. 3. Click on the Delete button and click on Confirm. The system will display the e The account group cannot be removed: This account group is in use."
Administrator cannot see pending Verifier Appointments	NA is fixed via the permission PERM_ACCEPT_APPOINT_VERIFIER so that NA is able to see tasks appointed to verifiers.	1. Appoint a Verifier into an account 2. Log in as a NA and go to "Task List". Click "General Task List" Button, and ma see and you can only Reject the task.
NA Auditor cannot see Task List	NA Auditors are allowed view-only access to the task list screen	The following is a pre-requisite in order to execute this scenario: The NA Auditor should have been given (by registry) the appropriate roles and each task that wants to appear in the Task list. In order to see the "Task list" the NA Auditor should have the permission: View (PERM_TASK_LIST) In order to see the "List of account request" the NA Auditor should have the pe account management requests (PERM_AMR_SEE) 1. Log in as NA Auditor 2. Click on "Task List" 3. Make sure that you can see all the tasks but you cannot claim or a assign any

The revamp of the Task List has to be revisited - Critical Showstopper	The task list is redesigned so that NAs can opt between tasks assigned explicitly to them ("exclusive tasks") and tasks which can be approved by other users as well ("general tasks").	Scenario 1 1. Log in as NA 2. Go to "Task List" 3. Make sure that at the top of the page you can see the tabs " Exclusive Task L List" and "History". 4. Select the tab " Exclusive Task List ". Ensure that the tasks belong to the NA 5. Select the tab "General Task List". Ensure that the tasks belong to other role access. 6. Ensure that the Fields "Account Identifier" and "Requester URID" are active. Scenario 2 1. Log in as AR or AAR 2. Go to "Task List" 3. Make sure that you can see the exclusive task list .The tabs " Exclusive Task L List", and the fields "Account Identifier" and "Requester URID" are not visible.
All transactions visible to NA	The NA and AR of the accounts should see all transactions and tasks of AAR.	1. Log in as NA 2. Go to "Task List" 3. make sure that NA is able to see/query all transactions including: _transactions waiting for AAR approval _transactions that were rejected be AAR similarly ARs are able to see/query the transactions _waiting for AAR approval _rejected by AAR

NAs should be able to perform certain actions on suspended accounts		1. Log in as NA 2. Select to suspend an OHA or AOHA account or choose an account in status " A. **Update of account details (Article 25);** 1. Log in as a NA. Go to "View Details" and select the "Account Main" tab" 2. Click on "Update Account Name", provide a new name for the account and 3. Make sure that the account name has been changed. B. **Transfers out (this is needed for the exceptional case where a suspended a closed but it has a non-zero balance (Article 32);** **NOTE** *** If the suspended account has AARs, then needs approval from NA.** 1. Log in as a NA. Go to "View Details" and select the "Holdings" tab. 2. Click on "Propose a transaction" 3. select to Transfer of allowances 4. select an account from the TAL, enter all the required fields and click on "Ne "Confirm". 5. Enter the ECAS password. 6. Log in as a second NA and approve the transaction 7. Go to "Transactions" and make sure that the transaction is in status "Comple *** If the suspended account does not have an AAR then the transaction is exe automatically.** C. **Transfers into a suspended account** 1. Log in as a NA. Select to suspend an OHA or AOHA account or choose an ac "Suspended". 2. Go to an other OHA or AOHA and make sure that the suspended account inc List 3. Go to "Holdings" tab and click on "Propose a transaction" 4. Select to transfer units. 5. in the field "Acquiring account identification code", select from trusted acco account. 6. Edit valid data in fields, and click on "Next" Button and then click on "Confirr 7. To sign the transaction, enter the ECAS password 8. Log in as an AAR of the account 9. Go to task List and approve the transaction. 10. Go to "Transaction" and make sure that the transfer is in status "Completed **D. Allocation (Articles 51 - 57);** 1. Log in as a NA 2. Go to "Allocation Phase 3" and choose the account. then clock on "Submit" (not units you have to go first to "Allocation Tables Phase 3 and upload files to E 3. Log in as a second NA and approve the task. 4. Make sure that the account receives allocation E. **Entry of verified emissions (Article 35);** 1. Log in as a NA 2. Go to "Compliance" select First Commitment Period and click on "Refresh" B 3. Propose emissions and click on Confirm. 4. Log in as a second NA and approve the transaction F. **Surrender of allowances (Article 67);** 1. Log in as a NA. Go to "View Details" and select the "Holdings" tab.

		2. Click on "Propose a transaction" 3. Select to Surrender of allowances 4. Ender valid data and click on "Submit" and "Confirm" 5. Enter ECAS password 6. the transaction is executed automatically.

PT - translations related to trusted account, search and export, error codes, message box missing from UT		1. Log in as NA 2. Select Portugal registry. Select "Home page" and change the language to "Portuguese" Scenario 1 1. Go to "Contas"- "Contas" and click on "Pesquisar" 2. Select an account with status (Estado: Aberta) and click on "Visualizar dados 3. Select "Extratos de conta" tab. 4. make sure that the buttons for PDF and CSV have been translated Scenario 2 1.Go to "Contas"- "Contas" and click on "Pesquisar" 2. Select an account with status (Estado: Aberta) and click on "Visualizar dados 3. Look at the top of the page, and make sure that the phrase "Returne to Sear translated (Voltar à pesquisa) Scenario 3 1. Go to "Contas"- "Operacoes" 2. Select the "Tipo de conta de origem da transferência:" and open the drop do Scenario 4 1. Go to "Contas"- "Operacoes" and click on "Pesquisar" 2. Select a transaction and click on its ID (ID da operação) 3. Make sure that the Transaction PDF has been translated (PDF da operacao) Senario 5 1. Go to "Comercio Europeu de Licencas de emissao" and click on "Contabilida 2. make sure that the whole page has been translated Scenario 6 1. Go to "Contas"- "Operacoes" and click on "Pesquisar" 2. Select a transaction and click on its ID (ID da operação) 3. Click on the "PDF da operacao" button 4. Make sure that the whole PDF has been tranlated
PL translation of Union Registry		make sure that the translation is correct, as defined in the Jira issue
Lack of PL translation in the new version		make sure that the translation is correct, as defined in the Jira issue
Netherlands - Update of PDF files		make sure that the translation is correct, as defined in the Jira issue
Logo in Account Statements		1. Select Slovakia registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
NL - Logo in Account Statements		1. Select Netherlands registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.

LI - Logo in Account Statements		1. Select Liechtenstein registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
Portugal - Logo for Account Statement		1. Select Portugal registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
DK - Logo in Account Statements		1. Select Denmark registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
BE - Logo in Account Statements		1. Select Belgium registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
Italy - Logo for Account Statements		1. Select Italy registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
LV - Logo in Account Statements		1. Select Latvia registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
Logo in Account Statements		1. Select Sweden registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem 5. make sure that you can see the logo at the top of the page of the PDF.
Pending / Ineligible for ICH - Reason	Export the "not on any list" value in CSV.	1. Go to "Administrator" - "Unit Block" 2.In the list of Unit Blocks make sure that at the column "Reason" you can see 3. Click on the "Search and Export" button. Make sure that the reason "Not on exported to the CSV file.
Account Statement Date	Show exact date in the generated account statement PDF/CSV.	1. Select Slovakia registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "view details" and select the "Account Statements". 4. enter a valid period and click on "Refresh" button. Click on "Account Statem "CSV'. 5. make sure that you can see the field "time" correctly.

Austria - New properties files for Account Opening		1. Select Austrian registry 2. Go to "List of account requests" and search with type "Account Creation". 3. Select a result and click on "Consult". 4. Open the PDF and make sure that it complies with the new regulations.
PT translations for v6.2	Received by e-mail on 14/10/13	make sure that the translation is as requested
PL translations for v6.2	Received by e-mail on 15/10/13	make sure that the translation is as requested
NA Auditor cannot see Task List	NA Auditor should be able to access the task list, but not execute tasks	1. Log in as Auditor for NA. 2. Select "Task List". 3. Make sure that you can see the tabs: General, Exclusive and History, and al authorized to see. 4. Try to Claim one task. The system will display the message "You are not auth action."
Impossible to edit emission for an account with excluded year	When an account is excluded for a year and has emissions for this year, it should be possible to edit the emissions	In order to test this issue, the following should be performed: Move the server date to a date beyond 2013, e.g. in 2015 Restart the server 1. Set an account to Excluded for 2013 with no emissions 2. Attempt to insert emissions for 2013 . Make sure that the link "propose" is n 3. Set an account to Excluded for 2013 with emissions. 4. Attempt to edit emissions for 2013 . Make sure that the Icon "edit" is active.
Confirmation message after saving change on "Excluded" property	Add a confirmation message after excluded years have been set.	1. Select an OHA or AOHA 2. Click on "View details" and go to the "Compliance" tab. 3. Select to exclude (or unexclude) a year by clicking into the check box and Sa 4. The system will display the message: "The account settings have been applie
If an account is Excluded for a certain year, you can still propose VE.	If an account is excluded for a year, emissions cannot be inserted for this year	In order to test this issue, the following should be performed: Move the server date to a date beyond 2013, e.g. in 2015 Restart the server 1. Set an account to Excluded for 2013 with no emissions 2. Attempt to edit emissions for 2013 . Make sure that the link "propose" is no Relates to TST-274
The amount of excess allocation is modified before the transaction 'return of excess allocation' is completed.	The Return of Excess Allocation transaction screen has been re-designed	Please follow this issue via TST-273, which implements the re-design of this scr 1. Select an Over - allocated OHA which has at least one AAR 2.Go to "View Details"- "Holdings" -"Propose a transaction". 3. Select the transaction: "Return of excess allocation" 4. At the top of the screen you can see a small table with the Fields: a) Year b) Pending 5.Click on the radio button of an over-allocated year at the field a) Year. 4. Enter quantity smaller than the excess amount and the amount of allowance 5. System displays the information message : "Your transfer proposal has been assigned the identifier EUxxxxx . The transaction has been submitted for appro 6. Make sure that the results are correct at the fields b) Over - Allocated and c) small table.

Unrecoverable error when inserting/edit emissions for an excluded year, for a blocked/suspended account	Do not produce unrecoverable error when attempting inserting/edit emissions for an excluded year, for a blocked/suspended account	In order to test this issue, the following should be performed: Move the server date to a date beyond 2013, e.g. in 2015 Restart the server 1. Log in as Na and select a blocked or suspended account. 2. Go to "View Details" and select the "Compliance" tab. 3. Select an excluded year (or exclude a year) with emissions. 4. Make sure that you can edit emissions for an excluded year. 5. Select an excluded year (or exclude a year) without emissions. 6. Make sure that the "propose" link is not visible.
Lack of Polish letters	Some special Polish characters do not appear correctly; this issue is now corrected.	1. Connect as NA for PL 2. Navigate to task list screen 3. Confirm the screen labels appear in Polish correctly
New Labels: Eligible and Ineligible	Labels in screens regarding ICH characterisation are modified.	1. Connect as NA 2. Navigate to an account's holdings screen 3. Confirm the labels for eligible/ineligible units are respectively: * Eligible * Ineligible
Transaction type '3-102 Reversal Surrender Kyoto Units' and '10-84 Reversal Surrender Kyoto Units (AOHA)' - need for clarification	Changes in the translations of some transaction types for some registries.	**Test case 1** 1.1. Connect as HR NA 1.2. Navigate to Accounts=>Transactions screen 1.3. Confirm the transaction type 3-82 is not available in the Transaction Types **Test case 2** 2.1. Connect as GR NA 2.2. Navigate to Accounts=>Transactions screen 2.3. Confirm the transaction type 10-84 is not available in the Transaction Type 2.4. Repeat steps 1-3 for PT NA **Test case 3** 3.1. Connect as NA of any registry. 3.2. Navigate to Accounts=>Transactions screen 3.3. Confirm the transaction type 3-102 is not available in the Transaction Type 3.4. Confirm the transaction type 3-82 is available in the Transaction Types dro
Trusted account message should have "CET" (The trust will become effective on 29/10/2012 15:49:16)	The abbreviation "CET" to be added after the date and time when an account will become trusted.	1. Navigate to an account's Trusted Accounts tab 2. Click on "Add" button 3. Submit and approve an addition to TAL 4. Confirm the message appearing after the approval has the abbreviation "CE

Allocation must be able to happen for past years and the current year	Allocations can be performed for all years since they start of Phase 3 up to and including the current year.	1. Connect as NA 2. Navigate to EUETS=>Allocation Phase 3 3. Confirm that in "Installations" and "Aircraft Operators" tabs the years from t Phase 3 up to and including the current year appear. 4. User selects allocations for a year 5. User clicks "Submit" 6. User connects as second NA and approves the allocations. 7. Allocations to the specified installations are performed at the next allocatio Repeat for aircraft operators. Note that enough units must have been issued and transferred to EU Allocatio
Unrecoverable error when you click Accounts link after your propose a transfer of allowance	Proposing a transfer and directly afterwards clicking the "Accounts" link produces an error; this issue is now fixed.	1. Enter a transfer transaction 2. Directly afterwards click the "Accounts" link 3. Confirm an error does not appear and system operates normally
Tasks List: Assign button available to AR users	Users can assign tasks to users with the same role (applicable to AR and AAR users).	1. Log in as AR. 2. Go to Task List. Select a task and click "Assign". 3. From the drop down list at the field "New claimant" check the names of the 4. Ensure that as an AR you can assign the task only to ARs. 5. Repeat the test with AARs. Ensure that as an AAR you can assign the task on
Allocation Phase 3 - Ticking boxes for future years should not be possible	Allocation cannot happen for years later than the current year.	1. Connect as NA 2. Navigate to EUETS=>Allocation Phase 3 3. Confirm that in "Installations" and "Aircraft Operators" tabs the years from t Phase 3 up to and including the current year appear as possible selections for " listbox. No future years appear. 4. User selects allocations for a year 5. User clicks "Submit" 6. User connects as second NA and approves the allocations. 7. Allocations to the specified installations are performed at the next allocatio Repeat for aircraft operators. Note that enough units must have been issued and transferred to EU Allocatio
CLONE - TaskList - can assign a person to a task who is not in the task assignee list	It is possible to assign a non-authorised user to a task. This is now fixed.	1. Go to Task List. Select a task and click "Assign". 2. From the drop down list at the field "New claimant" check the names of the 3. Select another task and check the names of the assignees with the same wa the two tasks have not the same assignees. 4. Having clicked the second task, select an assignee that appears only to the s to the first one. 5. Check both tasks and then click "Save". 6. Ensure that the name of the assignee is saved only to the second task.

CLONE - Navigation through pages in the allocation upload confirmation screen shows blank tab	While uploading an allocation XML, paging through it produces empty pages, after the first page. This is now fixed.	1. Go to Allocation Table Phase 3 2. Choose “National Allocation Table”. 3. At the “Batch administration” field, browse and choose to upload a correct X more than 10 Installation IDs 4. At the “NAT changes confirmation” screen try to navigate to page 2 (or any o one) 5. Ensure that you can see the right data in all pages. 6. Repeat the above test choosing to upload a correct XML NAAT file from “Nat Allocation Table” with more than 10 Aircraft operator IDs. 7. At the “NAVAT changes confirmation” screen try to navigate to page 2 (or an first one) 8. Ensure that you can see the right data in all pages.
Help page with intermediate terms-conditions page	A new help page is available to logged-in users.	1. Log in the application. 2. Visit the link "Help" on the top right corner 3. View the help page which is presented
Remove action "D" from allocation table upload	The action "D" should no longer be supported when uploading NAP XML files and NAAT XML files. This is applicable in EUTL.	1. Create a NAT XML file with the "D" directive (for example: <ns1:installation i action="D"/>) 2. Upload the NAT file in EUTL, by navigating to Registry Mgt=>Registry=>NAT L 3. Ensure an error message appears Repeat for NAAT XML file and navigate to Registry Mgt=>Registry=>NAAT Loac
NAT file with D flag causes the system to hang > Functionality gets locked and no more NAT files can be uploaded after that	The action "D" should no longer be supported when uploading NAP XML files and NAAT XML files. This is applicable in EUCR.	1. Create a NAT XML file with the "D" directive (for example: <ns1:installation i action="D"/>) 2. Upload the NAT file in EUCR, by navigating to EU ETS=>Allocation Tables Pha Allocation Table=>Batch Administration 3. Ensure an error message appears. Repeat for NAAT XML file and navigate to EU ETS=>Allocation Tables Phase 3= Allocation Table=>Batch Administration

CLONE - Error while uploading upload allocations	An error appears when uploading an XML file; this is now fixed.	***Scenario 1.a*** 1. Go to Allocation Table Phase 3 2. Choose “National Allocation Table”. 3. At the “Batch administration” field, browse and choose to upload a correct X **more** than 10 Installation IDs 4. At the “NAT changes confirmation” screen try to navigate to page 2 (or any c one) 5. Ensure that you can see the right data in all pages. 6. Click on "Confirm" button. 7. Ensure that the allocation plan has been imported. ***Scenario 1.b*** 1. Repeat the above test choosing to upload a correct XML NAAT file from “Nat Allocation Table” with **more** than 10 Aircraft operator IDs. 2. At the “NAVAT changes confirmation” screen try to navigate to page 2 (or ar first one) 3. Ensure that you can see the right data in all pages. 4.Click on "Confirm" button. 5. Ensure that the allocation plan has been imported. ***Scenario 2.a*** 1. Go to Allocation Table Phase 3 2. Choose “National Allocation Table”. 3. At the “Batch administration” field, browse and choose to upload a correct X **less** than 10 Installation IDs 4. At the “NAT changes confirmation” screen, ensure that you can see the right 6. Click on "Confirm" button. 7. Ensure that the allocation plan has been imported. ***Scenario 2.b*** 1. Repeat the above test choosing to upload a correct XML NAAT file from “Nat Allocation Table” with **less** than 10 Aircraft operator IDs. 2. At the “NAVAT changes confirmation”, ensure that you can see the right dat 4.Click on "Confirm" button. 5. Ensure that the allocation plan has been imported. ***NOTE*** ***Repeat the above test scenarios with Add, Update and Delete XML Files***
Optimization in the NA task-lists	The NA Generic and Exclusive lists are changed so as not to be populated by default (just like the task history). An indicator (ajax status) is shown (just below the filter buttons) while the task-list is being populated	1. Login as NA and navigate to task list screen 2. Click on Task list => General Task List tab 3. Provide conditions in the fields: Account Indentifier, Requested URID, Task n Tast status, Start Date, Due Date 4. Click on "Filter" 5. Ensure tasks presented conform to the provided conditions and are correct. 6. Ensure the task status ajax indicator is visible when filtering tasks Repeat the above for Task list => Exclusive Task list tab

ARs and AARs receive error when opening any Transaction Approval task (that renders the "Reject" button)	When proposing a transaction as an AR and reviewing the task, there is an error. This is now fixed.	Test case #1 1. Login as AR and submit a transaction request. 2. Navigate to task list and click on the top-most task, which corresponds to the transaction. 3. Ensure the task details screen appears correctly. Test case #2 1. Repeat step 1 of Test case #1 2. Connect as AAR of the account which is the transferring account of the trans entered during step [1]. 3. Navigate to task list. 4. Claim the task corresponding to the transaction request entered during step 5. Approve the task. 6. Ensure the screen appears correctly and the transaction is completed norma Test case #3 1. Repeat steps 1-4 of Test case #2 2. Reject the task. 3. Ensure the screen appears correctly and the transaction request is rejected. Test case #4 (Regression: approving Deletion on an account without AAR) 1. Locate an account without AAR (or with suspended AARs) 2. Log in as AR and submit a deletion 3. Log in as second AR and approve the deletion 4. Ensure the deletion is completed Test case #5 (Regression: rejecting Deletion on an account without AAR) 1. Locate an account without AAR (or with suspended AARs) 2. Log in as AR and submit a deletion 3. Log in as second AR and reject the deletion 4. Log in as NA and navigate to Task History. Ensure the deletion transaction re and no deletion transaction is initiated.

CLONE - Check7214 for allocation is not taking installation identifier correctly	It is possible to allocate a value larger than the one uploaded in EUTL. This is now fixed.	All of the following to be executed sequentially, for the same installation. <u>Test case #1</u> upload nat in EUCR for installation X for period year Y amount 12 upload nap in EUTL for installation X for period year Y amount 11 Allocation transaction should terminate with response code 7214. <u>Test case #2</u> upload nat in EUCR for installation X for period year Y amount 12 upload nap in EUTL for installation X for period year Y amount 13 Allocation transaction should terminate with response code 7214. <u>Test case #3</u> upload nat in EUTR for installation X for period year Y amount 12 upload nap in EUTL for installation X for period year Y amount 12 Allocation should be completed. <u>Test case #4</u> Update nat only in EUCR for installatin X, period year Y, amount 15. allocation transaction is generated for quantity 3, and should terminate with re (on the transaction) and 7216 (on the transaction blocks). <u>Test case #5</u> Update nat in EUTL with 15 also Allocation transaction is generated for quantity 3, and should be completed.
Translations from EN to PT		1. Connect as a user of PT registry. 2. Choose Portuguese language. 3. Navigate to Transactions screen. 4. Navigate all transaction types are translated to Portugues except 10-37 Auct
Change Labels "Surrendered International Credits" and "Exchanged International Credits"	In Entitlements page, two column labels are requested to be modified.	1. Connect as NA 2. Navigate to EUETS => Entitlements screen 3. Enter some search terms and click on "Search" 4. Ensure the sixth and seventh column of the presented table are correspondi "Surrendered International Credits in Phase 2" and "Exchanged International C
Transaction for Allocation delivery runs automatically (without needing submission and approval) after we increase the allocation value for an installation that has already been allocated for the same year.	After an allocation is performed, uploading a new NAT with an increased allocation value results in generating a second allocation transaction without approval. This is now fixed.	As NA user: 1. Upload a NAT file with allocation (e.g. 14) for a specific installation for year 2 EUTL. Ensure the corresponding account is not excluded for year 2014. 2. Allocation Phase 3 > Tick the allocation for this installation, Submit and Appr via another NA user. 3. The batch is executed and the allocation is performed. 4. Upload a new NAT file with a bigger allocation (e.g. 24) for this installation ir The difference (in this example: 10) is visible in the Allocation Phase 3 screen. 5. A new allocation batch is executed again. Expected results: 1. The difference shown in step [4] should not be ticked. 2. A new allocation transaction for the specific installation should NOT be auto after the second batch execution of step [5]. Repeat the same scenario for Aircraft Operators.

Allocation settings should not be enabled if there is a pending request	When clicking and submitting allocation(s), the allocation screen is still enabled while the allocation submission request is pending. This is now fixed.	As NA user: 1. Navigate to Allocations Phase3 page 2. Select some installations to be allocated and tick their allocation amounts 3. Submit the allocation but do NOT approve it 4. Navigate to the generated task via the tasklist and inspect the contained det the ticked installations 5. Return to Allocations Phase3 page: All check boxes for all years in the Installa DISABLED 6. Reject the related task Expected result: 1. Return to Allocations Phase3 page: All check boxes should be ENABLED agair corresponding account is excluded) Repeat the same test for Aircraft Operators
SEF 2013 inconsistencies	SEF corrections	1. Login as a National Administrator 2. Navigate to the page Administration/SEF Reporting 3. Select and download the latest report (for 2013) 4. Open the .xml file with an editor 5. Search for the element "SEFSubmission / Table5c / AnnualInformations" (thi each item should be searched for independently). 6. From the children elements "TransactionOrEventType", find the one having year="2013" 7. Some of the subelements "UnitQty", are filled with values other than "NO" 8. Return to the EUCR SEF Reporting page 9. Select and download an earlier report (ex. 2011) 10. Open the .xml file with an editor 11. Search for the element "SEFSubmission / Table5a / AnnualInformations" (t each item should be searched for independently). 12. From the children elements "TransactionOrEventType", all subelements "U selected year (ex. > 2011), are filled with values "NO" 13. Repeat the above steps 11, 12 for the element "SEFSubmission / Table5c / AnnualInformations.
Completion of anonymous account creation requests fails with exception	An anonymous (non logged-in) user could not request a new account. This is now fixed.	Steps: 1) As a "Guest" user make a request for a new account 2) As NA user find the approval task for the request above 3) Approve the account open request task Result: 1) The task should be completed normally 2) The account should be created as expected
Adjustments to the Task List page following the change of not loading it pre-populated	Visual changes into NA Tasklist screen, resulting from the revamp into exclusive and generic tabs.	As NA user: 1) Visit the Exclusive and Generic task list 2) Verify that the buttons are now labeled "Search" and "Search & Export" 3) Verify that the label of the Ajax indicator now says "Please wait"
Update of AOHA makes PERMIT_STATUS = NULL	Updating an AOHA via the screen interface erroneously sets its permit status to NULL.	1. Update an Aircraft Operator where the "Monitoring Plan Status" is ACTIVE 2. Approve the generated task 3. Review the Aircraft Operator, ensure that "Monitoring Plan Status" is still AC
Performance Issue on view Account Details when holding many unit blocks	An account's details may take too long to appear if the account holds many unit blocks.	1. Locate an account with many unit blocks. 2. Click its "Details" tab. 3. Ensure the time to appear is less than 30 seconds.

Allocation is not correctly disabled when the account is excluded for some years	Exclusion does not always disable allocation; this is now fixed.	A. 1) Exclude installation X for year 2014 2) Upload a NAT with a value for year 2014 that installation 3) Allocation Phase 3 > The checkbox for installation X, year 2014 is Enabled, al question mark next to it B. 1) Upload a NAT with a value for years 2013, 2014 for installation Y 2) Tick the delivery of allocation for year 2013, and wait for the batch to run 3) Exclude installation Y for year 2013 4) Allocation Phase 3 > The checkbox for installation Y, year 2014 is disabled. A Case "UCS.11 - Allocation v2.5" it should be enabled. C. 1) Upload a NAVATT with a value for years 2013, 2014 for aircraft operator Y 2) Tick the delivery of allocation for year 2013, and wait for the batch to run 3) Exclude operator Y for year 2013 4) Allocation Phase 3 > The checkbox for operator Y, year 2014 is disabled. Tha tooltip of the question mark says: "Allocation disabled because aircraft operato year(first excluded allocated not recovered year)". It should replace the text wi with the actual year (i.e. 2013) Scenario C is not implemented in 6.2.5.
Carry over figure not showing for an OHA	Carry over figure not showing for an OHA	1. Select an OHA where the verified emissions for some of the First Commitme have been amended. 2. Ensure that the compliance status has been updated correctly and the negat figure is showing. 3. Select to see the Second Commitment Period. 4. Ensure that the field "Carry over from previous period" is showing correct da
FI - Logo in Account Statements	Addition of logo on Finnish account statements.	1. Select Finland registry 2. Go to "Accounts"- "Accounts" and choose an (A)OHA. 3. Click on "View details" and select the "Account Statements". 4. Enter a valid period and click on "Refresh" button. Click on "Account Statem 5. Make sure that you can see the logo at the top of the page of the PDF.

NA lost access to Closed accounts	Under certain circumstances, an NA and a verified could not see any closed account; this is now fixed.	Scenario 1. 1. Select a user and enter this user as a/an: a) AR in to an (OHA/AOHA) account A b) AR in to an (OHA/AOHA) account B c) verifier in to an (OHA/AOHA) account C d) verifier in to an (OHA/AOHA) account D. 2. Close the accounts A and C. 3. Log in as the user (in step 1) and go to Accounts- Accounts and click on searc 4. Ensure that: a) the user can see at the "Account Search Results" table the account A with st the column "Actions" click the "View Details" link. Ensure that the user has only of the details of the account. b) the user can see at the "Account Search Results" table the account B and he "Actions " of the account. c) the user cannot see at the "Account Search Results" table the account C. d) the user can see at the "Account Search Results" table the account D and he "Actions " of the account. Scenario 2. 1. Repeat the above test, but this time select a user with National Administrato user as a/an: a) AR in to an (OHA/AOHA) account A b) AR in to an (OHA/AOHA) account B c) verifier in to an (OHA/AOHA) account C d) verifier in to an (OHA/AOHA) account D. 2. Close the accounts A and C. 3. Log in as the user (in step 1) and go to Accounts- Accounts and click on searc 4. Ensure that the user , as National Administrator, can see all the accounts at t Results" table and that he has access to "Actions " of the accounts depending o account.
Account Link doesn't work in Transaction Details Search	Correction of link in EUTL Public	1. Login in EUTL 2. Go to "Transaction Mgt " - "Transaction Mgt" and click on search button. 3.Select an account and click on the following lings "Blocks", "History" or "Resp 4. Ensure that you can see the correct data.
Completion of anonymous account creation requests fails with exception	When creating an account request as an anonymous user, an error occurs; this is now fixed.	Steps: 1) As a "Guest" user make a request for a new account, using at least one new enrolled) 2) As NA user find the approval task for the request above 3) Approve the account opening task 4) Approve the send enrolment keys task Result: 1) Both tasks should be completed normally 2) The account should be created as expected 3) The new AR should be in status Validated
Export of reconciliations - Columns Start Date, Snapshot and Updated are inversed	Wrong sequence of columns in export of reconciliations	1. Login EUCR and navigate to Reconciliations 2. Export the Reconciliations 3. Ensure the sequence of all columns is as presented on screen

CLONE - Optimization in the NA task-lists	Optimizations in the mechanism of presentation of tasks in task list.	1. Login as NA and navigate to task list screen 2. Click on Task list => General Task List tab 3. Provide conditions in the fields: Account Identifier, Requested URID, Task na status, Start Date, Due Date 4. Click on ""Filter"" 5. Ensure tasks presented conform to the provided conditions and are correct. 6. Ensure the task status Ajax indicator is visible when filtering tasks Repeat the above for Task list => Exclusive Task list tab
NAT file with D flag causes the system to hang > Functionality gets locked and no more NAT files can be uploaded after that	Correction in NAT processing of D flag.	1. Login as NA, navigate to Allocation Tables Phase 3 and try to upload a Delete an entry such as <ns1:installation identifier="523" action="D"/> (taken from the use case examp 2.The system will display the error message: "The content of the XML file is inv 3. Try to upload a valid Add (A) or Update (U) XML file 4. Ensure that the new XML file was uploaded successfully 5. Repeat the above test choosing to upload a Delete (D) XML NAAT file from “ Allocation Table” and then try to upload a valid XML file .

CLONE - Error while uploading upload allocations	Corrections in handling of paging in uploaded allocations XML files.	Scenario 1.a 1. Go to Allocation Table Phase 3 2. Choose “National Allocation Table”. 3. At the “Batch administration” field, browse and choose to upload a correct X more than 10 Installation IDs 4. At the “NAT changes confirmation” screen try to navigate to page 2 (or any o one) 5. Ensure that you can see the right data in all pages. 6. Click on ""Confirm"" button. 7. Ensure that the allocation plan has been imported. Scenario 1.b 1. Repeat the above test choosing to upload a correct XML NAAT file from “Nat Allocation Table” with more than 10 Aircraft operator IDs. 2. At the “NAVAT changes confirmation” screen try to navigate to page 2 (or ar first one) 3. Ensure that you can see the right data. 4.Click on ""Confirm"" button. 5. Ensure that the allocation plan has been imported. Scenario 2.a 1. Go to Allocation Table Phase 3 2. Choose “National Allocation Table”. 3. At the “Batch administration” field, browse and choose to upload a correct X less than 10 Installation IDs 4. At the “NAT changes confirmation” screen, ensure that you can see the right 5. Click on ""Confirm"" button. 6. Ensure that the allocation plan has been imported. Scenario 2.b 1. Repeat the above test choosing to upload a correct XML NAAT file from “Nat Allocation Table” with less than 10 Aircraft operator IDs. 2. At the “NAVAT changes confirmation”, ensure that you can see the right dat 4.Click on ""Confirm"" button. 5. Ensure that the allocation plan has been imported. NOTE Repeat the above test scenarios with Add and Update XML Files

ARs and AARs receive error when opening any Transaction Approval task (that renders the "Reject" button)	ARs and AARs could not reject transactions; this is now fixed.	"Test case #1 1. Login as AR and submit a transaction request. 2. Navigate to task list and click on the top-most task, which corresponds to th transaction. 3. Ensure the task details screen appears correctly. Test case #2 1. Repeat step 1 of Test case #1 2. Connect as AAR of the account which is the transferring account of the trans entered during step [1]. 3. Navigate to task list. 4. Claim the task corresponding to the transaction request entered during step 5. Approve the task. 6. Ensure the screen appears correctly and the transaction is completed norma Test case #3 1. Repeat steps 1-4 of Test case #2 2. Reject the task. 3. Ensure the screen appears correctly and the transaction request is rejected. Test case #4 (Regression: approving Deletion on an account without AAR) 1. Locate an account without AAR (or with suspended AARs) 2. Log in as AR and submit a deletion 3. Log in as second AR and approve the deletion 4. Ensure the deletion is completed Test case #5 (Regression: rejecting Deletion on an account without AAR) 1. Locate an account without AAR (or with suspended AARs) 2. Log in as AR and submit a deletion 3. Log in as second AR and reject the deletion 4. Log in as NA and navigate to Task History. Ensure the deletion transaction re and no deletion transaction is initiated. "

Automatic unblocking for AOHA	Changes in the blocking/unblocking mechanism of AOHA.	Scenario 1. 1. Log in as NA and search accounts with account type "Aircraft Operator Holdi 2. Ensure that you can not see the actions "Blocked" and "Unblocked". Scenario 2. 1. Log in as NA and search for "Aircraft Operator Holding Account" in Open sta 2. Click on action "Block". 3. Ensure that the account changed to "Blocked" status. Scenario 3. 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s 2. Click on action " Unblock". 3. Ensure that the account changed to "Open" status. Scenario 4 (AOHA has been manually UNBLOCKED in the past and has emission 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s compliance status C. 2. Click on action " View Details" - "Compliance" tab and submit and approve v all necessary years. 3. Ensure that the account changed to "Open" and compliance status is B. Scenario 5 (AOHA has been manually UNBLOCKED in the past and has emission 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s compliance status C. 2. Click on action " View Details" - "Compliance" tab and submit and approve v all necessary years. 3. Ensure that the account changed to "Open" and compliance status is A. Scenario 6 (AOHA has never been manually UNBLOCKED in the past). 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s compliance status C. 2. Click on action " View Details" - "Compliance" tab and submit and approve v all necessary years. 3. Ensure that the account remains to "BLOCKED" and compliance status is B o amounts of the emissions and surrenders.
Remove the possibility to manually block and unblock OHAs	Remove the possibility to manually block and unblock OHAs	1. Log in as NA and search accounts with account type "Operator Holding Acco 2. Ensure that you can not see the actions "Blocked" and "Unblocked".

Adapt EUCR with ERA (REQ 2,3,4,5)	Implement ERA requirements, referring to ignoring 2013 verified emissions for AOHAs.	Test case #1: 2013 emissions are excluded for AOHA Set the configuration parameter "ERA_VE_EXCLUSION_UNTIL_DATE" to a date system date 1. Enter Verified Emissions for 2013 to an AOHA account 2. When The VE have been approved, check the Compliance Tab of the AOHA a The "Cumulative Verified Emissions" should not contain the quantity entered f 3. There should be a footnote under the compliance section saying that 2013 is <<ERA_VE_EXCLUSION_UNTIL_DATE>> 4. Make a surrender of Allowances from the same AOHA 5. After the surrender completes, check the compliance tab: Ensure the compliance figures are calculated correctly, ignoring the 2013 VE Test case #2: 2013 emissions are no more excluded for AOHA Set the configuration parameter "ERA_VE_EXCLUSION_UNTIL_DATE" to a date system date 1. Enter Verified Emissions for 2013 to an AOHA account 2. When The VE have been approved, check the Compliance Tab of the AOHA a The "Cumulative Verified Emissions" should contain the quantity entered for 2 3. There should not be a footnote under the compliance section saying that 20 <<ERA_VE_EXCLUSION_UNTIL_DATE>> 4. Make a surrender of Allowances from the same AOHA 5. After the surrender completes, check the compliance tab: Ensure the compliance figures are calculated correctly, including the 2013 VE Test case #3: 2013 emissions are not excluded for OHA 1. Enter Verified Emissions for 2013 to an OHA account 2. When The VE have been approved, check the Compliance Tab of the OHA ac The "Cumulative Verified Emissions" should contain the quantity entered for 2 4. Make a surrender of Allowances from the same OHA 5. After the surrender completes, check the compliance tab: Ensure the compliance figures are calculated correctly, including the 2013 VE Test case #4 (regression): Test excluded years for OHA Exclude all years possible for exclusion for an OHA and ensure compliance stat normally Test case #5 (regression): Test excluded years for AOHA Exclude all years possible for exclusion for an AOHA and ensure compliance sta normally, ignoring 2013 emissions entered and verified for this aircraft operato Note: Dynamic compliance may need an additional "refresh" via the button ne Period in order to appear correctly after emissions have been entered and veri
CLONE - Help page	Introduction of help page	1. Login in EUCR 2. At the top of the page click on "Help" link 3. Ensure that a help page will be displayed.
EUCR-484 CLONE - Apply Role Checks in TAL tasks	Role checks are corrected when performing TAL operations.	Please refer to document: https://sc136.unisystems.gr:4443/jira/secure/attachment/11707/Add_Remov om%20Trusted%20Account%20List.doc
Compliance Carry Over from phase 1 to phase 2	A carry-over for compliance was calculated erroneously under certain circumstances; this is now fixed.	Test case #3.2 from EUCR-401.

CLONE - Allocation must be able to happen for past years and the current year	Allocations to future years is disabled.	1. Connect as NA 2. Navigate to EUETS=>Allocation Phase 3 3. Confirm that in "Installations" and "Aircraft Operators" tabs the years from t Phase 3 up to and including the current year appear. 4. User selects allocations for a year 5. User clicks "Submit" 6. User connects as second NA and approves the allocations. 7. Allocations to the specified installations are performed at the next allocatior Repeat for aircraft operators. Note that enough units must have been issued and transferred to EU Allocatior
CLONE - Tasks List: Assign button available to AR users	ARs functionality is modified so that they can assign tasks only to other ARs.	1. Log in as AR. 2. Go to Task List. Select a task and click "Assign". 3. From the drop down list at the field "New claimant" check the names of the 4. Ensure that as an AR you can assign the task only to ARs. 5. Repeat the test with AARs. Ensure that as an AAR you can assign the task on
Unrecoverable error when you click Accounts link after your propose a transfer of allowance	Clicking on Account links while transferring allowances produced error; this is now fixed.	1. Enter a transfer transaction 2. Directly afterwards click the "Accounts" link 3. Confirm an error does not appear and system operates normally
Transfer Call Sign from EUCR to EUTL	Call Sing is transferred to EUTL Public.	Test case #1 1.In EUCR create an new aircraft operator holding account and add a value in C 2.After approval, (and after data have been copied to EUTL Public) log in to EU 3. Go to "Operator Holding Accounts" and search for your new aircraft operato 4. Click on " Details - Current Period " or "Details - All Periods". 5. Ensure that you can see the field "Call Sign" with correct data. Test case #2 1.In EUCR create an new aircraft operator holding account and add a value in C 2.After approval check in EUTL-Public that in "Operator Holding Accounts" ->D Call Sign field has a value 3. In EUCR update the Call Sign field with a new value 4. After approval check in EUTL-Public that in "Operator Holding Accounts" ->D Call Sign field has been updated Test case #3 1. Log in EUTL Public and locate an existing AOHA 2. Ensure the Call Sign data are updated correctly

Transfer Account Opening Date from EUCR to EUTL	Account opening date is transferred to EUTL Public.	Test case #1 1. In EUCR create a new account 2. After approval, log in to EUTL-Public. 3. Go to "Accounts" -"Search" and search with right criteria for your new accou 4. Click on the "Detail" link of the account. 5. Ensure that the field " Account Opening Date" has the value of the day this a created. Repeat for OHA and AOHA. Test case #2 1. Locate an existing OHA in EUTL Public. 2. Ensure the opening date has been transferred to EUTL Public, Repeat for AOHA. Test case #3 1.In EUCR create an new aircraft operator holding account and add a value in C 2.After approval check in EUTL-Public that in "Operator Holding Accounts" ->D Call Sign field has a value 3. In EUCR update the Call Sign field with a new value 4. After approval check in EUTL-Public that in "Operator Holding Accounts" ->D Call Sign field has been updated.
Country of Birth - EU	Remove "EU" from list of possible countries for country of birth.	1. Log in as a new user in EUCR 2. Click on "Fill in your personal details" link 3. At the "Registration" page open the drop down list at the field "Country of b 4. Ensure that the drop down list doesn't contains European Union
Unnecessary error message received when updating user details	Unnecessary error message received when updating user details; this is now fixed.	1. Go to "Administration"- "Users". 2. Select a user and click on URID link. 3. At the "Personal Details" tab click "Edit". 4. Ensure that at the end of the page you can see the buttons "Cancel" and "Sa 5. Press "Save" without making any changes. Ensure that the system returns yo page.
Allocation Phase 3 - Ticking boxes for future years should not be possible	It should not be possible to tick allocation boxes for future years.	1. Connect as NA 2. Navigate to EUETS=>Allocation Phase 3 3. Confirm that in "Installations" and "Aircraft Operators" tabs the years from t Phase 3 up to and including the current year appear. No future years appear. 4. User selects allocations for a year 5. User clicks "Submit" 6. User connects as second NA and approves the allocations. 7. Allocations to the specified installations are performed at the next allocation Repeat for aircraft operators. Note that enough units must have been issued and transferred to EU Allocatio

wrong information displayed in the Accounting and clearing page of the union registry for FR	Correction of data presented in "Accounting and Clearing" page.	Test Case #1: Test clearing value 1. Connect to EUCR as NA 2. Navigate to EUETS=>Accounting and Clearing page 3. Confirm the value "Clearing Value" is equal to the values presented in the fo https://webgate.ec.europa.eu/etsis/browse/ETS-4654?focusedCommentId=98366&page=com.atlassian.jira.plugin.system.issue -tabpanel#comment-98366 Repeat for all Registries Test case #2: Test surrendered quantity 1. Connect to EUCR as NA 2. Navigate to EUETS=>Accounting and Clearing page 3. Note the value *Surrendered Chapter III allowances - Current value* 4. Navigate to Accounts=>Transactions=>Set Transaction Type equal to 10-02 a equal to 30/04/2013 and Transaction Status=Completed 5. Click on Search and Export 6. Open the exported file with Excel and sum the column "Nb of units". Confirm to the value noted in step [3] of this test case.
Four-eyes principle bypassed in Tasks List > ARs are able to Approve tasks (even transactions) posted by themselves	It was possible to bypass task approval using a technical tool. This is now fixed.	A) Test Environment: a. Firebug installed on your Firefox. b. Your ECAS account to be associated with two mobile phone numbers. B) Test Case(s): 1. Login as AR 2. Propose a transfer of allowance, sign it with Mobile A. 3. Navigate to the Task List. Locate the Approve Transaction task and Claim it. 4. Open its details. You will not see an Approve button. 5. Open your Firebug and inject the following code under the html of the detai <button id="trustedAccountRequestApproveButtonId" name="trustedAccountRequestApproveButtonId" onclick="confirmDialogAppr type="button" class="ui-button ui-widget ui-state-default ui-corner-all ui-butto role="button" aria-disabled="false"><span class="ui-button-text">Approve</sp 6. The approve button appears. 7. Click it and sign the transaction with Mobile B. C) Expected Result: An application error page is displayed informing the user that his signature was
Change User Quartz name to System Administrator	The task actor "Quartz" is renamed to "SYSTEM ADMINISTRATOR".	1. Go to Accounts - Transactions and search for Transaction Type:"Allocation G or "Allocation Aviation Allowances". 2. Click on a Transaction Id link. 3. Click on "Request Details" tab. 4. Ensure that at the column User URID you can see "SYSTEM ADMINISTRATOR
Account type wording incorrect when reviewing an account release prior to submission	Correction of account type prior to claiming.	1. Release an Operator Holding Account 2. Claim the account 3. Enter all the details of (A)ARs etc. 4. Review the final result prior to submission. Ensure that at the field "Type" yo "Operator holding account"

Release account process - confusing instructions	Addition of clarification in account release screen.	1. Select an OHA or AOHA. 2. Go to "Accounts" -"Release Account". 3. In "Account Release" page make sure that a hint with red colour has been ac more specific that the user needs to enter just the ID of the account (e.g.. EU-1
Transfer of allowances from account no longer possible	Button "Propose a transaction" was hidden under certain circumstances; this is now fixed.	Scenario 1. 1. Select an account that is able to facilitate a transfer out. 2. Go to Trusted Accounts tab and ensure that it has at least one trusted accou 3. Add a new Trusted Account and save. 4. Ensure that the new account has been submitted for approval and that the a Approval pending". 5. Click on 'Holdings" tab. 6. Ensure that the button "Propose a Transaction" is active. Scenario 2. 1. Select an account that is able to facilitate a transfer out. 2. Go to Trusted Accounts tab and ensure that it has at least one trusted accou 3. Add a new Trusted Account and save. 4. Approve the task : "Addition of account to Trusted Account List". 5. Go to the previous account and click on Trusted Accounts tab. 6. Check that the new account is in status " Trust delayed" 5. Click on 'Holdings" tab. 6. Ensure that the button "Propose a Transaction" is active. Scenario 3. 1. Select an account that is able to facilitate a transfer out. 2. Go to Trusted Accounts tab and ensure that it has at least two trusted accou them appears in the table "Other accounts". 3.Click on Delete button and save. 4. Ensure that the removal of the account has been submitted for approval anc in status " Delete approval pending". 5. Click on 'Holdings" tab. 6. Ensure that the button "Propose a Transaction" is active.

EUCR BW lists transferred to EUTL	Ensure ICH lists changes is propagated to EUTL.	Test case #1: Insert a simple list entry 1.1. Connect to EUTL and locate a Unit Block in (via Unit Block Management) w specific project, country, and unit type and does NOT belong in any ICH list. 1.2. Connect to EUCR as CA/EU Registry and navigate to "View ICH Lists" 1.3. Select "General Negative List" 1.4. Insert a list entry with the data noted from step [1] 1.5. Save the new list entry in EUCR and wait for the list action to propagate to accomplished by clicking "Search" on the list entry screen; when the yellow inf "There exists a pending request to update a list. All list modifications are prohil longer appear, the change is propagated. 1.6. Refresh the Unit Block Management screen in EUTL and ensure the columr "General Negative List" Test case #2: Delete a simple list entry 2.1. Connect to EUTL and locate a Unit Block in (via Unit Block Management) w specific project, country, and unit type and belongs to "General Negative List". 2.2. Connect to EUCR as CA/EU Registry and navigate to "View ICH Lists" 2.3. Select "General Negative List" 2.4. Locate the record pertaining to the record of step [1] 2.5. Delete this list entry in EUCR and wait for the list action to propagate to EU accomplished by clicking "Search" on the list entry screen; when the yellow inf "There exists a pending request to update a list. All list modifications are prohil longer appear, the change is propagated. 2.6. Refresh the Unit Block Management screen in EUTL and ensure the columr "Not in any list" Test case #3: Edit a simple list entry Repeat steps 2.1-2.4 of TC#2. 3.5. Edit the project_id of this record to 999; refresh the Unit Block Manageme and ensure the column "Reason" contains "Not in any list"; Edit the project_id the original value; refresh the Unit Block Management screen in EUTL and ensu "Reason" contains "General Negative List" 3.6. Edit the country of this record to another SPAIN; refresh the Unit Block Ma EUTL and ensure the column "Reason" contains "Not in any list"; Edit the count to the original value; refresh the Unit Block Management screen in EUTL and e "Reason" contains "General Negative List" 3.8. Edit the unit_type of this record to another unit_type; refresh the Unit Blo screen in EUTL and ensure the column "Reason" contains "Not in any list"; edit the record back to the original unit_type; refresh the Unit Block Management s ensure the column "Reason" contains "General Negative List" Repeat for General Positive List. Test case #4: Insert a complex list entry 4.1. Connect to EUTL and locate a Unit Block in (via Unit Block Management) w specific project, country, and unit type and does NOT belong in any ICH list. Ma start and end values. 4.2. Connect to EUCR as CA/EU Registry and navigate to "View ICH Lists" 4.3. Select "Art 58(1) Negative List" 4.4. Insert a list entry with the data noted from step [4.1] and unit start: the un step 1 and end value 10 unit blocks further. 4.5. Save the new list entry in EUCR and wait for the list action to propagate to accomplished by clicking "Search" on the list entry screen; when the yellow inf "There exists a pending request to update a list. All list modifications are prohil longer appear, the change is propagated. 4.6. Refresh the Unit Block Management screen in EUTL and ensure the columr "Art 58(1) Negative List" on the unit block entry pertaining to start and end as Test case #5: Delete a complex list entry 5.1. Connect to EUTL and locate a Unit Block in (via Unit Block Management) w

		specific project, country, and unit type and belongs to "Art 58(1) Negative List" 5.2. Connect to EUCR as CA/EU Registry and navigate to "View ICH Lists" 5.3. Select "Art 58(1) Negative List" 5.4. Locate the record pertaining to the record of step [5.1] 5.5. Delete this list entry in EUCR and wait for the list action to propagate to EU accomplished by clicking "Search" on the list entry screen; when the yellow inf "There exists a pending request to update a list. All list modifications are prohil longer appear, the change is propagated. 5.6. Refresh the Unit Block Management screen in EUTL and ensure the column "Not in any list" Test case #6: Edit a complex list entry Repeat steps 5.1-5.4 of TC#5. 3.5. Edit the project_id of this record to 999; refresh the Unit Block Manageme and ensure the column "Reason" contains "Not in any list"; Edit the project_id the original value; refresh the Unit Block Management screen in EUTL and ensu "Reason" contains "General Negative List" 3.6. Edit the country of this record to another SPAIN; refresh the Unit Block Ma EUTL and ensure the column "Reason" contains "Not in any list"; Edit the proje back to the original value; refresh the Unit Block Management screen in EUTL a column "Reason" contains "General Negative List" 3.7. Edit the country of this record to another unit type; refresh the Unit Block screen in EUTL and ensure the column "Reason" contains "Not in any list"; Edit the current unit type back to the original unit type; refresh the Unit Block Mana EUTL and ensure the column "Reason" contains "General Negative List" Repeat for application procedure positive list. Test case #7 (regression): Test unit blocks in multiple lists 1. Locate a unit block in EUTL belong in General Negative List 2. Insert a slice of this unit block into Application Procedure Positive List 3. Check via EUTL Unit Block Management that the unit block slice is generated Application Procedure Positive List 4. Edit the inserted unit block so that: *** Country is switched to another country and back to the original value *** Unit type is switched to another unit type and back to the original value *** Project Id is switched to another Project Id and back to the original value Ensure that in every case the new sliced unit block in EUTL belongs to General finally back to Application Procedure Positive List
		<u>Test case #4:</u> Scenario #1 1. Execute compliance computation for 2014 2. Execute EUTL Public copy job 3. Ensure AOHAs with YFE=2013 will not have compliance status visible in EUTL Scenario #2 1. Move the server date to 2015 2. Execute compliance computation for 2015 3. Execute EUTL Public copy job 4. Ensure AOHAs with YFE=2013 will have compliance status visible in EUTL Pul

Wrong Installation Permit Status on label before approving Opening Account request	Display of permit status during request approval was incorrect; this is now fixed.	1. Login as regular user 2. Request Opening New account (f.ex: Operator Holding account) 3. Fill all required fields, especially Installation Details 4. Submit this request 5. Open this request as NA 6. Go into Details of request and jump to "Installation" tab 7. Ensure that the Permit Status value is "ACTIVE" 8. Repeat the above test for Aircraft Operator Holding Account 9. Go into Details of request and jump to "Aircraft Operator" tab 10. Ensure that the Monitoring Plan Status value is "ACTIVE"
Navigation through pages in the allocation upload confirmation screen shows blank tab	Navigation through pages in the allocation upload confirmation screen shows blank tab; this is now fixed.	Scenario 1. 1. Go to Allocation Table Phase 3 2. Choose “National Allocation Table”. 3. At the “Batch administration” field, browse and choose to upload a correct X more than 10 Installation IDs 4. At the “NAT changes confirmation” screen try to navigate to page 2 (or any c one) 5. Ensure that you can see the right data in all pages. Scenario 2. 1. Repeat the above test choosing to upload a correct XML NAAT file from “Nat Allocation Table” with more than 10 Aircraft operator IDs. 2. At the “NAVAT changes confirmation” screen try to navigate to page 2 (or ar first one) 3. Ensure that you can see the right data in all pages.
Error in the text on page ref. #002	Correction of label for first-time user.	1. Connect as a first-time user. 2. Ensure the on-screen instructions contain "Fill-in your personal details."
Wording of approval box could be clearer	Change of message during task rejection.	1. Go to task list and approve a task. 2. Ensure that at the confirmation box you can see only the field "Comment:" v as mandatory. 3. Select to reject a task. 4. Ensure that at the confirmation box you can see the text "You are about to R request: XXXXXX Please confirm your choice after entering a comment." The fie marked as mandatory.
Correct emissions task could do with a before and after	Emission approval task contains before and after values.	1. Log in as NA. 2. Select an OHA or AOHA with emissions and change the emissions of a year. S 3. Log in as the verifier of the account (or as a second NA) and go to task list to task. 4. Ensure that you can see the fields "Emissions Before Correction" and "Emissi Correction" with correct data.
Reject emissions correction applied to installation	Rejection of emissions correctly restores the original values.	1. Log in as NA. 2. Select an OHA or AOHA with emissions and change the emissions of a year. S 3. Log in as the verifier of the account (or as a second NA), go to task list and re 4. Go to the previous account, and make sure that the a account has the correc
Thousands separators on allocation page missing	Thousands separators on allocation page missing; this is now fixed.	1. Log in as NA and go to "Allocation Phase 3" 2. Ensure that the displayed figures are right-adjusted and contain thousands s
Change "Cancel" button once surrender submitted	Renaming button "Cancel" to "Back", after surrender.	1. Select an OHA or AOHA. 2. Go to "Holdings" -" Propose a transaction" -" Surrender of allowances" 3. Ensure that once the surrender has been confirmed you can see only the "Ba

Account type wording incorrect when reviewing an account release prior to submission	Correction of information during account release.	1. Release an OHA or AOHA 2. Claim the account 3. Enter all the details of (A)ARs etc. 4. Review the final result prior to submission. 5. Ensure that at the field "Type" you can see "Operator holding account " for C operator holding account" for AOHA.
Allow RegAdmins to change the Year of First Emissions	During account update, it is now possible to modify Year of First Emissions of the account.	Scenario 1. 1.Login as an NA. Select an AOHA without emissions- View Details- Aircraft Ope 2. Click on "Update" button 3. Change the field "First Year of Verification" and enter: a) A year before 2012. Ensure that the system will display error message:"For A the earliest possible Year of First Emissions is 2012." b) A year greater than the current year. Ensure that the system will display erro Year of First Emissions cannot be greater than the current year." c) A year between 2012 up to the current year. Ensure that your request to upd operator has been submitted under identifier xxxxxxx. 4. Login as a second NA. Go to task list and approve/ reject the task " Update o Information" Scenario 2. 1.Login as an NA. Select an AOHA with emissions- View Details- Aircraft Operat 2. Click on "Update" button 3. Change the field "First Year of Verification" and enter: a) A year before 2012. Ensure that the system will display error message:"For A the earliest possible Year of First Emissions is 2012." b) A year greater than the current year. Ensure that the system will display erro Year of First Emissions cannot be greater than the current year." c) A year for which there are Verified Emissions introduced in years prior to the First Emissions. Ensure that the system will display error message: "There are V introduced in years prior to the proposed Year of First Emissions." d) A year between 2012 up to the current year (or which there are NOT Verifie introduced in years prior to the proposed Year of First Emissions). Ensure that update an aircraft operator has been submitted under identifier xxxxxxx. 4. Login as a second NA. Go to task list and approve/ reject the task " Update o Information" Scenario 3. 1.Login as an NA. Select an OHA without emissions- View Details- Installation ta 2. Click on "Update" button 3. Change the field "First Year of Verification" and enter: a) A year before 2005. Ensure that the system will display error message:"For C Accounts, the earliest possible Year of First Emissions is 2005.." b) A year greater than the current year. Ensure that the system will display erro Year of First Emissions cannot be greater than the current year." c) A year between 2005 up to the current year. Ensure your request to update information has been submitted under identifier xxxxxxx. 4. Login as a second NA. Go to task list and approve/ reject the task " Update o Information" Scenario 4. 1.Login as an NA. Select an OHA with emissions- View Details- Installation tab. 2. Click on "Update" button 3. Change the field "First Year of Verification" and enter: a) A year before 2005. Ensure that the system will display error message:"For C Accounts, the earliest possible Year of First Emissions is 2005.." b) A year greater than the current year. Ensure that the system will display erro Year of First Emissions cannot be greater than the current year." c) A year for which there are Verified Emissions introduced in years prior to the First Emissions. Ensure that the system will display error message: "There are V introduced in years prior to the proposed Year of First Emissions."

		d) A year between 2005 up to the current year (or which there are NOT Verifie introduced in years prior to the proposed Year of First Emissions). Ensure your installation information has been submitted under identifier xxxxxxx. 4. Login as a second NA. Go to task list and approve/ reject the task " Update o Information" .
AR able to view details of a Transfer Pending Trusted Account	AR not to be able to see an account which is released.	1. Create an account and make sure none of the ARs has admin rights. 2. Create an OHA/AOHA under the same account holder using the same ARs ar 3. Log in as one of the ARs 4. Go to the account you created in point 1 5. Go to the Trusted Accounts tab. The account you created under point 2 is th trusted accounts 6. Click on the link. 7. Ensure that you can see the system message: "You have no access to this acc
Explanation for compliance status should be given - also in the compliance history	Addition of details in compliance history.	1. Log in as NA and go to Compliance tab of an OHA or AOHA with history comp 2. At the field "Compliance History" ensure that you can see a (?) at the comp column which explains the compliance status.

Reverse button not available when compliance status changed	Reverse button is visible for surrenders, even in the case of compliance status change.	Test case#1: Reverse button is visible for surrenders, even if dynamic complian 1.1. Locate an account with dynamic compliance A 1.2. Locate a completed surrender transaction of this account (or insert and ap surrender if none exists) 1.3. Open the surrender of step [2] 1.4. Ensure the button "Reverse" is visible Test case#2: Regression test for new accounts Start from a new OHA account 1. Transfer or allocate some allowances to this account. 2. Enter some emissions. 3. Verify the emissions. 4. Make a surrender of allowances to offset the VE quantity. 5. After the surrender completes, your dynamic compliance status should be A 6. Go to Transactions and search for your surrender 7. Open the details of the surrender transaction. 8. The "Reverse" button should now be available, even though reversing this su your dynamic compliance status to B
Cumulative Verified Emissions do not make use of the thousands separator	Addition of thousands separators on Verified Emissions.	1. Log in as NA 2. Select an OHA or AOHA and go to the "Compliance" tab. 3. Look at the bottom area of the screen and make sure that numbers separate separator.
Trusted account message should have "CET"	Addition of "CET" in trusted account screen.	1. Navigate to an account's Trusted Accounts tab 2. Click on ""Add"" button 3. Submit and approve an addition to TAL 4. Confirm the message appearing after the approval has the abbreviation ""CE
NA get 403 when accessing multiple registries task-list	NA get 403 when accessing multiple registries task-list; this is now fixed.	1. Login as NA to a registry (for ex. GR) 2. Go to task list and select task id XXX, 3. Switch to another registry (for ex. AT) 3. Go to task list. 4. Ensure that you can select a task.
EUTL Compliance Computation Bug for CP2	Correction of EUTL Compliance Computation Bug for CP2	Repeat test scenarios 3.2, 3.3 and 3.4 of EUCR-401 but apply them on an instal Ensure results consider 2013 verified emissions, and are as follows: * Test case#3.2: The column compliance code for this account for year 2013 sh * A if total surrenders >= total emissions * B otherwise (provided no emissions are missing) * Test case#3.3: The column compliance code for this account for year 2013 sh * A if total surrenders >= total emissions * B otherwise (provided no emissions are missing) * Test case #3.4: The column compliance code for this account for year 2013 sh

Reversal of Surrendering on account with static Compliance Status=B in CP1 is possible	Reversals of surrenders are permitted, even though they should not; this is now fixed.	***Scenario #1: Account with no compliance status for this year*** 1. Enter a surrender after 1-MAY (or use the configuration mentioned in scenar 2. Reverse this surrender 3. Ensure the surrender is able to be reversed ***Scenario #2.1: Account with compliance status A for previous year, reversing will not change compliance status*** 1. Locate an account for which compliance status for previous year has been ca A. 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen 3. Reverse this surrender 4. Ensure the surrender is able to be reversed, because static compliance statu account and will not be changed after reversal. ***Scenario #2.2: Account with compliance status A for previous year, reversing will change compliance status*** 1. Locate an account for which compliance status for previous year has been ca A. 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen 3. Reverse this surrender 4. Ensure the surrender is NOT able to be reversed, because static compliance account and will be changed after reversal. ***Scenario #3: Account with compliance status B for previous year*** 1. Locate an account for which compliance status for previous year has been ca B. 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen 3. Reverse this surrender 4. Ensure the surrender is NOT able to be reversed, because static compliance account. Relevant EUTL validation rule is 7664. ***Scenario #4: Account with compliance status C for previous year*** 1. Locate an account for which compliance status for previous year has been ca C. 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen 3. Reverse this surrender 4. Ensure the surrender is NOT able to be reversed, because static compliance account. Relevant EUTL validation rule is 7664. ***Note:*** The Compliance Computation job must be run before any scenario, to er cumulative values are correctly updated.
BlockAccounts batch cannot run (throws exception)	The BlockAccountsTrigger in EUCR generated an error. This is now fixed.	1. Setup the Quartz trigger BlockAccountsTrigger in EUCR to execute 2. Execute the trigger 3. Ensure no exceptions are generated in the logs 4. Ensure accounts are blocked as required
Translation of Help page	Help page uses translations, where available	1. Login to a national registry as any user 2. Change the user interface language to the native language of this registry 3. Click the "Help" link on the top right Provided that a translation for this registry has been installed, you should see the translated help text

For checking reversal of surrender use ccc column of compliance_status_bl	Use a different column when checking EUTL static compliance status, ensuring updated results are applicable	Scenario #1: Reverse a surrender NOT affecting C.S. 1. We are before Surrender Deadline 2. Enter VE for 2013 => 10 3. Surrender for 2013 => 10 4. Run CS job 5. Enter a new surrender (this goes to 2013) => 5 6. Reverse the last surrender 7. It should be allowed to be reversed Scenario #2: Reverse a surrender affecting C.S. 1. We are before Surrender Deadline 2. Enter VE for 2013 => 10 3. Surrender for 2013 => 6 4. Run CS job 5. Enter a new surrender (this goes to 2013) => 4 6. Reverse the last surrender 7. It should not be allowed to be reversed (validation rule 7664)
Misleading communicate while rejecting Roles&Permissions request	Correction of error message when rejecting roles & permissions request	1. As NA1 make a change in Role & Permissions Matrix. 2. As same NA1 go to task list page and open request for Approving/ Rejecting. 3. Click "Reject" button, and don't enter any comments into the confirmation b button. 4. Ensure that the system is displaying the orange-error message: " Complete t case of rejection, a comment is mandatory". 5. Click on "Reject" button again and this time enter a comment into the confir "Confirm" button. 6. Ensure that the system is displaying the green message: " Roles/Permissions Update Rejected".
Blocking batch assigned a C and blocked installations with YFE = 2014	It was possible to block an account with YFE=2014 during blockaccounts trigger execution. This is now fixed.	1. Create and approve an OHA with YFE = 2014 (the current year of the server) 2. Run the BlockAccountsTrigger batch. Ensure the installation remains OPEN and it has NOT acquired dynamic complia completion of the batch.
Transaction List - Column "Nb. of units" rename to "Quantity"	Renaming of column heading.	1. Go to "Transactions" and click on button 2. Make sure that the column "Nb. of Units" has been renamed to "Quantity".
VE of AOHAs for 2013 are not taken into consideration for ICE calculation	Correction of data related to Entitlements and method of calculation No. 3.	1. Upload an ICE table. For a Specific AOHA method = 3, value = 3000 2. Verify emissions for this AOHA. 3. Navigate to Entitlements and check the calculation for this AOHA. Ensure tha the VE for 2013.
missing information on Account statement (transaction pdf)	Correction in account statements calculations.	1. Go to "Transactions" and search for a transaction for example with transacti External Transfer Kyoto Units" 2. Click on "Transaction Id" link. 3. Click on "Transaction PDF" button. 4. Ensure that the PDF contains information on Unit type; Project Nr; Nr of Uni
Confirmation message after saving change on "Excluded" property	Change in confirmation message after saving change on "Excluded" property	1. Select an OHA or AOHA. 2. Go to "Compliance" tab, exclude a year and click on "Save" button 3. Ensure that at the top of the screen the system displays the message: "The s sent to EUTL. They will be displayed after EUTL approval."

No cancellation should be available from Excluded OHA or AOHA for the current year.	No cancellation should be available from Excluded OHA or AOHA for the current year.	Scenario 1 1.Find a OHA or AOHA with Kyoto units and ensure that the current year is exc 2. Go to "Holdings" tab 3. Click on "Propose a Transaction" button. 4. Ensure that the transaction Cancellation is not available. Scenario 2 1. Find a OHA or AOHA with Kyoto units and ensure that the current year is no 2. Go to "Holdings" tab 3. Click "Propose a Transaction" and click on transaction link "Voluntary cancel CER, lCER and tCER" or "Cancellation of Kyoto units against deletions of genera 4. Enter the quantity of units that you want, and click on "Next" button. 5. Enter ECAS Signature. The system displays the message : "Your cancellation recorded and assigned the identifier EUxxxxx", or "Your cancellation proposal and assigned the identifier EUxxxxxx .Approval by the National Administrator i 6.Click on "Cancel" link and go to "Compliance" tab. 7. Exclude the current year and click on "Save" button. The system displays the settings have been sent to EUTL. They will be displayed after EUTL approval." 8. Ensure that the EUTL has been updated with the change. 9. Log in as an other NA. 10. Go to task list and approve the task. 11. Go to "Transactions" and search for the specific transaction ID. 12. Ensure that the Transaction has status " 5-Terminated". 13 Click on the Transaction Id link. 14. Click on "Response codes" tab. 15. Ensure that you can see the response code: "7665: This type of transaction excluded account."
An account that has VE>0 on 2012, and was excluded on all years starting 2013 should be able to surrender at any moment in Phase 3.	An account is always able to surrender, regarding of Exclusion property.	Scenario #1: OHA with YFE=2013, excluded for all years of CP2 1. Define an OHA with YFE=2013, excluded for all years of CP2 2. Enter a surrender 3. Ensure the surrender is completed. Repeat for AOHA Scenario #2: OHA with YFE = 2012, excluded for all years of CP2 1. Define an OHA with YFE = 2012, excluded for all years of CP2 2. Enter a surrender 3. Ensure the surrender is completed. Repeat for AOHA Scenario #3: OHA with YFE = 2013, not excluded for any year 1. Define an OHA with YFE = 2013, not excluded for any year 2. Enter a surrender 3. Ensure the surrender is completed. Repeat for AOHA

Reversal of Surrendering on account with static Compliance Status=B in CP1 is possible	System should only allow surrender reversals when the published compliance status is A and is not affected by the reversal, or it does not yet exist.	Scenario #1: Account with no compliance status for this year 1. Enter a surrender after 1-MAY (or use the configuration mentioned in scena 2. Reverse this surrender 3. Ensure the surrender reversal is completed. Scenario #2.1: Account with compliance status A for previous year, reversing a NOT change compliance status 1. Locate an account with VE for previous year: 6 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen with quantity = 1 and a surrender with quantity 6. 3. Run the compliance_computation job of 1-MAY manually; Ensure a static co calculated in EUTL and it is A; Reverse the surrender with quantity 1. 4. Ensure the surrender with quantity 1 is able to be reversed, because static c A for this account and will NOT be changed after reversal. Scenario #2.2: Account with compliance status A for previous year, reversing a change compliance status 1. Locate an account with VE for previous year: 6 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen with quantity = 1 and a surrender with quantity 6. 3. Run the compliance_computation job of 1-MAY manually; Ensure a static co calculated in EUTL and it is A; Reverse the surrender with quantity 6. 4. Ensure the surrender with quantity 6 is NOT able to be reversed, because sta status is A for this account and will be changed after reversal. Scenario #3: Account with compliance status B for previous year 1. Locate an account with VE for previous year: 6 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen with quantity =1. 3. Run the compliance_computation job of 1-MAY manually; Ensure a static co calculated in EUTL and it is B; Reverse this surrender 4. Ensure the surrender is NOT able to be reversed, because static compliance account. Relevant EUTL validation rule is 7664. Scenario #4: Account with compliance status C for previous year 1. Locate an account with no VE for previous year 2. Enter a surrender before 1-MAY (or use the configuration mentioned in scen 3. Run the compliance_computation job of 1-MAY manually; Ensure a static co calculated in EUTL, and it is C; Reverse this surrender 4. Ensure the surrender is NOT able to be reversed, because static compliance account. Relevant EUTL validation rule is 7664. Scenario #5: NOTE: Assume the account has YFE = current year -1
BlockAccounts batch cannot run (throws exception)	Technical issue	1. Setup the Quartz trigger BlockAccountsTrigger in EUCR to execute 2. Execute the trigger 3. Ensure no exceptions are generated in the logs 4. Ensure accounts are blocked as required

Exchange not allowed if account is excluded	Exchange was not allowed if account is excluded; this is now fixed.	Scenario 1 1.Find a OHA or AOHA with available entitlement and ensure that the current y 2. Go to "Holdings" tab 3. Click on "Propose a Transaction" button. 4. Ensure that the transaction "Exchange CER, ERU units for Phase 3 allowance Scenario 2 1. Find a OHA or AOHA with available entitlement and ensure that the current excluded. 2. Go to "Holdings" tab 3. Click "Propose a Transaction" and click on transaction link "Exchange CER, E allowances". 4. Enter the quantity of units that you want, and click on "Next" button. 5. Enter ECAS Signature. The system displays the message : "Your transfer prop recorded and assigned the identifier EUxxxxxx . The transaction has been subm 6.Click on "Cancel" link and go to "Compliance" tab. 7. Exclude the current year and click on "Save" button. The system displays the settings have been sent to EUTL. They will be displayed after EUTL approval." 8. Ensure that the EUTL has been updated with the change. 9. Log in as an other NA. 10. Go to task list and approve the task. 11. Go to "Transactions" and search for the specific transaction ID. 12. Ensure that the Transaction has status " 5-Terminated". 13 Click on the Transaction Id link. 14. Click on "Response codes" tab. 15. Ensure that you can see the response code: "7665: This type of transaction excluded account."

Dynamic Compliance Calculation upon account opening	The system did not calculate dynamic compliance status at account opening; this is now fixed.	Definitions: - SRND_DEADLINE = Surrender Deadline (typically 30/4 Each Year) - EOY = End Of Current Year - SOY = Start Of Current Year - CurDate = Current Date SRND_DEADLINE < CurDate <= EOY (after compliance job) Test case #1: 1. Request and approve an OHA with YFE < CurrentYear 2. Ensure its Dynamic Compliance is C Test case #2: 1. Request and approve an OHA with YFE = CurrentYear 2. Ensure its Dynamic Compliance is NULL SOY <= CurDate <= SRND_DEADLINE (before compliance job) Test case #3: 1. Request and approve an OHA with YFE < CurrentYear - 1 2. Ensure its Dynamic Compliance is C Test case #4: 1. Request and approve an OHA with YFE >= CurrentYear - 1 2. Ensure its Dynamic Compliance is NULL CurDate <= ERA_VE_EXCLUSION_UNTIL_DATE (2013 year is still excluded) Test case #5 1. Request and approve an AOHA 2. Ensure its Dynamic Compliance is NULL CurDate > ERA_VE_EXCLUSION_UNTIL_DATE (2013 is no longer excluded) Repeat the logic of Test Cases #1 ~ #4 for AOHA and ensure the compliance sta the corresponding test case.

When approving Transactions the "Acquiring account number" should be rendered as a link only if the current user has access to the target account details	When approving Transactions the "Acquiring account number" should be rendered as a link only if the current user has access to the target account details	Scenario 1. 1. Login to EUCR as an AR 2. Select an account with balance and AARs 3. Go to "Holdings" tab, click on "Propose a transaction" and Submit a Surrend transaction 4. Login as an AAR of the account and go to task list. 5. Open the task of surrender or deletion and make sure that the The Acquiring not clickable. Scenario 2. 1. Login to EUCR as an AR 2. Select an account with balance 3. Go to "Holdings" tab, click on "Propose a transaction" and Submit a Surrend transaction 4. Login as an other AR of the account and go to task list. 5. Open the task of surrender or deletion and make sure that the The Acquiring not clickable. Scenario 3. 1. Login to EUCR as an AR 2. Select an account with balance 3. Go to "Holdings" tab, click on "Propose a transaction" and Submit a Surrend transaction 4. Login as a NA and go to task list. 5. Open the task of surrender or deletion and make sure that the The Acquiring not clickable.
Compliance calculation in EUCR should be triggered when changing the YFE also	At change of YFE, dynamic compliance is re-calculated.	1. Enter and approve an OHA with YFE = CurrentYear - 1 2. Submit and verify emissions with zero value for all needed years 3. Ensure compliance_status = A 4. Update and approve YFE to CurrentYear - 2 5. Ensure Compliance_Status = C Repeat for AOHA
Problem with creating request after modifying Users and Permissions tables	Correction of task approval process, during Roles & Permissions change.	1. Login as NA 2. Navigate to the "Roles and Permissions" screen 3. Make a few changes and Submit 4. After ECAS signature a confirmation message with the submitted request ID 5. As a second NA locate the task in the task list and approve it 6. Your changes should now be applied.

Implementation of SDB-483 causes unwanted side-effects	Correction of permissions on transaction types available to users, with regard to TAL and transferring account type	Scenario 1. 1) Select an OHA with balance. 2) Ensure that this account is without TAL and without AAR 3) Click on "Holdings' tab and make sure that the button "Propose a transactio Scenario 2. 1) Select an OHA with balance. 2) Ensure that this account is without TAL but with valid AAR (s) 3) Click on "Holdings' tab and make sure that the button "Propose a transactio Scenario 3. 1) Select an OHA with balance. 2) Ensure that this account is without TAL and with invalid or suspended AAR (s 3) Click on "Holdings' tab and make sure that the button "Propose a transactio Scenario 4. 1) Select an OHA with balance. 2) Ensure that this account is with TAL but without AAR 3) Click on "Holdings' tab and make sure that the button "Propose a transactio Scenario 5. 1) Select an OHA with balance. 2) Ensure that this account is with TAL and with valid AAR (s) 3) Click on "Holdings' tab and make sure that the button "Propose a transactio Scenario 6. 1) Select an OHA with balance. 2) Ensure that this account is with TAL and with invalid or suspended AAR (s) 3) Click on "Holdings' tab and make sure that the button "Propose a transactio Repeat the above scenarios for AOHA, Person Holding Account, Party Holding A Account. Party Holding Account does not have a TAL so only variations are: 1) Test PaHA PaHA without AAR 3) Test PaHA with suspended AAR.
Comment in the task are not possible	It was not possible to add comments in a task; this is now fixed.	Scenario #1: NA testing 1. Log in as NA 2. Navigate to Task List=>Exclusive Task list 3. Locate a task and click on it 4. Enter three different comments; ensure the URID, date and entered comme 5. Claim and approve the task 6. Locate the task in task list history and ensure the entered comments appear Repeat for Task List=>General Task list Scenario #2: AR testing Repeat scenario #1 having logged in as AR and using the task list.

Administrative transfers require you to be AAR on the TQA.	Correction of a constraint, which forced user to be AAR on TQA when attempting administrative transfers.	1. Ensure that you have four users as Central Administrators, for example CA1, 2. At the Total Quantity Account enter CA1 and CA2 as ARs of the account, and 3. Login as CA1 and propose a pre-allocation or pre-auctioning. Go to task list a are not allowed as initiator to approve/reject the task. 4. Log in as CA2 and go to the task list. Ensure that you can approve/reject the 5. Repeat with the users CA3 and CA4. Ensure that you can approve/reject the 6. Repeat the above test for Aviation Total Quantity Account.
You can Reverse a Surrender that changes the Static Compliance from A to B	It was possible to reverse surrenders affecting the compliance status; this is now fixed	1. Create an OHA account with YFE = CurrentYear - 1 2. Enter VE for currentYear - 1 equal to: 1 3. Surrender one unit 4. Surrender one unit 5. Run EUTL Compliance job and confirm compliance status in EUTL = A 6. Reverse the first surrender; ensure it is completed. 7. Reverse the second surrender; ensure it is terminated (rule 7664). Repeat for AOHA
Automatic unblocking for AOHA	An AOHA was not unblocked when it received VE for 2012; this is now corrected	1. Locate a Blocked AOHA with YFE = 2012, without VE for 2012 2. As an NA, manually Unblock it and then Block it again. 3. Propose Emissions for 2012 4. Verify them 5. Check the Account. It must be OPEN, and its Dynamic Compliance is a B. **Regression testing:** Repeat all the following with YFE=2012 **Scenario 1.** 1. Log in as NA and search accounts with account type "Aircraft Operator Holdi 2. Ensure that you can not see the actions "Blocked" and "Unblocked". **Scenario 2.** 1. Log in as NA and search for "Aircraft Operator Holding Account" in Open sta 2. Click on action "Block". 3. Ensure that the account changed to "Blocked" status. **Scenario 3.** 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s 2. Click on action " Unblock". 3. Ensure that the account changed to "Open" status. **Scenario 4** (AOHA has been manually UNBLOCKED in the past and has emissior 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s compliance status C. 2. Click on action " View Details" - "Compliance" tab and submit and approve v all necessary years. 3. Ensure that the account changed to "Open" and compliance status is B.

		Scenario 5 (AOHA has been manually UNBLOCKED in the past and has emission 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s compliance status C. 2. Click on action " View Details" - "Compliance" tab and submit and approve v all necessary years. 3. Ensure that the account changed to "Open" and compliance status is A. **Scenario 6** (AOHA has never been manually UNBLOCKED in the past). 1. Log in as NA and search for "Aircraft Operator Holding Account" in Blocked s compliance status C. 2. Click on action " View Details" - "Compliance" tab and submit and approve v all necessary years. 3. Enter VE for 2012 equal to 10: dynamic compliance should be B and account 4. Insert for the same account surrender equal to 20: dynamic compliance shou account remain BLOCKED.
Incorrect Dynamic Compliance Status for AOHAs under certain conditions	If 2013 was clicked as "Excluded" year, then the dynamic compliance is not calculated correctly; this is now corrected	1. Locate an AOHA with YFE = 2012 that did not verify any emissions for 2012. 2. Exclude its year 2013 3. Ensure the dynamic compliance status is C.
Impossible to propose a voluntary cancellation from a person holding account.	Proposal Of Voluntary Cancellation of KP units is not Available to (A)OHA if the MS Registry does not possess a Cancellation account for the specific CP. This is now corrected.	1. Select a Registry without Voluntary Cancellation Account. 2. Select an (A)OHA with CERs for second commitment period. 3. Click on "Holdings" tab and propose "Voluntary cancellation of AAU, RMU, C 4. Enter the Quantity of CERs that you want to cancel and (optionally) a Projec 5. Approve the task. 6. Ensure that the Transaction has been Completed

It is possible to claim a task that you are unable to approve/reject	It is possible to claim a task that you are unable to approve/reject	**Scenario 1.** 1. Select an account with valid AAR(s) 2. Login as AR1 and propose a transaction (to be approved by AAR) 3. Go to task list. Ensure that as AR1 you can only see the task but you cannot c task. 4. Login as AR2 of the account and go to task list. Ensure that you can see the t claim/assign the task 5. Login as AAR of the account and go to task list. Ensure that you can claim/as the task 6. Log in as NA. Ensure that you can claim/assign/approve/reject the task **Scenario 2.** 1. Select an account without AAR(s) 2. Login as AR1 and propose a transaction (to be approved by AR2) 3. Go to task list. Ensure that as AR1 you can only see the task but you cannot c task. 4. Login as AR2 of the account and go to task list. Ensure that you can claim/as the task 5. Log in as NA. Ensure that you can claim/assign/approve/reject the task **Scenario 3.** 1. Select an account with valid AAR(s) 2. Login as AR1 and add to TAL (to be approved by AAR) 3. Go to task list. Ensure that as AR1 you cannot see the task 4. Login as AR2 of the account and go to task list. Ensure that you cannot see th 5. Login as AAR of the accountant go to task list. Ensure that you can claim/assi the task 6. Log in as NA. Ensure that you can claim/assign/approve/reject the task **Scenario 4.** 1. Select an account without AAR(s) 2. Login as AR1 and add to TAL (to be approved by AR2) 3. Go to task list. Ensure that as AR1 you can claim/assign/reject the task. 4. Login as AR2 of the account and go to task list. Ensure that you can claim/as the task 5. Log in as NA. Ensure that you can claim/assign/approve/reject the task **Scenario 5.** 1. Login as CA1 to EU Registry. 2. Propose a transaction (to be approved by CA2). 3. Go to task list. Ensure that as CA1 you can only see the task but you cannot c task. 4. Login as CA2 and go to task list. Ensure that you can claim/assign/approve/re
It is possible to create two emissions corrections tasks for the same installation	It is possible to create two emissions corrections tasks for the same installation	1. Enter some emissions for an OHA 2. Approve the emissions 3. Go back into the account, click on the pencil and enter a correction 4. Check that the request has been recorded in the task list but don't approve c 5. Go back into the account and go to the compliance tab. 6. Make sure that the pencil has been replaced by a question mark (?). When y mouse on it, you can see the information message: "You cannot submit a new c because a pending emissions correction request requires validation."

Cannot update Roles&Permission Matrix when there is pending update request on different registry	Cannot update Roles&Permission Matrix when there is pending update request on different registry	- Open Roles&Permissions Matrix as NA on Registry-1, update something, click Save button. Don't complete this request as second NA on this registry. - Login as NA on Registry-2 and Go into Roles&Permissions Matrix - NA on Reg-2 can make changes to his registry role permissions and click Next button. - Another NA on Reg-2 can approve the request just submitted.
Searching task list by non-EU account identifier causes unrecoverable error	When a duplicate identifier in different registries is used to filter tasks, there is an error; this is now fixed.	1. Locate two accounts in different registries with the same identifier, both pos 2. Connect as NA of one of the registries of step [1] and navigate to Exclusive ta 3. Enter the identifier of step [1] and perform search 4. Ensure the tasks returned concern the current NA's registry only
Some requests for Account Opening remain stuck in "User Approved" status (and are not forwarded to EUTL)	Account opening requests where the installation's contact person is supplied were not transferred correctly to EUTL. This is now fixed.	Scenario 1 1. Create an OHA, account holder is Person, provide installation contact persor address 2. Approve the account creation request as another NA 3. Ensure the account is created in EUCR; ensure the Contact Person tab of the the contact details entered 4. Navigate in EUTL => Account Mgt and locate the account just created; click c link and ensure the contact person details appear on the line "Installation Cont 4. Ensure the full provided details of the contact are registered in EUTL databa: EUTL the query "select * from people order by people_id desc" and checking tl record. Scenario 2 1. Create an OHA, account holder is Person, do not provide installation contact 2. Approve the account creation request as another NA 3. Ensure the account is created in EUCR; ensure the Contact Person tab of the 4. Navigate in EUTL => Account Mgt and locate the account just created; click c link and ensure no contact person details appear on the line "Installation Conta Scenario 3 Repeat scenario 1 but include an account holder which is a company Scenario 4 Repeat scenario 2 but include an account holder which is a company Repeat the above scenarios for AOHA.

Allocation tables page => Installation link leads to an empty page	In allocation tables, clicking on an installation hyperlink or aircraft operator hyperlink lead to an incorrect page. This is now fixed.	Scenario for OHA 1. Connect as NA. Navigate to EUEST=>Allocation Tables Phase 3=> National Al 2. Click on an installation ID link 3. Ensure the values detailed in this page agree with the aggregate allocation q in the previous page. 4. Click on the account hyperlink; ensure that the screen presented shows the account. Scenario for AOHA 1. Connect as NA. Navigate to EUEST=>Allocation Tables Phase 3=> National Av Table 2. Click on an Aircraft Operator ID link 3. Ensure the values detailed in this page agree with the aggregate allocation q in the previous page. 4. Click on the account hyperlink; ensure that the screen presented shows the account.
Issues with the task-list export	The export file of the tasklist was missing some data; this is now fixed.	Scenario 1 1. Login as NA; navigate to Task List => general tasklist; provide criterion Task T "Approve Transaction Request" 2. Export the General Task List: Ensure the first row includes the TransactionId ensure the contained data include the Transaction Id of each record Scenario 2 1. Login as NA 2. Export the CSV of General Task List or Task History. Ensure that the the numb exported is equal to the number of actual results on-screen and there are no d Scenario 3 1. Login as NA; navigate to Task List => History; export the list 2. Ensure that data for column Outcome are included in the exported file and c to respective data presented on screen.
CLONE - Allow update of NAT if YLE < allocationYear and allocation = 0	It must be allowed to upload a NAT/NAVAT where zero values are supplied for years greater than the YLE.	Select an OHA and set its YLE programmatically to 2015 in EUCR and EUTL. 1. Upload a NAT for its installation with non zero value for 2016. Ensure an erro when uploaded in EUCR and EUTL. 2. Upload a NAT for its installation with zero values for 2016 and 2017. Ensure successfully in EUCR and EUTL. Repeat for AOHA and include respective values in NAVAT file. Note: YLE is set programmatically as follows: In EUCR via verified_entity.end_year In EUTL via installation.year_of_last_emissions

Publicly Available Information Reporting Requirements	Public reports are provided as hyperlink in the public home page.	Connect to the home page of EUCR as not-registered user. Scenario 1 1. Connect to a Registry which does not have Public Reports; Public Reports are table FILE_REPOSITORY_ITEM in the database. 2. Click on the link "Public Reports" 3. Ensure the four sections of the reports appear, each with the disclaimer "Thi not available" Scenario 2 4. Connect to a Registry which has Public Reports defined in the table FILE_REP 5. Click on the link "Public Reports" 6. Ensure the four sections present the hyperlinks which are defined in table FILE_REPOSITORY_ITEM, for the particular Registry. 7. Ensure the hyperlinks when clicked lead to the address contained in column ITEM_REMOTE_URL, for the corresponding ITEM_TYPE and REGISTRY_CODE. Repeat for NA, AR, AAR.
ETS Email Notifications Template to be amended (DO NOT REPLY ...)	The footer in all automatically generated emails is modified.	1. Perform a comprehansive list of actions generating emails, e.g.: * create account * modify account holder * add/remove AR/AAR on account * propose and approve transaction 2. When you receive the notification email the body's last section should be th "Do not reply to this email address as the mailbox is not monitored. Please con administration should you require further assistance. Their contact details can http://ec.europa.eu/clima/policies/ets/registry/links_en.htm" Alternatively, if the property "doNotReplyProlog" has been translated in the Email_xx_YY.properties file for the user's language, the message presented wil the specific property.

Blocked AOHA gets open after proposing and rejecting account closure	Blocked AOHA was changed to OPEN after proposing and rejecting account closure; this is now fixed.	Scenario 1. 1. Select a registry as NA and go to "Account Request' to open a new AOHA wit 2. Login as an other NA of the registry and go to task list to approve the task. 3. Go to "Accounts" and search for the new AOHA. 4. Ensure that it is in "Blocked" status. 5. Click on " View Details" and go to "Compliance" tab. Ensure that the Dynami is null. 6. Propose the closure of the account and enter Last Verification Year 2013. 7. At the top of the screen ensure that you can see the information message: "' closure request has been submitted under identifier xxxxx". 8. Click on "Back" button and ensure that the status of the account remains "Bl 9. Click on "View Details" and go to "Compliance" tab. Ensure that the Dynamic is null. 10. Go to "Aircraft Operator" tab and ensure that the Monitoring Plan Status is 11. Login as an other NA of the registry and go to task list and reject the task. 12. Go back to the account and ensure that it s status is "Blocked". 13. Click on View Details" and go to "Compliance" tab. Ensure that the Dynamic is null. 14. Go to "Aircraft Operator" tab and ensure that the Monitoring Plan Status is 15. Repeat the appove test but at the step 11 select to approve the task. 16. Go back to the account and ensure that its status is "Closed". Scenario 2. 1. Repeat the appove test but at the step 6 enter Last Verification Year 2014. Scenario 3. 1. Select a registry as NA and go to "Account Request' to open a new AOHA wit 2. Login as an other NA of the registry and go to task list to approve the task. 3. Go to "Accounts" and search for the new AOHA. 4. Ensure that it is in "Blocked" status. 5. Click on " View Details" and go to "Compliance" tab. Ensure that the Dynami is C. Propose the closure of the account and enter Last Verification Year 2013 or 20 7. At the top of the screen ensure that you can see the information message: "' closure request has been submitted under identifier xxxxx". 8. Click on "Back" button and ensure that the status of the account remains "Bl 9. Click on "View Details" and go to "Compliance" tab. Ensure that the Dynamic is C. 10. Go to "Aircraft Operator" tab and ensure that the Monitoring Plan Status is 11. Login as an other NA of the registry and go to task list and reject the task. 12. Go back to the account and ensure that it s status is "Blocked". 13. Click on View Details" and go to "Compliance" tab. Ensure that the Dynamic is C. 14. Go to "Aircraft Operator" tab and ensure that the Monitoring Plan Status is 15. Repeat the appove test but at the step 11 select to approve the task. 16. Go back to the account and ensure that it s status is "Closed".
Change labels on the "Public Reports" page	KP Public reports change of static text	1. Log in to a Registry and make sure that you can see at the menu the link "Ky Reports". 2. Click on the the link "Kyoto Protocol Public Reports". Ensure that the text un Information (Paragraph 45)" has been corrected.

Task List history Export - From should be renamed "Initiator"	Change in column name in task list history export file	1. Login as NA of a registry and go to "Task list". 2. Go to "Exclusive Task List" tab and click on "Search & Export" button. 3. Ensure that you can see the field "Initiator". 4. Go to "General Task List" tab and click on "Search & Export" button. 5. Ensure that you can see the field "Initiator". 6. Go to "History" tab and click on "Search & Export" button. 7. Ensure that you can see the field "Initiator". 8. Login as (A)AR, Verifier and go to "Task List. 9. Go to "Task List" tab and click on "Search & Export" button. 10. Ensure that you can see the field "Initiator". 11. Go to "History" tab and click on "Search & Export" button. 12. Ensure that you can see the field "Initiator".
Visibility of Return Excess Allocation task: SD Agents do not have access to it	SD Agent role to gain access to Return of Excess Allocation functionality	1. Propose a 'Return of Excess Allocation' transaction. 2. Login as SD Agent and go to task list. (Ensure that the SD Agent has the perm "PERM_TR_RET_EXCESS_ALLOC_APPROVE"). 3. Ensure that he can see the pending task.
Real account holder name and account name in the details of Transaction request	Acquiring account of a transactions towards a TAL account should not show real account name and account holder name.	1. Add an account to the TAL, use a description and a comment 2. Propose a transfer to this account. 3. Check the data on the details of the created task. Ensure that at the acquirin see the description and the comment (and not the real account and account ho
java.lang.RuntimeException: Invalid date: 01012013 on search transactions panel	Exception when attempting search with invalid date; this is now fixed.	1. Go to "Accounts" - "Transactions" 2. Enter a date like 01012013 in of the date fields and click on "Search" button. 3. Ensure that at the top of the page you can see the error message: "searchFo your input could not be understood as a date. Example: 11/05/2014".
Visibility of request details tab	SD agents permissions modified so that they can see transaction request details	1. Login as a SD Agent of a registry. 2. Go to "Transactions" and make a search. 3. Select a transaction and click on its "Transaction Id". 4. Ensure that you can see the "Request Details" tab with correct data. 5. Repeat the above test as an Auditor of NA of the registry. 6. Ensure that you can see the "Request Details" tab with correct data.
Surrender Transaction do not trigger recalculation of dynamic compliance status and unblocking AOHA account	Compliance status mechanism modified so that at surrender compliance status is re-calculated.	1. Create an AOHA with YFE=2012; ensure it is in BLOCKED status and C 2. Transfer Aviation allowance so that it has balance; the account has never be by NA in the past. 3. Go to "Compliance" tab and enter Verified emissions for 2012; ensure it is B 4. Go to "Holdings" tab and surrender allowances >= of the sum of the emissio task. 5. Check the status of the account. Ensure that is OPEN status and A.
Two messages displayed at the same time	At addtion of account to TAL, previously existing messages are cleared.	1. Select an OHA/AOHA and propose a surrender transaction. Ensure that you information message at the top of the screen. 2. Immediately click on the "Trusted Accounts" tab. 3. Ensure that the information message has been disappeared. 4. Add an account at the TAL. Ensure that you can see the he information mess the screen. 5. Immediately click on the "Compliance" tab. 6. Ensure that the information message has been disappeared. 7. Select to Exclude/un-exclude a year and click on "Save" button. Ensure that y information message at the top of the screen. 8. Immediately click on the "Holdings" tab. 9. Ensure that the information message has been disappeared.

Transaction Requests > details popup is empty for pending transactions	Account statements modified to show today's pending transactions	1. Submit a Transaction but don't approve it 2. Go to Account Statement > Search for today's transaction, go to tab "Transa 3. Click the transaction link. Ensure that you can see correct data.
CLONE - Identity document type/expiry not recorded for Account Holder (Individual)	Identity document type/expiry support added for Account Holder (Individual)	1. Select an account and go to "Account Main" tab to update account holder d 2. Update account holder details, for example "Country", "Identity document t document other description" "Identity document identifier" and "Preferred La 3.Go to task list and see the task. 4. Ensure that you can see correct data at the Account Holder - Updated Detai
CLONE - NA and national SD roles to edit place and date of birth user details	NA and national SD roles become able to edit place and date of birth user details	1. Login as a user with Service Desk role.(Ensure that the Service Desk role has information" permission in order to be able to edit the Users). 2. Go to "Administration"- "Users". Select a user and click on URID link. 3. At the "Personal Details" tab, click on "Edit" button. 4. Make same changes at the fields "Date of birth", "Place of birth", and "Coun 5. Save your changes. 6. Login as NA and go to task list to approve the task. 7. Ensure that the changes have been implemented.
CLONE - AR/AAR email address update should require NA approval	AR/AAR email address update should require NA approval	Clarifications: The e-mail will be included in the fields that require NA approval. The phone numbers (phone 1, phone 2) present in the Business Details of the A distinguished by type (e.q. mobile, land line etc), also these numbers are just f are not used by the system to validate the user or send SMS security tokens. S critical as the user reports. Only as NA you can edit the Personal Details of a User including the mobile nu authenticate with ECAS) of the user. But this use-case already requires NA app Scenario 1. Select an account and click on "Authorised Representatives" tab. 2. Choose an AR and click on "Update" button and change his email adress. 3. Press "Submit". Ensure that the system displays the information message: Y update business details has been submitted under identifier xxxxxxx". 4. Log in as a Na and approve/reject the task. 5. Repeat the above test for Additional Authorised Representatives.

CLONE - Add estmated time of execution to (delayed) transactions	Estimated time of execution is added to (delayed) transactions	Scenario 1. 1. Ensure that Transactions_delay>0 2. Select an account and go to "Holdings" tab. 3. Select to propose a transaction (except Surrender of allowances). 4. Complete the proccess. 5. Go to "Transactions" to see the status of the transaction. Ensure that it is in ' status. 6. Click on "Transaction Id" link. 7. Ensure that at the "Transaction details" you can see the field : Estimated Tim dd/mm/yyy hh:mm:ss 8. Search for the transaction after the end of the delay. Ensure that you can no "Estimated Time of Completion" Scenario 2. 1. Ensure that Transactions_delay=0 Select an account and go to "Holdings" tab. 3. Select to propose a transaction (except Surrender of allowances). 4. Complete the proccess. 5. Go to "Transactions" and click on "Transaction Id" link. 6. Ensure that you can not see the field "Estimated Time of Completion".
EUCR-675 NAT Changes: Add foot-note	When uploading a NAT/NAVAT updating records, a footnote now appears specifying "Only values affected by this NAT/NAVAT update proposal are displayed."	1. Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. At the "Batch administration" field click on "Browse" button and select to up a U line. 5.Click on "Import" button. 6. Ensure that at the "NAT changes confirmation" pop-up screen you can see o with values in white colour. The unmodified cells without values shown in gray 7. At the end of the pop-up screen ensure that you can see the footnote: "Only this NAT update proposal are displayed. " 8 Repeat the above test for National Aviation Allocation Table. 9. At the end of the pop-up screen ensure that you can see the footnote: "Only this NAVAT update proposal are displayed."

NAT update following a cessation of activities	After an OHA or AOHA is CLOSED, a NAT or NAVAT can be uploaded provided that all the values of the NAT/NAVAT are zero, for all the allocation types (Free , Reserve, Transitional) that the operator had.	Scenario 1 1.Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. Select a closed account with YLE for example 2016 5. Try to upload a NAT file for this account with "U". At the xml file enter year the account and enter values >0. 6.The system displays the error message: "7727: The account is closed: 10282 Scenario 2 1. Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. Select a closed account with YLE for example 2016 5. Try to upload a NAT file for this account with U . At the xml file enter a year(the account and enter values >0. 6.The system displays the error message: "7727: The account is closed: xxxxx" allocation cannot be provided outside the years of first and last emissions: xxxx Scenario 3 1. Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. Select a closed account with YLE for example 2016 5. Try to upload a NAT file for this account with U flag. At the xml file enter valu some years) 6.The xml file will be uploaded successfully Repeat the above test for National Aviation Allocation Table. (*) When uploading an Update NAT/NAVAT, make sure you are updating to 0 a types (free, reserve, transitional) the operator has been previously assigned.
Claim Account Fails if AR is Suspended	In case an AR appointed to an account is suspended then the account cannot be claimed due to a EUTL error; this is now fixed	1. Login as NA 2. Select an account and suspend an AR 3. Go to "Accounts"- "Release account" and release the account 4. Go to "Accounts"-"Claim account" and claim the released account 5. Approve the claim account task using another NA 6. Ensure that the procedure has been completed successfully 7. Repeat the above test with suspend AAR
Problem with Country in tab Contact Person Update	A problem affected contact person information update; this is now fixed	1. Log in to Polish registry 2. Select an account and go to "Contact Person Information" tab 3. Click on "Update" button. 4. At the "Contact Person Update" screen click on "Address Provided" check bo 5. Choose Poland from drop-down list and enter: City, Postcode and Address. 6. Click on "Submit" button. 7. Ensure that the contact person information have been updated correctly.
Allocation Tables Phase 3 export faulty	A problem prohibited allocation tables export; this is now fixed	1. Login as NA and select a Registry 2. Go to "EU ETS"- "Allocation Tables Phase 3" 3. At the "National Allocation Table" tab check the data at the table "Details" 4. Click on "Filter & Export" button 5. Ensure that you can see correct data 6. Repeat the above test for the National Aviation Allocation Table

Authorised representatives can no longer assign tasks to their colleagues	Assignment of tasks by ARs was not allowed; this is now fixed.	1. Login as an AR of an account with valid AAR(s) 2. Go to "Holdings" tab of the account and propose a transfer transaction. 3. Complete the transfer procedure. 4. The system displays the information message: "Your transfer proposal has b assigned the identifier EUxxxxx . The transaction request with id 15xxxxx has b approval. 5. As the same user go to task list 6. Find the above request and claim it. 7. Ensure that you can only reject it. 8. Select the above request and click on "Assign" button 9. Ensure that you can assign the task to your colleagues. 10. Assign the task to one of the colleagues from the drop down list and save y 11. Login as the above assignee and go to task list 12. Ensure that you are able to re-assign and un claim the task even if you cann it.
NAT update following a cessation of activities	System now allows upload of NAT files for closed accounts with allocation=0 for years after Year of Last Emissions.	Scenario 1 1.Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. Select a closed account with YLE for example 2016 5. Try to upload a NAT file for this account with "U". At the xml file enter year(the account and enter values >0. 6.The system displays the error message: "7727: The account is closed: 10282" Scenario 2 1. Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. Select a closed account with YLE for example 2016 5. Try to upload a NAT file for this account with U . At the xml file enter a year(account and enter values >0. 6.The system displays the error message: "7727: The account is closed: xxxxx" allocation cannot be provided outside the years of first and last emissions: xxx Scenario 3 1. Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. Select a closed account with YLE for example 2016 5. Try to upload a NAT file for this account with U flag. At the xml file enter val some years) 6.The xml file will be uploaded successfully Repeat the above test for National Aviation Allocation Table. (*) When uploading an Update NAT/NAVAT, make sure you are updating to 0 a types (free, reserve, transitional) the operator has been previously assigned.

Problem with incoming transactions details	Incoming transactions e.g. from Japan were not presented correctly; this is now fixed.	1. Navigate to “Transactions”. 2. Search for a transaction with transaction type 03-00 (External Transfer Kyoto 3. Click on transaction ID. 4. Ensure that all the tabs in the transaction details screen appear correctly.
Long waiting period when assigning tasks	Task assignment list operation is now optimised.	Scenario#1: Assign task 1. Go to task list 2. Click on “Search” button 3. Select a task by clicking on its checkbox. 4. Click on “Assign” button. 5. At the field “New claimant” select a user. 6. Click on “Save” button. 7. Make sure that the time required has been reduced to perform the above pr 8. Check the hibernate_sql.log (exact name may differ in each deployment env queries executed for this particular action must be four. Scenario#2: Claim task 1. Go to task list 2. Click on “Search” button 3. Select a task by clicking on its checkbox. 4. Claim the task 5. Make sure that the time required has been reduced to perform the above pr 6. Check the hibernate_sql.log (exact name may differ in each deployment env queries executed for this particular action must be four. Scenario#3: Unclaim task 1. Go to task list 2. Click on “Search” button 3. Select a claimed task by clicking on its checkbox. 4. Unclaim the task 5. Make sure that the time required has been reduced to perform the above pr 6. Check the hibernate_sql.log (exact name may differ in each deployment env queries executed for this particular action must be four. Scenario#4: Comment task 1. Go to task list 2. Click on “Search” button 3. Select a task by clicking on its checkbox. 4. Write a comment to the task 5. Make sure that the time required has been reduced to perform the above pr 6. Check the hibernate_sql.log (exact name may differ in each deployment env queries executed for this particular action must be four. Repeat all the above scenarios for: NA tasklist - Exclusive tab NA tasklist - General tab Non-NA tasklist

EUCR-675 NAT Changes: Add foot-note	The NAT/NAAT update screen was modified in order to present updated values.	1. Login as NA of a registry. 2. Go to EU ETS- Allocation Tables Phase 3 3. Select National Allocation Table 4. At the "Batch administration" field click on "Browse" button and select to up a U line. 5.Click on "Import" button. 6. Ensure that at the "NAT changes confirmation" pop-up screen you can see o with values in white colour. The unmodified cells without values shown in gray 7. At the end of the pop-up screen ensure that you can see the footnote: "Only this NAT update proposal are displayed. " 8 Repeat the above test for National Aviation Allocation Table. 9. At the end of the pop-up screen ensure that you can see the footnote: "Only this NAVAT update proposal are displayed."
It is possible to add a Closed account to your Trusted Account List	It is possible to add a Closed account to your Trusted Account List; this is now fixed.	1. Create an account - Account A 2. Create another account under a different account holder - Account B 3. Log into Account A, go to the "Trusted accounts" tab and add Account B 4. Ensure that Account B goes into Approval Pending status. 5. Go to task list. Ensure that you can see the task "Addition of account to Trus 6. Close Account B (without approve/reject the task) 7. The reps of Account A receive an e-mail telling them that an account has bee their Trusted Account List 8. Go back into Account A and go to "Trusted Accounts" tab. 9. Ensure that the elements of Account B have been removed. 10. Go to the task list. Ensure that the task is in status "cancelled".
Able to close account with Last Year of Verification before First Year of Verification	At account closure, Year of Last Emissions is checked to be greater than Year of First Emissions.	Scenario for OHA 1. Select an OHA and go to "Installation" tab to check the "First Year of Verifica 2. Click on "Close" action link of the account. 3. At the "Close account" screen at the "Permit Revocation Date" and "Last Ver enter a date < FYV. 4. Click on "Confirm Account Closure" button. 5. Ensure that the system displays the error message: " ERROR CODE:10106 Th and revocation date must be later than its entry date". 6. At the "Permit Revocation Date" enter a date >= FYV but at the "Last Verifica enter a date < FYV. 7. Ensure that the system displays the error message: "ERROR CODE:10144 The emissions must be greater or equal to the year of first emissions" 8. At the Last Verification Year" field enter a date >= FYV but at the "Permit Rev enter a date < FYV. 9. Ensure that the system displays the error message: " ERROR CODE:10106 Th and revocation date must be later than its entry date". Scenario for AOHA 1. Select an AOHA and go to "Aircraft Operator" tab to check the "First Year of 2. Click on "Close" action link of the account. 3. At the "Last Verification Year" field enter a date < FYV. 4. Click on "Confirm Account Closure" button. 5. Ensure that the system displays the error message: "ERROR CODE:10144 The emissions must be greater or equal to the year of first emissions"

Allocation Phase 3 page > Incorrect message when page is locked	The message informing on Allocation Phase 3 locking did not present the locking user correctly; this is now fixed.	Scenario 1 1. Login as NA to Registry A 2. Navigate to Allocation Phase 3. 3. Switch to another registry (B) 4. Switch back to Registry A 5. Try to navigate to Allocation Phase 3. 6. Ensure that the page is not locked Scenario 2 1. Login as NA to Registry A 2. Navigate to Allocation Phase 3. 3. Don't do anything, let your session expire 4. Login again and try to navigate to Allocation Phase 5. Ensure that the page is not locked Scenario 3 1. Login as NA1 2. Navigate to Allocations Phase 3 page. 3. From another browser, login as NA2. 4. Navigate to Allocations Phase 3 page. You will see the following message: "T 3 page is locked by another session from user na - <NA1>"
Return of excess allocation' proposals for accounts without AARs raise an exception when proposed by NAs	Return of excess allocation' proposals for accounts without AARs produced an error; this is now fixed.	1. Locate an over-allocated account that does not have AARs or it has invalid A 2. Propose a Return of Excess allocation as NA. 3. Login as another NA and go to task list. 4. Go to "General Task List" tab 5. Ensure that the task is at the task list. 6. Claim the task. 7. Ensure that you can approve/reject it.
Public Reports page, text for missing JI reports, must be configurable per registry	In KP Public Reports page, a text informing on missing JI report is configurable per Registry.	This is a technical use case and is tested by specifying values in translations file publicReports_JIProjectsNotAvailable_<<language>>_<<registry>> and ensurin correctly in KP Public Reports page for the specific registry/language combinati
Not possible to export operators who have no entitlement set	It is made possible to export operators without entitlement value.	1. Navigate to EUETS => Entitlements 2. Click on Entitlement => Not Set and click on "Search" 3. Click on "Export XML"; no file should be generated 4. Click on "Export CSV"; a file should be generated containing the accounts no 5. Ensure paging mechanism works correctly
All accounts hyperlinked in ESD Entitlements Transactions	Account hyperlinks appeared for more accounts than needed in ESD Entitlement transactions	Test scenario for ESD-CA 1. Connect as ESD-CA and navigate to ESD Entitlement transactions 2. Ensure all accounts are hyperlinks Test scenario for ESD-AR 1. Connect as an AR of an account with ESD Entitlement transactions 2. Navigate to ESD Entitlement transactions 3. Ensure only accounts to which the user is appointed can be clicked. Repeat for ESD-AAR.

Entitlement Transactions List - Shows transactions of other MS	More ESD Entitlement transactions appeared to ESD-AR users; this is now fixed.	Test scenario for ESD-CA 1. Connect as ESD-CA and navigate to ESD Entitlement transactions 2. Ensure all ESD entitlement transactions are visible Test scenario for ESD-AR 1. Connect as an AR of an account with ESD Entitlement transactions 2. Navigate to ESD Entitlement transactions 3. Ensure only ESD transactions pertaining to accounts to which the user is app Repeat for ESD-AAR.
Prepare account closure job runs for the next compliance year	Account closure of ESD compliance accounts used wrong years' accounts; this is now fixed.	1. Configure 2013 as active year and execute closure date job 2. Ensure accounts affected pertain to 2013 and not to 2014
ESD Entitlements Transactions - search criteria	ESD Entitlement transaction search criteria mechanism did not search via dates correctly; this is now fixed	1. Navigate to ESD entitlement transactions 2. Search for transactions from: <<yesterday>> to <<today>> 3. Ensure transactions of two days appear in the results
Not possible to create a KP Account	It was not possible to create KP PHA. This is now fixed.	Connect as NA in an ETS Registry. 1. Request and approve (as another NA) the creation of a Party Holding accoun account holder 2. Request and approve (as another NA) the creation of a Party Holding accoun holder 3. Request and approve (as another NA) the creation of a OHA with existing ac 4. Request and approve (as another NA) the creation of a OHA with new accou 5. Request and approve (as another NA) the creation of a Person Holding Acco account holder 6. Request and approve (as another NA) the creation of a Person Holding Acco account holder Ensure that in all cases the account is created in OPEN state.
Spelling inconsistency - over-allocation	Throughout the system, the term over-allocation should be used	
ESD View Account misses "Return to Search" functionality	"Return to search" mechanism added in view account screen.	1. Connect as ESD-CA and navigate to accounts 2. Enter any search criteria, click "Search" and sort data via any field heading a subsequent page in the result set. 3. Click on any account's View Details link 4. Click on "Return to Search" link 5. Ensure the screen is now as defined during step 2 (same criteria, sorting, and

Transfer of AEAs between MS: label does not show the period to which the 5% restriction refers.	Transfer AEA transaction screen is modified to depict whether 5% limit is applicable.	1. Set date before balance calculation 2. Locate an ESD Compliance account of the active year. Propose AEA transfer. transferred are up to 5% of allocation quantity or current balance - emissions - already transferred quantity. 3. Ensure 5% of allocation quantity appears as a line in the transfer AEA screen 4. Set date between balance and compliance calculation 5. Locate an ESD Compliance account of the active year. Propose AEA transfer. transferred are up to current balance - emissions - pending quantity - already t 6. Ensure 5% of allocation quantity does NOT appear as a line in the transfer AE 7. Set date after compliance calculation 8. Locate an ESD Compliance account of the active year. Propose AEA transfer. transferred are up to current balance - emissions - ending quantity - already tra 9. Ensure 5% of allocation quantity does NOT appear as a line in the transfer AE
After Balance Calculation the user should be able to transfer out AEAs up to the positive balance, not up to the 5%.	Transfer AEA transaction screen allows full AEA balance transfer after balance date.	Refer to TC of EUCR-1286
ESD Account Search - Suspension Reason link missing for SUSPENDED acc	Suspension reason added in SUSPENDED ESD accounts	1. Connect as ESD-CA 2. Navigate to Accounts screen 3. Suspend an account 4. Search for accounts including the suspended account 5. Ensure the suspended account shows a hyperlink "suspension reason". 6. Click the "suspension reason" hyperlink and ensure the inserted reason via s
Check 7863 for ESD Dates should not check dates if they are the same as existing ones	ESD Compliance dates validations are enriched.	Test scenario #1: Current Date < Balance date of the active year 1. Connect as ESDCA and navigate to ESD Compliance Dates. 2. Edit Balance date of active year and click submit. 3. Ensure the orange information box appears in EUCR; after 10 seconds re-visi and ensure the orange box no longer appears 4. Confirm all dates are correct in EUTL database via the query select * from es by 1; 5. Repeat by editing all dates of the current year Test scenario #2: Balance date < Current Date < Compliance status date of the 1. Repeat step 1 of Test Scenario #1 2. Edit compliance status date of active year and click submit Repeat remaining steps of Test Scenario #1 Test scenario #3: Compliance status date < Current Date < Closure date of the a 1. Repeat step 1 of Test Scenario #1 2. Edit closure date of active year and click submit Repeat remaining steps of Test Scenario #1

Check 7848 has some spelling and terminology errors	Check 7848 descriptive text was modified.	1. Locate a transaction which is TERMINATED and produced error code 7848. 2. Ensure the descriptive text is as defined in this issue.
(SDB-2720) Error message 7865 not de-coded in transaction details	Check 7865 description did not appear on the screen	1. Create or locate a TERMINATED transaction with a response code equal to 7 2. Navigate to Request Details tab 3. Ensure the following text appears in Details column: "Amount should be up t Percent of Transferring Account Allocations minus already completed AEA Tran Calculation. Amount should be less or equal to the positive balance of the acco Calculation."
New feature: UC-ESD-REP-20 - View transaction information of ESD	(EUCR) UC-ESD-REP-20 - View transaction information of ESD	1. Connect as ESD-CA; assume 2014 is active year 2. Transfer to IT-2014 8 CER from Italian PHA; approve the transaction 3. Transfer to IT-2014 3 CER from Italian PHA; approve the transaction 4. Locate and update the country code of the received unit blocks via the query select end_ - start_ + 1, originating_country_code from unit_block where acco (select account_id from account where identifier = <<identifier of acquiring acc update unit_block set originating_country_code='ET' where ID = <<unit block I 5. Clear the contents of reports tables via the query: delete from esd_credits_report_detail; delete from esd_credits_report; 6. Execute job of Compliance date of 2014 7. Navigate to ESD=>ESD Transactions report; select country=IT and year=2014 8. View the generated report and ensure the corresponding quantities appear respectively. Repeat for ESD-AR of Italian ESD Compliance account of 2014 and ensure the u same report.
Transfer of credit entitlement should not be allowed from CLOSED account	EUCR-1421 Transfer of credit entitlement should not be allowed from CLOSED account	1. Open ESD account for example PL for 2013, make sure there is entitlement b 2. Close this account (by passing over Date of Closure) 3. When active year is 2014, go to ESD Entitlement and click "Propose transacti 2013 4. From drop-down list pick "Transfer" option and approve the transaction 5. Go to "ESD Entitlements Transactions" and search for the above transaction 6. Ensure that it has status "5-Terminated" and Response code: "7864 Transfer not be CLOSED"
Addition of transaction types in ESD screen	Transaction Search - Add to Transaction Type List - ESD KP Transfer Reversal*, Return to ETS*	1. Login to a registry (other than ESD) 2. Go to Accounts - Transactions 3. At the "Transaction Type:" field open the drop down list 4. Ensure that you can see the types: 03-12 ESD Transfer of KP units 10-12 ESD Transfer of KP units (Internal) 03-16 ESD Return of KP Transfer 10-16 Return of KP Transfer (Internal) 03-44 ESD Reversal KP Transfer 10-44 ESD Reversal KP Transfer (Internal)

Modifications for ESD transaction search	EUCR-1439 Transaction Search - Treat ED as EU when searching	1. Login to a registry (other than ESD) 2. Go to Accounts- Transaction and search for an ESD transaction type for exam Transaction of KP units". 3. Click on "Search" button 4. Check the data at the table results. 5. At the fields "Transaction Type:" select "03-12 ESD Transaction of KP units" a field "Acquiring Registry:" select "European Union" 6. Click on "Search" button 7. Ensure that you can see correct data 8. Repeat the above test for "Transaction Type: 03-16 ESD Return of KP units" a "Transferring Registry:" select "European Union" 9. Click on "Search" button 10. Ensure that you can see correct data
Modifications for ESD transaction search	EUCR-1439 Transaction Search - Add to Transaction Type List - ESD KP Transfer*	1. Login to a registry (other than ESD) 2. Go to Accounts - Transactions 3. At the "Transaction Type:" field open the drop down list 4. Ensure that you can see the types: "03-12 ESD Transfer of KP units" and "10- KP units (Internal)"
Corrections for ESD-SD users	ESD Entitlements Transaction Proposal - SD - Crash	1. Login as ESD-SD and go to ESD Entitlements Page. 2. Click on the proposal link and fill the various fields 3. Click on "Next" button 4. System appears the information message: "You are not authorized for this a
Correction of error message	Upload XML files in ESD: Click "Import" without selecting a file: it works but message appears twice on screen	1. Connects to ESD and go to "ESD" – "ESD Emissions Upload" 2. Click on "Import" button without selecting an ESD emissions XML file. 3. System displays the error message: "A file is required". 4. Ensure that the message appears only once. 5. Repeat the above test for: ESD Allocations Table Upload ESD Entitlements Lists Upload ESD Eligibility List Upload

Correction of error message	The Error Messages 7820 & 7821 appear together	Scenario 1 1. Define in EUCR and EUTL the same issuance limit 2. Upload total units in allocation XML higher to EUCR than in EUTL. (the total u EUCR must be lower than the issuance limit) 3. Go to EUCR and Issue AEAs units a higher level than the EUTL total units uplo XML, and lower than EUCR. 4. Approve the task 4. Go to transactions and ensure that the transaction is terminated. 5. Click on response codes tab. 6. Ensure that system displays only the response code: "7821 The amount of issued AEA units should be lower than or equal to the sum the ESD Allocation Table minus already issued amounts plus deleted amounts" Scenario 2 1. Define in EUCR an issuance limit higher than in EUTL. 2. Go to EUCR and Issue AEAs to a higher level than the EUTL limit, and lower t 3. Approve the task 4. Go to transactions and ensure that the transaction is terminated. 5. Click on response codes tab. 6. Ensure that you can see the response code: "7820 The amount of issued AEA units plus any already performed issuances sh or equal to the issuance limit"
ESD Entitlement Transactions - transaction type filter missing	ESD Entitlement Transactions - transaction type filter missing	1. Login to ESD registry 2. Go to ESD - ESD Entitlements Transactions 3. Ensure that you can see the filter "Esd Entitlements Transaction Type" 4. Open the drop down list 5. Ensure that you can see the values: {Blank}, Carry-over Transfer Carry-over Reversal Transfer Reversal 6. Make a search using the values of the filter 7. Ensure that you can see correct data
Opening ESD Compliance account when an MS is "not compliant" should send the account to "Blocked"	Opening ESD Compliance account when an MS is "not compliant" should send the account to "Blocked"	When creating the account for year Y: If any ESD account of this MS is BLOCKED => account is created as BLOCKED If for max(year) < Y the compliance status is I => account is created as BLOCKED else, account is created as OPEN Go to EUTL and check the status of the new account
Correction of exported data	UC-ESD-REP-20 : Export to Excel	1. Repeat the steps of EUCR-995 2. Click Export (Excel). 3. Ensure data on Excel are identical to the ones appearing on screen
Correction of label	Replace label "Member States" with "Member State" at View ESD Allocations screen	1. Connect as ESD-CA 2. Navigate to "View ESD Allocations" 3. Ensure the first column has as title "Member State"

Correction of removal of ESD-(A)AR mechanism	If there is a Pending task of additional / replacement of ESD (A)AR, system allows you to add/replace the same or a new one.	1. Connect as ESD-CA 2. Navigate to an ESD Compliance account 3. Navigate to ESD-AR tab 4. Locate and ESD-AR and click on "replace" button, select another ESD-AR and 5. Repeat steps 2 and 3 6. Ensure that the specific account's ESD-AR tab no longer presents the button an ESD-AR Repeat step 1 onwards for ESD-AR.
Correction of removal of ESD-(A)AR mechanism	Replace an ESD (A)AR - system displays the "Restore" button under the ESD (A)AR	1. Connect as ESD-CA 2. Navigate to ESD accounts and select an account and choose to replace an ES 3. Return to the mail list of the accounts and choose the same account again a above ESD-AR. 4. Ensure the "Restore" button does not appear under the ESD-AR. Repeat for ESD-AAR.
New feature: Marking of "ESD Used" units	Mark Used for ESD KP units	Assume current date is between balance and compliance calculation. 1. Connect as NA and navigate in a PHA, e.g. of Italy. 2. Propose a transfer of KP units from PHA to ESD Compliance account. 3. Approve the transaction and ensure it is COMPLETED. 4. Execute in EUTL database: select esd_used from unit_block, account_holdin where unit_block.block_id = account_holding.block_id and account_holding.account_id = <<account_id_in_EUTL>>; 5. Execute in EUCR database: select esd_used from unit_block where account_ <<account_id_in_EUCR>>; Note the ID of the unit block in EUCR and EUTL. Ensure column ESD_USED is 1 in both EUCR and EUTL. 6. Reverse the transaction of step [2]. 7. Ensure the unit blocks located in steps [4] and [5] have now ESD_USED equa and EUTL. Repeat the steps [1] to [5]. 7. Change compliance dates so current date is after compliance date. 8. Propose and approve a transfer of KP units from Italian ESD compliance acc Ensure it is completed. 9. Perform the previously defined queries in EUCR and in EUTL for the new uni Ensure column ESD_USED is 1 in both EUCR and EUTL.
Correction of ESD-AAR removal mechanism	ESD AAR removal - wrong buttons	1. Connect as ESD-CA and navigate to an ESD Compliance account with two ES buttons Remove, Replace, Update, Suspend appear. 2. I remove one ESD-AAR. 3. A removal request is generated. 4. The buttons Update and Suspend appear only.

KP units should arrive in ESD Compliance Accounts only through "ESD KP transfers"	KP units should arrive in ESD Compliance Accounts only through "ESD KP transfers"	1. Connect as ESD-CA and navigate to an ESD Compliance account of the active Assume the account has 100 Limit1. Note its full identifier 2. Connect as FR NA and navigate to EUETS, French registry 3. Locate a PHA with 100 CER units in General Positive list. 4. Send 10 CER units to the account noted in step [1] via a Regular Transfer 5. Submit and approve the transaction 6. Ensure the transaction is terminated with rule 7006.
Create clear down scripts for ESD	Create clear down scripts for ESD	Clear-down scripts implemented and added in a Confluence page.
ESD parameters page is enriched with account identifiers able to send/receive KP units into/out of ESD.	ESD parameters on accounts for KP / ESD transfer must be irrelevant of year and a screen allows their setup	1. Connect as ESD-CA and navigate to "Modify ESD Parameters" 2. Select MS equal to "MT" 3. Select KP PHA Registry = "Norway" 4. Set KP PHA Identifier = 199 5. Click on "Save" 6. Perform the following query in EUCR: select * from esd_parameter where esd_member_state = 'MT' and param_typ ('COMPL_PARTY_ACC_HOST_REG','COMPL_PARTY_ACC_IDENTIFIER'); 10. Ensure the values 'NO', 199 appear in the results. 11. Repeat steps 1 to 4 but set country = Luxembourg instead of Norway. 12. Repeat the query of step 9. 13. Ensure LU appears in the results instead of 'NO'. 14. Repeat steps 1 to 4 but set identifier = 333 15. Repeat the query of step 9. 16. Ensure 333 appears in the results instead of 199
There is missed GreenBox confirmation message with the request number after Allocation for Installation or AircraftOperators	After allocation request submission, a confirmation message was hidden; the message now appears again	1. Connect as NA and navigate to "Allocation Phase 3 page", and click checkbox installation. Click on "Submit" 2. A modal confirmation window appears. Confirm by clicking "Confirm" button confirmation box disappears. 3. Ensure a green message box appears at the top of the screen stating "The re <<allocation request ID>> was created and is waiting for approval by another N Administrator" Repeat for aicraft operator.

Cannot open PreAllocation page as CA in EU registry	Under certain allocation XML upload conditions, the Pre-Allocation page crashed; this is now fixed	Scenario #1 1. Add (action="A") FREE and RESERVE allocations for year 2013 for an installat does not exist 2. Update (action="U") the NAT for year 2014 with RESERVE only for that instal 3. Verify that no NULL values were inserted at table PHASE3_ALLOCATION_VAL Allocation and that Pre-Allocation page loads without errors. 4. Repeat for NAAT and AOHA Scenario #2 1. Add (action="A") X FREE, Y RESERVE and Z TRANSITIONAL allocations for yea installation for which NAT does not exist. 2. In Allocation Phase 3 page verify that the numbers are correct for this install and for each different type. 3. Update (action="U") NAT: Set X-1 FREE, Y-1 RESERVE and Z-1 TRANSITIONAL 2014 for the same installation. 4. In Allocation Phase 3 page verify that the numbers are correct for this install different type and years 2013 and 2014. 5. Repeat for NAAT and AOHA 6. Verify that no NULL values were inserted at table PHASE3_ALLOCATION_VAL Allocation and that Pre-Allocation page loads without errors.
CLONE - Allocations for disabled Aircraft Operator	Under certain conditions it was possible to click the allocation for an excluded AOHA (although the allocation was not performed eventually). This is now fixed and the corresponding checkbox is not clickable.	1. Log in as NA in EUETS 2. Exclude an AOHA for 2014 3. Upload NAAT for 2014 4. Navigate to Allocation Phase 3 5. Choose year equal to 2014 6. Click on "Free" checkbox so that the whole column us selected 7. Ensure the checkbox corresponding to the excluded AOHA is not checked.
Wrong description for "Approve Allocation Settings Delivery" task	A task description is modified	1. Log in as ESD-CA and perform an ESD allocation 2. Confirm the allocation request 3. Navigate to Task LIst => Exclusive Task List, click "Search" and locate the topr 4. Ensure its name is "Approve Allocation Settings Delivery"
Allow to going back to previous page - Account Transactions	Change is ESD transactions navigation mechanism	1. Set current date as after ESD compliance date 2. Connect as ESD-CA and navigate to an ESD compliance account with positive 3. Navigate to Holdings => Propose a transaction 4. Choose a tranasction type 5. Click on "Cancel" 6. Ensure the next screen is the transaction type selection screen of step [4]. Repeat for all available transaction types.

Problem with actions in Modify ESD Parameter page	Modify ESD parameters page had some screen errors; these are now fixed.	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 view only mode" and "Updated values have been submitted to EUTL for appro top of the screen 7. After 2 minutes re-visit the page and ensure the messages do not appear an 8. Perform the following query in EUTL and ensure the value "1.99" appears: 's esd_parameters where name like 'ABAT%'; 9. Set MS = "AT", KP PHA Registry = "Bulgaria", KP PHA Identifier = "999" and c 10. Ensure the message "KP Party Holding Account Identifier values have been 11. Select MS = "AT" and check the other values entered during step [9] appea 12. Select MS = "AT" and year = 2020 and set Carry-forward limit = 2 and Trans and click 'Save'. 13. Ensure the messages "There exists a pending request for modifying the ESD in view only mode" and "Updated values have been submitted to EUTL for app 14. After 2 minutes re-visit the page and ensure the messages do not appear a 15. Perform the following query in EUTL and ensure the entered values during stored: select * from esd_parameters where esd_registry='AT';
CLONE - Double value for ESD Issuance - first issuance time	ESD issuance assigned wrong balance to the AEA TQA. This is now fixed.	1. Remore 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 o during step [3].

Unrecoverable error when being redirected to ECAS	While proposing a KP transfer transaction, system did not handle ECAS authentication correctly; this is now fixed.	A. KP transaction from Italy to Finland 1. Connect as NA of Italian Registry 2. Navigate to a PHA and send 1 CER (existing in ITL) to a Finnish PHA 3. Ensure ECAS authentication is enforced in transaction signing 4. Approve the transaction request as another NA 5. Ensure ECAS authentication is enforced in transaction approval 6. Ensure the transaction is completed B. KP transaction from Italy to Japan (regression testing) Repeat steps 1-5 of scenario [A] but send to a Japanese account 6. Ensure the transaction is proposed C. KP transaction from Japan to Finland (regression testing) 1. Send from SoapUI a transaction from Japan to a Finnish PHA 2. Connect to EUETS as NA, Finnish Registry 3. Ensure the transaciton is completed D. Allowance transfer betweeen two OHA (regression testing) 1. Connect as NA in EUETS and navigate to an OHA 2. Transfer 10 allowances to an account in its transfer list 3. Ensure the transaction is completed.
RedBox error while clicking Save button in ESD Parameter Page with no data selected	Screen error at proposing ESD parameters change with no different values than existing. This is now fixed.	1. Login as CA in ESD registry 2. Navigate 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 subm

ANNEX VIII. TEST RESULTS – EU

Annex H TEST RESULTS - EU

Issue	:	1.0
Issue date	:	10th February 2015
Document Reference		NIR_2015_KAVH
Status	:	Definitive
Distribution		UNFCCC
	:	CGI
		TRASYS

Prepared by	:	Prasantha Annamreddy	09th February 2015
Reviewed by	:	Mahesh Gangarevaiah	10th February 2015
Authorised by	:	Youssouf Wabi	10th February 2015

Amendment history

date	issue	status	Author
09/02/2015	1.0	First version	Prasanth Annamreddy

Introduction

The custom Annex H tests were conducted between 4th and 6th February 2015. The environments used were ITL REG, EUTL and CSEUR ACC. LV and RO registries participated in this testing and were put into sandbox testing for the purpose of these tests.

1.1 Overview

This is the Annex H test result document for European Union registry (EU) and LV & RO were the participating registries in this test.

This is a custom test planned for EU and only important test cases from original Annex H test plan were executed as advised by UNFCCC.

ITL REGISTRY environment was used for this testing and government accounts provided were manually uploaded and database was tweaked while creating the projects.

1.2 Abbreviations

Abbreviation	Definition
AAU	Assigned Amount Unit
CDM	Clean Development Mechanism (UNFCCC IT system)
CER	Certified Emission Reduction [Unit]
CITL	Community Independent Transaction Log (EU IT system)
CP	Commitment Period
CSEUR	Consolidated System of EU Registries
DES	Technical Standard for Data Exchange
ERU	Emission Reduction Unit
EU	European Union
FTP	Functional Test Plan
ITL	International Transaction Log
lCER	Long-Term Certified Emission Reduction [Unit]
RMU	Removal Unit
RSA	Registry System Administrators
SSL	Secure Socket Layer (communications encryption)
STL	Supplementary Transaction Log
tCER	Temporary Certified Emission Reduction [Unit]
UNFCCC	United Nations Framework Convention on Climate Change
VPN	Virtual Private Network

1. Test Configuration

2.1 Registries

Following registries were used

ZZ	XX	YY	QQ	RR
LV	RO	--NA--	--NA--	--NA--

2.2 Additional Results

At the end of each scenario the relevant ITL logs will be captured.

A WebEx session is used for communication during the testing. This will be captured at the end of each day.

3 **TEST RESULTSScenario 1 – Issuance and External Transfer of AAUs and RMUs***Ref*	*Description*	*Pass/Fail Time*	*Notes*
1.1	*Successful AAU issuance*	*PASS*	
1.1bis	*Successful AAU issuance in CP2*	*PASS*	*This test has conducted as part of additional test which was successful*
1.4	*Successful RMU issuance LULUCF activity 1*	*PASS*	
1.17	*Reconciliation*	*PASS*	
1.18	*Account balance check*	*PASS*	

Scenario 2 – Conversion of AAUs and RMUs into ERUs*Ref*	*Description*	*Pass/Fail Time*	*Notes*
2.6	*Successful AAU conversion*	*PASS*	
2.7	*Successful RMU conversion*	*PASS*	
2.9	*Successful ERU transfer*	*PASS*	
2.10	*Reconciliation*	*PASS*	
2.11	*Account balance check*	*PASS*	

Scenario 3 – Cancel units unrelated to CDM projects *Ref*	*Description*	*Pass/Fail Time*	*Notes*
3.3	*Successful voluntary cancellation of AAUs*	*PASS*	

3.4	***Cancellation to fulfil net source cancellation notification***	***PASS***	***Initially sent notification for LULUCF 1 for 7 million units but it was to be done LULUCF 2 for 1 million units. Corrected and done successfully. Initially fulfilled with 10 million units but plan for 1 million units, corrected and done successfully***
3.5	***Cancellation to fulfil non-compliance cancellation notification***	***PASS***	
3.7	***Reconciliation***	***PASS***	

3.8	***Account balance check***	***PASS***	***Balance was mismatched due the extra notification sent out for 7 million on step 3.4 otherwise everything fine.*** ***As you can see from the below results in the account type 100 and Unit_type_code 1 the value is 2,983,750,000 where as in the test plan it 2,990,750,000 there is a difference of 7,000,000. In the same way there is a difference of 7,000,000 for account_type 210 and Unit type code 1 there is 7,250,000 in place of 250,000.*** ***Balance was :*** ACCOUNT_TYPE_CODE UNIT_TYPE_CODE HOLDINGS ---------------------- ---------------------- ---------------------- **100 1 2983750000** 100 2 1750000 100 3 200000 **210 1 7250000** 210 2 250000 210 3 500000 220 1 7000000 220 2 2000000 220 3 1000000 230 1 1000000

Scenario 4 – Cancel units related to CDM projects

Ref	*Description*	*Pass/Fail Time*	*Notes*
4.1	***Receive CERs, tCERs, ICERs and other units***	***PASS***	***There were some changes on the settings includes project creations (JI for XX registry), Project Limits updates, account ids, last year's data existed in the DB at ETS etc. These issues were encountered and fixed on the go to get the test successful.***
4.7	***Reconciliation***	***PASS***	
4.8	***Account balance check***	***PASS***	

3.1 Scenario 6 – Events and transactions at the end of CP1 and the start of CP2

Ref	*Description*	*Pass/Fail Time*	*Notes*
6.4	*Successful retirement of AAUs, ERUs, CERs and ICEs*	*PASS*	