ENVIRONMENT AGENCY OF ICELAND

2024

Informative Inventory Report

Emissions of Air Pollutants in Iceland from 1990 to 2022

Submitted under the Convention on Long-Range Transboundary Air Pollution

Informative Inventory Report 2024

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Suðurlandsbraut 24
108 Reykjavík
Tel. +354 591 2000

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Environment Agency of Iceland

Project management:	Nicole Keller
NIR Coordination:	Birgir Urbancic Ásgeirsson
Communication:	Rafn Helgason
Energy:	Brian Charles Barr Chanee Jónsdóttir Thianthong Kristinn Már Hilmarsson Sigríður Rós Einarsdóttir
IPPU:	Chanee Jónsdóttir Thianthong Kristinn Már Hilmarsson
Agriculture:	Ásta Karen Helgadóttir Diljá Helgadóttir Inga Rún Helgadóttir
Waste:	Ásta Karen Helgadóttir Birgir Urbancic Ásgeirsson Diljá Helgadóttir Inga Rún Helgadóttir

Preface

The Convention on Long-Range Transboundary Air Pollution (CLRTAP) was adopted in 1979 and entered into force in 1983. The Convention has been extended by eight Protocols, of which Iceland has ratified the Protocol on Persistent Organic Pollutants. Furthermore, in 2009 the National Emissions Ceilings Directive (NECD) 2001/81/EC was incorporated to the EEA agreement, with national emission targets set for Iceland for SO_2, NO_x, NMVOCs, and NH_3, for the year 2010.

According to Article 8 of the Convention, Parties shall exchange information on emissions of pollutants. To comply with this requirement and with the NECD, Iceland prepares an Informative Inventory Report (IIR) each year. The IIR, together with the associated Nomenclature for Reporting Tables (NFR tables) is Iceland's contribution to this round of reporting under the Convention. This report emphasises emissions of persistent organic pollutants (POPs), as Iceland has only ratified the Protocol on Persistent Organic Pollutants (POPs) under the CLRTAP. Emissions of the indirect greenhouse gases (NO_x, CO, and NMVOCs), NH_3, and SO_2 are provided in the NFR tables as they are calculated to comply with the reporting requirements of the NECD and the United Nations Framework Convention on Climate Change (UNFCCC). Emission estimates for particulate matter (PM), black carbon (BC), and heavy metals (HM) are provided for several emission sources. A description of the trends and the calculation method for the pollutants are given in this report. Further estimates are provided for SO_2, $PM_{2.5}$, and PM_{10} for the volcanic eruptions at Eyjafjallajökull (2010), Grímsvötn (2011), Holuhraun (2014-2015), Fagradalsfjall (2021), and Meradalir (2022).

The IIR is written by staff at the Environment Agency of Iceland (*Umhverfisstofnun*) (EAI).

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List of Abbreviations

AAP	Annual Average Populations
AFOLU	Agriculture Forestry and Other Land Use
BAT	Best Available Technology
BREF	Best Available Techniques Reference
CDFRS	Capital District Fire and Rescue Service
CLRTAP	Convention on Long-Range Transboundary Air Pollution
DOAS	Differential Optical Absorption Spectroscopy
EAI	Environment Agency of Iceland (*Umhverfisstofnun*)
EEA	European Environment Agency
EF	Emission Factor
EMEP	European Monitoring and Evaluation Programme
E-PRTR	European Pollutant Release and Transfer Register
ERT	Expert Review Team
ETS	Emissions Trading System
EU	European Union
FAI	Farmers Association of Iceland (*Bændasamtök Íslands*)
GHG	Greenhouse Gas
IEF	Implied Emission Factor
IFVA	Icelandic Food and Veterinary Authority (*Matvælastofnun*)
IGLUD	Icelandic Geographic Land-use Database
IIASA	International Institute for Applied Systems Analysis
IIR	Informative Inventory Report
IMO	Icelandic Meteorological Office (*Veðurstofa Íslands*)
IPPU	Industrial Processes and Product Use
IRCA	Icelandic Road and Coastal Administration (*Vegagerðin*)
ITA	Icelandic Transport Authority (*Samgöngustofa*)
KC	Key Category
KCA	Key Category Analysis
LTO	Landing and Take-Off
MFAF	Ministry of Food, Agriculture, and Fisheries (*Matvælaráðuneytið*)
MMS	Manure Management System
MRV	Measurement, Reporting, and Verification
NCV	Net Calorific Value
NEA	National Energy Authority (*Orkustofnun*)
NECD	National Emission Ceilings Directive
NLSI	National Land Survey of Iceland (*Landmælingar Íslands*)
NFR	Nomenclature for Reporting
NK	Nitrogen (N), Potassium (K) ratio
NPK	Nitrogen (N), Phosphorus (P), and Potassium (K) ratio
OECD	Organisation for Economic Co-operation and Development
QA/QC	Quality Assurance/Quality Control
SCSI	Soil Conservation Service of Iceland (*Landgræðslan*)
SI	Statistics Iceland (*Hagstofa Íslands*)
SWDS	Solid Waste Disposal Sites
TAN	Total Ammoniacal Nitrogen
TFEIP	Task Force on Emission Inventories and Projections
UNFCCC	United Nations Framework Convention on Climate Change

Pollutants:

Main Pollutants	
BC	Black Carbon
CO	Carbon Monoxide
NH_3	Ammonia
NMVOC	Non-Methane Volatile Organic Compounds
NO_x	Nitrogen Oxides
$PM_{2.5}$	Particulate Matter ≤ 2.5 μm
PM_{10}	Particulate Matter ≤ 10 μm
SO_x	Sulphur Oxides
TSP	Total Suspended Particulate
POPs (Persistent Organic Pollutants)	
HCB	Hexachlorobenzene
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo(P)Dioxins
PCDF	Polychlorinated Dibenzofurans
Heavy Metals	
As	Arsenic
Cd	Cadmium
Cr	Chromium
Cu	Copper
Hg	Mercury
Ni	Nickel
Pb	Lead
Se	Selenium
Zn	Zinc

Notation keys:

IE	Included Elsewhere
NA	Not Applicable
NE	Not Estimated
NO	Not Occurring

Executive Summary

ES.1 Background

The Convention on Long-Range Transboundary Air Pollution (CLRTAP) entered into force in 1983. The Convention has been extended by eight Protocols, of which Iceland has ratified the Protocol on Persistent Organic Pollutants (POPs). The Protocol on Persistent Organic Pollutants entered into force in 2003. According to Article 8 of the Convention, Parties shall exchange information on emissions of pollutants. In 2009, the national emission ceilings directive (NECD) 2001/81/EC was incorporated to the EEA agreement, with national emission targets set for Iceland for SO_2, NO_x, NMVOCs, and NH_3 for the year 2010. At the time of writing, work is underway by the Icelandic government to evaluate and work on the incorporation of the new National Emissions Ceilings Directive (Directive (EU) 2016/2284) into the EEA agreement. In 2020, the International Institute for Applied Systems Analysis (IIASA) carried out an analysis of reduction potentials for Iceland for NO_x, SO_2, NMVOCs, NH_3, and $PM_{2.5}$, which was done in a way comparable to the analysis done by IIASA for the EU Member States (see also TSAP Report no 16).

To comply with the requirements of CLRTAP and the NECD, Iceland prepares an Informative Inventory Report (IIR) annually. The IIR, together with the associated Nomenclature for Reporting tables (NFR tables), is Iceland's contribution to this round of reporting under the LRTAP Convention and covers emissions in the period 1990-2022.

This report and the associated NFR tables, as well as reports and data from previous years, are available on the Centre on Emission Inventories and Projections (CEIP) webpage: https://www.ceip.at/status-of-reporting-and-review-results

ES.2 Responsible Institution

The Environment Agency of Iceland (*Umhverfisstofnun*) (EAI), an agency under the Ministry of the Environment, Energy, and Climate (*Umhverfis-, orku- og loftslagsráðuneytið*), is responsible for the annual preparation and submission of the Icelandic IIR and NFR tables to the CLRTAP. The EAI participates in meetings under the United Nations Economic Commission for Europe (UNECE) Task Force on Emission Inventories and Projections (TFEIP) and related expert panels, where parties to the Convention prepare the guidelines and methodologies on inventories.

ES.3 Overview of POPs Emissions

All sources of POPs emissions fall under the Energy, Industry, and Waste sectors; activities belonging to the Agriculture sector do not generate POPs emissions.

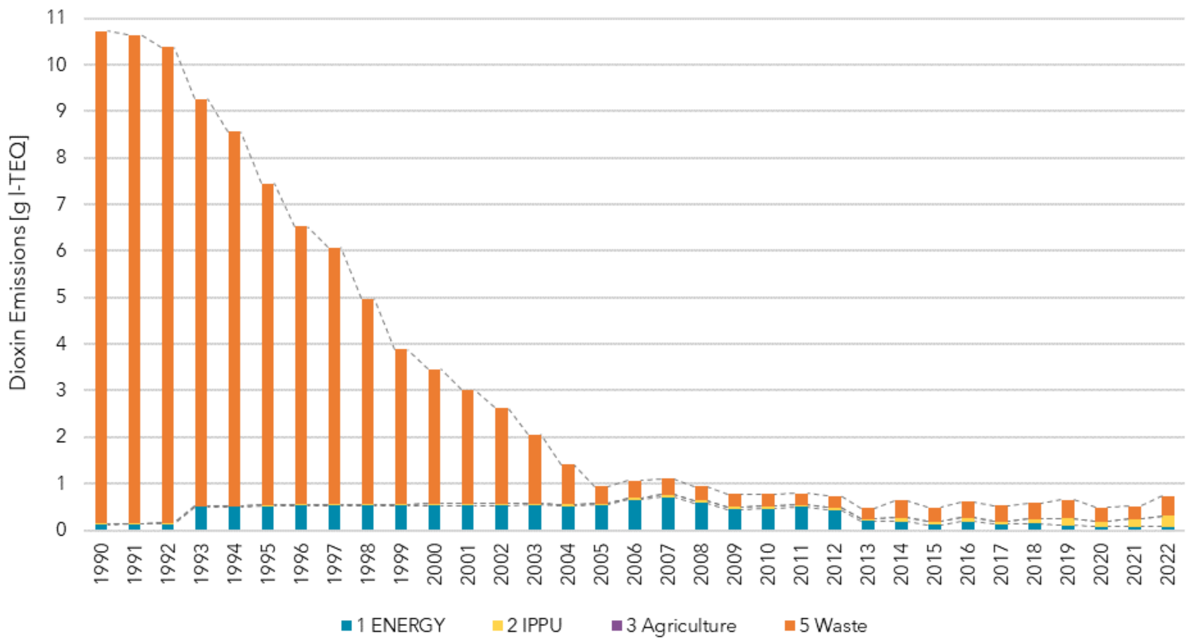


Figure ES.1 Trends in dioxin emissions by source, since 1990.

Dioxin (PCDD/PCDF) emissions decreased substantially over the reported time period (Figure ES.1), due to a significant decrease in the occurrence of open burning of waste. Open burning of waste was a common waste management practice in Iceland before 2004. Iceland's largest waste incineration plant was opened in 2004. It is without energy recovery and the last waste incineration plant with energy recovery was closed in 2013.

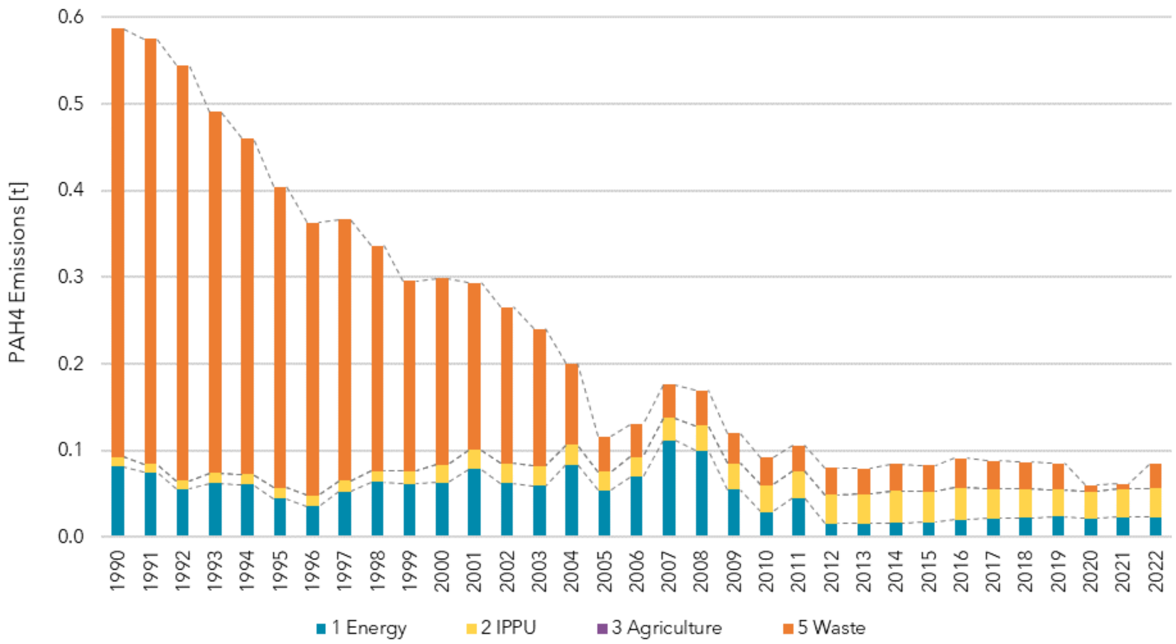


Figure ES.2 Trends in PAH4 emissions by source, since 1990.

PAH4 (Benzo(a)pyrene-BaP, Benzo(b)fluoranthene-BbF, Benzo(k)fluoranthene-BkF, Indeno(1,2,3-cd)pyrene-IPy) emissions also decreased substantially over the reported time period (Figure ES.2), for the same reason as described above for dioxin emissions. The largest contributors of PAH4 emissions in Iceland in recent years are the Metal Industry (Industry sector), Road Transport (Energy sector) and Open Buring of Waste, i.e. bonfires (Waste sector). There are almost no emissions from open burning of waste in 2020 and 2021 as most bonfires were cancelled due to COVID-19.

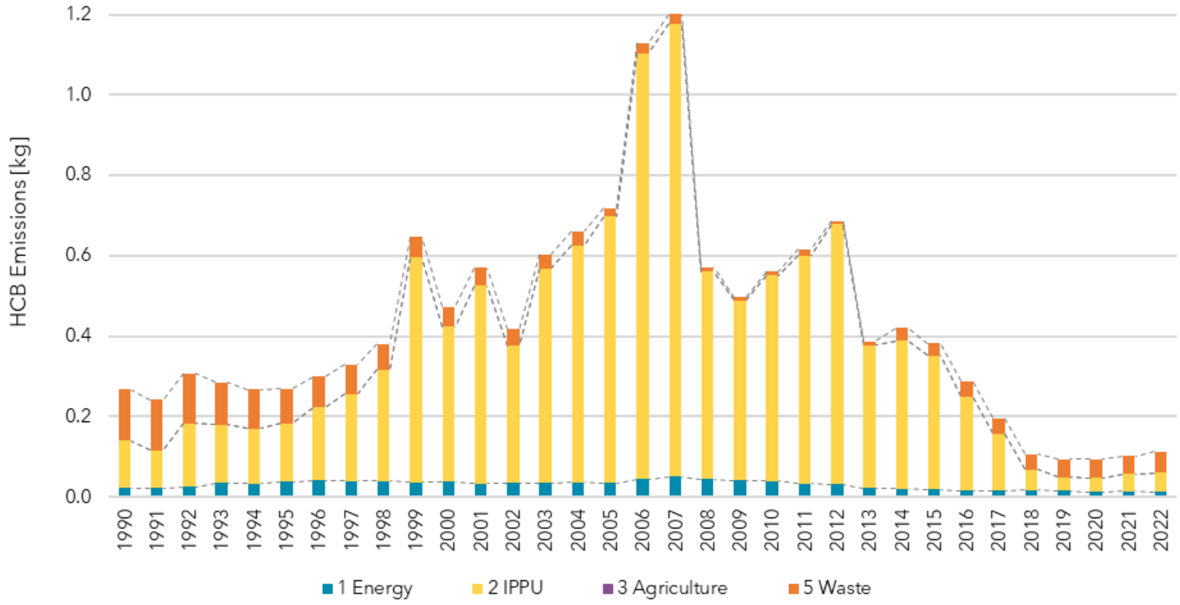


Figure ES.3 Trends in HCB emissions by sector, since 1990.

The estimated hexachlorobenzene (HCB) emissions have fluctuated markedly over the reported time series (Figure ES.3). For most of the time period observed, Fireworks (Industry sector) were the largest contributor of HCB emissions in Iceland. Those emissions have been decreasing since 2012 after samples of all imported fireworks were tested for HCB and those that contained more than 50 mg/kg were banned. Other main sources of HCB emissions are Clinical Waste Incineration (Waste sector) followed by emissions originating from the Metal Industry (Industry sector) and from Fishing (Energy sector). HCB emissions from the Industry sector increased in 2004 following the opening of a secondary aluminium plant. Open burning of waste was a common waste management practice in Iceland before 2004. However, an increase in the amount of waste incinerated in incineration plants without energy recovery occurred in 2004 while a reduction of the amount of waste burned in the open occurred in that same year. The increase in emissions from the Waste sector in 2014 is linked to an increased quantity of clinical waste incinerated.

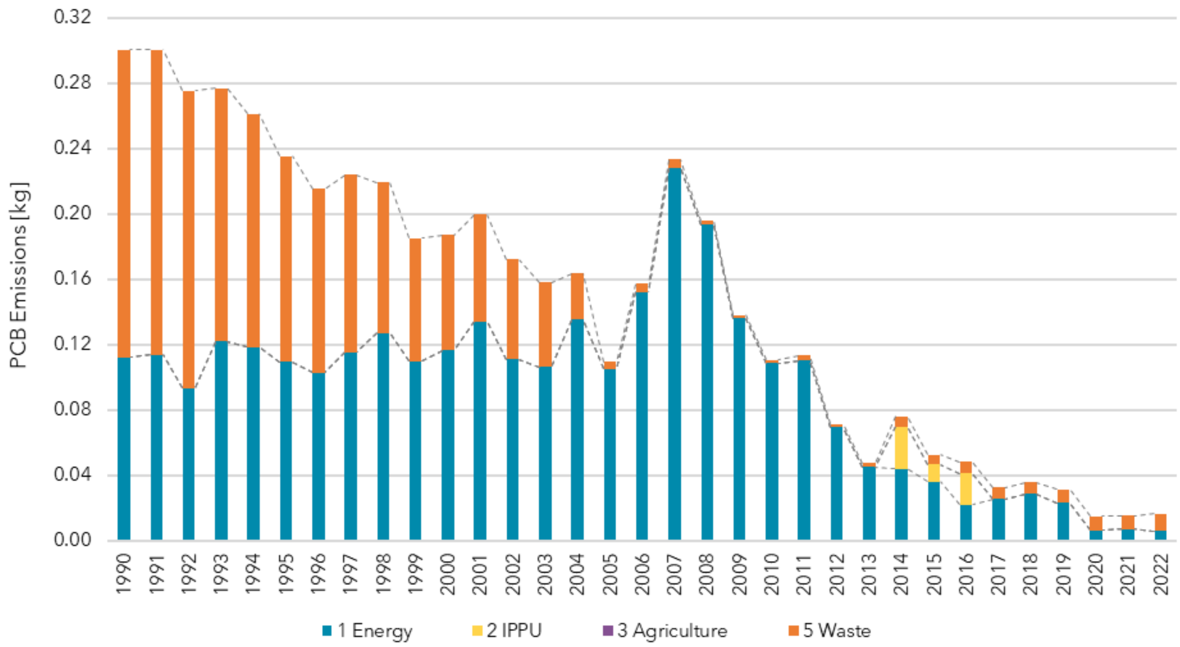


Figure ES.4 Trends in PCB emissions by sector, since 1990.

Polychlorinated biphenyl (PCB) emissions have decreased across the time series (Figure ES.4). Over most of the timeline the largest contributor of PCB emissions in Iceland is fuel consumption by the fishing fleet, primarily diesel oil. The only source of PCB estimated from industrial processes is secondary steel production (2C1), which occurred only for three years (2014-2016). Open burning of waste was a common waste management practice in Iceland before 2004 and the largest source of PCB emissions in 1990 and the years after that. However, an increase in the amount of waste incinerated in incineration plants without energy recovery occurred in 2004 while a reduction of the amount of waste burned in the open was occurring simultaneously. Interpretations of the total PCB trend analysis should be undertaken with care as emissions factors are not available for all sources.

1 Introduction

1.1 Background Information

The 1979 Convention on Long-Range Transboundary Air Pollution (CLRTAP) was signed by Iceland on 13 November 1979 and ratified in May 1983. CLRTAP entered into force in August 1983. One of the requirements under CLRTAP is that Parties are to report their national emissions by sources.

CLRTAP has been extended by eight Protocols, of which the Protocol on Persistent Organic Pollutants (Protocol on POPs) was ratified by Iceland in May 2003 and entered into force in October 2003. By ratifying the protocol Iceland is required to emit less PCDD/F, PAH and HCB annually than in the year 1990. The air pollutant PCB was added with an amendment to the protocol and Iceland ratified that amendment in June 2022. Additionally, Iceland signed the Protocol on Heavy Metals in 1998 but the country has not ratified it.

In 2009, Directive 2001/81/EC[1] on national emission ceilings was incorporated into the Agreement on the European Economic Area (EEA), with national emission targets set for Iceland for SO_2, NO_x, NMVOCs, and NH_3 as shown in Table 1.1. The targets set were to be reached by 2010 and not exceeded thereafter.

Table 1.1 Emission targets set for Iceland for SO2, NOx, NMVOC, and NH3 according to Directive 2001/81/EC.

Air Pollutant	Emission target [kt]
SO_2	90
NO_x	27
NMVOC	31
NH_3	8

In December 2016, Directive (EU) 2016/2284[2] (National Emission Ceilings Directive, NECD) entered into force in the EU, repealing the previous NEC Directive 2001/81/EC. The new NECD includes the same pollutants as the Directive it replaces, with the additions of obligatory reporting on CO, Cd, Hg, Pb, POPs (PCDD/F (Dioxins/furans), PAH, HCB, PCBs), $PM_{2.5}$, PM_{10}, and BC if available, as well as voluntary reporting on TSP, As, Cr, Cu, Ni, Se, and Zn. At the time of writing, work is underway at the EAI and the Icelandic government to evaluate and work towards the incorporation of the new National Emissions Ceiling Directive (Directive (EU) 2016/2284) into the EEA agreement; Iceland-specific targets are yet to be determined. In 2020, the International Institute for Applied Systems Analysis (IIASA) carried out an analysis of reduction potentials for Iceland for NO_x, SO_2, NMVOCs, NH_3, and $PM_{2.5}$, which was done in a way comparable to the analysis done by IIASA for the European Union (EU) Member States (see also TSAP Report no 16[3]).

[1] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.
[2] Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC
[3] http://www.iiasa.ac.at/web/home/research/researchPrograms/air/policy/TSAP_16b.pdf

The present report and associated NFR (Nomenclature for Reporting) tables are Iceland's contribution to the 2024 reporting under CLRTAP. A description of the trends and calculation methods is given.

Anthropogenic emissions of the precursors (NO_x, CO, NMVOCs, NH_3, and SO_2) are provided in the NFR tables as they are calculated to comply with the reporting requirements of the UNFCCC and of the NECD. Emission estimates for particulate matter (PM), black carbon (BC), and heavy metals (HM) are provided for all emission sources where an EF is provided in the 2019 EEA/EMEP Guidebook. A short description of the trends and the calculation methods for those pollutants are given in this report.

Estimates for SO_2, $PM_{2.5}$, and PM_{10} for the volcanic eruptions at Eyjafjallajökull (2010), Grímsvötn (2011), Holuhraun (2014-2015), and Fagradalsfjall (2021, 2022) are also provided (Chapter 7).

1.2 Protocol on Persistent Organic Pollutants

The Protocol on Persistent Organic Pollutants (POPs) was adopted on 24 June 1998 and entered into force on 23 October 2003. It was amended in 2009 and those amendments were ratified by Iceland on 1 June 2022. It focuses on a list of substances that have been singled out according to agreed risk criteria. The substances comprise pesticides, industrial chemicals, and by-products/contaminants. The ultimate objective is to eliminate any discharges, emissions, and losses of POPs. The Protocol bans the production and use of some products outright, while others are scheduled for elimination at a later stage. Finally, the Protocol severely restricts the use of those products which use is not banned completely. The Protocol includes provisions for dealing with the wastes of products that will be banned. It also obliges Parties to reduce their emissions of dioxins, furans, PAHs, and HCB below their levels in 1990 (or an alternative year between 1985 and 1995), and PCB emissions below the 2005 level (or an alternative year between 1995 and 2010). The PCB reduction requirement was added in the 2009 amendment to the protocol. Of the POPs chemicals only aldrin has been used in Iceland, though not since 1975. DDT and heptachlor have not been used in Iceland since 1975 and were banned in 1996. Lindane (HCH) was used in Iceland until the early nineties. Sales statistics exist for 1990 to 1992, and the use of lindane was banned in 1999. PCBs were banned in Iceland in 1988. Iceland is in compliance with the emission reductions required by this protocol.

1.3 Institutional Arrangements for Inventory Preparation

Article 36 of the Icelandic Act on Public Health and Pollution Control no 7/1988 (*Lög um hollustuhætti og mengunarvarnir*) establishes the responsibility of the Environment Agency of Iceland (*Umhverfisstofnun*) (EAI), an agency under the the Ministry of the Environment, Energy, and Climate (*Umhverfis-, orku- og loftslagsráðuneytið*), for the annual preparation and submission of the national inventory to the CLRTAP. This act also authorises the EAI to collect all necessary data and information from relevant authorities, institutions, and companies. Figure 1.1 illustrates the flow of information and allocation of responsibilities. The methodologies and data sources used for different sectors are described in more details in the respective sectoral chapters.

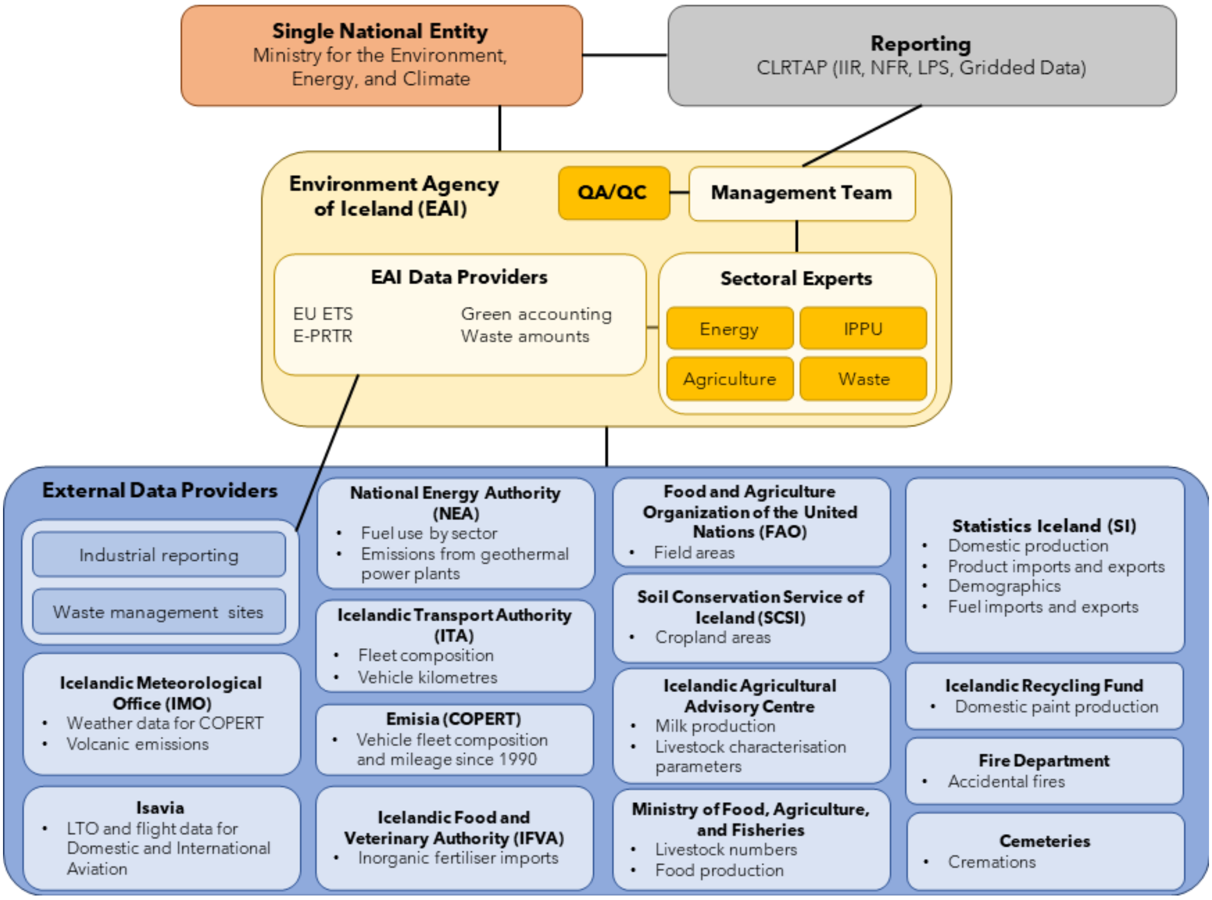


Figure 1.1 Information flow and distribution of responsibilities in the Icelandic emissions inventory system for reporting to the CLRTAP.

1.4 Inventory Preparation

The EAI collects the bulk of data necessary to calculate yearly emissions, i.e., activity data and emission factors. Activity data is collected from various institutions and companies. In most cases, the same activity data information is used both for the air pollutants inventory (as per this report) and for the National Greenhouse Gas Inventory submitted to the EU according to Regulation 2018/1999 and to the UNFCCC. Data is gathered according to Icelandic Regulation No. 520/2017 on data collection for the greenhouse gas inventory, as well as provided by various teams within the EAI. The main data streams are the following:

1. The National Energy Authority (*Orkustofnun*) (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 formally obtain sales statistics from the oil companies.

2. The Ministry of Food, Agriculture, and Fisheries (Matvælaráðuneytið) (MFAF) has been responsible for assessing the size of the animal population each year since 2019. On request by the EAI, the Farmers Association of Iceland (*Bændasamtök Íslands*) (FAI) assisted the development of a method to account for young animals that are mostly excluded from national statistics on animal population.

3. Statistics Iceland (*Hagstofa Íslands*) (SI) provides information on population, GDP, imports and exports of various products, domestic production, and domestic usage.
4. The EAI collects various additional data through the annual emission reports reported under the European Emissions Trading System (EU ETS (Directive 2003/87/EC) as implemented into Icelandic legislation with Act No. 70/2012 on Climate Change), European Pollutant Release and Transfer Register (E-PRTR (Regulation (EC) no 166/2006, as implemented into Icelandic legislation with Regulation No. 990/2008), and Green Accounting reports from industry submitted under Icelandic Regulation No. 851/2002.
5. Data for using the transport model COPERT originates from the NEA, the Icelandic Transport Authority (*Samgöngustofa)* (ITA), the Icelandic Meteorological Office (*Veðurstofa Íslands*) (IMO), and EMISIA SA[4] and used for emission estimates from Road Transport (NFR 1A3b) (see more details in the Energy sector).
6. Aviation emissions are calculated using LTO and flight data provided by ISAVIA, the national airport and air navigation service of Iceland.
7. Emission factors are mainly taken from the EMEP/EEA Emission Inventory Guidebook (European Environment Agency, 2019) unless otherwise referenced.
8. The EAI also collects activity data on waste amounts split by treatment pathways and plant-specific emission factors based on measurements from the industry.

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

[4] https://www.emisia.com/utilities/copert-data/

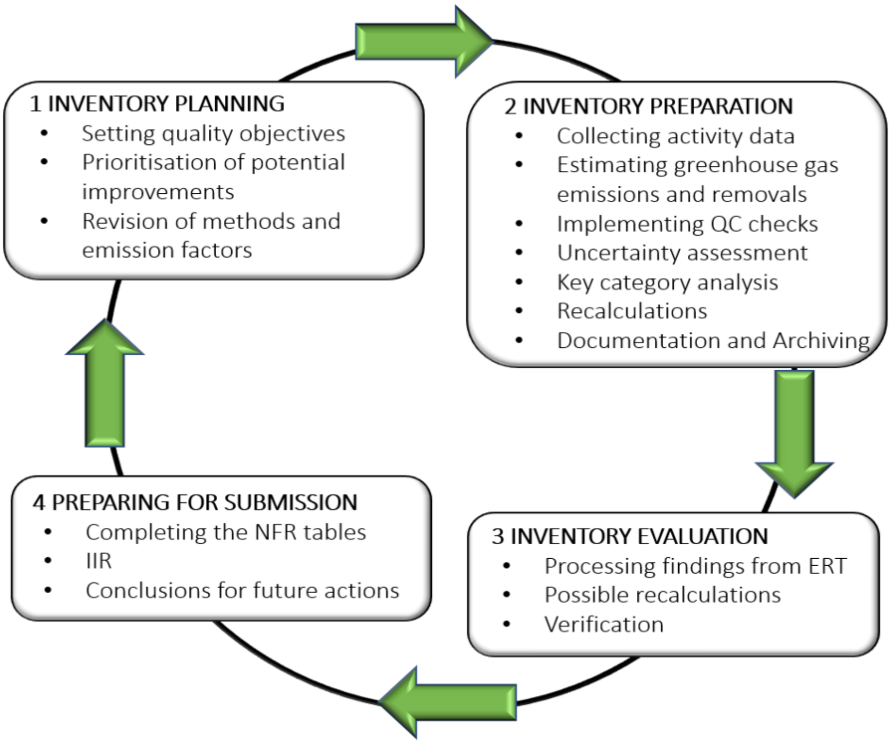


Figure 1.2 The annual inventory cycle.

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, taking into account the outcome of the internal and external 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 are calculated, and quality checks performed to validate results.

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 key source categories and those categories where data and methodological changes have recently occurred.

1.5 Key Category Analysis (KCA)

A key category is one that is prioritised within the national inventory system because it has a significant influence on a country's total inventory of a given pollutant in terms of the absolute level of emissions, the trend in emissions, or both. Total emissions from the key categories amount to 80% of the total emissions included in the inventory. The KCA has been undertaken based on Approach 1 outlined in the 2019 EMEP/EEA Guidebook. A KCA has been performed for each pollutant, calculating both the level assessment for the base year (1990) and the most recent inventory year (2022) as well as the trend assessment (1990-2022). Memo items are excluded from the KCA.

Table 1.2, Table 1.3, and Table 1.4 present the results of the KCA for main pollutants, POPs, and heavy metals, respectively, for the year 2022. The KCAs for the abovementioned pollutant categories in 1990 as well as the 1990-2022 trend assessment are presented in KCA Results for 1990 and Trends 1990-2022.

Table 1.2 Key Category Analysis for reported main pollutants in 2022.

Component	Key Categories (Sorted from high to low, from left to right, and from top to bottom)					Total (%)
NO_x	National fishing	Ferroalloy production	Aluminium production	Road transport: Passenger cars	Road Transport: Heavy Duty Vehicles and Buses	81.0%
	NFR 1A4ciii	NFR 2C2	NFR 2C3	NFR 1A3bi	NFR 1A3biii	
	59.8%	9.0%	4.3%	4.2%	3.7%	
NMVOC	Domestic solvent use including fungicides	Manure managment: horses	Food and beverages industry	International aviation LTO (civil)	Road transport: Passenger cars	81.9%
	NFR 2D3a	NFR 3B4e	NFR 2H2	NFR 1A3ai(i)	NFR 1A3bi	
	16.6%	9.7%	8.1%	8.0%	7.8%	
	Manure management - Dairy cattle	Coating applications	Distribution of oil products	National fishing	Solid Waste Disposal on Land	
	NFR 3B1a	NFR 2D3d	NFR 1B2av	NFR 1A4ciii	NFR 5A	
	7.8%	6.5%	5.0%	4.7%	4.1%	
	Manure management - Non-dairy cattle					
	NFR 3B1b					
	3.6%					
SO_x	Other Fugitive Emissions from Energy Production (Geothermal Energy)	Aluminium Production				96.2%
	NFR 1B2d	NFR 2C3				
	78.8%	17.3%				
NH_3	Animal Manure Applied to Soils	Urine and Dung Deposited by Grazing Animals	Manure Management - Dairy Cattle	Manure Management - Sheep	Manure Management - Non-dairy Cattle	81.6%
	NFR 3Da2a	NFR 3Da3	NFR 3B1a	NFR 3B2	NFR 3B1b	
	29.1%	16.1%	15.2%	10.9%	10.4%	
$PM_{2.5}$	Road Transport: Automobile Road Abrasion	Aluminium Production	National Fishing	Ferroalloy Production	Road Transport: Automobile Tyre and Brake Wear	80.9%
	NFR 1A3bvii	NFR 2C3	NFR 1A4ciii	NFR 2C2	NFR 1A3bvi	
	23.3%	20.8%	16.8%	5.8%	5.1%	
	Construction and Demolition	Other product use (Tobacco, Fireworks)				
	NFR 2A5b	NFR 2G				
	4.9%	4.2%				
PM_{10}	Aluminium production	Construction and demolition	Road transport: Automobile road abrasion	National fishing	Road transport: Automobile tyre and brake wear	82.3%
	NFR 2C3	NFR 2A5b	NFR 1A3bvii	NFR 1A4ciii	NFR 1A3bvi	
	23.0%	21.5%	19.1%	7.4%	4.3%	
	Quarrying and mining of	Other product use (Tobacco, Fireworks)				

Component	Key Categories (Sorted from high to low, from left to right, and from top to bottom)					Total (%)
	minerals other than coal					
	NFR 2A5a	NFR 2G				
	3.7%	3.4%				
TSP	Construction and demolition	Road transport: Automobile road abrasion	Aluminium production	Quarrying and mining of minerals other than coal	National Fishing	83.2%
	NFR 2A5b	NFR 1A3bvii	NFR 2C3	NFR 2A5a	NFR 1A4ciii	
	39.2%	20.7%	15.0%	4.2%	4.0%	
BC	Mobile Combustion in manufacturing industries and construction	Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages, and Tobacco	Road transport: Automobile tyre and brake wear	Road transport: Passenger cars	Road transport: Automobile road abrasion	83.2%
	NFR 1A2gvii	NFR 1A2e	NFR 1A3bvi	NFR 1A3bi	NFR 1A3bvii	
	14.9%	13.0%	12.5%	10.6%	9.6%	
	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	National fishing	Road transport: Heavy duty vehicles and buses			
	NFR 1A4cii	NFR 1A4ciii	NFR 1A3biii			
	9.0%	8.0%	5.5%			
CO	Aluminium Production					96.0%
	NFR 2C3					
	96.0%					

Table 1.3 Key Category Analysis for reported POPs in 2022.

Component	Key Categories (Sorted from high to low and from left to right)					Total (%)
Dioxin	Clinical waste incineration	Ferroalloys production	Accidental fires	Open burning of waste		83.4%
	NFR 5C1biii	NFR 2C2	NFR 5E	NFR 5C2		
	27.3%	26.6%	15.5%	14.0%		
PAH4	Open burning of waste	Aluminium production	Ferroalloys production	Road Transport: Passenger Cars		81.2%
	NFR 5C2	NFR 2C3	NFR 2C2	NFR 1A3bi		
	28.1%	19.7%	19.2%	14.2%		
HCB	Clinical waste incineration	Other product use (Fireworks)	Aluminium production			86.1%
	NFR 5C1biii	NFR 2G	NFR 2C3			
	43.8%	28.5%	13.8%			
PCB	Clinical waste incineration	National fishing				95.4%
	NFR 5C1biii	NFR 1A4ciii				
	60.6%	34.8%				

Table 1.4 Key Category Analysis for reported heavy metals in 2022.

Component	Key Categories (Sorted from high to low and from left to right)					Total (%)
Pb	Road transport: Automobil tyre and brake wear	Aluminium production	Domestic aviation LTO (civil)			81.3%
	NFR 1A3bvi	NFR 2C3	NFR 1A3aii(i)			
	50.1%	24.2%	7.0%			
Cd	Aluminium production					95.3%
	NFR 2C3					
	95.3%					
Hg	National fishing	Cremation	Road transport: Passenger cars	Clinical waste incineration		84.5%
	NFR 1A4ciii	NFR 5C1bv	NFR 1A3bi	NFR 5C1biii		
	45.3%	16.6%	14.5%	8.1%		
As	Aluminium production					88.7%
	NFR 2C3					
	88.7%					
Cr	Road transport: Automobil tyre and brake wear	Aluminium production				88.0%
	NFR 1A3bvi	NFR 2C3				
	53.4%	34.6%				
Cu	Road Transport: Automobile Tyre and Brake Wear					81.7%
	NFR 1A3bvi					
	81.7%					
Ni	Aluminium production					89.1%
	NFR 2C3					
	89.1%					
Se	National fishing	Road transport: Automobil tyre and brake wear				88.1%
	NFR 1A4ciii	NFR 1A3bvi				
	76.0%	12.1%				
Zn	Aluminium production	Road transport: Automobil tyre and brake wear				89.6%
	NFR 2C3	NFR 1A3bvi				
	72.8%	16.8%				

1.6 Quality Assurance & Quality Control (QA/QC)

The objective of QA/QC activities in national inventories is to improve transparency, consistency, comparability, completeness, accuracy, confidence, and timeliness.

1.6.1 Background Information on Iceland's QA/QC Activities

The web application *Notion* developed by Notion Labs inc. is now used as a QA/QC systems management. It provides a centralised basis for the inventory team to design, manage, and record its QA/QC activities and improvement plan. The QA/QC procedures for the national inventory for air pollutants are closely linked to the ones established for the national inventory for greenhouse gases, since the two inventories are produced by the same team, and in most categories the activity data is the same for both inventories.

Each sector has a live improvement plan. Every item on the plan includes a record of which review report suggested the improvement, if relevant, and is assigned to a sectoral expert. The sectoral expert is then responsible for assessing the feasibility and timeframe of the improvement at the end of the submission period. This should ensure that over time, Iceland's inventory submissions continue to improve in quality.

QC procedures are outlined in a general guidance document (one document for both AP and GHG inventories), where general and sector-specific QC activities are listed. The QC guidance document is in line with the QC activities listed in Table 6.1 in the 2006 IPCC guidelines and with the activities detailed in Chapter 5 of Part A.6 of the 2019 EMEP/EEA guidebook. QC activities are clearly outlined in detail and documented in the guidance document in a centralised location (Notion) along with the live improvement plan.

Each subsector has a live progress list for every step of the inventory cycle:

- Implementation of planned improvements
- Compilation of the input data and calculations of emissions
- QC activities
- Report writing

All steps are time-bound and assigned to one or more team members who are responsible for completing the task and signing it as complete.

1.6.2 Roles and Responsibilities Overview

The same inventory team takes care of the greenhouse gas (GHG) inventory and the air pollutant inventory. Sectoral experts thus calculate emissions from their respective sector both for GHG and air pollutants.

The overall responsibility over the inventory lies with the inventory team leader at the Environment Agency of Iceland (EAI), who has overall responsibility for the completion of QA/QC activities, submission, improvements planning, and review coordination. The inventory team leader is assisted by the IIR coordinator who oversees daily tasks relating to the generation of the IIR. Within the inventory team at the EAI there are two sectoral subgroups within the team, one Energy/IPPU group and one Agriculture/Waste group. Data collection, processing, QC, and improvements are conducted within each group, in collaboration with the IIR coordinator and the team leader. The various roles within the inventory team are described below:

- Inventory Team Leader – Overall responsibility for the accurate and timely production and submission of the inventories according to the rules and deadlines specified in relevant domestic and international legislation. The team leader is responsible for the communication with the Icelandic ministries, as well as communication with the UNECE, the EU and CLRTAP expert review teams. The team leader is also responsible for the submission process.

- IIR coordinator – Responsible for leading the work on producing the air pollutants inventory.
- NIR coordinator – Responsible for leading the work on producing the greenhouse gas inventory.
- Sectoral Experts – Main knowledge holders on individual inventory sectors. They are responsible for completion of day-to-day data processing and QC activities. Each sector comprises three to four sectoral experts; prior to each submission cycle, it is decided how roles are divided between the sectoral experts, making sure that QC activities are done by someone other than the individual who did the calculations. In addition, each IIR chapter is proof-read by one of the experts not involved in the writing of the chapter. Sectoral experts are responsible for communication with relevant data providers.
- Lawyer – Responsible for all the legal aspects of the inventory work, such as examining new legal texts, implementing EU regulation into domestic legislation, as well as understanding Iceland's various air pollutants and greenhouse gases commitments.
- Communications Strategist – Responsible for coordinating all media-related activities relating to the inventory work, such as publication of news, website updates, as well as lectures and seminars.

1.6.3 Quality Assurance (QA)

Iceland's air pollutant inventory has been undergoing regular CLRTAP reviews in recent years. It was subjected to a Stage 3 in-depth review in 2020, as well as Stage 3 ad-hoc reviews in 2022 and 2023. A review of the IPPU sector is scheduled for this year, a review of projections for 2025 and a review of the transport sector is scheduled for 2026.

In many categories, activity data used for the air pollutant inventory are the same as those used for the greenhouse gas inventories. Regular reviews of the GHG inventory thus also contributes to increased quality of the air pollutant inventory, and QA of the GHG inventory often leads to QA of the air pollutant inventory.

Further QA is provided by Iceland's collaboration with consultants at Aether Ltd., who assist with and review sector-specific methodological choices and calculations. As part of this collaboration, the calculations for the Agriculture and Waste sectors were revised and improved in recent years, as well as the aviation subsector (under Energy) for this submission.

Iceland participates in a Nordic inventory experts' working group, funded by the Nordic Council of Ministers and focussing on comparisons of emission factors across Nordic countries, where inventory compilers from Norway, Sweden, Finland, Denmark, and Iceland meet regularly to discuss specific topics/sectors/air pollutants.

Furthermore, Iceland participates in the annual TFEIP meetings.

1.6.4 Quality Control (QC)

The team uses standardised notation protocols in the calculation files to document changes, possible issues, and necessary improvements. This is done via an excel tool ("Q Comments"), which allows the documentation of changes and flagging of issues by use of comments starting with hashtags including the initials of the inventory compiler/QC reviewer, the date, and one or more flags pertaining to the type of issue (such as, for instance, potentially identified issue, transparency issue, or reason for change). A summary of all comments can be generated for each calculation file, enabling for instance someone performing QC checks to track and verify changes made to the file, as well as check the status of flagged issues. The issues can then either be marked as resolved, addressed immediately, or added to the improvement plan, depending on the type of issue. This tool is an important source of information when QC activities are performed.

Aether also assists Iceland in the development of QA/QC activities and has provided Iceland with several tools running checks on the latest inventory. Those checks include:

- **Recalculation check:** Comparing the values reported in the current and previous versions of the inventory.
- **Negative and zero values checks:** To highlight the occurrence of negative values and zero values in the inventory.
- **Notation keys check:** To summarise the occurrence of each notation key to ensure consistency and accuracy in the inventory.
- **PAHs sum check:** To ensure that the sum of the four reported PAHs equals the reported "total" PAH emissions.
- **Particulate Matter check:** To ensure that reported TSP emissions are greater than or equal to PM_{10}, and similarly that reported PM_{10} emissions are greater than or equal to $PM_{2.5}$.
- **Trends check:** To highlight large changes in emissions between any two adjacent years, that need reviewing.

In all cases, the findings of the checks are reviewed, not only to identify where corrections may be required, but also to consider whether there are any steps of the inventory compilation process that need improvement. This ensures that all results from the QC process feed back into the continuous improvement programme. Further details are available under Annex 1.

As per Article 15 of Regulation (EU) 2020/1208, EU member states, Iceland and Norway are to perform checks on the consistency of the data used to estimate emissions in preparation of the GHG inventories with the data used to prepare inventories of air pollutants pursuant to Directive (EU) 2016/2284, for the year X-2 and for the air pollutants CO, SO_2, NO_x, and NMVOCs. Directive (EU) 2016/2284 has not yet been incorporated into the EEA Agreement, and thus Iceland is not reporting according to that directive. However, as these checks are useful in terms of QA/QC, Iceland performed similar checks with the data reported under the CLRTAP.

Other QC activities include investigating the following:

- Are appropriate activity data, methods, calculations, units, emission factors, and notation keys used?
- Are all data sources well referenced/documented?
- Are the emission estimate files consistent with summary files and NFR outputs?
- Are recalculations properly documented?

- Documentation of performed checks within the emission estimation files and on separate document to track progress and enhance transparency.

1.6.5 Planned Improvements for QA/QC Activities

It is planned to interlink QA/QC activities with the KCA and the uncertainty analysis in order to prepare a prioritised improvement plan at the sectoral level as well as for the inventory work in general.

1.7 Uncertainty Evaluation

Work on the uncertainty analysis has started and will be included in next year's submission.

1.8 General Assessment of Completeness

The aim is to make, in the highest possible level of disaggregation, estimates of all known emissions to air in the IIR. The inventory is generally complete, however there are some pollutants and/or categories that have not been estimated at all or only for part of the time series. The activities/pollutants not included in the present submission were not estimated due to lack of emission factors in tables provided in the EMEP/EEA Guidebook, lack of data, and/or that additional work was impossible due to time constraints in the preparation of the emission inventory.

1.8.1 Categories Not Estimated (NE)

In the 2020 Stage 3 review, the ERT pointed out to Iceland that NE has a different meaning in the Guidebook and in the NFR tables, and that NA is the correct notation key if it is not the responsibility of Iceland that the emissions are not estimated. Therefore, notation keys have been reviewed.

Table 1.5 List of pollutants not estimated by sector.

NFR Code	NFR Category	Pollutants Not Estimated (NE)	Reason
1A3bvi	Road Transport: Automobile Tyre and Brake Wear	B(a)P, B(b)f, B(k)f, IPy, PAHs, dioxin	No T1 EF in GB 2019
1A3bvii	Road Transport: Automobile Road Abrasion	B(a)P, B(b)f, B(k)f, IPy, PAHs, Heavy metals	No T1 EF in GB 2019
5B2a	Composting: Anaerobic Digestion	NH_3	No relevant activity data available
5D1	Domestic Wastewater Handling	NMVOC	No relevant activity data available
5D2	Industrial Wastewater Handling	NMVOC	No relevant activity data available

1.8.2 Categories Reported as Included Elsewhere (IE)

The table below indicates the categories where the notation key IE has been used in the reporting for some or all pollutants.

Table 1.6 Categories included elsewhere.

NFR Code	NFR Category	Pollutants Included Elsewhere (IE)	Reported Under NFR Code	Reported Under NFR Category
1A4bii	Residential: Household and gardening (mobile)	All	1A2gvii	Mobile combustion in manufacturing industries and construction
2B1	Ammonia production	All	2B10a	Chemical industry: Other
5C1bi	Industrial Waste Incineration	NO_x, SO_2, PM, CO	5C1a	Municipal Waste Incineration
5C1bii	Hazardous Waste Incineration	NO_x, SO_2, PM, CO	5C1a	Municipal Waste Incineration
5C1biii	Clinical Waste Incineration	NO_x, SO_2, PM, CO	5C1a	Municipal Waste Incineration
5C1biv	Sewage Sludge Incineration	NO_x, SO_2, PM, CO	5C1a	Municipal Waste Incineration

1.9 Recalculations

A recalculation file is used to identify and document all recalculations. This QC file compares Year x-3 (the latest year which exists in both inventories) and the base year (1990) for the current and previous submissions for all pollutants. The data have been compiled to enable any changes in the data to be easily identified and justifications for changes provided where required. As far as possible, the recalculation check includes all reported sectors.

The main sector-specific recalculations and improvements done for this submission are mentioned below for each sector, and all recalculations are described in more details in each subsector in the relevant chapter.

1.9.1 Energy

The main improvements and recalculations in the Energy sector are listed below.

- Sulphur content in diesel: Default sulphur content values were updated for 1990-2005 while they were replaced by country specific values for 2006 onwards (categories affected: 1A2a, 1A2b, 1A2e, 1A2f, 1A2gviii, 1A5, 1A2gvii, 1A3eii and 1A4cii)
- Sulphur content in residual fuel: Error in the default values was fixed for 1990-2011; country specific values replaced default values for 2012 onwards (categories affected: 1A1ai, 1A1aii, 1A2b, 1A2c, 1A2e, 1A2f and 1A2gviii)
- Sulphur content in residual fuel and marine diesel/gas oil: Error in the default values was fixed 1990-2011 while the default values for 2012 onwards have been replaced by country specific values (categories affected: 1A3dii and 1A4ciii).
- Default values for sulphur content in LPG was updated in 1A4ai and 1A5.
- The activity data for gas/diesel oil in 1A1ai a 1A1aii were not properly accounted for 2020 and 2021.
- A calculation error fixed for BC (categories affected: 1A1ai, 1A4ci and 1A4bi).
- Emissions factors for pet coke in 1A2f were mistaken for solid fuel.
- Activity data on LPG was updated for 2021 in 1A2gviii.
- The master emissions calculator tool used to calculate emissions for domestic and international aviation was updated from the 2016 version to the 2023 version. This caused

large recalculations for these subsectors. Additionally, Pb emissions were added for the first time for domestic aviation from consumption of aviation gasoline.

- Road transport emissions had minor recalculations for 2016 and 2021 due to updated fuel consumption data from the NEA.

1.9.2 Industrial Processes and Product Use (IPPU)

The main recalculations and improvements for IPPU are:

- In 2A5a Quarrying and Mining of Minerals other than Coal, an update in activity data from the IRCA caused large recalculations for 2021.
- In 2C2 Ferroalloys Production, the dioxin emissions were recalculated due to incorrect reporting of emissions in the previous submission. This led to recalculation for 2018-2021.
- In 2C3 Primary Aluminium Production, the PM emissions were recalculated since what was thought to be measurements of TSP were in fact measurements of PM_{10}. Recalculations were therefore made for the whole timeseries for TSP, PM_{10}, $PM_{2.5}$, and BC. Additionally, heavy metals were reported for the first time.
- In 2D3 Solvent and Product Use (2D3d Coating, 2D3e Degreasing, 2D3h Printing and 2D3i Organic Solvent Borne Preservative) and 2H2 Food and Beverages Industry, some recalculations were done for NMVOCs due to updated import/export data from SI. This applies to various years in the timeline.
- In 2D3 Other: Road Paving with Asphalt, new activity data was introduced to the inventory and caused recalculations for 2020 and 2021.
- In 2G4 Other Solvent and Product Use, the emission factor for Pb for fireworks was recalculated for years prior to the measurements in 2018 based on implementation of law regarding PE markings for fireworks. This led to recalculations for the whole timeseries. Emissions of HCB were also recalculated due to measurements made in 2012. This led to recalculation for 1990-2018. Updated import/export data also led to recalculations for all air pollutants in various years for both fireworks and tobacco.

1.9.3 Agriculture

The main recalculations and improvements in the Agriculture sector are as follows:

- The NMVOC emissions methodology for Cattle was moved up a tier and is now Tier 2.
- The manure management allocations for Laying hens were also updated, affecting NO_x, NH_3, $PM_{2.5}$, PM_{10}, and TSP emissions.
- Updated livestock numbers for Cattle, Sheep, and Horses, as well as updated livestock parameters for Non-dairy cattle. These updates affect NO_x, NH_3, NMVOC, $PM_{2.5}$, PM_{10} and TSP emissions from Manure Management for these animal groups, as well as NO_x and NH_3 emissions from Livestock Manure Applied to and Urine and Dung Deposited by Grazing Livestock.
- The fraction between N fertiliser type was updated for ammonium nitrate, urea, CAN and other NPK fertilisers, affecting NH_3 emissions from Inorganic N-fertilisers.
- Updated nitrogen amount in sewage sludge used as fertilizer affected NO_x and NH_3 emissions from 3Sewage sludge applied to soils.

- Other organic fertilizers applied to soils, where updated due to updated activity data on bone meal and led to recalculation of NO_x and NH_3 emissions.
- Updated cropland area, affecting $PM_{2.5}$, PM_{10} and TSP emissions in 2021.

1.9.4 Waste

The main recalculations and improvements in the Waste sector are the following:

- Recalculations were made for 5A Solid waste disposal on land for the years 1990-2021 due to updated activity data, error fixing and updated methodology. This resulted in changes in emissions from NMVOC, TSP, PM_{10} and $PM_{2.5}$.
- No recalculations were made for 5B Biological treatment of solid waste for this submission.
- Recalculations were made for 5C1a Municipal waste incineration for the year 2021 due to updated activity data. This resulted in changes in emissions from NMVOC, NH_3, Pb, Cd, Hg, As, Cr, Cu and Ni.
- Recalculations were made for 5C1bi Industrial waste incineration, 5C1bii Hazardous waste incineration and 5V1biv Sewage sludge incineration for the years 1990-2021 due to the updated emission factor for Dioxin (PCDD/F).
- Recalculations were made for 5C1bii Hazardous waste incineration for the year 2021 due to updated activity data. This resulted in changes in emissions from NMVOC, Pb, Cd, Hg, As, Ni, Dioxin (as mentioned above), PAH and HCB.
- Recalculations were made for 5C1biii Clinical waste incineration for the years 2001-2003. This resulted in changes in emissions from $PM_{2.5}$ and PM_{10}. Previously, $PM_{2.5}$ emissions were reported as NA, which has now been changed to NO. Furthermore, PM_{10} emissions were previously reported as NA, which has now been changed to an emission estimate.
- No recalculations were made for 5C2 Open burning of waste.
- No recalculations were made for 5D Wastewater handling for this submission.
- Recalculations were made for 5E Other waste for the years 1990-2021 due to updated activity data on vehicle fires for the year 2021 and updated emission factors for the whole timeline. This resulted in changes in emissions from NMVOC, NO_x, SO_x, CO, PAH4, $PM_{2.5}$, PM_{10}, TSP, Dioxin, Pb, Cd, Hg, As, Cr, Cu and Ni.

1.10 Planned Improvements

Various improvements are planned to increase the overall quality of the inventory and the report. Those include:

- Adding a comprehensive uncertainty analysis;
- Finalising a complete QA/QC plan, covering both AP and GHG inventories, and adding the plan as an annex the IIR and the NID.
- Update to the EMEP/EEA Guidebook.
- Gather data to be able to estimate NH_3 emissions from 5B Biological Treatment of Solid Waste.
- Investigate the availability of more detailed data on wastewater handling to improve emission estimates for 5D Wastewater Handling.

Improving the workflow pertaining to keeping track and acting upon comments received by reviewers. Furthermore, several sector-specific improvements are planned. The main improvements are mentioned below for each sector, and all planned improvements are described in more details in each subsector in the relevant chapter.

1.10.1 Energy

For future submissions:

- The EAI and the NEA will try to investigate and attributed the fuels use in 1A5 to the correct categories.
- The EAI and the NEA plans to find constant proportion between the three Mobile Machinery categories for 1990-2018.
- The EAI will investigate weather total flight numbers for several years can be obtained. Also, the EAI will investigate if test flights can and should be included.
- It is planned, in collaboration with the ITA, to develop procedures to obtain enhanced data on vehicle stock and mileage data for COPERT.
- Differentiate between emissions linked to electricity production and those linked to district heating.
- There is need to harmonise energy data processing between various organizations (such as EAI, NEA, ITA, SI, and Isavia) and produce a complete uncertainty analysis.

Moreover, plans are underway to upgrade methodology for Navigation and Fishing.

1.10.2 Industrial Processes and Product Use (IPPU)

The main improvement planned for the IPPU sector consists of harmonising the reporting under CLRTAP with the reports under the E-PRTR Regulation (E-PRTR, according to Icelandic Regulation No. 990/2008, which implements Regulation (EC) no 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register).

Moreover, for the future emissions, the production data from the IRCA for 2020 and 2021 will be updated to more accurate data.

1.10.3 Agriculture

The main improvement planned for the Agriculture sector consists of continuing to update the method for calculating NMVOC emissions from manure management from Tier 1 to Tier 2 for Sheep. This requires a detailed investigation into which data are easily available in Iceland and which data need to be collected specifically for this task. Furthermore, it is planned to improve the registration of different inorganic N fertiliser types in our inventory for future submissions as well as updating to the 2023 EMEP/EEA Guidebook.

1.10.4 Waste

For future submissions it is planned to obtain the activity data necessary to estimate emissions from wastewater handling and review the methodology to estimate emissions from accidental fires. Furthermore, it is planned to obtain data on the amount of nitrogen in the waste inserted into the anaerobic digestion plant GAJA, to be able to estimate NH_3 emissions in 5B2. Finally, we plan to update methodology and parameters according to the recommendations in the 2023 EMEP/EEA Guidebook.

2 Trends in Emissions

2.1 Emissions Profile in Iceland

The emissions profile for Iceland differs from that of other European countries for a number of reasons:

- Emissions from the generation of **Electricity and Space Heating** are low due to the widespread use of renewable energy sources. Almost all electricity in Iceland is produced with hydropower (around 70%) and geothermal power (around 30%), with wind power and fossil fuel-derived power accounting for less than 0.1%.
- **Geothermal Energy** is used for space heating in over 90% of all homes. It should be noted, however, that significant amounts of sulphur are emitted from geothermal power plants as hydrogen sulphide (H_2S).
- Around 90% of the fuel used in the Energy sector is used by **Mobile Sources** (Transport, Mobile Machinery, and Fishing Vessels).
- Emissions from **Industrial Processes**, especially from non-ferrous metal production, contribute a higher share of total emissions in Iceland than in most other countries. Around 75% of the electricity produced in Iceland is now used in the metal production industry. The production capacity has increased considerably since 1990.

The emissions profile of Iceland is further influenced by the fact that Iceland was severely affected by a financial collapse in 2008, when its three largest banks collapsed. In the years preceding the crisis, the economy experienced a significant upswing, resulting in an increase in fuel consumption. The crisis resulted in a serious contraction of the economy, and as a result oil consumption decreased. The result of this can be seen in several pollutants associated with fuel consumption, with a clear peak in 2007, or the years preceding the crisis. In recent years, the economy has recovered, and the tourism sector has increased significantly, leading to rising fuel consumption. In 2020, the country again experienced an economic downturn as a result of the COVID-19 Pandemic.

2.2 Emission Trends for SO_x, NO_x, NH_3, NMVOC, PM, BC, and CO

The total amount of SO_x, NO_x, NH_3, NMVOC, PM_{10}, $PM_{2.5}$, TSP, BC, and CO emissions in Iceland in 1990 and the latest year is presented in Table 2.1. The emissions of SO_2 have increased significantly since 1990 levels. This includes H_2S from geothermal plants; all sulphur species emitted are to be reported as SO_2 equivalents. CO emissions have approximately doubled since 1990. The most significant decrease in emissions are BC emissions, which have roughly halved since 1990 levels.

Table 2.1 Emissions of SO_x, NO_x, NH_3, NMVOC, PM, BC, and CO in 1990 and 2022.

	SO_x [kt SO_2]	NO_x [kt NO_2]	NH_3 [kt]	NMVOC [kt]	PM2.5 [kt]	PM10 [kt]	TSP [kt]	BC [kt]	CO [kt]
1990	18.8	28.8	5.14	9.40	1.40	2.98	6.37	0.231	56.3
2022	62.0	18.2	4.41	5.59	0.96	2.17	3.98	0.091	105.1
Change 1990-2022	230%	-37%	-14.2%	-41%	-32%	-27%	-37%	-61%	87%

For the current inventory year, the emissions of all pollutants included in the NECD 2001/81/EC were below the emission maxima set by the 2001 NECD, as shown in Table 2.2.

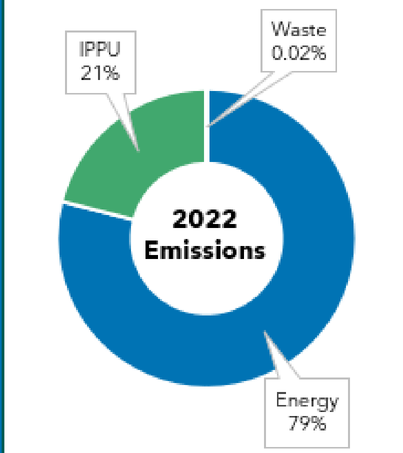
Table 2.2 Emissions of SO_x, NO_x, NH_3, and NMVOC compared to their respective NECD 2001/81/EC target.

Pollutant	Target	Notes
SO_x	90 kt	Has not been exceeded during the reporting period.
NO_x	27 kt	Emissions have been below the target since 2008.
NH_3	8 kt	Emissions have been stable between 4 and 5 kt since 1990.
NMVOC	31 kt	Emissions have been decreasing steadily since 1992 when the maximum NMVOC emissions occurred (9.5 kt in that year).

As of March 2024, no emission targets have been set yet for Iceland for 2030 and the incorporation of the new NECD (Directive 2016/2284) into the EEA is still pending.

2.2.1 Trends in SO_x Emissions

Total emissions in this inventory year: **62.0 kt**

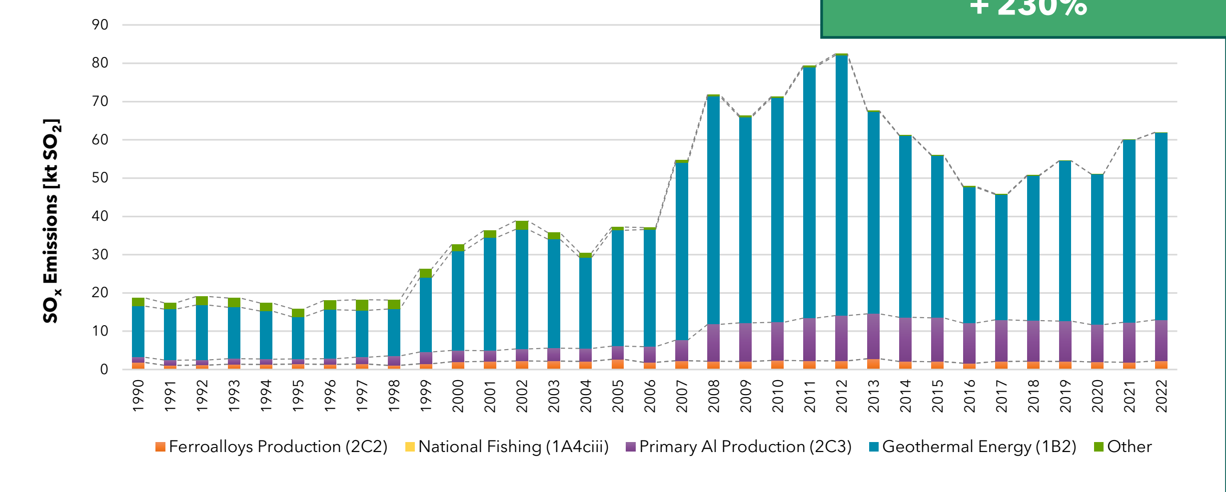


Change over the timeseries:
+ 230%

SO_x (SO_2)

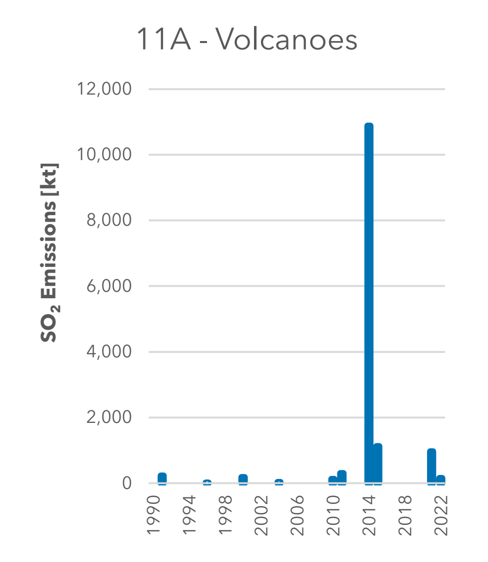
The main sources for SO_x include:

- **Geothermal Energy (1B2d):** Geothermal energy is the largest source of sulphur emissions in Iceland. Emissions have increased substantially since 1990 due to increasing geothermal energy production. A sulphur capture and storage project started in 2014 which proportionally lowers the SO_x emissions per production unit.
- **Metal Production (2C):** Emissions from industrial processes are dominated by aluminium and ferroalloy production. SO_2 emissions were relatively stable until 1998, after which there has been a great expansion of the metal industry. Sulphur comes mostly from impurities in the carbon reductants used in the metal production process.



Volcanic eruptions contribute significantly to sulphur emissions (11A, memo). Emissions from this source are reported as a memo item and do not contribute to the national total. The last three eruptions are:

- **2022:** Meradalir. A fissure eruption that started in August and lasted 18 days. It is part of the same volcanic system as the Fagradalsfjall eruption.
- **2021:** Fagradalsfjall. A fissure eruption that started in March and lasted until September. The first eruption on the Reykjanes peninsula since the 12th century.
- **2014-2015:** Holuhraun. A large eruption started on 29 August 2014 and ended on 27 February 2015 in the north of the Vatnajökull ice sheet. It was the biggest eruption in Iceland since 1783.



The trend overview for SO_x emissions is provided above. The main source of SO_x emissions is geothermal power plants. The overall trend in the emissions can mostly be explained by changes within the emissions from the geothermal power plants. Other sources are metal production and fishing ships. SO_x emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.3.

- **Geothermal Energy (1B2d):** Geothermal energy exploitation is the largest source of sulphur emissions in Iceland. Sulphur is emitted from geothermal power plants in the form of H_2S. Emissions have increased substantially since 1990 due to electricity production at geothermal power plants increasing approximately 15-fold since 1990. Since 2014 a sulphur capture and storage project (*Sulfix*) has been operated at one of the geothermal power plants (*Hellisheiði Power Plant*). *SulFix* consists of separating H_2S from the steam and also reinjecting the gas into the subsurface and mineralising on contact with the basalt host rock. About 6-8 kt are captured and stored annually.
- **Aluminium Production (2C3):** Aluminium is currently produced at three primary aluminium plants in Iceland. Sulphur emissions are due to the S content of alumina and electrodes in the production process. The emissions rose slightly in 1998 due to the opening of a new facility, and more significantly in the period 2006-2008 due to an expansion of one facility and the onset of operations at a new facility. The emissions from primary Al production have been relatively stable since 2008.
- **Ferroalloys Production (2C2):** Currently, two factories produce ferroalloys in Iceland. One company has been producing FeSi75 since 1979 and another one started production of ≥98.5% pure silicon metal in 2018. A third company was operating between 2016-2017 producing silicon metal but stopped production in 2017. Sulphur emissions are due to the S content of the reducing agents in the production process.
- **National Fishing (1A4ciii):** Emissions from the fishing fleet have decreased over the timeline. The reduction is mainly due to lower sulphur content of the fuel and less fuel use.

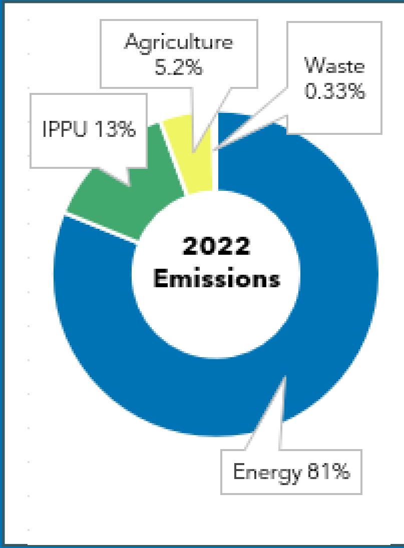
Table 2.3 SO_x emissions by main sources since 1990 [kt SO_2].

SO_x Emissions [kt SO_2]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Geothermal Energy (1B2)	13.3	11.0	26.0	30.3	58.7	42.4	39.3	47.7	48.9	+267%	+61%	+2.4%
Primary Al Production (2C3)	1.34	1.36	2.94	3.41	9.93	11.5	9.8	10.40	10.7	+705%	+215%	+3.3%
Ferroalloys Production (2C2)	1.85	1.38	2.04	2.64	2.37	2.06	1.95	1.90	2.26	+22%	-15%	+19%
National Fishing (1A4ciii)	0.040	0.054	0.022	0.026	0.024	0.014	0.003	0.003	0.003	-93%	-89%	-11%
Other	2.21	2.05	1.67	0.85	0.34	0.17	0.040	0.062	0.11	-95%	-87%	+80%
Total [kt]	**18.8**	**15.8**	**32.7**	**37.2**	**71.3**	**56.1**	**51.1**	**60.1**	**62.0**	**+230%**	**+67%**	**+3.2%**

2.2.2 Trends in NO_x Emissions

NO_x (NO_2)

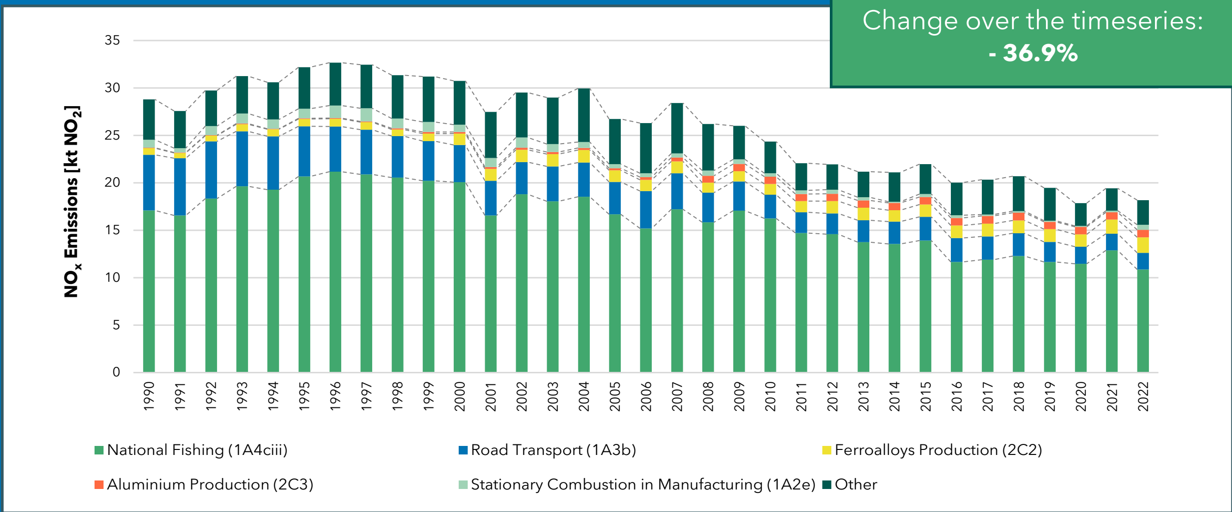
Total emissions in this inventory year: **18.2 kt**



NO_x emissions are dominated by the Energy sector, specifically:

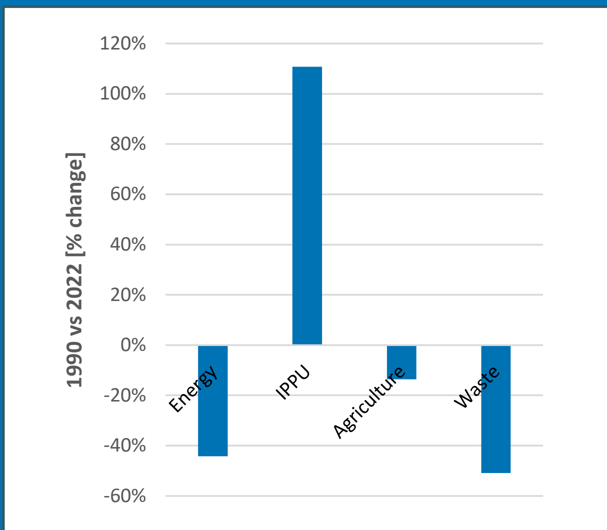
- **Fishing (1A4ciii)**: Emissions from fisheries rose between 1990 and 1996 because a substantial portion of the fishing fleet was operating in unusually distant fishing grounds. Since 1996, the emissions have generally been decreasing, with large annual variations due to changes in fish stock size and location. Emissions remain below 1990 levels.
- **Road Transport (1A3b)**: Emissions decreased rapidly after the use of catalytic converters in all new vehicles became obligatory in 1995, even though fuel consumption has significantly increased. However, the significant expansion of the vehicle fleet over the past few years has caused emissions to rise again.

Change over the timeseries: **- 36.9%**



Other sources of NO_2 emissions include:

- **Metal Production (2C):** Since 1990, the production capacity of the metal factories has seen a significant increase, and the NO_x emissions have increased accordingly.
- **Agriculture (3):** The majority of emissions occur due to the application of organic and inorganic fertilisers on agricultural soils.
- **Waste (5):** There are very low emissions from waste incineration, which have steadily declined since 1990.



The trend overview for NO_x emissions is provided above. The main source of NO_x emissions is the fishing fleet. As fuel is burned, nitrogen monoxide (NO) is formed when nitrogen and oxygen react. In the atmosphere, NO oxidises into nitrogen dioxide (NO_2). The overall trend in the emissions can mostly be explained by less fuel usage within the fishing fleet. Other significant sources are metal production and Road Transport. NO_x emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.4.

- **National Fishing (1A4ciii):** The decrease in emissions over the timeline are mainly due to less fuel use within the fishing fleet. However, emissions from fisheries rose from 1990 to 1996 because a substantial portion of the fishing fleet was operating in unusually distant fishing grounds. Since 1996, the emissions have generally been decreasing, however, with large annual variations due to annual differences in fish stock size and location. Emissions remain below 1990 levels.
- **Road Transport (1A3b):** Emissions from Road Transport have decreased significantly, (especially from passenger cars) due to the use of catalytic converters from 1995 onwards, despite fuel consumption having significantly increased over the timeline.
- **Ferroalloys Production (2C2):** Emissions of NO_x from Ferroalloys Production follow the production amount. Two factories produce ferroalloys in Iceland. One company has been producing FeSi75 since 1979 and another one started production of ≥98.5% pure silicon metal in 2018. A third company was operating between 2016-2017 producing silicon metal but stopped production in 2017.
- **Aluminium Production (2C3):** Emissions of NO_x emissions from Aluminium Production follow the production amount. Aluminium is currently produced at three primary aluminium plants in Iceland. The increase over the timeline mirrors the expansion of the industry.
- **Food Processing (1A2e):** This sector is primarily comprised of fishmeal production and other food processing. Fishmeal production is a large industry in Iceland and has historically had relatively high emissions, but in recent years many fishmeal factories have been using electricity instead of fossil fuels, leading to a general downward trend in emissions for this sector.

Table 2.4 NO_x emissions by main sources since 1990 [kt NO_2].

NO_x Emissions [kt NO_2]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
National Fishing (1A4ciii)	17.1	20.7	20.1	16.7	16.3	13.9	11.5	12.9	10.9	-36%	-35%	-15.6%
Road Transport (1A3b)	5.86	5.27	3.92	3.41	2.50	2.50	1.81	1.76	1.76	-70%	-49%	-0.34%
Ferroalloys Production (2C2)	0.69	0.79	1.20	1.22	1.12	1.30	1.30	1.50	1.64	+138%	+35%	9.8%
Aluminium Production (2C3)	0.061	0.069	0.17	0.22	0.76	0.80	0.77	0.77	0.78	+1179%	+258%	0.57%
Stationary Combustion in Manufacturing (1A2e)	0.85	1.01	0.75	0.44	0.37	0.30	0.11	0.15	0.54	-36%	+22%	251%
Other	4.26	4.37	4.62	4.76	3.35	3.17	2.41	2.36	2.59	-39%	-46%	9.6%
Total [kt]	**28.8**	**32.2**	**30.7**	**26.7**	**24.4**	**22.0**	**17.9**	**19.4**	**18.2**	**-37%**	**-32%**	**-6.5%**

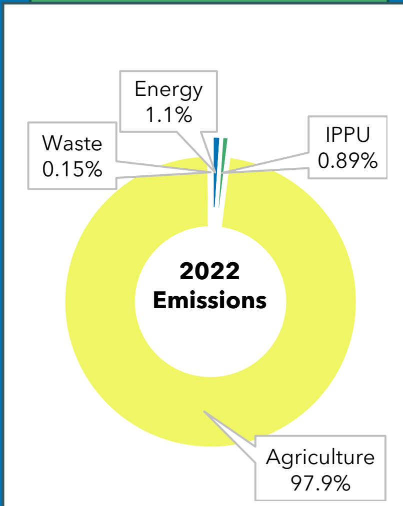
2.2.3 Trends in NH_3 Emissions

NH_3

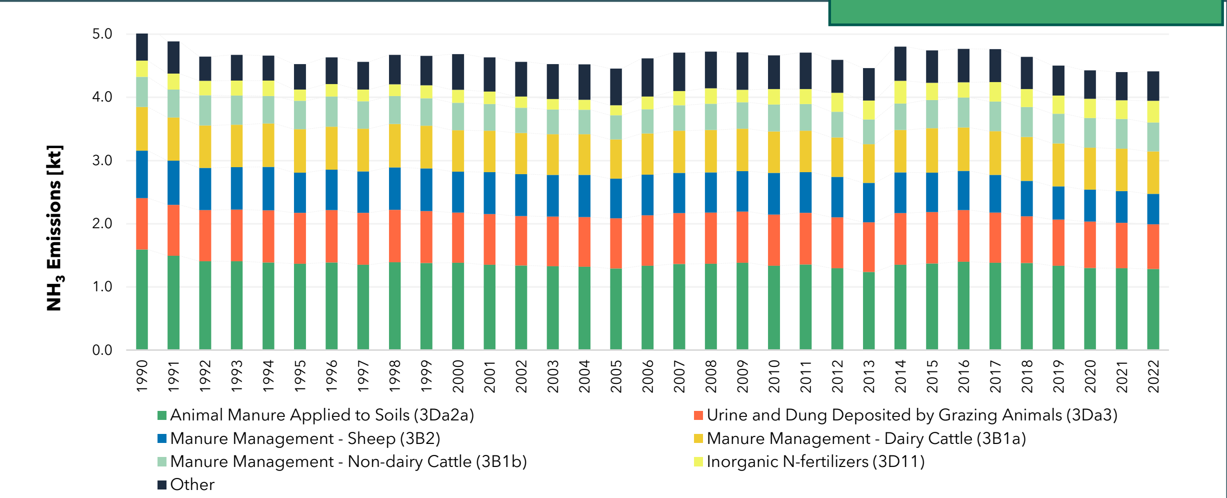
Total emissions in this inventory year: **4.4 kt**

Ammonia (NH_3) emissions mostly originate from the Agriculture sector. Emissions have been fluctuating between 4 and 5 kt NH_3 since 1990. The main driver behind the general trend and its oscillations is the trend in livestock population and fertiliser use. There is also a small amount of NH_3 from other sources, including:

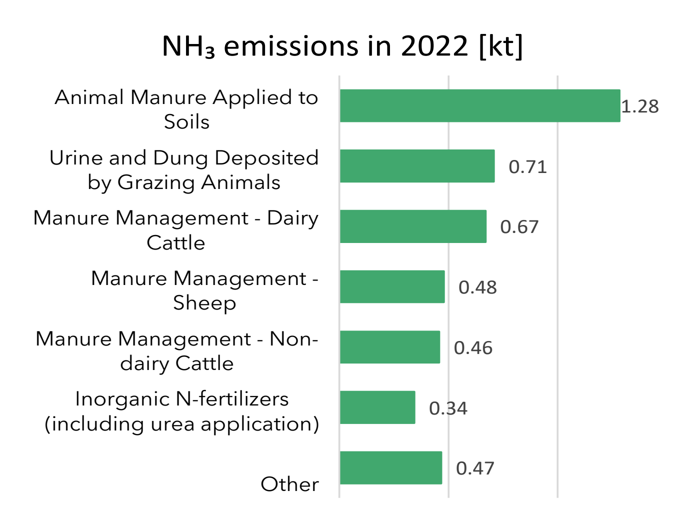
- **Road Transport (1A3b)**: Catalytic converters cause a small amount of NH_3 emissions. Emissions peaked in 2004 due to a reduction of Euro 1 and 2 vehicles on the roads.
- **Mineral Products (2A)**: Mineral wool production.
- **Biological Treatment of Waste (5B)**: NH_3 emissions are released during composting.



Change over the timeseries: **-14.2%**



- Animal Manure Applied to Soils (3Da2), Manure Management (3B), and Urine and Dung Deposited by Grazing Animals (3Da3) are the main sources of NH_3 in Iceland.
- Sheep and cattle are the livestock categories which have the biggest contribution to ammonia emissions, causing over 80% of NH_3 emissions from manure management.
- NH_3 emissions from Inorganic Fertiliser Application (3Da1) only have a minor contribution to the overall emissions.



The trend overview for ammonia (NH_3) emissions is provided above. The main source of NH_3 is the Agriculture sector. Most of the emissions come from 3Da2 Organic Fertilisers Applied to Soils (although most of this is attributable to livestock), 3B Manure Management and 3Da3 Urine and Dung Deposited by Grazing Animals. Emissions have been fluctuating between 4 and 5 kt NH_3 since 1990. The trend in NH_3 emissions is relatively steady which is driven by relatively little overall variability in livestock numbers.

NH_3 emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.5.

- **Manure Management (3B):** The main driver behind the general trend and its oscillations is the trend in livestock population of sheep and cattle, as manure management practices have not changed significantly. The population of sheep and dairy cattle has been declining in recent years and the trend in the population of non-dairy cattle is increasing.
- **Organic Fertilisers Applied to Soils (3Da2a):** The main driver behind the general trend and its oscillations is the trend in livestock population as for 3B.
- **Urine and Dung Deposited by Grazing Animals (3Da3):** The main driver behind the general trend and its oscillations is the trend in livestock population as for 3B.

Table 2.5 NH_3 emissions by main sources since 1990 [kt].

NH_3 Emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Animal Manure Applied to Soils (3Da2a)	1.59	1.37	1.39	1.29	1.33	1.37	1.30	1.30	1.28	-19%	-0.66%	-0.94%
Urine and Dung Deposited by Grazing Animals (3Da3)	0.82	0.81	0.79	0.79	0.81	0.81	0.74	0.72	0.71	-13%	-11%	-1.6%
Manure Management - Sheep (3B2)	0.75	0.63	0.65	0.63	0.66	0.62	0.50	0.50	0.48	-36%	-24%	-4.2%
Manure Management - Dairy Cattle (3B1a)	0.69	0.69	0.66	0.62	0.66	0.70	0.67	0.67	0.67	-3.1%	+8.3%	-0.17%
Manure Management - Non-dairy Cattle (3B1b)	0.48	0.45	0.43	0.38	0.42	0.45	0.47	0.47	0.46	-3.6%	+20%	-1.9%
Inorganic N-fertilizers (3D11)	0.26	0.18	0.20	0.16	0.24	0.27	0.30	0.30	0.34	+33%	+119%	+15%
Other	0.82	0.40	0.57	0.58	0.53	0.51	0.45	0.44	0.47	-43%	-20%	+5.5%
Total [kt]	**5.14**	**4.52**	**4.68**	**4.45**	**4.66**	**4.74**	**4.43**	**4.40**	**4.41**	**-14%**	**-1.0%**	**+0.33%**

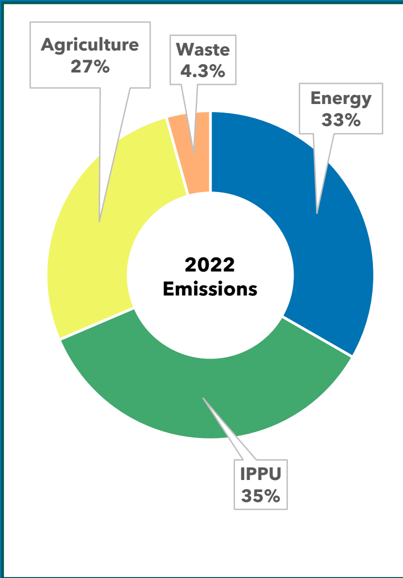
2.2.4 Trends in NMVOC Emissions

NMVOC

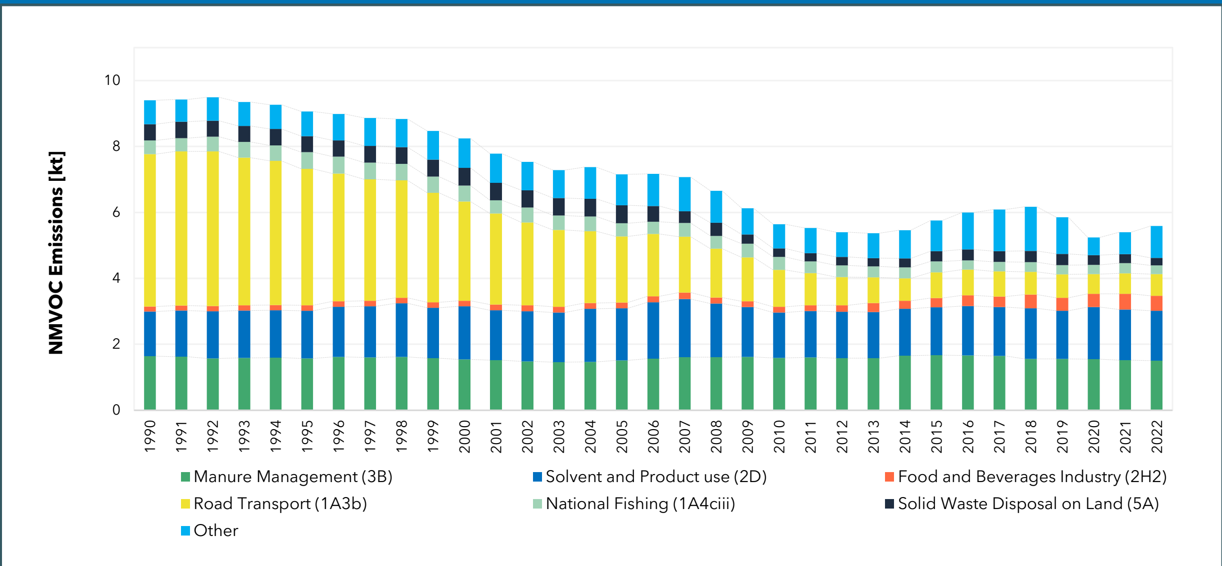
Total emissions in latest inventory year: **5.6 kt**

Many sources contribute to NMVOC emissions in Iceland. The main sources are:

- **Solvent and Product Use (2D3):** The main source of NMVOCs linked to solvent use is domestic solvent use, which in turn is linked to population size. The population in Iceland has been increasing steadily since 1990.
- **Manure Management (3B):** Horse and cattle manure management systems are responsible for most of the NMVOC emissions from Agriculture. The variations over the years are mostly linked to livestock population fluctuations.
- **Food and Beverage Industry (2H2):** NMVOC emissions are released during the production of beer and other alcoholic beverages. Emissions have increased in recent years.
- **Road Transport (1A3b):** A general decrease in emissions over the timeline exists due to improved emissions-limiting technologies in newer vehicles.
- **National Fishing (1A4ciii):** Emissions in the latest inventory year were around a third lower than the 1990 level. Annual variations are inherent to the nature of fisheries.
- **Solid Waste Disposal on Land (5A):** Emissions have halved over the time series.



Change over the timeseries: **- 40.5%**



The trend overview for NMVOC emissions is provided above. NMVOC emissions come from a variety of sources across sectors. The decrease in emissions since 1990 is mainly due to the increased use of newer vehicles with higher emissions standards and emission-reducing technologies.

NMVOC emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.6.

- **Solvent and Product Use (2D):** The emissions from solvent and product use have not changed much over the timeline. Some increase is apparent, which can partly be explained by an increasing population and consequent increased usage of solvents.
- **Manure Management (3B):** Horse and cattle manure management systems are responsible for most of the NMVOC emissions from Agriculture. The variations over the years are mostly linked to livestock population fluctuations.
- **Food and Beverages Industry (2H2):** The increase in NMVOC emissions from the food and beverage industry is caused by growing spirit production. In recent years, spirit production has increased, leading to an increase in exports of spirits.
- **Road Transport: Passenger Cars (1A3bi):** The decrease in emissions since 1990 is mainly due to the modernisation of the car fleet with the introduction of more cars with higher emission standards and improved emission-reducing technologies.
- **National Fishing (1A4ciii):** The decrease in emissions over the timeline is mainly due to less fuel use within the fishing fleet. Emissions from commercial fishing rose from 1990 to 1996 when a substantial portion of the fishing fleet was operating in distant fishing grounds. Emissions in the latest year were around a third lower than the 1990 level. Annual variations are inherent to the nature of fisheries.
- **Solid Waste Disposal on Land (5A):** The declining trend in NMVOC emissions in this category is due to a lower amount of waste being deposited on land.

Table 2.6 NMVOC emissions by main sources since 1990 [kt].

NMVOC Emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Manure Management (3B)	1.64	1.57	1.54	1.51	1.59	1.67	1.55	1.52	1.50	-8.3%	-0.31%	-1.1%
Solvent and Product use (2D)	1.35	1.45	1.61	1.58	1.38	1.45	1.58	1.53	1.51	+11.8%	-4.5%	-1.3%
Food and Beverages Industry (2H2)	0.15	0.16	0.17	0.18	0.17	0.28	0.40	0.48	0.46	+197%	+159%	-5.1%
National Fishing (1A4ciii)	0.41	0.50	0.49	0.40	0.39	0.34	0.28	0.31	0.26	-36%	-35%	-16%
Solid Waste Disposal on Land (5A)	0.49	0.49	0.53	0.54	0.26	0.31	0.30	0.27	0.23	-54%	-58%	-16%
Road Transport (1A3b)	4.62	4.14	3.01	2.00	1.12	0.78	0.60	0.62	0.66	-86%	-67%	6.6%
Other	0.73	0.75	0.90	0.94	0.73	0.93	0.54	0.67	0.97	+32%	+3.3%	46%
Total [kt]	**9.40**	**9.06**	**8.25**	**7.15**	**5.64**	**5.75**	**5.24**	**5.40**	**5.59**	**-41%**	**-22%**	**3.5%**

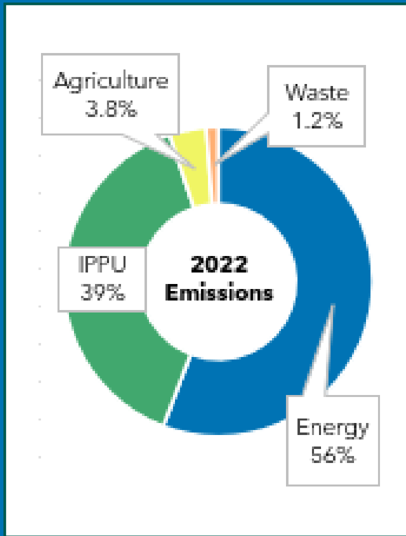
2.2.5 Trends in $PM_{2.5}$ Emissions

$PM_{2.5}$

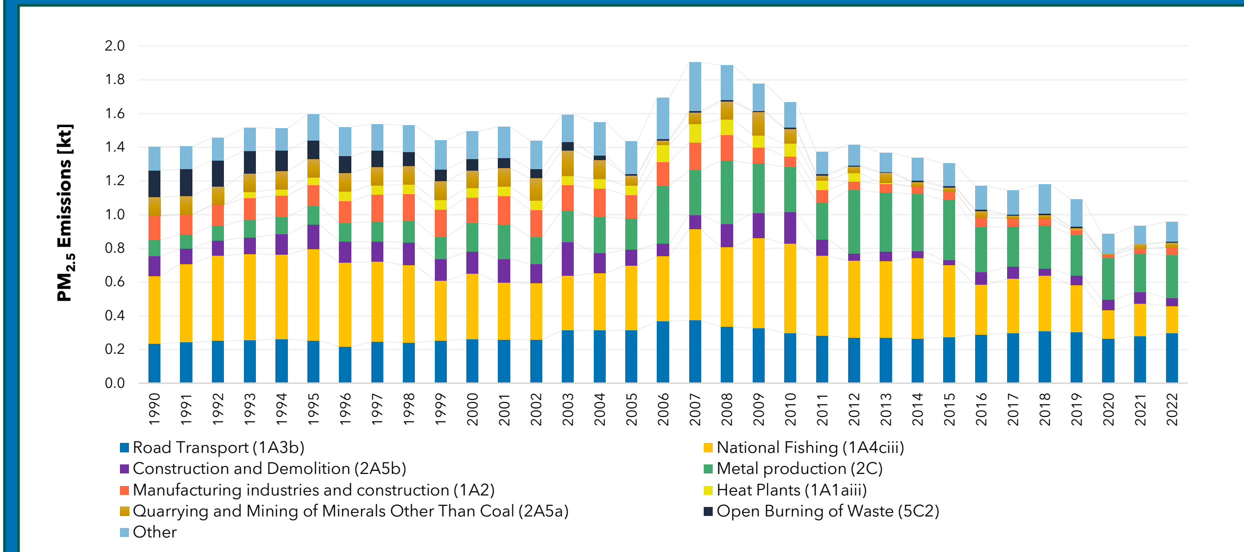
Total emissions in latest inventory year: **0.96 kt**

Emissions of $PM_{2.5}$ are dominated by the Energy and IPPU sectors; the main sources are:

- **Metal Production (2C):** Production capacity in the metal production sector has increased substantially.
- **Road Transport (1A3b):** Fluctuations in PM emissions result from the combination of changes in the pollution control standards and an increase in vehicle fleet size.
- **National Fishing (1A4ciii):** Emissions remain below 1990 levels, however there are large annual variations due to the inherent nature of fisheries.
- **Construction and Demolition (2A5b):** The emissions from this category are from road and building construction.
- **Open Burning of Waste (5C2):** Open burning of waste resulted in PM emissions in the 1990s.

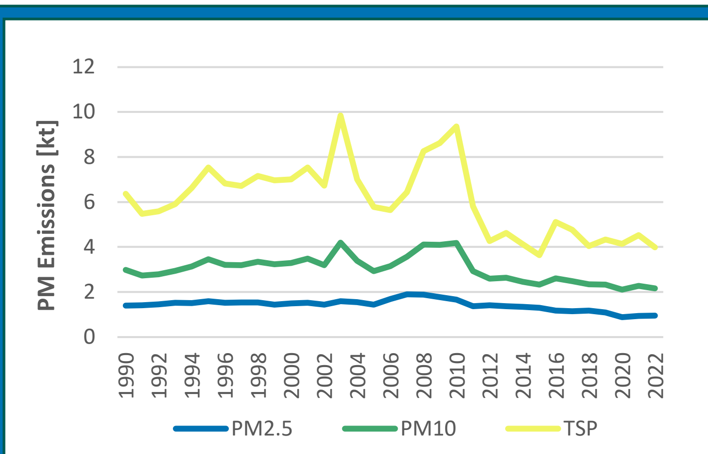


Change over the timeseries: **-31.8 %**



Particulate Matter:

Emissions from PM_{10} and Total Suspended Particulate (TSP) follow the same trend as $PM_{2.5}$ and are dominated by the same main sources.



The trend overview for $PM_{2.5}$ emissions is provided above. $PM_{2.5}$ emissions are predominantly derived from 2C Metal Production, 1A3b Road Transport, and 1A4ciii Fishing. The overall decrease in emissions since 1990 can largely be explained by less fuel usage within the fishing fleet.

$PM_{2.5}$ emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.7.

- **Metal Production (2C):** PM emissions from aluminium and ferroalloys production follow the production amount. The increase over the timeline mirrors the expansion of the industry.
- **Road Transport (1A3b):** Fluctuations in PM emissions result from the combination of changes in the pollution control standards, increased fuel usage, and vehicle kilometres driven.
- **National Fishing (1A4ciii):** The decrease in emissions over the timeline is mainly due to less fuel use within the fishing fleet.
- **Construction and Demolition (2A5b) and Quarrying and Mining of Minerals Other Than Coal (2A5a):** The emissions follow the number of houses built and roads constructed. The main reason for the decrease in PM emissions over the timeline is the reduction in road construction.
- **Manufacturing Industries and Construction (1A2):** Significant $PM_{2.5}$ emissions resulted from the combustion of other bituminous coal for cement production until 2012 when production was stopped. Additionally, food processing, especially fish meal production, causes $PM_{2.5}$ emissions.
- **Open Burning of Waste (5C2):** Open pit burning was a common practice in Iceland the early nineties but has since been stopped. Since 2010, New Year's Eve bonfires, which are heavily regulated, monitored, and restricted, have been the only source of emissions in this category.
- **Heat Plants (1A1aiii):** Waste incineration with energy recovery was occurring between 1993-2013, which caused significant emissions.

Table 2.7 $PM_{2.5}$ emissions by main sources since 1990 [t].

$PM_{2.5}$ Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	'05-'22	'21-'22
Metal production (2C)	95	108	169	186	268	359	245	229	254	+167%	+37%	11%
Road Transport (1A3b)	235	252	261	315	297	275	264	281	297	+26%	-5.7%	5.8%
National Fishing (1A4ciii)	402	545	391	384	533	425	170	191	161	-60%	-58%	-16%
Construction and Demolition (2A5b)	117	145	128	93	185	29	62	68	47	-60%	-50%	-31%
Quarrying and Mining of Minerals Other Than Coal (2A5a)	109	109	103	57	89	22	6.8	24	28	-74%	-51%	15%
Manufacturing industries and	142	125	153	141	64	51	21	32	46	-67%	-67%	46%

$PM_{2.5}$ Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
construction (1A2)												
Open Burning of Waste (5C2)	159	111	67	9.8	7.6	7.1	0.85	0.36	7.1	-96%	-27%	1900%
Heat Plants (1A1aiii)	2.3	45.2	55.8	54.9	74.6	0.11	0.00	4.4E-03	0.024	-99%	-100%	461%
Other	140	155	165	196	148	135	117	108	116	-17%	-41%	8.0%
Total [kt]	**1,403**	**1,596**	**1,494**	**1,435**	**1,666**	**1,304**	**887**	**933**	**957**	**-32%**	**-33%**	**2.6%**

Emissions of PM_{10} can be seen in Table 2.8 and Figure 2.1. Emissions of TSP (total suspended particles) can be seen in Table 2.9 and Figure 2.2. The trend descriptions above are also applicable to PM_{10} and TSP trends.

Table 2.8 PM_{10} emissions by main sources since 1990 [kt].

PM_{10} Emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Construction and Demolition (2A5b)	1.17	1.45	1.28	0.93	1.85	0.29	0.62	0.68	0.47	-60%	-50%	-31%
Road Transport (1A3b)	0.34	0.36	0.38	0.48	0.47	0.46	0.47	0.50	0.53	+58%	+12%	6.2%
Metal production (2C)	0.17	0.20	0.32	0.37	0.59	0.72	0.52	0.51	0.57	+230%	+56%	11%
Quarrying and Mining of Minerals Other Than Coal (2A5a)	0.31	0.31	0.29	0.16	0.25	0.062	0.019	0.069	0.079	-74%	-51%	15%
National Fishing (1A4ciii)	0.40	0.55	0.39	0.38	0.53	0.43	0.17	0.19	0.16	-60%	-58%	-16%
Fireworks (2G)	0.011	0.014	0.038	0.064	0.049	0.060	0.049	0.053	0.069	+503%	+7.7%	31%
Open Burning of Waste (5C2)	0.17	0.12	0.073	0.011	0.0082	0.0077	9.2E-4	3.8E-4	7.7E-3	-96%	-27%	+1900%
Other	0.41	0.45	0.51	0.54	0.44	0.30	0.26	0.26	0.28	-31%	-47%	7.6%
Total [kt]	**2.98**	**3.45**	**3.29**	**2.93**	**4.18**	**2.32**	**2.11**	**2.27**	**2.17**	**-27%**	**-26%**	**-4.4%**

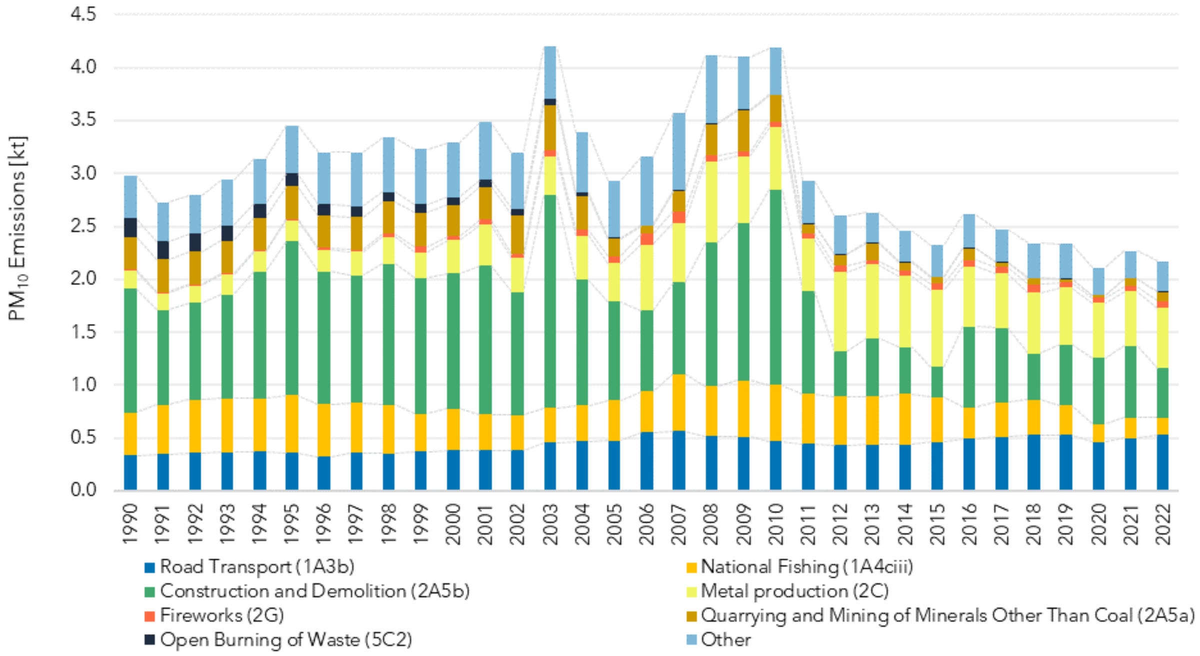


Figure 2.1 PM_{10} emissions by sector, since 1990.

Table 2.9 TSP emissions by main sources since 1990 [kt].

TSP Emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Construction and Demolition (2A5b)	68	74	75	92	84	57	40	38	38	-43%	-58%	0.86%
Road Transport (1A3b)	17	21	28	31	15	15	9.9	8.4	8.2	-53%	-73%	-2.9%
Quarrying and Mining of Minerals Other Than Coal (2A5a)	56	61	72	70	33	31	13	19	27	-52%	-61%	44%
Metal production (2C)	13	16	14	13	14	12	7.7	8.6	7.3	-44%	-42%	-16%
National Fishing (1A4ciii)	0.15	0.17	0.69	1.0	3.5	3.6	6.6	4.2	4.8	+3121%	+364%	14%
Other	67	47	28	4.1	3.2	3.0	0.36	0.15	3.0	-96%	-27%	1900%
Total [kt]	**9.3**	**13**	**16**	**21**	**14**	**7.6**	**6.5**	**2.8**	**2.0**	**-79%**	**-90%**	**-29%**

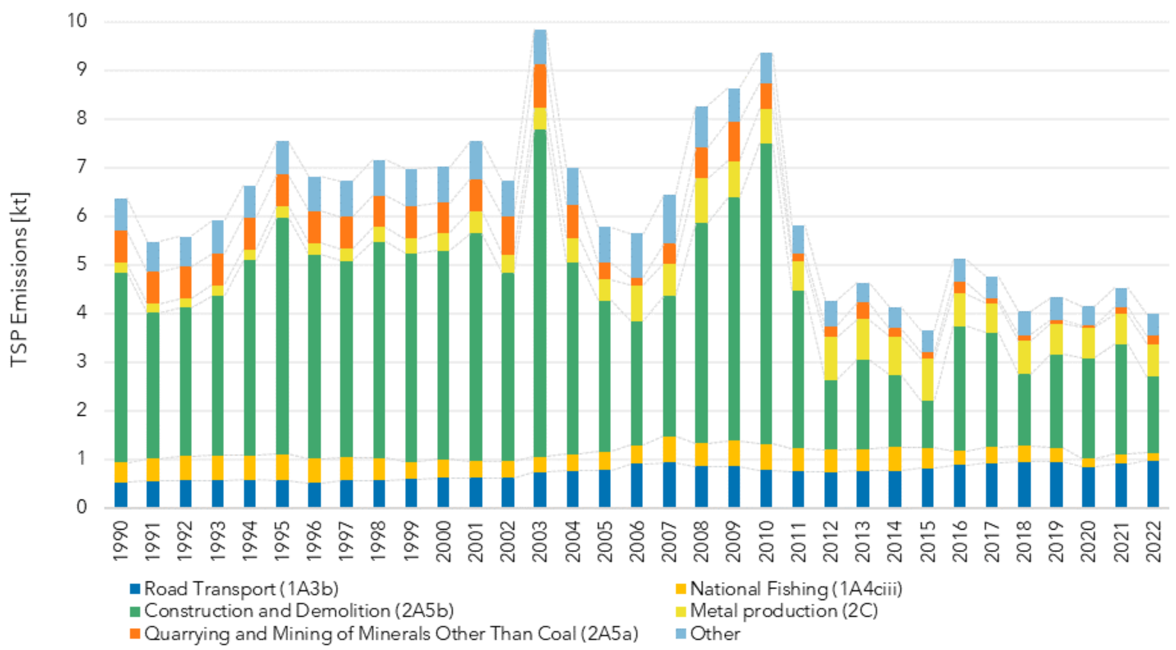


Figure 2.2 TSP emissions by sector, since 1990.

2.2.6 Trends in BC (Black Carbon) Emissions

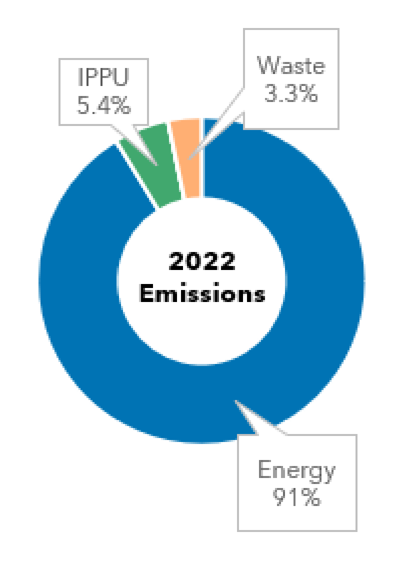
BC

Total emissions in latest inventory year: **91 t**

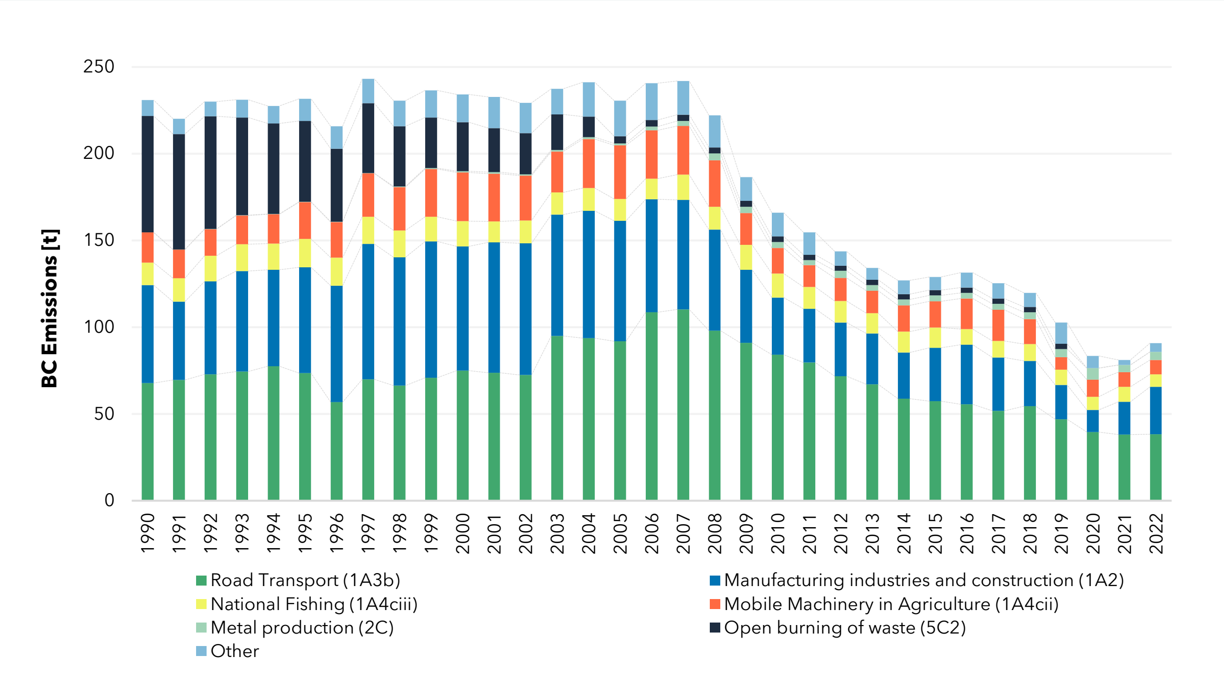
Black carbon contributes relatively few emissions compared to the NECD pollutants. Emissions of black carbon are heavily dominated by the Energy sector. As with SO_x, there are no emissions of black carbon associated with the Agriculture sector. The following sources comprise the majority of black carbon emissions:

- **Road Transport (1A3b)**
- **Manufacturing Industries and Construction (1A2)**
- **Fishing (1A4ciii)**
- **Mobile Machinery in Agriculture (1A4cii)**

After the Energy sector, the next biggest source of black carbon emissions is from Aluminium Production (2C3). Emissions have increased with the expansion of the production capacity of the metal factories.



Change over the timeseries: **- 60.7 %**



The trend overview for black carbon (BC) emissions is provided above. Emissions of black carbon are heavily dominated by the Energy sector. As with SO_x, there are no emissions of black carbon associated with the Agriculture sector. The majority of black carbon emissions are from mobile sources. The overall decrease in emissions since 1990 can mostly be explained by less fuel usage and changes in pollution standards.

BC emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.10.

- **Road Transport (1A3b):** Fluctuations in BC emissions result from the combination of changes in the pollution control standards and an increase in vehicle fleet size.
- **Mobile Machinery in Construction (1A2gvii) and Agriculture (1A4cii):** During the economic upswing prior to 2008, there was an increase in fuel use for off-road vehicles and other machinery, which caused an increase in emissions.
- **Food Processing (1A2e):** This sector is primarily comprised of fishmeal production and other food processing. Fishmeal production is a large industry in Iceland and has historically had relatively high emissions, but in recent years many fishmeal factories have been using electricity instead of fossil fuels, leading to a general downward trend in emissions for this sector.
- **National Fishing (1A4ciii):** The decrease in emissions over the timeline is mainly due to less fuel use within the fishing fleet.
- **Metal Production (2C):** PM emissions from aluminium and ferroalloys production follow the production amount. The increase over the timeline mirrors the expansion of the industry.
- **Open Burning of Waste (5C2):** Open pit burning was a common practice in Iceland the early nineties but has since been stopped. Since 2010, New Year's Eve bonfires, which are heavily regulated, monitored, and restricted, have been the only source of emissions in this category.

Table 2.10 BC emissions by main sources since 1990 [t].

BC Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Road Transport (1A3b)	68	74	75	92	84	57	40	38	38	-43%	-58%	0.86%
Mobile Machinery in Agriculture (1A4cii)	17	21	28	31	15	15	9.9	8.4	8.2	-53%	-73%	-2.9%
Manufacturing industries and construction (1A2)	56	61	72	70	33	31	13	19	27	-52%	-61%	44%
National Fishing (1A4ciii)	13	16	14	13	14	12	7.7	8.6	7.3	-44%	-42%	-16%
Metal production (2C)	0.15	0.17	0.69	1.0	3.5	3.6	6.6	4.2	4.8	+3121%	+364%	14%
Open burning of waste (5C2)	67	47	28	4.1	3.2	3.0	0.36	0.15	3.0	-96%	-27%	1900%
Other	9.3	13	16	21	14	7.6	6.5	2.8	2.0	-79%	-90%	-29%
Total [t]	**231**	**232**	**234**	**231**	**166**	**129**	**83**	**81**	**91**	**-61%**	**-61%**	**12%**

2.2.7 Trends in Carbon Monoxide (CO) Emissions

CO emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.11. Figure 2.3 shows the sectoral emission trends since 1990. It should be noted that in previous years, 1A3ai(i) International Aviation LTO and 1A3aii(i) Domestic Aviation LTO were two of the largest sources of CO, however due to a methodology upgrade in how emissions from these sectors are calculated, they are no longer considered top sources of CO in Iceland.

- **Aluminium Production (2C3):** The main source of CO is Primary Aluminium Production. The varying increase in emissions from the IPPU sector corresponds to the expansion of production capacity. This sector accounts for over 96% of Iceland's CO emissions.
- **Road Transport (1A3b):** In the earlier part of the time series, more than half of the total CO emissions originated from Road Transport. Emissions from Road Transport have been steadily decreasing since 1990 due to advances in pollution control equipment in vehicles, and now they amount to a small percentage of the total emissions.
- **Manufacturing Industries and Construction (1A2):** Although this sector accounts for <1% of Iceland's CO emissions, it (comprised of its subsectors) is the third largest source of CO.
- **Open Burning of Waste (5C2):** Open pit burning was a common practice in Iceland the early nineties but has since been stopped. Since 2010, New Year's Eve bonfires, which are heavily regulated, monitored, and restricted, have been the only source of emissions in this category.

Table 2.11 CO emissions by main sources since 1990 [kt].

CO Emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Aluminium Production (2C3)	11	12	27	33	98	103	100	100	101	+856%	+208%	0.51%
Road Transport (1A3b)	41	33	22	15	8.4	5.6	2.6	2.5	2.6	-94%	-82%	3.1%
Manufacturing Industries and Construction (1A2)	0.82	0.63	0.83	0.75	0.33	0.24	0.10	0.14	0.19	-76%	-74%	35%
Open Burning of Waste (5C2)	2.1	1.5	0.90	0.13	0.10	0.095	0.011	0.0047	0.095	-96%	-27%	1900%
Other	1.6	1.8	2.0	1.9	1.6	1.6	1.3	1.4	1.4	-12%	-26%	-2.7%
Total [kt]	**56**	**49**	**53**	**50**	**109**	**110**	**104**	**104**	**105**	**+87%**	**+109%**	**0.66%**

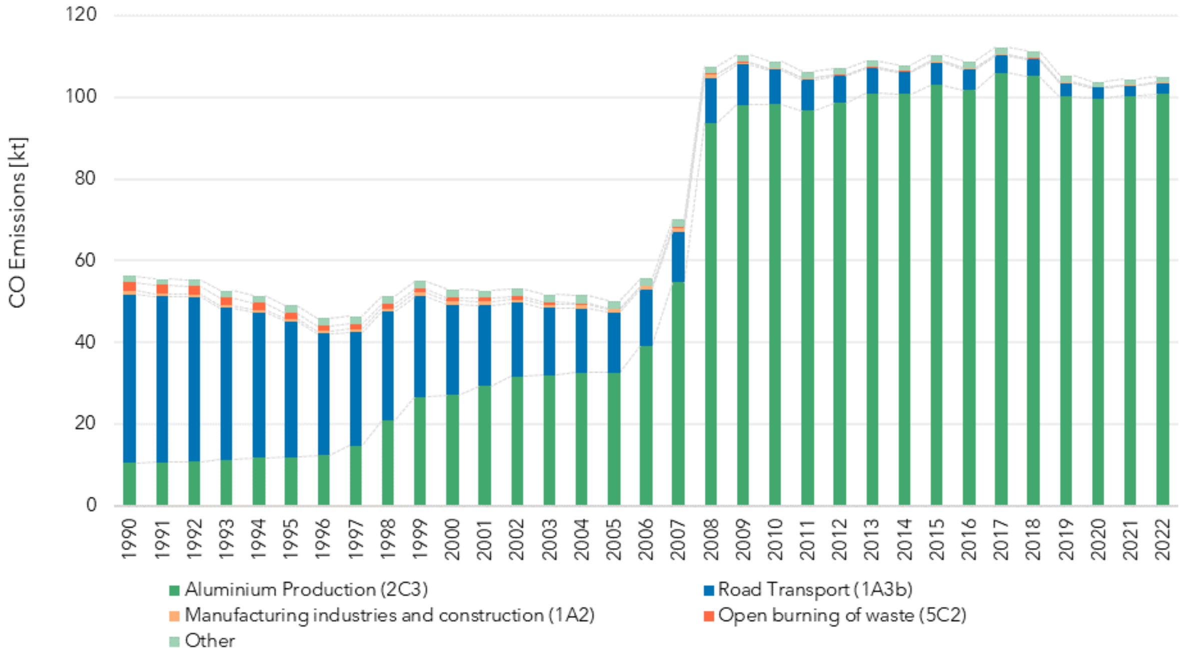


Figure 2.3 CO emissions by sector, since 1990.

2.3 Emission Trends for Persistent Organic Pollutants (POPs)

The total amount of dioxins, PAH4, HCB, and PCB emitted in Iceland has significantly decreased since 1990, as is presented in Table 2.12.

Table 2.12 Emissions of POPs in Iceland 1990 and 2022.

Year	Dioxin [g I-TEQ]	PAH4 [t]	HCB [kg]	PCB [kg]
1990	10.73	0.587	0.267	0.300
2022	0.73	0.084	0.114	0.016
Change 1990-2022	-93%	-86%	-58%	-95%

2.3.1 Trends in Dioxin Emissions

Dioxin emissions in Iceland have decreased by more than 90% since 1990. The main reason for this large reduction of emissions is a significant decrease in open burning of waste between 1990 and 2004. In recent years, the main contributors to dioxin emissions have been Clinical Waste Incineration (5C1biii), Accidental Fires (reported as 5E Other Waste), and Bonfires (reported as 5C2 Open Burning of Waste).

Dioxin emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.13 and Figure 2.4 and Figure 2.5.

- **Clinical Waste Incineration (5C1biii) and Open Burning of Waste (5C2):** Practices of waste disposal treatment have undergone a radical change in Iceland since 1990. This is one of the main reasons for the substantial decline in dioxin emissions since 1990. Various factors that have influenced the dioxin emission profile from the Waste sector are described below:
    - Open pit burning, which used to be the most common means of waste disposal outside the Capital Region, has gradually decreased since 1990. Open pit burning is practically non-existent today, as the last site was closed by the end of 2010;
    - In recent years, smaller waste incinerators, most of which were considered as open burning of waste due to the lack of emission abatement, have been closed. Currently, there is only one large incineration plant operating in Iceland. The incineration plant is called *Kalka* and it does not recover energy.
    - Emissions from bonfires around New Year's Eve and Twelfth Night celebrations are included in the waste incineration sector. Emissions from bonfires have decreased since 1990, due to the fact that bonfires are fewer and better controlled. Guidelines for bonfires, published in 2000, include restrictions on size, burnout time, and the material allowed.
    - The total amount of waste being incinerated has decreased.
- **Accidental Fires (5E):** A peak in emissions from accidental fires occurred in 2004, when a major fire broke out at a recycling company (*Hringrás*). In the fire, 300 tonnes of tyres, among other separated waste materials, burned. A fire broke out in the same company in 2011 which was estimated to be 10% the size of the 2004 fire. In 2014, a major fire broke out in an industrial laundry service when, among other materials, around 60-80 tons of asphalt roll roofing burned.
- **Public Electricity and Heat Generation (1A1a):** Waste burning with energy recovery occurred in Iceland between 1994 and 2012. Other sources within the Energy sector,

contributing to dioxin emissions since 2013, are Road Transport and Fishing, but the emissions from these sources are generally decreasing.

Table 2.13 Dioxin emissions by main sources since 1990 [g I-TEQ].

Dioxin Emissions [g I-TEQ]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Open Burning of Waste (5C2)	10	6.8	2.8	0.15	0.12	0.10	0.012	0.0051	0.10	-99%	-33%	+1900%
Clinical Waste Incineration (5C1biii)	NO	NO	NO	0.078	0.033	0.11	0.16	0.16	0.20		+154%	+24%
Metal production (2C)	0.014	0.016	0.027	0.030	0.047	0.064	0.11	0.16	0.23	+1593%	+668%	+44%
Road Transport (1A3b)	0.064	0.069	0.088	0.11	0.11	0.072	0.044	0.040	0.039	-39%	-63%	-2.4%
National Fishing (1A4ciii)	0.043	0.057	0.044	0.041	0.053	0.043	0.021	0.023	0.020	-55%	-53%	-16%
Public Electricity and Heat Generation (1A1a)	3.3E-04	0.38	0.39	0.38	0.29	3.9E-05	1.8E-05	2.2E-05	7.1E-05	-78%	-100%	+229%
Accidental Fires (5E)	0.085	0.085	0.085	0.14	0.11	0.069	0.10	0.10	0.11	+33%	-18%	+9.4%
Other	0.021	0.020	0.024	0.023	0.016	0.019	0.034	0.028	0.025	+18%	+9.4%	-10%
Total [g I-TEQ]	**11**	**7.5**	**3.5**	**0.95**	**0.78**	**0.48**	**0.49**	**0.52**	**0.73**	**-93%**	**-23%**	**+40%**

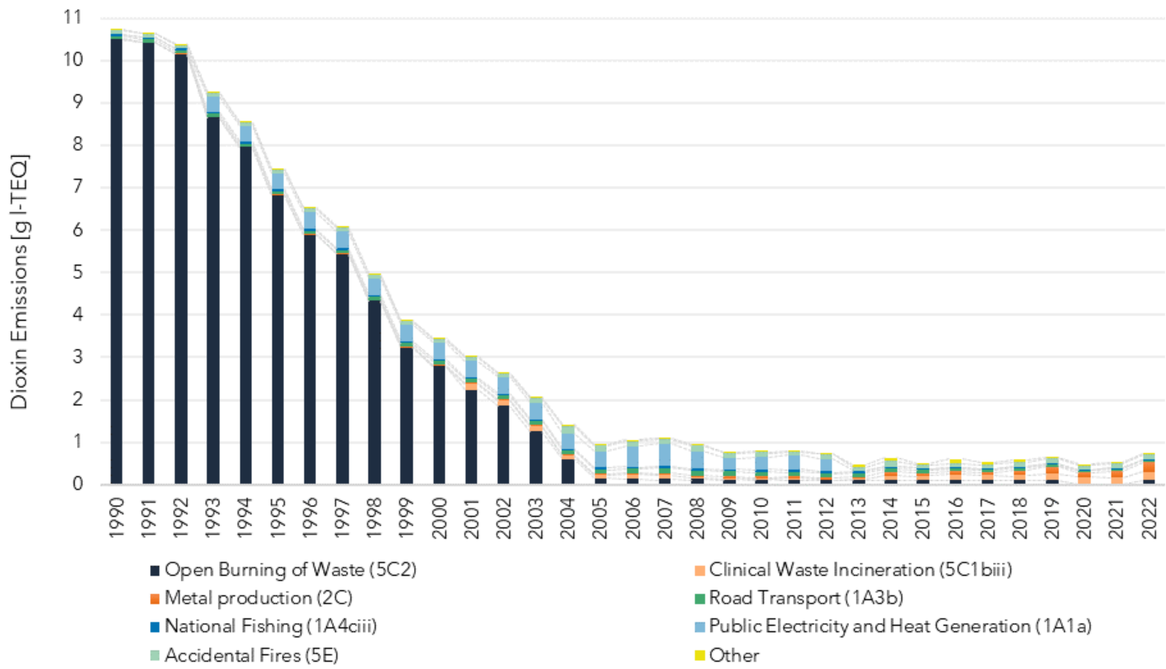


Figure 2.4 Dioxin emissions by main sources since 1990 [g I-TEQ].

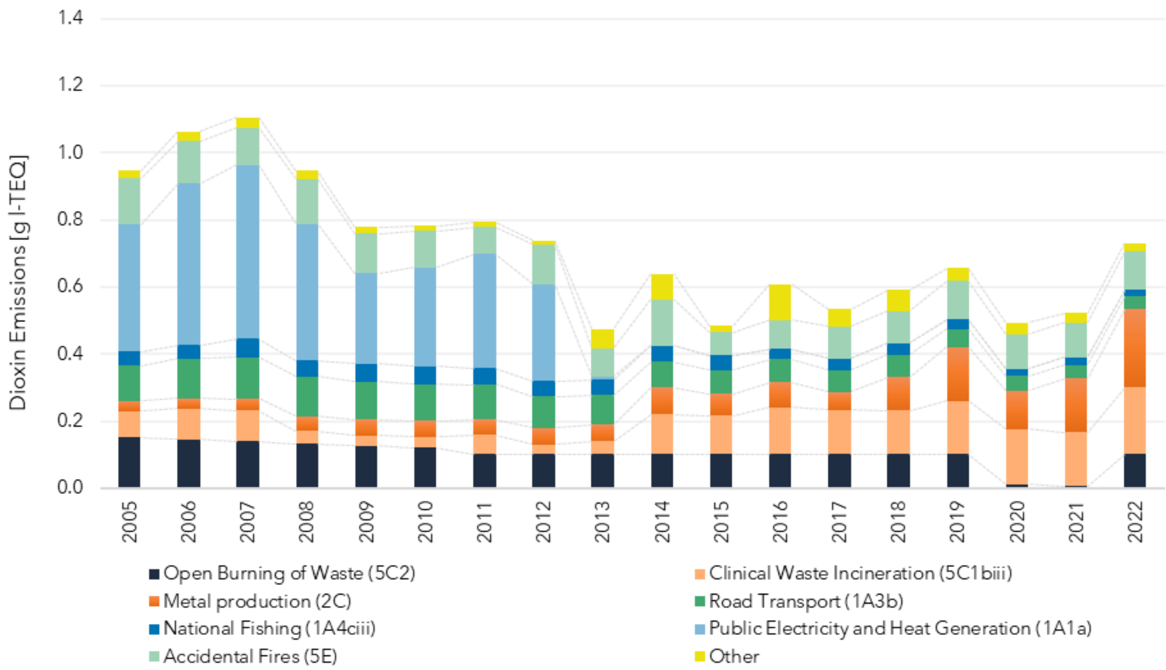


Figure 2.5 Dioxin emissions by main sources since 2005 [g I-TEQ].

Dioxins form a family of toxic chlorinated organic compounds that share certain chemical structures and biological characteristics. Dioxins are members of two closely related families: the polychlorinated dibenzo(p)dioxins (PCDDs; 75 congeners) and polychlorinated dibenzofurans (PCDFs; 135 congeners). Dioxins bioaccumulate in humans and wildlife due to their fat solubility and 17 of these compounds are especially toxic. Dioxins are formed during combustion processes such as commercial or municipal waste incineration and from burning fuels like wood, coal, or oil. Dioxins can also be formed in natural processes such as forest fires. Dioxins also enter the environment through the production and use of organochlorine compounds, chlorine bleaching of pulp and paper, certain types of chemical manufacturing and processing, and other industrial processes that create small quantities of dioxins. Cigarette smoke also contains small amounts of dioxins.

Emissions of dioxins are presented in [g I-TEQ] (International Toxic Equivalents). 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is the most toxic of the dioxin congeners. Other congeners (or mixtures thereof) are given a toxicity rating from 0 to 1, where TCDD is 1. The total dioxin toxic equivalence (TEQ) value expresses the toxicity as if the mixture were pure TCDD.

2.3.2 Trends in Polycyclic Aromatic Hydrocarbons (PAHs) Emissions

Since 1990, total emissions of PAH4 in Iceland have decreased substantially. The main reason for the significant reduction of PAH4 emissions is the significant decrease in open burning of waste between 1990 and 2004. In recent years, the main contributors to PAH4 emissions have been Bonfires (reported as 5C2 Open Burning of Waste), Aluminium Production (2C3), Ferroalloys Production (2C2) and Road Transport (1A3b).

PAH4 emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.14 and Figure 2.6.

- **Open Burning of Waste (5C2):** PAH4 emissions from Open Burning of Waste have decreased significantly since 1990, partly because outdated incineration plants and open pit burning have been discontinued. A more detailed description of the decrease in emissions from this sector is in Section 2.3.1 above.
- **Metal Production (2C):** Since 2005, PAH4 emissions from industrial processes (Industry) have increased due to substantially increased production capacity in the Metal Production sector. The contribution of the sector to the total PAH4 emissions has been steadily increasing since 1990. The main increase in emissions happened in 1998-2000 as well as in 2006-2008. Between 1998 and 2000, the increase in emissions was due to increased production capacity both in the aluminium and the ferrosilicon industries. In 2006-2008, the cause was increased production capacity in the aluminium industry.
- **Road Transport (1A3b):** Road Transport is an important source of PAH4 emissions in Iceland. PAH4 emissions from this sector are estimated to have more than doubled since 1990 due to more vehicle kilometres travelled and consequent increase in fuel usage.
- **Accidental Fires (5E):** The calculations are based on data from the fire department of the capital region on building and vehicle fires each year.
- **Stationary Combustion: Non-metallic Minerals (1A2f):** Significant PAH4 emissions resulted from the combustion of other bituminous coal for cement production until 2012 when production was stopped.

Table 2.14 PAH4 emissions by main sources since 1990 [t].

PAH4 Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Open Burning of Waste (5C2)	0.49	0.34	0.21	0.033	0.025	0.024	0.0028	0.0012	0.024	-95%	-27%	1900%
Stationary Combustion: Non-metallic Minerals (1A2f)	0.070	0.033	0.050	0.038	0.014	9.2E-08	1.1E-07	1.1E-07	1.1E-07	-100%	-100%	0.41%
Aluminium Production (2C3)	0.0020	0.0022	0.0048	0.0058	0.016	0.017	0.016	0.017	0.017	748%	188%	0.48%
Ferroalloys Production (2C2)	0.0090	0.010	0.016	0.016	0.015	0.017	0.015	0.016	0.016	79%	1.4%	-1.1%
Road Transport (1A3b)	0.0076	0.0076	0.0079	0.011	0.013	0.014	0.018	0.019	0.020	161%	83%	3.8%
Accidental Fires (5E)	0.0078	0.0080	0.0072	0.0079	0.0061	0.0063	0.0043	0.0042	0.0042	-46%	-47%	0.22%
Other	0.0036	0.0043	0.0054	0.0059	0.0030	0.0050	0.0036	0.0040	0.0038	4.5%	-36%	-4.7%
Total [t]	**0.59**	**0.40**	**0.30**	**0.12**	**0.092**	**0.083**	**0.060**	**0.061**	**0.084**	**-86%**	**-28%**	**37%**

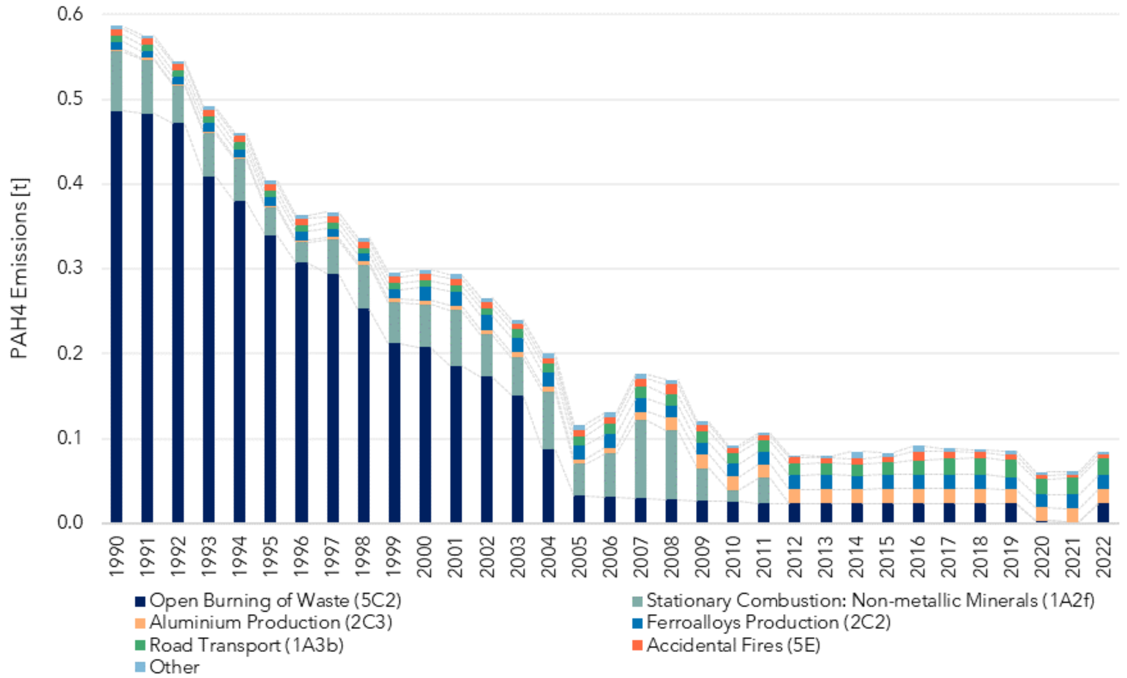


Figure 2.6 PAH emissions by sector, since 1990.

The polycyclic aromatic hydrocarbons (PAH) are molecules built up of benzene rings which resemble fragments of single layers of graphite. PAHs are a group of approximately 100 compounds. Most PAHs in the environment arise from incomplete burning of carbon-containing materials like oil, coal, wood, or waste. Fires can produce fine PAH particles; they bind to ash particles and sometimes move long distances through the air. Thus, PAHs have been ubiquitously distributed in the natural environment for thousands of years. The four compounds benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene are used as PAH indicators for the purposes of emission inventories, as specified in the POPs - Protocol.

2.3.3 Trends in Hexachlorobenzene (HCB) Emissions

There have been significant changes in HCB emissions since 1990. For most of the years since 1990, Fireworks (2G) were the largest source of HCB emissions in Iceland. More stringent restrictions on HCB in fireworks are the reason for a significant reduction in HCB emissions since 2012. Other main sources of HCB emissions are Clinical Waste Incineration (5C1biii), Aluminium Production (2C3) and National Fishing (1A4ciii). The emissions from these sources are described below and can be seen in Table 2.15 and Figure 2.7.

- **Fireworks (2G):** Fireworks now use a country-specific emission factor based on measurements of the average Pb and HCB taking from samples of different fireworks sold in Iceland in 2018. The new emissions factors indicate that fireworks are now a key category for HCB emissions. It is worth noting that fireworks are only legal to use in Iceland around New Year's, but their usage during this time is widespread and extremely high.
- **Clinical Waste Incineration (5C1biii):** Clinical waste incineration was responsible for most HCB emissions in Iceland in recent years.

- **Aluminium Production (2C3):** The HCB emissions rise from secondary aluminium production. HCB emissions from primary aluminium production are not estimated since there is no emission factor available in the 2019 EMEP/EEA Guidebook.
- **National Fishing (1A4ciii):** Emissions from commercial fishing rose from 1990 to 1996 when a substantial portion of the fishing fleet was operating in distant fishing grounds. Since then, emissions have been following a generally decreasing trend, but with fluctuations due to varying conditions in the fishing industry (renewing of fishing fleet, status of fish stocks, etc), as well as different ratios of the use of marine gas oil versus heavy fuel oil.
- **Open Burning of Waste (5C2):** HCB emissions from Open Burning of Waste have decreased significantly since 1990, mostly because outdated incineration plants and open pit burning have been discontinued, and less waste is burned overall. A more detailed description of the decrease in emissions from this sector is in Section 2.3.1 above.

Table 2.15 HCB emissions by main sources since 1990 [kg].

HCB Emissions [kg]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Fireworks (2G)	0.12	0.14	0.39	0.65	0.50	0.32	0.023	0.025	0.032	-72%	-95%	+31%
Clinical Waste Incineration (5C1biii)	NO	NO	NO	0.020	0.008	0.029	0.041	0.040	0.050		+154%	+24%
National Fishing (1A4ciii)	0.021	0.027	0.024	0.021	0.022	0.019	0.013	0.014	0.012	-43%	-41%	-16%
Aluminium Production (2C3)	NA	NA	NA	0.011	0.010	0.011	0.011	0.018	0.016		+40%	-13%
Open Burning of Waste (5C2)	0.13	0.085	0.048	3.8E-04	2.9E-04	1.5E-04	1.8E-05	7.7E-06	1.5E-04	-100%	-60%	+1900%
Other	2.4E-03	0.012	0.015	0.016	0.019	3.3E-03	5.8E-03	4.2E-03	3.5E-03	+47%	-77%	-16%
Total [kg]	**0.27**	**0.27**	**0.47**	**0.72**	**0.56**	**0.38**	**0.094**	**0.10**	**0.11**	**-58%**	**-84%**	**+12%**

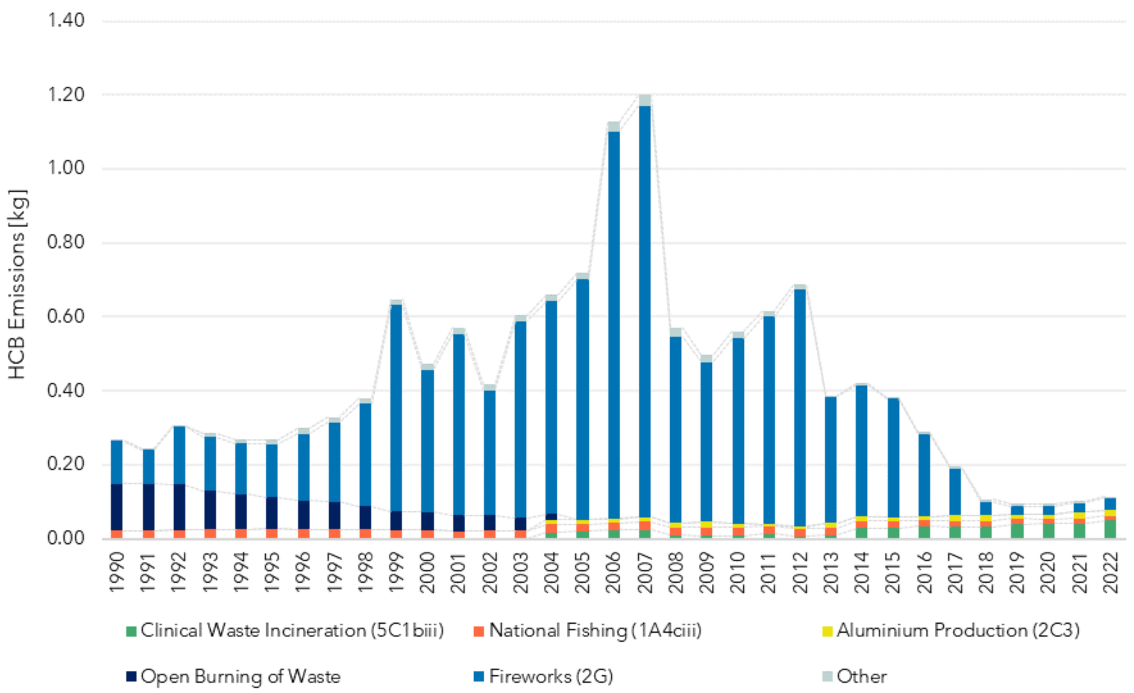


Figure 2.7 HCB emissions by sector, since 1990.

Hexachlorobenzene (HCB) or perchlorobenzene is a chlorocarbon with the molecular formula C6Cl6. HCB is a fungicide that was first introduced in 1945 for seed treatment, especially for the control of bunt of wheat. HCB is currently emitted as a by-product in the manufacture of several chlorinated solvents. Overall, processes resulting in dioxin formation also result in HCB emissions. HCB is considered to be a probable human carcinogen. HCB is a very persistent environmental chemical due to its chemical stability and resistance to biodegradation.

2.3.4 Trends in Polychlorinated Biphenyl (PCB) Emissions

In the early years of the time series, one of the main sources of PCB in Iceland was open burning of waste, following a decreasing trend between 1990 and 2004 as seen for the other POPs. The other main sources contributing to PCB emission trends were National Fishing (1A4ciii), Stationary Combustion: Non-metallic Minerals (1A2f), and Heat Plants (1A1aiii). Currently, the main source is Clinical Waste Incineration (5C1biii). The only source of PCB estimated from industrial processes is Secondary Steel Production (2C1). The only secondary steel plant in Iceland started its activities in 2014 and closed in 2016. PCB emissions in Iceland are mainly from the subsectors described below. The emissions from these sources can be seen in Table 2.16 and Figure 2.8.

The analysis of the trends in PCB emissions in Iceland must be interpreted with care as only a few sources have been estimated, which reflects the lack of emission factors in the 2019 EMEP/EEA Guidebook.

- **Clinical Waste Incineration (5C1biii):** Waste incineration was responsible for the majority of PCB emissions in recent years, as emissions from other sectors have decreased.

- **National Fishing (1A4ciii):** Emissions from commercial fishing have fluctuated due to varying conditions in the fishing industry (renewing of fishing fleet, status of fish stocks, etc.), as well as different ratios of the use of marine gas oil versus residual fuel oil. Those two fuel types have very different emission factors for PCB. Residual fuel oil use on ships has been banned since 1 January 2020, hence the lower PCB emissions since then.
- **Open Burning of Waste (5C2):** PCB emissions from Open Burning of Waste have decreased significantly since 1990, partly because outdated incineration plants and open pit burning have been discontinued. A more detailed description of the decrease in emissions from this sector is in Section 2.3.1 above.
- **Stationary Combustion: Non-metallic Minerals (1A2f):** Significant PCB emissions resulted from the combustion of other bituminous coal for cement production until 2012 when production was stopped.
- **Heat Plants (1A1aiii):** Waste incineration with energy recovery, which caused significant emissions, was occurring between 1993-2013.

Table 2.16 PCB emissions by main sources since 1990 [kg].

PCB Emissions [kg]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Clinical Waste Incineration (5C1biii)	NO	NO	NO	0.0039	0.0017	0.0057	0.0082	0.0080	0.010		+154%	+24%
National Fishing (1A4ciii)	0.028	0.041	0.022	0.026	0.046	0.035	0.0060	0.0068	0.0057	-80%	-78%	-16%
Open Burning of Waste (5C2)	0.19	0.13	0.071	2.6E-4	2.5E-4	1.8E-6	2.2E-7	9.2E-8	1.8E-6	-100%	-99%	+1900%
Stationary Combustion: Non-metallic Minerals (1A2f)	0.082	0.038	0.058	0.043	0.016	NA	NA	NA	NA	-100%	-100%	
Heat Plants (1A1aiii)	NA	0.025	0.032	0.032	0.043	NA	NA	NA	NA		-100%	
Secondary Steel Production (2C1)	NO	NO	NO	NO	NO	0.011	NO	NO	NO			
Other	0.0026	0.0055	0.0036	0.0040	0.0039	0.012	7.1E-4	6.0E-4	7.5E-4	-71%	-81%	+25%
Total [kg]	**0.30**	**0.24**	**0.19**	**0.11**	**0.11**	**0.053**	**0.015**	**0.015**	**0.016**	**-95%**	**-85%**	**+6.6%**

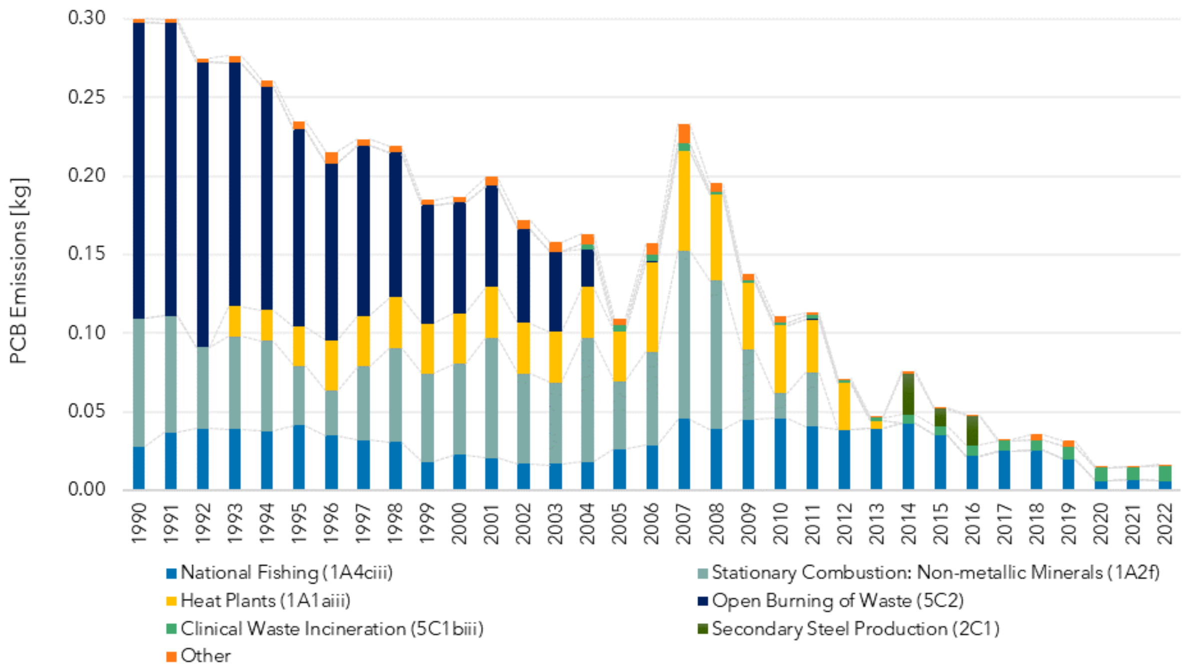


Figure 2.8 PCB emissions by sector, since 1990.

2.4 Emission Trends for Heavy Metals

Emission estimates for 1990 and 2022 for priority heavy metals (Pb, Cd, and Hg) as well as additional heavy metals (As, Cr, Cu, Ni, Se, and Zn) are shown in Table 2.17.

The sectors contributing to the emissions of heavy metals are Energy, Industrial Processes, and Waste. According to the 2019 EMEP/EEA Guidebook, heavy metal emissions in the Agriculture sector only arise from the burning of crop residues. Since this activity does not occur in Iceland, there are no heavy metal emissions from the Agriculture sector.

Current emissions are dominated by either emissions from Road Transport or Aluminium Production for all heavy metals other than Hg and Se, where National Fishing is the largest source of emissions.

Table 2.17 Estimated emissions of heavy metals, 1990 and 2022.

	Pb [t]	Cd [t]	Hg [t]	As [t]	Cr [t]	Cu [t]	Ni [t]	Se [t]	Zn [t]
1990	0.88	0.022	0.140	0.070	0.12	1.71	1.72	0.035	2.31
2022	0.69	0.131	0.010	0.145	0.24	3.43	1.86	0.020	5.70
Change 1990-2022	-22%	486%	-93%	106%	96%	101%	9%	-44%	147%

2.4.1 Trends in Priority Heavy Metals (Pb, Cd, Hg)

Pb, Cd and Hg emissions in Iceland are mainly from the subsectors described below. The Pb emissions from the main sources can be seen in Table 2.16 and Figure 2.8. The Cd emissions from the main sources can be seen in Table 2.16 and Figure 2.8. The Hg emissions from the main sources can be seen in Table 2.16 and Figure 2.8.

- **Road Transport (1A3b):** Emissions from Road Transport are a part of the current Pb and Hg emissions. The emissions have increased over the timeline due to more fuel use.
- **Aluminium Production (2C3):** Emissions from Aluminium Production are then main source of Cd emissions over the whole timeline, as well as a part of the current Pb emissions. The emissions increased significantly in 2006-2008 due to increased production and have been relatively stable since.
- **Domestic Aviation LTO (civil) (1A3aii(i)):** Emissions have decreased significantly since 1990 due to reduced use of aviation gasoline.
- **Fireworks (2G):** A contributor to the Pb emissions is the use of fireworks (under IPPU), mostly around New Year's Eve. A peak in the years 2006-2007 reflects the peak in economic growth, before the economic collapse of 2008.
- **Accidental Fires (5E):** Accidental Fires cause a part of the Pb emissions.
- **Heat Plants (1A1aiii):** In 1993, Waste Incineration with Recovery of Energy (included in the Energy sector under 1A1a Public Electricity and Heat Production) started in Iceland, leading to an increase in Pb, Cd, and Hg. The amount of waste burned with recovery of energy peaked in 2007, and after that decreased until 2013, at which point this activity stopped.
- **National Fishing (1A4ciii):** Emissions from Commercial Fishing contribute to Cd and Hg emissions. Since 1995, the emissions have been following a generally decreasing trend, but with fluctuations due to varying conditions in the fishing industry (renewing of fishing fleet, status of fish stocks, etc.), as well as different ratios of use of marine gas oil versus heavy fuel oil.

- **Open Burning of Waste (5C2):** The main source of Hg emissions in the 1990s was open burning of waste. It was also a contributor of Cd emissions. Open pit burning was mostly occurring between 1990 and 2004.
- **Clinical Waste Incineration (5C1biii):** The largest emission source of Hg in recent years is Clinical Waste Incineration. Clinical waste was burnt openly, until 2011 when the waste incinerator *Kalka* started handling all of Iceland's clinical waste.
- **Cremation (5C1bv):** Cremations are an increasing source of Hg emissions in Iceland as it becomes a more popular option among Icelanders.

Table 2.18 Pb emissions by main sources since 1990 [t].

Pb Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change		
										'90-'22	'05-'22	'21-'22
Fireworks (2G)	0.089	0.11	0.30	0.50	0.22	0.029	0.024	0.026	0.033	-63%	-93%	+31%
Road transport: Automobile tyre and brake wear (1A3bvi)	0.16	0.17	0.20	0.25	0.27	0.28	0.31	0.33	0.34	+112%	+36%	+4.9%
Accidental Fires (5E)	0.056	0.058	0.051	0.053	0.041	0.045	0.026	0.026	0.025	-55%	-52%	-2.7%
Stationary Combustion: Non-metallic Minerals (1A2f)	0.064	0.030	0.046	0.034	0.013	3.7E-07	4.4E-07	4.4E-07	4.4E-07	-100%	-100%	+0.41%
Heat Plants (1A1aiii)	5.5E-04	0.48	0.63	0.62	0.84	2.5E-5	NO	2.2E-5	1.2E-4	-77%	-100%	+461%
Domestic Aviation LTO (Civil) (1A3aii(i))	0.35	0.24	0.23	0.18	0.14	0.11	0.043	0.052	0.048	-86%	-74%	-8.6%
Aluminium Production (2C3)	0.017	0.020	0.045	0.054	0.16	0.17	0.16	0.17	0.17	+856%	+208%	+0.51%
Other	0.51	0.47	0.52	0.49	0.45	0.40	0.28	0.29	0.28	-44%	-42%	-1.3%
Total [t]	**0.88**	**1.3**	**1.7**	**1.9**	**1.8**	**0.75**	**0.63**	**0.67**	**0.69**	**-22%**	**-65%**	**+2.9%**

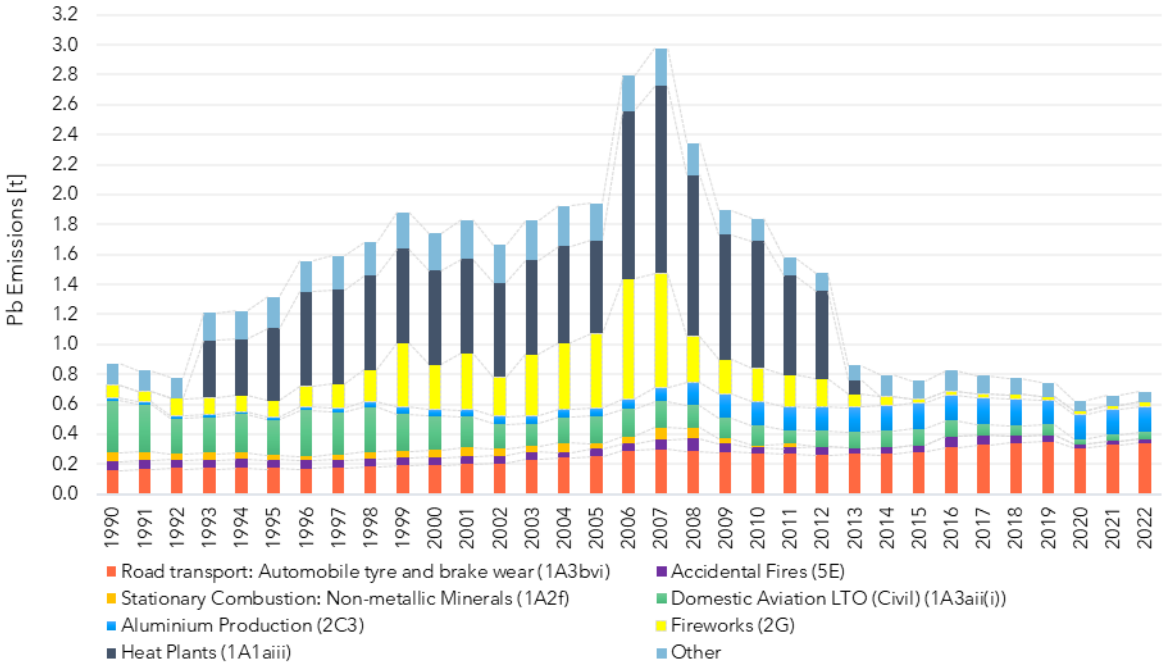


Figure 2.9 Pb emissions by sector, since 1990.

Table 2.19 Cd emissions by main sources since 1990 [kg].

Cd Emissions [kg]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change		
										'90-'22	'05-'22	'21-'22
Aluminium Production (2C3)	13	15	34	40	121	127	123	124	125	+856%	+208%	+0.51%
National Fishing (1A4ciii)	2.7	3.5	3.0	2.7	3.0	2.5	1.6	1.8	1.5	-45%	-43%	-16%
Open burning of waste (5C2)	3.8	2.6	1.6	0.23	0.18	0.17	0.020	0.0085	0.17	-96%	-27%	+1900 %
Heat Plants (1A1aiii)	0.14	16	21	20	28	0.0066	NO	0.0074	4.2E-5	-100%	-100%	-99%
Other	2.6	3.9	5.0	5.6	4.1	3.9	4.1	3.5	4.5	+73%	-20%	+27%
Total [kg]	**22**	**41**	**64**	**69**	**156**	**134**	**129**	**129**	**131**	**+486%**	**+89%**	**+1.1%**

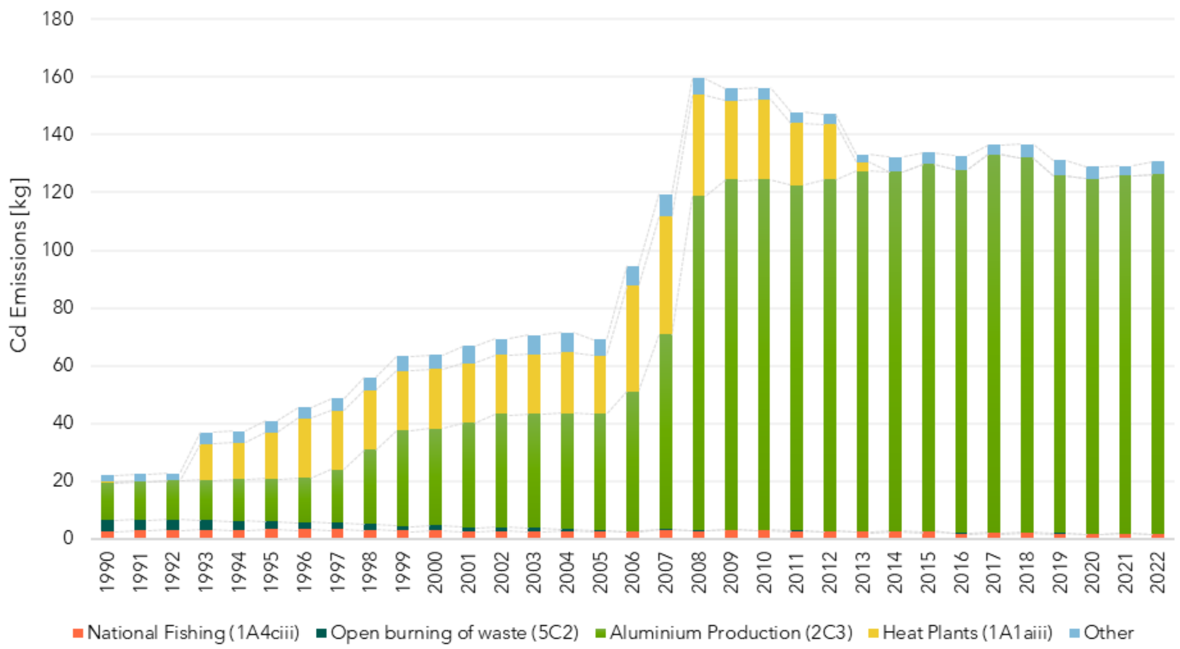


Figure 2.10 Cd emissions by sector, since 1990.

Table 2.20 Hg emissions by main sources since 1990 [kg].

Hg Emissions [kg]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
National Fishing (1A4ciii)	6.8	8.1	8.2	6.7	6.1	5.3	4.8	5.3	4.5	-34%	-32%	-16%
Road Transport (1A3b)	1.3	1.4	1.5	1.8	1.9	1.9	1.9	2.0	2.0	+57%	+13%	+2.5%
Cremation (5C1bv)	0.19	0.25	0.32	0.52	0.67	0.94	1.5	1.4	1.6	+779%	+215%	+18%
Clinical waste incineration (5C1biii)	NO	NO	NO	0.32	0.13	0.46	0.67	0.65	0.81		+154%	+24%
Heat Plants (1A1aiii)	0.041	13	17	17	23	0.0019	NO	7.4E-3	4.2E-2	+0.93%	-100%	+461%
Open burning of waste (5C2)	126	84	47	0.20	0.17	0.017	0.0021	8.6E-4	1.7E-2	-100%	-91%	+1900 %
Other	14	14	16	14	12	10	7.3	8.0	7.4	-45%	-48%	-7.2%
Total [kg]	**140**	**112**	**81**	**32**	**35**	**12**	**9.5**	**10**	**10**	**-93%**	**-69%**	**-1.1%**

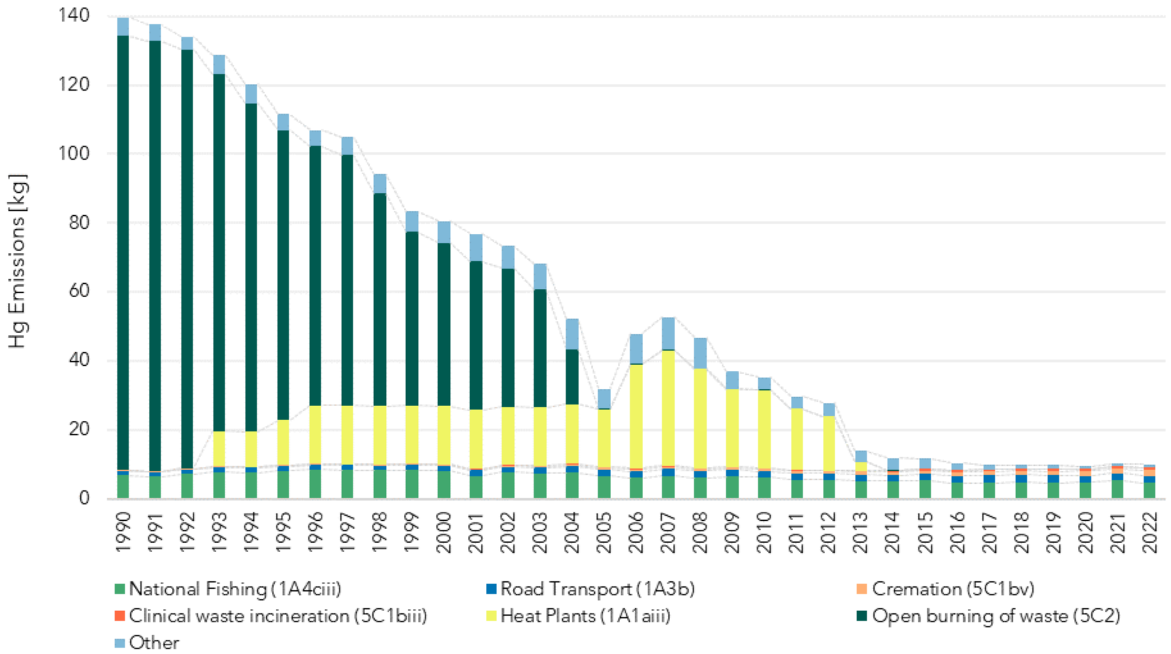


Figure 2.11 Hg emissions by sector, since 1990.

2.4.2 Trends in Additional Heavy Metals (As, Cr, Cu, Ni, Se, and Zn)

The sectors contributing to the emissions of As, Cr, Cu, Ni, Se, and Zn are Energy, Industrial Processes, and Waste. Current emissions are dominated by emissions Road Transport, National Fishing, or Aluminium Production, for all heavy metals.

As, Cr, Cu, Ni, Se, and Zn emissions in Iceland are mainly from the subsectors described below. The emissions can be seen in the tables and figures below.

- **National Fishing (1A4ciii):** Commercial Fishing is the largest contributor of Se emissions and the second largest of As and Ni emissions. Since 1995, the emissions have been following a generally decreasing trend, but with fluctuations due to varying conditions in the fishing industry (renewing of fishing fleet, status of fish stocks, etc), as well as different ratios of use of marine gas oil versus heavy fuel oil.
- **Road Transport (1A3b):** Road Transport is the largest contributor of Cr and Cu emissions and the second largest of Se and Zn emissions, with most of the emissions coming from tyre and brake wear. The emissions have increased over the timeline due to more driving in Iceland.
- **Aluminium Production (2C3):** Aluminium Production is the largest source of As, Ni and Zn emissions and the second largest source of Cr emissions. Aluminium is currently produced at three primary aluminium plants in Iceland. The emissions rose slightly in 1998 due to the opening of a new facility, and more significantly in the period 2006-2008 due to an expansion of one facility and the onset of operations at a new facility. The emissions from primary Al production have been relatively stable since 2008.
- **Heat Plants (1A1aiii):** In 1993, Waste Incineration with Recovery of Energy started in Iceland, leading to an increase in As emissions. The amount of waste burned with recovery of energy peaked in 2007, and after that decreased until 2013, after which year this activity stopped.
- **Open Burning of Waste (5C2):** It was a large contributor of As, Se and Zn emissions in 1990. These emissions decreased steadily until 2004, when open burning of waste, other than bonfires around New Year's Eve, was stopped in Iceland.
- **Fireworks (2G):** A contributor to the Cr, Cu, Ni, and Zn trend is the use of fireworks (under IPPU). The steady increase since 1990 reflects the growing popularity of fireworks in Iceland (mostly around New Year's Eve). A peak in 2007 reflects the peak in economic growth that year, before the economic collapse of 2008.
- **National Navigation (Shipping) (1A3dii):** A contributor to the Cr, Ni and Se trend is National Navigation. This is due to fuel use for National Navigation.
- **Stationary Combustion: Non-metallic Minerals (1A2f):** Some Cr and Se emissions resulted from the combustion of other bituminous coal for cement production until 2012 when production was stopped.
- **Public Electricity and Heat Generation (1A1a):** Emissions from Public Electricity and Heat Generation cause a part of the current Se emissions. This is because of diesel used for electricity production.
- **Accidental Fires (5E):** Emissions from Accidental Fires cause some Zn emissions.

Table 2.21 As emissions by main sources since 1990 [kg].

As Emissions [kg]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
National Fishing (1A4ciii)	32	48	25	30	54	41	6.4	7.1	6.0	-81%	-80%	-16%
Road Transport (1A3b)	1.9	2.0	2.3	2.9	3.2	3.3	3.6	3.8	4.0	+111%	+35%	+4.9%
Aluminium Production (2C3)	13	15	35	42	125	131	127	128	129	+856%	+208%	+0.5%
Heat Plants (1A1aiii)	0.48	10	13	13	17	0.022	NO	0.010	5.5E-05	-100%	-100%	-99%
Open burning of waste (5C2)	16	11	6.6	1.0	0.75	0.70	0.084	0.035	7.0E-04	-100%	-100%	-100%
Other	6.5	7.2	5.9	6.0	5.7	5.6	3.6	4.3	6.4	-2.3%	+6.1%	+47%
Total [kg]	**70**	**94**	**88**	**95**	**206**	**182**	**141**	**143**	**145**	**+106%**	**+53%**	**+1.2%**

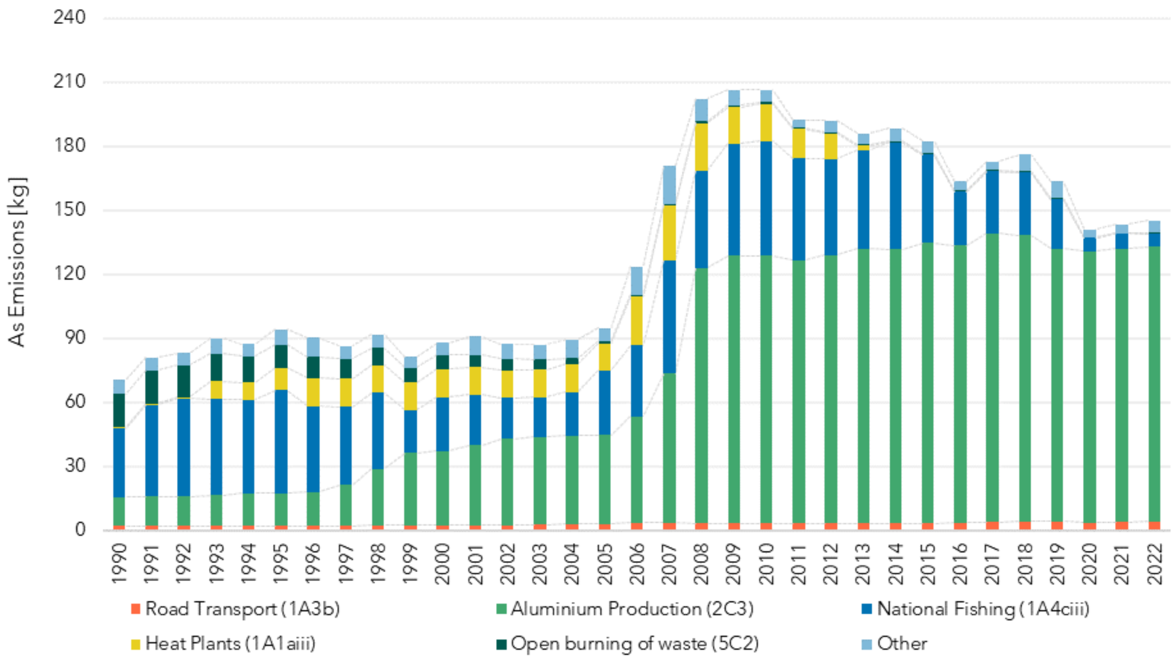


Figure 2.12 As emissions by sector, since 1990.

Table 2.22 Cr emissions by main sources since 1990 [kg].

Cr Emissions [kg]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Road transport: Automobile tyre and brake wear (1A3bvi)	60	65	74	94	101	105	114	122	128	+112%	+36%	+4.9%
National Fishing (1A4ciii)	36	53	29	33	58	45	7.9	8.9	7.5	-79%	-78%	-16%
Fireworks (2G)	1.8	2.2	5.9	10.0	7.7	9.4	7.7	8.2	11	+503%	+7.7%	+31%
Stationary Combustion: Non-metallic Minerals (1A2f)	6.5	3.1	4.7	3.5	1.3	9.1E-04	1.1E-03	1.1E-03	1.1E-03	-100%	-100%	+0.41%
Aluminium Production (2C3)	8.7	9.9	22	27	81	85	82	83	83	+856%	+208%	+0.51%
Other	9.5	11.4	9.4	10.0	9.4	10.8	8.6	9.7	10.6	+11%	+5.8%	+9.3%
Total [kg]	**123**	**145**	**145**	**178**	**259**	**254**	**221**	**231**	**240**	**+96%**	**+35%**	**+3.6%**

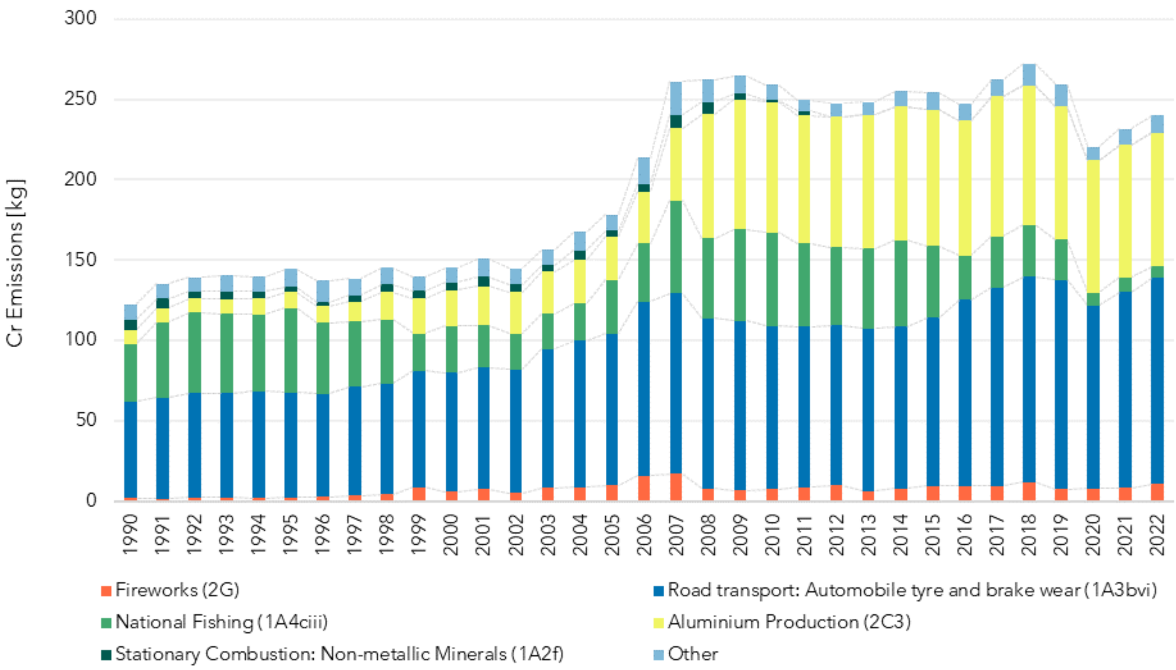


Figure 2.13 Cr emissions by sector, since 1990.

Table 2.23 Cu emissions by main sources since 1990 [t].

Cu Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Road transport: Automobile tyre and brake wear (1A3bvi)	1.32	1.43	1.63	2.07	2.23	2.30	2.50	2.68	2.81	+112%	+35%	+4.8%
Fireworks (2G)	0.051	0.063	0.168	0.283	0.218	0.267	0.219	0.234	0.305	+503%	+7.7%	+30.5%
National Fishing (1A4ciii)	0.223	0.275	0.254	0.217	0.227	0.191	0.140	0.157	0.132	-41%	-39%	-16%
Aluminium Production (2C3)	0.014	0.016	0.037	0.044	0.134	0.140	0.136	0.136	0.137	+856%	+208%	+0.51%
Other	0.097	0.107	0.124	0.133	0.075	0.080	0.056	0.051	0.053	-45%	-60%	+4.1%
Total [t]	**1.71**	**1.89**	**2.21**	**2.75**	**2.88**	**2.97**	**3.06**	**3.26**	**3.43**	**+101%**	**+25%**	**+5.5%**

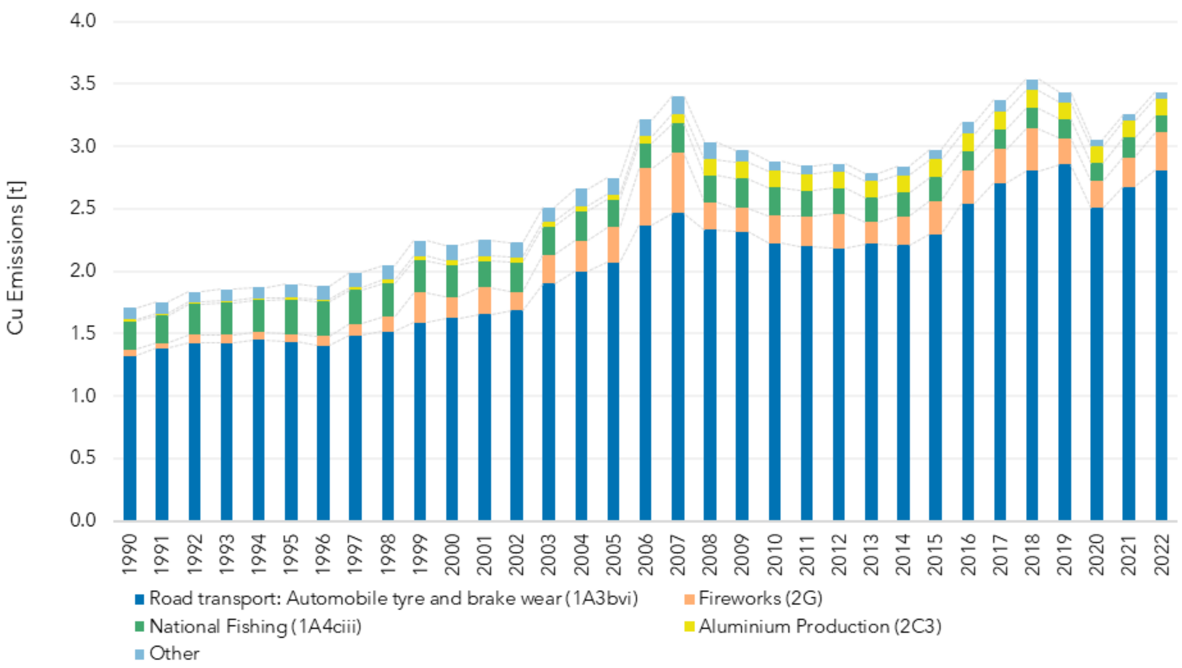


Figure 2.14 Cu emissions by sector, since 1990.

Table 2.24 Ni emissions by main sources since 1990 [t].

Ni Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
National Fishing (1A4ciii)	1.34	2.06	0.97	1.24	2.39	1.82	0.16	0.18	0.15	-89%	-88%	-16%
Aluminium Production (2C3)	0.17	0.20	0.45	0.54	1.62	1.70	1.64	1.65	1.66	+856%	+208%	+0.51%
National Navigation (Shipping) (1A3dii)	0.13	0.16	0.021	0.034	0.092	0.022	0.0078	0.0055	0.0077	-94%	-78%	+40%
Other	0.067	0.065	0.044	0.051	0.037	0.044	0.036	0.038	0.045	-33%	-12%	+17%
Total [t]	**1.72**	**2.48**	**1.48**	**1.87**	**4.14**	**3.58**	**1.85**	**1.88**	**1.86**	**+8.6%**	**-0.18%**	**-0.58%**

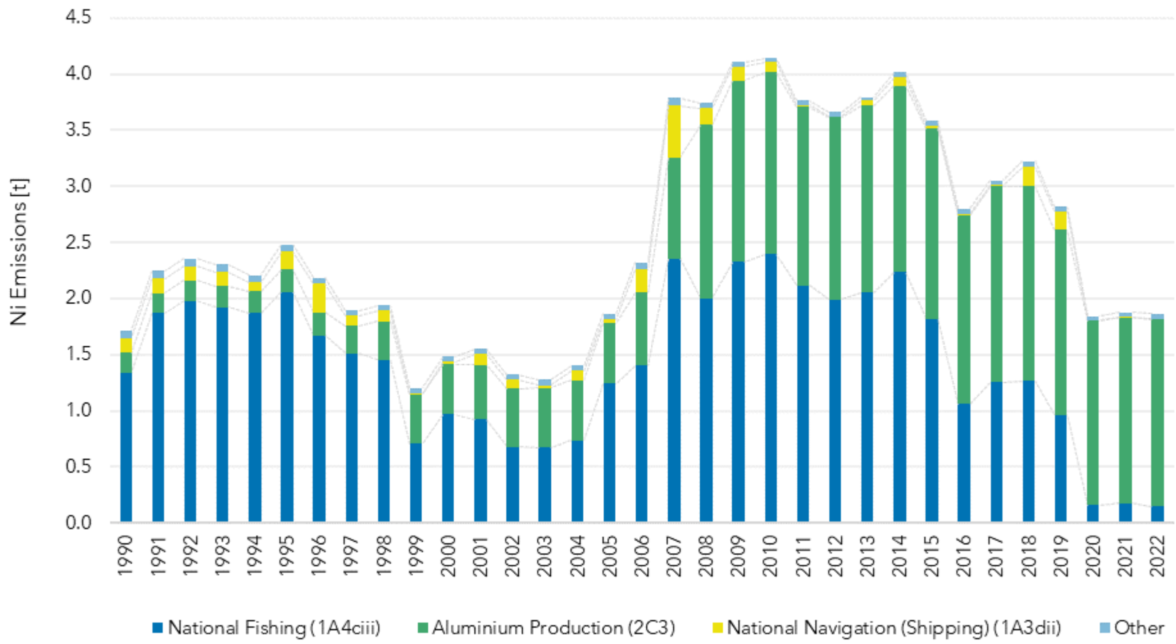


Figure 2.15 Ni emissions by sector, since 1990.

Table 2.25 Se emissions by main sources since 1990 [kg].

Se Emissions [kg]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
National Fishing (1A4ciii)	28	35	30	27	31	25	16	18	15	-46%	-44%	-16%
Road transport: Automobile tyre and brake wear (1A3bvi)	1.1	1.2	1.3	1.7	1.8	1.9	2.1	2.3	2.4	+122%	+42%	+6.0%
National Navigation (Shipping) (1A3dii)	1.47	1.70	0.46	0.80	1.39	0.88	0.78	0.55	0.77	-48%	-4.5%	+40%
Stationary Combustion: Non-metallic Minerals (1A2f)	0.87	0.42	0.64	0.50	0.17	5.0E-4	6.0E-4	6.1E-4	6.1E-7	-100%	-100%	-100%
Open burning of waste (5C2)	2.66	1.85	1.13	0.16	0.13	1.2E-4	1.4E-5	6.0E-6	1.2E-4	-100%	-100%	+1900 %
Other	1.33	1.41	1.32	1.19	1.02	1.07	0.65	0.74	1.58	+19%	+33%	+115%
Total [kg]	**35**	**42**	**35**	**31**	**35**	**29**	**19**	**21**	**20**	**-44%**	**-37%**	**-7.4%**

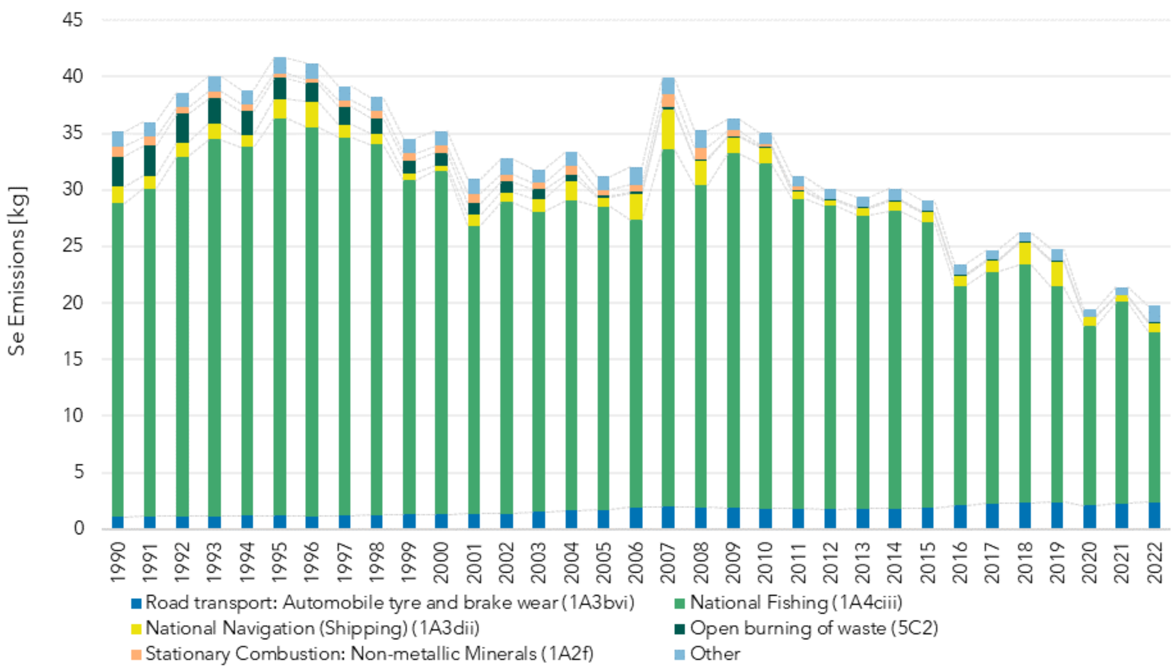


Figure 2.16 Se emissions by sector, since 1990.

Table 2.26 Zn emissions by main sources since 1990 [t].

Zn Emissions [t]	1990	1995	2000	2005	2010	2015	2020	2021	2022	Change '90-'22	Change '05-'22	Change '21-'22
Road transport: Automobile tyre and brake wear (1A3bvi)	0.43	0.47	0.53	0.68	0.73	0.75	0.84	0.90	0.96	+121%	+41%	+5.9%
National Fishing (1A4ciii)	0.29	0.35	0.33	0.28	0.27	0.23	0.19	0.21	0.18	-37%	-35%	-16%
Accidental Fires (5E)	0.22	0.22	0.20	0.21	0.16	0.18	0.10	0.10	0.10	-55%	-52%	-2.7%
Fireworks (2G)	0.030	0.037	0.10	0.17	0.13	0.16	0.13	0.14	0.18	+503%	+7.7%	+31%
Open burning of waste (5C2)	0.67	0.46	0.28	0.041	0.032	0.0298	0.0036	0.0015	0.0298	-96%	-27%	+1900 %
Aluminium Production (2C3)	0.43	0.50	1.12	1.35	4.05	4.24	4.11	4.13	4.15	+856%	+208%	+0.51%
Other	0.24	0.21	0.23	0.22	0.12	0.11	0.088	0.072	0.11	-56%	-51%	+47%
Total [t]	**2.31**	**2.24**	**2.79**	**2.93**	**5.49**	**5.69**	**5.46**	**5.56**	**5.70**	**+147%**	**+95%**	**+2.6%**

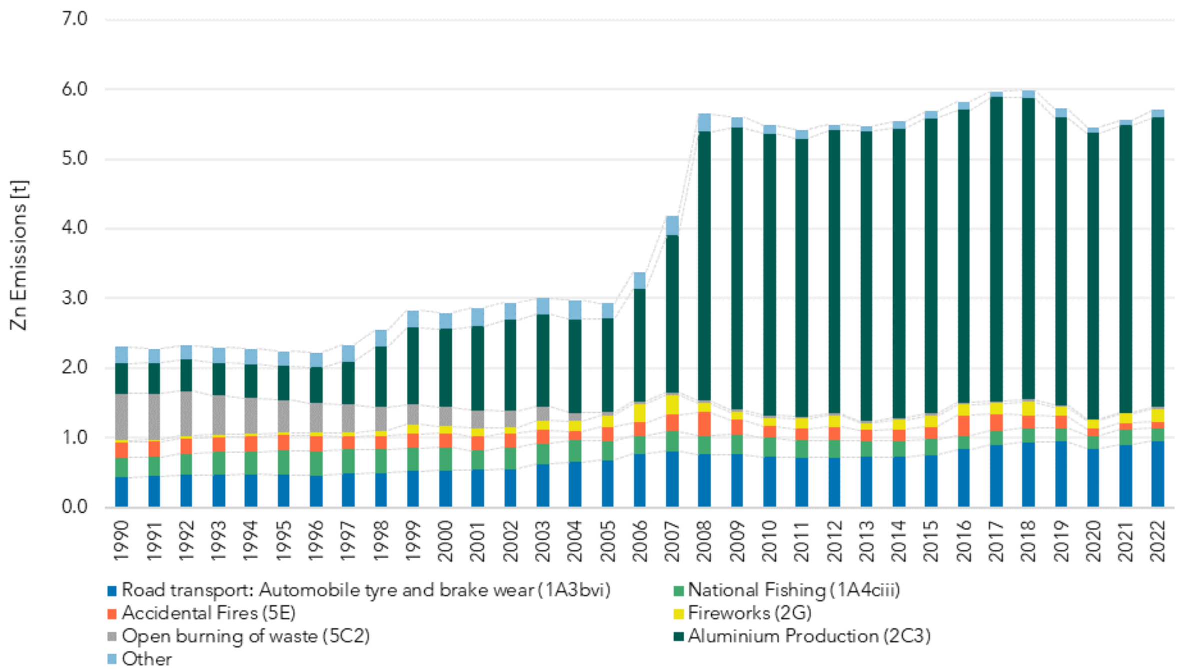


Figure 2.17 Zn emissions by sector, since 1990.

3 Energy (NFR Sector 1)

3.1 Overview

Iceland ranks first among Organisation for Economic Co-operation and Development (OECD) countries in the per capita consumption of primary energy. However, the proportion of domestic renewable energy in the total energy budget is approximately 85%, which is a much higher share than that of most other countries. The cold climate and sparse population call 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 uses around three-quarters of the total electricity produced in Iceland. Iceland relies heavily on its geothermal energy sources for space heating (over 90% of all homes) and electricity production (approx. 30% of the electricity) and on hydropower for electricity production (70% of the electricity). Thus, atmospheric pollutant emissions in the Energy sector originate predominantly from mobile sources: Road Transport, Fishing, and Off-road Machinery Including Construction, as well as waste incineration with energy recovery (occurring from 1993-2012). One exception to this is the emission of H_2S from geothermal powerplants, which is by far the largest key category in Iceland's inventory for sulphur (calculated as SO_2e).

The EAI has been working with a consulting company (Aether Ltd.) since 2015 to improve the Icelandic inventory, and in 2018 a complete review and restructuring of the Energy sector took place in collaboration with experts from Aether, including updating/redesigning calculation spreadsheets as well as checking all emission factors across the sector. Further work is planned in collaboration with the National Energy Authority (*Orkustofnun*) (NEA), the Icelandic Transport Authority (*Samgöngustofa*) (ITA), and Statistics Iceland (*Hagstofa Íslands*) (SI) in order to harmonise all datasets used.

The Energy chapter is divided into the following subchapters:

- Stationary Combustion (NFR 1A1, 1A2, 1A4, and 1A5)
- Transport and Other Mobile Sources (NFR 1A2, 1A3, and 1A4)
- Fugitive Emissions (NFR 1B2) (including emissions from geothermal utilisation)

Table 3.1 illustrates the key categories of air pollutants within the Energy sector, as determined by their significance in terms of absolute level, trend, or uncertainty in emissions within the national inventory system (EEA, 2019). Categories whose cumulative percentage contribution is greater than 80% should be identified as key.

Table 3.1 Key categories for air pollutants within Energy.

SOx, NOx, NH3, NMVOCs, PM, BC, and CO	1990	2022	Trend
1A2e Stationary Combustion in Manufacturing Industries and Construction: Food Processing and Beverages	NOx, BC	BC	SOx, BC
1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals	PM2.5		PM2.5
1A2gvii Mobile Combustion in Manufacturing Industries and Construction	PM2.5, BC	BC	BC
1A3ai(i) International Aviation LTO (Civil)		NMVOC	NOx, NMVOC
1A3bi Road Transport: Passenger Cars	NOx, NMVOC, PM2.5, BC, CO	NOx, NMVOC, BC	NOx, NMVOC, CO
1A3bii Road transport: Light duty vehicles			NOx
1A3biii Road Transport: Heavy-duty Vehicles and Buses	NOx, PM2.5, BC	NOx, BC	BC
1A3bv Road Transport: Gasoline Evaporation	NMVOC		NMVOC
1A3bvi Road Transport: Automobile Tire and Brake Wear		PM2.5, PM10, BC	PM2.5, PM10, BC
1A3bvii Road Transport: Automobile Road Abrasion	PM2.5, PM10, TSP	PM2.5, PM10, TSP, BC	PM2.5, PM10, TSP, BC
1A4cii Agriculture/Forestry/Fishing: Off-road Vehicles and other machinery	BC	BC	
1A4ciii National Fishing	NOx, NMVOC, PM2.5, PM10, TSP, BC	NOx, NMVOC, PM2.5, PM10, TSP, BC	PM2.5, PM10
1B2av Distribution of Oil Products	NMVOC	NMVOC	NMVOC
1B2d Other Fugitive Emissions from Energy Production (Geothermal Energy)	SOx	SOx	SOx
Persistent Organic Pollutants (POPs)	**1990**	**2022**	**Trend**
1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals	PCB		PAH4
1A3bi Road Transport: Passenger Cars		PAH4	PAH4
1A4ciii National Fishing		PCB	
Heavy Metals (HMs)	1990	2022	**Trend**
1A1a Public electricity and heat production			Se
1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals	Pb		Pb, Cr
1A3aii(i) Domestic aviation LTO (civil)	Pb	Pb	Pb

Heavy Metals (HMs)			
	1990	2022	Trend
1A3bi Road Transport: Passenger Cars		Hg	Hg
1A3bvi Road Transport: Automobile Tire and Brake Wear	Pb, Cr, Cu, Zn	Pb, Cr, Cu, Se, Zn	Pb, Cu, Se
1A4ciii National Fishing	Cd, As, Cr, Cu, Ni, Se, Zn	Hg, Se	Cd, Hg, As, Cr, Cu, Ni, Se, Zn

3.2 General Methodology

Emissions from fuel combustion activities are estimated at the sector level based on methodologies suggested by the 2006 IPCC Guidelines and the 2019 EEA/EMEP Guidebook. They are calculated by multiplying energy use by source and sector with pollutant-specific emission factors. Activity data is provided by the NEA, which collects data from the oil companies on fuel sales by sector.

Emissions from Road Transportation are estimated using COPERT 5.6.1, which follows the methodology presented in the 2019 EEA/EMEP Guidebook. A more detailed description is provided in Chapter 3.4.3.

For the 2020 submission, a comprehensive review was performed on how the fuels sales data from the NEA is attributed to IPCC/NFR sectors. For the 2023 submission the review only included the years 2003-2019 because the methodology used to collect the data by the NEA changed between 2002 and 2003. For the 2022 submission, the same attribution of fuels to IPCC categories for 1990-2002 was performed with a review of the sales statistics. Consequently, the whole time series has been reviewed and methodologies harmonised from 1990 and onwards. The aim of the review of the fuel sales data from the NEA was to make the adjustments from the sales statistics to the IPCC/NFR categories more transparent. This is what was done for each category to achieve the following:

- 1A1 Energy Industries – sales statistics are used directly, and no adjustments are needed;
- 1A2 Manufacturing Industries – adjustments are needed to transform sales statistics into IPCC categories (detailed description below);
- 1A4a and 1A4b Commercial/Residential Combustion – sales statistics are used directly, and no adjustments are needed;
- 1A5 Other – all fuels that are categorised as Other in sales statistics without any explanation of use are attributed to this category.

Due to insufficiently detailed splits in the sales statistics between fuel used for different manufacturing industries that belong to NFR category 1A2, some adjustments are needed. To try to have this input data as accurate as possible:

- It is assumed that Green Accounting reports (Regulation 851/2002) and EU ETS Annual Emission Reports from 2013 are correct for each company and that data is used for 1A2a, 1A2b, 1A2c, and 1A2f – this is the known usage.
- Because these fuels are purchased from domestic oil companies, they will be subtracted from the sales statistics received from the NEA.

- The difference between known usage and sales statistics is attributed to the category 1A2gviii Other Industry.

These adjustments are described in Figure 3.1. For some fuel types and years, the subtraction of known use from sales statistics does result in a negative number indicating that usage was more than what was sold. It is considered more likely that some data is missing from sales statistics and therefore these values will be input as zero. This will cause more fuel used than what is in the sales statistics, and a possible overestimate of emissions. This is however a very low amount compared to the total energy emissions.

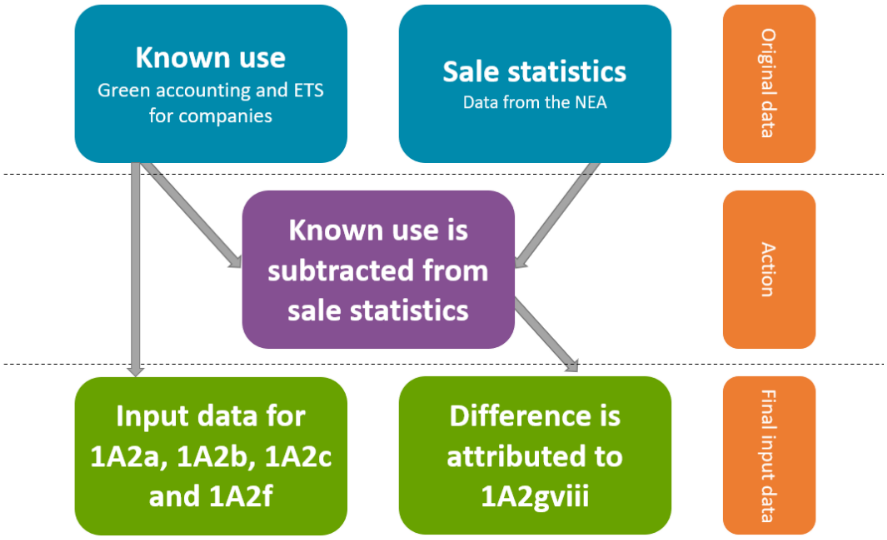


Figure 3.1 Description of adjustments in input data for IPCC category 1A2.

In the sales statistics received from the NEA there are unspecified categories for all fuels, labelled as "Other." These fuels are accounted for in NFR Category 1A5. For future submissions the EAI will work with the NEA to aim to attribute these fuels to specific categories.

3.3 Stationary Combustion (NFR 1A1, 1A2, 1A4, and 1A5)

3.3.1 Electricity and Heat (NFR 1A1a)

Energy Industries include emissions from Electricity and Heat production. Iceland has extensively utilised renewable energy sources for electricity and heat production, thus emissions from this sector are low. For dioxin, PAH4, SO_X, and NMVOC waste incineration with energy recovery is the main source of emissions for this category. However, waste incineration with energy recovery has not been occurring in Iceland since 2013. Activity data on fuel use for the energy industries are based on data provided by the NEA and adjusted by the EAI (see Chapter 3.2). Activity data on waste is collected by EAI directly from the plants.

The main sources of electricity in Iceland are hydropower and geothermal energy. In recent years, wind power development has taken place. As can be seen in Table 3.2, only a small fraction of electricity is produced with fuel combustion; electricity was produced with fuel combustion at two locations that are located far from the distribution system (two sparsely populated islands, Grímsey and Flatey); furthermore, some public electricity facilities have emergency backup fuel combustion power plants which are used if problems occur in the distribution system. Those plants are seldom used apart from testing and during maintenance.

Table 3.2 Electricity production in Iceland [GWh]

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Hydropower	4159	4677	6350	7015	12592	13781	13157	13804	14196
Geothermal	283	290	1323	1658	4465	5003	5961	5802	5916
Fuel Combustion	4.6	8.4	4.4	7.8	1.7	3.9	3.1	2.5	4.7
Wind Power	–	–	–	–	–	11	6.7	6.1	5.7
Total [GWh]	**4446**	**4976**	**7678**	**8681**	**17059**	**18799**	**19127**	**19614**	**20122**

Geothermal energy is the main source of heat production in Iceland. Some district heating facilities that lack access to geothermal energy sources use electric boilers to produce heat from electricity. These depend on curtailable energy. These heat plants have backup fuel combustion in case of electricity shortages or problems in the distribution system. Three district heating facilities burned waste to produce heat and were connected to the local distribution system. However, since 2013 no more waste burning with energy recovery is occurring in Iceland. Emissions from these waste incineration plants are reported under Energy Industries.

3.3.1.1 Activity Data

Activity data for electricity and heat production with fuel combustion and waste incineration are given in Table 3.3. The use of residual fuel oil for electricity production in 2007 was much higher than in surrounding years. In 2007, a new aluminium plant was established in Iceland. Because the *Kárahnjúkar Hydropower Project* (hydropower plant that was purpose-built for this aluminium plant) was delayed, the aluminium plant was supplied with electricity for a while from the distribution system. This led to electricity shortages for the district heating system and industry depending on curtailable energy leading to increased fuel combustion.

The different fuel composition from year to year (waste, fuel) affects the implied emission factor (IEF). For example, the IEF for dioxin in this sector is higher in years when fuel combustion is low, and the sector is dominated by waste incineration. The following years were unusual: 1995 (issues in the electricity distribution system caused by snow avalanches in northwest Iceland (the Westfjords) and icing in the northern part of the country); 1997/1998 (unfavourable weather conditions for hydropower plants during the winter); and 2007 (explained above).

Table 3.3 Fuel combustion and waste incineration [kt] for Electricity and Heat Production.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
1A1ai – Gas/Diesel Oil	1.3	1.1	1.1	0.021	1.0	1.2	0.82	0.88	2.6
1A1ai – Residual Fuel Oil	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A1ai – Biomethane	NO	NO	NO	0.3	NO	NO	NO	NO	NO
1A1ai – Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A1aiii – Gas/Diesel Oil	NO	NO	NO	NO	NO	NO	NO	0.13	0.71
1A1aiii – Residual Fuel Oil	3.0	3.1	0.12	0.2	NO	0.14	NO	NO	NO
1A1aiii – Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO

	1990	1995	2000	2005	2010	2015	2020	2021	2022
1A1aiii – Solid Waste	NO	4.7	6.1	6.0	8.1	NO	NO	NO	NO

Emission factors are Tier 1 factors taken from the 2019 EMEP/EEA Guidebook (Chapter 1.A.1. Energy Industries, Tables 3-4 (gaseous fuels), 3-5 (fuel oil), and 3-6 (gas oil and biodiesel)). Emission factors for the burning of waste with energy recovery are taken from Table 3-2 of Chapter 5C1a of the 2019 EMEP/EEA Guidebook. Due to the lack of emission factors given in the 2019 Guidebook, the following pollutants are not estimated:

- Gas oil: NH_3, PCBs, HCB, BaP, BbF, BkF;
- Residual fuel oil: NH_3, PCBs, BaP, HCB;
- Gaseous fuels (biomethane): NH_3, PCBs, HCB.

3.3.1.2 Recalculations and Improvements

Recalculations for the 2024 Submission

1A1ai Electricity Generation

In the last submission, the activity data for gas/diesel oil was not properly accounted for 2020 and 2021 and a country specific NCV for diesel was missing for 2016. These have been fixed and led to recalculations of all air pollutants for those three years (see Table 3.4), minor for 2016 but large for the other two. As for sulphur content in residual fuel, an error in the default value was fixed for 1990-2011 while country specific values were applied for 2012 onwards. These changes in sulphur content in residual fuel led to large recalculations of SO2 through the time series (see Table 3.5). Lastly, a calculation error was fixed for BC which also led to large recalculations for BC through the time series (see Table 3.6).

Table 3.4 Recalculations of all air pollutants except SO_2 and BC in 1A1ai Electricity Generation and between submissions.

1A1aiElectricity Generation	2016	2020	2021
2023 submission NO_X [kt]	2.029 E-03	1.6 E-03	2.09 E-03
2024 submission NO_X [kt]	2.039 E-03	2.3 E-03	2.46 E-03
Change relative to the 2023 submission NO_X [%]	0.47%	47%	18%
2023 submission CO [kt]	5.057 E-04	3.9 E-04	5.2 E-04
2024 submission CO [kt]	5.081 E-04	5.7 E-04	6.1 E-04
Change relative to the 2023 submission CO [%]	0.47%	47%	18%
2023 submission NMVOC [kt]	2.497 E-05	1.9 E-05	2.6 E-05
2024 submission NMVOC [kt]	2.509 E-05	2.8 E-05	3.0 E-05
Change relative to the 2023 submission NMVOC [%]	0.47%	47%	18%
2023 submission dioxin [mg]	1.5609 E-05	1.20 E-05	1.60 E-05
2024 submission dioxin [mg]	1.5682 E-05	1.76 E-05	1.89 E-05
Change relative to the 2023 submission dioxin [%]	0.47%	47%	18%
2023 submission TSP [kt]	2.029 E-04	1.6 E-04	2.09 E-04

1A1aiElectricity Generation	2016	2020	2021
2024 submission TSP [kt]	2.039 E-04	2.3 E-04	2.46 E-04
Change relative to the 2023 submission TSP [%]	0.47%	47%	18%
2023 submission PM_{10} [kt]	9.99 E-05	7.7 E-05	1.03 E-04
2024 submission PM_{10} [kt]	1.00 E-04	1.1 E-04	1.21 E-04
Change relative to the 2023 submission PM10 [%]	0.47%	47%	18%
2023 submission $PM_{2.5}$ [kt]	2.497 E-05	1.9 E-05	2.6 E-05
2024 submission $PM_{2.5}$ [kt]	2.509 E-05	2.8 E-05	3.0 E-05
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.47%	47%	18%
2023 submission Pb [t]	1.2706 E-04	9.8 E-05	1.31 E-04
2024 submission Pb [t]	1.2765 E-04	1.4 E-04	1.54 E-04
Change relative to the 2023 submission Pb [%]	0.47%	47%	18%
2023 submission Cd [t]	4.246 E-05	3.3 E-05	4.4 E-05
2024 submission Cd [t]	4.265 E-05	4.8 E-05	5.2 E-05
Change relative to the 2023 submission Cd [%]	0.47%	47%	18%
2023 submission Hg [t]	4.246 E-05	3.3 E-05	4.4 E-05
2024 submission Hg [t]	4.265 E-05	4.8 E-05	5.2 E-05
Change relative to the 2023 submission Hg [%]	0.47%	47%	18%
2023 submission As [t]	5.650 E-05	4.3 E-05	5.8 E-05
2024 submission As [t]	5.677 E-05	6.4 E-05	6.9 E-05
Change relative to the 2023 submission As [%]	0.47%	47%	18%
2023 submission Cr [t]	4.246 E-05	3.3 E-05	4.4 E-05
2024 submission Cr [t]	4.265 E-05	4.8 E-05	5.2 E-05
Change relative to the 2023 submission Cr [%]	0.47%	47%	18%
2023 submission Cu [t]	8.49 E-05	6.5 E-05	8.7 E-05
2024 submission Cu [t]	8.53 E-05	9.6 E-05	1.0 E-04
Change relative to the 2023 submission Cu [%]	0.47%	47%	18%
2023 submission Ni [t]	4.246 E-05	3.3 E-05	4.4 E-05
2024 submission Ni [t]	4.265 E-05	4.8 E-05	5.2 E-05
Change relative to the 2023 submission Ni [%]	0.47%	47%	18%
2023 submission Se [t]	2.120 E-04	1.6 E-04	2.18 E-04
2024 submission Se [t]	2.130 E-04	2.4 E-04	2.57 E-04
Change relative to the 2023 submission Se [%]	0.47%	47%	18%
2023 submission Zn [t]	5.650 E-05	4.3 E-05	5.8 E-05
2024 submission Zn [t]	5.677 E-05	6.4 E-05	6.9 E-05
Change relative to the 2023 submission Zn [%]	0.47%	47%	18%
2023 submission IPy [t]	2.160.E-07	1.7.E-07	2.22.E-07
2024 submission IPy [t]	2.170.E-07	2.4.E-07	2.62.E-07
Change relative to the 2023 submission IPy [%]	0.47%	47%	18%
2023 submission PAH4 [t]	2.160 E-07	1.7 E-07	2.22 E-07

1A1aiElectricity Generation	2016	2020	2021
2024 submission PAH4 [t]	2.170 E-07	2.4 E-07	2.62 E-07
Change relative to the 2023 submission PAH4 [%]	0.47%	47%	18%

Table 3.5 Recalculations of SO_2 in 1A1ai Electricity Generation between submissions.*

1A1ai Electricity Generation	1996	1997	1998	1999	2002	2007	2013	2020	2021
2023 submission SO_2 [kt]	0.00315	0.0033	0.031	0.0099	0.00305	0.164	0.0067	0.00111	0.00149
2024 submission SO_2 [kt]	0.00348	0.0044	0.045	0.0140	0.00347	0.137	0.0055	0.00163	0.00176
Change relative to the 2023 submission SO_2 [%]	10%	31%	48%	42%	14%	-16%	-17%	47%	18%

* Recalculations for 2006, 2012, 2016, 2017 and 2018 are not shown as they are relatively small (between -6.0% to +1.8%) compared to other years.

Table 3.6 Recalculations of BC in 1A1ai Electricity Generation between submissions.

1A1ai Electricity Generation	2003	2004	2005	2006	2007	2016	2020	2021
2023 submission BC [kt]	1.7 E-05	8.3 E-06	1.3 E-05	1.88 E-05	1.47 E-05	8.37 E-06	6.4 E-06	8.6 E-06
2024 submission BC [kt]	7.5 E-06	1.5 E-06	5.7 E-07	1.56 E-05	1.30 E-05	8.41 E-06	9.4 E-06	1.0 E-05
Change relative to the 2023 submission BC [%]	-55%	-82%	-96%	-17%	-12%	0.47%	47%	18%

1A1aiii Heat Plants

Similar to 1Aai Electricity Generation, the activity data for gas/diesel oil for 2021 was not properly accounted in the last submission. This has been fixed and led to recalculations of all air pollutants for 2021 (see Table 3.7). Changes in sulphur content in residual fuel that were describe in 1A1ai Electricity Generation also apply for 1A1aii Heat Plants, i.e. an error in the default value was fixed for 1990-2011 while country specific values were applied for 2012 onwards. Additionally, emission factor for SO2 emissions from gas/diesel was corrected, contributing to large recalculations of SO2 through the time series (see Table 3.8)

Table 3.7 Recalculations of all air pollutants except SO_2 in 1A1aiii Heat Plant between submissions.

1A1aiii Heat Plants	2021
2023 submission NO_X [kt]	0.00017
2024 submission NO_X [kt]	0.00035
Change relative to the 2023 submission NO_X [%]	108%
2023 submission NMVOC [kt]	0.0000021
2024 submission NMVOC [kt]	0.0000044
Change relative to the 2023 submission NMVOC [%]	108%
2023 submission $PM_{2.5}$ [kt]	0.0000021
2024 submission $PM_{2.5}$ [kt]	0.0000044
Change relative to the 2023 submission $PM_{2.5}$ [%]	108%
2023 submission PM_{10} [kt]	0.0000084
2024 submission PM_{10} [kt]	0.0000174
Change relative to the 2023 submission PM_{10} [%]	108%

1A1aiii Heat Plants	2021
2023 submission TSP [kt]	0.000017
2024 submission TSP [kt]	0.000035
Change relative to the 2023 submission TSP [%]	108%
2023 submission BC [kt]	0.00000070
2024 submission BC [kt]	0.00000146
Change relative to the 2023 submission BC [%]	108%
2023 submission CO [kt]	0.000042
2024 submission CO [kt]	0.000088
Change relative to the 2023 submission CO [%]	108%
2023 submission Pb [t]	0.000011
2024 submission Pb [t]	0.000022
Change relative to the 2023 submission Pb [%]	108%
2023 submission Cd [t]	0.0000036
2024 submission Cd [t]	0.0000074
Change relative to the 2023 submission Cd [%]	108%
2023 submission Hg [t]	0.0000036
2024 submission Hg [t]	0.0000074
Change relative to the 2023 submission Hg [%]	108%
2023 submission As [t]	0.0000047
2024 submission As [t]	0.0000099
Change relative to the 2023 submission As [%]	108%
2023 submission Cr [t]	0.0000036
2024 submission Cr [t]	0.0000074
Change relative to the 2023 submission Cr [%]	108%
2023 submission Cu [t]	0.0000071
2024 submission Cu [t]	0.0000148
Change relative to the 2023 submission Cu [%]	108%
2023 submission Ni [t]	0.0000036
2024 submission Ni [t]	0.0000074
Change relative to the 2023 submission Ni [%]	108%
2023 submission Se [t]	0.000018
2024 submission Se [t]	0.000037
Change relative to the 2023 submission Se [%]	108%
2023 submission Zn [t]	0.0000047
2024 submission Zn [t]	0.0000099
Change relative to the 2023 submission Zn [%]	108%
2023 submission dioxin [g]	0.0000013
2024 submission dioxin [g]	0.0000027
Change relative to the 2023 submission dioxin [%]	108%

1A1aiii Heat Plants	2021
2023 submission IPy [t]	0.000018
2024 submission IPy [t]	0.000038
Change relative to the 2023 submission IPy [%]	108%
2023 submission PAH4 [t]	0.000018
2024 submission PAH4 [t]	0.000038
Change relative to the 2023 submission PAH4 [%]	108%

Table 3.8 Recalculations of SO_2 in 1A1aiii Heat Plant between submissions.*

1A1aiii Heat Plants	1990	1995	2000	2005	2015	2021
2023 submission SO_2 [kt]	0.108	0.119	0.0147	0.0171	0.00493	0.00284
2024 submission SO_2 [kt]	0.161	0.174	0.0169	0.0206	0.00269	0.00025
Change relative to the 2023 submission SO2 [%]	50%	47%	15%	20%	-46%	-91%

* The table shows 5-years interval and the latest inventory year, excluding 2010 and 2020 as there were no recalculations for those two years (no use fuels involved).

Recalculations for the 2023 Submission

1A1ai Electricity Generation: A recalculation was done in 1A1ai due to an error in the calculations of pollutants from biofuels. In previous submissions, NCV for diesel was used to calculate the amount of biomethane. This increased the activity data from 43TJ/kt to 50.4 TJ/kt. Consequently, all air pollutants that are estimated for biomethane increased in relation to that increase in activity data for the years 2003-2007 where biomethane is reported. Furthermore, the NCV for diesel was used to calculate the implied emission factor for both diesel and biodiesel in previous submission for NOx, CO, NMVOC and dioxin. This caused a minor change where biodiesel was present in 2017-2018. However, the recalculation is relatively minor, a decrease in emissions of the abovementioned pollutants by 1.7% and 0.8% in 2017 and 2018, respectively.

1A1aiii Heat Plants: A minor recalculation of SO_2 is present in this category. This only applies to the year 2019 which is the only year were biodiesel is utilised. In previous submission the emission factor for SO_2 for biodiesel was linked incorrectly. This caused an increase in SO_2 by 5.2% in 2019.

Planned Improvements

No improvements are planned for this subcategory.

3.3.2 Manufacturing Industries, Stationary Combustion (NFR 1A2, Excluding Mobile Sources)

3.3.2.1 Activity Data

The total amount of fuel sold to the manufacturing industries for stationary combustion was obtained from the NEA. The sales statistics do not fully specify by which type of industry the fuel is being purchased. This division is made by the EAI on the basis of the reported fuel use by all major industrial plants falling under Act 70/2012 and the EU ETS

Directive 2003/87/EC (metal production, fish meal production, and mineral wool) and from green accounts submitted by the industry in accordance with regulation No 851/2002. All major industries falling under Act 70/2012 report their fuel use to the EAI along with other relevant information for industrial processes. The difference between the given total for the sector and the sum of the fuel use as reported by industrial facilities is categorised as 1A2gviii non-specified industry (see Figure 3.1). The total fuel consumption per fuel type can be seen in Table 3.9.

Emissions from the cement industry (the single operating cement plant was closed in 2011) and the mineral wool production are reported under 1A2f. For PAH4, emissions from the mineral wool production are not estimated, and for dioxin, emissions from the cement industry are reported under industrial processes (2A1).

Table 3.9 Fuel use [kt], Stationary Combustion in the Manufacturing Industry.

Fuel Type	1990	1995	2000	2005	2010	2015	2020	2021	2022
1A2a - Iron and Steel									
Gas/Diesel Oil	0.11	0.22	0.56	0.46	0.46	0.29	0.21	0.24	0.21
LPG	NO	NO	NO	NO	NO	0.10	0.20	0.14	0.22
1A2b - Non-ferrous Metals									
Gas/Diesel Oil	NO	NO	0.55	5.37	1.35	0.046	1.72	2.70	1.33
Residual Fuel Oil	3.93	5.16	7.51	NO	3.31	1.40	NO	NO	NO
LPG	0.41	0.31	0.67	0.66	0.61	0.39	0.23	0.21	0.70
1A2c - Chemicals									
Residual Fuel Oil	2.38	2.31	2.27	NO	NO	NO	NO	NO	NO
1A2e - Food processing, Beverages, and Tobacco (Fishmeal Production)									
Gas/Diesel Oil	NO	NO	NO	NO	2.16	NO	NO	1.10	14.60
Residual Fuel Oil	41.03	48.54	36.37	21.44	9.61	8.41	1.22	0.54	2.70
Waste Oil	NO	NO	NO	NO	1.36	1.59	0.37	2.34	4.63
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A2e - Food processing, Beverages, and Tobacco (Other)									
Gas/Diesel Oil	NO	NO	NO	NO	2.71	3.75	3.37	3.22	3.03
Residual Fuel Oil	NO	NO	NO	NO	1.71	0.33	NO	NO	NO
1A2f - Non-metallic Minerals (Cement)									
Gas/Diesel Oil	NO	NO	0.0060	0.019	0.0050	NO	NO	NO	NO
Residual Fuel Oil	0.06	NO	NO	NO	NO	NO	NO	NO	NO
Petroleum Coke	NO	NO	NO	8.13	NO	NO	NO	NO	NO
Waste Oil	NO	4.99	6.04	1.82	NO	NO	NO	NO	NO
Other Bituminous Coal	18.60	8.65	13.26	9.91	3.65	NO	NO	NO	NO
1A2f - Non-metallic Minerals (Mineral Wool)									
Gas/Diesel Oil	NO	0.15	0.17	0.16	0.07	0.11	0.13	0.13	0.13
Residual Fuel Oil	0.59	NO	NO	NO	NO	NO	NO	NO	NO
Petroleum Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A2gviii - Other Industry									
Gas/Diesel Oil	4.96	0.76	7.64	9.19	NO	2.92	2.13	2.57	2.27
Residual Fuel Oil	7.91	0.16	1.00 E-05	3.56	0.30	0.052	NO	NO	NO
LPG	NO	NO	0.19	0.27	0.44	0.32	0.57	0.64	0.33
Other Bituminous Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO

3.3.2.2 Emission Factors

Emission factors (EFs) for all pollutants are Tier 1 EFs from Chapter 1.A.2 of the 2019 EMEP/EEA Guidebook. However, it is assumed that the PAH emission factors given in the Table 3-4 should be in µg/GJ rather than mg/GJ (after comparison with Table 3-37, Volume 1.A.4).

Table 3.10 Emission factors for pollutants from Stationary Combustion in the Manufacturing Industry.

<table>
<tr><th>Fuel Type</th><th>Reference</th><th>Exception</th></tr>
<tr><td>Gas/Diesel Oil</td><td rowspan="3">Tier 1 EF for liquid fuels from Table 3-4 from Chapter 1.A.2 of the 2019 EMEP/EEA Guidebook</td><td>SO_2 emissions are based on Tier 1 sulphur content from Table 3-14 in chapter 1A3b Road Transport of the EMEP/EEA 2019 Guidebook for 1990-2005. The emissions are then based country specific sulphur content from 2006.

SO_2 from 1A2f (cement) included in IPPU 2A1</td></tr>
<tr><td>Residual Fuel Oil</td><td>SO2 emissions are based on Tier 1 sulphur content from Table 3-1 in chapter 1A3d Navigation of the EMEP/EEA 2016 Guidebook for 1990-2011. The emissions are then based on country specific sulphur content from 2012.

SO_2 from 1A2f (cement) included in IPPU 2A1</td></tr>
<tr><td>Waste Oil</td><td>SO_2 emissions are based on a country specific sulphur content of 0.5%.

SO_2 from 1A2f (cement) included in IPPU 2A1</td></tr>
<tr><td>LPG</td><td>Tier 1 EF for gaseous fuels from Table 3-3 from Chapter 1.A.2 of the 2019 EMEP/EEA Guidebook</td><td>SO_2 emissions are based on 0.00052% sulphur content which was calculated by using the equation from chapter 4.3.2, 1A4 Small Combustion, of the 2019 EMEP/EEA Guidebook.</td></tr>
<tr><td>Other Bituminous Coal</td><td rowspan="2">Tier 1 EF for solid fuels from Table 3-2 from Chapter 1.A.2 of the 2019 EMEP/EEA Guidebook</td><td rowspan="2">SO_2 emissions are based on a country specific sulphur content of 1.5%.

SO_2 and dioxins emissions are included in 2A1 in IPPU Chapter</td></tr>
<tr><td>Petroleum Coke</td></tr>
</table>

Due to the lack of emission factors given in the 2019 Guidebook, the following pollutants are not estimated:

- All liquid fuels and LPG: NH_3, PCB, HCB;
- Other bituminous coal: NH_3.

3.3.2.3 Recalculations and Improvements

Recalculations for the 2024 Submission

In this submission, several changes were made in emission factors used to calculate emissions from various fuels in the Energy sector. These changes led to recalculations in most subcategories within the Energy sector, including categories in this chapter.

- Default sulphur content values for diesel was updated to more appropriate default values for 1990-2005 while it was replaced by country specific values for 2006 onwards. This led to large decrease in emissions and recalculations of SO_2 **through the time series**. This led to recalculations in 1A2a Iron and Steel, 1A2b Non-Ferrous Metal, 1A2e Food Processing, 1A2f Other – Non-Metallic Minerals, and 1A2gviii Other Industry.

- As for sulphur content in residual fuel, an error in the default for 1990-2011 was fixed and country specific values were applied for 2012 onwards. This led to recalculations **through the time series** in 1A2b Non-Ferrous Metal, 1A2c Chemicals, 1A2e Food Processing, 1A2f Other – Non-Metallic Minerals, and 1A2gviii Other Industry.

- A country specific NCV for diesel was missing for 2016. This has been fixed and led to minor recalculations of all air pollutants for the year **2016** in 1A2a Iron and Steel, 1A2b Non-Ferrous Metal, 1A2e Food Processing, 1A2f Other – Non-Metallic Minerals, and 1A2gviii Other Industry.

1A2a Iron and Steel

Table 3.11 Recalculations of SO_2 in 1A2a Iron and Steel between submissions.

1A2a Iron and Steel	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	4.5 E-04	9.0 E-04	2.2 E-03	1.8 E-03	1.8 E-03	1.4 E-03	1.3 E-03	1.2 E-03
2024 submission SO_2 [kt]	8.9 E-05	1.8 E-04	3.3 E-04	3.6 E-05	3.2 E-06	6.1 E-06	5.9 E-06	5.7 E-06
Change relative to the 2023 submission SO_2 [%]	-80.0%	-80.0%	-85.0%	-98.0%	-99.8%	-99.5%	-99.5%	-99.5%

Table 3.12 Recalculations of all air pollutants except SO_2 in 1A2a Iron and Steel between submissions.

1A2a Iron and Steel	2016
2023 submission NO_X [kt]	0.007862
2024 submission NO_X [kt]	0.007895
Change relative to the 2023 submission NO_X [%]	0.43%
2023 submission CO [kt]	0.0011710
2024 submission CO [kt]	0.0011753
Change relative to the 2023 submission CO [%]	0.37%
2023 submission NMVOC [kt]	0.0005419
2024 submission NMVOC [kt]	0.0005436
Change relative to the 2023 submission NMVOC [%]	0.30%
2023 submission dioxin [mg]	0.000019801
2024 submission dioxin [mg]	0.000019893
Change relative to the 2023 submission dioxin [%]	0.47%

1A2a Iron and Steel	2016
2023 submission TSP [kt]	0.000289
2024 submission TSP [kt]	0.000291
Change relative to the 2023 submission TSP [%]	0.45%
2023 submission PM_{10} [kt]	0.000289
2024 submission PM_{10} [kt]	0.000291
Change relative to the 2023 submission PM_{10} [%]	0.45%
2023 submission $PM_{2.5}$ [kt]	0.000289
2024 submission $PM_{2.5}$ [kt]	0.000291
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.45%
2023 submission BC [kt]	0.0001587
2024 submission BC [kt]	0.0001594
Change relative to the 2023 submission BC [%]	0.46%
2023 submission Pb [t]	0.0000012216
2024 submission Pb [t]	0.0000012268
Change relative to the 2023 submission Pb [%]	0.43%
2023 submission Cd [t]	0.00000009223
2024 submission Cd [t]	0.00000009263
Change relative to the 2023 submission Cd [%]	0.43%
2023 submission Hg [t]	0.0000061195
2024 submission Hg [t]	0.0000061274
Change relative to the 2023 submission Hg [%]	0.13%
2023 submission As [t]	0.0000012433
2024 submission As [t]	0.0000012452
Change relative to the 2023 submission As [%]	0.16%
2023 submission Cr [t]	0.000002935
2024 submission Cr [t]	0.000002948
Change relative to the 2023 submission Cr [%]	0.45%
2023 submission Cu [t]	0.000003133
2024 submission Cu [t]	0.000003147
Change relative to the 2023 submission Cu [%]	0.46%
2023 submission Ni [t]	0.0000002196
2024 submission Ni [t]	0.0000002201
Change relative to the 2023 submission Ni [%]	0.24%
2023 submission Se [t]	0.0000020308
2024 submission Se [t]	0.0000020380
Change relative to the 2023 submission Se [%]	0.36%
2023 submission Zn [t]	0.0004161
2024 submission Zn [t]	0.0004180
Change relative to the 2023 submission Zn [%]	0.46%

1A2a Iron and Steel	2016
2023 submission BaP [t]	0.00000003277
2024 submission BaP [t]	0.00000003289
Change relative to the 2023 submission BaP [%]	0.38%
2023 submission BbF [t]	0.0000002359
2024 submission BbF [t]	0.0000002369
Change relative to the 2023 submission BbF [%]	0.42%
2023 submission BkF [t]	0.00000003305
2024 submission BkF [t]	0.00000003316
Change relative to the 2023 submission BkF [%]	0.34%
2023 submission IPy [t]	0.00000003006
2024 submission IPy [t]	0.00000003016
Change relative to the 2023 submission IPy [%]	0.33%
2023 submission PAH4 [t]	0.0000003318
2024 submission PAH4 [t]	0.0000003331
Change relative to the 2023 submission PAH4 [%]	0.40%

1A2b Non-Ferrous Metal

Table 3.13 Recalculations of SO2 in 1A2b Non-Ferrous Metal between submissions.

1A2b Non-Ferrous Metal	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	0.14	0.19	0.27	0.02280	0.126	0.051	0.007324	0.011226
2024 submission SO_2 [kt]	0.21	0.28	0.41	0.00044	0.099	0.027	0.000033	0.000049
Change relative to the 2023 submission SO_2 [%]	49%	49%	48%	-98.1%	-21%	-47%	-99.6%	-99.6%

Table 3.14 Recalculations of all air pollutants except SO_2 in 1A2b Non-Ferrous Metal between submissions.

1A2b Non-Ferrous Metal	2016
2023 submission NO_X [kt]	0.03290479
2024 submission NO_X [kt]	0.03290492
Change relative to the 2023 submission NO_X [%]	0.00040%
2023 submission CO [kt]	0.004510756
2024 submission CO [kt]	0.004510773
Change relative to the 2023 submission CO [%]	0.00037%
2023 submission NMVOC [kt]	0.001879717
2024 submission NMVOC [kt]	0.001879723
Change relative to the 2023 submission NMVOC [%]	0.00034%
2023 submission dioxin [mg]	0.0000943277
2024 submission dioxin [mg]	0.0000943281
Change relative to the 2023 submission dioxin [%]	0.00038%

1A2b Non-Ferrous Metal	2016
2023 submission TSP [kt]	0.0012528626
2024 submission TSP [kt]	0.0012528676
Change relative to the 2023 submission TSP [%]	0.00040%
2023 submission PM_{10} [kt]	0.0012528626
2024 submission PM_{10} [kt]	0.0012528676
Change relative to the 2023 submission PM_{10} [%]	0.00040%
2023 submission $PM_{2.5}$ [kt]	0.0012528626
2024 submission $PM_{2.5}$ [kt]	0.0012528676
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.00040%
2023 submission BC [kt]	0.000695827
2024 submission BC [kt]	0.000695830
Change relative to the 2023 submission BC [%]	0.00041%
2023 submission Pb [t]	0.000005123662
2024 submission Pb [t]	0.000005123683
Change relative to the 2023 submission Pb [%]	0.00040%
2023 submission Cd [t]	0.0000003853427
2024 submission Cd [t]	0.0000003853442
Change relative to the 2023 submission Cd [%]	0.00039%
2023 submission Hg [t]	0.000015140197
2024 submission Hg [t]	0.000015140228
Change relative to the 2023 submission Hg [%]	0.00020%
2023 submission As [t]	0.000003286645
2024 submission As [t]	0.000003286653
Change relative to the 2023 submission As [%]	0.00023%
2023 submission Cr [t]	0.00001260267
2024 submission Cr [t]	0.00001260272
Change relative to the 2023 submission Cr [%]	0.00040%
2023 submission Cu [t]	0.000013696332
2024 submission Cu [t]	0.000013696388
Change relative to the 2023 submission Cu [%]	0.00041%
2023 submission Ni [t]	0.0000006818237
2024 submission Ni [t]	0.0000006818257
Change relative to the 2023 submission Ni [%]	0.00030%
2023 submission Se [t]	0.00000765558
2024 submission Se [t]	0.00000765561
Change relative to the 2023 submission Se [%]	0.00036%
2023 submission Zn [t]	0.0018109404
2024 submission Zn [t]	0.0018109478
Change relative to the 2023 submission Zn [%]	0.00041%

1A2b Non-Ferrous Metal	2016
2023 submission BaP [t]	0.0000001282196
2024 submission BaP [t]	0.0000001282201
Change relative to the 2023 submission BaP [%]	0.00038%
2023 submission BbF [t]	0.0000009726128
2024 submission BbF [t]	0.0000009726166
Change relative to the 2023 submission BbF [%]	0.00039%
2023 submission BkF [t]	0.00000012121333
2024 submission BkF [t]	0.00000012121376
Change relative to the 2023 submission BkF [%]	0.00036%
2023 submission IPy [t]	0.00000010851098
2024 submission IPy [t]	0.00000010851136
Change relative to the 2023 submission IPy [%]	0.00035%
2023 submission PAH4 [t]	0.000001330557
2024 submission PAH4 [t]	0.000001330562
Change relative to the 2023 submission PAH4 [%]	0.00038%

1A2c Chemicals

Table 3.15 Recalculations of SO2 in 1A2c Chemicals between submissions.

1A1ai Electricity Generation	1990	1995	2000	2004
2023 submission SO_2 [kt]	0.086	0.083	0.082	0.058
2024 submission SO_2 [kt]	0.128	0.125	0.122	0.086
Change relative to the 2023 submission SO_2 [%]	50%	50%	50%	50%

1A2e Food Processing

Table 3.16 Recalculations of SO_2 in 1A2e Food Processing between submissions.

1A2e Food Processing	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	1.48	1.75	1.31	0.77	0.37	0.32	0.048	0.047
2024 submission SO_2 [kt]	1.11	1.31	0.98	0.58	0.18	0.10	0.010	0.026
Change relative to the 2023 submission SO_2 [%]	-25%	-25%	-25%	-25%	-50%	-68%	-79%	-45%

Table 3.17 Recalculations of all air pollutants except SO_2 in 1A2e Food Processing between submissions.

1A2e Food Processing	2016
2023 submission NO_X [kt]	0.2974
2024 submission NO_X [kt]	0.2982
Change relative to the 2023 submission NO_X [%]	0.27%
2023 submission CO [kt]	0.03826
2024 submission CO [kt]	0.03836
Change relative to the 2023 submission CO [%]	0.27%

1A2e Food Processing	2016
2023 submission NMVOC [kt]	0.01449
2024 submission NMVOC [kt]	0.01453
Change relative to the 2023 submission NMVOC [%]	0.27%
2023 submission dioxin [mg]	0.0008116
2024 submission dioxin [mg]	0.0008138
Change relative to the 2023 submission dioxin [%]	0.27%
2023 submission TSP [kt]	0.011594
2024 submission TSP [kt]	0.011626
Change relative to the 2023 submission TSP [%]	0.27%
2023 submission PM_{10} [kt]	0.01159
2024 submission PM_{10} [kt]	0.01163
Change relative to the 2023 submission PM_{10} [%]	0.27%
2023 submission $PM_{2.5}$ [kt]	0.01159
2024 submission $PM_{2.5}$ [kt]	0.01163
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.27%
2023 submission BC [kt]	0.00649
2024 submission BC [kt]	0.00651
Change relative to the 2023 submission BC [%]	0.27%
2023 submission Pb [t]	0.00004638
2024 submission Pb [t]	0.00004650
Change relative to the 2023 submission Pb [%]	0.27%
2023 submission Cd [t]	0.000003478
2024 submission Cd [t]	0.000003488
Change relative to the 2023 submission Cd [%]	0.27%
2023 submission Hg [t]	0.00006956
2024 submission Hg [t]	0.00006975
Change relative to the 2023 submission Hg [%]	0.27%
2023 submission As [t]	0.00001739
2024 submission As [t]	0.00001744
Change relative to the 2023 submission As [%]	0.27%
2023 submission Cr [t]	0.0001159
2024 submission Cr [t]	0.0001163
Change relative to the 2023 submission Cr [%]	0.27%
2023 submission Cu [t]	0.00012753
2024 submission Cu [t]	0.00012788
Change relative to the 2023 submission Cu [%]	0.27%
2023 submission Ni [t]	0.000004638
2024 submission Ni [t]	0.000004650
Change relative to the 2023 submission Ni [%]	0.27%
2023 submission Se [t]	0.00006377
2024 submission Se [t]	0.00006394

1A2e Food Processing	2016
Change relative to the 2023 submission Se [%]	0.27%
2023 submission Zn [t]	0.016811
2024 submission Zn [t]	0.016857
Change relative to the 2023 submission Zn [%]	0.27%
2023 submission BaP [t]	0.0000011014
2024 submission BaP [t]	0.0000011044
Change relative to the 2023 submission BaP [%]	0.27%
2023 submission BbF [t]	0.000008695
2024 submission BbF [t]	0.000008719
Change relative to the 2023 submission BbF [%]	0.27%
2023 submission BkF [t]	0.0000009855
2024 submission BkF [t]	0.0000009882
Change relative to the 2023 submission BkF [%]	0.27%
2023 submission IPy [t]	0.0000008695
2024 submission IPy [t]	0.0000008719
Change relative to the 2023 submission IPy [%]	0.27%
2023 submission PAH4 [t]	0.000011652
2024 submission PAH4 [t]	0.000011684
Change relative to the 2023 submission PAH4 [%]	0.27%

1A2f Other: Non-Metallic Minerals

Besides the causes mentioned earlier in this section, the recalculations in 1A2f were also caused by changes in emission factors for pet coke (emissions factors for liquid fuel were mistaken for solid). These changes led to recalculations of all air pollutants for all occurring years of pet coke in this category (2004-2007).

Table 3.18 Recalculations of SO_2 in 1A2f Other between submissions.

1A2f Other Non-Metallic Minerals	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	2.1 E-02	5.8 E-04	6.8 E-04	6.3 E-04	3.0 E-04	4.3 E-04	5.1 E-04	5.1 E-04
2024 submission SO_2 [kt]	3.2 E-02	1.2 E-04	1.0 E-04	1.3 E-05	5.2 E-07	1.9 E-06	2.3 E-06	2.2 E-06
Change relative to the 2023 submission SO_2 [%]	50%	-80%	-85%	-98.0%	-99.8%	-99.6%	-99.6%	-99.6%

Table 3.19 Recalculations of all air pollutants except SO_2 in 1A2f Other between submissions.

1A2f Other: Non-Metallic Minerals	2004	2005	2006	2007	2016
2023 submission NO_X [kt]	0.1080	0.1314	0.1119	0.1150	0.002274
2024 submission NO_X [kt]	0.1196	0.2213	0.2032	0.1176	0.002284
Change relative to the 2023 submission NO_X [%]	10.8%	68%	82%	2.3%	0.47%
2023 submission CO [kt]	0.108	0.13	0.11	0.1150	0.002274
2024 submission CO [kt]	0.120	0.22	0.20	0.1176	0.002284
Change relative to the 2023 submission CO [%]	10.8%	68%	82%	2.3%	0.47%

1A2f Other: Non-Metallic Minerals	2004	2005	2006	2007	2016
2023 submission NMVOC [kt]	0.466	0.49	0.58	0.594	0.0002925
2024 submission NMVOC [kt]	0.436	0.26	0.35	0.588	0.0002939
Change relative to the 2023 submission NMVOC [%]	-6.4%	-47%	-40%	-1.1%	0.47%
2023 submission dioxin [mg]	No recalculation				0.000006205
2024 submission dioxin [mg]					0.000006234
Change relative to the 2023 submission dioxin [%]					0.47%
2023 submission TSP [kt]	0.062	0.066	0.077	0.0793	0.0000886
2024 submission TSP [kt]	0.059	0.039	0.049	0.0785	0.0000891
Change relative to the 2023 submission TSP [%]	-5.7%	-42%	-36%	-1.0%	0.47%
2023 submission PM_{10} [kt]	0.0590	0.062	0.073	0.0748	0.0000886
2024 submission PM_{10} [kt]	0.0557	0.037	0.047	0.0741	0.0000891
Change relative to the 2023 submission PM_{10} [%]	-5.6%	-41%	-36%	-1.0%	0.47%
2023 submission $PM_{2.5}$ [kt]	0.0545	0.058	0.067	0.0691	0.0000886
2024 submission $PM_{2.5}$ [kt]	0.0515	0.035	0.043	0.0684	0.0000891
Change relative to the 2023 submission $PM_{2.5}$ [%]	-5.5%	-40%	-35%	-1.0%	0.47%
2023 submission BC [kt]	0.0039	0.0045	0.0044	0.004510	0.00004964
2024 submission BC [kt]	0.0041	0.0056	0.0055	0.004542	0.00004987
Change relative to the 2023 submission BC [%]	3.7%	25%	26%	0.73%	0.47%
2023 submission Pb [t]	0.0666	0.070	0.083	0.0855	0.0000003546
2024 submission Pb [t]	0.0620	0.034	0.047	0.0845	0.0000003562
Change relative to the 2023 submission Pb [%]	-6.9%	-51%	-43%	-1.2%	0.47%
2023 submission Cd [t]	0.000895	0.00094	0.00112	0.001148	0.00000002659
2024 submission Cd [t]	0.000834	0.00046	0.00063	0.001135	0.00000002672
Change relative to the 2023 submission Cd [%]	-6.9%	-51%	-43%	-1.2%	0.47%
2023 submission Hg [t]	0.00393	0.0041	0.0049	0.00504	0.0000005319
2024 submission Hg [t]	0.00367	0.0021	0.0028	0.00498	0.0000005343
Change relative to the 2023 submission Hg [%]	-6.8%	-50%	-43%	-1.2%	0.47%
2023 submission As [t]	0.00199	0.0021	0.0025	0.00255	0.00000013296
2024 submission As [t]	0.00185	0.0010	0.0014	0.00252	0.00000013358
Change relative to the 2023 submission As [%]	-6.8%	-50%	-43%	-1.2%	0.47%
2023 submission Cr [t]	0.00672	0.0070	0.0084	0.00861	0.000000886
2024 submission Cr [t]	0.00626	0.0035	0.0048	0.00851	0.000000891
Change relative to the 2023 submission Cr [%]	-6.8%	-50%	-43%	-1.2%	0.47%
2023 submission Cu [t]	0.00871	0.0091	0.0108	0.01116	0.000000975
2024 submission Cu [t]	0.00812	0.0046	0.0062	0.01103	0.000000980
Change relative to the 2023 submission Cu [%]	-6.8%	-50%	-43%	-1.2%	0.47%
2023 submission Ni [t]	0.00646	0.0068	0.0081	0.00829	0.00000003546
2024 submission Ni [t]	0.00602	0.0033	0.0046	0.00819	0.00000003562
Change relative to the 2023 submission Ni [%]	-6.9%	-51%	-43%	-1.2%	0.47%

1A2f Other: Non-Metallic Minerals	2004	2005	2006	2007	2016
2023 submission Se [t]	0.00090	0.00094	0.00112	0.00115	0.000000488
2024 submission Se [t]	0.00084	0.00050	0.00066	0.00114	0.000000490
Change relative to the 2023 submission Se [%]	-6.4%	-47%	-41%	-1.1%	0.47%
2023 submission Zn [t]	0.101	0.106	0.124	0.1278	0.0001285
2024 submission Zn [t]	0.095	0.061	0.078	0.1265	0.0001291
Change relative to the 2023 submission Zn [%]	-5.8%	-42%	-37%	-1.0%	0.47%
2023 submission PCB [t]	0.084	0.088	0.105	0.1084	No recalculation
2024 submission PCB [t]	0.079	0.043	0.060	0.1071	
Change relative to the 2023 submission PCB [%]	-6.9%	-51%	-43%	-1.2%	
2023 submission BaP [t]	0.0226	0.024	0.028	0.0290	0.000000008421
2024 submission BaP [t]	0.0211	0.012	0.016	0.0287	0.000000008460
Change relative to the 2023 submission BaP [%]	-6.9%	-51%	-43%	-1.2%	0.47%
2023 submission BbF [t]	0.0293	0.031	0.036	0.0376	0.00000006648
2024 submission BbF [t]	0.0273	0.015	0.021	0.0371	0.00000006679
Change relative to the 2023 submission BbF [%]	-6.9%	-51%	-43%	-1.2%	0.47%
2023 submission BkF [t]	0.01178	0.0123	0.0147	0.0151	0.000000007535
2024 submission BkF [t]	0.01097	0.0061	0.0083	0.0149	0.000000007570
Change relative to the 2023 submission BkF [%]	-6.9%	-51%	-43%	-1.2%	0.47%
2023 submission IPy [t]	0.0092	0.0096	0.0115	0.01180	0.000000006648
2024 submission IPy [t]	0.0086	0.0047	0.0065	0.01166	0.000000006679
Change relative to the 2023 submission IPy [%]	-6.9%	-51%	-43%	-1.2%	0.47%
2023 submission PAH4 [t]	0.073	0.076	0.091	0.0935	0.00000008909
2024 submission PAH4 [t]	0.068	0.038	0.051	0.0924	0.00000008950
Change relative to the 2023 submission PAH4 [%]	-6.9%	-51%	-43%	-1.2%	0.47%

1A2gviii Other Industry

Besides the causes mentioned earlier in this section, the recalculations in 1A2gviii were also caused by an update in activity data on LPG for 2021.

Table 3.20 Recalculations of SO_2 in 1A2gviii Other Industry between submissions.

1Agviii Other Industry	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	0.304638	0.008871	0.030928	0.165546	0.011502	0.014183	0.009640	0.010722
2024 submission SO_2 [kt]	0.431162	0.009363	0.004586	0.193086	0.008855	0.001079	0.000043	0.000051
Change relative to the 2023 submission SO_2 [%]	42%	6%	-85%	17%	-23%	-92%	-99.6%	-99.5%

Table 3.21 Recalculations of all air pollutants except SO_2 in 1A2gviii Other Industry between submissions.

1Agviii Other Industry	2016	2021
2023 submission NO_x [kt]	0.05235	0.0574
2024 submission NO_x [kt]	0.05246	0.0589

1Agviii Other Industry	2016	2021
Change relative to the 2023 submission NO_x [%]	0.23%	2.6%
2023 submission CO [kt]	0.00709	0.0076
2024 submission CO [kt]	0.00711	0.0082
Change relative to the 2023 submission CO [%]	0.22%	7.7%
2023 submission NMVOC [kt]	0.002908	0.0030
2024 submission NMVOC [kt]	0.002913	0.0035
Change relative to the 2023 submission NMVOC [%]	0.20%	16%
2023 submission dioxin [mg]	0.0001487	0.000160
2024 submission dioxin [mg]	0.0001490	0.000170
Change relative to the 2023 submission dioxin [%]	0.22%	6.6%
2023 submission TSP [kt]	0.0020020	0.002216
2024 submission TSP [kt]	0.0020067	0.002232
Change relative to the 2023 submission TSP [%]	0.23%	0.71%
2023 submission PM_{10} [kt]	0.0020020	0.002216
2024 submission PM_{10} [kt]	0.0020067	0.002232
Change relative to the 2023 submission PM_{10} [%]	0.23%	0.71%
2023 submission $PM_{2.5}$ [kt]	0.0020020	0.002216
2024 submission $PM_{2.5}$ [kt]	0.0020067	0.002232
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.23%	0.71%
2023 submission BC [kt]	0.0011137	0.00123705
2024 submission BC [kt]	0.0011163	0.00123768
Change relative to the 2023 submission BC [%]	0.23%	0.05%
2023 submission Pb [t]	0.000008153	0.0000089
2024 submission Pb [t]	0.000008172	0.0000092
Change relative to the 2023 submission Pb [%]	0.23%	2.5%
2023 submission Cd [t]	0.0000006129	0.000000672
2024 submission Cd [t]	0.0000006143	0.000000690
Change relative to the 2023 submission Cd [%]	0.23%	2.7%
2023 submission Hg [t]	0.000021857	0.0000187
2024 submission Hg [t]	0.000021885	0.0000296
Change relative to the 2023 submission Hg [%]	0.13%	59%
2023 submission As [t]	0.0000048206	0.0000043
2024 submission As [t]	0.0000048276	0.0000063
Change relative to the 2023 submission As [%]	0.14%	47%
2023 submission Cr [t]	0.000020116	0.00002221
2024 submission Cr [t]	0.000020163	0.00002248
Change relative to the 2023 submission Cr [%]	0.23%	1.2%
2023 submission Cu [t]	0.000021913	0.000024319
2024 submission Cu [t]	0.000021964	0.000024372

1Agviii Other Industry	2016	2021
Change relative to the 2023 submission Cu [%]	0.23%	0.22%
2023 submission Ni [t]	0.0000010342	0.00000101
2024 submission Ni [t]	0.0000010360	0.00000128
Change relative to the 2023 submission Ni [%]	0.18%	26%
2023 submission Se [t]	0.000011999	0.0000127
2024 submission Se [t]	0.000012025	0.0000139
Change relative to the 2023 submission Se [%]	0.21%	9.2%
2023 submission Zn [t]	0.002896	0.003210
2024 submission Zn [t]	0.002902	0.003224
Change relative to the 2023 submission Zn [%]	0.23%	0.46%
2023 submission BaP [t]	0.00000020207	0.000000217
2024 submission BaP [t]	0.00000020251	0.000000232
Change relative to the 2023 submission BaP [%]	0.22%	6.7%
2023 submission BbF [t]	0.0000015441	0.00000169
2024 submission BbF [t]	0.0000015476	0.00000174
Change relative to the 2023 submission BbF [%]	0.23%	3.5%
2023 submission BkF [t]	0.00000018918	0.000000199
2024 submission BkF [t]	0.00000018958	0.000000221
Change relative to the 2023 submission BkF [%]	0.21%	11%
2023 submission IPy [t]	0.0000001689	0.000000176
2024 submission IPy [t]	0.0000001693	0.000000198
Change relative to the 2023 submission IPy [%]	0.21%	12%
2023 submission PAH4 [t]	0.0000021043	0.00000228
2024 submission PAH4 [t]	0.0000021090	0.00000240
Change relative to the 2023 submission PAH4 [%]	0.22%	5.2%

Recalculations for the 2023 Submission

No recalculations were done for this subcategory.

3.3.2.4 Planned Improvements

There are no planned improvements.

3.3.3 Commercial/Institutional, Residential, and Agricultural Stationary Fuel Combustion (NFR 1A4ai, 1A4bi, and 1A4ci)

Since Iceland relies largely on its renewable energy sources, fuel use for residential, commercial, and institutional heating is low. Residential heating with electricity is subsidised and occurs in areas far from public heat plants. Previously, there were two waste incineration plants that used waste to produce heat. One of them used the heat for heating a swimming pool and a school building (*Skaftárhreppur*, closed in December

2012), and the other one used the heat for heating a swimming pool (*Svínafell*, closed in 2010). Commercial/Institutional fuel combustion also includes the heating of swimming pools with gas oil, but only a few swimming pools in the country are heated with oil.

3.3.3.1 Activity Data

Activity data for fuel use is provided by the NEA, which collects data on fuel sales by sector. The EAI adjusts the data provided by the NEA, as further explained in Chapter 3.2. Activity data for waste incineration is collected by the EAI directly. Activity data for stationary fuel combustion and waste incineration in 1A4 are given in Table 3.22. It should be noted that data reported by the NEA indicates negligible solid fuel use for subcategory 1A4bi, and by extension condensables are also negligible.

Table 3.22 Fuel use [kt] from Stationary Combustion from subsectors of NFR 1A4.

Fuel Type	1990	1995	2000	2005	2010	2015	2020	2021	2022
1A4ai Commercial/Institutional									
Gas/Diesel Oil	1.80	1.60	1.60	1.00	0.30	0.30	0.13	0.12	0.12
LPG	0.78	0.83	0.46	0.50	0.17	0.37	0.41	0.46	0.58
Waste – Fossil	NO	0.14	0.19	0.19	0.15	NO	NO	NO	NO
Waste – Biogenic	NO	0.31	0.39	0.39	0.20	NO	NO	NO	NO
1A4bi Residential									
Gas/Diesel Oil	8.82	6.94	6.03	3.24	1.34	0.99	1.06	0.63	0.52
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	0.72	0.93	1.42	0.93	1.10	1.06	1.00
1A4ci Agriculture									
LPG	NO	NO	NO	NO	NO	0.0040	0.0080	0.0070	0.0070

3.3.3.2 Emission Factors

EFs for Stationary Combustion are taken from the Chapter 1A4 Small Combustion in 2019 EMEP/EEA Guidebook except EFs for dioxin from stationary combustion of LPG and waste oil. They are taken from *Utslipp til luft av dioksiner i Norge* (Statistics Norway, 2002) which is 0.06 µg/t fuel for LPG and 4 µg/t fuel for waste oil.

Emissions from Waste Incineration with Recovery, where the energy is used for swimming pools/school buildings are reported here. The IEF for dioxin in the sector shows fluctuations over the time series. From 1994 to 2012 (as stated above, one plant was closed in 2010 and the other one in 2012) waste was incinerated to produce heat at two locations (swimming pool, school building). The IEF for dioxin for waste is considerably higher than for liquid fuel.

Table 3.23 Emission factors for 1A4ai, 1A4ci, and 1A4bi.

Fuel Type	Reference	Exception
1A4ai & 1A4ci		

Fuel Type	Reference	Exception
Gas/Diesel Oil	Tier 1 EF for liquid fuels from **Table 3-9** from Chapter 1.A.4 of the 2019 EMEP/EEA Guidebook	SO_2 emissions are based on Tier 1 sulphur content from Table 3-14 in chapter 1A3b Road Transport of the 2019 EMEP/EEA Guidebook for 1990-2005. The emissions are then based country specific sulphur content from 2006.
LPG	Tier 1 EF for gaseous fuels from **Table 3-8** from Chapter 1.A.4 of the 2019 EMEP/EEA Guidebook	SO2 emissions are based on 0.00052% sulphur content (calculated using equation from chapter 4.3.2 and EF from Table A22 in 1A4 Small Combustion, 2019 EMEP/EEA Guidebook). Dioxin emissions from (Statistics Norway, 2002).
Waste	Tier 2 EF for municipal waste incineration from **Table 3-2** from Chapter 5.C.1.a of the 2019 EMEP/EEA Guidebook	NH_3, Se & IPy estimated with T1 EF from **Table 3-1** in same chapter.
1A4bi		
Gas/Diesel Oil	Tier 1 EF for liquid fuels from **Table 3-5** from Chapter 1.A.4 of the 2019 EMEP/EEA Guidebook	SO_2 emissions are based on Tier 1 sulphur content from table 3-14 in chapter 1A3b Road Transport in the 2019 EMEP/EEA Guidebook. The emissions are then based on country specific sulphur content from 2006.
LPG	Tier 1 EF for gaseous fuels from **Table 3-4** from Chapter 1.A.4 of the 2019 EMEP/EEA Guidebook	SO2 emissions are based on 0.00052% sulphur content (calculated using equation from chapter 4.3.2 and EF from Table A22 in 1A4 Small Combustion, 2019 EMEP/EEA Guidebook). Dioxin emissions from (Statistics Norway, 2002).

3.3.3.3 Recalculations and Improvements

Recalculations for the 2024 Submission

For this submission, a lot of changes were made regarding emissions factors used in the Energy sector, mainly in terms of sulphur content. This includes the default sulphur content for diesel being updated to more appropriate defaults for 1990-2005 while it was replaced by country specific values for 2006 onwards. Simultaneously, the default sulphur content for LPG was also updated. These changes together led to large recalculations of SO_2 in all three categories of 1A4 Stationary through the time series.

Furthermore, the country specific NCV for diesel was accidently excluded in the last submission. This has been fixed and let to minor recalculations of all air pollutants in both 1A4ai Commercial Stationary and 1A4bi Residential Stationary for 2016.

1A4ai Commercial Stationary

Table 3.24 Recalculations of SO_2 in 1A4ai Commercial Stationary between submissions.

1A4ai Commercial Stationary	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	8.8 E-03	8.8 E-03	8.3 E-03	6.0 E-03	2.1 E-03	1.9 E-03	1.3 E-03	1.4 E-03
2024 submission SO_2 [kt]	1.4 E-03	2.1 E-03	2.0 E-03	1.1 E-03	6.0 E-04	9.1 E-06	6.5 E-06	6.8 E-06
Change relative to the 2023 submission SO_2 [%]	-83%	-77%	-77%	-82%	-72%	-99.5%	-99.5%	-99.5%

Table 3.25 Recalculations of all air pollutants except SO_2 in 1A4ai Commercial Stationary between submissions.

1A4ai Commercial Stationary	2016
2023 submission NO_X [kt]	0.003409
2024 submission NO_X [kt]	0.003418
Change relative to the 2023 submission NO_X [%]	0.27%
2023 submission CO [kt]	0.0011622
2024 submission CO [kt]	0.0011650
Change relative to the 2023 submission CO [%]	0.24%
2023 submission NMVOC [kt]	0.00057504
2024 submission NMVOC [kt]	0.00057564
Change relative to the 2023 submission NMVOC [%]	0.10%
2023 submission dioxin [mg]	0.00006330
2024 submission dioxin [mg]	0.00006348
Change relative to the 2023 submission dioxin [%]	0.28%
2023 submission TSP [kt]	0.0001506
2024 submission TSP [kt]	0.0001512
Change relative to the 2023 submission TSP [%]	0.42%
2023 submission PM_{10} [kt]	0.0001506
2024 submission PM_{10} [kt]	0.0001512
Change relative to the 2023 submission PM_{10} [%]	0.42%
2023 submission $PM_{2.5}$ [kt]	0.00013123
2024 submission $PM_{2.5}$ [kt]	0.00013177
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.41%
2023 submission BC [kt]	0.00006562
2024 submission BC [kt]	0.00006592
Change relative to the 2023 submission BC [%]	0.46%
2023 submission Pb [t]	0.00005181
2024 submission Pb [t]	0.00005205
Change relative to the 2023 submission Pb [%]	0.46%
2023 submission Cd [t]	0.0000009850
2024 submission Cd [t]	0.0000009895
Change relative to the 2023 submission Cd [%]	0.46%

1A4ai Commercial Stationary	2016
2023 submission Hg [t]	0.0000025843
2024 submission Hg [t]	0.0000025873
Change relative to the 2023 submission Hg [%]	0.12%
2023 submission As [t]	0.000005164
2024 submission As [t]	0.000005179
Change relative to the 2023 submission As [%]	0.29%
2023 submission Cr [t]	0.00006475
2024 submission Cr [t]	0.00006505
Change relative to the 2023 submission Cr [%]	0.46%
2023 submission Cu [t]	0.000019400
2024 submission Cu [t]	0.000019490
Change relative to the 2023 submission Cu [%]	0.46%
2023 submission Ni [t]	0.0008065
2024 submission Ni [t]	0.0008103
Change relative to the 2023 submission Ni [%]	0.46%
2023 submission Se [t]	0.0000017698
2024 submission Se [t]	0.0000017728
Change relative to the 2023 submission Se [%]	0.17%
2023 submission Zn [t]	0.00013026
2024 submission Zn [t]	0.00013080
Change relative to the 2023 submission Zn [%]	0.41%
2023 submission PCB [kg]	0.000000839
2024 submission PCB [kg]	0.000000842
Change relative to the 2023 submission PCB [%]	0.47%
2023 submission HCB [kg]	0.000001419
2024 submission HCB [kg]	0.000001426
Change relative to the 2023 submission HCB [%]	0.47%
2023 submission BaP [t]	0.000013975215
2024 submission BaP [t]	0.000013975272
Change relative to the 2023 submission BaP [%]	0.00041%
2023 submission BbF [t]	0.00005633645
2024 submission BbF [t]	0.00005633690
Change relative to the 2023 submission BbF [%]	0.00080%
2023 submission BkF [t]	0.00002134327
2024 submission BkF [t]	0.00002134332
Change relative to the 2023 submission BkF [%]	0.00024%
2023 submission IPy [t]	0.000020954115
2024 submission IPy [t]	0.000020954160
Change relative to the 2023 submission IPy [%]	0.00021%

1A4ai Commercial Stationary	2016
2023 submission PAH4 [t]	0.00011260905
2024 submission PAH4 [t]	0.00011260965
Change relative to the 2023 submission PAH4 [%]	0.00054%

1A4bi Residential Stationary

Table 3.26 Recalculations of SO_2 in 1A4bi Residential Stationary between submissions.

1A4bi Residential Stationary	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	3.5 E-02	2.8 E-02	2.6 E-02	1.5 E-02	8.2 E-03	5.8 E-03	6.5 E-03	4.7 E-03
2024 submission SO_2 [kt]	7.1 E-03	5.5 E-03	3.6 E-03	2.7 E-04	2.4 E-05	2.7 E-05	8.9 E-05	9.5 E-05
Change relative to the 2023 submission SO_2 [%]	-80%	-80%	-86%	-98.2%	-99.7%	-99.5%	-98.6%	-98.0%

Table 3.27 Recalculations of air pollutants except SO_2 in 1A4bi Residential Stationary between submissions.

1A4bi Residential Stationary	2016
2023 submission NO_X [kt]	0.00429
2024 submission NO_X [kt]	0.00430
Change relative to the 2023 submission NO_X [%]	0.21%
2023 submission CO [kt]	0.00339
2024 submission CO [kt]	0.00340
Change relative to the 2023 submission CO [%]	0.30%
2023 submission NMVOC [kt]	0.00011319
2024 submission NMVOC [kt]	0.00011331
Change relative to the 2023 submission NMVOC [%]	0.11%
2023 submission dioxin [mg]	0.0002856
2024 submission dioxin [mg]	0.0002867
Change relative to the 2023 submission dioxin [%]	0.37%
2023 submission TSP [kt]	0.00012803
2024 submission TSP [kt]	0.00012837
Change relative to the 2023 submission TSP [%]	0.27%
2023 submission PM_{10} [kt]	0.00012803
2024 submission PM_{10} [kt]	0.00012837
Change relative to the 2023 submission PM_{10} [%]	0.27%
2023 submission $PM_{2.5}$ [kt]	0.00012803
2024 submission $PM_{2.5}$ [kt]	0.00012837
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.27%
2023 submission BC [kt]	0.00000919
2024 submission BC [kt]	0.00000922
Change relative to the 2023 submission BC [%]	0.32%

1A4bi Residential Stationary	2016
2023 submission Pb [t]	0.0000005317
2024 submission Pb [t]	0.0000005338
Change relative to the 2023 submission Pb [%]	0.41%
2023 submission Cd [t]	0.0000000500
2024 submission Cd [t]	0.0000000502
Change relative to the 2023 submission Cd [%]	0.36%
2023 submission Hg [t]	0.00000919
2024 submission Hg [t]	0.00000921
Change relative to the 2023 submission Hg [%]	0.23%
2023 submission As [t]	0.00000554322
2024 submission As [t]	0.00000554358
Change relative to the 2023 submission As [%]	0.01%
2023 submission Cr [t]	0.000007757
2024 submission Cr [t]	0.000007793
Change relative to the 2023 submission Cr [%]	0.46%
2023 submission Cu [t]	0.000005023
2024 submission Cu [t]	0.000005047
Change relative to the 2023 submission Cu [%]	0.46%
2023 submission Ni [t]	0.0000002163
2024 submission Ni [t]	0.0000002172
Change relative to the 2023 submission Ni [%]	0.42%
2023 submission Se [t]	0.00000057828
2024 submission Se [t]	0.00000057864
Change relative to the 2023 submission Se [%]	0.06%
2023 submission Zn [t]	0.00001629
2024 submission Zn [t]	0.00001636
Change relative to the 2023 submission Zn [%]	0.46%
2023 submission BaP [kg]	0.000003115
2024 submission BaP [kg]	0.000003129
Change relative to the 2023 submission BaP [%]	0.46%
2023 submission BbF [t]	0.000001583
2024 submission BbF [t]	0.000001590
Change relative to the 2023 submission BbF [%]	0.45%
2023 submission BkF [t]	0.000002741
2024 submission BkF [t]	0.000002754
Change relative to the 2023 submission BkF [%]	0.46%
2023 submission IPy [t]	0.000006217
2024 submission IPy [t]	0.000006245
Change relative to the 2023 submission IPy [%]	0.46%

1A4bi Residential Stationary	2016
2023 submission PAH4 [t]	0.00001366
2024 submission PAH4 [t]	0.00001372
Change relative to the 2023 submission PAH4 [%]	0.46%

1A4ci Agriculture Stationary

Table 3.28 Recalculations of SO_2 in 1A4ci Agriculture Stationary between submissions.

1A4ci Agriculture Stationary	2012	2015	2020	2021
2023 submission SO_2 [kt]	9.4 E-05	8.0 E-06	1.6 E-05	1.4 E-05
2024 submission SO_2 [kt]	4.9 E-07	4.2 E-08	8.3 E-08	7.3 E-08
Change relative to the 2023 submission SO_2 [%]	-99.5%	-99.5%	-99.5%	-99.5%

Recalculations for the 2023 Submission

1A4ai Commercial/Institutional: The reason for recalculations in 1A4ai is an error that occurred in the allocation of fuels between 1A4ai and 1A4bi. Diesel oil was wrongly reported under this subsector when it should instead have been reported under 1A4bi Residential Stationary; this caused recalculations for 2019 and 2020. The recalculation is minor in the context of the Energy sector, but major in the context of this subsector, i.e., the change in activity data is between -0.35 kt and -0.4 kt of gas/diesel oil with consequent changes for all air pollutants. This is partly explained by the reallocation of gas/diesel oil between 1A4ai and 1A4bi.

1A4bi Residential Stationary: There are two reasons for recalculations in 1A4bi. Firstly, an error occurred in the allocation of fuels between 1A4ai and 1A4bi, as mentioned in the previous subchapter. Diesel oil was wrongly reported under 1A4ai Commercial/Institutional when it should instead have been reported under this subsector; this caused recalculations for 2019 and 2020. The recalculation is minor in the context of the Energy sector but major in the context of this sub-sector, i.e., the change in activity data is between 0.3 kt and 0.65 kt of gas/diesel oil with consequent changes for all air pollutants. Secondly, charcoal usage was added to this sector for the first time, but only for the years 2019-2022. Although usage is low, this contributed to small changes in the emissions totals, and thus recalculations were warranted. The increase in total activity data was between 5% and 8% for 2019-2022, with a corresponding increase in emissions.

No recalculations were done for this subcategory.

3.3.3.4 Planned Improvements

There are no planned improvements.

3.3.4 Other, Stationary (NFR 1A5a)

For the 2020 submission, sector 1A5 was reported for the first time for the time series 2003-2018 as part of the review of the energy input data. For the 2021 submission, a review for the timeseries 1990-2002 was performed. For previous submissions, these emissions were reported under NFR Category 1A2gvii, but after a review of the sales statistics, no justification was found for that attribution. Therefore, all fuels categorised as "Other" in sales statistics without any explanation of type of use, are now allocated to CRF Category 1A5. For future submissions, the EAI will work with the NEA to try to investigate where these fuels were used so they can be attributed to the correct categories.

The emissions from this sector are calculated by multiplying energy use with a pollutant specific emission factor from the 2019 EMEP/EEA guidebook.

3.3.4.1 Activity Data

Activity data is provided by the NEA, which collects data on fuel sales by sector. All fuels categorised as "Other" in sales statistics without any explanation of which sector it is used in, was allocated to NFR category 1A5.

Table 3.29 Fuel use [kt] from sector 1A5 Other.

Fuel Type	1990	1995	2000	2005	2010	2015	2020	2021	2002
Gas/Diesel Oil	NO	0.46	1.4	8.9	2.7	NO	0.084	0.52	0.16
Residual Fuel Oil	0.039	0.05	0.067	NO	1.6	NO	NO	NO	NO
Other Kerosene	NO	NO	NO	0.15	0.047	0.029	0.030	0.28	0.076
LPG	NO	NO	NO	NO	NO	0.032	NO	NO	0.0060
Biodiesel	NO	NO	NO	NO	NO	NO	0.044	0.035	0.030
Biomethane	NO	NO	NO	NO	NO	NO	0.11	0.066	0.020
Biogasoline	NO	NO	NO	NO	NO	NO	0.0010	NO	0.00016

3.3.4.2 Emission Factors

All emission factors are the same as for 1A2 which are presented in Table 3.10.

3.3.4.3 Recalculations and Improvements

Recalculations for the 2024 Submission

For this submission, a lot of changes were made regarding emissions factors used in the Energy sector, mainly in terms of sulphur content. This includes the default sulphur content value for diesel being updated to more appropriate default values for 1990-2005 while it was replaced by country specific values for 2006 onwards. Simultaneously, the default sulphur content value for LPG was also updated. These changes together led to large recalculations of SO_2 in 1A5 Other Energy through the time series.

Table 3.30 Recalculations of SO_2 in 1A5 Other Energy between submissions.

1A5 Other Energy	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	1.6 E-04	2.0 E-03	5.8 E-03	3.6 E-02	1.8 E-02	1.8 E-04	8.6 E-04	3.5 E-03
2024 submission SO_2 [kt]	3.1 E-05	4.1 E-04	8.7 E-04	7.3 E-04	3.1 E-05	8.4 E-07	4.0 E-06	1.5 E-05
Change relative to the 2023 submission SO_2 [%]	-80%	-80%	-85%	-98.0%	-99.8%	-99.5%	-99.5%	-99.6%

Recalculations for the 2023 Submission

No recalculations were done for this subcategory.

3.3.4.4 Planned Improvements

As mentioned earlier, all fuels categorised as "Other" in sales statistics without any explanation of type of use are allocated to CRF Category 1A5. For future submissions, the EAI will work with the NEA to try to investigate where these fuels were used so they can be attributed to the correct categories.

3.4 Transport and Other Mobile Sources (CRF 1A2, 1A3, and 1A4)

3.4.1 Mobile Machinery (NFR 1A2gvii, 1A3eii, and 1A4cii)

This section includes all non-road mobile machinery sources that are included under CRF 1A2, 1A3, and 1A4.

3.4.1.1 Activity Data

Activity data and information available from the NEA for 1990-2018 did not allow for the distinction between fuels sold to machinery in construction, agriculture, or other uses, but did provide data on fuel sold from fuel delivery trucks (as opposed to fuel sold at petrol stations). This means that, for the previous submission, category *1A3eii Other Off-road Vehicles and Machinery* (*1A3eii Other Mobile Machinery* for short) included all emissions derived from fuels sold to off-road machinery for 1990-2018, including *1A2gvii Mobile Machinery in Construction* and *1A4cii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery* (*1A4cii Mobile Machinery in Agriculture* for short), as well as transport activities not reported under Road Transport (such as ground activities in airports and harbours (1A3eii)). Categories 1A2gvii and 1A4cii were marked as "IE" in the CRF reporter for 1990-2018 and were all included under 1A3eii.

However, improvements were made in the data gathering by the NEA for the 2023 submission and it became possible to distinguish between off-road vehicles in agriculture and construction, but only from the inventory years 2019 onwards. As such, an extrapolation was made for 1990-2018 to split the gas/diesel oil previously reported under 1A3eii to the other categories for Mobile Machinery. An average proportion of each category was calculated based on the split for 2019-the latest year. The extrapolation will be done for every submission, and cause recalculations for 1990-2018, until a constant proportion between the three Mobile Machinery categories is available. The categorical proportions used to extrapolate for 1990-2018 for the 2014 submission can be seen in Table 3.31.

Table 3.31 Proportion used for 1990-2018 extrapolation of Mobile Machinery.

CRF code	IPCC name	Proportion used for 1990-2018 extrapolation
1A2gvii	Off-road Vehicles and Other Machinery in Construction	51%

CRF code	IPCC name	Proportion used for 1990-2018 extrapolation
1A3eii	Off-road Vehicles and Other Machinery	14%
1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	35%

Since 2019, 1A2gvii Mobile Machinery in Construction and 1A4cii Mobile Machinery in Agriculture are reported separately by the NEA, but other transport activities not reported under Road Transport (such as ground activities in airports and harbours) are still reported under 1A3eii Other Mobile Machinery.

Activity data for fuel combustion is given in Table 3.32.

Table 3.32 Fuel use [kt] for Mobile Machinery in Construction (1A2gvii), Other Mobile Machinery (1A3eii), and Agriculture (1A4cii).

Fuel Type	1990	1995	2000	2005	2010	2015	2020	2021	2022
1A2gvii - Mobile Machinery in Construction									
Gas/Diesel Oil	19.4	23.9	31.7	34.7	16.5	16.9	6.4	9.9	10.4
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A3eii - Other Mobile Machinery									
Gas/Diesel Oil	5.3	6.5	8.6	9.5	4.5	4.6	3.7	0.73	0.32
Other Kerosene	NO	NO	NO	0.022	1.2	0.16	0.33	0.16	0.026
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4cii - Mobile Machinery in Agriculture									
Gas/Diesel Oil	13.2	16.3	21.6	23.6	11.2	11.5	7.6	6.5	6.3
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO

3.4.1.2 Emission Factors

Emission factors for dioxins from this sector are taken from *Utslipp til luft av dioksiner i Norge* (Statistics Norway, 2002). They are 0.1 µg/t fuel. SO_x emissions are calculated from the S-content of the fuels (default and country specific). All other emission factors are from Table 3-1 from Chapter 1A4 Non-Road Mobile Machinery in the 2019 EMEP/EEA Guidebook. Emission factor information can be found in Table 3.33.

Table 3.33 Emission factor information for Non-road Mobile Machinery (NFR 1A2gvii, 1A3eii, 1A4cii)

Fuel Type	Reference	Exception
Gas/Diesel Oil	Tier 1 EF for liquid fuels from **Table 3-1** from Chapter *1.A.4 Non-Road Mobile Machinery* of the 2019 EMEP/EEA Guidebook	SO_2 emissions are based on Tier 1 sulphur contents from Table 3-14 in chapter 1A3b Road Transport in the 2019 EMEP/EEA Guidebook for 1990-2005. The emissions are then based on country specific sulphur content from 2006. Dioxin emissions from (Statistics Norway, 2002)
Kerosene	Same EFs as for gas/diesel oil as kerosene is most likely used for similar engines as diesel engines	
Biodiesel	Same EFs as for gas/diesel oil as biodiesel is used in diesel engines	

3.4.1.3 Recalculations and Improvements

Recalculations for the 2024 Submission

As explained above, an extrapolation of data from 2019- the latest year was performed for the years in the time series where data was not available (1990-2018). This will be done for every submission, and cause recalculations in all air pollutants for 1990-2018, until a constant proportion between the three Mobile Machinery categories is available. Table 3.35 Recalculations of all air pollutants except SO_2 in 1A2gvii Mobile Machinery in Construction between submissions., Table 3.37 and Table 3.39 show the recalculations caused by the extrapolation done for the 2024 submission.

Beside the extrapolation, the recalculations in Mobile Machinery were also caused by changes in emission factors including the update of sulphur content value for diesel (to more appropriate default values for 1990-2005 and to country specifics from 2006) which caused large recalculations of SO_2 (see Table 3.34, Table 3.36 and Table 3.38).

1A2gvii Mobile Machinery in Construction

Table 3.34 Recalculations of SO_2 in 1A2gvii Mobile Machinery in Construction between submissions.

1A2gvii Mobile Machinery in Construction	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	0.073	0.090	0.119	0.1298	0.06172	0.06337	0.02563	0.03949
2024 submission SO_2 [kt]	0.016	0.019	0.019	0.0028	0.00012	0.00030	0.00011	0.00017
Change relative to the 2023 submission SO_2 [%]	-79%	-79%	-84%	-97.9%	-99.8%	-99.5%	-99.6%	-99.6%

Table 3.35 Recalculations of all air pollutants except SO_2 in 1A2gvii Mobile Machinery in Construction between submissions.

1A2gvii Mobile Machinery in Construction	1990	1995	2000	2005	2010	2015	2018
2023 submission NO_X [kt]	0.593	0.730	0.967	1.059	0.503	0.517	0.491
2024 submission NO_X [kt]	0.635	0.781	1.034	1.132	0.538	0.553	0.525
Change relative to the 2023 submission NO_X [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission CO [kt]	0.196	0.241	0.319	0.350	0.166	0.171	0.162
2024 submission CO [kt]	0.210	0.258	0.341	0.374	0.178	0.182	0.173
Change relative to the 2023 submission CO [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission NMVOC [kt]	0.0614	0.0756	0.1001	0.1096	0.0521	0.0535	0.0508
2024 submission NMVOC [kt]	0.0657	0.0808	0.1070	0.1172	0.0557	0.0572	0.0544
Change relative to the 2023 submission NMVOC [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission NH_3 [kt]	0.000145	0.000179	0.000237	0.000260	0.000123	0.000127	0.000120
2024 submission NH_3 [kt]	0.000156	0.000191	0.000253	0.000278	0.000132	0.000136	0.000129
Change relative to the 2023 submission NH_3 [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission dioxin [g]	0.00182	0.00224	0.00296	0.00325	0.00154	0.00158	0.00151

1A2gvii Mobile Machinery in Construction	1990	1995	2000	2005	2010	2015	2018
2024 submission dioxin [g]	0.00194	0.00239	0.00317	0.00347	0.00165	0.00169	0.00161
Change relative to the 2023 submission dioxin [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission $PM_{2.5}$ [kt]	0.0383	0.0471	0.0623	0.0683	0.0325	0.0333	0.0317
2024 submission $PM_{2.5}$ [kt]	0.0409	0.0503	0.0667	0.0730	0.0347	0.0356	0.0339
Change relative to the 2023 submission $PM_{2.5}$ [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission PM_{10} [kt]	0.0383	0.0471	0.0623	0.0683	0.0325	0.0333	0.0317
2024 submission PM_{10} [kt]	0.0409	0.0503	0.0667	0.0730	0.0347	0.0356	0.0339
Change relative to the 2023 submission PM_{10} [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission TSP [kt]	0.0383	0.0471	0.0623	0.0683	0.0325	0.0333	0.0317
2024 submission TSP [kt]	0.0409	0.0503	0.0667	0.0730	0.0347	0.0356	0.0339
Change relative to the 2023 submission TSP [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission BC [kt]	0.0238	0.0292	0.0387	0.0424	0.0202	0.0207	0.0197
2024 submission BC [kt]	0.0254	0.0313	0.0414	0.0453	0.0215	0.0221	0.0210
Change relative to the 2023 submission BC [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission Pb [t]	0.0409	0.0504	0.0667	0.0730	0.0347	0.0356	0.0339
2024 submission Pb [t]	0.0438	0.0538	0.0713	0.0781	0.0371	0.0381	0.0362
Change relative to the 2023 submission Pb [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission Cd [t]	0.000182	0.000224	0.000296	0.000325	0.000154	0.000158	0.000151
2024 submission Cd [t]	0.000194	0.000239	0.000317	0.000347	0.000165	0.000169	0.000161
Change relative to the 2023 submission Cd [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission Cu [t]	0.0309	0.0380	0.0504	0.0552	0.0262	0.0269	0.0256
2024 submission Cu [t]	0.0331	0.0407	0.0539	0.0590	0.0280	0.0288	0.0274
Change relative to the 2023 submission Cu [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission Cr [t]	0.000909	0.001119	0.001482	0.001623	0.00077	0.00079	0.00075
2024 submission Cr [t]	0.000972	0.001196	0.001584	0.001735	0.00082	0.00085	0.00080
Change relative to the 2023 submission Cr [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission Ni [t]	0.00127	0.00157	0.00207	0.00227	0.00108	0.00111	0.00105
2024 submission Ni [t]	0.00136	0.00168	0.00222	0.00243	0.00115	0.00119	0.00113
Change relative to the 2023 submission Ni [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission Se [t]	0.000182	0.000224	0.000296	0.000325	0.000154	0.000158	0.000151
2024 submission Se [t]	0.000194	0.000239	0.000317	0.000347	0.000165	0.000169	0.000161
Change relative to the 2023 submission Se [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission Zn [t]	0.0182	0.0224	0.0296	0.0325	0.0154	0.0158	0.0151
2024 submission Zn [t]	0.0194	0.0239	0.0317	0.0347	0.0165	0.0169	0.0161
Change relative to the 2023 submission Zn [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission BaP [t]	0.000546	0.000671	0.000889	0.000974	0.000463	0.000475	0.000452
2024 submission BaP [t]	0.000583	0.000718	0.000951	0.001041	0.000495	0.000508	0.000483

1A2gvii Mobile Machinery in Construction	1990	1995	2000	2005	2010	2015	2018
Change relative to the 2023 submission BaP [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission BbF [t]	0.000909	0.001119	0.001482	0.001623	0.000772	0.000792	0.00075
2024 submission BbF [t]	0.000972	0.001196	0.001584	0.001735	0.000825	0.000847	0.00080
Change relative to the 2023 submission BbF [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
2023 submission PAH4 [t]	0.00145	0.00179	0.00237	0.00260	0.00123	0.00127	0.001204
2024 submission PAH4 [t]	0.00156	0.00191	0.00253	0.00278	0.00132	0.00136	0.001288
Change relative to the 2023 submission PAH4 [%]	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%

1A3eii Other Mobile Machinery

Table 3.36 Recalculations of SO2 in 1A3eii Other Mobile Machinery between submissions.

1A3eii Other Mobile Machinery	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	2.7 E-02	3.4 E-02	4.5 E-02	4.9 E-02	2.8 E-02	2.4 E-02	1.6 E-02	3.6 E-03
2024 submission SO_2 [kt]	4.2 E-03	5.2 E-03	5.2 E-03	7.6 E-04	4.0 E-05	8.4 E-05	7.1 E-05	1.5 E-05
Change relative to the 2023 submission SO_2 [%]	-84%	-84%	-88%	-98.4%	-99.9%	-99.7%	-99.6%	-99.6%

Table 3.37 Recalculations in all air pollutants except SO_2 in 1A3eii Other Mobile Machinery between submissions.

1A3eii Other Mobile Machinery	1990	1995	2000	2005	2010	2015	2018
2023 submission NO_X [kt]	0.223	0.274	0.363	0.399	0.227	0.199	0.186
2024 submission NO_X [kt]	0.173	0.213	0.282	0.310	0.185	0.156	0.145
Change relative to the 2023 submission NO_X [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission CO [kt]	0.074	0.091	0.120	0.132	0.075	0.066	0.062
2024 submission CO [kt]	0.057	0.070	0.093	0.102	0.061	0.051	0.048
Change relative to the 2023 submission CO [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission NMVOC [kt]	0.023	0.028	0.038	0.041	0.024	0.021	0.019
2024 submission NMVOC [kt]	0.018	0.022	0.029	0.032	0.019	0.016	0.015
Change relative to the 2023 submission NMVOC [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission NH_3 [kt]	0.000055	0.000067	0.000089	0.000098	0.000056	0.000049	0.000046
2024 submission NH_3 [kt]	0.000042	0.000052	0.000069	0.000076	0.000045	0.000038	0.000036
Change relative to the 2023 submission NH3 [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission dioxin [g]	0.000683	0.000841	0.001114	0.001222	0.000697	0.000611	0.000571
2024 submission dioxin [g]	0.000530	0.000653	0.000864	0.000949	0.000567	0.000478	0.000445
Change relative to the 2023 submission dioxin [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission $PM_{2.5}$ [kt]	0.0144	0.0177	0.0234	0.0257	0.0147	0.0129	0.0120
2024 submission $PM_{2.5}$ [kt]	0.0112	0.0137	0.0182	0.0200	0.0119	0.0101	0.0094
Change relative to the 2023 submission $PM_{2.5}$ [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%

1A3eii Other Mobile Machinery	1990	1995	2000	2005	2010	2015	2018
2023 submission PM_{10} [kt]	0.0144	0.0177	0.0234	0.0257	0.0147	0.0129	0.0120
2024 submission PM_{10} [kt]	0.0112	0.0137	0.0182	0.0200	0.0119	0.0101	0.0094
Change relative to the 2023 submission PM_{10} [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission TSP [kt]	0.0144	0.0177	0.0234	0.0257	0.0147	0.0129	0.0120
2024 submission TSP [kt]	0.0112	0.0137	0.0182	0.0200	0.0119	0.0101	0.0094
Change relative to the 2023 submission TSP [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission BC [kt]	0.0089	0.0110	0.0145	0.0160	0.0091	0.0080	0.0075
2024 submission BC [kt]	0.0069	0.0085	0.0113	0.0124	0.0074	0.0062	0.0058
Change relative to the 2023 submission BC [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission Pb [t]	0.0154	0.0189	0.0251	0.0275	0.0157	0.0137	0.0129
2024 submission Pb [t]	0.0119	0.0147	0.0194	0.0214	0.0128	0.0107	0.0100
Change relative to the 2023 submission Pb [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission Cd [t]	0.000068	0.000084	0.000111	0.000122	0.000070	0.000061	0.000057
2024 submission Cd [t]	0.000053	0.000065	0.000086	0.000095	0.000057	0.000048	0.000044
Change relative to the 2023 submission Cd [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission Cu [t]	0.0116	0.0143	0.0189	0.0208	0.0118	0.0104	0.0097
2024 submission Cu [t]	0.0090	0.0111	0.0147	0.0161	0.0096	0.0081	0.0076
Change relative to the 2023 submission Cu [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission Cr [t]	0.00034	0.00042	0.00056	0.00061	0.00035	0.00031	0.00029
2024 submission Cr [t]	0.00027	0.00033	0.00043	0.00047	0.00028	0.00024	0.00022
Change relative to the 2023 submission Cr [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission Ni [t]	0.00048	0.00059	0.00078	0.00086	0.00049	0.00043	0.00040
2024 submission Ni [t]	0.00037	0.00046	0.00061	0.00066	0.00040	0.00033	0.00031
Change relative to the 2023 submission Ni [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission Se [t]	0.000068	0.000084	0.000111	0.000122	0.000070	0.000061	0.000057
2024 submission Se [t]	0.000053	0.000065	0.000086	0.000095	0.000057	0.000048	0.000044
Change relative to the 2023 submission Se [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission Zn [t]	0.0068	0.0084	0.0111	0.0122	0.0070	0.0061	0.0057
2024 submission Zn [t]	0.0053	0.0065	0.0086	0.0095	0.0057	0.0048	0.0044
Change relative to the 2023 submission Zn [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission BaP [t]	0.00021	0.00025	0.00033	0.00037	0.00021	0.00018	0.00017
2024 submission BaP [t]	0.00016	0.00020	0.00026	0.00028	0.00017	0.00014	0.00013
Change relative to the 2023 submission BaP [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%
2023 submission BbF [t]	0.00034	0.00042	0.00056	0.00061	0.00035	0.00031	0.00029
2024 submission BbF [t]	0.00027	0.00033	0.00043	0.00047	0.00028	0.00024	0.00022
Change relative to the 2023 submission BbF [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%

1A3eii Other Mobile Machinery	1990	1995	2000	2005	2010	2015	2018
2023 submission PAH4 [t]	0.00055	0.00067	0.00089	0.00098	0.00056	0.00049	0.00046
2024 submission PAH4 [t]	0.00042	0.00052	0.00069	0.00076	0.00045	0.00038	0.00036
Change relative to the 2023 submission PAH4 [%]	-22%	-22%	-22%	-22%	-19%	-22%	-22%

1A4cii Mobile Machinery in Agriculture

Table 3.38 Recalculations of SO_2 in 1A4cii Mobile Machinery in Agriculture between submissions.

1A4cii Mobile Machinery in Agriculture	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	5.2 E-02	6.4 E-02	8.4 E-02	9.3 E-02	4.4 E-02	4.5 E-02	3.0 E-02	2.6 E-02
2024 submission SO_2 [kt]	1.1 E-02	1.3 E-02	1.3 E-02	1.9 E-03	7.9 E-05	2.0 E-04	1.3 E-04	1.1 E-04
Change relative to the 2023 submission SO_2 [%]	-80%	-80%	-85%	-98.0%	-99.8%	-99.6%	-99.6%	-99.6%

Table 3.39 Recalculations of all air pollutants except SO_2 in 1A4cii Mobile Machinery in Agriculture between submissions.

Mobile Machinery in Agriculture	1990	1995	2000	2005	2010	2015	2018
2023 submission NO_X [kt]	0.422852	0.520324	0.688981	0.754623	0.358769	0.368321	0.349985
2024 submission NO_X [kt]	0.431679	0.531185	0.703364	0.770375	0.366258	0.376010	0.357291
Change relative to the 2023 submission NO_X [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission CO [kt]	0.139625	0.171809	0.227500	0.249174	0.118465	0.121619	0.115564
2024 submission CO [kt]	0.142539	0.175396	0.232249	0.254376	0.120937	0.124157	0.117976
Change relative to the 2023 submission CO [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission NMVOC [kt]	0.043764	0.053852	0.071307	0.078101	0.037131	0.038120	0.036222
2024 submission NMVOC [kt]	0.044677	0.054976	0.072796	0.079731	0.037907	0.038916	0.036978
Change relative to the 2023 submission NMVOC [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission NH3 [kt]	0.000104	0.000128	0.000169	0.000185	0.000088	0.000090	0.000086
2024 submission NH3 [kt]	0.000106	0.000130	0.000172	0.000189	0.000090	0.000092	0.000088
Change relative to the 2023 submission NH3 [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission dioxin [g]	0.001296	0.001595	0.002112	0.002313	0.001100	0.001129	0.001073
2024 submission dioxin [g]	0.001323	0.001628	0.002156	0.002361	0.001122	0.001152	0.001095
Change relative to the 2023 submission dioxin [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission $PM_{2.5}$ [kt]	0.027267	0.033552	0.044427	0.048660	0.023134	0.023750	0.022568
2024 submission $PM_{2.5}$ [kt]	0.027836	0.034252	0.045355	0.049676	0.023617	0.024246	0.023039
Change relative to the 2023 submission $PM_{2.5}$ [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission BC [kt]	0.016925	0.020826	0.027577	0.030204	0.014360	0.014742	0.014008
2024 submission BC [kt]	0.017278	0.021261	0.028153	0.030835	0.014660	0.015050	0.014301
Change relative to the 2023 submission BC [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission PM_{10} [kt]	0.027267	0.033552	0.044427	0.048660	0.023134	0.023750	0.022568
2024 submission PM_{10} [kt]	0.027836	0.034252	0.045355	0.049676	0.023617	0.024246	0.023039

Mobile Machinery in Agriculture	1990	1995	2000	2005	2010	2015	2018
Change relative to the 2023 submission PM_{10} [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission TSP [kt]	0.027267	0.033552	0.044427	0.048660	0.023134	0.023750	0.022568
2024 submission TSP [kt]	0.027836	0.034252	0.045355	0.049676	0.023617	0.024246	0.023039
Change relative to the 2023 submission TSP [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission Pb [t]	0.029159	0.035880	0.047510	0.052037	0.024740	0.025398	0.024134
2024 submission Pb [t]	0.029767	0.036629	0.048502	0.053123	0.025256	0.025929	0.024638
Change relative to the 2023 submission Pb [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission Cd [t]	0.000130	0.000159	0.000211	0.000231	0.000110	0.000113	0.000107
2024 submission Cd [t]	0.000132	0.000163	0.000216	0.000236	0.000112	0.000115	0.000110
Change relative to the 2023 submission Cd [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission Cu [t]	0.022031	0.027109	0.035897	0.039317	0.018692	0.019190	0.018235
2024 submission Cu [t]	0.022491	0.027675	0.036646	0.040137	0.019082	0.019590	0.018615
Change relative to the 2023 submission Cu [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission Cr [t]	0.000648	0.000797	0.001056	0.001156	0.000550	0.000564	0.000536
2024 submission Cr [t]	0.000661	0.000814	0.001078	0.001181	0.000561	0.000576	0.000548
Change relative to the 2023 submission Cr [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission Ni [t]	0.000907	0.001116	0.001478	0.001619	0.000770	0.000790	0.000751
2024 submission Ni [t]	0.000926	0.001140	0.001509	0.001653	0.000786	0.000807	0.000767
Change relative to the 2023 submission Ni [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission Se [t]	0.000130	0.000159	0.000211	0.000231	0.000110	0.000113	0.000107
2024 submission Se [t]	0.000132	0.000163	0.000216	0.000236	0.000112	0.000115	0.000110
Change relative to the 2023 submission Se [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission Zn [t]	0.012959	0.015947	0.021116	0.023127	0.010995	0.011288	0.010726
2024 submission Zn [t]	0.013230	0.016280	0.021556	0.023610	0.011225	0.011524	0.010950
Change relative to the 2023 submission Zn [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission BaP [t]	0.000389	0.000478	0.000633	0.000694	0.000330	0.000339	0.000322
2024 submission BaP [t]	0.000397	0.000488	0.000647	0.000708	0.000337	0.000346	0.000329
Change relative to the 2023 submission BaP [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission BbF [t]	0.000648	0.000797	0.001056	0.001156	0.000550	0.000564	0.000536
2024 submission BbF [t]	0.000661	0.000814	0.001078	0.001181	0.000561	0.000576	0.000548
Change relative to the 2023 submission BbF [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
2023 submission PAH4 [t]	0.001037	0.001276	0.001689	0.001850	0.000880	0.000903	0.000858
2024 submission PAH4 [t]	0.001058	0.001302	0.001725	0.001889	0.000898	0.000922	0.000876
Change relative to the 2023 submission PAH4 [%]	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%

Recalculations for the 2023 Submission

For the 2023 submission, an extrapolation was made for 1990-2018 to split the gas/diesel oil previously reported under 1A3eii to the other categories for Mobile Machinery. An average proportion of each category was calculated based on the split for 2019-2021. Thus, Categories 1A2gvii and 1A4cii are no longer marked as "IE" and are no longer included under 1Aeii. The categorical proportions used to extrapolate for 1990-2018 can be seen in Table 3.40 Reallocations of gas/diesel oil sales in 1A2gvii, 1A3eii, and 1A4cii.

1A2gvii Mobile Machinery in Construction: In previous submissions, this category was reported as "IE," and its emissions were reported under 1A3eii. However, due to the aforementioned extrapolation of gas/diesel oil sales, data now exists for the entire timeseries and thus recalculations have occurred for each year from 1990-2018 for all pollutants, although these recalculations merely indicate a change from IE, and the total yearly emissions are not affected.

Moreover, an error in the fuel allocation between this category and 1A3eii for 2019-2020 caused recalculations for these years in the timeseries. This error was corrected before the extrapolation was performed.

1A3eii Other Mobile Machinery: In previous submissions, this category was included all emissions from fuels sold to off-road machinery (including fuels used for Construction and Agriculture), but in the 2023 submission, data became available that speciated off-road machinery gas/diesel oil sales between 1A2gvii, 1A3eii, and 1A4cii. Due to the aforementioned extrapolation, fuel that was reported under this category for 1990-2018 was reallocated to 1A2gvii and 1A4cii for these years, and thus recalculations occurred for these years in the timeseries. Moreover, an error in the fuel allocation between this category and 1A2gvii for 2019-2020 caused recalculations for these years in the timeseries. This error was corrected before the extrapolation was performed.

1A4cii Mobile Machinery in Agriculture: In previous submissions, this category was reported as "IE", and its emissions were reported under 1A3eii. However, due to the aforementioned extrapolation of gas/diesel oil sales, data now exists for the entire timeseries and thus recalculations have occurred for each year from 1990-2018 for all pollutants, although these recalculations merely indicate a change from IE, and the total yearly emissions are not affected.

Table 3.40 Reallocations of gas/diesel oil sales in 1A2gvii, 1A3eii, and 1A4cii.

Category	Submission	Gas/Diesel Oil [kt]							
		1990	1995	2000	2005	2010	2015	2019	2020
1A2gvii Construction	2022	IE	IE	IE	IE	IE	IE	7.1	3.7
	2023	18.2	22.4	29.6	32.5	15.4	15.8	12.3	6.4
1A3eii Other Mobile Machinery	2022	38.0	46.7	61.9	67.8	32.2	33.1	12.3	6.4
	2023	6.8	8.4	11.1	12.2	5.8	6.0	7.1	3.7
1A4cii Agriculture	2022	IE	IE	IE	IE	IE	IE	5.4	7.6
	2023	13.0	15.9	21.1	23.1	11.0	11.3	5.4	7.6

3.4.1.4 Planned Improvements

For future submissions, the EAI, together with the NEA, plans to find constant proportion between the three Mobile Machinery categories for 1990-2018.

3.4.2 Civil Aviation (NFR 1A3a)

Emissions from aviation are divided into four groups: International Landing and Take-Off (LTO) (1A3ai(i)), Domestic LTO (1A3aii(i)), International Climb, Cruise, and Descent (CCD) (1A3ai(ii)), and Domestic CCD (1A3aii(ii)). As defined by Eurocontrol, LTO includes taxi out, take off, climb out (up to a height of 3,000 ft.), final approach (from a height of 3,000 ft), landing, and taxi in. CCD includes climb from a height of 3,000 ft up to the cruise level, cruise, and descent down to a height of 3,000 ft. Emissions occurring during LTO of both domestic and international flights are included in national totals, whereas emissions occurring during the CCD part of the flights are reported as "memo" items and are thus not counted in the national totals.

A Tier 3 methodology is used for reporting, which uses a complete flight list containing data on the origin and destination airport, aircraft type, and date of each flight for a range of years for both domestic and international flights. The EMEP/EEA master emissions calculator tool, attached as an annex to the 2023 EMEP/EEA guidebook, was used to obtain estimates for NO_X, SO_X, CO, and PM emissions based on flight distances and aircraft types. International and domestic flight totals were used as proxies to project the results backwards to years pre-2011 in the case of domestic flights, and pre-1998 for international flights, as complete detailed flight data is not available for these years.

BC emissions are estimated using the suggested fraction of PM equal to 0.15 that is provided in the 2023 EMEP/EEA Guidebook. The ratio of $PM_{2.5}$ to PM_{10} emissions is assumed to be 1.

A Tier 1 method is used for NMVOC, Pb, and dioxins using fuel consumption data, as these pollutants are not included in the EMEP/EEA calculator.

NH_3, heavy metals, and PAHs are currently reported as NE due to lack of available emission factors.

3.4.2.1 Activity Data

In Iceland, there is one main airport for international flights, Keflavík International Airport (KEF). Under normal circumstances almost all international flights to and from Iceland depart and arrive from KEF, except for flights to Greenland, the Faroe Islands, and some flights with private airplanes which depart and arrive from Reykjavík Airport. Domestic flights sometimes depart from KEF in case of special weather conditions.

Activity data is provided by Isavia, the national airport and air navigation service provider of Iceland. This is in the form of Station Reports comprising detailed, timestamped data on every flight passing through each of Iceland's airports. This data includes the origin and destination airports, and aircraft type used for each flight. It is therefore straightforward to distinguish between national and international flights using the Origin and Destination fields. This detailed data is available for the years 2011-2022 for domestic flights, and

1998-2022 for international flights. International and domestic flight totals are provided from 1993-2006 and 2008, which are used as a proxy to project emissions backwards where full flight data is not available, using linear extrapolation. For 2007, 2009, and 2010, estimates are linearly interpolated for domestic flights.

For domestic flights, the average emissions for the years 1993-2000 are reported in 1990-1992 because a linear trend is not observed. For international flights, the range 1993-1995 is linearly extrapolated back to 1990 for reporting, following the observed trend.

Flight distances are obtained by using an online great circle distance (GCD) calculator tool, which assumes the Earth to be a perfect sphere, for each origin/destination combination. In a few cases where the distance is unable to be found in this way, a conservative figure of the width of Iceland is applied for domestic flights, and the average figure found for the relevant country in the case of international flights. Some manual matching of aircraft types was also performed in cases where aircrafts may be referred to by multiple equivalent codes.

For the Tier 1 method for NMVOC, dioxins, and Pb, fuel consumption data from the NEA is used.

3.4.2.2 Emission Factors

LTO and CCD emissions are calculated using the emission factors inherent in the 2023 EMEP/EEA master emissions calculator for the years where full detailed flight data is available. Emissions were not able to be calculated using this method for a fraction of the flights, due to missing aircraft codes, limitations of the tool, and also a small number of flights for which distances weren't found. This equates to 27.1% of domestic flights and 26.0% of international flights for LTO emissions, and 50.7% of domestic flights and 26.6% of international flights for CCD emissions, with the larger gaps appearing in the earlier years in the time series. For 2022 only 3.0% of LTO and 4.4% of CCD emission were missing for international flights but 24.0% of LTO and 49.7% of CCD for domestic. The emissions totals were therefore afterwards multiplied by a correction factor based on the total number of flights in that year and category, which is equivalent to assigning the average amount of emissions produced by a flight in the same year and category, to each missing flight. In this way, complete estimates are provided for NO_x, SO_x, CO, and PM emissions.

For NMVOC emissions, the default emission factor from the EMEP/EEA Guidebook 2023 is used, from Table 3.3.

Emission factors for dioxin were taken from the Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases (UNEP, 2005) and from Utslipp til luft av dioksiner i Norge (Statistics Norway, 2002).

New emission factor was added for Pb. Aviation gasoline used for domestic aviation is Avgas 100LL which has an emission factor in Annex 2 table A2.1 in EMEP/EEA Guidebook 2023.

3.4.2.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Recalculations were made for the whole timeline due to the new master emissions calculator tool for 2023. Major changes were made to the emission factors for PM and CO for domestic flights between the 2016 and 2023 master emissions calculator tool as well as a significant change to the PM emission factor for international flights. LTO and CCD fuel usage activity data changes, and other emission factor changes, were minor. See emission changes due to the update of the master emissions calculator tool in Table 3.41 to Table 3.44.

Table 3.41 Recalculations for International LTO (1A3ai(i)) due to update of master emissions calculator tool.

International LTO	Submission	Emissions [kt]							
		1990	1995	2000	2005	2010	2015	2020	2021
PM	2023	0.00082	0.00096	0.00139	0.00173	0.00167	0.00275	0.00114	0.00164
	2024	0.00118	0.00136	0.00192	0.00237	0.00224	0.00367	0.00132	0.00159
CO	2023	0.06202	0.07384	0.10654	0.13379	0.12809	0.21247	0.10696	0.16660
	2024	0.06072	0.07281	0.10621	0.13353	0.13009	0.21557	0.10461	0.15694
NO_x	2023	0.05915	0.07638	0.13036	0.16510	0.15640	0.27422	0.12755	0.19489
	2024	0.06213	0.07857	0.12976	0.16514	0.15661	0.27161	0.11344	0.16977
SO_x	2023	0.00581	0.00685	0.00994	0.01243	0.01174	0.01967	0.00856	0.01256
	2024	0.00583	0.00684	0.00987	0.01239	0.01173	0.01962	0.00788	0.01108

Table 3.42 Recalculations for International CCD (1A3ai(ii)) due to update of master emissions calculator tool.

International CCD	Submission	Emissions [kt]							
		1990	1995	2000	2005	2010	2015	2020	2021
PM	2023	0.0091	0.0114	0.0199	0.0230	0.0218	0.0393	0.0169	0.0267
	2024	0.0154	0.0190	0.0323	0.0377	0.0356	0.0636	0.0222	0.0304
CO	2023	0.1114	0.1325	0.1984	0.2380	0.2288	0.3829	0.1818	0.2918
	2024	0.1100	0.1333	0.1972	0.2454	0.2476	0.4179	0.1970	0.3008
NO_x	2023	0.3590	0.5194	1.1001	1.3056	1.2043	2.2359	1.1000	1.8368
	2024	0.4205	0.5853	1.1175	1.4093	1.3531	2.4188	1.0667	1.7504
SO_x	2023	0.0428	0.0525	0.0872	0.1019	0.0932	0.1628	0.0731	0.1179
	2024	0.0436	0.0540	0.0882	0.1076	0.1024	0.1781	0.0730	0.1160

Table 3.43 Recalculations for Domestic LTO (1A3aii(i)) due to update of master emissions calculator tool.

Domestic LTO	Submission	Emissions [kt]							
		1990	1995	2000	2005	2010	2015	2020	2021
PM	2023	3.4E-05	3.5E-05	3.4E-05	3.5E-05	3.5E-05	5.3E-05	9.8E-06	2.7E-05
	2024	6.3E-05	6.3E-05	6.3E-05	6.1E-05	6.2E-05	8.3E-05	1.9E-05	4.9E-05
CO	2023	0.0658	0.0621	0.0629	0.0546	0.0607	0.0502	0.0537	0.0999
	2024	0.0954	0.0910	0.0920	0.0821	0.0894	0.0840	0.0532	0.1062
NO_x	2023	0.0427	0.0406	0.0410	0.0364	0.0398	0.0368	0.0265	0.0488
	2024	0.0364	0.0341	0.0346	0.0293	0.0332	0.0283	0.0232	0.0450

Domestic LTO	Submission	1990	1995	2000	2005	2010	2015	2020	2021
		Emissions [kt]							
SO_x	2023	0.0042	0.0040	0.0040	0.0035	0.0039	0.0035	0.0028	0.0050
	2024	0.0037	0.0035	0.0035	0.0030	0.0034	0.0029	0.0024	0.0045

Table 3.44 Recalculations for Domestic CCD (1A3aii(ii)) due to update of master emissions calculator tool.

Domestic CCD	Submission	1990	1995	2000	2005	2010	2015	2020	2021
		Emissions [kt]							
PM	2023	0.0001	0.0001	0.0001	0.0001	0.0001	2.0E-04	3.5E-05	8.5E-05
	2024	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0001	0.0002
CO	2023	0.1501	0.1457	0.1467	0.1369	0.1441	0.1395	0.0518	0.1850
	2024	0.2416	0.2414	0.2414	0.2408	0.2412	0.2547	0.0389	0.2072
NO_x	2023	0.1240	0.1196	0.1206	0.1109	0.1181	0.1144	0.0745	0.1285
	2024	0.1489	0.1382	0.1406	0.1167	0.1344	0.1068	0.0913	0.1810
SO_x	2023	0.0085	0.0082	0.0083	0.0076	0.0081	0.0076	0.0056	0.0097
	2024	0.0098	0.0092	0.0093	0.0079	0.0090	0.0075	0.0061	0.0116

Recalculations for the 2023 Submission

By using actual flight data, these estimates provide a more accurate description of emissions emanating from Iceland's aviation sector. In some cases, they show a more probable trend, with the large change in emissions from 2004 to 2005 (which was very noticeable for CO emissions for example) from the previous method no longer observed. This has resulted in some large recalculations from the previous submission. The methodology is now also more transparent than it had been with previous extensive use of Eurocontrol data. PM_{10}, $PM_{2.5}$, TSP, and BC emissions for the years 1990-2004 are estimated for the first time in this submission. Dioxin emissions were also recalculated for the whole timeseries for two reasons. The main reasons for this were an error in unit conversion resulting in an increase by a factor of one thousand, and a small change in the emission factor (from 2.2 to 2.0 μg/tonne).

3.4.2.4 Planned Improvements

There are a few possible improvements planned for the next submissions, as follows:

Data on total flight numbers for domestic and international flights will be sought for 2007, 2009, and 2010, which would enable better backwards projections of results.

The flight totals data provided suggest that a number of test and "other" flights are happening in the country, which are not being accounted for in either the new or previous estimates. This could be clarified with data providers for future submissions, but we believe this would have a very small impact on emissions.

3.4.3 Road Transport (NFR 1A3b)

Emissions from the Road Transport category is split into seven subcategories:

- 1A3bi Cars
- 1A3bii Light-duty Trucks
- 1A3biii Heavy-duty Trucks and Buses
- 1A3biv Motorcycles
- 1A3bv Gasoline Evaporation
- 1A3bvi Automobile Tyre and Brake Wear
- 1A3bvii Automobile Road Abrasion

3.4.3.1 Methodology

The transport model COPERT 5.6.1 (developed by EMISIA SA) was used to produce emission estimates for all pollutants for the whole time series. The following text is taken from the COPERT website regarding the applied methodology[5]: *"The COPERT methodology is part of the EMEP/EEA air pollutant emission inventory Guidebook for the calculation of air pollutant emissions."* Results from the COPERT model were adjusted to calculate the emissions of $PM_{2.5}$, PM_{10}, TSP, and BC within Automobile Road Abrasion because of studded tyre use. It should be noted that condensable PM is included in COPERT calculations.

3.4.3.2 Activity Data

Country-specific data was used where it was available. That data is:

- Average temperature values were obtained from the Icelandic Meteorological Office (*Veðurstofa Íslands*) (IMO).
- Vehicle stock numbers for 2017-2022 were obtained from the ITA.
- Measurements collected by the EAI for energy content, density, and sulphur content were used where available. Calculations of SO_X emissions in COPERT are based on country-specific sulphur content in fuels, where it is assumed that all sulphur is converted to SO_X. Country-specific measurements are only available from 2006, so for previous years the maximum allowed sulphur content according to European regulations was used as an approximation.
- Total fuel sales were obtained from sales statistics collected by the NEA for the whole timeseries.
- Measurements of carbon content (%C/%H/%O) in gasoline and diesel oil used in Road Transport were done from fuel samples from 2019, 2020, and 2021. The 2019 value was applied for 1990-2019 and the 2021 value was applied for 2022. The measurements for gasoline were done on 5% blended fuel. A correction was made before emissions were calculated so that the carbon content represents pure fossil gasoline.

[5] https://www.emisia.com/utilities/copert/

A comprehensive dataset was purchased from EMISIA, the company that develops COPERT. That data was used where country-specific data was not available.

Total fuels sales were obtained from sales statistics collected by the NEA for the whole timeseries.

In Table 3.45 the total use of diesel oil, gasoline, and biofuels can be seen. They are based on the NEA's annual sales statistics for fuels in Road Transport.

Table 3.45 Fuel use [kt], Road Transport.

Fuel Type	1990	1995	2000	2005	2010	2015	2020	2021	2022
Gasoline	67.1	117.6	142.6	156.7	148.2	132.5	91.6	84.8	91.8
Gasoline, leaded	60.7	18.0	NO	NO	NO	NO	NO	NO	NO
Diesel oil	36.6	36.9	47.5	83.5	106.4	126.4	167.9	183.2	197.1
Biomethane	NO	NO	0.006	0.039	0.595	2.18	1.44	1.50	1.56
Biodiesel	NO	NO	NO	NO	NO	11.9	13.0	11.9	4.2
Biogasoline/ Bioethanol	NO	NO	NO	NO	NO	1.93	11.04	25.6	20.6
Hydrogen	NO	NO	NO	0.00001	0.002	NO	4.2E-04	0.0002	0.0003

A dataset about the usage of studded tyres (for $PM_{2.5}$, PM_{10}, TSP, and BC emissions within Automobile Road Abrasion) was obtained from the city of Reykjavík (for 2000-2019) and the city of Akureyri (for 1990-2019).

3.4.3.3 Emission Factors

All emission factors in COPERT are based on the Tier 3 methodology in the 2019 EMEP/EEA Guidebook which are presented in Chapter 3.4 in the guidebook. The updated version of COPERT does, however, use updated emission factors.

Emission factors for 1A3bvii Automobile Road Abrasion due to studded tyres are based on Swedish research on studded tyre wear from pavement (Gustafsson, et al., 2005). The emission factor for PM_{10} for studded tyres for passenger cars and light-duty trucks is 50 times higher than for non-studded tyres.

The same particle size fraction factors and BC fraction factors based on 2019 EMEP/EEA Guidebook are used for both studded and non-studded tyres.

The use of studded tyres on passenger cars and light duty trucks is 25% based on following information and assumptions:

- Studded tyres are banned in Iceland from 15 April to 31 October each year. During this period, the usage is assumed to be zero.
- Usage during studded tyre season (1 November to 14 April) is based on counting of studded tyres in two municipalities, one in the greater Reykjavík area and one in Akureyri, a city in the north of approximately 20,000 people.
- Since 1990, the percentage of the Icelandic population living in the Capital Region has been 62% on average. The other 38% of the population live outside of the Capital Region. There, studded tyre usage is assumed to be the same as in Akureyri.

Studded tyre usage of heavy-duty trucks, buses, and motorcycles is very low and considered to be zero in this estimation.

3.4.3.4 Recalculations and Improvements

Recalculations for the 2024 Submission

Recalculations for this submission were only due to minor reallocation of fuels for 2016 and 2021. See changes in emissions in Table 3.46.

Table 3.46 Recalculations in Road Transport due to minor reallocation of fuels between the 2023 and 2024 submission

1A3b Road Transport	2016	2021
2023 Submission NO_x [kt]	2.52	1.7621
2024 Submission NO_x [kt]	2.53	1.7616
Change relative to the 2023 Submission [kt]	0.01	-0.0005
Change relative to the 2023 Submission [%]	0.4%	-0.03%
2023 Submission NMVOC [kt]	0.7735	0.6199
2024 Submission NMVOC [kt]	0.7738	0.6196
Change relative to the 2023 Submission [kt]	0.0003	-0.0002
Change relative to the 2023 Submission [%]	0.04%	-0.04%
2023 Submission NH_3 [kt]	0.08067	0.04460
2024 Submission NH_3 [kt]	0.08070	0.04455
Change relative to the 2023 Submission [kt]	0.00003	-0.00005
Change relative to the 2023 Submission [%]	0.04%	-0.12%
2023 Submission $PM_{2.5}$ [kt]	0.2887	0.2808
2024 Submission $PM_{2.5}$ [kt]	0.2895	0.2807
Change relative to the 2023 Submission [kt]	0.0008	-0.0001
Change relative to the 2023 Submission [%]	0.29%	-0.02%
2023 Submission PM_{10} [kt]	0.4923	0.5002
2024 Submission PM_{10} [kt]	0.4937	0.5000
Change relative to the 2023 Submission [kt]	0.0014	-0.0001
Change relative to the 2023 Submission [%]	0.28%	-0.03%
2023 Submission TSP [kt]	0.873	0.912
2024 Submission TSP [kt]	0.876	0.911
Change relative to the 2023 Submission [kt]	0.0024	-0.0002
Change relative to the 2024 Submission [%]	0.27%	-0.02%
2023 Submission BC [kt]	0.05529	0.03802
2024 Submission BC [kt]	0.05550	0.03801
Change relative to the 2023 Submission [kt]	0.00021	-0.00001
Change relative to the 2023 Submission [%]	0.38%	-0.01%
2023 Submission CO [kt]	5.000	2.504
2024 Submission CO [kt]	5.002	2.501
Change relative to the 2023 Submission [kt]	0.002	-0.004
Change relative to the 2023 Submission [%]	0.04%	-0.14%
2023 Submission Pb [t]	0.3100	0.3280
2024 Submission Pb [t]	0.3108	0.3278
Change relative to the 2023 Submission [t]	0.0007	-0.0002
Change relative to the 2023 Submission [%]	0.2%	-0.1%
2023 Submission Cd [t]	1.397E-3	1.486E-3
2024 Submission Cd [t]	1.400E-3	1.485E-3
Change relative to the 2023 Submission [t]	3.2E-6	-7.7E-7
Change relative to the 2023 Submission [%]	0.2%	-0.1%

1A3b Road Transport	2016	2021
2023 Submission As [t]	3.601E-3	3.807E-3
2024 Submission As [t]	3.609E-3	3.805E-3
Change relative to the 2023 Submission [t]	8.448E-6	-2.174E-6
Change relative to the 2023 Submission [%]	0.2%	-0.1%
2023 Submission Cr [t]	0.1178	0.1245
2024 Submission Cr [t]	0.1181	0.1244
Change relative to the 2023 Submission [t]	0.0003	-0.0001
Change relative to the 2023 Submission [%]	0.2%	-0.1%
2023 Submission Cu [t]	2.538	2.681
2024 Submission Cu [t]	2.544	2.680
Change relative to the 2023 Submission [t]	0.006	-0.002
Change relative to the 2023 Submission [%]	0.2%	-0.1%
2023 Submission Ni [t]	0.01814	0.01918
2024 Submission Ni [t]	0.01818	0.01917
Change relative to the 2023 Submission [t]	0.00004	-0.00001
Change relative to the 2023 Submission [%]	0.2%	-0.1%
2023 Submission Se [t]	0.002112	0.002296
2024 Submission Se [t]	0.002117	0.002296
Change relative to the 2023 Submission [t]	0.000005	-0.000001
Change relative to the 2023 Submission [%]	0.23%	-0.04%
2023 Submission Zn [t]	0.8375	0.9102
2024 Submission Zn [t]	0.8394	0.9098
Change relative to the 2023 Submission [t]	0.0020	-0.0004
Change relative to the 2023 Submission [%]	0.23%	-0.04%
2023 Submission Dioxin [t]	0.06920	0.04022
2024 Submission Dioxin [t]	0.06940	0.04019
Change relative to the 2023 Submission [t]	0.00020	-0.00002
Change relative to the 2023 Submission [%]	0.3%	-0.1%
2023 Submission B(a)P [t]	3.271E-3	3.898E-3
2024 Submission B(a)P [t]	3.283E-3	3.897E-3
Change relative to the 2023 Submission [t]	1.155E-5	-1.166E-6
Change relative to the 2023 Submission [%]	0.35%	-0.03%
2023 Submission B(b)F [t]	5.25E-3	5.98E-3
2024 Submission B(b)F [t]	5.27E-3	5.97E-3
Change relative to the 2023 Submission [t]	1.98E-5	-1.67E-6
Change relative to the 2023 Submission [%]	0.38%	-0.03%
2023 Submission B(k)F [t]	4.715E-3	5.162E-3
2024 Submission B(k)F [t]	4.733E-3	5.160E-3
Change relative to the 2023 Submission [t]	1.833E-5	-1.384E-6
Change relative to the 2023 Submission [%]	0.39%	-0.03%
2023 Submission I(1,2,3)p [t]	3.440E-3	4.131E-3
2024 Submission I(1,2,3)p [t]	3.451E-3	4.129E-3
Change relative to the 2023 Submission [t]	1.162E-5	-1.446E-6
Change relative to the 2023 Submission [%]	0.34%	-0.04%
2023 Submission PAH [t]	1.668E-2	1.917E-2
2024 Submission PAH [t]	1.674E-2	1.916E-2
Change relative to the 2023 Submission [t]	6.128E-5	-5.669E-6
Change relative to the 2023 Submission [%]	0.37%	-0.03%

1A3b Road Transport	2016	2021
2023 Submission HCB [t]	6.66E-5	3.86E-5
2024 Submission HCB [t]	6.68E-5	3.85E-5
Change relative to the 2023 Submission [t]	1.92E-7	-2.32E-8
Change relative to the 2023 Submission [%]	0.3%	-0.06%
2023 Submission PCBs [t]	1.366E-5	7.831E-6
2024 Submission PCBs [t]	1.369E-5	7.826E-6
Change relative to the 2023 Submission [t]	3.830E-8	-4.700E-9
Change relative to the 2023 Submission [%]	0.3%	-0.1%

Recalculations for the 2023 Submission

Several minor recalculations were due to the update of COPERT, which is done annually to reflect the latest science in emissions from the sector. For the 2023 submission, COPERT version 5.6.1 was used, and the methodological changes made from the previous version can be seen on EMISIA's website[6], the company that develops COPERT. These updated emission factors affected all pollutants in 1A3bi, 1A3bii, 1A3biii, and 1A3biv, as well as NMVOCs for 1A3bv, and BC and heavy metals for 1A3bvi and 1A3bvii. Additionally, changes to kilometres driven in COPERT affected 1A3bv, 1A3bvi, and 1A3bvii.

Additionally, recalculations occurred due to the incorrect allocation of diesel fuel to 1A3biv Motorcycles in the previous submission. This subcategory does not use diesel fuel, and the fuel that was improperly allocated to it was reallocated to other sectors. This caused an increase of emissions from gasoline fuel in 1A3biv and an increase in diesel emissions from 1A3bi, 1A3bii, and 1A3biii. The changes from this reallocation are minor.

The majority of minor recalculations can be traced to revisions of emission factors in COPERT while major recalculations are likely due to revisions of vehicle activity (mainly due to changes to 1A3bii Light-duty Trucks). The reason for a revision of activity, in terms of vehicle kilometres, in 1A3bii Light-duty Trucks was that the data set received from COPERT was not accurately representing the average utilisation of the aforementioned vehicle types.

3.4.3.5 Planned Improvements

For future submissions it is planned, in collaboration with the ITA, to develop procedures to obtain enhanced data on vehicle stock and mileage data for COPERT.

3.4.4 Domestic Navigation (NFR 1A3dii)

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

[6] https://www.emisia.com/utilities/copert/versions/

3.4.4.1 Activity Data

Total use of residual fuel oil, gas/diesel oil, and biodiesel for Domestic Navigation is based on the NEA's annual sales statistics for fossil fuels. Activity data for fuel combustion is given in Table 3.47.

Table 3.47 Fuel use [kt] in 1A3dii Domestic Navigation.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Residual Fuel Oil	3.9	4.8	0.54	0.88	2.6	0.44	NO	NO	NO
Gas/Diesel Oil	6.4	7.0	3.4	6.2	8.5	7.9	7.8	5.5	7.7
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO

3.4.4.2 Emission Factors

Emission factors for all pollutants are T1 emission factors from the 2019 EMEP/EEA Guidebook on Navigation (Shipping). This chapter was updated in December 2021 and all EFs in EAI's calculation files have been updated accordingly. Emission factor references are presented in Table 3.48.

Table 3.48 Emission factors for emissions from 1A3dii Domestic Navigation.

Fuel Type	Reference	Exception
Residual Fuel Oil	Tier 1 EF for bunker fuel oil from **Table 3-1** from Chapter *1.A.3.d Navigation* of the 2019 EMEP/EEA Guidebook.	SO_2 emissions are based on Tier 1 sulphur content under Table 3-1 in chapter 1A3d Navigation of the 2016 EMEP/EEA Guidebook. The emissions are then based on country specific sulphur content from 2012. It is assumed that TSP = PM_{10} = $PM_{2.5}$
Gas/Diesel Oil	Tier 1 EF for marine diesel oil from **Table 3-2** from Chapter *1.A.3.d Navigation* of the 2019 EMEP/EEA Guidebook.	SO_2 emissions are based on Tier 1 sulphur content under Table 3-1 in chapter 1A3d Navigation of the 2016 EMEP/EEA Guidebook. The emissions are then based on country specific sulphur content from 2012. It is assumed that TSP = PM_{10} = $PM_{2.5}$
Biodiesel	Same EFs as for gas/diesel oil as biodiesel are used in diesel engines.	

3.4.4.3 Recalculations and Improvements

Recalculations for the 2024 Submission

As for sulphur content of residual fuel and marine diesel/gas oil, an error has been fixed for 1990-2011 and changed to country specific from 2012. This led to large recalculations of SO_2 through the time series (see Table 3.49).

Table 3.49 Recalculations of SO_2 in 1A3dii Domestic Navigation between submissions.

1A3dii Domestic Navigation	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	2.8 E-01	3.3 E-01	4.3 E-02	7.2 E-02	9.5 E-02	2.9 E-02	1.4 E-02	9.9 E-03

1A3dii Domestic Navigation	1990	1995	2000	2005	2010	2015	2020	2021
2024 submission SO_2 [kt]	2.8 E-03	3.3 E-03	4.3 E-04	7.2 E-04	9.5 E-04	3.2 E-04	1.4 E-04	9.9 E-05
Change relative to the 2023 submission SO_2 [%]	-99.0%	-99.0%	-99.0%	-99.0%	-99.0%	-98.9%	-99.0%	-99.0%

NEA's reallocation of fuel for 2021 between domestic and international navigation led to minor recalculations of all air pollutants for 2021 (see Table 3.50)

Table 3.50 Recalculations of all air pollutants except SO_2 in 1A3dii Domestic Navigation between submissions.

1A3dii Domestic Navigation	2021
2023 submission PCB [kg]	0.0002084
2024 submission PCB [kg]	0.0002085
Change relative to the 2023 submission PCB [%]	0.091%
2023 submission HCB [kg]	0.0004386
2024 submission HCB [kg]	0.0004390
Change relative to the 2023 submission HCB [%]	0.091%
2023 submission PCDD/F [g]	0.0007128
2024 submission PCDD/F [g]	0.0007134
Change relative to the 2023 submission PCDD/F [%]	0.091%
2023 submission NO_X [kt]	0.3959
2024 submission NO_X [kt]	0.3962
Change relative to the 2023 submission NO_X [%]	0.091%
2023 submission CO [kt]	0.021055
2024 submission CO [kt]	0.021074
Change relative to the 2023 submission CO [%]	0.091%
2023 submission NMVOC [kt]	0.009595
2024 submission NMVOC [kt]	0.009604
Change relative to the 2023 submission NMVOC [%]	0.091%
2023 submission TSP [kt]	0.005867
2024 submission TSP [kt]	0.005872
Change relative to the 2023 submission TSP [%]	0.091%
2023 submission PM_{10} [kt]	0.005867
2024 submission PM_{10} [kt]	0.005872
Change relative to the 2023 submission PM_{10} [%]	0.091%
2023 submission $PM_{2.5}$ [kt]	0.005867
2024 submission $PM_{2.5}$ [kt]	0.005872
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.091%
2023 submission BC [kt]	0.0002648
2024 submission BC [kt]	0.0002651
Change relative to the 2023 submission BC [%]	0.091%
2023 submission Pb [t]	0.0007128

1A3dii Domestic Navigation	2021
2024 submission Pb [t]	0.0007134
Change relative to the 2023 submission Pb [%]	0.091%
2023 submission Cd [t]	0.000054830
2024 submission Cd [t]	0.000054880
Change relative to the 2023 submission Cd [%]	0.091%
2023 submission Hg [t]	0.00016449
2024 submission Hg [t]	0.00016464
Change relative to the 2023 submission Hg [%]	0.091%
2023 submission As [t]	0.00021932
2024 submission As [t]	0.00021952
Change relative to the 2023 submission As [%]	0.091%
2023 submission Cr [t]	0.00027415
2024 submission Cr [t]	0.00027440
Change relative to the 2023 submission Cr [%]	0.091%
2023 submission Cu [t]	0.0048250
2024 submission Cu [t]	0.0048294
Change relative to the 2023 submission Cu [%]	0.091%
2023 submission Ni [t]	0.0054830
2024 submission Ni [t]	0.0054880
Change relative to the 2023 submission Ni [%]	0.091%
2023 submission Se [t]	0.00054830
2024 submission Se [t]	0.00054880
Change relative to the 2023 submission Se [%]	0.091%
2023 submission Zn [t]	0.0065796
2024 submission Zn [t]	0.0065856
Change relative to the 2023 submission Zn [%]	0.091%

Recalculations for the 2023 Submission

The 2019 EMEP/EEA guidebook was updated in December 2021 with new emission factors for domestic navigation. This caused recalculations of NO_x, CO, NMVOC, TSP, PM_{10}, $PM_{2.5}$, Cu, As, and Se for the whole timeseries. Furthermore, in this update of the guidebook, emission factors for BaP, BbF, BkF, and IPy are no longer estimated. Additionally, some very minor recalculations occurred due to a linking issue for 1990-1994 that affected all pollutants.

3.4.4.4 Planned Improvements

No planned improvement for this category,

3.4.5 International Navigation (Memo Item - NFR 1A3di(i))

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 and Domestic Navigation based whether the vessel is sailing to an Icelandic or a foreign harbour (regardless of flag). Fuel used for International Navigation can be seen in Table 3.51.

Table 3.51 Fuel use [kt] in 1A3di(i) International Navigation.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Residual Fuel Oil	0.25	NO	2.00	0.44	0.08	13.25	NO	3.48	7.53
Gas/Diesel Oil	8.53	1.05	15.04	0.12	NO	33.55	24.28	36.79	82.48

The emission factors used to estimate emissions from International Navigation are the same as those used for Domestic Navigation and can be found in Table 3.48.

3.4.5.1 Recalculations and Improvements

Recalculations for the 2024 Submission

As for sulphur content of residual fuel and marine diesel/gas oil, an error has been fixed for 1990-2011 and changed to country specific from 2012. This led to large recalculations of SO_2 through the time series (see Table 3.52).

Table 3.52 Recalculations of SO_2 in 1A3di(i) International Navigation between submissions.

1A3di(i) International Navigation (memo item)	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	0.09893	0.01053	0.16789	0.02412	0.00240	0.46458	0.04370	0.09837
2024 submission SO_2 [kt]	0.00099	0.00011	0.00168	0.00024	0.00002	0.00357	0.00044	0.00101
Change relative to the 2023 submission SO_2 [%]	-99.0%	-99.0%	-99.0%	-99.0%	-99.0%	-99.2%	-99.0%	-99.0%

NEA's reallocation of fuel for 2021 between domestic and international navigation led to minor recalculations of all air pollutants for 2021 (see Table 3.50)

Table 3.53 Recalculations of all air pollutants except SO_2 in 1A3di(i) International Navigation between submissions.

1A3di(i) International Navigation (memo item)	2021
2023 submission PCB [kg]	0.003327
2024 submission PCB [kg]	0.003383
Change relative to the 2023 submission PCB [%]	1.7%
2023 submission HCB [kg]	0.00331
2024 submission HCB [kg]	0.00343
Change relative to the 2023 submission HCB [%]	3.6%
2023 submission PCDD/F [g]	0.00623
2024 submission PCDD/F [g]	0.00642
Change relative to the 2023 submission PCDD/F [%]	3.1%

1A3di(i) International Navigation (memo item)	2021
2023 submission NO_X [kt]	2.79
2024 submission NO_X [kt]	2.90
Change relative to the 2023 submission NO_X [%]	3.8%
2023 submission CO [kt]	0.148
2024 submission CO [kt]	0.154
Change relative to the 2023 submission CO [%]	3.8%
2023 submission NMVOC [kt]	0.068
2024 submission NMVOC [kt]	0.070
Change relative to the 2023 submission NMVOC [%]	3.8%
2023 submission TSP [kt]	0.0559
2024 submission TSP [kt]	0.0575
Change relative to the 2023 submission TSP [%]	2.8%
2023 submission PM_{10} [kt]	0.0559
2024 submission PM_{10} [kt]	0.0575
Change relative to the 2023 submission PM_{10} [%]	2.8%
2023 submission $PM_{2.5}$ [kt]	0.0559
2024 submission $PM_{2.5}$ [kt]	0.0575
Change relative to the 2023 submission $PM_{2.5}$ [%]	2.8%
2023 submission BC [kt]	0.00202
2024 submission BC [kt]	0.00209
Change relative to the 2023 submission BC [%]	3.6%
2023 submission Pb [t]	0.00522
2024 submission Pb [t]	0.00541
Change relative to the 2023 submission Pb [%]	3.7%
2023 submission Cd [t]	0.000423
2024 submission Cd [t]	0.000438
Change relative to the 2023 submission Cd [%]	3.5%
2023 submission Hg [t]	0.001129
2024 submission Hg [t]	0.001173
Change relative to the 2023 submission Hg [%]	3.9%
2023 submission As [t]	0.00378
2024 submission As [t]	0.00384
Change relative to the 2023 submission As [%]	1.6%
2023 submission Cr [t]	0.00427
2024 submission Cr [t]	0.00435
Change relative to the 2023 submission Cr [%]	1.7%
2023 submission Cu [t]	0.0354
2024 submission Cu [t]	0.0367
Change relative to the 2023 submission Cu [%]	3.7%

1A3di(i) International Navigation (memo item)	2021
2023 submission Ni [t]	0.1468
2024 submission Ni [t]	0.1482
Change relative to the 2023 submission Ni [%]	1.0%
2023 submission Se [t]	0.00426
2024 submission Se [t]	0.00441
Change relative to the 2023 submission Se [%]	3.5%
2023 submission Zn [t]	0.0465
2024 submission Zn [t]	0.0483
Change relative to the 2023 submission Zn [%]	3.8%

Recalculations for the 2023 Submission

The 2019 EMEP/EEA guidebook was updated in December 2021 with new emission factors for domestic navigation. This caused recalculations of NO_x, CO, NMVOC, TSP, PM_{10}, $PM_{2.5}$, Cu, As, and Se for the whole timeseries. Furthermore, in this update of the guidebook, emission factors for BaP, BbF, BkF, and IPy are no longer estimated. Additionally, some very minor recalculations occurred due to a linking issue for 1990-1994 that affected all pollutants.

3.4.5.2 Planned Improvements

No planned improvement for this category,

3.4.6 Fishing (NFR 1A4ciii)

Emissions from the Fishing sector in Iceland are significant as the fishing industry is one of the main industries and fish products are one of Iceland's primary exports.

3.4.6.1 Activity Data

Total use of residual fuel oil and gas/diesel oil for commercial fishing is based on the NEA's annual sales statistics for fossil fuels and includes both Domestic and International Fishing. Activity data for fuel combustion in the Fishing sector is given in Table 3.54.

Table 3.54 Fuel use [kt] in 1A4ciii Fishing.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Residual Fuel Oil	35.6	57.2	22.3	32.6	69.9	52.4	NO	NO	NO
Gas/Diesel Oil	202.6	231.8	256.9	199.9	158.3	142.5	158.7	178.3	150.4
Biodiesel	NO	NO	NO	NO	NO	0.094	0.075	0.065	0.032

3.4.6.2 Emission Factors

Emission factors for all pollutants are the same as for Domestic Navigation and can be seen in Table 3.48.

3.4.6.3 Recalculations and Improvements

Recalculations for the 2024 Submission

As for sulphur content of residual fuel and marine diesel/gas oil, an error has been fixed for 1990-2011 and changed to country specific from 2012. This led to large recalculations of SO_2 through the time series (see Table 3.55).

Table 3.55 Recalculations of SO_2 in 1A4ciii Fishing between submissions.

1A4ciii Fishing	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission SO_2 [kt]	3.9510	5.4042	2.2298	2.5608	2.4132	1.8586	0.2858	0.3237
2024 submission SO_2 [kt]	0.0395	0.0540	0.0223	0.0256	0.0241	0.0144	0.0029	0.0032
Change relative to the 2023 submission SO_2 [%]	-99.0%	-99.0%	-99.0%	-99.0%	-99.0%	-99.2%	-99.0%	-99.0%

NEA's reallocation of fuel for 2021 between domestic and international navigation also led to minor recalculations of all air pollutants in 1A4ciii Fishing for 2021 (see Table 3.56).

Table 3.56 Recalculations of all air pollutants except SO_2 in 1A4ciii Fishing between submissions.

1A4ciii Fishing	2021
2023 submission PCB [kg]	0.00683
2024 submission PCB [kg]	0.00678
Change relative to the 2023 submission PCB [%]	-0.83%
2023 submission HCB [kg]	0.01438
2024 submission HCB [kg]	0.01427
Change relative to the 2023 submission HCB [%]	-0.83%
2023 submission PCDD/F [g]	0.02338
2024 submission PCDD/F [g]	0.02318
Change relative to the 2023 submission PCDD/F [%]	-0.83%
2023 submission NO_X [kt]	12.98
2024 submission NO_X [kt]	12.87
Change relative to the 2023 submission NO_X [%]	-0.83%
2023 submission CO [kt]	0.690
2024 submission CO [kt]	0.685
Change relative to the 2023 submission CO [%]	-0.83%
2023 submission NMVOC [kt]	0.3147
2024 submission NMVOC [kt]	0.3121
Change relative to the 2023 submission NMVOC [%]	-0.83%
2023 submission TSP [kt]	0.1924
2024 submission TSP [kt]	0.1908
Change relative to the 2023 submission TSP [%]	-0.83%
2023 submission PM_{10} [kt]	0.1924

1A4ciii Fishing	2021
2024 submission PM_{10} [kt]	0.1908
Change relative to the 2023 submission PM_{10} [%]	-0.83%
2023 submission $PM_{2.5}$ [kt]	0.1924
2024 submission $PM_{2.5}$ [kt]	0.1908
Change relative to the 2023 submission $PM_{2.5}$ [%]	-0.83%
2023 submission BC [kt]	0.008685
2024 submission BC [kt]	0.008613
Change relative to the 2023 submission BC [%]	-0.83%
2023 submission Pb [t]	0.02338
2024 submission Pb [t]	0.02318
Change relative to the 2023 submission Pb [%]	-0.83%
2023 submission Cd [t]	0.001798
2024 submission Cd [t]	0.001783
Change relative to the 2023 submission Cd [%]	-0.83%
2023 submission Hg [t]	0.005394
2024 submission Hg [t]	0.005350
Change relative to the 2023 submission Hg [%]	-0.83%
2023 submission As [t]	0.007192
2024 submission As [t]	0.007133
Change relative to the 2023 submission As [%]	-0.83%
2023 submission Cr [t]	0.008990
2024 submission Cr [t]	0.008916
Change relative to the 2023 submission Cr [%]	-0.83%
2023 submission Cu [t]	0.1582
2024 submission Cu [t]	0.1569
Change relative to the 2023 submission Cu [%]	-0.83%
2023 submission Ni [t]	0.1798
2024 submission Ni [t]	0.1783
Change relative to the 2023 submission Ni [%]	-0.83%
2023 submission Se [t]	0.01798
2024 submission Se [t]	0.01783
Change relative to the 2023 submission Se [%]	-0.83%
2023 submission Zn [t]	0.2158
2024 submission Zn [t]	0.2140
Change relative to the 2023 submission Zn [%]	-0.83%

Recalculations from the 2023 Submission

The 2019 EMEP/EEA guidebook was updated in December 2021 with new emission factors for domestic navigation. This caused recalculations of NO_x, CO, NMVOC, TSP,

PM_{10}, $PM_{2.5}$, Cu, As, and Se for the whole timeseries. Furthermore, in this update of the guidebook, emission factors for BaP, BbF, BkF, and IPy are no longer estimated. Additionally, some very minor recalculations occurred due to a linking issue for 1990-1994 that affected all pollutants.

3.4.6.4 Planned Improvements

No planned improvement for this category.

3.5 Fugitive Emissions (NFR 1B2)

In Iceland, fugitive emissions occur only from two sources: Distribution of Oil Products (1B2av) and Geothermal Energy Production (1B2d).

3.5.1 Distribution of Oil Products (NFR 1B2av)

NMVOC emissions from distribution of oil products are estimated by multiplying the total imported fuel with an emission factor.

3.5.1.1 Activity Data

The calculations are based on yearly fuel import data provided by SI.

3.5.1.2 Emission Factors

The emission factor is taken from Table 4.2.4 2006 IPCC Guidelines Tanker Trucks and Rail Cards and is 0.00025 Gg per 1,000 m^3 total oil transported.

3.5.1.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No recalculations were performed for this sector.

Recalculations for the 2023 Submission

No recalculations were performed for this sector.

3.5.1.4 Planned Improvements

No improvements are planned for this sector.

3.5.2 Geothermal Energy (NFR 1B2d)

Iceland relies heavily on geothermal energy for space heating and to a significant extent for electricity production (27% of the total electricity production in 2016). 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 extensive than from fossil fuel power plants, or 19 times less (Baldvinsson, 2011). Very small amounts of methane, but considerable quantities of sulphur in the form of hydrogen supplied (H_2S) are emitted from geothermal power plants. The H_2S values are stoichiometrically converted to SO_2 and reported as such.

3.5.2.1 Activity Data and Emissions

The H_2S 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 H_2S is based on direct measurements. The enthalpy and flow of each well are measured and the H_2S concentration of the steam fraction determined at the wellhead pressure. The steam fraction of the fluid and its H_2S 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 H_2S discharge from each well and finally the total H_2S is determined by adding up the H_2S discharge from individual wells.

The *CarbFix* project, located at the *Hellisheiði Power Plant*, has been pioneering CO_2 capture and reinjection on site into the basaltic subsurface, and has proven rapid and complete reaction to calcium carbonate precipitates (Matter, et al., 2016). A sister project, *SulFix*, consists of separating H_2S from the steam and also reinjecting the gas into the subsurface and mineralizing on contact with the basalt host rock. Injection of H_2S started in 2014 at *Hellisheiði*. This project has had a significant impact on sulphur emissions from geothermal power production at *Hellisheiði*.

Table 3.57 shows the electricity production with geothermal energy and the total sulphur emissions (calculated as SO_2).

Table 3.57 Electricity production and emissions from geothermal energy in Iceland.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Electricity production [GWh]	283	290	1,323	1,658	4,465	5,003	5,961	5,802	5,916
Sulphur emissions [kt SO_2]	13.3	11.0	26.0	30.3	58.7	42.4	39.3	47.7	48.9

3.5.2.2 Recalculations and Improvements

Recalculations for the 2024 Submission

No recalculations were performed for this sector.

Recalculations for the 2023 Submission

No recalculations were performed for this sector.

3.5.2.3 Planned Improvements

For future submissions the plan is to differentiate between emissions linked to electricity production and those linked to district heating.

4 Industrial Processes and Product Use (IPPU) (NFR Sector 2)

4.1 Overview

As a result of the expansion of the Industrial sector, the contribution of this sector to the total emissions has been increasing since 1990. By far the main contributor to the emissions from this sector is metal production (aluminium, ferrosilicon alloy, and silicon metal in recent years). The emission trends of the various pollutants closely match the opening and closing of various facilities.

While most of the air pollutant emissions from the industrial processes sector can be traced back to the metal production industry, exceptions include NMVOC, which mostly originate from solvents and product use, NH_3 which comes from the mineral wool industry and Capacitor Production, and most heavy metals that are emitted during the use of fireworks and tobacco (2G Other Solvent and Product Use).

The Industrial Processes and Product Use (IPPU) sector is divided into the following subsectors:

- Mineral Industry (NFR 2A)
- Chemical Industry (NFR 2B)
- Metal Production (NFR 2C)
- Solvent and Product Use (NFR 2D)
- Other Solvent and Product Use (NFR 2G)
- Other Industry Production (NRF 2H)
- Food and Beverages Industry (NFR 2H2)

A summary of the categories included in the IPPU sector by pollutant, including the tier methodology used, is presented in Table 4.1 to Table 4.3.

Table 4.1 Overview table NECD gases, PM, and CO (NA – not available, NO – not occurring).

Sector		NECD Gases				PM				
		NO_X	NMVOC	SO_X	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2A1	Cement Production[1]	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A2	Lime Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A3	Glass production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A5a	Quarrying and Mining of Minerals other than Coal	NA	NA	NA	NA	T2	T2	T2	NA	NA
2A5b	Construction and Demolition	NA	NA	NA	NA	T1	T1	T1	NA	NA
2A5c	Storage, Handling, and Transport of Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A6	Other Mineral Products (Mineral Wool)	NA	NA	T3	T3	T2	T3	T2	T2	T3
2B1	Ammonia Production[2]	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B2	Nitric Acid Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B3	Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B5	Carbide Production	NO	NO	NO	NO	NO	NO	NO	NO	NO

Sector		NECD Gases				PM				
		NO_X	NMVOC	SO_X	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2B6	Titanium Dioxide Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B7	Soda Ash Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10a	Diatomite[3]	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10a	Fertiliser[2]	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10 b	Storage, Handling, and Transport of Chemical Products	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C1	Iron and Steel Production[4]	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C2	Ferroalloys Production	T2	T2	T3	NA	T1/T3	T1/T3	T3	T1	T2
2C3	Primary Aluminium Production	T2/T3	NA	T3	NA	T2/T3	T3	T2	T2/T3	T2
2C3	Secondary Aluminium Production	NA	NA	NA	NA	T2	T2	T3	T2	NA
2C4	Magnesium Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C5	Lead Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C6	Zinc Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C7a	Copper Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C7b	Nickel Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C7c	Capacitor Production	NO	NO	NO	T3	NO	NO	NO	NO	NO
2C7d	Storage, Handling, and Transport of Metal Products	NO	NO	NO	NO	NO	NO	NO	NO	NO
2D3a	Domestic Solvent Use Including Fungicides	NA	T2b	NA	NA	NA	NA	NA	NA	NA
2D3b	Road Paving with Asphalt	NA	T1	NA	NA	T1	T1	T3	T1	NA
2D3c	Asphalt Roofing	NO	NO	NO	NO	NO	NO	NO	NO	NO
2D3d	Coating Applications	NA	T2	NA	NA	NA	NA	NA	NA	NA
2D3e	Degreasing	NA	T1	NA	NA	NA	NA	NA	NA	NA
2D3f	Dry Cleaning	NA	T2	NA	NA	NA	NA	NA	NA	NA
2D3g	Chemical Products	NA	T2	NA	NA	NA	NA	NA	NA	NA
2D3h	Printing	NA	T1	NA	NA	NA	NA	NA	NA	NA
2D3i	Creosotes[5]	NO	NO	NO	NO	NO	NO	NO	NO	NO
2D3i	Organic Solvent-borne Preservatives	NA	T2	NA	NA	NA	NA	NA	NA	NA
2D3i	Aircraft De-icing	NA	T2	NA	NA	NA	NA	NA	NA	NA
2G4	Tobacco	T2	T2	NA	T2	T2	T2	T2	T2	T2
2G4	Fireworks	T2	NA	T2	NA	T2	T2	T2	NA	T2
2H1	Pulp and Paper Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
2H2	Food and Beverages Industry	NA	T2	NA	NA	NA	NA	NA	NA	NA
2H3	Other Industrial Processes	NO	NO	NO	NO	NO	NO	NO	NO	NO
2I	Wood Processing	NO	NO	NO	NO	NO	NO	NO	NO	NO
2J	Production of POPs	NO	NO	NO	NO	NO	NO	NO	NO	NO
2K	Consumption of POPs and Heavy Metals	NO	NO	NO	NO	NO	NO	NO	NO	NO
2L	Other Production, Consumption, Storage, Transportation, or Handling of Bulk Products	NO	NO	NO	NO	NO	NO	NO	NO	NO

[1] Cement Production was operational until 2011 and used Tier 3 and Tier 1 methodology.
[2] Fertiliser Production (2B10a) was operational until 2001 and used Tier 3 methodology (NO_x only).
[3] Diatomite Production was operational until 2004 and used Tier 3 methodology (NO_x only).
[4] Iron Production was operational from 2014 to 2016 and used Tier 2 methodology for all pollutants except HCB which used Tier 1 methodology.
[5] Creosotes were imported until 2011 and used Tier 2 methodology.

Table 4.2 Overview table POPs (NA – not available, NO – not occurring).

Sector		POPs			
		Dioxin	PAH	HCB	PCB
2A1	Cement Production	NO	NO	NO	NO
2A2	Lime Production	NO	NO	NO	NO
2A3	Glass Production	NO	NO	NO	NO
2A5a	Quarrying and Mining of Minerals other than Coal	NA	NA	NA	NA
2A5b	Construction and Demolition	NA	NA	NA	NA
2A5c	Storage, Handling, and Transport of Mineral Products	NO	NO	NO	NO
2A6	Other Mineral Products (Mineral Wool)	T1	NA	NA	NA
2B1	Ammonia Production	NO	NO	NO	NO
2B2	Nitric Acid Production	NO	NO	NO	NO
2B3	Adipic Acid Production	NO	NO	NO	NO
2B5	Carbide Production	NO	NO	NO	NO
2B6	Titanium Dioxide Production	NO	NO	NO	NO
2B7	Soda Ash Production	NO	NO	NO	NO
2B10a	Diatomite	NO	NO	NO	NO
2B10a	Fertiliser	NO	NO	NO	NO
2B10b	Storage, Handling, and Transport of Chemical Products	NO	NO	NO	NO
2C1	Iron and Steel Production	NO	NO	NO	NO
2C2	Ferroalloys Production	T3	T3	NA	NA
2C3	Primary Aluminium Production	T2/T3	T2/T3	NA	NA
2C3	Secondary Aluminium Production	T3	NA	T2	NA
2C4	Magnesium Production	NO	NO	NO	NO
2C5	Lead Production	NO	NO	NO	NO
2C6	Zinc Production	NO	NO	NO	NO
2C7a	Copper Production	NO	NO	NO	NO
2C7b	Nickel Production	NO	NO	NO	NO
2C7c	Capacitor Production	NO	NO	NO	NO
2C7d	Storage, Handling, and Transport of Metal Products	NO	NO	NO	NO
2D3a	Domestic Solvent Use Including Fungicides	NA	NA	NA	NA
2D3b	Road Paving with Asphalt	T2	NA	NA	NA
2D3c	Asphalt Roofing	NO	NO	NO	NO
2D3d	Coating Applications	NA	NA	NA	NA
2D3e	Degreasing	NA	NA	NA	NA
2D3f	Dry Cleaning	NA	NA	NA	NA
2D3g	Chemical Products	NA	NA	NA	NA
2D3h	Printing	NA	NA	NA	NA
2D3i	Creosotes	NO	NO	NO	NO
2D3i	Organic Solvent-borne Preservatives	NA	NE	NA	NA
2D3i	Aircraft De-icing	NA	NA	NA	NA
2G4	Tobacco	T2	T2	NA	NA
2G4	Fireworks	NA	NA	T3	NA
2H1	Pulp and Paper Industry	NO	NO	NO	NO
2H2	Food and Beverages Industry	NA	NA	NA	NA
2H3	Other Industrial Processes	NO	NO	NO	NO
2I	Wood Processing	NO	NO	NO	NO
2J	Production of POPs	NO	NO	NO	NO

Sector		POPs			
		Dioxin	PAH	HCB	PCB
2K	Consumption of POPs and Heavy Metals	NO	NO	NO	NO
2L	Other Production, Consumption, Storage, Transportation, or Handling of Bulk Products	NO	NO	NO	NO

Table 4.3 Overview table heavy metals (NA – not available, NO – not occurring).

Sector		Heavy Metals								
		Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
2A1	Cement Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A2	Lime Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A3	Glass Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A5a	Quarrying and Mining of Minerals other than Coal	NA	NA	NA	NA	NA	NA	NA	NA	NA
2A5b	Construction and Demolition	NA	NA	NA	NA	NA	NA	NA	NA	NA
2A5c	Storage, Handling, and Transport of Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO
2A6	Other Mineral Products (Mineral Wool)	NA	NA	NA	NA	NA	NA	NA	NA	NA
2B1	Ammonia Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B2	Nitric Acid Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B3	Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B5	Carbide Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B6	Titanium Dioxide Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B7	Soda Ash Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10a	Diatomite	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10a	Fertiliser	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10b	Storage, Handling, and Transport of Chemical Products	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C1	Iron and Steel Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C2	Ferroalloys Production	T3	T3	T3	T3	T3	T3	T3	NA	T3
2C3	Primary Aluminium Production	T3	T3	NA	T3	T3	T3	T3	NA	T3
2C3	Secondary Aluminium Production	NA	NA	NA	NA	NA	NA	NA	NA	NA
2C4	Magnesium Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C5	Lead Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C6	Zinc Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C7a	Copper Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C7b	Nickel Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C7c	Capacitor Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C7d	Storage, Handling, and Transport of Metal Products	NO	NO	NO	NO	NO	NO	NO	NO	NO
2D3a	Domestic Solvent Use Including Fungicides	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3b	Road Paving with Asphalt	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3c	Asphalt Roofing	NO	NO	NO	NO	NO	NO	NO	NO	NO
2D3d	Coating Applications	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3e	Degreasing	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3f	Dry Cleaning	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3g	Chemical Products	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3h	Printing	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3i	Creosotes	NO	NO	NO	NO	NO	NO	NO	NO	NO

Sector		Heavy Metals								
		Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
2D3i	Organic Solvent-borne Preservatives	NA	NA	NA	NA	NA	NA	NA	NA	NA
2D3i	Aircraft De-icing	NA	NA	NA	NA	NA	NA	NA	NA	NA
2G4	Tobacco	T2	T2	T2	T2	T2	T2	T2	T2	T2
2G4	Fireworks	T3	T2	T2	T2	T2	T2	T2	NA	T2
2H1	Pulp and Paper Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
2H2	Food and Beverages Industry	NA	NA	NA	NA	NA	NA	NA	NA	NA
2H3	Other Industrial Processes	NO	NO	NO	NO	NO	NO	NO	NO	NO
2I	Wood Processing	NO	NO	NO	NO	NO	NO	NO	NO	NO
2J	Production of POPs	NO	NO	NO	NO	NO	NO	NO	NO	NO
2K	Consumption of POPs and Heavy Metals	NO	NO	NO	NO	NO	NO	NO	NO	NO
2L	Other Production, Consumption, Storage, Transportation, or Handling of Bulk Products	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 4.4 shows which subsectors in IPPU are key categories for which air pollutants. A key category is one that is prioritised within the national inventory system because it is significantly important for one or a number of air pollutants in a country's national inventory of air pollutants in terms of the absolute level, the trend, or the uncertainty in emissions (EEA, 2019). Categories whose cumulative percentage contribution is greater than 80% should be identified as key.

Table 4.4 Key categories for air pollutants within IPPU.

SO_X, NO_X, NH_3, NMVOC, PM, BC, and CO			
	1990	2022	Trend
2A5a Quarrying and Mining of Minerals other than Coal	$PM_{2.5}$, PM_{10}, TSP	PM_{10}, TSP	$PM_{2.5}$, PM_{10}, TSP
2A5b Construction and Demolition	$PM_{2.5}$, PM_{10}, TSP	$PM_{2.5}$, PM_{10}, TSP	$PM_{2.5}$, PM_{10}, TSP
2C2 Ferroalloys Production	SO_x, $PM_{2.5}$, PM_{10}	NO_x, $PM_{2.5}$	NO_x, SO_x
2C3 Aluminium Production	PM_{10}, CO	NOx, SOx, $PM_{2.5}$, PM_{10}, TSP, CO	NO_x, SO_x $PM_{2.5}$, PM_{10}, TSP, BC, CO
2D3a Domestic Solvent Use Including Fungicides	NMVOC	NMVOC	NMVOC
2D3d Coating Applications	NMVOC	NMVOC	
2G Other Product Use (Fireworks, Tobacco)		$PM_{2.5}$, PM_{10}	
2H2 Food and Beverages Industry		NMVOC	NMVOC
Persistent Organic Pollutants (POPs)			
	1990	**2022**	**Trend**
2C2 Ferroalloys Production		PCDD/F, PAH4	PCDD/F, PAH4
2C3 Aluminium Production		PAH4, HCB	PAH4
2G Other Product Use (Fireworks, tobacco)	HCB	HCB	HCB
Heavy Metals (HMs)			
	1990	**2022**	**Trend**
2C3 Aluminium Production	Cd, As, Cr, Ni, Zn	Pb, Cd, As, Cr, Ni, Zn	Pb, Cd, As, Cr, Cu, Ni, Zn
Heavy Metals (HMs)			
	1990	**2022**	**Trend**
2G Other Product Use (Fireworks, Tobacco)	Pb		Cu

4.2 General Methodology

Methodology is generally based on the most recent EMEP/EEA air pollutant emission inventory Guidebook (EEA, 2019). In most cases, emissions are calculated by multiplying the quantity of production or product use with pollutant-specific emissions factors. Emissions factors are also taken from the Standardized Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs (UNEP, 2003), *Utslipp til luft av dioksiner I Norge* (Statistics Norway, 2002), the 2006 IPCC Guidelines for Greenhouse Gas Inventories (IPCC, 2006) as well as plant-specific emission factors derived from direct measurements at the plants. Activity data is collected from data reported under the EU ETS (as per Directive 2003/87/EC of the European Parliament and of the Council), Statistics Iceland (*Hagstofa Íslands*) (SI), Green Accounting, Icelandic Road and Coastal Administration (*Vegagerðin*) (IRCA) or directly from the operators. Detailed, activity-specific methodology for emission estimates is described for each subsector. Work is underway to harmonise this reporting with data reported under the E-PRTR Regulation (Regulation (EC) No 166/2006).

4.3 Mineral Industry (NFR 2A)

4.3.1 Cement Production (NFR 2A1)

The single cement plant in Iceland produced cement from shell sand and rhyolite in a rotary kiln using a wet process. The raw material calcium carbonate, which came from shell sand, was calcinated in the production process. The resulting calcium oxide was heated to form clinker and then crushed to form cement.

The production at the cement plant in Iceland slowly decreased after 2000. 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.

4.3.1.1 Activity Data

Process specific data on cement production, clinker production and amounts of coal were collected by the Environment Agency of Iceland (*Umhverfisstofnun*) (EAI) directly from the cement production plant.

4.3.1.2 Emission Factors

Emission factor for dioxin is taken from the Toolkit for Identification and Quantification of Dioxin and Furan Releases (UNEP, 2003). The factor applies for wet kilns, with ESP/FF temperature < 200°C and is 0.05 µg I-TEQ/t cement. The HCB emission factor is based on the chapter Sources of HCB emissions from the Emission Inventory Guidebook (EEA, 2007). Emission factors for TSP, PM_{10}, and $PM_{2.5}$ are based on measurements and the BC emission factor (3% of $PM_{2.5}$) is based on the 2019 EMEP/EEA Guidebook. Emission estimates for SO_2 are based on measurements from the plant but include both process-related and combustion-related emissions, and the total SO_2 emissions are reported under 2A1 Cement Production. Emissions of PAH, NO_x, CO, and NMVOC originate mainly from combustion and are reported under 1A2f (Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals); process-related emissions for those pollutants are not applicable. All emission factors used are summarised in the table below.

Table 4.5 Emission factors for 2A1 Cement Production.

	Dioxin [µg/t I-TEQ]	HCB [µg/t]	TSP [kg/kt]	PM_{10} [kg/kt]	$PM_{2.5}$ [kg/kt]	BC % of $PM_{2.5}$
Cement Production	0.050	11	220	200	100	3.0%

4.3.1.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations for the 2023 Submission

No category-specific recalculations were done for the 2023 submission.

4.3.1.4 Planned Improvements

No improvements are currently planned for this subsector.

4.3.2 Lime Production (NFR 2A2)

This activity does not occur in Iceland.

4.3.3 Glass Production (NFR 2A3)

This activity does not occur in Iceland.

4.3.4 Quarrying and Mining of Minerals other than Coal (NFR 2A5a)

4.3.4.1 Activity Data

The activity data was retrieved from the IRCA who provided a timeseries from 1999 of aggregates with used by the IRCA for road construction, divided by the nature of the deposit. Currently no data is available prior to 1999, so the average 1999-2001 has been used for the years 1990-1999. Data from the IRCA was also used to estimate which proportion of aggregate production is used by others (municipalities, private companies, etc.).

4.3.4.2 Emission Factors

Only particulate matter emissions (TSP, PM_{10}, and $PM_{2.5}$) arise from this category. The methodology follows Tier 2 technology-specific approach of the 2019 EMEP/EEA Guidebook and divides the emission into drilling and blasting, material processing, internal transport, material handling operations, and wind erosion from stockpiles.

The parameters to calculate the emission factors are taken from Section 3.3, Chapter 2.A.5.a of the Guidebook. Parameters concerning the nature of the quarries within Iceland were retrieved from the IRCA. Where country-specific parameters are not available, the sample parameters based on French context from the 2019 EMEP/EEA Guidebook are used. Average values are used as an input in the spreadsheet model provided by the 2019 EMEP/EEA Guidebook to calculate the emission factors used. All quarries in Iceland are small quarries (yearly production less than 100 kt). No data is available on the amount of recycled aggregate, produced from Construction and Demolition residues. Therefore, the emissions from recycled aggregate are not estimated. No data is available on the distance travelled by dumpers within the quarries and the emissions from that part are therefore not estimated. Table 4.6 shows the emission factors used that show the emissions per tonne of aggregate production.

Table 4.6 Emission factors used within 2A5a Quarrying and Mining of Minerals.

Emission Factors – Quarrying and Mining (2A5a)	Drilling and Blasting	Material Processing		Internal Transport	Material Handling Operation		Wind Erosion from Stockpiles	
	Crushed Rock	Crushed Rock	Sand & Gravel		Crushed Rock	Sand & Gravel	Crushed Rock	Sand & Gravel
TSP [g/t]	1.23	10.5	5.73	NE	10.7	2.29	41.3	20.7
PM_{10} [g/t]	0.647	3.80	2.17	NE	5.04	1.08	20.7	10.3
$PM_{2.5}$ [g/t]	0.637	0.685	0.577	NE	0.764	0.164	8.26	4.13

4.3.4.3 Recalculations and Improvements

Recalculations for the 2024 Submission

The recalculations in 2A5a for the 2024 submission were caused by an update in the activity data (see Table 4.7). For the previous submission, the IRCA did not managed to provide the EAI with their production data for 2021, as such, a three-year average was applied instead. For the 2024 submission, the production data for 2021 was still unavailable, but the IRCA made an expert judgement and estimated the 2021 production to be the average of the production between 2015-2019 multiplied by 1.15 (2020 was excluded in the five-year-average as it was not accurate enough according to the IRCA). This estimation is only temporary and will be replace by more accurate data for future submissions.

Table 4.7 Recalculations in 2A5a Quarrying and Mining of Minerals Other Than Coal between submissions.

2A5a Quarrying and Mining of Minerals Other Than Coal	2021
2023 submission TSP [kt]	0.074
2024 submission TSP [kt]	0.146
Change relative to the 2023 submission TSP [%]	96%
2023 submission PM_{10} [kt]	0.035
2024 submission PM_{10} [kt]	0.069
Change relative to the 2023 submission PM_{10} [%]	96%
2023 submission $PM_{2.5}$ [kt]	0.012
2024 submission $PM_{2.5}$ [kt]	0.024
Change relative to the 2023 submission $PM_{2.5}$ [%]	96%

Recalculations for the 2023 Submission

For the 2023 submission, 2A5a was upgraded from Tier 1 to Tier 2 which caused large recalculations.

4.3.4.4 Planned Improvements

For the future submissions, the production data from the IRCA for 2020 and 2021 will be updated to more accurate data.

4.3.5 Construction and Demolition (NFR 2A5b)

4.3.5.1 Activity Data

To retrieve activity data, the number of buildings per construction year, subdivided by the type of houses (terraced, detached, semi-detached, apartment buildings, non-residential buildings) is obtained from the Housing and Construction Authority (*Húsnæðis- og mannvirkjastofnun*). Data about road construction is retrieved from the IRCA for the years since 2003 and for the remaining time series is estimated as average 2003-2011.

4.3.5.2 Emission Factors

The methodology follows Tier 1 of the 2019 EMEP/EEA Guidebook. Default values from the Guidebook are used for the duration of construction (houses 0.5, apartment buildings 0.75, non-residential 0.83, and roads 1.00 years), for the control efficiency (houses 0, apartment buildings 0, non-residential 0.5, roads 0.5), silt content is assumed to be 20% and the Thornthwaite Precipitation-Evaporation Index was calculated with precipitation and temperature data recorded at a weather station in Reykjavík. Only particulate matter emissions, that is TSP, PM_{10}, and $PM_{2.5}$ arise from this category.

The implementation of a Tier 3 method it is not possible to source any of the required data. US EPA provides methodologies with AP-42 that require very detailed local data. The 2019 EMEP/EEA Guidebook states that collection of such data is likely to be possible only for individual large point sources. This data is not available for any Construction and Demolition sites in Iceland.

4.3.5.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations for the 2023 Submission

Recalculation has been made for the whole timeseries due to updated activity data about constructed buildings from the Housing and Construction Authority.

4.3.5.4 Planned Improvements

No improvements are currently planned for this subsector.

4.3.6 Storage, Handling, and Transport of Mineral Products (NFR 2A5c)

This emissions within the sector are insignificant and therefore not estimated.

4.3.7 Mineral Wool Production (NFR 2A6)

There is one mineral wool production plant in operation in Iceland. Although it is an activity falling under Annex I of Directive 2003/87/E (ETS Directive), it is excluded from the EU ETS scheme following the conditions described in Article 27 of the ETS Directive. The operator submits annual emission reports for GHGs to the EAI, using the same template as the companies reporting within the EU ETS scheme.

4.3.7.1 Activity Data

Activity data for the mineral wool plant originates from the annual emission reports mentioned above, as well as annual Green Accounting reports.

4.3.7.2 Emission Factors

Emissions of dioxins are calculated from the amount (weight) of electrodes used in the production process. The emission factor is taken from *Utslipp til luft av dioksiner i Norge* (Statistics Norway, 2002). PAH emissions are not applicable. Emissions of SO_2 are calculated using the S content of the electrodes used. Emission Factors of CO, NH_3, and PM_{10} were calculated based on measurements at the factory. In the case of NH_3 and PM_{10}, measurements were available every second year from 2002-2017. For those years, the actual measurements were used to derive a year-specific emission factor. For the years in between, the average of the emission factor of the previous year and of the following year was used. For all years prior to 2002, the average IEF of measurements 2002, 2004, 2006, 2009, 2011, 2013, and 2015 was used. Since 2018 yearly total emissions for NH_3 are communicated from company directly. TSP and $PM_{2.5}$ were calculated from PM_{10} using the TSP vs. PM_{10} vs. $PM_{2.5}$ ratios given in Table 3.5 in Chapter 2.A.3 in the EMEP/EEA Guidebook (EEA, 2019). BC was calculated using the ratio to $PM_{2.5}$ given in the EMEP/EEA Guidebook (EEA, 2019). NO_x and NMVOC emissions originate from combustion and are reported under 1A2f. Table 4.8 shows the emission factors used for Mineral Wool Production.

Table 4.8 Emission factors for Mineral Wool Production (for NH_3, CO, TSP, and PM_{10} the values are IEF averages for the whole timeline).

	NH_3 [t/kt]	CO [t/kt]	TSP % of PM_{10}	PM_{10} [t/kt]	$PM_{2.5}$ % of TSP	BC % of $PM_{2.5}$	Dioxin [µg/t I-TEQ/t]
Mineral Wool Production	1.12	1.40	114%	1.01	77.6%	2.00%	1.60

4.3.7.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations for the 2023 Submission

PM, CO, and NH_3 (prior to 2018) emissions are calculated based on number of hours/year the factory is in operation. Until now, a whole year production was assumed. Now, factory data about number of hours/year in production are used. This data is available since 2015. Before 2015, the average production per hour for 2015-2019 is used to calculate production hours per year. Since number of production hours is less than total hours, these recalculations led to reduction in emission.

In addition, the factory data about PM emissions were assumed to be TSP but are PM_{10}. This was now corrected in the inventory and TSP and $PM_{2.5}$ are calculated from the PM_{10} using the ratios from the 2019 EMEP/EEA Guidebook as described above.

4.3.7.4 Planned Improvements

No improvements are currently planned for this subsector.

4.4 Chemical Industry (NFR 2B)

4.4.1 Ammonia Production (NFR 2B1)

Ammonia was produced amongst other fertilisers during the period 1990-2001. The associated emissions are marked as Included Elsewhere under 2B1 Ammonia Production and are included in the emissions reported under 2B10a other: Fertiliser Production. The emission estimation methodology associated with Ammonia Production is also described there.

4.4.2 Nitric Acid Production (NFR 2B2)

This activity does not occur in Iceland.

4.4.3 Adipic Acid Production (NFR 2B3)

This activity does not occur in Iceland.

4.4.4 Carbide Production (NFR 2B5)

This activity does not occur in Iceland.

4.4.5 Titanium Dioxide Production (NFR 2B6)

This activity does not occur in Iceland.

4.4.6 Soda Ash Production (NFR 2B7)

This activity does not occur in Iceland. Emissions from the use of soda ash in the silica (diatomite) industry (NFR 2B10a; reported until 2004) are reported under that NFR code.

4.4.7 Chemical Industry: Other (NFR 2B10a)

The only chemical industry that existed in Iceland was the production of fertiliser and diatomite. The fertiliser production plant ceased its operations in 2001 and the diatomite production plant shut down in 2004. This industry is not considered to be a source of POPs nor heavy metals.

The fertiliser production plant was operational until there was an explosion at the site in 2001. In the early days of the factory, only one type of fertiliser was produced (a nitrogen fertiliser), whereas at the end of its production phase it was producing over 20 different types of fertilisers. CO_2 and CH_4 emissions are considered insignificant, as the fertiliser plant used H_2 produced on-site by electrolysis. Methodology NO_x and N_2O emissions were reported directly by the factory to the EAI.

4.4.7.1 Activity Data

When the fertiliser production plant was operational it reported its emissions of NO_X and N_2O to the EAI. At the diatomite production plant, silica containing sludge was burned to remove organic material. Emissions of CO_2 and NO_X were estimated based on the C-content and N-content of the sludge provided by the operator. Activity data for both industries are presented in Table 4.9.

Table 4.9 Production data for 1990, 1995, and 2000 for fertiliser and silica production [kt].

	1990	1995	2000	Notes
Fertiliser Production [kt]	63.7	58.5	41.5	Facility closed in 2001
Diatomite Production [kt]	26.1	28.1	27.6	Facility closed in 2004

4.4.7.2 Emission Factors

For diatomite production, emissions of CO_2 and NO_x were estimated based on the C-content and N-content of the sludge provided by the operator. Average NO_X implied EF for the period 1990-2004 was 15.6 t NO_x/kt Si production. Other emissions from soda ash use were not estimated and are considered to be small.

For the fertiliser production, the average implied EF for NO_x for the period 1990-2001 was 0.296 t NO_x/kt fertiliser production. As there is no data readily available about the types of fertilisers produced at the time, no other pollutants were estimated for this industry.

4.4.7.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations for the 2023 Submission

Recalculations were made due to an oversight from previous calculations, where NO_X emissions from Diatomite production for the years 2005 and 2006 were included. The production had ceased at this point.

4.4.7.4 Planned Improvements

No improvements are currently planned for this subsector.

4.5 Metal Production (NFR 2C)

4.5.1 Iron and Steel Production (NFR 2C1)

From 2014 to 2016, a secondary steelmaking facility was operating. It produced steel from scrap iron and steel from the aluminium smelters. Carbonates and slags were added to the smelting process, which occurred in an electric arc furnace.

4.5.1.1 Activity Data

Activity data used to estimate emissions from secondary steel production are total steel production, which is obtained from yearly Green Accounting reports submitted by the facility to the EAI.

4.5.1.2 Emission Factors

All emissions are calculated using Tier 2 emission factors for electric arc furnaces (Table 3.15 in Chapter 2.C.1 from the 2019 EMEP/EEA Guidebook (EEA, 2019)), except for HCB for which there is no Tier 2 estimate. In this case we used the Tier 1 emission factor, which is unrelated to technology. It should be noted that Tier 1 and Tier 2 exclude condensable PM.

4.5.1.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations from the 2023 Submission

The HCB emissions were missing in the inventory due to a mistake. Now they are included.

4.5.1.4 Planned Improvements

No improvements are currently planned for this subsector.

4.5.2 Ferroalloys Production (NFR 2C2)

Two factories produce ferroalloys in Iceland. One company has been producing FeSi75 since 1979 and another one started production of ≥98.5% pure silicon metal in 2018. A third company was operating between 2016-2017 producing silicon metal but has stopped production in 2017. Both active operators are under the EU Emission Trading Scheme (as per Directive 2003/87/EC).

In both factories, raw ore, carbon material and slag forming materials are mixed and heated to high temperatures for reduction and smelting. For the production of FeSi75 electric (submerged) arc furnaces with consumable Söderberg electrodes are used. The furnaces are semi-covered. The other factory is using submerged arc furnaces using pre-baked graphite electrodes.

Waste gases are cleaned via dry absorption units (bag-house filters). When the temperature inside the units gets too high, emergency bypass of the bag-house filters is induced. The operating permit for the ferrosilicon plant contains provisions on the maximal duration of such incidences (in percent over the year).

4.5.2.1 Activity Data

The consumption of reducing agents and electrodes is collected by the EAI directly from the plants and provided by the plants through annual emission reports submitted within the EU ETS. Activity data for raw materials and products are given in Table 4.10.

Table 4.10 Raw materials use [kt] and production [kt], ferrosilicon and silicon production.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Electrodes	3.83	3.88	5.73	6.00	4.79	4.86	4.82	5.15	5.37
Coking Coal	45.1	52.4	73.2	86.9	96.1	115	129	146	165
Coke Oven Coke	24.9	30.1	46.6	42.6	30.3	30.9	23.5	23.6	21.7
Charcoal	NA	NA	NA	2.08	NA	NA	1.67	4.21	9.83
Wood	16.7	7.73	16.2	15.6	11.3	27.2	59.9	77.9	100
Limestone	NA	NA	0.469	1.62	0.497	2.19	0.950	2.09	3.01
Production (FeSi, Si)	62.8	71.4	109	111	102	118	116	133	144
Microsilica	14.0	15.9	22.7	25.8	18.1	22.2	20.3	19.5	17.9
Slag	3.83	3.88	5.73	6.00	4.79	4.86	4.82	5.15	5.37

4.5.2.2 Emission Factors

FeSi Production: In 2011, emissions of dioxin and PAH4 (BaP, BaF, BkF, IPy) were measured at the ferrosilicon plant. These measurements were used to obtain plant-specific emission factors per tonne of production that were used for the whole time series. Emission factors for CO, NO_X, and NMVOC were taken from Table 8.18 of the Best Available Techniques Reference (BREF) document for the non-ferrous metals industries (Cusano, et al., 2017). In the case where a range was given, the highest value of the range was chosen. The emission factors are presented in Table 4.12. Sulphur emissions were calculated from S-content of the reducing agents for the time period 1990-2002 and were taken directly from Green Accounting reports submitted yearly by the factory since 2003.

Emissions of particulates for the period 1990-2011 are calculated by adding up the emissions from filtered exhaust and the amount of particulates that are released during emergency bypass of the exhaust. The emission factor for filtered exhaust is taken from Table 8.12 of the BREF document for Best Available Techniques for the non-ferrous metals industries (Cusano, et al., 2017). It is 5 mg/Nm^3. This factor is then multiplied with the plant-specific yearly amount of exhaust (in Nm^3). To calculate the bypass emissions, first the total microsilica, fine (collected and sold e.g., to cement producers) and coarse (cyclone dust) are added up and divided by the hours per year (8,760 hrs.) to get microsilica production rate per hour. This is known for all years since 2005. The production rate is then multiplied with the bypass time per furnace and the ratio of the FeSi production per furnace of the total FeSi production each year. The bypass rate is known since 2002 and taken from Green Accounts, submitted in accordance with Regulation No 851/2002. The bypass rate for previous years was calculated as the average of 2002-2006. Microsilica (fine and coarse) production rate and production per furnace were extrapolated for the years 1990 to 2001 based on total produced FeSi at the plant each year. Since 2012, TSP are obtained from the yearly Green Accounting report submitted to EAI. Emissions factors of PM_{10} and $PM_{2.5}$ relative to TSP are Tier 1 default values from the 2019 EMEP/EEA Guidebook (EEA, 2019); this excludes condensable PM. The emission factor for BC is taken from (Aasestad, 2013) in accordance with the Norwegian IIR (Norwegian Environment Agency, 2020).

Several heavy metals (As, Cd, Cr, Cu, Hg, Pb, and Zn) were measured in silicon dust in the ferrosilicon plant in 2014 and 2019. These measurements were used in combination with the emitted TSP to calculate heavy metals emissions since 1990. Hg was found to be below detection (i.e., < 9 mg/kg silicon dust in 2014 and <0.1 mg/kg in 2019) in all samples. Prior to 2014 the values from the 2014 measurements are used, after 2019 the values from the 2019 measurements are used and between 2014 and 2019 a linear interpolation of the IEF from 2014 and 2019 was done. The heavy metal contents in silica dust are shown in Table 4.11.

Table 4.11 Heavy metal contents in silica dust in 2014 and 2019 [mg metal / kg dust].

	As [mg/kg]	Cd [mg/kg]	Cr [mg/kg]	Cu [mg/kg]	Hg [mg/kg]	Pb [mg/kg]	Zn [mg/kg]
Content in silicon dust 2014	11.8	0.460	8.80	10.8	< 9	8.70	25.2
Content in silicon dust 2019	23.3	0.600	59.0	160.7	< 0.1	41.7	186.7

Si Production: Emission factors for filterable particulate matter, excluding condensables, are Tier 3 plant specific and for BC are Tier 1 default values as published in the 2019 EMEP/EEA Guidebook based on the ratio of BC to $PM_{2.5}$. The NO_X emission factor is taken from the BREF document on non-ferrous minerals (Cusano, et al., 2017). SO_2 emissions as well as emission of the heavy metals Pb, Cd, Cu, and Zn and dioxin are reported by the operator to the EAI in the annual Green Accounting report. Emissions from the other pollutants are not estimated due to lack of available information in the EMEP/EEA Guidebooks and in the BREF document cited above.

All emission factors used for calculating emissions from FeSi and Si production are presented in Table 4.12.

Table 4.12 Emission factors from FeSi and Si production.

	NO_X [kg/t]	NMVOC [kg/t]	CO [kg/t]	TSP [kg/t]	PM_{10}	$PM_{2.5}$
FeSi	11	0.045	2.5	0.58	85% of TSP	60% of TSP
Si	13	NA	NA	0.51	0.51 kg/t	0.51 kg/t
	BC % of $PM_{2.5}$	**Dioxin [µg/t FeSi]**	**B(a)P [mg/t FeSi]**	**B(b)F [mg/t FeSi]**	**B(k)F [mg/t FeSi]**	**IPy [mg/t FeSi]**
FeSi	0.23%	0.114	2.79	102.22	29.68	9.39
Si	10%	5.81	NA	NA	NA	NA

4.5.2.3 Recalculations

Recalculations from the 2024 Submission

One change resulted in recalculations. The dioxin emissions from the Si plant were corrected which also changes the IEF. This led to recalculations for 2018-2022.

Table 4.13 Recalculations of dioxin for Ferroalloys production.

2C2 Ferroalloys Production	2018	2019	2020	2021
2022 Submission dioxin [g]	0.048	0.093	0.060	0.093
2023 Submission dioxin [g]	0.061	0.123	0.078	0.123
Change relative to the 2023 Submission dioxin	27%	33%	30%	32%

Recalculations from the 2023 Submission

Three changes resulted in recalculations. First, the result of heavy metal measurements at the FeSi plant from 2019 was now added to the inventory. Since the earlier measurement was from 2014, a linear interpolation from the 2014 IEF to the 2019 IEF was made for the years between. The 2019 IEF is used for the years after 2019. This lead to recalculation of the heavy metals. In addition, Pb emissions were estimated to be zero since the measurements were below the detection limits. For the approach to be conservative, the detection limit is now used as an emission estimate instead of zero. This lead to recalculation of Pb for the whole timeline.

Dioxin emissions were reported for the first time for the Si plant in the annual Green Accounting report. Assuming same IEF in past years, recalculations were made for dioxin emissions for the years 2018-2020.

Second, the production amount for the year 2012 was corrected from 118.358 kt. To 118.359 kt. This led to recalculations for all air pollutants for the year 2012.

Third, measurements for As, Cr, and Ni at the Si plant were used to calculate an implied emission factor and applied to the whole timeline. This means Ni was included in this sector for the first time.

4.5.2.4 Planned Improvements

Work is underway to harmonise this reporting with the E-PRTR reports.

4.5.3 Primary Aluminium Production (NFR 2C3)

Aluminium is currently produced at three primary aluminium plants in Iceland. Best Available Technology (BAT) is used at all plants, i.e., closed prebake systems with point feeding of alumina, efficient process control, hoods covering the entire pot and efficient collection of air pollutants.

Primary Aluminium Production results in emissions of dioxins, PAH4, NO_X, CO, particulate matter, heavy metals, and SO_2. Emissions originate from the consumption of electrodes during the electrolysis process.

4.5.3.1 Activity Data

The EAI collects annual process specific data from the three operators through EU ETS and Green Accounting reports. The total production of the three aluminium plants is given in Table 4.14.

Table 4.14 Primary Aluminium Production [kt].

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Primary Al Production [kt]	88	100	226	272	819	857	831	836	840

4.5.3.2 Emission Factors

In 2011, emissions of dioxin were measured at one of the aluminium plants. The same plant also measured PAH4 in 2002 and in 2011, and the average emission factors from these two measurements were calculated. The measurements were used to obtain country specific emission factors per tonne of production that were used for the whole time series. Of the total pot gases 98.5% are collected and cleaned via dry adsorption unit. Thus, 1.5% of the pot gases leak unfiltered to the atmosphere. Both dioxin and PAH4 are below detection limit in the cleaned gas. Emission factors are derived from the concentration of dioxin and PAH4 in the raw gas. They are presented in Table 4.15 and used for two factories as country specific emission factors. In 2023 one plant had an updated operating licence and reported emissions from PAH4 and dioxin.

NO_x (for two plants) and CO (for all plants) are Tier 2 emission factor, taken from Table 3.2 of the 2019 EMEP/EEA Guidebook (EEA, 2019). Particulate matter was calculated from information on particulates per tonne of produced aluminium that the aluminium plants report in their Green Accounting reports submitted to the EAI. Ratios of TSP:PM_{10}:$PM_{2.5}$ as well as the BC emission factor were also taken from the 2019 EMEP/EEA Guidebook. Green Accounting includes filterable PM, condensable PM is therefore excluded. Emissions of SO_2 are estimated from S-content of alumina and electrodes for the time prior to reporting of SO_2 emission in the Green Accounts (2003-2013, depending on the company), and from SO_2 emission calculations reported in the Green Accounts in the later years. One plant operating under an updated licence has an updated plant specific emission factor for NO_X and updated ratios for BC and $PM_{2.5}$. Emission factors are presented in Table 4.15.

Table 4.15 Emission factors, Primary Aluminium Production. CS: Country Specific, PS: Plant Specific, and GB: EMEP/EEA Guidebook.

	Dioxin [µg/t Al]	PAH4 [g/t Al]	B(a)P % of PAH4	B(b)F % of PAH4	B(k)F % of PAH4	IPy % of PAH4
Emission factors	CS: 0.0329 PS: 0.074	CS: 0.0189 PS: 0.022	CS: 13%	CS: 61%	CS: 18%	CS: 8.0%
	CO [kg/t Al]	**NO_x [kg/t Al]**	**TSP % of PM_{10}**	**$PM_{2.5}$ % of PM_{10}**	**BC % of $PM_{2.5}$**	
Emission factors	GB: 120	GB: 1.0 PS: 0.692	GB: 120%	GB: 40% PS: 40%	GB: 2.3% PS: 0.03%	

For the 2024 submission, heavy metal emissions from primary aluminium are reported for the first time. Implied emission factors were calculated from emissions reported from the updated operating license of one plant and applied as country specific emission factors. Emission factors for heavy metals are presented in Table 4.16.

Table 4.16 Emission factors for heavy metals, Primary Aluminium Production.

	As [g/t]	Cd [g/t]	Cr [g/t]	Cu [g/t]	Ni [g/t]	Pb [g/t]	Zn [g/t]
Emission factors	0.153	0.148	0.0989	0.163	1.98	0.198	4.94

4.5.3.3 Recalculations and Improvements

Recalculations from the 2024 Submission

Recalculations were made for the whole timeline due to several improvements. Mainly due to an updated operating permit of one plant resulting in plant specific emission factors. As well as an update to TSP:PM_{10}:$PM_{2.5}$ ratios since what was thought to be TSP reported by the plants was PM_{10}. Heavy metal emissions were added for the first time.

Table 4.17 Recalculations for 2C3 Primary Aluminium Production.

2C3 Aluminium Production	1990	1995	2000	2005	2010	2015	2020	2021
2023 Submission TSP [kt]	0.088	0.10	0.17	0.24	0.48	0.49	0.44	0.44
2024 Submission TSP [kt]	0.105	0.12	0.21	0.28	0.57	0.59	0.52	0.53
Change relative to the 2023 Submission TSP	20%	20%	20%	20%	20%	20%	20%	20%
2023 Submission PM_{10} [kt]	0.073	0.083	0.14	0.20	0.40	0.41	0.36	0.37
2024 Submission PM_{10} [kt]	0.088	0.100	0.17	0.24	0.48	0.49	0.44	0.44
Change relative to the 2023 Submission PM_{10}	20%	20%	20%	20%	20%	20%	20%	20%
2023 Submission $PM_{2.5}$ [kt]	0.059	0.067	0.116	0.157	0.32	0.33	0.29	0.30
2024 Submission $PM_{2.5}$ [kt]	0.035	0.040	0.070	0.094	0.19	0.20	0.17	0.18
Change relative to the 2023 Submission $PM_{2.5}$	-40%	-40%	-40%	-40%	-40%	-40%	-40%	-40%
2023 Submission BC [kt]	0.001347	0.001536	0.00267	0.00361	0.0073	0.0075	0.0067	0.0068
2024 Submission BC [kt]	0.000011	0.000012	0.00046	0.00080	0.0033	0.0032	0.0032	0.0032
Change relative to the 2023 Submission BC	-99%	-99%	-83%	-78%	-55%	-58%	-52%	-53%
2023 Submission NO_x [kt]	0.088	0.100	0.23	0.27	0.82	0.86	0.83	0.84
2024 Submission NO_x [kt]	0.061	0.069	0.17	0.22	0.76	0.80	0.77	0.77
Change relative to the 2023 Submission NO_x	-31%	-31%	-23%	-20%	-7.1%	-7.2%	-6.8%	-7.5%
2023 Submission PAH4 [kg]	1.7	1.9	4.3	5.2	15.5	16.2	15.7	15.8
2024 Submission PAH4 [kg]	2.0	2.2	4.8	5.8	16.1	16.9	16.3	16.5
Change relative to the 2023 Submission PAH4	17%	17%	13%	12%	4.1%	4.1%	3.9%	4.2%
2023 Submission BaP [kg]	0.22	0.25	0.57	0.69	2.06	2.16	2.09	2.10
2024 Submission BaP [kg]	0.26	0.30	0.64	0.76	2.14	2.24	2.17	2.19
Change relative to the 2023 Submission BaP	17%	17%	13%	12%	4.1%	4.1%	3.9%	4.2%
2023 Submission BbF[kg]	1.0	1.2	2.6	3.2	9.5	10.0	9.6	9.7
2024 Submission BbF [kg]	1.2	1.4	3.0	3.5	9.9	10.4	10.0	10.1
Change relative to the 2024 Submission BbF	17%	17%	13%	12%	4.1%	4.1%	3.9%	4.2%

2C3 Aluminium Production	1990	1995	2000	2005	2010	2015	2020	2021
2023 Submission BkF [kg]	0.30	0.34	0.76	0.92	2.8	2.9	2.8	2.8
2024 Submission BkF [kg]	0.35	0.40	0.86	1.02	2.9	3.0	2.9	2.9
Change relative to the 2023 Submission BkF	17%	17%	13%	12%	4.1%	4.1%	3.9%	4.2%
2023 Submission IPy [kg]	0.13	0.14	0.33	0.39	1.18	1.24	1.20	1.21
2024 Submission IPy [kg]	0.15	0.17	0.37	0.44	1.23	1.29	1.25	1.26
Change relative to the 2023 Submission Ipy	17%	17%	13%	12%	4.1%	4.1%	3.9%	4.2%
2023 Submission PCDD/F [g]	0.0029	0.0033	0.0074	0.0090	0.027	0.028	0.027	0.027
2024 Submission PCDD/F [g]	0.0065	0.0074	0.0144	0.0164	0.035	0.036	0.035	0.036
Change relative to the 2023 Submission PCDD/F	126%	126%	93%	83%	29%	29%	28%	30%

Recalculations from the 2023 Submission

Recalculations were made for the year 2008 due to a typing error of activity data from one smelter.

4.5.3.4 Planned Improvements

Work is underway to harmonise this reporting with the E-PRTR reports.

4.5.4 Secondary Aluminium Production (NFR 2C3)

Secondary Aluminium Production started in 2004. In 2012, a second facility opened. At the end of 2014 the facilities merged and only one production area is active now. The plant recycles aluminium skimmings and scrap aluminium from two primary aluminium plants by melting scrap metal in batches in a rotary kiln. The re-melt process is carried out under a layer of salt and the resulting salt slag traps part of the contaminants. The scrap aluminium is not treated with organic material such as paints, lacquers, oils, and greases prior to recycling and comes directly from the primary aluminium plants.

4.5.4.1 Activity Data

All activity data, consisting of produced secondary aluminium, is obtained in Green Accounting reports submitted yearly to the EAI, see Table 4.18.

Table 4.18 Secondary Aluminium Production [kt].

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Secondary Al Production [kt]	NO	NO	NO	2.25	2.04	2.20	2.20	3.61	3.15

4.5.4.2 Emission Factors

Emissions of dioxin, HCB, and PM (excluding condensable PM) are estimated. The dioxin implied emission factor is based on four on-site measurements at the factory in different years. The average of these four measurements (0.45 µg/t aluminium) is in accordance with the emissions factor from the *Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases* (UNEP, 2003) for production where high efficiency controls are in place (0.5 µg/t aluminium). The plant only recycles scrap metal from primary aluminium plants and no coated aluminium, so organic compounds in the input material is minimum. Also, no chlorine is added in the process and further oxy-fuel burners are used.

The TSP emissions are based on on-site measurements in 2014 and every year since 2016. For the year 2015, the average of the implied emission factor for 2014 and 2016 is used. For the years 2012 and 2013 the implied emission factor for 2014 is used. For the first factory (before 2004) the emission factors are taken from the Table 3.4 in the EMEP/EEA Guidebook (EEA, 2019). The PM_{10} and $PM_{2.5}$ emission factors are based on the same ratios to TSP as in Table 3.4 in the EMEP/EEA Guidebook. The BC emission factor is taken from the same table.

The emission factor for HCB was chosen as a value in the lower range (0.04-40 mg/t) given in Table 5-9 and Figure 5-18 of BiPRO (2006). As the recycled scrap material is directly coming from the primary aluminium smelters, contamination with organic substances in form of paintings or lacquers is expected to be insignificant and subsequently emissions of organochloride are expected to be low as well. A comparison across Nordic Countries shows that the used emissions factors are 1.365 mg/t in Finland, 1.7 mg/t in Norway and 20 mg/t in Denmark (from the IIR of the respective countries).

Table 4.19 Emission factors, Secondary Aluminium Production. TSP IEF is the average of the years 2012-2022.

	Dioxin [µg/t Al]	HCB [mg/t Al]	TSP [kg/t]	PM_{10} [% of TSP]	$PM_{2.5}$ [% of TSP]	BC [% of $PM_{2.5}$]
Emission factors	0.45	5.0	0.46	70%	28%	2.3%

4.5.4.3 Recalculations

No category-specific recalculations were done for the current submission.

Recalculations from the 2023 Submission

The particulate matter emissions are now based on measurements on-site but not the default emission factor from the 2019 EMEP/EEA Guidebook. However, the emissions of PM_{10}, $PM_{2.5}$, and BC as a fraction of TSP according to the ratios in the Guidebook are unchanged. The recalculation was made for the factory that started in 2012 and not for the factory that closed in 2014.

4.5.4.4 Planned Improvements

No improvements are currently planned for this subsector.

4.5.5 Magnesium Production (NFR 2C4)

This activity does not occur in Iceland.

4.5.6 Lead Production (NFR 2C5)

This activity does not occur in Iceland.

4.5.7 Zinc Production (NFR 2C6)

This activity does not occur in Iceland.

4.5.8 Capacitor Production (NFR 2C7c)

Production of the dielectric of aluminium electrolytic capacitor started in 2009 in a single plant and achieved full capacity in 2011. The plant receives aluminium sheets and a thin layer of aluminium oxide "forms" on the surface of the etched aluminium foil during a process called "formation." During the formation the aluminium sheet is submerged in a liquid bath and ammonium hydroxide is used to control the pH level of the liquid.

4.5.8.1 Activity Data

All activity data, consisting of used ammonium hydroxide, is obtained in Green Accounting reports submitted yearly to the EAI, see Table 4.20.

Table 4.20 Ammonium hydroxide used during production [kt].

	2009	2010	2015	2020	2021	2022
Ammonium hydroxide used [kt]	0.0509	0.1119	0.0654	0.0494	0.0452	0.0776

4.5.8.2 Emission Factors

The plant only emits NH_3. In Green Accounting, the concentration, and thereby the emission factor of NH_3, of the ammonium hydroxide is given as 24.5%.

4.5.8.3 Recalculations

No recalculations were made for this submission.

4.5.8.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6 Solvent and Product Use (NFR 2D)

Activities related to 2D Solvent and product use mostly generate NMVOC. 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 evaporation. Emissions of other pollutants than NMVOC were only estimated from Road Paving with Asphalt (2D3b - Dioxin, PM, and BC), and other solvent use (Creosotes - 2D3i - PAH). The categories Coating, Degreasing, and Other NMVOC emissions from printing and other product use have in common that their activity data consists of data about imported goods. This data was received from SI.

Emission factors for subcategories of 2D3 are presented in Table 4.21 and Table 4.22. References and more details about individual emission factors are included in the respective subchapters.

Table 4.21 Emission factors for NMVOC, PM and BC in sector 2D3.

		Unit	NMVOC [g/unit]	TSP [g/unit]	PM_{10} [g/unit]	$PM_{2.5}$ [g/unit]	BC [% of $PM_{2.5}$]
2D3b	Road Paving with Asphalt	t asphalt	16	20	4.3	5.7	5.7%
2D3d	Coating Applications	kg paint	230	-	-	-	-
2D3e	Degreasing	kg cleaning product	460	-	-	-	-
2D3f	Dry Cleaning	kg textile treated	19.5	-	-	-	-
2D3g	Chemical Products: Paint Manufacturing	kg product	11	-	-	-	-
2D3h	Printing	kg ink	500	-	-	-	-
2D3i	Creosotes	kg creosote	105	-	-	-	-
2D3i	Organic Solvent-borne Preservatives	kg preservative	945	-	-	-	-
2D3i	Aircraft De-icing	kg de-icing fluid	53	-	-	-	-

Table 4.22 Emission factors for dioxin and PAH in sector 2D3.

		Unit	Dioxin [μg I-TEQ/unit]	BaP [mg/unit]	BbF [mg/unit]	BkF [mg/unit]	IPy [mg/unit]
2D3b	Road Paving with Asphalt	t asphalt	0.0070	-	-	-	-
2D3d	Coating Applications	kg paint	-	-	-	-	-
2D3e	Degreasing	kg cleaning product	-	-	-	-	-
2D3f	Dry Cleaning	kg textile treated	-	-	-	-	-
2D3g	Chemical Products: Paint Manufacturing	kg product	-	-	-	-	-
2D3h	Printing	kg ink	-	-	-	-	-
2D3i	Creosotes	kg creosote	-	1.05	0.53	0.53	0.53
2D3i	Organic Solvent-borne Preservatives	kg preservative	-	-	-	-	-
2D3i	Aircraft De-icing	kg de-icing fluid	-	-	-	-	-

4.6.1 Domestic Solvent Use Including Fungicides (NFR 2D3a)

The emission factors for 2D3a Domestic Solvent Use are Tier 2b from Table 3.5 in chapter 2.D.3.a of the 2019 EMEP/EEA Guidebook (EEA, 2019).

4.6.1.1 Activity Data

Activity data consists of the Icelandic population and is given by Statistics Iceland (SI) (*Hagstofa Íslands*).

4.6.1.2 Emission Factors

The emission factor for NMVOC for different products and product types per person was taken from Table 3.5, Chapter 2.D.3.a (EEA, 2019).

Hg is not estimated due to uncertainty around the releases according to the 2019 EMEP/EEA Guidebook (EEA, 2019). The Hg emissions may be accounted for elsewhere in the inventory since emissions of Hg could arise from the use of fluorescent tubes.

4.6.1.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations for the 2023 Submission

No category-specific recalculations were done for the 2023 submission.

4.6.1.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6.2 Road Paving with Asphalt (NFR 2D3b)

Asphalt road surfaces are composed of compacted aggregate and asphalt binder. Gases are emitted from the asphalt plant itself, the road surfacing operations, and subsequently from the road surface.

4.6.2.1 Activity Data

Information on the amount of asphalt produced comes from SI until 2011, and directly from the companies producing asphalt since 2012, see Table 4.23.

Table 4.23 Production of asphalt for road paving [kt].

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Road Paving with Asphalt Production [kt]	172	172	324	335	235	194	330	371	172

4.6.2.2 Emission Factors

The emission factor for NMVOC is taken from Table 3.1 in Chapter 2.D.3.b, Tier 1, in the EMEP/EEA Guidebook (EEA, 2019). Emissions factors for TSP are based on measurements from the second-largest asphalt production plant. BC, $PM_{2.5}$, and PM_{10} emission factors are then calculated by using the same ratio to TSP as given in Table 3.1, Chapter 2.D.3.b in the Guidebook (EEA, 2019), this excludes condensable PM. Emissions of dioxin are based on emission factor 0.007 µg TEQ/t from the Toolkit for Identification and Quantification of Releases of Dioxins, Furans, and Other Unintentional POPs (UNEP, 2003). 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 1A2gvii.

4.6.2.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Recalculations were made for the 2024 submissions due to updates in activity data (see Table 4.24). One asphalt producing company was added to the inventory for the 2024 submission. The company has been operating since 2020, meaning that its production data for 2020 and 2021 have been missing from the inventory.

Table 4.24 Recalculations in 2D3 Other: Road Paving with Asphalt between submissions.

2D3 Other: Road Paving with Asphalt	2020	2021
2023 submission TSP [kt]	0.0048	0.0055
2024 submission TSP [kt]	0.0053	0.0066
Change relative to 2023 submission TSP [%]	9.6%	21%
2023 submission PM_{10} [kt]	0.00103	0.00117
2024 submission PM_{10} [kt]	0.00113	0.00141
Change relative to 2023 submission PM_{10} [%]	9.6%	21%
2023 submission $PM_{2.5}$ [kt]	0.000137	0.000156
2024 submission $PM_{2.5}$ [kt]	0.000150	0.000188
Change relative to 2023 submission $PM_{2.5}$ [%]	9.6%	21%
2023 submission BC [kt]	0.0000078	0.0000089
2024 submission BC [kt]	0.0000086	0.0000107
Change relative to 2023 submission BC [%]	9.6%	21%
2023 submission NMVOC [kt]	0.0038	0.0044
2024 submission NMVOC [kt]	0.0042	0.0053
Change relative to 2023 submission NMVOC [%]	9.6%	21%
2023 submission PCDD/F [g]	0.00168	0.00191
2024 submission PCDD/F [g]	0.00184	0.00231
Change relative to 2023 submission PCDD/F [%]	9.6%	21%

Recalculations for the 2023 Submission

No category-specific recalculations were done for the 2023 submission.

4.6.2.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6.3 Coating Applications (NFR 2D3d)

The emissions in this category stem from paint applications. Only NMVOC emissions are estimated; emissions from other pollutants are either considered minimal or non-existent.

4.6.3.1 Activity Data

Data exists on imported paint since 1990 (SI) and on domestic production of paint since 1998 from the Icelandic Recycling Fund annual report (Icelandic Recycling Fund, 2019) or via direct communication, see Table 4.25. 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.

Table 4.25 Total solvent-based paint (domestic production and imports) [kt].

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Total solvent-based paint [kt]	2.21	2.38	2.44	1.56	1.28	1.40	1.79	1.58	2.21

4.6.3.2 Emission Factors

The emission factor for NMVOC is taken from Table 3.4 in Chapter 2.D.3.d, Tier 2, in the EMEP/EEA Guidebook (EEA, 2019). The EMEP/EEA Guidebook (EEA, 2019) provides emission factors based on amounts of paint applied. The Tier 1 emission factor from the EMEP/EEA Guidebook (EEA, 2019) refers to all paints applied, e.g., waterborne, powder, high solid, and solvent-based paints. The existing data on produced and imported paints, however, makes it possible to narrow activity data down to conventional solvent-based paints. Therefore, Tier 2 emission factors for conventional solvent-based paints could be applied. The activity data does not allow for 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.

4.6.3.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Minor recalculations were made through the time series from 1995-2021 due to updates in import/export data from SI (see Table 4.26).

Table 4.26 Recalculations of NMVOC in 2D3d Coating between submissions.

2D3d Coating	1995	2000	2005	2010	2015	2020	2021
2023 submission NMVOC [kg]	547419	560077	342397	288710	318265	442115	409674
2024 submission NMVOC [kg]	547552	561879	359634	293804	321996	468208	410659
Change relative to 2023 submission NMVOC [%]	0.024%	0.32%	5.0%	1.8%	1.2%	5.9%	0.24%

Recalculations for the 2023 Submission

Minor recalculations were made for 1999, 2009, 2012, 2015, and 2019 between the 2022 and 2023 submissions due to updates in import/export data from SI.

4.6.3.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6.4 Degreasing (NFR 2D3e)

Degreasing only generates NMVOC emissions. Emissions are estimated by Tier 1, based on amounts of cleaning products used.

4.6.4.1 Activity Data

The data on the amount of imported cleaning products imported provided by SI (see Table 4.27). Of the chemicals listed by the EMEP/EEA Guidebook, activity data is available for: 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 with more accuracy and without underestimating them, half of the imported PER was allocated to degreasing. Emissions from Dry Cleaning are estimated without using data on solvents used (see below). However, the use of PER in Dry Cleaning is implicitly contained in the method. In Iceland, xylenes are mainly used in paint production (expert judgement). Furthermore, 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-trichloroethylene (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.

Table 4.27 Imports of cleaning products [kt].

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Cleaning product imports [kt]	0.166	0.123	0.185	0.125	0.083	0.101	0.113	0.102	0.166

4.6.4.2 Emission Factors

The amount of imported solvents for degreasing was multiplied with the NMVOC Tier 1 emission factor from Table 3-1 in chapter 2.D.3.e of the EMEP/EEA Guidebook (EEA, 2019) for degreasing: 460 g/kg cleaning product.

4.6.4.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Minor recalculations were made for 2010, 2011, 2016, 2018, 2019, 2020 and 2021 between 2023 and 2024 submissions due to updates in import/export data from SI (see Table 4.28).

Table 4.28 Recalculations of NMVOC in 2D3e Degreasing between submissions.

2D3e Degreasing	2010	2011	2016	2018	2019	2020	2021
2023 submission NMVOC [kg]	37950	34054	49915	54863	57822	43055	51762
2024 submission NMVOC [kg]	37955	34060	50017	54887	58204	46433	51795
Change relative to 2023 submission NMVOC [%]	0.012%	0.019%	0.20%	0.044%	0.66%	7.8%	0.064%

Recalculations for the 2023 Submission

Minor recalculations were made for 2010, 2014 and 2019 between 2022 and 2023 submissions due to updates in import/export data from SI.

4.6.4.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6.5 Dry Cleaning (NFR 2D3f)

Dry Cleaning only generates NMVOC emissions. Emissions related to Dry Cleaning were estimated by Tier 2, based on the default amount of textile cleaned per capita.

4.6.5.1 Activity Data

Activity data for calculation of NMVOC emissions is the amount of textile treated annually, which is assumed to be 0.3 kg/head, default value from chapter 2.D.3.f of the 2019 EMEP/EEA Guidebook and calculated using demographic data.

4.6.5.2 Emission Factors

Emissions from Dry Cleaning were calculated using the Tier 2 emission factor from for conventional closed-circuit PER machines with abatement efficiency provided in Table 3-2 in chapter 2.D.3.f of the 2019 EMEP/EEA Guidebook. The unabated NMVOC emission factor is 177 g/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 reduction default value of $\eta_{\text{abatement}} = 89\%$. The abated emission factor is therefore:

$$EF_{\text{technology,abated}} = (1 - \eta_{\text{abatement}}) \cdot EF_{\text{technology,unabated}} = (1 - 0.89) \cdot 177 = 19.47 \text{ g/kg}$$

4.6.5.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations for the 2023 Submission

No category-specific recalculations were done for the 2023 submission.

4.6.5.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6.6 Chemical Products (NFR 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 Tier 2 of the Guidebook (EEA, 2019).

4.6.6.1 Activity Data

The activity data consists of the amount of paint produced domestically as discussed above in chapter 4.6.3 Coating Applications, see Table 4.29.

Table 4.29 Domestically produced solvent-based paint [kt].

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Solvent-based Paint Domestic Production [kt]	1.42	1.42	1.11	0.492	0.291	0.301	0.361	0.257	1.42

4.6.6.2 Emission Factors

NMVOC emissions from the manufacture of paints were calculated using Tier 2 emission factor of 11 g/kg product from Table 3-11 in chapter 2D3g in the 2019 EMEP/EEA Guidebook.

4.6.6.3 Recalculations and Improvements

Recalculations for the 2024 Submission

No category-specific recalculations were done for the 2024 submission.

Recalculations for the 2023 Submission

No category-specific recalculations were done for the 2023 submission.

4.6.6.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6.7 Printing (NFR 2D3h)

4.6.7.1 Activity Data

Import data on ink was received from SI, see Table 4.30.

Table 4.30 Total imports of ink [kt]

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Print/ink import [kt]	0.155	0.218	0.396	0.614	0.378	0.414	0.162	0.171	0.180

4.6.7.2 Emission Factors

NMVOC emissions for printing were calculated using the 2019 EMEP/EEA Guidebook (EEA, 2019). Tier 1 emission factor of 500 g/kg ink used.

4.6.7.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Recalculations were done for 1997, 2000 and 2002-2021 for the 2024 submission due to updates in import/export data from SI (see Table 4.31).

Table 4.31 Recalculations of NMVOC in 2D3h Printing between submissions.

2D3h Printing	1997	2000	2002	2005	2010	2015	2020	2021
2023 submission NMVOC [kg]	149342	198147	172747	305126	188777	206688	78365	85538

2D3h Printing	1997	2000	2002	2005	2010	2015	2020	2021
2024 submission NMVOC [kg]	149347	198147	172753	307163	188859	206795	80846	85634
Change relative to 2023 submission NMVOC [%]	0.0033%	0.00025%	0.0035%	0.67%	0.043%	0.052%	3.2%	0.11%

Recalculations for the 2023 Submission

Recalculations were made for 1999, 2000, 2013, 2014 and 2019 for the 2023 submission due to updates in import/export data from SI.

4.6.7.4 Planned Improvements

No improvements are currently planned for this subsector.

4.6.8 Other Product Use (NFR 2D3i)

Wood is preserved to protect it against fungal and insect attack and also against weathering. There are three main types of preservative: creosote, organic solvent-based (often referred to as "light organic solvent-based preservatives" (LOSP)) and water borne. Creosote is oil prepared from coal tar distillation and contains a high proportion of aromatic compounds such as polycyclic aromatic hydrocarbons (PAHs). In Iceland, creosotes have been banned since 2011. Other wood preservation substances used in Iceland are Organic Solvent-borne Preservatives. De-icing fluid is used to de-ice aircrafts at airports. NMVOC emissions occur from the propylene glycol in the de-icing fluid.

4.6.8.1 Activity Data

Activity data consists of annual import of creosotes and organic solvent-borne preservatives, and the assumption that all these products are applied during the year of import. Import data on both wood preservatives is provided by SI. Data on de-icing fluid used are provided by Icelandair/Jet Centre and Airport Associates Keflavík.

Table 4.32 Total import of preservatives [kg] and total de-icing fluid used [l].

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Creosote preservative import [kg]	12,450	6,930	2,245	300	1,968	NO	NO	NO	NO
Organic solvent-borne preservative import [kg]	7,795	19,021	26,666	91,245	32,513	28,019	39,800	43,628	27,436
De-icing fluid used [l]	664,772	664,772	664,772	664,772	664,772	570,614	690,152	424,670	894,213

4.6.8.2 Emission Factors

All emission factors used in sector 2D3i are from chapter 2.D.3.i of the 2019 EMEP/EEA Guidebook (EEA, 2019).

NMVOC emissions from wood preservation were calculated using Tier 2 emissions factor from Table 3-5 for creosote preservative type (105 g/kg creosote).

NMVOC emissions from organic solvent borne preservative were calculated using Tier 2 emission factor from Table 3-6 (945 g/kg preservative).

NMVOC emission from aircraft de-icing were calculated using Tier 2 emission factor from Table 3-12 (53 kg/t de-icing fluid)

PAH emissions from wood preservation are calculated using Tier 2 emission factors from Table 3-5 in chapter 2.D.3.i, 2.G of the 2019 EMEP/EEA Guidebook (1.05 mg BaP per kg of creosote; 0.53 mg BbF/BkF/IPy per kg creosote).

4.6.8.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Recalculations were made for the 2024 submission due to updates in import/export data from SI.

Table 4.33 Recalculations of NMVOC in 2D3i Other Solvent Borne Preservative between submissions.*

2D3i Organic Solvent Borne Preservative	1997	1998	1999	2004	2005	2006	2008	2011	2013
2023 submission NMVOC [kg]	15275	10711	14707	81273	85873	96388	91367	8909	17383
2024 submission NMVOC [kg]	15322	15428	16524	82255	86227	97541	91713	23332	17894
Change relative to 2023 submission NMVOC [%]	0.31%	44%	12%	1.2%	0.41%	1.2%	0.38%	162%	2.9%

*Recalculations for 2001, 2003 and 2020 are smaller than 0.1% and are therefore not shown.

Recalculations for the 2023 Submission

For the 2023 submission, recalculations were made for 2019 due to updates in import/export data of Organic Solvent-borne Preservatives from SI.

4.6.8.4 Planned Improvements

No improvements are currently planned for this subsector.

4.7 Other Solvent and Product Use (NFR 2G)

4.7.1 Other: Tobacco and Fireworks (NFR 2G4)

The two emission sources estimated in this category are use of tobacco and fireworks.

Tobacco smoking is a minor source of dioxins, PAH, and other pollutants including heavy metals, whereas fireworks are one of the most significant source of heavy metals in the IPPU sector. The yearly imported amount of tobacco shows a downward trend over the time series, which is reflected also in the emission.

Firework imports follow in general the economic development of the country. A prominent peak around 2007 is due to a very sharp rise in the economy leading to the financial collapse of 2008.

4.7.1.1 Activity Data

Activity data consist of all smoking tobacco and all fireworks imported and are provided by SI.

4.7.1.2 Emission Factors

For tobacco use, Tier 2 emission factors for NO_x, CO, NH_3, TSP, PM, BC, NMVOC, dioxin, and PAH4 were taken from Table 3-15 in Chapter 2.D.3.i, 2.G in the 2019 EMEP/EEA Guidebook (EEA, 2019). Emission factors for heavy metals are taken from the Danish IIR (Nielsen, et al., 2021), which uses emission factors derived from burning of wood.

For firework use, Tier 2 emission factors for SO_2, CO, NO_x, TSP, PM, and heavy metals (except for Pb and HCB) were taken from Table 3-14 in Chapter 2.D.3.i, 2.G of the 2019 EMEP/EEA Guidebook (EEA, 2019). The emissions factors for Pb and HCB are based on measurements of the average Pb and HCB content in a sample of different fireworks sold in Iceland from 2018. HCB content was higher in the past. Measurements from 2012 showed significantly higher HCB content and the emission factor is linearly lowered from the 2012 value to the 2018 value. The Pb emission factor is linearly lowered from the default guidebook value to the measurement value between 2007 and 2015. EU law on PE markings for fireworks (2007/23/EB) was implemented into Icelandic law in 2015. All emission factors are presented in Table 4.34.

Table 4.34 Emission factors for use of tobacco and of fireworks, per mass unit of imported goods.

	NO_x [kg/t]	NMVOC [kg/t]	SO_2 [kg/t]	NH_3 [kg/t]	TSP [kg/t]	PM_{10} [kg/t]	$PM_{2.5}$ [kg/t]	BC % of $PM_{2.5}$	CO [kg/t]
Tobacco	1.80	0.00484	NA	4.15	27.0	27.0	27.0	0.45%	55.1
Fireworks	0.260	NA	3.02	NA	109.8	99.9	51.9	NA	7.15

	Dioxin [ng I-TEQ/t]	B(a)P [g/t]	B(b)F [g/t]	B(k)F [g/t]	IPy [g/t]	HCB [g/t]
Tobacco	100	0.11	0.045	0.045	0.045	NA
Fireworks	NA	NA	NA	NA	NA	0.047[1]

[1]Value from 1990-2012 is 1.019 g/t and linearly lowered to the value from the 2018 measurements.

	Pb [g/t]	Cd [g/t]	Hg [g/t]	As [g/t]	Cr [g/t]	Cu [g/t]	Ni [g/t]	Se [g/t]	Zn [g/t]
Tobacco	0.640	0.0200	0.0100	0.159	0.152	0.354	0.0300	0.0100	1.61
Fireworks	48.5[2]	1.48	0.057	1.33	15.6	444	30	NA	260

[2]Value is linearly lowered from the default EMEP/EEA guidebook value to the measurement value between 2007 and 2015.

4.7.1.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Tobacco: Recalculations were made for the 2024 submission due to updates in import/export data from SI. These recalculations were minor but occurred in all air pollutants in this category (see Table 4.35).

Table 4.35 Recalculations in 2G4 Other: Tobacco between submission.

2G4 Other: Tobacco	2005	2007	2008	2009	2010	2020	2021
2023 submission TSP [kt]	1.038574 E-02	1.12707 E-02	1.094021 E-02	1.02 E-02	9.332 E-03	6.54656 E-03	5.824 E-03
2024 submission TSP [kt]	1.038582 E-02	1.12715 E-02	1.094045 E-02	1.02 E-02	9.364 E-03	6.54683 E-03	5.836 E-03
Change relative to the 2023 submission TSP [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission PM_{10} [kt]	1.038574 E-02	1.12707 E-02	1.094021 E-02	1.02 E-02	9.332 E-03	6.54656 E-03	5.824 E-03
2024 submission PM_{10} [kt]	1.038582 E-02	1.12715 E-02	1.094045 E-02	1.02 E-02	9.364 E-03	6.54683 E-03	5.836 E-03
Change relative to the 2023 submission PM_{10} [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission $PM_{2.5}$ [kt]	1.038574 E-02	1.12707 E-02	1.094021 E-02	1.02 E-02	9.332 E-03	6.54656 E-03	5.824 E-03
2024 submission $PM_{2.5}$ [kt]	1.038582 E-02	1.12715 E-02	1.094045 E-02	1.02 E-02	9.364 E-03	6.54683 E-03	5.836 E-03
Change relative to the 2023 submission $PM_{2.5}$ [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission BC [kt]	4.67358 E-05	5.0718 E-05	4.92309 E-05	4.580465 E-05	4.199 E-05	2.94595 E-05	2.6208 E-05
2024 submission BC [kt]	4.67362 E-05	5.0722 E-05	4.92320 E-05	4.580489 E-05	4.214 E-05	2.94607 E-05	2.6261 E-05
Change relative to the 2023 submission BC [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission NOx [kt]	6.92383 E-04	7.5138 E-04	7.29347 E-04	6.785874 E-04	6.221 E-04	4.36437 E-04	3.883 E-04
2024 submission NOx [kt]	6.92388 E-04	7.5143 E-04	7.29364 E-04	6.785910 E-04	6.242 E-04	4.36455 E-04	3.890 E-04
Change relative to the 2023 submission NOX [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission NMVOC [kt]	1.861740 E-03	2.02038 E-03	1.961134 E-03	1.824646 E-03	1.6728 E-03	1.173531 E-03	1.0440 E-03
2024 submission NMVOC [kt]	1.861754 E-03	2.02052 E-03	1.961178 E-03	1.824656 E-03	1.6785 E-03	1.173579 E-03	1.0461 E-03
Change relative to the 2023 submission NMVOC [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission CO [kt]	2.119460 E-02	2.30006 E-02	2.232613 E-02	2.077231 E-02	1.904 E-02	1.33598 E-02	1.189 E-02
2024 submission CO [kt]	2.119477 E-02	2.30022 E-02	2.232663 E-02	2.077242 E-02	1.911 E-02	1.33604 E-02	1.191 E-02
Change relative to the 2023 submission CO [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission NH3 [kt]	1.596327 E-03	1.73235 E-03	1.681551 E-03	1.564521 E-03	1.4343 E-03	1.006230 E-03	8.952 E-04
2024 submission NH3 [kt]	1.596339 E-03	1.73247 E-03	1.681588 E-03	1.564529 E-03	1.4392 E-03	1.006271 E-03	8.970 E-04
Change relative to the 2023 submission NH3 [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission PAH4 [t]	9.46256 E-05	1.02689 E-04	9.96775 E-05	9.274028 E-05	8.502 E-05	5.96464 E-05	5.306 E-05
2024 submission PAH4 [t]	9.46264 E-05	1.02696 E-04	9.96797 E-05	9.274077 E-05	8.531 E-05	5.96489 E-05	5.317 E-05
Change relative to the 2023 submission PAH4 [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission BaP [t]	4.26969 E-05	4.63352 E-05	4.49764 E-05	4.184622 E-05	3.836 E-05	2.69136 E-05	2.3943 E-05
submission BaP [t]	4.26973 E-05	4.63383 E-05	4.49774 E-05	4.184645 E-05	3.850 E-05	2.69147 E-05	2.3991 E-05
Change relative to the 2023 submission BaP [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission BbF [t]	1.730957 E-05	1.87845 E-05	1.82337 E-05	1.696469 E-05	1.555 E-05	1.09109 E-05	9.707 E-06

2G4 Other: Tobacco	2005	2007	2008	2009	2010	2020	2021
submission BbF [kg]	1.730970 E-05	1.87858 E-05	1.82341 E-05	1.696478 E-05	1.561 E-05	1.09114 E-05	9.726 E-06
Change relative to the 2023 submission BbF [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission BkF [t]	1.730957 E-05	1.87845 E-05	1.82337 E-05	1.696469 E-05	1.555 E-05	1.09109 E-05	9.707 E-06
submission BkF [t]	1.730970 E-05	1.87858 E-05	1.82341 E-05	1.696478 E-05	1.561 E-05	1.09114 E-05	9.726 E-06
Change relative to the 2023 submission BkF [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission IPy [t]	1.730957 E-05	1.87845 E-05	1.82337 E-05	1.696469 E-05	1.555 E-05	1.09109 E-05	9.707 E-06
2024 submission IPy [t]	1.730970 E-05	1.87858 E-05	1.82341 E-05	1.696478 E-05	1.561 E-05	1.09114 E-05	9.726 E-06
Change relative to the 2023 submission IPy [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission PCDD/F [g]	3.84657 E-05	4.17434 E-05	4.0519 E-05	3.769930 E-05	3.4562 E-05	2.42465 E-05	2.157 E-05
2024 submission PCDD/F [g]	3.84660 E-05	4.17462 E-05	4.0520 E-05	3.769950 E-05	3.4680 E-05	2.42475 E-05	2.161 E-05
Change relative to the 2023 submission PCDD/F [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Pb [g]	246.1805	267.158	259.3235	241.2755	221.20	155.178	138.05
2024 submission Pb [g]	246.1824	267.176	259.3293	241.2768	221.95	155.184	138.33
Change relative to the 2023 submission Pb [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Cd [g]	7.69314	8.3487	8.1039	7.53986	6.912	4.849	4.314
2024 submission Cd [g]	7.69320	8.3492	8.1040	7.53990	6.936	4.850	4.323
Change relative to the 2023 submission Cd [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Hg [g]	3.84657	4.17434	4.0519	3.7699	3.456	2.42465	2.157
2024 submission Hg [g]	3.84660	4.17462	4.0520	3.7700	3.468	2.42475	2.161
Change relative to the 2023 submission Hg [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission As [g]	61.16046	66.3720	64.4257	59.9419	54.95	38.5519	34.296
2024 submission As [g]	61.16094	66.3765	64.4271	59.9422	55.14	38.5535	34.366
Change relative to the 2023 submission As [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Cr [g]	58.4679	63.4500	61.5893	57.3029	52.53	36.8547	32.79
2024 submission Cr [g]	58.4683	63.4542	61.5907	57.3032	52.71	36.8562	32.85
Change relative to the 2023 submission Cr [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Cu [g]	136.1686	147.772	143.438	133.4555	122.35	85.8326	76.36
submission Cu [g]	136.1696	147.782	143.442	133.4562	122.77	85.8362	76.51
Change relative to the 2023 submission Cu [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Ni [g]	11.53971	12.52302	12.1558	11.30979	10.37	7.27395	6.471
2024 submission Ni [g]	11.53980	12.52386	12.1561	11.30985	10.40	7.27425	6.484
Change relative to the 2023 submission Ni [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Se [g]	3.84657	4.17434	4.0519	3.769930	3.456	2.42465	2.157
2024 submission Se [g]	3.84660	4.17462	4.0520	3.769950	3.468	2.42475	2.161

2G4 Other: Tobacco	2005	2007	2008	2009	2010	2020	2021
Change relative to the 2023 submission Se [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%
2023 submission Zn [g]	619.298	672.069	652.361	606.959	556.447	390.369	347.277
2024 submission Zn [g]	619.303	672.114	652.375	606.962	558.353	390.385	347.981
Change relative to the 2023 submission Zn [%]	0.00078%	0.0067%	0.0022%	0.00053%	0.34%	0.0041%	0.20%

Fireworks: For the 2024 submission, there were major recalculations for HCB and Pb due to updated emission factors (see Table 4.36) and minor recalculations were due to updated activity data (see Table 4.37).

Table 4.36 Recalculations of Pb and HCB emission within 2G4 (Fireworks) between 2023 and 2024 Submissions.

2G4 Other: Fireworks	1990	1995	2000	2005	2010	2015	2020
2023 Submission Pb [kg]	5.5	6.9	18	31	24	No recalculation	23.9670
2024 Submission Pb [kg]	89	111	296	500	224		23.9681
Change relative to the 2023 Submission Pb	1516%	1516%	1516%	1516%	842%		0.0049%
2023 Submission HCB [g]	0.0054	0.0067	0.018	0.030	0.023	0.028	0.0232651
2024 Submission HCB [g]	0.1161	0.1439	0.385	0.650	0.500	0.321	0.0232662
Change relative to the 2023 Submission HCB	2064%	2064%	2064%	2064%	2064%	1032%	0.0049%

Table 4.37 Recalculations of emissions within 2G4 Fireworks for the years 2007, 2009, 2010, 2012, 2016, and 2020, between the 2023 and 2024 Submissions.

2G4 Fireworks	2007	2009	2010	2012	2016	2018	2020
2023 Submission TSP [kt]	0.11943	0.04628	0.0538600	0.0689753	0.0661095	0.0834074	0.0542446
2024 Submission TSP [kt]	0.11985	0.04648	0.0538668	0.0689765	0.0661170	0.0834084	0.0542472
Change relative to the 2023 Submission TSP	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission PM_{10} [kt]	0.1087	0.04211	0.0490002	0.0627517	0.060144	0.0758815	0.0493501
2024 Submission PM_{10} [kt]	0.1090	0.04228	0.0490064	0.0627528	0.060151	0.0758824	0.0493525
Change relative to the 2023 Submission PM_{10}	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission $PM_{2.5}$ [kt]	0.05648	0.02189	0.0254711	0.03261931	0.0312640	0.03944443	0.0256530
2024 Submission $PM_{2.5}$ [kt]	0.05668	0.02198	0.0254743	0.03261988	0.0312676	0.03944490	0.0256542
Change relative to the 2023 Submission $PM_{2.5}$	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission NO_x [kt]	2.827 E-04	1.096 E-04	1.27502 E-04	1.63285 E-04	1.56501 E-04	1.974500 E-04	1.284130 E-04
2024 Submission NO_x [kt]	2.837 E-04	1.100 E-04	1.27519 E-04	1.63288 E-04	1.56518 E-04	1.974523 E-04	1.284192 E-04
Change relative to the 2023 Submission NO_x	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission SO_2 [kt]	3.284 E-03	1.2726 E-03	1.48099 E-03	1.896617 E-03	1.8178 E-03	1.8337 E-03	2.293457 E-03
2024 Submission SO_2 [kt]	3.295 E-03	1.2780 E-03	1.48118 E-03	1.896651 E-03	1.8180 E-03	1.8337 E-03	2.293485 E-03
Change relative to the 2023 Submission SO_2	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%

2G4 Fireworks	2007	2009	2010	2012	2016	2018	2020
2023 Submission CO [kt]	7.77 E-03	3.013 E-03	3.50632 E-03	4.49034 E-03	4.3038 E-03	5.42987 E-03	3.53136 E-03
2024 Submission CO [kt]	7.80 E-03	3.026 E-03	3.50676 E-03	4.49041 E-03	4.3043 E-03	5.42994 E-03	3.53153 E-03
Change relative to the 2023 Submission CO	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission As [kg]	1.446	0.5605	0.65222	0.835265	0.80056	1.010033	0.65688
2024 Submission As [kg]	1.451	0.5628	0.65231	0.835280	0.80065	1.010045	0.65691
Change relative to the 2023 Submission As	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission Cd [kg]	1.609	0.6237	0.72578	0.929468	0.89085	1.123946	0.73097
2024 Submission Cd [kg]	1.615	0.6263	0.72587	0.929484	0.89095	1.123959	0.73100
Change relative to the 2023 Submission Cd	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission Cr [kg]	16.96	6.57	7.6501	9.79710	9.3900	11.84700	7.7048
2024 Submission Cr [kg]	17.02	6.60	7.6511	9.79727	9.3911	11.84714	7.7052
Change relative to the 2023 Submission Cr	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission Cu [kg]	482.8	187.10	217.735	278.8404	267.255	337.1838	219.29
2024 Submission Cu [kg]	484.5	187.89	217.762	278.8453	267.285	337.1878	219.30
Change relative to the 2023 Submission Cu	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission Hg [kg]	0.06198	0.02402	0.0279525	0.03579708	0.0343098	0.04328711	0.0281521
2024 Submission Hg [kg]	0.06220	0.02412	0.0279560	0.03579771	0.0343137	0.04328762	0.0281534
Change relative to the 2023 Submission Hg	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission Ni [kg]	32.62	12.64	14.7118	18.84057	18.0578	22.78269	14.8169
2024 Submission Ni [kg]	32.74	12.70	14.7137	18.84090	18.0598	22.78296	14.8176
Change relative to the 2023 Submission Ni	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%
2023 Submission Zn [kg]	282.7	109.6	127.502	163.2849	156.501	197.4500	128.4130
2024 Submission Zn [kg]	283.7	110.0	127.519	163.2878	156.518	197.4523	128.4192
Change relative to the 2023 Submission Zn	0.35%	0.42%	0.013%	0.0018%	0.011%	0.0012%	0.0049%

Recalculations for the 2023 Submission

There were two reasons for recalculations. First, the Pb EF for fireworks is now country specific, based on sample measurements, but was from the EMEP/EEA Guidebook in the last submission. Emissions of HCB were also added for the first time, based on sample measurements of fireworks in Iceland. Second, there were updates in import/export data from SI.

4.7.1.4 Planned Improvements

No improvements are currently planned for this subsector.

4.8 Other Industry Production (NRF 2H)

4.8.1 Food and Beverages Industry (NFR 2H2)

The only other industry production occurring in Iceland is the Food and Beverages Industry. The only pollutant emitted in this industry is NMVOC.

4.8.1.1 Activity Data

Production statistics for animal feed are available for 2005-2013. The statistics were linearly extrapolated for earlier and later years in the timeseries.

Production of bread, cakes/biscuits, meat, fish, poultry, coffee, beer, malt/pilsner, and spirits was estimated as follows. The total consumption within the country was estimated by using results of the survey *The Diet of Icelanders* (Embætti Landlæknis, 2022) (Embætti Landlæknis, 2011), (Embætti Landlæknis, 2002), (Embætti Landlæknis, 1990). The results give average consumption figures per person for the years 1990, 2002, 2011, and 2020. The consumption figures were interpolated for the years in between. The total consumption was calculated by using the population (or adult population in the case of coffee, beer/pilsner, and spirits). A waste factor of 33% was also used when produced amounts were calculated from consumption figures (FAO, 2011). In the case of bread, cakes/biscuits, meat, fish, and poultry, it is assumed that the total production in Iceland is for the domestic market. There is an export of fish and meat, but it is almost exclusively fresh or frozen and therefore not cooked in Iceland. In the case of coffee, beer/pilsner and spirits, the import and export statistics were available from Statistic Iceland. The net import (import minus export) was subtracted from the calculated consumption to estimate the domestic production.

There is no distinction made between industry and household emissions in these calculations. All NMVOC emission from bread and cake baking and fish/meat/poultry cooking is therefore estimated.

4.8.1.2 Emission Factors

Tier 2 emission factors for NMVOC were taken from chapter 2.H.2 Food and Beverages of the 2019 EMEP/EEA Guidebook (EEA, 2019) and are presented in Table 4.38.

Table 4.38 NMVOC emission factors for the production of various food and beverage products.

	NMVOC [kg/t produced]
Meat, fish, and poultry	0.30
Cakes, biscuits, and breakfast cereals	1.0
Beer and malt	0.035
Bread (European)	4.5
Coffee roasting	0.55
Animal feed	1.0

4.8.1.3 Recalculations and Improvements

Recalculations for the 2024 Submission

Recalculations were made for the 2024 submission due to updates in import/export data from SI (see Table 4.39).

Table 4.39 Recalculations of NMVOC in 2H Food and Beverages between submissions.

2H Food and Beverages Industry	2020	2021
2023 submission NMVOC [kt]	0.40235	0.51
2024 submission NMVOC [kt]	0.40207	0.48
Change relative to the 2023 submission NMVOC [%]	-0.072%	-5.6%

Recalculations for the 2023 Submission

There was recalculation for the years 2013-2020 due to updated activity data which is based on a new survey on food consumption.

4.8.1.4 Planned Improvements

No improvements are currently planned for this subsector.

5 Agriculture (NFR Sector 3)

5.1 Overview

Iceland is 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 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 barley, rapeseed and some other crops are grown on limited acreage.

The main pollutant emitted from the Agriculture sector is ammonia (NH_3) and the largest source is manure management. Almost all of Iceland's NH_3 emissions come from the Agriculture sector. Furthermore, one third of all NMVOC emissions come from this sector. This can be seen in Table 5.1 below.

Table 5.1 Contribution from the Agriculture sector to the national total for 2022.

	NH_3	NO_x	NMVOC	TSP	PM_{10}	$PM_{2.5}$
National Total [kt]	4.41	18.17	5.59	3.98	2.17	0.96
Agriculture Total [kt]	4.32	0.94	1.51	0.24	0.18	0.04
Agriculture Sector Share of Total	98%	5%	27%	6%	8%	4%

Emission estimates from the Agriculture sector include emission estimates from the following sources:

- Manure Management (NFR 3B)
- Crop Production and Agricultural Soils (NFR 3D)
- Agriculture Other Including Use of Pesticides (NFR 3Df and 3I)

Each of these sources are described in more detail in Sections 5.3 to 5.5.

Ammonia, nitric oxide, NMVOCs, and particulate matter emissions are estimated for Animal Husbandry and Manure Management (3B), as well as Crop Production and Agricultural Soils (3D).

Dioxin, PAH4, HCB, PCB and heavy metals emissions are not applicable, not occurring or not estimated.

Buffalos, mules, and asses are not farmed in Iceland and, therefore, these animal categories are not occurring (NO) in the Icelandic inventory. Field Burning of Agricultural Residues (3F) is also identified as not occurring (NO) in Iceland.

A summary of the categories included in the Agriculture sector by pollutant, including the Tier methodology used, is presented in Table 5.2.

Table 5.2 Overview table NECD gases and PM (NA – not available, NO – not occurring).

Sector		NECD Gases			PM		
		NO_x	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP
3B1a	Manure Management – Dairy cattle	T2	T2	T2	T2	T2	T2
3B1b	Manure Management – Non-dairy Cattle	T2	T2	T2	T2	T2	T2
3B2	Manure Management – Sheep	T2	T1	T2	T2	T2	T2
3B3	Manure Management – Swine	T2	T1	T2	T2	T2	T2
3B4a	Manure Management – Buffalo	NO	NO	NO	NO	NO	NO
3B4d	Manure Management – Goats	T2	T1	T2	T2	T2	T2
3B4e	Manure Management – Horses	T2	T1	T2	T2	T2	T2
3B4f	Manure Management – Mules and Asses	NO	NO	NO	NO	NO	NO
3B4gi	Manure Management – Laying Hens	T2	T1	T2	T2	T2	T2
3B4gii	Manure Management – Broilers	T2	T1	T2	T2	T2	T2
3B4giii	Manure Management – Turkeys	T2	T1	T2	T1	T1	T1
3B4giv	Manure Management – Other Poultry	T2	T1	T2	T1	T1	T1
3B4h	Manure Management – Other Animals (Fur Animals)	T2	T1	T2	T2	T2	T2
3Da1	Inorganic N-fertilisers (incl. Urea Application)	T1	NA	T2	NA	NA	NA
3Da2a	Animal Manure Applied to Soils	T1	NA	T2	NA	NA	NA
3Da2b	Sewage Sludge Applied to Soils	T1	NA	T1	NA	NA	NA
3Da2c	Other Organic Fertilisers Applied to Soils (incl. Compost)	T1	NA	T1	NA	NA	NA
3Da3	Urine and Dung Deposited by Grazing Animals	T1	NA	T2	NA	NA	NA
3Da4	Crop Residues Applied to Soils	NA	NA	NA	NA	NA	NA
3Db	Indirect Emissions from Managed Soils	NA	NA	NA	NA	NA	NA
3Dc	Farm-level Agricultural Operations incl. Storage, Handling, and Transport of Agricultural Products	NA	NA	NA	T2	T2	T2
3Dd	Off-farm Storage, Handling, and Transport of Bulk Agricultural Products	NA	NA	NA	NA	NA	NA
3De	Cultivated Crops	NA	T1	NA	NA	NA	NA
3Df	Use of Pesticides	NA	NA	NA	NA	NA	NA
3F	Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO

Table 5.3 shows which subsectors in Agriculture are key categories for which air pollutants. A key category is one that is prioritised within the national inventory system because it is significantly important for one or a number of air pollutants in a country's national inventory of air pollutants in terms of the absolute level, the trend, or the uncertainty in emissions (EEA, 2019). Categories whose cumulative percentage contribution is greater than 80% should be identified as key.

Table 5.3 Key categories for air pollutants within Agriculture.

NO_x, NH_3, NMVOC, and PM			
Sector	1990	2022	Trend
3B1a Manure Management – Dairy Cattle	NMVOC, NH_3	NMVOC, NH_3	NMVOC, NH_3
3B1b Manure Management – Non-dairy Cattle	NH_3	NMVOC, NH_3	NH_3
3B2 Manure Management – Sheep	NMVOC, NH_3	NH_3	NH_3
3B4e Manure Management – Horses	NMVOC	NMVOC	NMVOC
3B4gi Manure Management – Laying Hens			NH_3
3B4gii Manure Management – Broilers			NH_3
3B4h Manure Management – Other Animals			NH_3

NO_x, NH_3, NMVOC, and PM			
Sector	1990	2022	Trend
3Da1 Inorganic N-fertilisers (includes also urea application)			NH_3
3Da2a Animal Manure Applied to Soils	NH_3	NH_3	NH_3
3Da3 Urine and Dung Deposited by Grazing Animals	NH_3	NH_3	

5.2 General Methodology

The methodology is based on Chapters 3B and 3D of the 2013 and 2019 EMEP/EEA Guidebooks (EEA, 2013; EEA, 2019). All equations, as well as the majority of Emission Factors (EF) and other parameters, stem from the corresponding EMEP/EEA Guidebook chapters.

For estimating emissions of NH_3 and NO_x in 3B Manure Management, the N-flow approach is used as outlined in the 2019 EMEP/EEA Guidebook. This considers the flow of total ammoniacal N (TAN) through the manure management system. In the 2019 EMEP/EEA Guidebook, this flow is modelled by a series of equations that considers the amount of TAN and losses at all different stages of the manure management process. The set of equations provided by the 2019 EMEP/EEA Guidebook was applied to more disaggregated livestock categories than the NFR methodology demands, as can be seen in Table 5.4. The resulting emissions were then aggregated to the respective NFR categories.

NH_3 and NO_x emissions from grazing animals are part of this N flow approach and are, therefore, calculated in this context, although they are reported under Agricultural Soils (3D). Similarly, the manure that is available as organic fertiliser for application to land is determined from the N-flow approach and is used as an input term in estimating the NH_3 and NO_x. Activity data, emission factors and other parameters used in these calculations will be discussed in the following chapters.

5.3 Manure Management (NFR 3B)

5.3.1 Activity Data

Animal population numbers are directly retrieved from the livestock database (www.bustofn.is) of the Ministry of Food, Agriculture, and Fisheries (*Matvælaráðuneytið*) (MFAF) and annual average populations (AAP) are calculated according to the 2006 IPCC Guidelines. Since the data from the annual census of MFAF represents livestock populations at a certain point in time (in November) it does not reflect their seasonal changes, e.g., animals with a life spanning only one summer. Also, for some livestock categories, it does not include data on young animals, e.g., fattening pigs. Therefore, the number of animals not included in the census is estimated using information on fertility rates, number of offspring, number of animals slaughtered, etc. The inclusion of young animals leads to livestock populations being considerably higher for some categories than the ones published by the MFAF or by other public sources such as Statistics Iceland (*Hagstofa Íslands*) (SI)[7]. For the complete methodology of calculating the AAP and a

[7] https://hagstofa.is/talnaefni/atvinnuvegir/landbunadur/bufe-og-uppskera/

comparison with published livestock numbers please refer to Iceland's latest National Inventory Document on Greenhouse Gas Emissions (Environment Agency of Iceland, 2024).

Livestock data is available on a more disaggregated level than requested by the reporting requirements, as can be seen in Table 5.4. Therefore, the emissions are estimated on a more disaggregated level and then combined to the NFR categories.

Table 5.4 Livestock as reported in NFR tables and as calculated in the Icelandic inventory on a more disaggregated level.

NFR Code	Animal Category	Disaggregation in Icelandic Inventory
3B1a	Dairy Cattle	Mature Dairy Cattle
3B1b	Non-dairy Cattle	Other Mature Cattle; Pregnant Heifers; Steers and Non-inseminated Heifers; Calves
3B2	Sheep	Ewes; Rams; Animals for Replacement; Lambs
3B3	Swine	Sows; Piglets
3B4a	Buffalo	NO
3B4d	Goats	Goats
3B4e	Horses	Horses; Young horses; Foals
3B4f	Mules and Asses	NO
3B4gi	Laying Hens	Laying hens
3B4gii	Broilers	Pullets; Chickens
3B4giii	Turkeys	Turkeys
3B4giv	Other Poultry	Ducks; Geese
3B4h	Other (Fur Animals)	Turkeys

Table 5.5 shows the AAP of Icelandic livestock categories for selected years since 1990. The most prominent trends in the development of livestock populations since 1990 are a decrease in the dairy cattle and sheep populations and an increase in non-dairy, swine, and poultry populations.

Table 5.5 Annual average population of livestock according to NFR categorisation in Iceland.

NFR Code	Animal Category	1990	1995	2000	2005	2010	2015	2020	2021	2022
3B1a	Dairy Cattle	32,249	30,428	27,066	24,488	25,379	27,441	25,941	25,848	25,842
3B1b	Non-dairy Cattle	43,299	42,771	45,078	41,482	47,130	51,335	55,229	54,950	54,161
3B2	Sheep	858,008	718,544	730,177	713,419	753,120	752,515	635,894	613,224	586,475
3B3	Swine	29,768	30,746	32,242	39,350	38,032	42,542	39,253	38,381	38,435
3B4a	Buffalo	NO	NO	NO	NO	NO	NO	NO	NO	NO
3B4d	Goats	485	511	548	657	1,015	1,476	2,367	2,442	2,754
3B4e	Horses	73,867	80,246	75,630	76,629	78,849	79,392	73,397	70,522	70,066
3B4f	Mules and Asses	NO	NO	NO	NO	NO	NO	NO	NO	NO
3B4gi	Laying Hens	506,165	186,295	284,612	212,795	164,374	171,161	240,853	230,383	254,770
3B4gii	Broilers	149,103	150,688	210,468	433,237	423,187	490,669	548,121	553,337	571,489
3B4giii	Turkeys	3,534	3,044	10,908	8,146	9,148	11,810	12,406	11,414	13,460
3B4giv	Other Poultry	5,806	5,270	2,498	1,772	1,347	1,057	581	609	477
3B4h	Other (Fur Animals)	49,592	37,893	41,431	37,093	39,904	48,038	15,849	16,659	12,924

5.3.2 Emission Factors and Associated Parameters

NH_3 and NO Tier 2 emissions depend on the total amounts of nitrogen (N) and total ammoniacal nitrogen (TAN) in manure. Total N is calculated by multiplying livestock AAP with the nitrogen excretion (Nex) rate per animal. TAN is calculated by multiplying total N with livestock specific TAN fractions provided in the 2019 EMEP/EEA Guidebook. The Nex rate per livestock category is calculated using default values from the 2006 IPCC Guidelines (Volume 4, Chapter 10) that take animal weight, and therefore, the smaller size of Icelandic breeds into account. For most animal categories other than Cattle and Sheep, the animal parameters are not changing over the timeseries, and the Nex rate is, therefore, also constant. Cattle and Sheep subcategories have a variable Nex rate over the timeline, since they are calculated by the Tier 2 approach, and for Horses and Poultry the Nex rate has been calculated on a more disaggregated level and reported as a weighted average in relation to the population data. The calculation method for the Nex rate for Cattle and Sheep follows the Tier 2 methodology from the 2006 IPCC Guidelines by applying Equation 10.31, Equation 10.32[8], and Equation 10.33 for cattle and $N_{retention\_frac}$ of 0.10 from Table 10.20 for Sheep. Detailed calculations and explanations can be found in the newest edition of the National Inventory Document of Iceland.

Total N and TAN have to be allocated to either slurry or solid manure management. Fractions for slurry and solid manure management are country specific and identical to the ones used in Iceland's National Inventory Document. The same is valid for the fractions of the year spent inside versus outside. Two more parameters used in the calculation of TAN mass flow are the amount of straw used in animal housing and the amount of N contained in it (only for solid manure management). Calves are the only cattle subcategory whose manure is stored in solid storage. In 2022, the Icelandic Agricultural Advisory Centre (*Ráðgjafamiðstöð landbúnaðarins*) interviewed farmers on their use of straw for bedding for calves and came up with the estimate of 350 kg straw/animal/year for 2021, which is an increase from 47 kg/animal/year in 1990, when only 10% of calf manure was stored in solid storage. Straw amounts for sheep, goats, and horses are based on 2019 EMEP/EEA Guidebook default data (Table 3.7) of hay used per day, adjusted for the time periods animals stay inside. As an example, sheep have a default housing period of 30 days (Table 3.7 of the 2019 EMEP/EEA Guidebook) but in Iceland it is 200 days. So, the default straw value of 20 kg/yr is multiplied by 200/30 to obtain 133.3 kg/yr. The above-mentioned parameters are summarised in Table 5.6.

Table 5.6 Parameters used in the N-flow calculations, for the year 2022.

NFR Code	Animal Category	Nex [kg $head^{-1}$ yr^{-1}]	Prop. TAN (of N)	Fraction Slurry	Fraction Solid	Housing Period [days]	Straw [kg/yr]
3B1a	Dairy cattle	94	0.6	1	0	309	
3B1b	Non-dairy cattle	37	0.6	0.70	0.30	305	7,668,150
3B2	Sheep	10	0.5	0.35	0.65	200	31,935,787
3B3	Swine	8.8	0.7	1	0	365	
3B4d	Goats	20	0.5	0	1	200	367,154
3B4e	Horses	28	0.6	0	1	51	8,809,520
3B4gi	Laying hens	1.4	0.7	0.18	0.82	365	

[8] According to the 2019 refinements to the 2006 IPCC Guidelines, Eq. 10.32 is valid for Cattle, Sheep, and Goats.

NFR Code	Animal Category	Nex [kg head^{-1} yr^{-1}]	Prop. TAN (of N)	Fraction Slurry	Fraction Solid	Housing Period [days]	Straw [kg/yr]
3B4gii	Broilers	0.2	0.7	0	1	365	
3B4giii	Turkeys	1.4	0.7	0	1	365	
3B4giv	Other poultry	1.2	0.7	0	1	365	
3B4h	Other (fur animals)	4.6	0.6	0	1	365	

[1] Values for Non-dairy Cattle are weighted averages for the subcategories Other Mature Cattle, Pregnant Heifers, Steers and Non-inseminated Heifers, and Calves.
[2] Values for Sheep are weighted averages for the subcategories Ewes, Animals for Replacement, Rams, and Lambs. However, lambs are not taken into account for the housing period. Lambs only live 4.5 months in Iceland (over the summer) and spend all their days outside.

All manure is assumed to be stored before spreading. Emission factors for animal manure, either managed as slurry or solid manure during housing and storage, as well as EFs for manure spreading and manure deposited by grazing animals, are given as shares of TAN by livestock category in the 2019 EMEP/EEA Guidebook. In the absence of default values for sheep slurry, 2019 EMEP/EEA Guidebook default values for Cattle were used instead. The emissions factors are shown in Table 5.7.

Table 5.7 Emission factors for NH_3, NO, and N_2O used in the N-flow methodology. The EFs are a fraction of Total Ammoniacal Nitrogen (TAN).

NFR Code	Animal Category	MMS	EF NH_3-N Housing	EF NH_3-N Storage	EF NH_3-N Application	EF NO-N Storage	EF N_2O-N Storage
3B1a	Dairy Cattle	Slurry	0.24	0.25	0.55	0.0001	0.01
		Solid	0.08	0.32	0.68	0.01	0.02
3B1b	Non-dairy Cattle	Slurry	0.24	0.25	0.55	0.0001	0.01
		Solid	0.08	0.32	0.68	0.01	0.02
3B2	Sheep	Slurry[1]	0.24	0.25	0.55	0.0001	0.001
		Solid	0.22	0.32	0.9	0.01	0.02
3B3	Swine – Piglets	Slurry	0.27	0.11	0.4	0.0001	0
		Solid	0.23	0.29	0.45	0.01	0.01
3B3	Swine – Sows	Slurry	0.35	0.11	0.29	0.0001	0
		Solid	0.24	0.29	0.45	0.01	0.01
3B4d	Goats	Solid	0.22	0.28	0.9	0.01	0.02
3B4e	Horses	Solid	0.22	0.35	0.9	0.01	0.02
3B4gi	Laying Hens	Slurry	0.41	0.14	0.69	0.0001	0
		Solid	0.2	0.08	0.45	0.01	0.002
3B4gii	Broilers	Solid	0.21	0.3	0.38	0.01	0.002
3B4giii	Turkeys	Solid	0.35	0.24	0.54	0.01	0.002
3B4giv	Other Poultry	Solid	0.24	0.24	0.54	0.01	0.002
3B4h	Other (Fur Animals)	Solid	0.27	0.09	NA[2]	0.01	0.002

[1] No EFs exist for NH_3 emissions from slurry for Sheep in the 2019 EMEP/EEA Guidebook. Hence, the EFs for Cattle are applied.
[2] The emission factor is Not Applicable in the 2019 EMEP/EEA Guidebook and Iceland does not have a country-specific emission factor.

NMVOC emissions are calculated using methodology from the 2019 EMEP/EEA Guidebook. Tier 2 methodology is used for dairy cattle and non-dairy cattle, but Tier 1 methodology for other animal categories, applying the default emission factors from Table 3.4, shown here in Table 5.8. When default emission factors with silage feeding are available, these are used.

Table 5.8 Emission factors used for calculating NMVOC emissions.

NFR code	Animal Category	EF NMVOC [kg AAP^{-1} a^{-1}]
3B1a	Dairy cattle	16.8[1]
3B1b	Non-dairy cattle	3.67[1]
3B2	Sheep	0.28
3B3	Swine - Fattening pigs	0.55
3B3	Swine - Sows	1.70
3B4d	Goats	0.62
3B4e	Horses	7.78
3B4gi	Laying hens	0.17
3B4gii	Broilers	0.11
3B4giii	Turkeys	0.49
3B4giv	Other poultry (ducks, geese)	0.49
3B4h	Other animals (fur animals)	1.94
3B4h	Other animals (rabbits)	0.059

[1] Implicit emission factor, since Tier 2 methodology used for Cattle.

Tier 2 calculations of particulate matter emissions are based on information on the amount of time livestock spends in housing and the fractions of manure either managed as slurry or as solid manure (seeTable 5.6 above). The applied emission factors are reported in Table 5.9 and derive from the 2019 EMEP/EEA Guidebook and from the 2013 EMEP/EEA Guidebook. In the case of Turkeys, Ducks, and Geese, the Tier 1 emission factors are applied.

Table 5.9 Emission factors used for calculating particulate emissions, Tier 2.

NFR Code	Animal Category	MMS	EF TSP [kg AAP^{-1} a^{-1}]	EF PM_{10} [kg AAP^{-1} a^{-1}]	EF $PM_{2.5}$ [kg AAP^{-1} a^{-1}]	Source
3B1a	Dairy Cattle	Slurry Solid	1.81 0.94	0.83 0.43	0. 54 0.28	Table A1.7 2019 EMEP/EEA Guidebook
3B1b	Non-dairy Cattle[1]	Slurry Solid	0.69 0.52	0.32 0.24	0.21 0.16	Table A1.7 2019 EMEP/EEA Guidebook
3B1b	Calves[1]	Slurry Solid	0.34 0.35	0.15 0.16	0.1 0.1	Table A1.7 2019 EMEP/EEA Guidebook
3B2	Sheep	Slurry Solid	--- 0.14	--- 0.056	--- 0.017	Table A1.7 2019 EMEP/EEA Guidebook
3B3	Swine – Piglets	Slurry Solid	0.7 0.83	0.31 0.37	0.06 0.07	Table A3-4 2013 EMEP/EEA Guidebook
3B3	Swine – Sows	Slurry Solid	1.36 1.77	0.61 0.8	0.11 0.14	Table A3-4 2013 EMEP/EEA Guidebook
3B4d	Goats	Solid	0.139	0.056	0.017	Table A1.7 2019 EMEP/EEA Guidebook
3B4e	Horses	Solid	0.48	0.22	0.14	Table A1.7 2019 EMEP/EEA Guidebook
3B4gi	Laying Hens	Slurry Solid	0.025 0.119	0.025 0.119	0.003 0.023	Table A3-4 2013 EMEP/EEA Guidebook
3B4gii	Broilers	Solid	0.069	0.069	0.009	Table A3-4 2013 EMEP/EEA Guidebook
3B4giii	Turkeys	Solid	0.52	0.52	0.07	Table 3.3 2013 EMEP/EEA Guidebook
3B4giv	Other Poultry (Ducks)	Solid	0.14	0.14	0.018	Table A1.7 2019 EMEP/EEA Guidebook
3B4giv	Other Poultry (Geese)	Solid	0.24	0.24	0.032	Table A1.7 2019 EMEP/EEA Guidebook
3B4h	Other (Fur Animals)	Solid	0.018	0.0081	0.0042	Table A1.7 2019 EMEP/EEA Guidebook

[1] Non-dairy Cattle and Calves are calculated separately and subsequently aggregated in the category 3B1b Non-Dairy Cattle.

5.3.3 Recalculations and Improvements

5.3.3.1 Recalculations for the 2024 submission

For the 2024 submission, the NMVOC emissions methodology for Cattle was moved up a tier and is now Tier 2. The effects can be seen in Table 5.10 and Table 5.11.

For this submission, the manure management allocations for laying hens were also updated, affecting the whole timeline, shown in Table 5.13.

Other changes with smaller impacts are the reporting of NMVOC emissions from rabbits with other fur animals, Table 5.12, small livestock number corrections for the years 2020-2021, and a corrected pregnancy ratio for non-dairy cattle, Table 5.10.

Table 5.10 Recalculations in 3B1a Dairy Cattle, 3B1b Non-dairy Cattle, 3B2 Sheep and 3B4e Horses for NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, and TSP due to updated livestock numbers in 2020 and 2021, and updated pregnancy ratio for non-dairy cattle, affecting the whole timeline.

3B1a, 3B1b, 3B2 and 3B4e	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NO_x [kt]	0.02053	0.01821	0.01997	0.02010	0.02260	0.02163	0.01839	0.01833
2024 submission NO_x [kt]	0.02053	0.01822	0.01997	0.02010	0.02260	0.02164	0.01840	0.01836
Change relative to 2023 submission NO_x	0.0023%	0.0074%	0.0019%	0.0002%	-0.012%	0.0035%	0.047%	0.15%
2023 submission NMVOC [kt]	1.77	1.75	1.68	1.60	1.70	1.78	1.70	1.67
2024 submission NMVOC [kt]	1.42	1.43	1.36	1.32	1.41	1.46	1.39	1.36
Change relative to 2023 submission NMVOC	-19.4%	-18.6%	-19.0%	-17.5%	-17.2%	-17.8%	-18.7%	-18.6%
2023 submission NH_3 [kt]	1.986	1.841	1.813	1.706	1.817	1.849	1.706	1.703
2024 submission NH_3 [kt]	1.987	1.843	1.814	1.707	1.818	1.851	1.709	1.708
Change relative to 2023 submission NH_3	0.049%	0.15%	0.075%	0.084%	0.075%	0.080%	0.20%	0.31%
2023 submission $PM_{2.5}$ [kt]	No recalculation						0.02046	0.02019
2024 submission $PM_{2.5}$ [kt]							0.02049	0.02024
Change relative to 2023 submission $PM_{2.5}$							0.14%	0.26%
2023 submission PM_{10} [kt]	No recalculation						0.035	0.035
2024 submission PM_{10} [kt]							0.035	0.035
Change relative to 2023 submission PM_{10}							0.13%	0.24%
2023 submission TSP [kt]	No recalculation						0.0801	0.0787
2024 submission TSP [kt]							0.0802	0.0789
Change relative to 2023 submission TSP							0.12%	0.24%

Table 5.11 Recalculations in 3B1a Dairy cattle and 3B1b Non-dairy cattle for NMVOC due to a tier upgrade for cattle and corrected pregnancy ratio for growing cattle, affecting the whole timeline.

3B1a + 3B1b	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NMVOC [kt]	0.95	0.93	0.89	0.81	0.87	0.95	0.96	0.95
2024 submission NMVOC [kt]	0.35	0.37	0.36	0.32	0.37	0.39	0.41	0.40
Change relative to 2023 submission NMVOC	-63%	-60%	-59%	-61%	-57%	-59%	-57%	-57%

Table 5.12 Recalculations in 3B4h Other (fur animals) for NMVOC due to emissions from rabbits being included with other fur animals, as done for other pollutants, affecting the whole timeline.

3B4h	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NMVOC [kt]	0.09274	0.07339	0.07905	0.07147	0.07713	0.09258	0.03061	0.03220
2024 submission NMVOC [kt]	0.09284	0.07339	0.07909	0.07149	0.07714	0.09260	0.03061	0.03220
Change relative to 2023 submission NMVOC	0.12%	0.01%	0.05%	0.02%	0.01%	0.02%	0.02%	0.01%

Table 5.13 Recalculations in 3B4gi Laying hens for NO_x, NH_3, $PM_{2.5}$, PM_{10}, and TSP due to updated manure management allocations, affecting the whole timeline.

3B4gi	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NO_x [kt]	0.0131	0.0048	0.0073	0.0055	0.0042	0.0044	0.0062	0.0059
2024 submission NO_x [kt]	0.0008	0.0004	0.0008	0.0007	0.0010	0.0020	0.0045	0.0046
Change relative to 2023 submission NO_x	-94%	-92%	-89%	-87%	-77%	-54%	-28%	-23%
2023 submission NH_3 [kt]	0.159	0.059	0.090	0.067	0.052	0.054	0.076	0.072
2024 submission NH_3 [kt]	0.294	0.107	0.161	0.119	0.087	0.080	0.095	0.087
Change relative to 2023 submission NH_3	84%	82%	80%	78%	69%	48%	25%	21%
2023 submission $PM_{2.5}$ [kt]	0.0116	0.0043	0.0065	0.0049	0.0038	0.0039	0.0055	0.0053
2024 submission $PM_{2.5}$ [kt]	0.0020	0.0008	0.0014	0.0012	0.0012	0.0021	0.0042	0.0042
Change relative to 2023 submission $PM_{2.5}$	-83%	-80%	-78%	-76%	-67%	-47%	-25%	-20%
2023 submission PM_{10} [kt]	0.060	0.022	0.034	0.025	0.020	0.020	0.029	0.027
2024 submission PM_{10} [kt]	0.015	0.006	0.010	0.008	0.008	0.012	0.022	0.022
Change relative to 2023 submission PM_{10}	-75%	-73%	-71%	-69%	-61%	-43%	-22%	-18%
2023 submission TSP [kt]	0.060	0.022	0.034	0.025	0.020	0.020	0.029	0.027
2024 submission TSP [kt]	0.015	0.006	0.010	0.008	0.008	0.012	0.022	0.022
Change relative to 2023 submission TSP	-75%	-73%	-71%	-69%	-61%	-43%	-22%	-18%

5.3.3.2 Recalculations for the 2023 Submission

Livestock numbers for cattle, sheep, horses, and poultry were updated before the 2023 Submission, as well as a number of other livestock parameters for Cattle and Sheep. This change affected the reported NOx, NMVOC, NH3, PM2.5, PM10, and TSP emissions, over the whole timeline.

5.3.4 Planned Improvements

As suggested by the 2020 Step 3 review, it is planned to change from Tier 1 to Tier 2 calculations for NMVOC emissions. NMVOC emissions methodology for Cattle was moved up a tier and is now Tier 2, but other animal categories still use Tier 1 methodology. As a first step, a detailed investigation will be made about which data are easily available in

Iceland and which data needs to be collected specifically for this task. Furthermore, it is planned to update to the 2023 EMEP/EEA Guidebook.

5.4 Crop Production and Agricultural Soils (NFR 3D)

5.4.1 Activity Data

Activity data for NH_3 and NO emissions consists of the amount of fertiliser nitrogen applied to agricultural soils (Table 5.14). For NH_3 this amount is divided into type of fertiliser N. The total amount of N in fertiliser, which is imported annually, is obtained from SI[9]. No official data exists that provides information on the types of N fertilisers imported. However, an expert on fertilisers at the Icelandic Food and Veterinary Authority (*Matvælastofnun*) (IFVA) has helped provide a rudimentary split into ammonium nitrate, calcium ammonium nitrate, urea, and other N fertilisers. The fraction of each type varies over the timeline, as shown in Table 5.14. The fertiliser type data is still incomplete and will be improved for future submissions.

Table 5.14 Total amount of synthetic N fertilisers applied to Agricultural Soils.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
N applied in inorganic N fertiliser [kt N]	12.5	11.2	12.7	9.8	10.9	11.6	11.4	12.2	11.2
Ammonium nitrate [%]	67%	0%	0%	0%	0%	7.2%	16%	24%	17%
Calcium ammonium nitrate [%]	0%	67%	67%	67%	41%	32%	43%	38%	22%
Urea [%]	0%	0%	0%	0%	0%	0.0%	6.2%	4.5%	5.3%
Other NK and NPK [%]	33%	33%	33%	33%	59%	61%	34%	33%	56%

Other organic fertilisers in the form of bone meal and compost are also included in the inventory. According to the Soil Conservation Service of Iceland (*Landgræðslan*) (SCSI) organic fertilisers have been applied on a small scale since 2009, especially for land reclamation purposes. Even though their use is still small compared to other fertilisers, they are still taken into account for the calculation of NH_3 and NO_x emissions from agricultural soils.

Activity data for PM and NMVOC emissions consists of the areas of crops cultivated, as can be seen in Table 5.15. The total amount of cropland is recorded in the Icelandic Geographic Land-use Database (IGLUD), which is maintained by the SCSI. Data regarding the area of barley fields was exported from the FAO database[10] for the time series available (2015-2022) and gap filled using the ratio between the annual areas harvested with the crop field for known years. A more detailed explanation is provided in the most recent National Inventory Document (Environment Agency of Iceland, 2024). The area of grass fields is calculated by subtracting the area of barley fields from the total cropland area. Barley fields are cultivated and harvested once a year and the produce is cleaned and dried. Grass fields are cultivated about once every 10 years and hay is cut twice per year on average (Brynjólfsson, written communication). The total area of active cropland is used to estimate the NMVOC emissions.

[9] https://hagstofa.is/talnaefni/atvinnuvegir/landbunadur/aburdur/

[10] The data can be retrieved from the FAO database (FAO.org/faostat/en/#data) under „Production“ and „Crops and livestock products“.

Table 5.15 Areas of cropland in Iceland, distinguished by barley cultivation and grassland for haymaking.

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Area Barley Cultivation [ha]	0	145	911	2,926	3,945	1,455	1,500	2,400	2,814
Area Grass Cultivation [ha]	122,602	116,595	110,793	105,620	103,691	106,069	105,925	105,005	104,590

5.4.2 Emission Factors

NH_3 emission factors were taken from Table 3.2 in the 2019 EMEP/EEA Guidebook. These emission factors depend on the mean spring air temperature, i.e., the mean temperature of the three-month period following the day when accumulated day degrees since the 1st of January have reached 400°C. According to this definition, the mean spring temperature in Iceland is about 9°C, therefore the emission factors for cool climate and normal pH are applied as can be seen in Table 5.16

Table 5.16 Emission factors for NH_3 emissions from inorganic fertilisers for a cool climate and normal pH used in Iceland.

	EF [g NH_3/ kg N applied]
Ammonium sulphate	90
Ammonium nitrate	15
Calcium ammonium nitrate	8
Anhydrous ammonia	19
Urea	155
Ammonium phosphates	50
Other NK and NPK[1]	33

[1] Average between NK mixtures and NPK mixtures.

The emission factors for NO, NMVOC, and NH_3 are taken from the 2019 EMEP/EEA Guidebook and are reported in Table 5.17 with the respective sources and NFR codes. The biggest contributor to the Tier 1 emission factor for NMVOC is grass at 25°C, which is not relevant for Iceland, where the average temperature during the summer is 10°C. Grass for hay making is, however, the greatest source of NMVOC emissions in Iceland and hence the EF for NMVOC emissions from grass at 15°C is used.

Table 5.17 Emission factors for NO, NMVOC, and NH_3 in NFR category 3D.

Category	NFR Code	EF	Unit	Source
NH3 from sewage sludge	3Da2b	0.13	kg NH_3 (kg N applied)$^{-1}$	Annex 1 2019 EMEP GB
NH3 from other organic fertilisers	3Da2c	0.08	kg NH_3 (kg N applied)$^{-1}$	Table 3.1 2019 EMEP GB
NO from N applied in fertiliser, manure, and excreta	3Da1, 3Da2a, 3Da3	0.04	kg NO_2 (kg fertilizer and manure N applied)$^{-1}$	Table 3.1 2019 EMEP GB
NO from sewage sludge	3Da2b	0.04	kg NO_2 (kg sewage sludge)$^{-1}$	Annex 2 A2.3 2019 EMEP GB
NO from other organic fertilisers	3Da2c	0.04	kg NO_2 (kg organic waste)$^{-1}$	Table 3.1 2019 EMEP GB
NMVOC from standing crops	3De	0.1	kg ha^{-1}	Table 3.3 2019 EMEP GB[1]

[1] The biggest contributor to the Tier 1 emissions factor for NMVOC is grass at 25°C, which is not relevant for Iceland, where the average temperature during the summer is 10°C. Grass for hay making is, however, the greatest source of NMVOC emissions in Iceland and hence the EF for NMVOC emissions from grass at 15°C is used.

PM_{10} and $PM_{2.5}$ emission factors for barley and grass were taken from Tables 3.5 and 3.7 of the 2019 EMEP/EEA Guidebook and are reported in Table 5.18.

Table 5.18 Emission factors for PM_{10} and $PM_{2.5}$ for agricultural crop operations in wet climate conditions, in kg ha^{-1}, from the 2019 EMEP/EEA Guidebook.

Air Pollutant	Crop	Soil Cultivation	Harvesting	Cleaning	Drying
PM_{10} [kg/ha]	Barley	0.25	2.3	0.16	0.43
PM_{10} [kg/ha]	Grass	0.25	0.25	0	0
$PM_{2.5}$ [kg/ha]	Barley	0.015	0.016	0.008	0.129
$PM_{2.5}$ [kg/ha]	Grass	0.015	0.01	0	0

5.4.3 Recalculations and Improvements

5.4.3.1 Recalculations for the 2024 submission

Multiple updates were done for the 2024 submission, affecting the emissions from Crop Production and Agricultural Soils. They are:

- The fraction between N fertiliser types were updated for ammonium nitrate, urea, CAN and other NPK fertilisers, affecting NH_3 emissions from 3Da1 Inorganic N-fertilisers. The recalculations are shown in Table 5.19.
- Updated livestock numbers for Cattle, Sheep, and Horses, as well as updated livestock parameters for Non-dairy cattle. These updates affect NO_x and NH_3 emissions from 3Da2a Livestock Manure Applied to Soils and 3Da3 Urine and Dung Deposited by Grazing Livestock, over the whole timeline, as shown in Table 5.20.
- Updated nitrogen amount in sewage sludge used as fertiliser affected NO_x and NH_3 emissions from 3Da2b Sewage sludge applied to soils, as shown in Table 5.21.
- 3Da2c Other organic fertilisers applied to soils were updated due to updated activity data on bone meal, which led to recalculation of NO_x and NH_3 emissions. The recalculations are shown in Table 5.22.
- Updated cropland area, affecting PM2.5, PM10 and TSP emissions in 2021. The recalculations are shown in Table 5.23.

Table 5.19 Recalculations in 3Da1 Inorganic N-fertilisers for NH3 emissions, due to updated activity data.

3Da2a + 3Da3	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NO_x [kt]	0.26	0.18	0.20	0.16	0.18	0.21	0.30	0.31
2024 submission NO_x [kt]	0.26	0.18	0.20	0.16	0.24	0.27	0.30	0.30
Change relative to 2023 submission NO_x	0.0%	0.0%	0.0%	0.0%	34.7%	30.5%	0.1%	-3.1%

Table 5.20 Recalculations in 3Da2a Livestock Manure Applied to Soils and 3Da3 Urine and Dung Deposited by Grazing Livestock for NO_x and NH_3 emissions.

3Da2a + 3Da3	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NO_x [kt]	0.51	0.45	0.46	0.44	0.46	0.47	0.43	0.43
2024 submission NO_x [kt]	0.57	0.51	0.51	0.50	0.52	0.53	0.47	0.46
Change relative to 2023 submission NO_x	10.2%	13.3%	11.7%	13.8%	13.3%	11.6%	8.8%	9.1%
2023 submission NH_3 [kt]	2.25	2.14	2.13	2.05	2.12	2.17	2.02	2.00
2024 submission NH_3 [kt]	2.41	2.18	2.18	2.09	2.15	2.19	2.04	2.02
Change relative to 2022 submission NH_3	7.2%	1.6%	2.3%	1.7%	1.2%	0.9%	0.8%	0.7%

Table 5.21 Recalculations in 3Da2b Sewage sludge applied to soils for NO_x and NH_3 emissions, due to updated nitrogen amount in sewage sludge used as fertiliser.

3Da2b	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NO_x [kt]	NO	NO	NO	NO	NO	0.00	0.00	0.00
2024 submission NO_x [kt]	NO	NO	NO	NO	NO	0.00	0.00	0.00
Change relative to 2023 submission NO_x	-	-	-	-	-	108.8%	108.8%	108.8%
2023 submission NH_3 [kt]	NO	NO	NO	NO	NO	0.00	0.00	0.00
2024 submission NH_3 [kt]	NO	NO	NO	NO	NO	0.00	0.00	0.00
Change relative to 2023 submission NH_3	-	-	-	-	-	108.8%	108.8%	108.8%

Table 5.22 Recalculations in 3Da2c Other organic fertilizers applied to soils for NO_x and NH_3 emissions, due to updated activity data on bone meal.

3Da2b	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission NO_x [kt]	NO	NO	NO	NO	0.00	0.01	0.01	0.01
2024 submission NO_x [kt]	NO	NO	NO	NO	0.00	0.01	0.01	0.01
Change relative to 2023 submission NO_x	-	-	-	-	0.0%	7.2%	9.4%	25.6%
2023 submission NH_3 [kt]	NO	NO	NO	NO	0.01	0.01	0.01	0.01
2024 submission NH_3 [kt]	NO	NO	NO	NO	0.01	0.01	0.02	0.02
Change relative to 2023 submission NH_3	-	-	-	-	0.0%	7.2%	9.4%	25.6%

Table 5.23 Recalculations in 3Dc Cropland for $PM_{2.5}$, PM_{10} and TSP due to updated cropland area in 2021.

3Dc	2021
2023 submission $PM_{2.5}$ [kt]	0.0026
2024 submission $PM_{2.5}$ [kt]	0.0027
Change relative to 2023 submission $PM_{2.5}$	1.0%
2023 submission PM_{10} [kt]	0.0619
2024 submission PM_{10} [kt]	0.0624
Change relative to 2023 submission PM_{10}	0.78%
2023 submission TSP [kt]	0.0619
2024 submission TSP [kt]	0.0624
Change relative to 2023 submission TSP	0.78%

5.4.3.2 Recalculations for the 2023 Submission

Three updates were done for the 2023 Submission affecting the emissions from Crop Production and Agricultural Soils. They were:

- Updated livestock numbers for Cattle, Sheep, Horses, and Poultry, as well as updated livestock parameters for Cattle and Sheep. These updates affected NO_x and NH_3 emissions from 3Da2a Livestock Manure Applied to Soils and 3Da3 Urine and Dung Deposited by Grazing Livestock, over the whole timeline.
- Fertiliser activity data was updated for Urea and CAN, along with the split into N fertiliser type over the whole timeline. Affecting NH_3 emissions from 3Da1 Inorganic N-fertilisers.
- The cropland area was updated, affecting PM and NMVOC emissions from 3D Crop Production and Agricultural Soils over the whole timeline. The methodology for calculating NMVOC emissions was changed from the 2009 EMEP/EEA Guidebook, where the emissions are calculated based on fertiliser use, to the method listed in the 2019 EMEP/EEA Guidebook, where the NMVOC emissions are calculated the same way as PM emissions, i.e., based on land area cultivated.

5.4.4 Planned Improvements

For future submissions, improvements are planned for the registration of different inorganic N fertiliser types in Iceland's inventor. Furthermore, it is planned to update to the 2023 EMEP/EEA Guidebook.

5.5 Other Agriculture Including Use of Pesticides (NFR 3Df and 3I)

The POP-protocol focuses on a list of 16 substances, 11 of which are pesticides. A number of pesticides, however, had already been banned in Iceland in 1996 in order to conform to EU legislation (Iceland is part of the European Economic Area). The only pesticide of the ones listed in Chapter 3Df of the EMEP/EEA Guidebook not banned until 2009 is lindane, a gamma-Hexachlorocyclohexane (HCH). The last recorded sale of lindane took place in 1992 when 1 kg was sold. In 1990 and 1991, 2 and 16.2 kg were sold, respectively. It is assumed that the lindane sold was applied during the same year. An EF of 0.5 kg/kg, as listed in Table 3.1 in Chapter 3Df in the 2013 EMEP/EEA Guidebook, was applied to these values resulting in HCH emissions of 1, 8, and 0.5 kg for the years 1990-1992. HCH is no longer included in the reporting obligations which explains the use of an emission factor from the 2013 EMEP/EEA Guidebook. Table 5.24 gives an overview of the use of pesticides in Iceland.

Table 5.24 Pesticide use and regulation in Iceland.

Pesticide	Last Recorded Use	Year of Ban
Aldrin	1975	1996
Chlordane	No recorded use	1996
DDT	1975	1996
Dieldrin	No recorded use	1996
Endrin	No recorded use	1996
Heptachlor	1975	1996
Hexachlorobenzene (HCB)	No recorded use	1996
Mirex	No recorded use	1998
Toxaphene	No recorded use	1998
Pentachlorophenol (PCP)	No recorded use	1998
Lindane	1992	2009

6 Waste (NRF Sector 5)

6.1 Overview

During most of the 20th century, solid waste disposal sites (SWDs) in Iceland were numerous, small, and located close to the locations of waste generation so that the waste did not have to be transported far for disposal. In 1967, the waste disposal site in Gufunes started operating and most of the waste from the capital was landfilled there. Prior to that year, the waste from the capital area was landfilled in smaller SWDs.

Until the 1970s, the most common form of waste management outside of 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 dumping it into the sea. Akureyri and Selfoss, two of the biggest communities 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 t of waste annually. They operated at low or varying temperatures and the energy produced was not recovered. Waste incineration in Iceland as such started in 1993 with the opening of an incineration plant in Vestmannaeyjar, an archipelago to the south of Iceland with a population of over 4,000. In 2004, the incineration plant *Kalka*, located at the southwest part of Iceland, opened; this facility is currently the only operational waste incineration plant in Iceland. Open burning of waste was banned in 1999. The last place to burn waste openly was the island of Grímsey to the north of Iceland, which stopped doing so by the end of 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 about the waste composition of landfilled waste since 1999. For the last few years, the waste sector has had to report data about amounts and kinds of waste landfilled, incinerated, and recycled.

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 as an 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 points. Hazardous substances collected included 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 (*Úrvinnslusjóður*) in late 2002.

Clinical waste has been incinerated in incinerators either at hospitals or at waste incineration plants.

The trend in waste management practices has been toward managed SWDs as municipalities have increasingly cooperated with each other on running waste collection schemes and operating joint landfill sites. This development has resulted in larger SWDs and enabled the shutdown of a number of small sites. Currently a large majority of landfilled waste is being 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 increased since then.

Summaries of the categories included in the Waste sector by pollutants, including the Tier methodologies used, are presented in Table 6.1,

Table 6.2, and Table 6.3.

Table 6.1 Overview table NECD gases, PM, and CO (NA – not available, NE – not estimated, NO – not occurring, IE – included elsewhere).

Sector		NECD gases				PM			BC	CO
		NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP		
5A	Solid Waste Disposal on Land	NA	T1	NA	NA	T1	T1	T1	NA	NA
5B1	Composting	NA	NA	NA	T2	NA	NA	NA	NA	T2
5B2a	Anaerobic Digestion – MSW	NA	NA	NA	NE	NA	NA	NA	NA	NA
5B2b	Anaerobic Digestion – Other	NO	NO	NA	NO	NA	NA	NA	NA	NO
5C1a	MSW Incineration – *Kalka*	T1	T1	T1	T1	T1	T1	T1	T1	T1
5C1a	MSW Incineration – Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
5C1bi	Industrial Waste Incineration	IE[1]	T1	IE[1]	NA	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]
5C1bii	Hazardous Waste Incineration	IE[1]	T1	IE[1]	NA	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]
5C1biii	Clinical Waste Incineration	IE[1]	T2	IE[1]	NA	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]
5C1biv	Sewage Sludge Incineration	IE[1]	NO	IE[1]	NO	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]
5C1bv	Cremation	T1	T1	T1	T1	T1	T1	T1	NA	T1
5C1bvi	Other Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO
5C2	Open Burning	T1	T1	T1	T1	T1	T1	T1	T1	T1
5D1	Domestic Wastewater Handling	NA	NE	NA	NA	NA	NA	NA	NA	NA
5D2	Industrial Wastewater Handling	NA	NE	NA	NA	NA	NA	NA	NA	NA
5D3	Other Wastewater Handling	NA	NE	NA	NA	NA	NA	NA	NA	NA
5E	Other Waste	T2	T2	T2	NA	T2	T2	T2	NA	T2

[1] Included in 5C1a.

Table 6.2 Overview table POPs (NA – not available, NO – not occurring).

Sector		POPs			
		Dioxin	PAH	HCB	PCB
5A	Solid Waste Disposal on Land	NA	NA	NA	NA
5B1	Composting	NA	NA	NA	NA
5B2a	Anaerobic Digestion – MSW	NA	NA	NA	NA
5B2b	Anaerobic Digestion – Other	NA	NA	NA	NA
5C1a	MSW Incineration – *Kalka*	T1	T1	T1	T1
5C1a	MSW Incineration – Other	NO	NO	NO	NO
5C1bi	Industrial Waste Incineration	T1	T1	T1	NA
5C1bii	Hazardous Waste Incineration	T1	T1	T1	NA
5C1biii	Clinical Waste Incineration	T2	T2	T2	T2
5C1biv	Sewage Sludge Incineration	T1	T1	T1	NA

Sector		POPs			
		Dioxin	PAH	HCB	PCB
5C1bv	Cremation	T1	T1	T1	T1
5C1bvi	Other Waste Incineration	NO	NO	NO	NO
5C2	Open Burning	T1	T1	T1	T1
5D1	Domestic Wastewater Handling	NA	NA	NA	NA
5D2	Industrial Wastewater Handling	NA	NA	NA	NA
5D3	Other Wastewater Handling	NA	NA	NA	NA
5E	Other Waste	T2	T2	NA	NA

Table 6.3 Overview table heavy metals (NA – not available, NO – not occurring).

Sector		Heavy Metals								
		Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
5A	Solid Waste Disposal on Land	NA	NA	NA	NA	NA	NA	NA	NA	NA
5B1	Composting	NA	NA	NA	NA	NA	NA	NA	NA	NA
5B2a	Anaerobic Digestion – MSW	NA	NA	NA	NA	NA	NA	NA	NA	NA
5B2b	Anaerobic Digestion – Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
5C1a	MSW Incineration – *Kalka*	T1	T1	T1	T1	T1	T1	T1	T1	T1
5C1a	MSW Incineration – Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
5C1bi	Industrial Waste Incineration	T1	T1	T1	T1	NA	NA	T1	NA	NA
5C1bii	Hazardous Waste Incineration	T1	T1	T1	T1	NA	NA	T1	NA	NA
5C1biii	Clinical Waste Incineration	NO	T2	T2	T2	T2	T2	T2	NA	NA
5C1biv	Sewage Sludge Incineration	T1	T1	T1	T1	NA	NA	T1	NA	NA
5C1bv	Cremation	T1	T1	T1	T1	T1	T1	T1	T1	T1
5C1bvi	Other Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO
5C2	Open Burning	T1	T1	T1	T1	T1	T1	T1	T1	T1
5D1	Domestic Wastewater Handling	NA	NA	NA	NA	NA	NA	NA	NA	NA
5D2	Industrial Wastewater Handling	NA	NA	NA	NA	NA	NA	NA	NA	NA
5D3	Other Wastewater Handling	NA	NA	NA	NA	NA	NA	NA	NA	NA
5E	Other Waste	T2	T2	T2	T2	T2	T2	T2	NA	T2

Each of these sources is described in more detail in Sections 6.3 to 6.8. Emission estimates for Waste Incineration without Energy Recovery are included in this section, while emission estimates for Waste Incineration with Energy Recovery are reported under Sector 1A Energy.

Table 6.4 shows which subsectors in Waste are key categories for which air pollutants. A key category is one that is prioritised within the national inventory system because it is significantly important for one or a number of air pollutants in a country's national inventory of air pollutants in terms of the absolute level, the trend, or the uncertainty in emissions (EEA, 2019). Categories whose cumulative percentage contribution is greater than 80% should be identified as key.

Table 6.4 Key categories for air pollutants within Waste.

SOx, NOx, NH3, NMVOC, PM, BC, and CO			
	1990	**2022**	**Trend**
5A Solid Waste Disposal on Land	NMVOC	NMVOC	
5C2 Open Burning of Waste	$PM_{2.5}$, PM_{10}, BC		$PM_{2.5}$, PM_{10}, TSP, BC
Persistent Organic Pollutants (POPs)			
	1990	**2022**	**Trend**
5C1biii Clinical Waste Incineration		PCDD/F, HCB, PCB	PCDD/F, HCB, PCB
5C2 Open Burning of Waste	PCDD/F, PAH4, HCB, PCB	PCDD/F, PAH4	PCDD/F, PAH4, HCB, PCB
5E Accidental Fires		PCDD/F	
Heavy Metals (HMs)			
	1990	**2022**	**Trend**
5C1biii Clinical Waste Incineration		Hg	
5C1bv Cremation		Hg	Hg
5C2 Open Burning of Waste	Cd, Hg, As, Se, Zn		Cd, Hg, As, Se, Zn
5E Accidental Fires	Pb, Zn		

6.2 General Methodology

The methodology is mainly based on the 2019 EMEP/EEA air pollutant emission inventory guidebook (EEA, 2019) and the 2023 EMEP/EEA air pollutant emission inventory guidebook (EEA, 2023). Emissions estimates are calculated by multiplying relevant activity data by source with pollutant specific emissions factors. Emission factors are taken from the 2019 Emissions Inventory Guidebook (EEA, 2019), the 2023 Emissions Inventory Guidebook (EEA, 2023), the Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases (UNEP, 2005), Annual Danish Informative Inventory Report to the UNECE (Nielsen, et al., Annual Danish Informative Inventory Report To UNECE, 2023), and measurements at incineration plants.

The activity data used for the emission estimates is mainly based on treated waste in Iceland which is reported annually to the Environment Agency of Iceland (*Umhverfisstofnun*) (EAI). This follows an exclusion of waste being treated outside of Iceland and its associated emissions. In addition to data on treated waste in Iceland, activity data for accidental fires, cremation, and bonfires is used for estimating emissions from these sources.

6.3 Sector-Specific QA/QC

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, archiving information, and reporting. Further information can be found in 1.6 on Quality Assurance and Quality Control.

6.4 Solid Waste Disposal (NFR 5A)

For most of the 20th century, SWDs in Iceland were numerous, small, and located close to the locations of waste generation so that the waste did not have to be transported far for disposal. In 1967, the waste disposal site in Gufunes started operating and most of the waste generated in the capital area was landfilled there. Prior to that year, the waste of the capital area was landfilled in smaller SWDs.

The trend in waste management practices has been toward managed SWDs as municipalities have increasingly cooperated with each other on running waste collection schemes and operating joint landfill sites. This development has resulted in larger SWDs and enabled the shutdown of a number of small sites. Currently a large majority of landfilled waste is being 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 increased since then.

6.4.1 Methodology

The Tier 1 approach of Chapter 5A in the 2019 EMEP/EEA Guidebook is used for the emission estimates for all estimated pollutants. Thus, the total mass of waste disposed of in all landfill sites in Iceland is multiplied with its pollutant-specific emission factor.

6.4.2 Activity Data

Total mass of waste landfilled in Iceland is used for the emission estimates. The EAI compiles data on total amounts of waste generated since 1995. This data is published by Statistics Iceland (*Hagstofa Íslands*) (SI)[11]. The data for the time-period from 1995 to 2004 relies on assumptions and estimations and is less reliable than the data generated since 2005. Data from 2005-2014 was received from most operators according to the European Waste Catalogue (EWC) categorisation. Smaller operators did not submit data on waste amounts during that period, so some gap-filling estimations were performed by experts at the EAI. From 2014, the EAI has received data according to the Waste Statistic Regulation (WStatR) categorisation from all waste operators in Iceland. Waste generation before 1995 was estimated using a linear regression with gross domestic product (GDP) from 1995-2022 as surrogate data. The combination of these different datasets was carried out with the help of an external consultant company, Aether Ltd. Further information on the annual mass of waste landfilled and the source of data can be found in Iceland's National Inventory Document on Greenhouse Gas Emissions.

6.4.3 Emission Factors

Emission factors from the Tier 1 approach of Table 3-1, Chapter 5A in the 2019 EMEP/EEA Guidebook, are used for estimating emissions from solid waste disposal. Emission factors are assumed to be constant for all the years in the calculations. This section discusses the emission estimates from Solid Waste Disposal on Land and covers the emissions of NMVOCs, TSP, PM_{10}, and $PM_{2.5}$.

The 2019 EMEP/EEA Guidebook mentions the possibility of small quantities of NO_X, NH_3, and CO being emitted from this activity. However, no emission factors are provided in the

[11] Available at https://statice.is/statistics/environment/material-flow/waste/

Guidebook and these emissions have not been estimated in Iceland. Other pollutants are considered not applicable in accordance with that same table.

6.4.4 Recalculations and Improvements

6.4.4.1 Recalculations for the 2024 submission

Recalculations were made in sector 5A Solid waste disposal on land for the years 1990-2021 due to updated activity data, error, fixing and updated methodology, see Table 6.5.

The methodology to estimate waste amount activity data was updated for the years 1950-1994. Previously, the waste generation for those years was estimated using a linear regression with GDP from 1995-2007 as surrogate data. Now it is estimated using a linear regression with GDP from 1995-2022 as surrogate data.

Furthermore, the classification into Solid Waste Disposal Sites (SWDS) types was updated alongside the 5A transition to the 2019 IPCC Refinements for the greenhouse gas inventory. Before the transition, the smaller managed sites were still classified as 5A2 Unmanaged – shallow after they became managed, because no classification matched these sites. They were managed, but too small for fully anaerobic conditions to form and did not fulfil all the criteria for 5A1b Managed well – semi-aerobic SWDS as they were defined in the 2006 IPCC Guidelines. However, since they all had a permeable cover layer, they did fit the definition of 5A1b Managed well – semi-aerobic SWDS as they are defined in the 2019 IPCC Refinements. Since Act No 55/2003 required all SWDS in Iceland to be managed and follow the rules stated in the operation permits, it was decided to reclassify the small SWDS from 5A2 to 5A1b from the year 2004 and onwards. The change for the inventory is though large since all 5A2 emissions are moved over to 5A1 in the year 2004.

Table 6.5 Recalculations in 5A Solid Waste Disposal for the whole timeseries due to updated activity data, error fixing and updated methodology.

5A Solid Waste Disposal	1990	1995	2000	2005	2010	2015	2020	2021
2023 Submission NMVOC [kt]	0.53	0.49	0.53	0.54	0.26	0.31	0.30	0.27
2024 Submission NMVOC [kt]	0.49	0.49	0.53	0.54	0.26	0.31	0.30	0.27
Change relative to the 2023 Submission NMVOC	-7.7%	0%	0%	0%	0%	0%	0%	0%
2023 Submission TSP [kt]	1.6E-04	1.5E-04	1.6E-04	1.6E-04	7.6E-05	9.1E-05	8.8E-05	8.1E-05
2024 Submission TSP [kt]	1.5.E-04	1.5.E-04	1.6.E-04	0.028	0.021	0.024	0.020	0.020
Change relative to the 2023 Submission TSP	-7.7%	0%	0%	17,384%	27,050%	26,857%	22,749%	24,747%
2023 Submission PM_{10} [kt]	7.5E-05	6.9E-05	7.5E-05	7.6E-05	3.6E-05	4.3E-05	4.1E-05	3.8E-05
2024 Submission PM_{10} [kt]	6.9E-05	6.9E-05	7.5E-05	0.013	0.010	0.012	0.009	0.010
Change relative to the 2023 Submission PM_{10}	-7.7%	0%	0%	17,384%	27,050%	26,857%	22,749%	24,747%
2023 Submission $PM_{2.5}$ [kt]	1.1E-05	1.0E-05	1.1E-05	1.1E-05	5.4E-06	6.5E-06	6.2E-06	5.8E-06
2024 Submission $PM_{2.5}$ [kt]	1.0E-05	1.0E-05	1.1E-05	0.0020	0.0015	0.0017	0.0014	0.0014
Change relative to the 2023 Submission $PM_{2.5}$	-7.7%	0%	0%	17,384%	27,050%	26,857%	22,749%	24,747%

6.4.4.2 Recalculations for the 2023 submission

For the 2023 submission, recalculations were performed on both subsectors of 5A. The cause was late arrival (post-2022 submission date) of the final amount of waste at SWDs in 2020 and the corrected amount of waste at SWDs in 2019. The amount of waste at managed SWDs in 2019 was corrected slightly and the amount of waste at unmanaged SWDs in 2019 and 2020 was corrected slightly, leading to overall smaller emissions for those two years for both subsectors.

6.4.5 Planned Improvements

For future submissions, it is planned to update the uncertainty analysis for the Waste sector. Furthermore, it is planned to update to the 2023 EMEP/EEA Guidebook.

6.5 Biological Treatment of Solid Waste (NRF 5B)

6.5.1 Composting (NRF 5B1)

6.5.1.1 Methodology

Recycling and biological treatment of waste started on a larger scale in the middle of the 1990s. Their share of total waste management increased rapidly since then. The Tier 2 approach of Chapter 5B1 in the 2019 EMEP/EEA Guidebook is used for the emission estimates in which emission estimates are calculated by multiplying waste amounts with relevant pollutant-specific emission factors.

6.5.1.2 Activity Data

Compost production as a means of waste treatment started in Iceland in 1995 and the EAI receives the amount of waste going to compost production facilities annually. Reliable activity data for the amount of waste composted has, however, only been reported to the EAI since 2005. Therefore, the amounts composted from 1995-2004 are estimated to be between 2 and 3 kt each year. Since 2005, this amount has increased by roughly 2 kt per year and was 32 kt in 2020. The collected data refers to wet weight and is transformed to dry matter. Further information on the annual mass of waste composted and the source of data can be found in Iceland's National Inventory Document on Greenhouse Gas Emissions.

6.5.1.3 Emission Factors

For composting, Tier 2 emission factors from Table 3-1 and Table 3-2, Chapter 5B1 in the 2019 EMEP/EEA Guidebook are used for estimating NH_3 and CO emissions. The emission factors are assumed constant between years. Emission factors for other pollutants are not provided in the 2019 EMEP/EEA Guidebook.

6.5.1.4 Recalculations and improvements

Recalculations from the 2024 submission.

No recalculations were made for this submission.

Recalculations from the 2023 submission

For the 2023 submission, recalculations were performed on sector 5B1. The cause was late arrival (post-2022 submission date) of the final annual amount of MSW composted in 2020. The amount was slightly, leading to smaller NH_3 and CO_2 emission for the year 2020.

6.5.1.5 Planned Improvements

For future submissions, it is planned to update the uncertainty analysis for the Waste sector. Furthermore, it is planned to update to the 2023 EMEP/EEA Guidebook.

6.5.2 Anaerobic Digestion at Biogas Facilities (NFR 5B2)

In 2020, the gas and composting facility *GAJA* started operating. *GAJA* is located in Reykjavík and is the only one of its kind in Iceland. In *GAJA*, organic waste from the capital area is processed into CH_4 gas and soil amendment. *GAJA* is currently not operating at its full capacity.

6.5.2.1 Methodology

The Tier 1 approach of Chapter 5B2 in the 2019 EMEP/EEA Guidebook is used for the emission estimates. The approach only takes NH_3 into account, other pollutants are either not applicable (NA) or not estimated (NE). Equation 1 from Chapter 5B2 is used to calculate the NH_3 emissions.

6.5.2.2 Activity Data

The Tier 1 method requires the total annual amount of N in the feedstock entering the biogas plants to be known. However, this information is currently not available.

6.5.2.3 Emission Factors

Tier 1 emission factor from Table 3-1, Chapter 5B2 in the 2019 EMEP/EEA Guidebook are used for estimating NH_3.

6.5.2.4 Recalculations and improvements

Recalculations from the 2024 submission.

No recalculations were made for this submission.

Recalculations from the 2023 submission.

No recalculations were made for this submission.

6.5.2.5 *Planned Improvements*

For the future submissions, it is planned to estimate NH_3 emissions. To be able to do so, the total amount of N in the feedstock is required from *GAJA*.

For future submissions, it is planned to update the uncertainty analysis for the Waste sector. Furthermore, it is planned to update to the 2023 EMEP/EEA Guidebook.

6.6 Waste Incineration and Open Burning (NFR 5C)

This section discusses the emission estimates from burning of waste, which falls under the subcategories; 5C1 Waste Incineration and 5C2 Open Burning of Waste. Waste Incineration covers the emission estimates from waste incineration plants without energy recovery[12] and not from Waste Incineration with Energy Recovery. Emission estimates for Waste Incineration with Energy Recovery are reported in the relevant subsector under NFR sector 1A1 (Chapter 3.3.1). Waste Incineration is separated further into 5C1a Municipal Waste Incineration, 5C1bi Industrial Waste Incineration, 5C1bii Hazardous Waste Incineration, 5C1biii Clinical Waste Incineration, 5C1biv Sewage Sludge Incineration, 5C1bv Cremation, and 5C1bvi Other Waste Incineration.

Open Burning of Waste covers the emission estimates from open pit burning facilities and bonfires.

The scope of this section does not include the emissions from waste incinerated outside of Iceland as this would lead to double counting of the emission estimates in a common international emission estimate inventory. Activity data on waste which is exported and incinerated outside Iceland is provided to the EAI annually by the waste burning facilities. Data on waste generation and waste management practices is published by SI.

6.6.1 Municipal Waste Incineration (NFR 5C1a)

Waste Incineration in incineration plants started in 1993 in Iceland and waste incineration in incineration plants without energy recovery started in 2001. Sector 5C1a includes emissions from two incineration plants, the plant in Tálknafjörður which operated from 2001 to 2004 and *Kalka* incineration plant which has been operating from 2004. Since 2004, *Kalka* has been the only operating waste incineration plant in Iceland. From around 1990, incinerators were built around the country with higher combustion temperatures but still no satisfactory emission controls, especially regarding air pollutants such as dioxin. All these incinerators are considered as open burning and are included in category 5C2 due to the lack of emission controls.

6.6.1.1 *Methodology*

The Tier 1 approach of Chapter 5C1a in the 2019 EMEP/EEA Guidebook is used for the emission estimates. The total amount of waste incinerated in all waste incineration plants without energy recovery in Iceland is multiplied with its pollutant-specific emission factor.

[12] A quantitative definition of waste incineration with energy recovery is found in Annex IV of regulation 1040/2016 (IS).

This applies to all pollutants except NO_x, SO_2, PM ($PM_{2.5}$, PM_{10}, TSP, and BC), and CO emissions from *Kalka* as *Kalka* runs continuous measurements for these pollutants.

6.6.1.2 Activity Data

Activity data on incinerated waste from major incineration plants has been collected by the EAI since 2000. There is a sharp increase in the amount of 5C1 Waste Incinerated (5C1) and corresponding decrease in 5C2 Open Burning of Waste in 2004 due to the opening of the *Kalka* incineration plant. This trend is also seen in the emissions. Furthermore, emission amounts for NO_x, SO_2, PM, and CO from *Kalka* are reported to the EAI as activity data since 2023.

Historic data which was not reported to the EAI was estimated using the assumption of 500 kg of waste per inhabitant in communities where waste is known to have been incinerated.

6.6.1.3 Emission Factors

Emission factors (T1) for all pollutants except NO_x, SO_2, PM, and CO for *Kalka* are taken from Table 3-1, Chapter 5C1a in the 2019 EMEP/EEA Guidebook. Lower emission factors were used for *Kalka* than for the Tálknafjörður plant due to the following abatement technologies present at *Kalka*:

- Dry cleaning process;
- Hydrated lime;
- Combustion at approximately 1,100°C;
- Particle abatement (bag filters with capacity 50 kg/hr).

For the incineration plant in Tálknafjörður, Tier 2 emission factors from Table 3-2, Chapter 5C1a in the 2019 EMEP/EEA Guidebook, is used for all pollutants except for NH_3, Se, and Indeno(1,2,3-cd)pyrene. As Tier 2 emission factors are unavailable for NH_3, Se, and Indeno (1,2,3-cd)pyrene, the Tier 1 emission factors from Table 3-1, Chapter 5C1a in the 2019 EMEP/EEA Guidebook have been used. The reason for this is the lack of emission factors given for these pollutants in Table 3-2 of the Guidebook.

6.6.1.4 Recalculations and Improvements

Recalculations from the 2024 submission

Recalculations were made in the sector 5C1a Municipal Waste Incineration due to updated activity data which affected the 2021 emission, see Table 6.6.

Table 6.6 Recalculation for 5C1a Municipal Waste Incineration for 2021 due to updated activity data.

5C1a Municipal Waste Incineration	2021
2023 submission NMVOC [kt]	0.0035
2024 submission NMVOC [kt]	0.0039
Change relative to 2023 submission NMVOC	12%
2023 submission NH_3 [kt]	6.1E-04
2024 submission NH_3 [kt]	6.8E-04
Change relative to 2023 submission NH_3	12%

5C1a Municipal Waste Incineration	2021
2023 submission Pb [kt]	4.7E-05
2024 submission Pb [kt]	5.2E-05
Change relative to 2023 submission Pb	12%
2023 submission Cd [kt]	2.6E-05
2024 submission Cd [kt]	2.9E-05
Change relative to 2023 submission Cd	12%
2023 submission Hg [kt]	7.5E-06
2024 submission Hg [kt]	8.3E-06
Change relative to 2023 submission Hg	12%
2023 submission As [kt]	6.5E-05
2024 submission As [kt]	7.3E-05
Change relative to 2023 submission As	12%
2023 submission Cr [kt]	0.16
2024 submission Cr [kt]	0.0052
Change relative to 2023 submission Cr	-96.8%
2023 submission Cu [kt]	9.3E-06
2024 submission Cu [kt]	1.0E-05
Change relative to 2023 submission Cu	11.5%
2023 submission Ni [kt]	9.3E-04
2024 submission Ni [kt]	1.0E-03
Change relative to 2023 submission Ni	11.5%

Recalculations from the 2023 submission

For the 2023 submission, recalculations were performed on Sector 5C1a for two reasons. First, emissions from NO_x, SO_2, PM, and CO were recalculated back to 2004 due to the methodological change made in 5C1a, for NO_x, SO_2, PM, and CO emissions from *Kalka*. These emissions were previously calculated by multiplying the incinerated waste amount with emission factors from Table 3-1 in 2019 EMEP/EEA Guidebook. The emission values are now available in *Kalka's* Green Accounting back to 2004. Furthermore, emissions from all pollutants for 2019 and 2020 were recalculated due to the late arrival of the final annual amount of waste at SWDs in 2020 and corrected numbers for 2019.

6.6.1.5 Planned Improvements

An uncertainty analysis is in progress. Furthermore, it is planned to update to the 2023 EMEP/EEA Guidebook.

6.6.2 Industrial Waste Incineration (NFR 5C1bi)

6.6.2.1 Methodology

The Tier 1 approach of Chapter 5C1b in the 2019 EMEP/EEA Guidebook is used for the emission estimates. Slaughterhouse waste is the only type of waste that is assumed to be constituting Industrial Waste Incineration for the year 2021. Total reported slaughterhouse waste is multiplied by pollutant specific emission factors to estimate these emissions.

6.6.2.2 Activity Data

Activity data for this category has been included for the year 2014 onward. Activity data for previous years are included in 5C1a.

6.6.2.3 Emission Factors

Emission factors (T1) are taken from Table 3-1, Chapter 5C1b in the 2019 EMEP/EEA Guidebook for all pollutants, except for NO_X, SO_2, PM, and CO as they are included in 5C1a.

6.6.2.4 Recalculations and Improvements

Recalculations from the 2024 submission

Recalculations were made for the for the sectors 5C1bi Industrial Waste Incineration, 5C1bii Hazardous Waste Incineration and 5C1biv Sewage Sludge Incineration for the whole timeseries due the updated emission factor for Dioxin (PCDD/F), see Table 6.7.

Table 6.7 Recalculation for Dioxin (PFCC/F) for 5C1bi Industrial Waste Incineration, 5C1bii Hazardous Waste Incineration and 5C1biv Sewage Sludge Incineration for the whole timeseries.

5C1bi + 5C1bii + 5C1biv	1990	1995	2000	2005	2010	2015	2020	2021
2023 Submission PCDD/F [g I-TEQ]	NO	NO	NO	NO	NO	0.32	0.79	NO
2024 Submission PCDD/F [g I-TEQ]	NO	NO	NO	NO	NO	0.01	0.02	NO
Change relative to the 2023 Submission PCDD/F	NO	NO	NO	NO	NO	-97%	-97%	NO

Recalculations from the 2023 submission

Recalculations were performed on 5C1bi for the year 2014 to 2020. Firstly, *Kalka* provides continuous emission measurements for these pollutants, but all waste categories are incinerated together at *Kalka*. This makes it impossible to differentiate emissions from one waste category to another. However, it is known that the majority, or about 70% of all waste incinerated in *Kalka*, is household waste. As such, emissions from NO_x, SO_2, PM, and CO from industrial waste are now included in 5C1a MSW Incineration, leading to recalculations for these pollutants back to 2014. Secondly, prior to the 2022 Submission, the same emission factors were used for Industrial Waste Incineration as for MSW (Tier 2 emission factors from Table 3-2, Chapter 5C1a in the 2019 EMEP/EEA Guidebook). For the 2022 Submission, emission factors for Industrial Waste Incineration were updated to the emission factors specified for Industrial Waste Incineration from Table 3-1, Chapter 5C1b in the 2019 EMEP/EEA Guidebook as they are considered to be more accurate. However, in Table 3-1, the pollutants NH_3, BaP, BbF, BkF, IPy, Cr, Cu, Se, and Zn are not estimated. As such, the notation key NE was chosen to represent these pollutants. This has been reconsidered and the notation key for NH_3, BaP, BbF, BkF, IPy, Cr, Cu, Se, and Zn was changed to NA. Thirdly, the amount incinerated industrial waste for 2020 was updated from approximately 864 t to 1,046 t, leading to 134% higher NMVOC, dioxin, PAH4, HCB, Pb, Cd, Hg, As, and Ni emissions in 2020. Additionally, HCB emissions were reported as tons instead of kilograms from 2014.

6.6.2.5 Planned Improvements

It is planned to update to the 2023 EMEP/EEA Guidebook.

6.6.3 Hazardous Waste Incineration (NFR 5C1bii)

6.6.3.1 Methodology

The Tier 1 approach of Chapter 5C1b in the 2019 EMEP/EEA Guidebook is used for the emission estimates. Total amount of hazardous waste is multiplied by a pollutant specific emission factor.

6.6.3.2 Activity Data

Activity data for incinerated hazardous waste is available from 2006 and is collected by the EAI.

6.6.3.3 Emission Factors

Emission factors (T1) are taken from Table 3-1, Chapter 5C1b in the 2019 EMEP/EEA Guidebook for all pollutants, except for NO_X, SO_2, PM, and CO as they are included in 5C1a.

6.6.3.4 Recalculations and Improvements

Recalculations from the 2024 submission

Recalculations were made for the for the sectors 5C1bi Industrial Waste Incineration, 5C1bii Hazardous Waste Incineration and 5C1biv Sewage Sludge Incineration for the whole timeseries due the updated emission factor for Dioxin (PCDD/F), see Section 6.6.2.4.

Furthermore, recalculations were made for 2021 for 5C1bii Hazardous Waste Incineration due to updated activity data, see Table 6.8.

Table 6.8 Recalculation for 5Cbii Hazardous Waste Incineration for 2021 due to updated activity data.

5C1bii Hazardous Waste Incineration	2021
2023 submission NMVOC [kt]	0.0035
2024 submission NMVOC [kt]	0.0039
Change relative to 2023 submission NMVOC	12%
2023 submission Pb [kt]	0.00061
2024 submission Pb [kt]	0.00068
Change relative to 2023 submission Pb	12%
2023 submission Cd [kt]	0.000047
2024 submission Cd [kt]	0.000052
Change relative to 2023 submission Cd	12%
2023 submission Hg [kt]	0.000026
2024 submission Hg [kt]	0.000029
Change relative to 2023 submission Hg	12%
2023 submission As [kt]	0.0000075

5C1bii Hazardous Waste Incineration	2021
2024 submission As [kt]	0.0000083
Change relative to 2023 submission As	12%
2023 submission Ni [kt]	0.16
2024 submission Ni [kt]	0.0052
Change relative to 2023 submission Ni	-96.8%
2023 submission PCDD/F [g I-TEQ]	0.0000093
2024 submission PCDD/F [g I-TEQ]	0.000010
Change relative to 2023 submission PCDD/F	11.5%
2023 submission PAH4 [kt]	0.00093
2024 submission PAH4 [kt]	0.0010
Change relative to 2023 submission PAH4	11.5%
2023 submission HCB [kt]	0.16
2024 submission HCB [kt]	0.0052
Change relative to 2023 submission HCB	-96.8%

Recalculations from the 2023 submission

Recalculations were performed on 5C1bii for the year 2006 to 2020. The reasons for the recalculations are the same for 5C1bi: emissions from NO_X, SO_2, PM, and CO are now included in 5C1a; the notation key for NH_3, BaP, BbF, BkF, IPy, Cr, Cu, Se, and Zn was changed from NE to NA as NA is considered more appropriate; the amount incinerated hazardous waste for 2020 was updated from approx. 971 t to 1,213 t, leading to 25% higher NMVOC, dioxin, PAH4, HCB, Pb, Cd, Hg, As, and Ni emissions in 2020.

6.6.3.5 Planned Improvements

It is planned to update to the 2023 EMEP/EEA Guidebook.

6.6.4 Clinical Waste Incineration (NFR 5C1biii)

6.6.4.1 Methodology

The Tier 2 approach of Chapter 5C1b in the 2019 EMEP/EEA Guidebook is used for the emission estimates. Total amount of clinical waste is multiplied by a pollutant-specific emission factor.

6.6.4.2 Activity Data

Activity data for incinerated clinical waste under this sector is available from 2001, when the first incineration plant opened.

6.6.4.3 Emission Factors

The emission factors (T2) are taken from Table 3-2, Chapter 5Cbiii in the 2019 EMEP/EEA Guidebook. As for abatement efficiencies, default abatement efficiencies (T2) from Table 3-3, Chapter 5C1biii in 2019 EMEP/EEA Guidebook are used for Pb, Cd, Hg, As, Cr, Cu, and Ni from the year 2004 (when *Kalka* opened) and the default abatement efficiencies (T2) from Table 3-5, Chapter 5C1biii in 2019 EMEP/EEA Guidebook are used for dioxin.

The emission factors and abatement efficiencies for NO_X, SO_2, PM, and CO are included in 5C1a.

6.6.4.4 Recalculations and Improvements

Recalculations from the 2024 submission

Recalculations were in the sector 5C1biii Clinical Waste Incineration due to updated emission factors for $PM_{2.5}$ and PM_{10} which only affected emissions in the years 2001-2003, see Table 6.9, since measurements are used for these emissions from the incinerator Kalka, which has been the only waste incinerator burning clinical waste in Iceland since 2004.

Table 6.9 Recalculation in 5C1biii Clinical Waste Incineration due to updated emission factors for PM_{10} and $PM_{2.5}$ for the years 2001-2003.

5C1biii Clinical Waste Incineration	2001	2002	2003
2023 submission PM2.5 [kt]	NA	NA	NA
2024 submission PM2.5 [kt]	NO	NO	NO
Change relative to 2023 submission PM2.5	Updated notation key	Updated notation key	Updated notation key
2023 submission PM10 [kt]	NA	NA	NA
2024 submission PM10 [kt]	4.9E-06	4.9E-06	4.9E-06
Change relative to 2023 submission PM10	Changed from notation key to emission estimate	Changed from notation key to emission estimate	Changed from notation key to emission estimate

Recalculations from the 2023 submission

Recalculations were performed on 5C1biii for the years 2001 to 2020. For the same reason as in 5C1bi and 5C1bii, NO_x, SO_2, PM, and CO emissions are now included in 5C1a. In the previous submission, NH_3, BaP, BbF, BkF, IPy, Se, and Zn were represented by the notation key NE as they are not estimated in Table 3-2, Chapter 5Cbiii in the 2019 EMEP/EEA Guidebook. However, the notation key has been changed to NA for this submission as it is considered more appropriate. As for dioxin, the emissions were reported as kilograms instead of grams and no abatement was applied. The unit error has been fixed and a Tier 2 default abatement efficiency from Table 3-5, Chapter 5C1biii in 2019 EMEP/EEA Guidebook has been applied. As for Pb, Cd, Hg, As, Cr, Cu, and Ni, abatement efficiencies were updated with Tier 2 default values from Table 3-3, Chapter 5C1biii in 2019 EMEP/EEA Guidebook now being used instead of those from Table 3-4, Chapter 5C1biii in 2016 EMEP/EEA Guidebook.

6.6.4.5 Planned Improvements

It is planned to update to the 2023 EMEP/EEA Guidebook.

6.6.5 Sewage Sludge Incineration (NFR 5C1biv)

6.6.5.1 Methodology

The Tier 1 approach of Chapter 5C1b in the 2019 EMEP/EEA Guidebook is used for the emission estimates. Total amount of sewage sludge is multiplied by a pollutant-specific emission factor.

6.6.5.2 Activity Data

Activity data for Sewage Sludge Incineration was included in NFR sector 5C1a until 2014. This is because it was not possible to distinguish between the waste categories until then, as the EAI has only received data according to the WStatR categorisation from all waste operators in Iceland since 2014.

6.6.5.3 Emission Factors

Emission factors (T1) are taken from Table 3-1, Chapter 5C1b in the 2019 EMEP/EEA Guidebook, except for NO_X, SO_2, PM, and CO as they are included in 5C1a.

6.6.5.4 Recalculations and Improvements

Recalculations from the 2024 submission

Recalculations were made for the for the sectors 5C1bi Industrial Waste Incineration, 5C1bii Hazardous Waste Incineration and 5C1biv Sewage Sludge Incineration for the whole timeseries due the updated emission factor for Dioxin (PCDD/F), see Section 6.6.2.4.

Recalculations from the 2023 submission

Recalculations were performed on 5C1biii for the years 2014 to 2020. For the same reason as in 5C1bi, 5C1bii, and 5C1biii, NO_X, SO_2, PM, and CO emissions are now included in 5C1a and the notation keys for NH_3, BaP, BbF, BkF, IPy, Cr, Cu, Se, and Zn were changed from NE to NA. NMVOC, Pd, Cd, Hg, As, Ni, dioxin, and HCB emissions were recalculated for the year 2019. The cause was a unit error of the amount of incinerated sewage sludge for 2019.

6.6.5.5 Planned Improvements

It is planned to update to the 2023 EMEP/EEA Guidebook.

6.6.6 Cremation (NFR 5C1bv)

6.6.6.1 Methodology

The total number of bodies incinerated is multiplied by a pollutant specific emission factor from the Tier 1 approach of the 2019 EMEP/EEA Guidebook, Chapter 5C1bv.

6.6.6.2 Activity Data

Cremation is performed at a single facility located in Reykjavík where human remains are incinerated along with the coffin. The activity data, total number of remains incinerated, is provided by the facility.

6.6.6.3 Emission Factors

Emission factors (T1) are taken from Table 3-1, Chapter 5C1bv in the 2019 EMEP/EEA Guidebook.

6.6.6.4 Recalculations and Improvements

Recalculations from the 2024 submission

No recalculations were made for this submission.

Recalculations from the 2023 submission

BC emissions were recalculated for the whole timeline. As Table 3-1, Chapter 5C1bv in the 2019 EMEP/EEA Guidebook do not estimate the emission of BC, BC was initially represented as NE in previous submission. This has been reconsidered and the notation key NA is now used instead.

6.6.6.5 Planned Improvements

It is planned to update to the 2023 EMEP/EEA Guidebook.

6.6.6.6 Other Waste Incineration (NFR 5C1bvi)

Data for other waste incineration is not available for the time being.

6.6.7 Open Burning of Waste (NFR 5C2)

Open Burning of Waste includes combustion in nature and open dumps, as well as combustion in incineration devices that do not control the combustion air to maintain adequate temperature and do not provide sufficient residence time for complete combustion. Incineration devices on the other hand are characterised by creating conditions for complete combustion. Therefore, the burning of waste in historic incineration devices that did not ensure conditions for complete combustion is allocated to Open Burning of Waste. Open pit burning was a common procedure in the early 1990s. In general, open pit burning results in poor combustion conditions due to inhomogeneous and poorly mixed fuel material, chlorinated precursors, humidity, or catalytically active metals. All these factors influence the dioxin formation and therefore it can be hard to come up with reasonable emission factors. In addition, the activity data is quite uncertain, as no official statistics are available.

It is a tradition in Iceland to light bonfires on New Year's Eve (31 December) and Epiphany/Twelfth Night (6 January). These are quite common throughout the country. In the early 1990s, there were no restrictions and no supervision with these bonfires. In the early 1990s, some surveillance officers from the Environmental and Public Health Offices (Local Competent Authority) started to control these fires, by informing the bonfire personnel. In 2000, the EAI, Iceland Fire Authority, and National Commissioner of Iceland Police published guidelines for bonfires. They include restrictions on size, burnout time, and the material allowed. Since that time, only wood and paper are allowed on bonfires. Additionally, the Environmental and Public Health Offices supervise all bonfires. Now bonfires are fewer and better organised.

6.6.7.1 Methodology

The total amount of waste incinerated in all open pit waste burning facilities in Iceland is multiplied with its pollutant-specific emission factor as given in Chapter 5C2 in the 2019 EMEP/EEA Guidebook. This applies to most reported pollutants except for dioxin, where the emission estimates are based on technology specific emission factors from the Standardized Toolkit for the Identification of Dioxin and Furan releases (UNEP, 2005). The same methodology is used for emission estimates from bonfires, with dioxin being calculated differently. See more detailed descriptions in the following sections.

6.6.7.2 Activity Data

Historic data on open pit burning was estimated with the assumption that 500 kg of waste has been incinerated, per inhabitant, in the communities where waste is known to have been incinerated. The estimate was made for the years 1990, 1995, and 2000 and interpolated for the years in between. These communities were mapped by the EAI in the respective years. The EAI has information on the dates at which sites, where open pit burning has been performed, have been closed and other means of waste disposal have been found. Open pit burning is likely to be still occurring at various rural sites, but this has not been estimated and no public statistics or estimations are currently available. The amount of waste burned in open pits has decreased rapidly since the early 1990s, when more than 30,000 t of waste were burned. Between 2005 and 2010, there was only one site left which was burning waste openly, on the island of Grímsey. This site was closed by the end of 2010. Based on the population, it was assumed that around 50 t of waste was burned there annually.

For the 31 December and 6 January bonfires, activity data is not easily obtained. In 2011, the EAI, along with the municipality of Reykjavík, decided to weigh all the material of a single bonfire. Then the piled material was photographed, and its height, width, and length measured. The weight was then correlated to the more readily measurable parameters pile height and diameter. The Environmental and Public Health Offices were asked to measure the height and diameter of the bonfires in their areas, take photos and send them to the EAI. From this information the total weight of bonfires was estimated for the whole country. The amount was further extrapolated back to 1990, in cooperation with an expert from one Environmental and Public Health Office that has been involved with this field of work for a long time. This tradition as well as the number of bonfires has remained consistent in Iceland and, therefore, the same estimate is used for all years since 2011 with the exception of 2020, as the COVID-19 pandemic caused all bonfires to be cancelled. Emissions from bonfires for 2020 are consequently distinctively low.

6.6.7.3 Emission Factors

For open pit burning, the dioxin emission factor is taken from Table 54, Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases (UNEP, 2005). The emission factor is 300 µg/t waste (given for uncontrolled domestic waste burning). Tier 2 emission factors, from Table 3-2, 5C1a, 2019 EMEP/EEA Guidebook, are used for NH_3, Hg, Ni, I(1, 2, 3-cd)P, HCB, and PCB emissions. Emission factors for the remaining pollutants are taken from Table 3-1, Chapter 5C2 in the 2019 EMEP/EEA Guidebook.

For bonfires, the dioxin emission factor has been estimated historically, based on assumptions. From 2003 onwards an emission factor of 60 µg/t is used. For 1990 to 1995 an emission factor of 400 µg/t of burnt material was used. Both factors are taken from Table II.6.5, Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases (UNEP 2012) and is given for open burning of wood and accidental fires in houses. This relates to the fact that the burnt material was very miscellaneous at that time. It was common practice to burn tires, discarded home interiors and even boats at the bonfires. Furthermore, some business/es used the opportunity to get rid of all kinds of waste. Therefore, this dioxin emission factor was considered suitable for open pit burning for the years 1990 to 1995. The emission factor was then interpolated from 400 µg to 60 µg/t burnt material from 1996 to 2003. The emission factors for pollutants, other than dioxin, are taken from Table 3-1, Chapter 5C2 in the 2019 EMEP/EEA Guidebook.

6.6.7.4 Recalculations and Improvements

Recalculations from the 2024 submission

No recalculations were made for this submission.

Recalculations from the 2023 submission

Recalculations were performed in Sector 5C2 MSW, specifically for dioxin emissions for the years 2001-2020. This sector previously included dioxin emissions from Tálknafjörður incineration plant and from *Kalka*. However, these emissions do not belong in this sector as they are not emissions from open burning. As such dioxin emissions from Tálknafjörður and *Kalka* were removed from the sector, resulting in less emissions between 2001-2010 and none from 2011.

Recalculations were as well performed in Sector 5C2 Bonfires as it was previously assumed that no bonfires occurred due to COVID-19 gathering strictions. However, the assumption was wrong as the Twelfth Night bonfires did in fact occurred in 2020, right before the pandemic.

6.6.7.5 Planned Improvements

It is planned to update to the 2023 EMEP/EEA Guidebook.

6.7 Wastewater Handling (NFR 5D)

According to Chapter 5D in the 2019 EMEP/EEA Guidebook, wastewater handling is an insignificant source of air pollutants. However, in urban areas, NMVOC emissions from wastewater treatment plants can be of local importance. Activities considered within this sector are biological treatment plants and latrines (storage tanks of human excreta, located under naturally ventilated wooden shelters).

In Iceland, most wastewater is discharged into the sea, either untreated or after primary treatment. Only a small amount of wastewater is treated with secondary treatment and latrines are not occurring. Therefore, emissions have not been estimated from wastewater handling.

6.7.1 Methodology

No methodology is used due to the lack of relevant activity data.

6.7.2 Activity Data

No relevant activity data.

6.7.3 Emission Factors

No emission factors used.

6.7.4 Recalculations and Improvements

6.7.4.1 Recalculations from the 2024 submission

No recalculations were made for this submission.

6.7.4.2 Recalculations from the 2023 submission

No recalculations were made for the last submission.

6.7.5 Planned Improvements

It is planned to contact the relevant companies and investigate if it is possible to get the relevant data about the volume of handled wastewater. This would make it possible to report the NMVOC emissions from wastewater handling. Furthermore, it is planned to update to the 2023 EMEP/EEA Guidebook.

6.8 Other Waste (NFR 5E)

This section discusses the emission estimates from other waste, for which Iceland estimates emissions from accidental house and vehicle burning. Emission estimates for all reported pollutants are provided, except for NH_3, BC, Se, HCB, and PCB, where emission factors have not been found or are considered not applicable.

6.8.1 Methodology

For accidental house fires, emission estimates are calculated as follows: the number of fire events multiplied with a pollutant specific emission factor from the Tier 2 approach of Chapter 5E in the 2023 EMEP/EEA Guidebook and the most recent Danish Informative Inventory Report (IIR).

For accidental vehicle fires, emission estimates are calculated as the mass of vehicles burned multiplied with a pollutant-specific emission factor from the most recent Danish IIR. The weight of different types of vehicles is used in the calculations and taken from Table 6-28 of the most recent Danish IIR. The assumption is made that 70% of the total mass is burned.

6.8.2 Activity Data

Activity data for vehicle and building fires were obtained from the Capital District Fire and Rescue Service (CDFRS) for the years 2003 onward. Building fires are classified by duration of response into small (<60 min.), medium (60-120 min.) and large fires (>120 min.) The data is presented in Table 6.10. As two thirds of the Icelandic population lives in the capital area, it is assumed that the CDFRS serves two thirds of the incidents in Iceland.

In Table 6.11, data on vehicle and building fires, extrapolated for Iceland, is presented. As the emission factors used comply for full scale building fires, the activity data is scaled as a full-scale equivalent where it is assumed that a small and medium fire leads to 5% and 50% of a large fire respectively, and that a large fire is a full-scale fire. Table 6.11 shows the total scaled building fires. This scaling is similar to the scaling used in the 2011 Danish IIR, although the scaling in Denmark is based on response activity rather than response time. It does, however, seem appropriate to scale the fires in this way for the Icelandic data. It is further assumed that 10% of each year's building fires, are industrial building fires.

In 2004, a major industrial fire broke out at a recycling company *Hringrás*. In the fire, 300 t of tires among other separated waste materials burned. In 2011, a fire broke out at the same company, but that fire is assumed to have been about 10% of the size of the one in 2004. In 2014, a major fire incident occurred when fire broke out in an industrial laundry service *Fönn*. The building had a thick layer of asphalt roll roofing with an estimated weight of around 80 t.

For 1990 to 2002, an average of the total scaled building fires (38) and vehicle fires (60) was used. The possibility to obtain better data for 1990 to 2002 has been further explored. However, the reports on accidental fires for that period are in a completely different format, making them both difficult to obtain and interpret. As the extra information gained would not be of that much importance, it is not a priority to further explore this subject.

The yearly combusted mass is calculated by multiplying the number of different vehicles fires with the average weight of the given vehicle type.

As the types of vehicles that have caught fire are not registered at the CDFRS, the average ratio of vehicle type caught on fire are taken from the 2020 Danish IIR. Motorcycles are excluded, as motorcycle fires are very rare in Iceland. The ratios are:

- Passenger Cars 83%
- Buses 8%
- Light-duty Vehicles 3%
- Heavy-duty Vehicles 7%

The total amount of vehicle mass involved in fires is then calculated from the number of vehicle fires and the average weights of the different vehicle types (weight is also taken from the Danish IIR, as national data was not available). It is assumed that 70% of the total vehicle mass involved in a fire actually burns.

Table 6.10 Vehicle and building fires, Icelandic Capital Area.

Year	Vehicle Fires	Building Fires			
		<60 min	60-120 min	>120 min	Total Scaled
2005	43	141	24	11	30
2010	34	118	17	9	23
2015	37	88	14	3	14
2020	27	69	13	13	23
2021	26	85	18	10	23

Table 6.11 Vehicle and building fires scaled for all of Iceland (scaled using data from the Capital Area).

Year	Vehicle Fires	Building Fires			
		<60 min	60-120 min	>120 min	Total Scaled
2005	67	220	37	17	47
2010	53	184	27	14	36
2015	58	137	22	5	22
2020	42	108	20	20	36
2021	41	133	28	16	36

6.8.3 Emission Factors

The emission factor for undetached houses is used for all building fires, except for industrial building fires. This is because Icelandic regulations demand more fire resistance than the regulations in other Scandinavian countries. Emission factors for undetached building fires are taken from Table 3-4, Chapter 5E in the 2023 EMEP/EEA Guidebook, for all estimated pollutants provided in the Guidebook except for dioxin, which is taken from the most recent Danish IIR. Other non-estimated sources of the 2023 EMEP/EEA Guidebook are taken from Table 6.22 in the most recent Danish IIR. No emission factors are provided for BC, Ni, Se, Zn, HCB, and PCB. NH_3 is considered not applicable as the 2023 EMEP/EEA Guidebook suggests.

Similarly, for industrial building fires, emission factors from Table 3-5, Chapter 5E in the 2023 EMEP/EEA Guidebook is used except for dioxin which is taken from the most recent Danish IIR. Other non-estimated sources of the 2023 EMEP/EEA Guidebook are taken from Table 6.22 in the most recent Danish IIR. No emission factors are provided for BC, Ni, Se, Zn, HCB, and PCB. NH_3 is considered not applicable as the 2023 EMEP/EEA Guidebook suggests. For vehicle fires, the burned mass is multiplied with a pollutant specific emission factor taken from Table 6.30 of the most recent Danish IIR.

For the major industrial fire at *Hringrás* in 2004, an emission factor of 220 µg/t of tires, from the Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases (UNEP, 2005), was taken. Using this factor, this single fire was estimated to be the size of around 16 industrial building fires and other emissions were scaled accordingly.

Asphalt roll roofing, which burned in the 2014 industrial laundry fire *Fönn*, was assumed to emit dioxin levels comparable to scrap tires and, therefore, the same emission factor for dioxin was used as for the industrial fire at the recycling company (Hringrás). Dioxin emissions from other materials that burned were included by assuming that the scale of the fire was comparable to five industrial buildings. Thus, the emission from this particular fire corresponds to five industrial building fires plus the special assessment of the asphalt roll roofing, in total around nine industrial fires. Other POP's emission estimates were calculated by using emission factors from Table 6.22 in the most recent Danish IIR for industrial buildings, scaled according to the estimation of corresponding industrial building fires. Emission factors for NO_x, NMVOC, SO_2, and CO are also taken from Table 6.22 in the most recent Danish IIR. Other reported pollutants are taken from Table 3-5, Chapter 5E in the 2023 EMEP/EEA Guidebook. No emission factors are provided for BC, Ni, Se, Zn, HCB, and PCB. NH_3 is considered not applicable as the 2023 EMEP/EEA Guidebook suggests.

6.8.4 Recalculations and Improvements

Recalculations from the 2024 submission

Recalculations were made in the sector 5E Other Waste due to updated activity data on vehicle fires for the year 2021 and updated emission factors for the whole timeline, shown in Table 6.12 and Table 6.13.

Table 6.12 Recalculation in 5E Other Waste due to updated activity data on vehicle fires for the year 2021 and updated emission factors for the whole timeline.

5E Other Waste	1990	1995	2000	2005	2010	2015	2020	2021
2023 Submission NMVOC [kt]	0.00294	0.00296	0.00289	0.00443	0.00346	0.00239	0.00320	0.00356
2024 Submission NMVOC [kt]	0.00291	0.00292	0.00285	0.00437	0.00342	0.00236	0.00315	0.00314
Change relative to the 2023 Submission NMVOC	-1.3%	-1.3%	-1.3%	-1.4%	-1.4%	-1.3%	-1.5%	-11.9%
2023 Submission NO_x [kt]	0.00061	0.00061	0.00060	0.00090	0.00071	0.00049	0.00065	0.00073
2024 Submission NO_x [kt]	0.00060	0.00060	0.00059	0.00089	0.00070	0.00049	0.00064	0.00064
Change relative to the 2023 Submission NO_x	-1.2%	-1.2%	-1.3%	-1.4%	-1.4%	-1.3%	-1.5%	-13.3%
2023 Submission SO_x [kt]	0.0081	0.0081	0.0081	0.0131	0.0103	0.0064	0.0094	0.0096
2024 Submission SO_x [kt]	0.0080	0.0080	0.0080	0.0130	0.0102	0.0063	0.0093	0.0093
Change relative to the 2023 Submission SO_x	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.3%	-1.4%	-3.6%
2023 Submission CO [kt]	0.0109	0.0110	0.0105	0.0149	0.0116	0.0088	0.0102	0.0129
2024 Submission CO [kt]	0.0108	0.0109	0.0104	0.0147	0.0115	0.0087	0.0101	0.0100
Change relative to the 2023 Submission CO	-0.96%	-0.95%	-1.00%	-1.15%	-1.15%	-1.00%	-1.32%	-22.5%
2023 Submission PAH4 [t]	0.00782	0.00799	0.00715	0.00790	0.00611	0.00627	0.00427	0.00873
2024 Submission PAH4 [t]	0.00783	0.00800	0.00716	0.00790	0.00611	0.00627	0.00427	0.00421
Change relative to the 2023 Submission PAH4	0.032%	0.031%	0.035%	0.052%	0.052%	0.033%	0.075%	-52%

Table 6.13 Recalculation in 5E Other Waste due to updated activity data on vehicle fires for the year 2021.

5E Other Waste	2021
2023 submission $PM_{2.5}$ [kt]	4.9E-03
2024 submission $PM_{2.5}$ [kt]	3.2E-03
Change relative to 2023 submission $PM_{2.5}$	-34%
2023 submission PM_{10} [kt]	4.9E-03
2024 submission PM_{10} [kt]	3.2E-03
Change relative to 2023 submission PM_{10}	-34%
2023 submission TSP [kt]	4.9E-03
2024 submission TSP [kt]	3.2E-03
Change relative to 2023 submission TSP	-34%
2023 submission PCDD/F [g I-TEQ]	0.11
2024 submission PCDD/F [g I-TEQ]	0.10
Change relative to 2023 submission PCDD/F	-2%
2023 submission Pb [t]	0.062
2024 submission Pb [t]	0.026
Change relative to 2023 submission Pb	-58%
2023 submission Cd [t]	1.4E-04
2024 submission Cd [t]	6.5E-05
Change relative to 2023 submission Cd	-53%
2023 submission As [t]	3.9E-05
2024 submission As [t]	2.7E-05
Change relative to 2023 submission As	-29%
2023 submission Cr [t]	3.1E-04
2024 submission Cr [t]	1.4E-04
Change relative to 2023 submission Cr	-55%
2023 submission Cu [t]	2.1E-03
2024 submission Cu [t]	8.9E-04
Change relative to 2023 submission Cu	-57%
2023 submission Ni [t]	2.1E-04
2024 submission Ni [t]	8.8E-05
Change relative to 2023 submission Ni	-58%

Recalculations from the 2023 submission

In Sector 5E, the notation key for is changed from NE to NA. As the 2019 EMEP/EEA Guidebook does not estimate the emissions from these pollutants in 5E. Furthermore, recalculations were performed on sector 5Eii through the whole timeline for all pollutants. This is due to changes in input values for mass of vehicles burned.

6.8.5 Planned Improvements

Review of the data used for 1990 to 2002 for the number of accidental house and vehicle fires. General data improvement needed. There were two larger fires in 2018, which have yet to be researched further. The EAI has been in touch with the Capital's Fire Department and the large fires are included here under the category "building fires <120 min." A further collaboration is being set up with the Iceland Building Authority with the aim of providing better estimates of emissions from building fires.

7 Natural Sources (NFR Sector 11)

7.1 Volcanoes (NFR 11A)

Volcanic emissions are frequent in Iceland and both remote and in-situ analytical techniques allow for a good estimation of associated emissions. While the following chapters describe the four latest eruptions (from 2010) in detail, the Table 7.1 reports the emissions for the whole time series and the respective sources of information. As emissions from these eruptions are natural, they are reported in this chapter and in the NFR Tables under Memo Item 11A but are not included in national totals.

Table 7.1 Volcanic eruptions and associated SO_X and particulate emissions from 1990.

Year	Volcano	Emissions [kt]			Measurement Method/Source
		SO_x	$PM_{2.5}$	PM_{10}	
1991	Hekla	230			Satellite Nimbus-7 TOMS, https://volcano.si.edu/volcano.cfm?vn=372070&vtab=Emissions
1996	Grímsvötn	10			Satellite Aura OMI https://volcano.si.edu/volcano.cfm?vn=373010&vtab=Emissions
2000	Hekla	183			Satellite Earth Probe TOMS https://volcano.si.edu/volcano.cfm?vn=372070&vtab=Emissions
2004	Grímsvötn	30			Satellite Aura OMI https://volcano.si.edu/volcano.cfm?vn=373010&vtab=Emissions
2010	Eyjafjallajökull	127	1,673	5,970	See Section 7.1.1
2011	Grímsvötn	300	13,184	47,039	Satellite Aura OMI https://volcano.si.edu/volcano.cfm?vn=373010&vtab=Emissions
2014-2015	Holuhraun	12,006	N/A	N/A	See Section 7.1.3
2021	Fagradalsfjall	967	N/A	N/A	See Section 7.1.4
2022	Meradalir	152	N/A	N/A	See Section 7.1.5

The last five volcanic eruptions (Eyjafjallajökull, April-May 2010; Grímsvötn, May 2011; Holuhraun, September 2014-February 2015; Fagradalsfjall, March-September 2021; Meradalir, August 2022) are reported in detail below.

7.1.1 Eyjafjallajökull Eruption: 2010

The Eyjafjallajökull eruption lasted from 14 April until 23 May 2010. For this eruption, emissions of sulphur dioxide (SO_2) and particulate matter (PM_{10}, $PM_{2.5}$) were estimated and reported. The emissions estimates are based on satellite observations on a daily basis during the eruption[13] and amounted to approximately 127 kt of SO_2, 6,000 kt of PM_{10}, and 1,700 kt. of $PM_{2.5}$. These 6,000 kt of PM_{10} were around 3,500 times more than the total estimated anthropogenic PM_{10} emissions in Iceland in 2010.

[13] https://wiki.met.no/emep/emep_volcano_plume

Figure 7.1 Eyjafjallajökull eruption at its peak in April 2010 (Photo: Þorsteinn Jóhannsson).

7.1.2 Grímsvötn Eruption: 2011

Grímsvötn volcano lays below the biggest glacier in Iceland, Vatnajökull, in the southeast of the country, and reaches 1,725 m above sea level. It is one of Iceland's most active volcanoes, and has erupted frequently in the past century (1934, 1983, 1996, 1998, 2004, and 2011).

The 2011 Grímsvötn eruption lasted from 21 May until 28 May. The eruption at Grímsvötn was much larger than that of Eyjafjallajökull the year before, and it has been estimated that during the first day, more sulphur and particulates were emitted than during the entirety Eyjafjallajökull eruption. SO_2 emissions from Grímsvötn have been estimated to be around 1,000 kt. The total mass of particulates emitted has not been estimated, but the Environment Agency of Iceland (*Umhverfisstofnun*) (EAI) has scaled the emissions of particulates using the ratio of sulphur emissions from the two eruptions (1,000/127). This gives an approximate estimate of 47,000 kt PM_{10} and 13,000 kt of $PM_{2.5}$. Figure 7.2, a NASA MODIS satellite image acquired at 05:15 UTC on 22 May 2011, shows the plume from Grímsvötn casting shadow to the west.

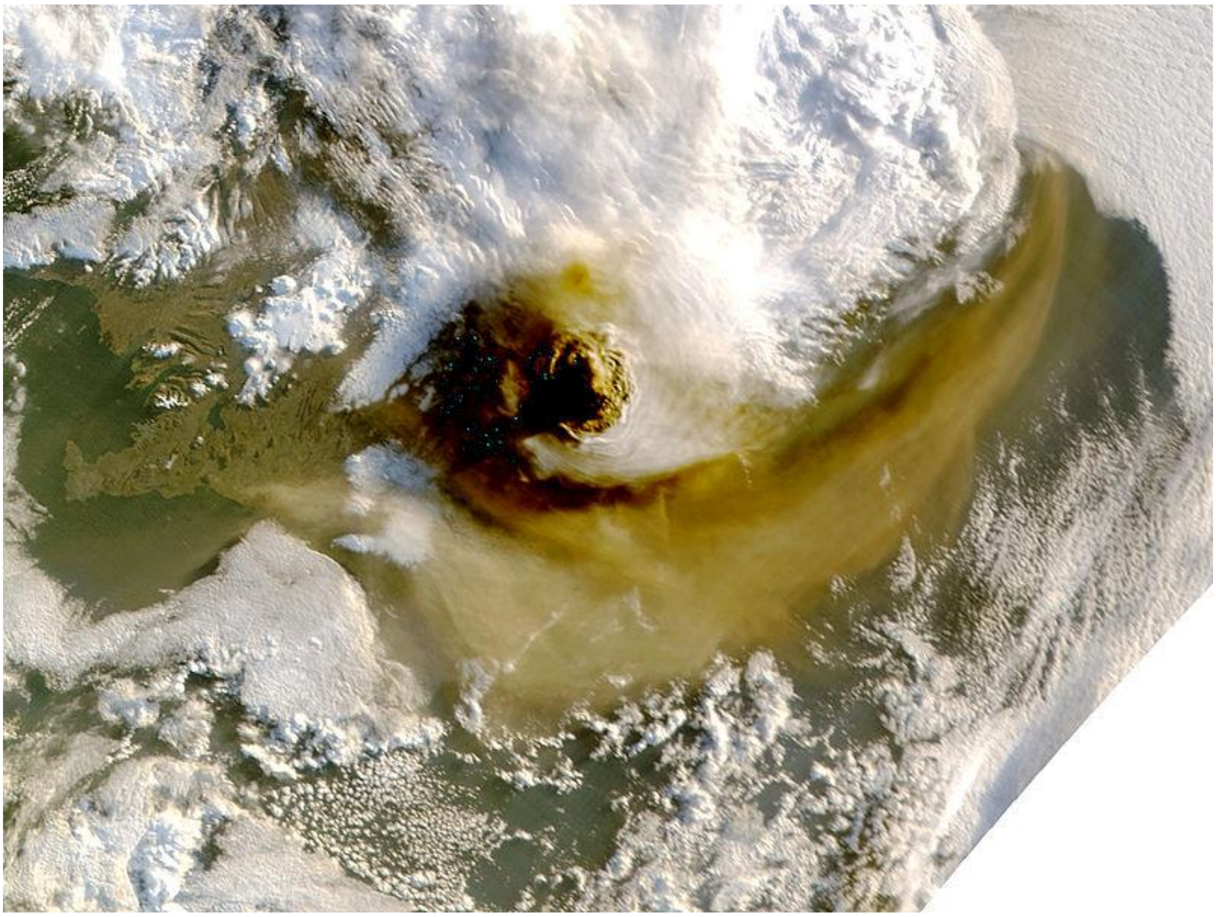


Figure 7.2 Grímsvötn eruption in May 2011. (Photo NASA/GSFC/Jeff Schmaltz/MODIS Land Rapid Response Team).

7.1.3 Holuhraun Eruption: 2014-2015

Holuhraun is located to the north of Vatnajökull glacier and is associated with the volcano Bárðabunga situated beneath Vatnajökull. Prior to the eruption, seismic measurements showed the emplacement of a dike, originating from the Bárðabunga caldera and migrating to the northeast over the course of a few weeks. The eruption in Holuhraun began on 31 August 2014, just to the north of the northern edge of Vatnajökull, and ended on 27 February 2015. It was the biggest eruption in Iceland since the Laki eruption 1783.

Emission estimates from the Holuhraun eruption were done by the volcanic hazard team at the Icelandic Meteorological Office (*Veðurstofa Íslands*) (IMO). According to information from Sara Barsotti and Melissa Anne Pfeffer, specialists at the IMO, the estimates were conducted as follows: the emission rate of SO_2 was calculated using wind parameters provided by the HARMONIE numerical prediction model, and column concentrations of SO_2 detected with different types of Differential Optical Absorption Spectroscopy (DOAS) measurements. The DOAS techniques used include two NOVAC scanning DOAS instruments (Galle, et al., 2010): one installed 7 km from the main degassing vent, Baugur, but moved during the eruption due to the advancing lava to 10 km from the main vent; a second scanning DOAS installed 10 km from the main vent but damaged by advancing lava two weeks after the start of the eruption; campaign DOAS traverses, made as close to the main vent as conditions allowed; and ring road DOAS traverses (Gíslason, 2015). All measurements were analysed closely to remove the data most impacted by scattering. For all techniques, good quality measurements were used to calculate daily averages of the SO_2 emission rate. On days when good quality data was acquired from more than one DOAS technique, the larger value was used, and then these daily values were used to calculate the monthly averages. Some minor degassing from the cooling lava continued after the end of the eruption (maximum 3 kg/s; Simmons et al., 2016); this contribution to the emissions is not included here.

Total SO_2 emission from this eruption was estimated 12,006 kt, as communicated in 2016 by the IMO. Divided on calendar years, 10,880 kt of SO_2 were emitted in 2014 and 1,126 kt of SO_2 in 2015. To put these numbers in in perspective, it can be said that the total SO_2 emissions from all the European Union (EU) countries for 2012 was 4,576 kt. This means that the emissions from the eruption in 2014 (i.e., from 29 August 2014 to 31 December 2014) were more than twice the total SO_2 emissions from all the EU for the whole year. For September alone, during the most intensive period of the eruption, the SO_2 emissions from the eruption were similar to the annual SO_2 emissions of the EU.

Because the eruption occurred in an area free of ice, emissions of ash were negligible. Further information about SO_2 emissions from the eruption are in Table 7.2 below. As these emissions are natural, they are not included in national totals.

Table 7.2 Monthly emission rates (Pfeffer (IMO), 2016, email communication).

Date	Average monthly emission rates [kg/s]	SO_2 per month [kt]
August 2014	124	332
September 2014	1,708	4,427
October 2014	1,051	2,815
November 2014	1,143	2,963
December 2014	128	343
January 2015	304	814
February 2015	129	312

Figure 7.3 Holuhraun eruption in September 2014. The height of the lava fountains was around 100 m (Photo: Ólafur F. Gíslason).

7.1.4 Fagradalsfjall Eruption: 2021

A basaltic effusive eruption started at Mt. Fagradalsfjall along a fissure on 19 March and lasted until 18 September 2021 (Figure 7.4). This eruption ended a 781-year dormancy on the Reykjanes peninsula in the southwest of Iceland. This peninsula is an onshore continuation of the Mid-Atlantic plate boundary and has volcanic systems consisting of 10-40 km long NE-SW-trending fissure swarms and geothermal areas. However, Fagradalsfjall is the least active volcanic system of the peninsula. The March-September mean bulk effusion rate was 9.5 ±0.2 m^3/s, ranging between 1 and 8 m^3/s in March-April and increasing to 9-13 m^3/s in May-September. This is uncommon for recent Icelandic eruptions, where the highest discharge usually occurs in the opening phase (Pedersen, 2022).

Measurements of SO_2 emissions were done by the IMO in the following way: the flux of SO_2 was measured with ground-based UV spectrometers. A three-instrument network of DOAS instruments (10 km NNW of the eruption site, 6 km to the NW, and 4.5 km to the SW) was augmented by traverses directly under the eruption cloud which were primarily car-borne, but a few measurements were also made by foot and by aircraft. These measurements are used together with plume height and meteorological conditions to calculate the emission rate of SO_2. The scanning instruments measured the SO_2 flux 4,900 times over the duration of the eruption. These measurements include only those where the plume was within ±15 degrees of line of site from the eruption to the instrument and the measurements were not obviously impacted by the low solar angle during sunrise and sunset. Additionally, 148 traverse measurements were made. The traverse calculations attempt to include the uncertainty related to wind properties to have the true measurement uncertainty represented in the results. The total SO_2 emissions are 967 ±538 kt.

Figure 7.4 Fagradalsfjall eruption on 1 May 2021. Photo: Nicole Keller.

7.1.5 Meradalir Eruption 2022

A basaltic effusive eruption started on the 3rd of August in Meradalir along a 300-metre-long fissure. It was approximately 1 km northeast of the Fagradalsfjall eruption site and is a part of the same volcanic system. The eruption lasted until the 21st of August and was in exponential decay in terms of lava effusion.

The Icelandic Meteorological Office (IMO) estimate that a total of 152 kt of SO_2 were emitted during the eruption with a range of 136-169 kt. This is based on the average of six DOAS traverses made in the middle of the eruption.

Figure 7.5 Meradalir eruption in August 2021. Photo: Vísir/Arnar

8 Spatially Distributed Emissions on a Grid

8.1 Scope

The present document provides explanations about the methodology and the data sources used. Gridded emissions were reported in 2021 for the years 2015 and 2019 and for the following components: PCDD/PCDF (dioxins/furans), PAHs, HCB, and PCB. It should be noted that no updates were made between the 2021 Submission and this one, as gridded data only needs to be submitted every four years. Iceland intends to include updates to this section in the 2025 Submission.

The gridded emissions were aggregated into the following GNFR sectors: A_PublicPower, B_Industry, C_OtherStationaryComb, E_Solvents, F_RoadTransport, G_Shipping, H_Aviation, I_Offroad, J_Waste. POPs emissions do not originate in the Agriculture sector therefore no emissions are reported under the GNFR codes K_AgriLivestock and L_AgriOther.

As a geographical basis the EMEP grid with resolution of 0.1°x 0.1° was used for the first time, as in the 2016 submission the former 50 km x 50 km grid was used.

8.2 Methodology

The methodology follows the approach described in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019. Following steps were carried out in order to provide a spatial allocation of the emissions reported in the NFR tables:

- Understand type and origin of emissions (point or diffuse source);
- Associate geographical locations;
- Find proxy datasets for the emissions which could not be allocated to a location;
- Assign to each grid cell of the EMEP 0.1°x 0.1° resolution grid a unique number (2,273 grid cells in total);
- Allocate the emissions to the grid cells subdivided per GNFR code;
- Sum emissions within one grid cell to obtain total emission within that grid cell;
- Consistency check: crosscheck sum of emissions of all grid cells with national total emissions reported in NFR tables.

The spatially distributed emissions are based on the data collected for the Informative Inventory Report with addition of geographical datasets which can be downloaded from the website of the National Land Survey of Iceland (Landmælingar Íslands) (NLSI)14. Population density maps and the locations of major ports and airports were extracted from these datasets with the help of GIS software. Locations of point locations were extracted from the EPRTR registry. Some statistical data (tonnage of fish landed, farm numbers per region) was retrieved from Statistics Iceland (Hagstofa Íslands) (SI)15. Flight statistics for

[14] https://www.lmi.is/
[15] https://statice.is/

international and domestic flights were collected from Isavia16, the operator of all airports and manager of air traffic in Iceland. In some cases, expert judgement from the national inventory compiler was applied to ensure a correct allocation of emissions.

Table 8.1 summarises source of the datasets and proxy spatial dataset used, if necessary.

Table 8.1 Summary of the source of emission allocation and/or proxy spatial dataset used for the spatial mapping of emissions.

GNFR Code	NFR Code	Long Name	Source and Proxy Spatial Dataset Used
A_PublicPower	1A1a	Public Electricity and Heat Production	National Energy Authority (*Orkustofnun*) (NEA), two main areas in Iceland where electricity is still produced by fossil fuels, 80% assigned to Grímsey and 20% to Grímsstaðir. The third area, Flatey, is an island which is not inhabited all year round.
B_Industry	1A2a	Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	Fuel consumption of Ferroalloy producers known, NEA – NIR/IIR, EPRTR registry
B_Industry	1A2b	Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals	Fuel consumption of Aluminium producers known, NEA – NIR/IIR, EPRTR registry
B_Industry	1A2e	Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages, and Tobacco	These emissions stem from the fishmeal factories; the oil consumption numbers were looked up from their annual Green reports and the emissions distributed accordingly.
B_Industry	1A2f	Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals	Fuel consumption of mineral wool producers known, NEA – NIR/IIR, EPRTR registry
I_Offroad	1A2gvii	Mobile Combustion in Manufacturing Industries and Construction	Population density used as proxy spatial dataset, dataset from NLSI.
B_Industry	1A2gviii	Stationary Combustion in Manufacturing Industries and Construction: Other	This category is not very well defined, and the origin of emissions is not clearly stated by the NEA, so it was decided to split these emissions onto all known big industries.
H_Aviation	1A3ai(i)	International Aviation LTO (Civil)	Flight statistics published from Isavia, the operator of all airports and manager of air traffic in Iceland. Exact location of airports from dataset from NLSI.
H_Aviation	1A3aii(i)	Domestic Aviation LTO (Civil)	Flight statistics published from Isavia, the operator of all airports and manager of air traffic in Iceland. Exact location of airports from dataset from NLSI.
F_Road-Transport	1A3bi	Road Transport: Passenger Cars	Population density used as proxy, dataset from NLSI
F_Road-Transport	1A3bii	Road transport: Light-duty Vehicles	Population density used as proxy, dataset from NLSI
F_Road-Transport	1A3biii	Road Transport: Heavy-duty Vehicles and Buses	Population density used as proxy, dataset from NLSI
F_Road-Transport	1A3biv	Road transport: Mopeds and Motorcycles	Population density used as proxy, dataset from NLSI
G_Shipping	1A3dii	National Navigation (Shipping)	This category comprises ferries, whale watching boats, and (probably) the coast guard, even though there are no information on the latter. From NIR/IIR data, the annual fuel use was split between ferries and whale watching (the consumption of the main ferry to Westman Islands is known). Expert judgement from the Energy sector compiler split then the fuel to the rest of ferries/whale watching ports.

[16] https://www.isavia.is/en

GNFR Code	NFR Code	Long Name	Source and Proxy Spatial Dataset Used
C_Other-StationaryComb	1A4ai	Commercial/Institutional: Stationary	This category comprises pools heated by fossil fuels; according to the NEA, there is only one public pool left heated with fossil fuels (Grundarfjörður and the school building as well).
C_Other-StationaryComb	1A4bi	Residential: Stationary	Population density used as proxy, dataset from NLSI
C_Other-StationaryComb	1A4ci	Agriculture/Forestry/Fishing: Stationary	A) Farm numbers per region for sheep and cattle farmers retrieved from Statistics Iceland, combined percentage per region calculated. B) In GIS all houses located (no info about farm houses available) and intersected with the regions. C) Grid cells with fewer than 10 houses excluded. D) Percentage from A assigned to each grid cell within a region having >10 houses according to the houses present in one grid cell. Geographical dataset from NLSI.
I_Offroad	1A4cii	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	A) Farm numbers per region for sheep and cattle farmers retrieved from Statistics Iceland, combined percentage per region calculated. B) In GIS all houses located (no info about farm houses available) and intersected with the regions. C) Grid cells with less than 10 houses excluded. D) Percentage from A assigned to each grid cell within a region having >10 houses according to the houses present in one grid cell. Geographical dataset from NLSI.
I_Offroad	1A4ciii	Agriculture/Forestry/Fishing: National Fishing	Main ports defined from the tonnage landed, dataset from SI and emissions split accordingly.
C_Other-StationaryComb	1A5a	Other Stationary (including Military)	Population density used as proxy, dataset from NLSI
B_Industry	2A6	Other Mineral Products (please specify in the IIR)	Fuel consumption from the mineral wool producers are known, NEA – NIR/IIR
B_Industry	2C2	Ferroalloys Production	Fuel consumption from the ferroalloys producers are known, NEA – NIR/IIR
B_Industry	2C3	Aluminium Production	Fuel consumption from the aluminium producers are known, NEA – NIR/IIR
B_Industry	2D3b	Road Paving with Asphalt	The asphalt production is known, and the emissions distributed accordingly. – NIR/IIR
E_Solvents	2G	Tobacco	Population density used as proxy, dataset from NLSI
J_Waste	5C1a	Municipal Waste Incineration	All incineration occurs in one incinerator in the Reykjanes peninsula.
J_Waste	5C1bi	Industrial Waste Incineration	All incineration occurs in one incinerator in the Reykjanes peninsula.
J_Waste	5C1bii	Hazardous Waste Incineration	All incineration occurs in one incinerator in the Reykjanes peninsula.
J_Waste	5C1biii	Clinical Waste Incineration	All incineration occurs in one incinerator in the Reykjanes peninsula.
J_Waste	5C1biv	Sewage Sludge Incineration	All incineration occurs in one incinerator in the Reykjanes peninsula.
J_Waste	5C1bv	Cremation	Cremation occurs only in one crematorium in Reykjavík.
J_Waste	5C2	Open Burning of Waste	This comprises the yearly New Year's eve bonfires. Locations have been determined by searching newspapers and local news, 76 locations determined; emissions split equally as no information about size of single bonfires is known.
J_Waste	5E	Other Waste	Population density used as proxy, dataset from NLSI

8.3 Emissions 2019

The following figures show the national total emissions of dioxin/furans, PAHs, HCB, and PCB for the year 2019.

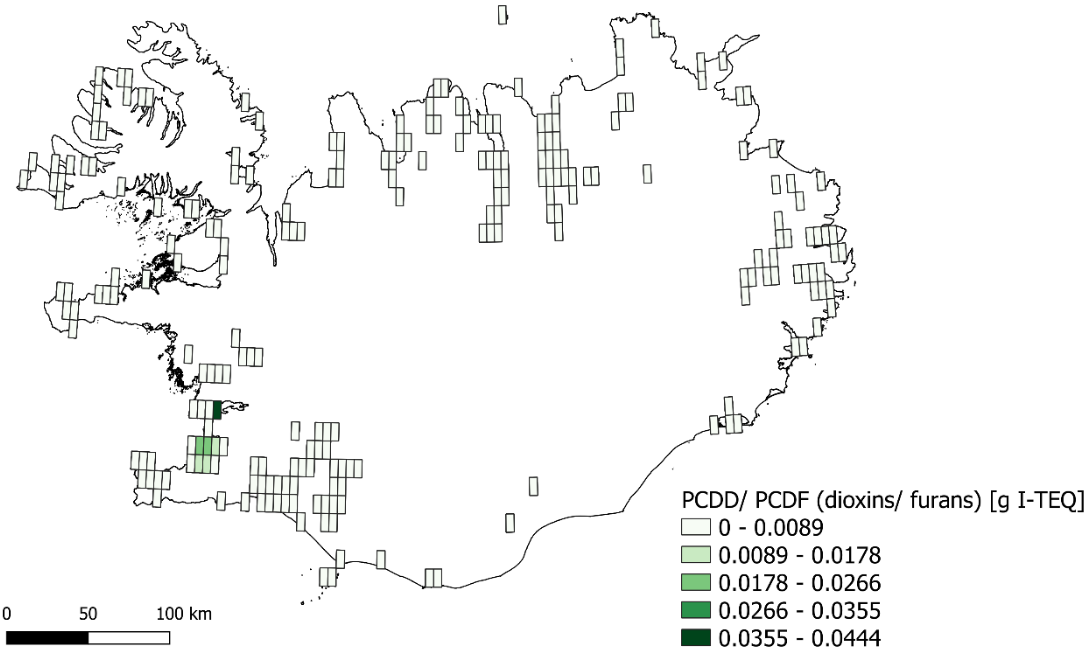


Figure 8.1 Emissions of dioxin/furans 2019 [g I-TEQ].

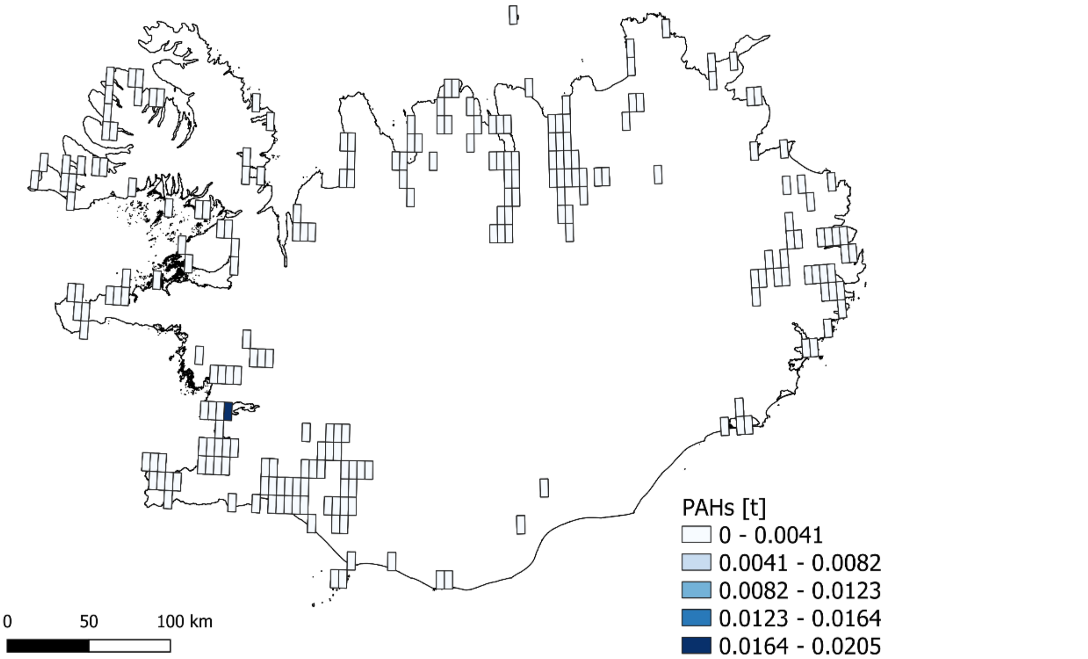


Figure 8.2 Emissions of PAHs [t] in 2019.

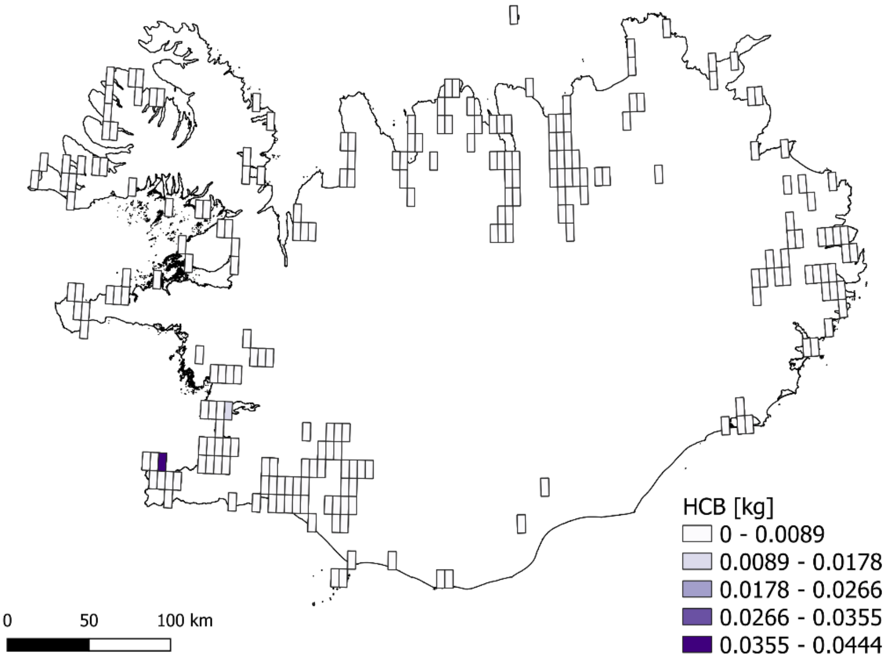


Figure 8.3 Emissions of HCB [kg] in 2019.

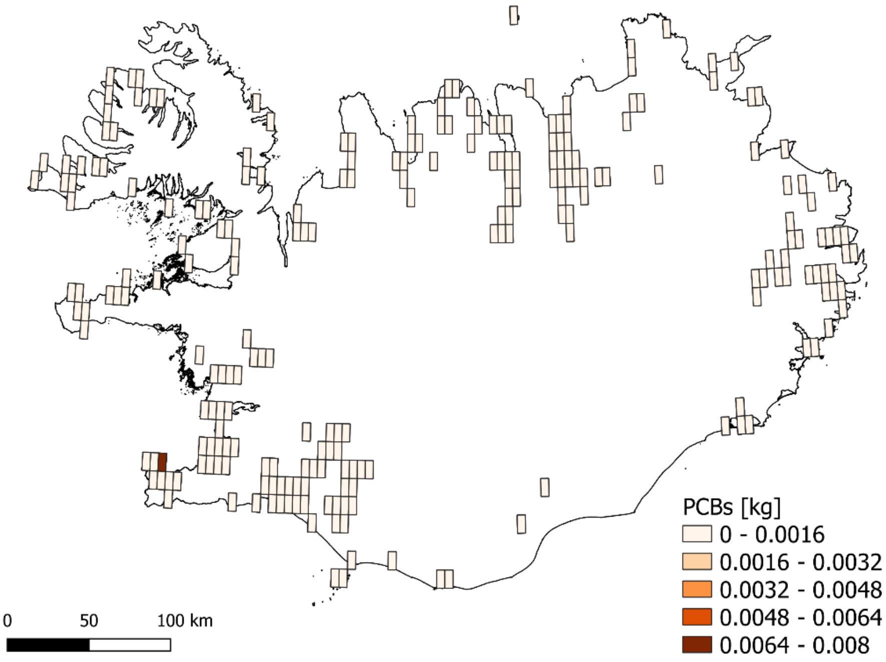


Figure 8.4 Emissions of PCBs [kg] in 2019.

8.4 Emissions 2015

The following figures show the national total emissions of dioxin/furans, PAHs, HCB, and PCB for the year 2015.

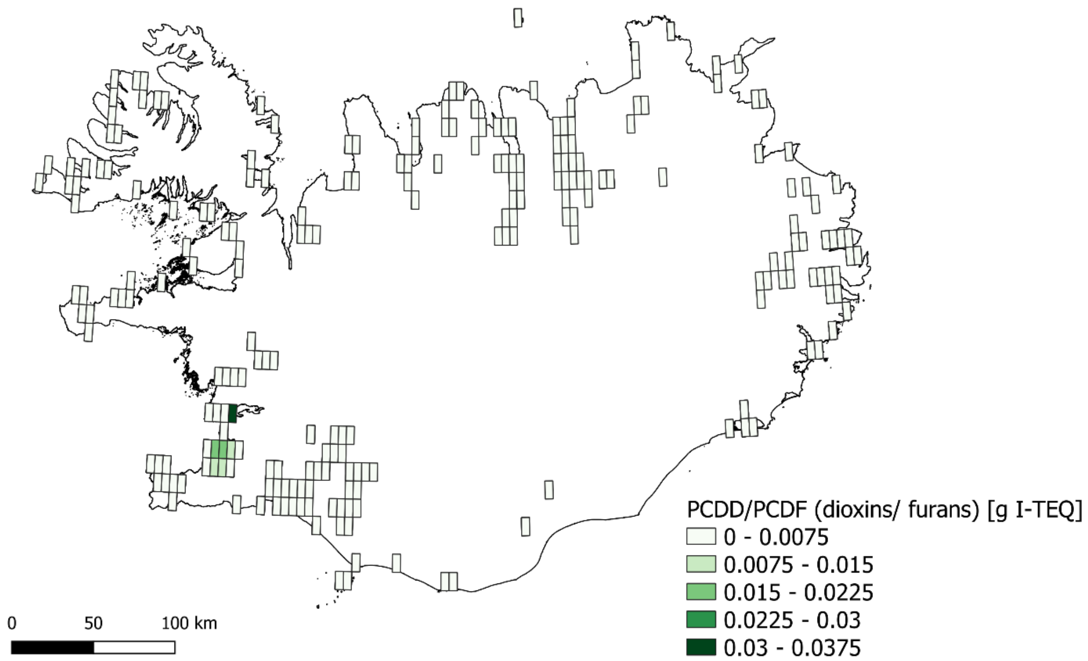


Figure 8.5 Emissions of Dioxin/furans 2015 in [g I-TEQ].

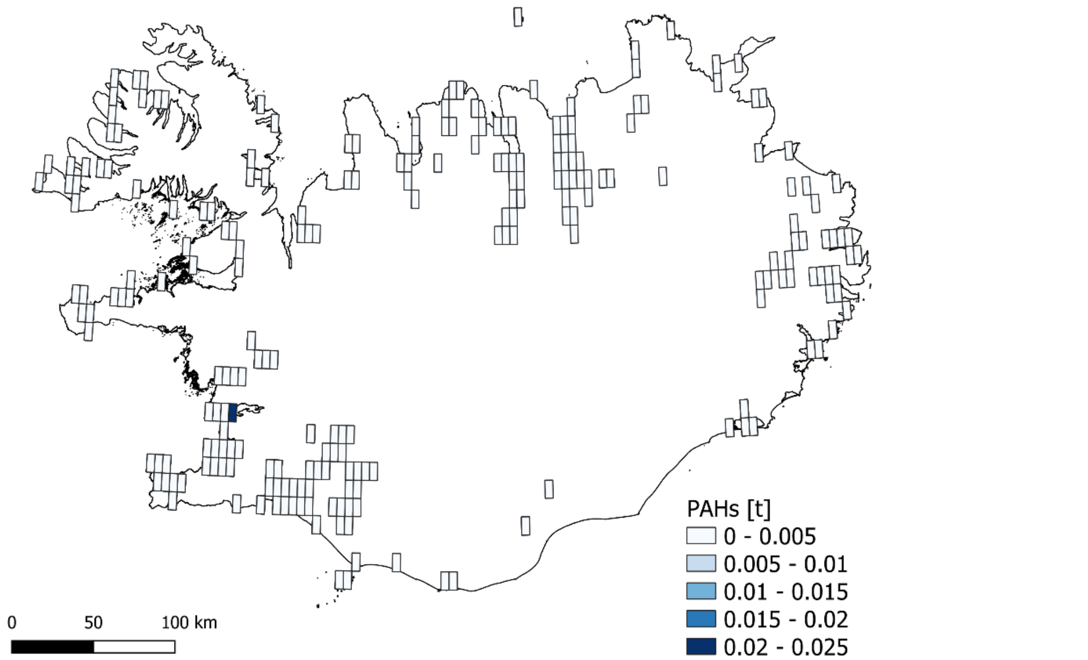


Figure 8.6 Emissions of PAHs [t] in 2015.

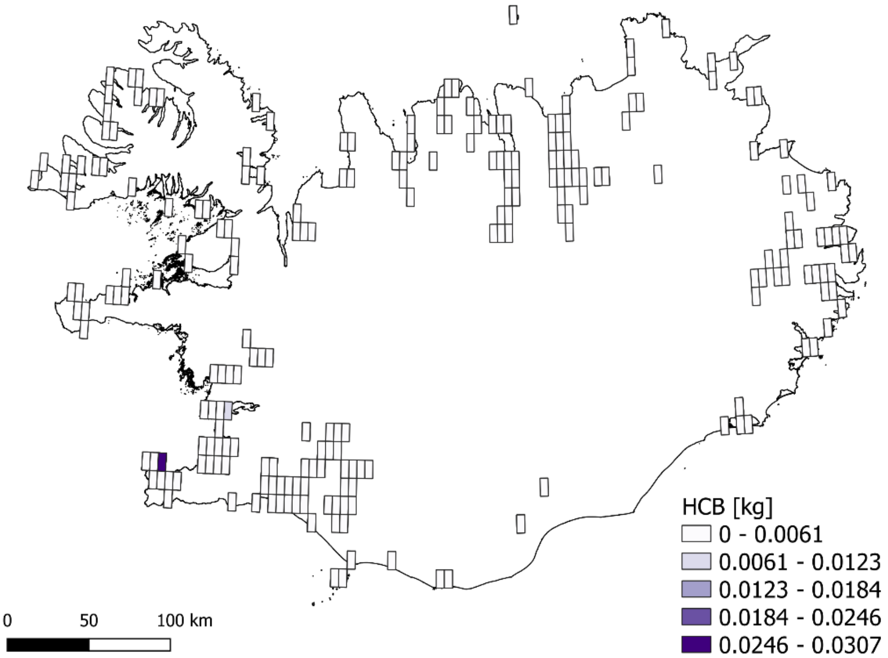


Figure 8.7 Emissions of HCB [kg] in 2015.

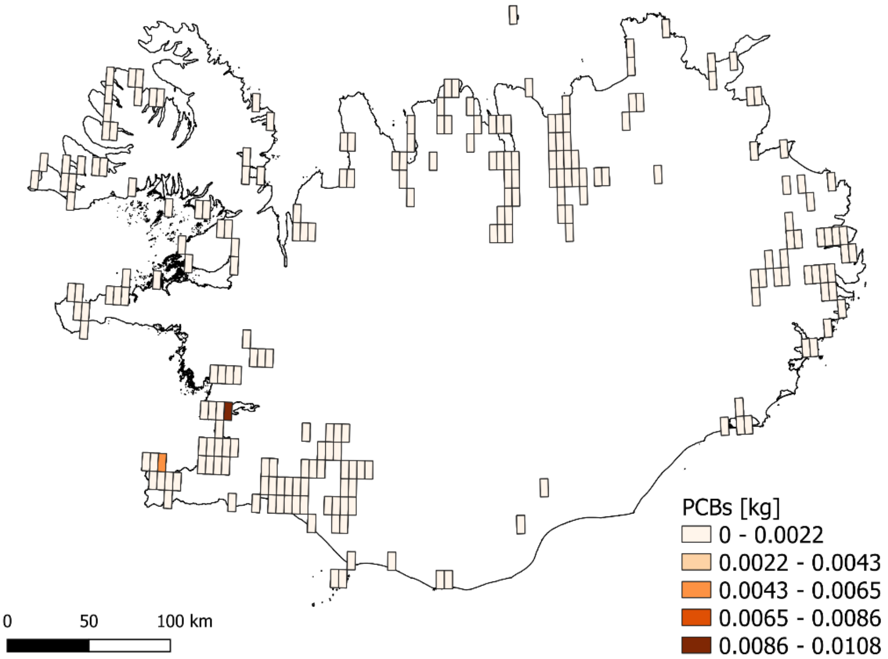


Figure 8.8 Emissions of PCBs [kg] in 2015.

9 Projections

Emissions of NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, BC, CO, dioxin, PAHs, HCB, PCB, and heavy metals are projected until 2050. The projections are predominantly based on historical trends. A summary of the projected emissions for these pollutants is presented in Table 9.1. The projections are built on one scenario, the **W**ith **E**xisting **M**easures (WEM) scenario. The projections, therefore, include existing measures based on current legislation. Additional measures to reduce emissions are not included in the projections. The trend by pollutant is presented in Chapter 2. The methodology and underlying assumptions for the projections are presented for each sector in the following subchapters.

Table 9.1 Emissions of all air pollutants. Historical data for 2005 and 2022 and projected emissions for 2030, 2040, and 2050.

Pollutant	Unit	2005	2022	2030	2040	2050	Change '22-'50	Change '05-'50
NO_x	[kt NO_2]	26.7	18.2	17.0	14.6	13.0	-28%	-51%
NMVOC	[kt]	7.2	5.6	6.1	5.7	5.6	+0.0%	-22%
SO_x	[kt SO_2]	37.2	62.0	47.5	52.9	58.2	-6.1%	+56%
NH_3	[kt]	4.5	4.4	4.3	4.2	4.1	-7.8%	-8.7%
$PM_{2.5}$	[kt]	1.4	1.0	1.1	1.0	1.0	+3.4%	-31%
PM_{10}	[kt]	2.9	2.2	2.1	2.1	2.1	-4.8%	-30%
TSP	[kt]	5.8	4.0	4.0	4.0	3.9	-1.2%	-32%
BC	[t]	231	91	84	75	67	-26%	-71%
CO	[kt]	50	105	109	108	108	+2.5%	+115%
Dioxin	[g I-TEQ]	0.95	0.73	0.67	0.66	0.66	-10%	-31%
PAH4	[t]	0.12	0.08	0.08	0.07	0.07	-20%	-42%
HCB	[kg]	0.72	0.11	0.11	0.11	0.11	-0.5%	-84%
PCB	[kg]	0.11	0.016	0.014	0.014	0.013	-20%	-88%
Pb	[t]	1.95	0.69	0.71	0.58	0.48	-30%	-75%
Cd	[kg]	69	131	139	138	138	+5%	+99%
Hg	[kg]	32	10	9.8	9.2	9.2	-8%	-71%
As	[kg]	95	145	152	150	149	+2%	+57%
Cr	[kg]	178	240	239	200	175	-27%	-2%
Cu	[t]	2.8	3.4	3.4	2.5	2.0	-42%	-27%
Ni	[t]	1.9	1.9	2.0	1.9	1.9	+2%	+2%
Se	[kg]	31	20	19	16	14	-29%	-55%
Zn	[t]	2.9	5.7	6.0	5.9	5.8	+1.7%	+98%

9.1 Projected Trends by Pollutant

9.1.1 Nitrogen Oxides (NO_x)

The projected decrease in emissions in the next decade is due to a decrease in fuel use. Figure 9.1 shows historical NO_x emissions from 2005 and projected emissions to 2050.

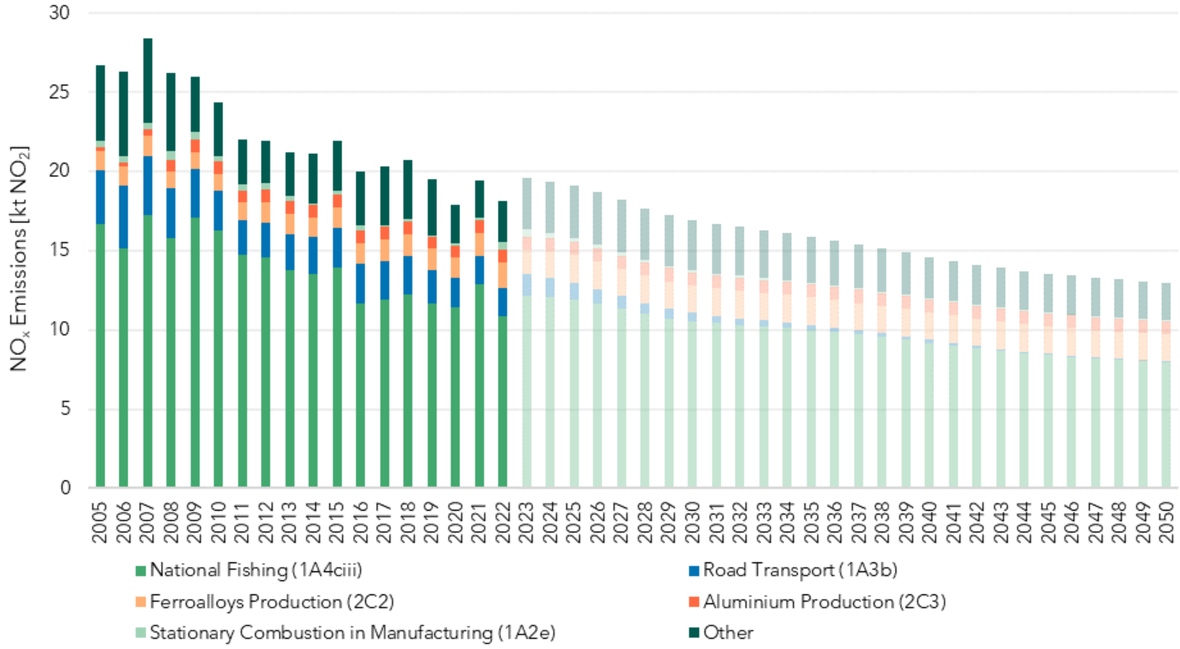


Figure 9.1 NO_x emissions by main sources. Historical data and projections, 2005-2050.

9.1.2 Non-methane Volatile Organic Compounds (NMVOCs)

The decrease in emissions since 2005 is mainly due to the renewal of the car fleet. This trend is projected to continue until 2050. A further decrease in NMVOC emissions is due to reduced emissions from Waste. One reason for the projected reduction in waste emissions is a ban on landfilling organic waste in the year 2023. An increase in the emissions from 2H2 Food and Beverages Industry is due to increased production and export of spirits. Figure 9.2 shows the historical NMVOC emissions from 2005 and projected emissions to 2050.[17]

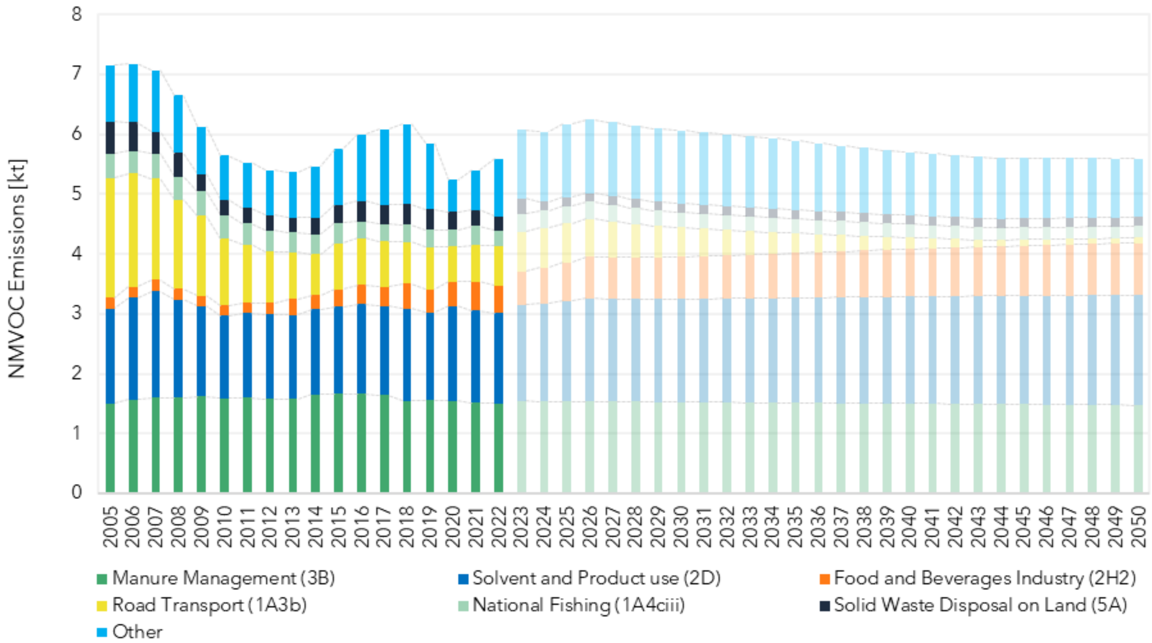


Figure 9.2 NMVOC emissions by main sources. Historical data and projections, 2005-2050.

[17] The figure includes emissions from 3B Manure Management and 3D Agricultural Soils, but these emissions are not accounted for in the national emission reduction commitments (see Article 4, paragraph 3d of Directive (EU) 2016/2284). At the time of this writing, work is underway by the Icelandic government to evaluate and work at the incorporation of the new National Emissions Ceilings Directive (Directive (EU) 2016/2284) into the EEA agreement.

9.1.3 Sulfur Oxides (SO_x)

Geothermal energy exploitation is the largest source of sulphur emissions in Iceland. Sulphur is emitted from geothermal power plants in the form of H_2S. Emissions from this source (shown in Figure 9.3 as 1B2d Other Fugitive Emissions from Energy Production) have increased substantially since 2005 due to an increase in electricity production at geothermal power plants. However, in recent years, SO_2 emissions have started decreasing following the onset in 2014 of a sulphur capture and storage project (*Sulfix*) at one of the geothermal power plants (*Hellisheiði Power Plant*).

Further capture and storage are planned at *Hellisheiði* and another geothermal plant (*Nesjavellir Power Plant*). This explains the projected decrease in emissions between 2029 and 2030, overall emissions increase again with increasing energy production. Figure 9.3 shows the historical SO_x emissions from 2005 and projected emissions to 2050.

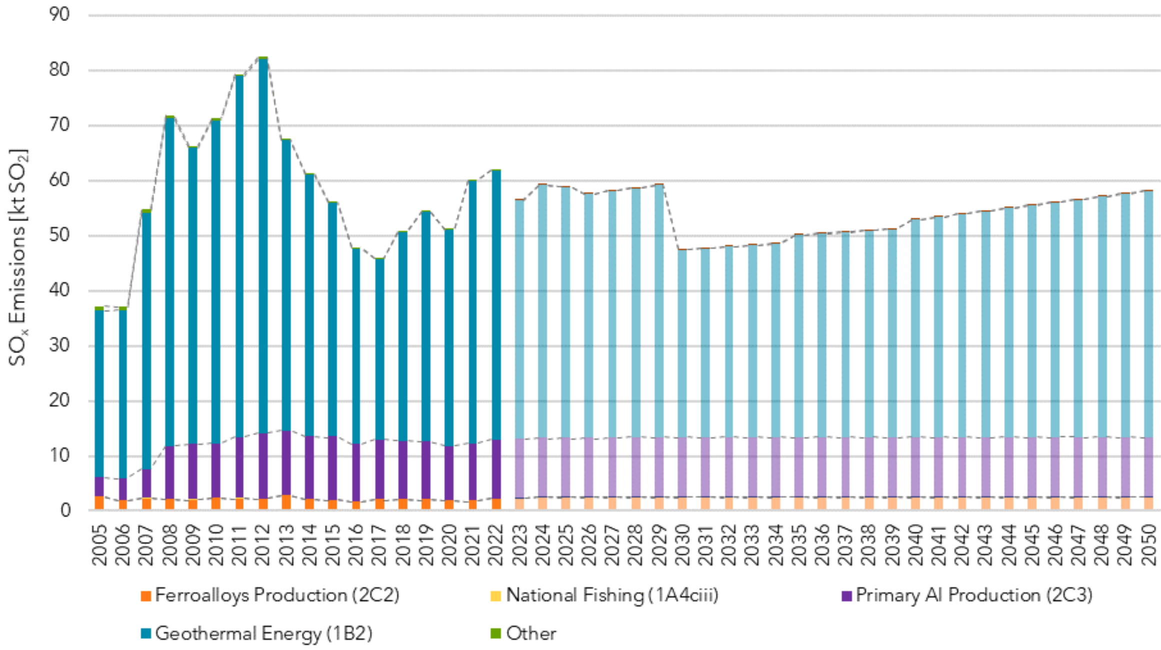


Figure 9.3 SO_x emissions by main sources. Historical data and projections, 2005-2050.

9.1.4 Ammonia (NH_3)

Projected emissions of NH_3 are expected to decrease over the next decade due to a decrease in livestock numbers. Figure 9.4 shows historical NH_3 emissions from 2005 and projected emissions to 2050.

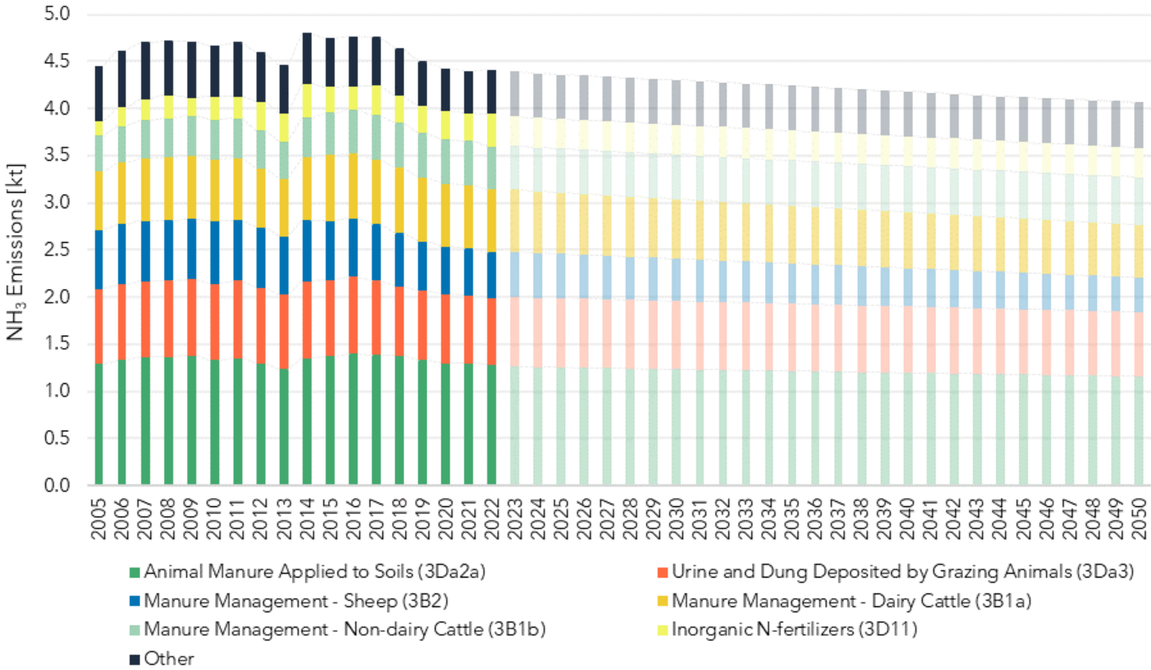


Figure 9.4 NH_3 emissions by main sources. Historical data and projections, 2005-2050.

9.1.5 Particulate Matter ($PM_{2.5}$, PM_{10}, TSP)

Particulate matter emissions are projected to remain relatively constant until 2050. Figure 9.5, Figure 9.6, and Figure 9.7 show the historical particulate emissions from 2005 and projected emissions to 2050.

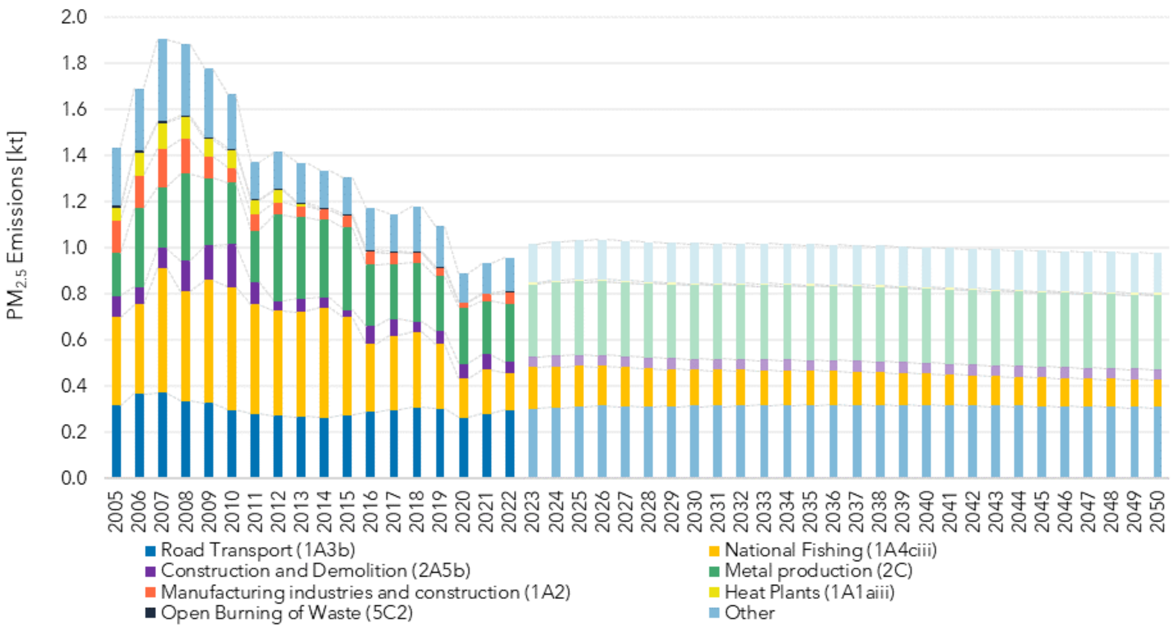


Figure 9.5 $PM_{2.5}$ emissions by main sources. Historical data and projections, 2005-2050.

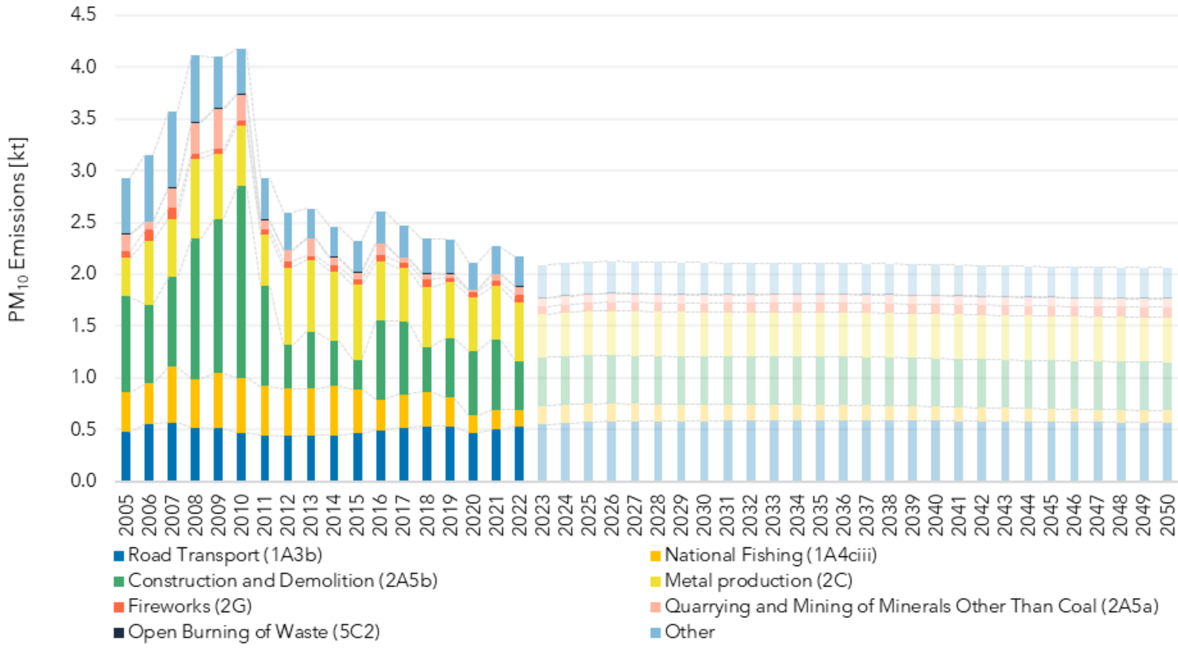


Figure 9.6 PM_{10} emissions by main sources. Historical data and projections, 2005-2050.

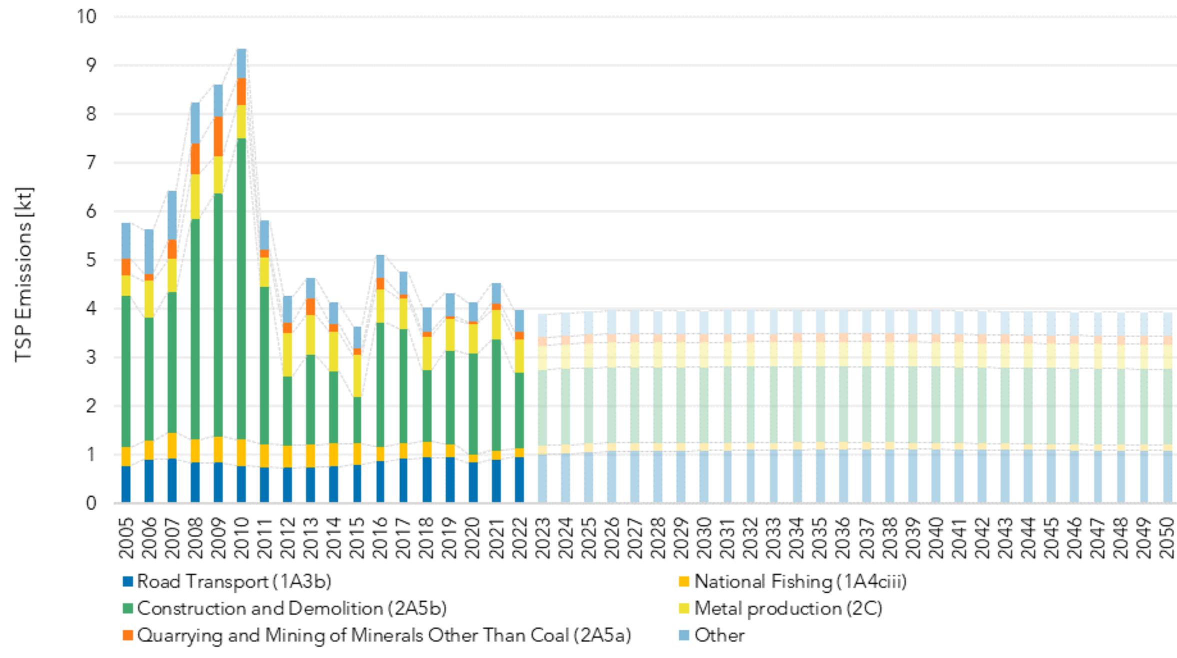


Figure 9.7 TSP emissions by main sources. Historical data and projections, 2005-2050.

9.1.6 Black Carbon (BC)

Black carbon emissions have decreased in the last years and are projected to decrease further. The main reason for the expected decrease is that emission control systems in vehicle engines have improved. Figure 9.8 shows the historical BC emissions from 2005 and projected emissions to 2050.

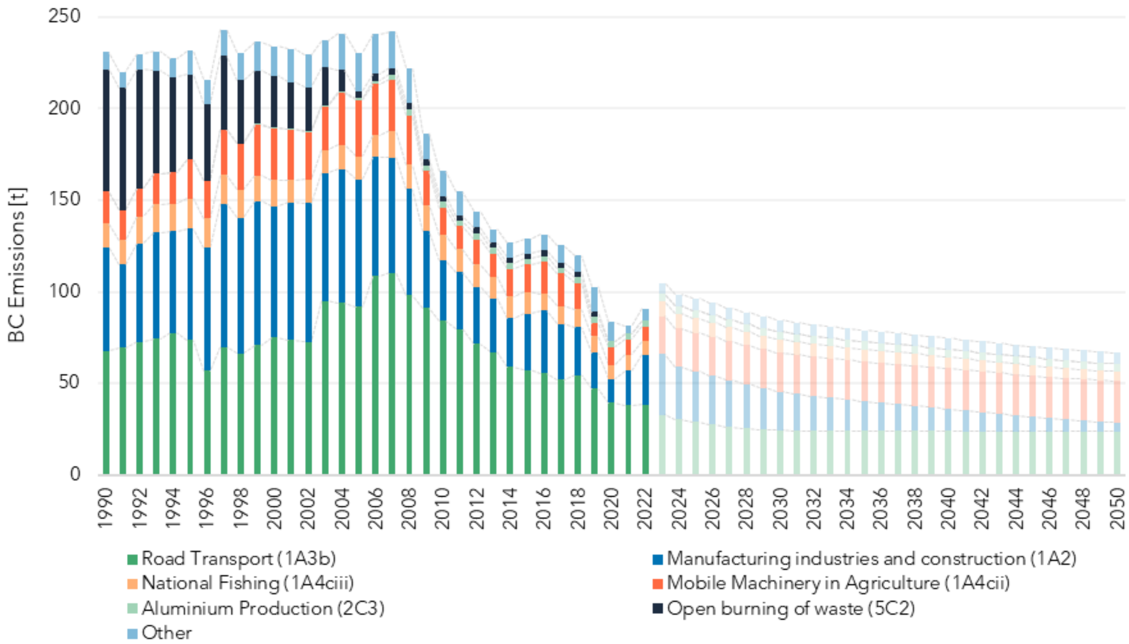


Figure 9.8 BC emissions by main sources. Historical data and projections, 2005-2050.

9.1.7 Carbon Monoxide (CO)

Carbon monoxide emissions are dominated by 2C3 Aluminium Production and are expected to remain relatively stable. Figure 9.9 shows the historical CO emissions from 2005 and projected emissions to 2050.

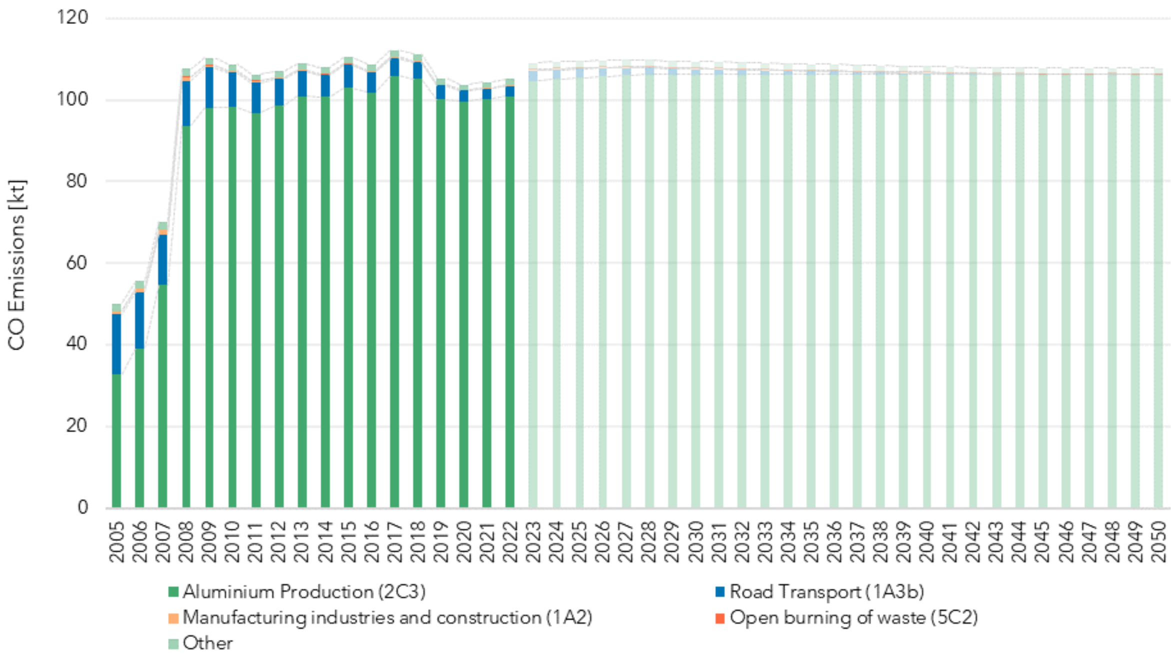


Figure 9.9 CO emissions by main sources. Historical data and projections, 2005-2050.

9.1.8 Dioxin

Dioxin emissions are projected to remain relatively stable from the present to 2050. Figure 9.10 shows the historical dioxin emissions from 2005 and projected emissions to 2050.

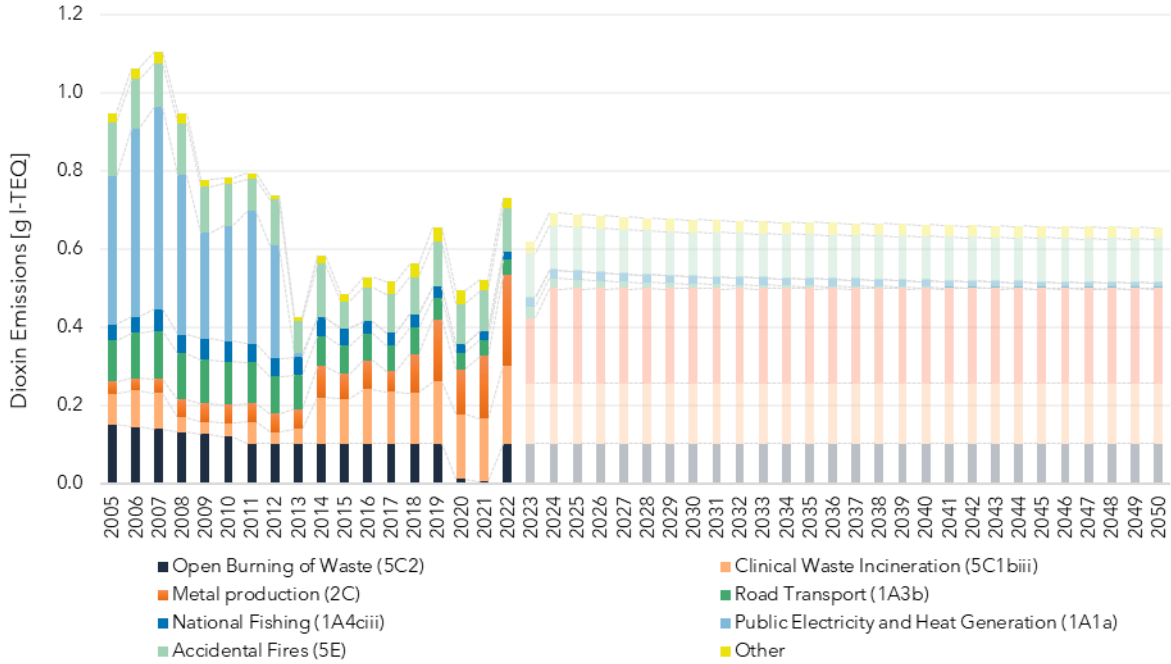


Figure 9.10 Dioxin emissions by main sources. Historical data and projections, 2005-2050.

9.1.9 Polycyclic Aromatic Hydrocarbons (PAHs)

PAH emissions are expected to trend slightly downwards until 2050, highlighted by projected reductions in 1A3b Road Transport. Figure 9.11 shows the historical PAH emissions from 2005 and projected emissions to 2050.

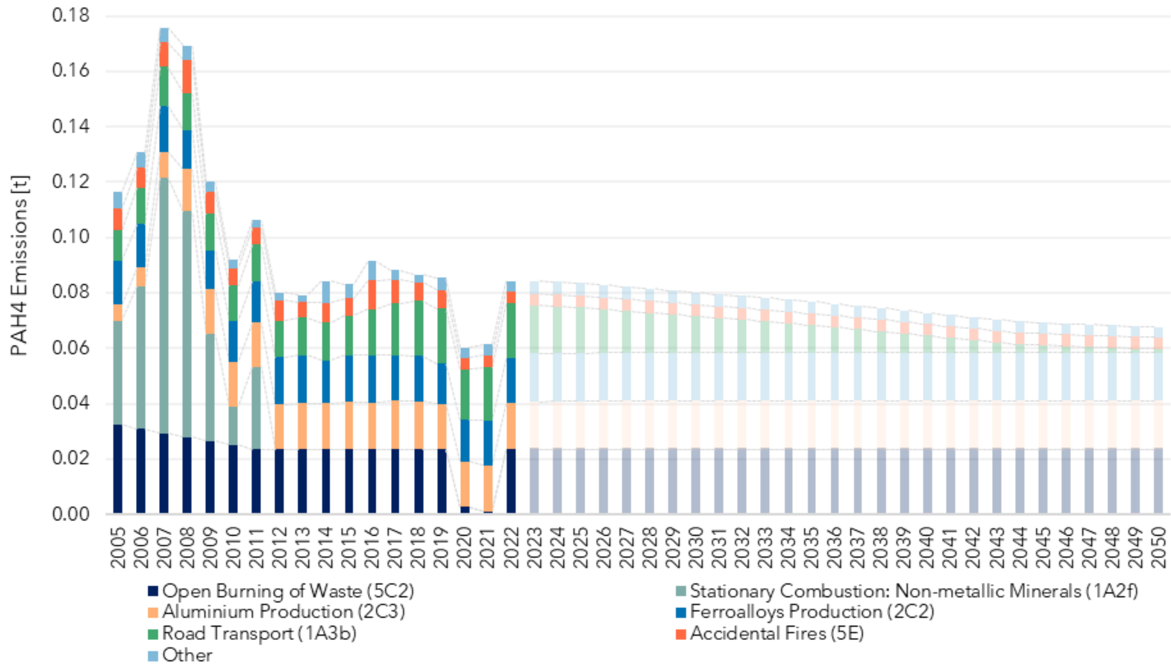


Figure 9.11 PAH4 emissions by main sources. Historical data and projections, 2005-2050.

9.1.10 Hexachlorobenzene (HCB)

HCB emissions are projected to remain relatively stable from the present to 2050. Figure 9.12 shows the historical HCB emissions from 2005 and projected emissions to 2050.

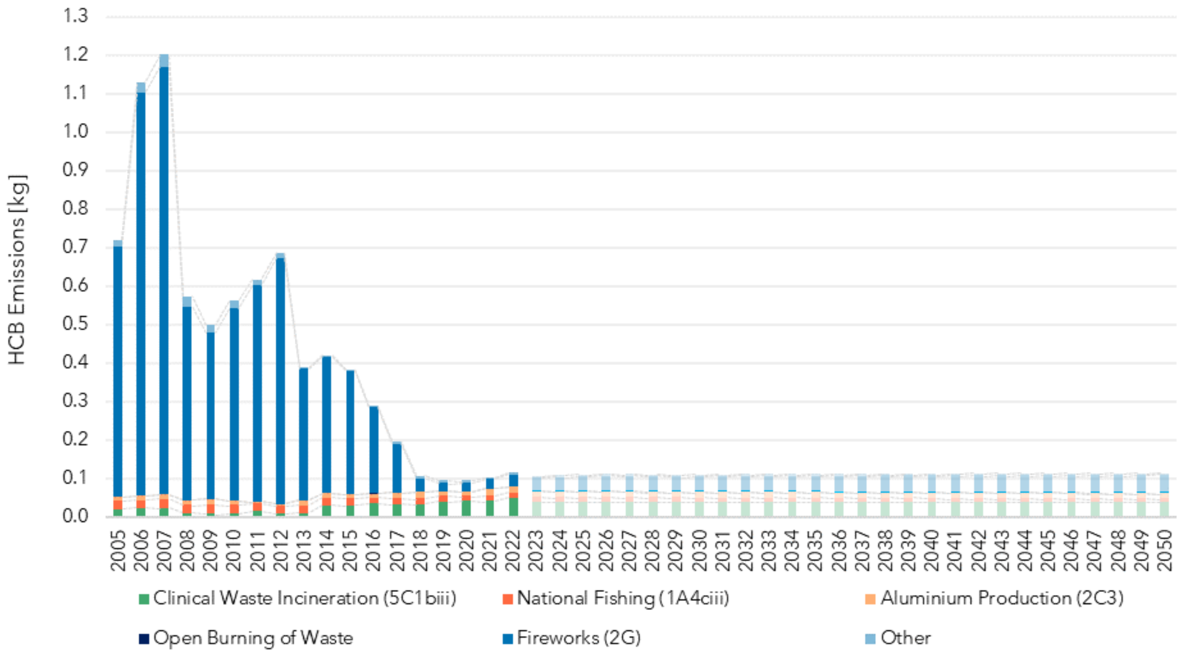


Figure 9.12 HCB emissions by main sources. Historical data and projections, 2005-2050.

9.1.11 Polychlorinated Biphenyl (PCB)

PCB emissions are projected to remain relatively stable from the present to 2050. Figure 9.13 shows the historical PCB emissions from 2005 and projected emissions to 2050.

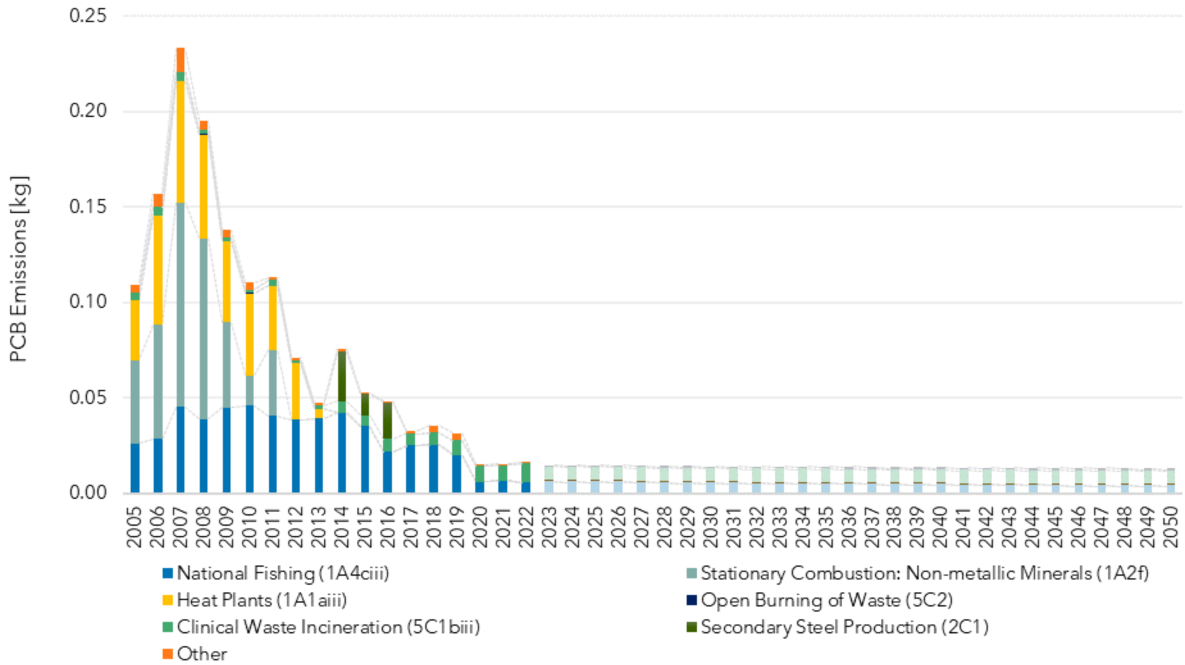


Figure 9.13 PCB emissions by main sources. Historical data and projections, 2005-2050.

9.1.12 Priority Heavy Metals (Pb, Cd, Hg)

Projections for the main heavy metals (lead, cadmium, and mercury) are displayed here in Figures Figure 9.14, Figure 9.15, and Figure 9.16, respectively. These figures include historical data from 2005 and projected emissions to 2050.

9.1.12.1 Lead (Pb)

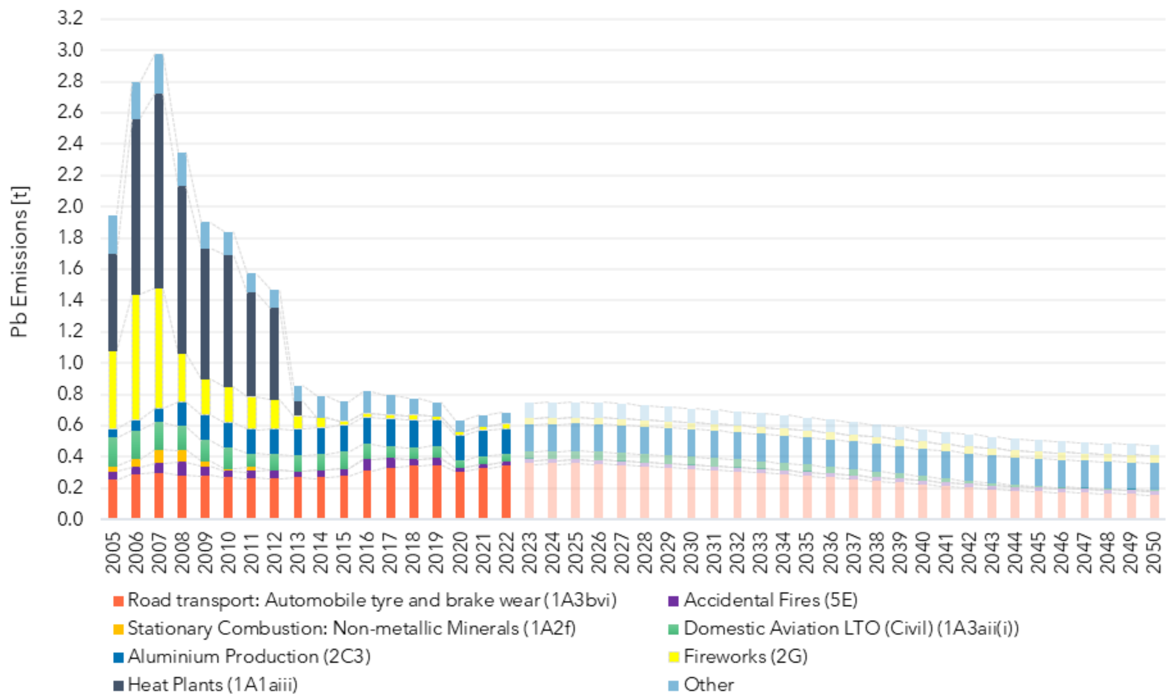


Figure 9.14 Pb emissions by main sources. Historical data and projections, 2005-2050.

9.1.12.2 Cadmium (Cd)

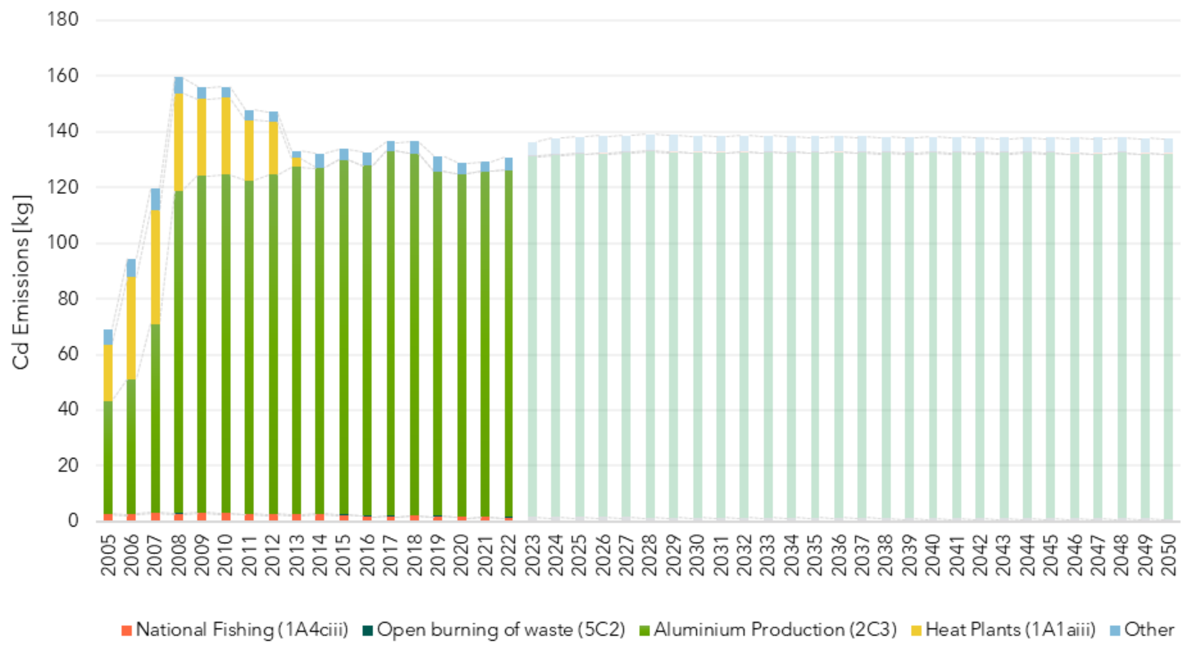


Figure 9.15 Cd emissions by main sources. Historical data and projections, 2005-2050.

9.1.12.3 Mercury (Hg)

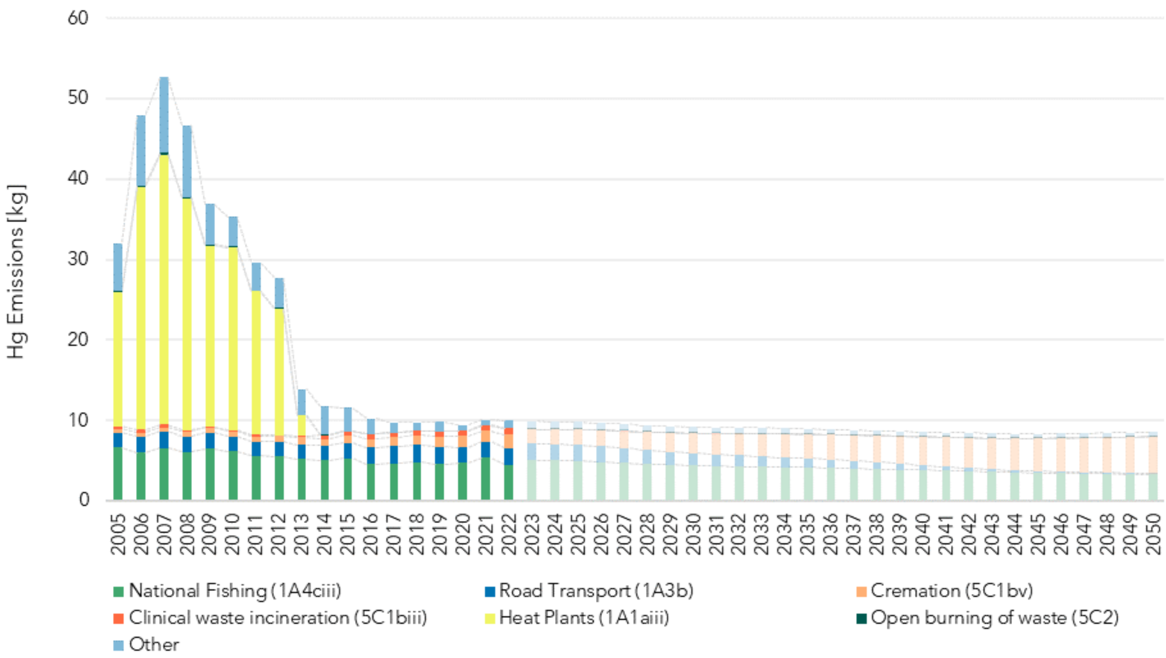


Figure 9.16 Hg emissions by main sources. Historical data and projections, 2005-2050.

9.1.13 Additional Heavy Metals (As, Cr, Cu, Ni, Se, Zn)

Projections for additional heavy metals (arsenic, chromium, copper, nickel, selenium, and zinc) are displayed here in Figures Figure 9.17, Figure 9.18, Figure 9.19, Figure 9.20, Figure 9.21, and Figure 9.22, respectively. These figures include historical data from 2005 and projected emissions to 2050.

9.1.13.1 Arsenic (As)

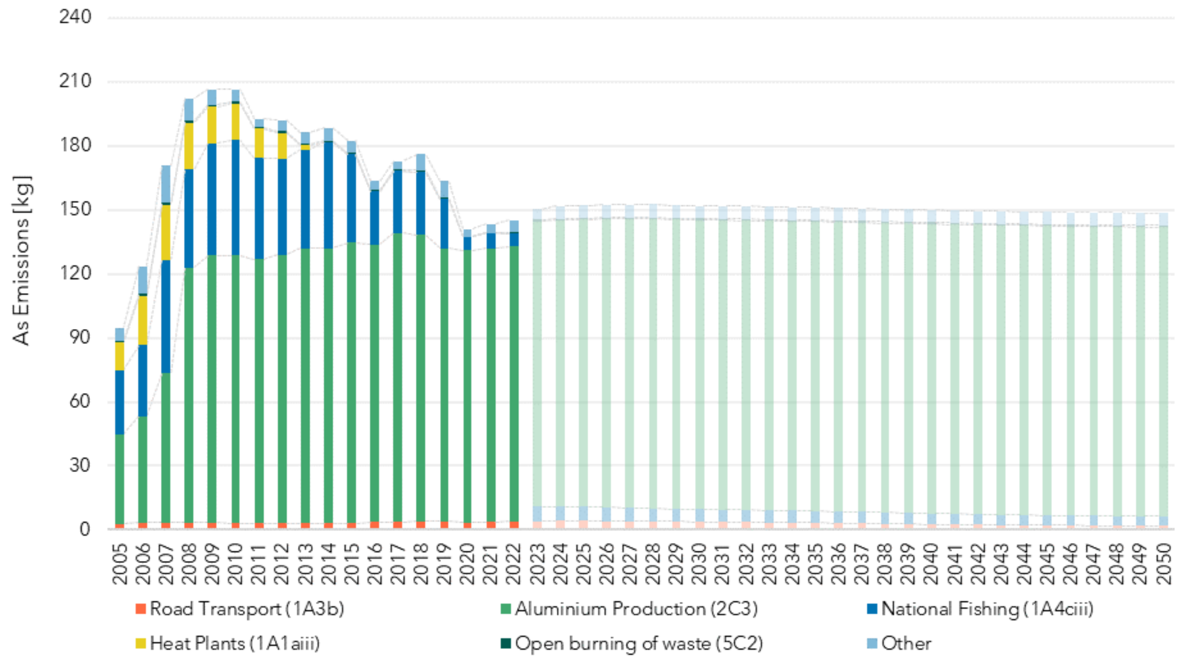


Figure 9.17 As emissions by main sources. Historical data and projections, 2005-2050.

9.1.13.2 Chromium (Cr)

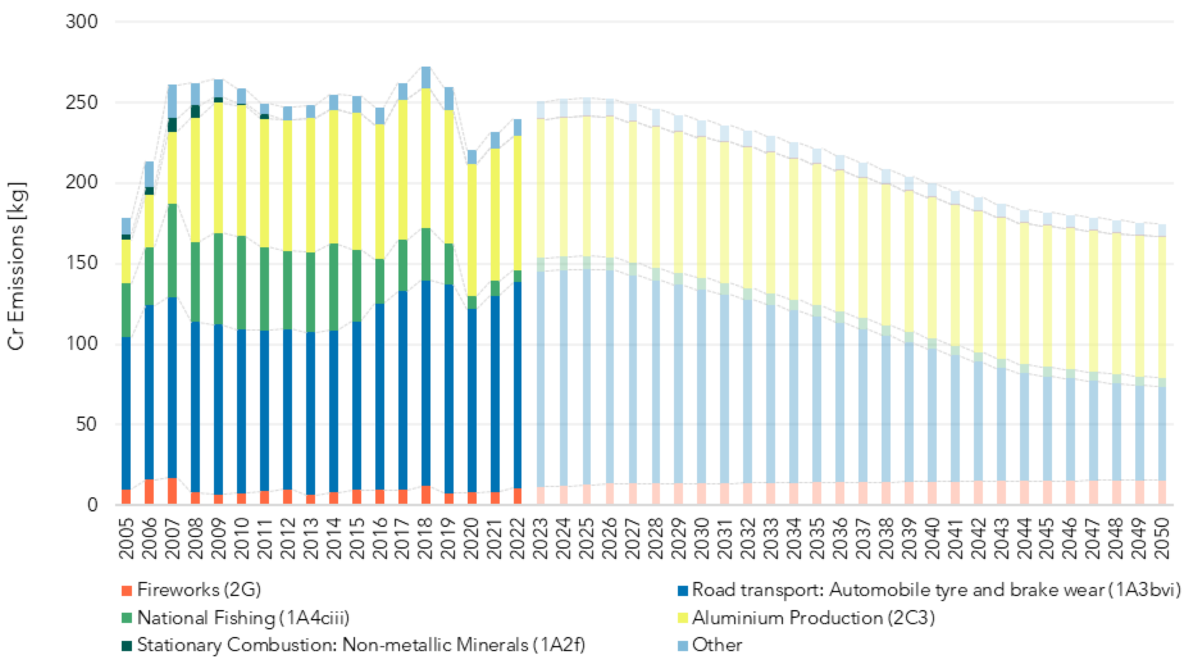


Figure 9.18 Cr emissions by main sources. Historical data and projections, 2005-2050.

9.1.13.3 Copper (Cu)

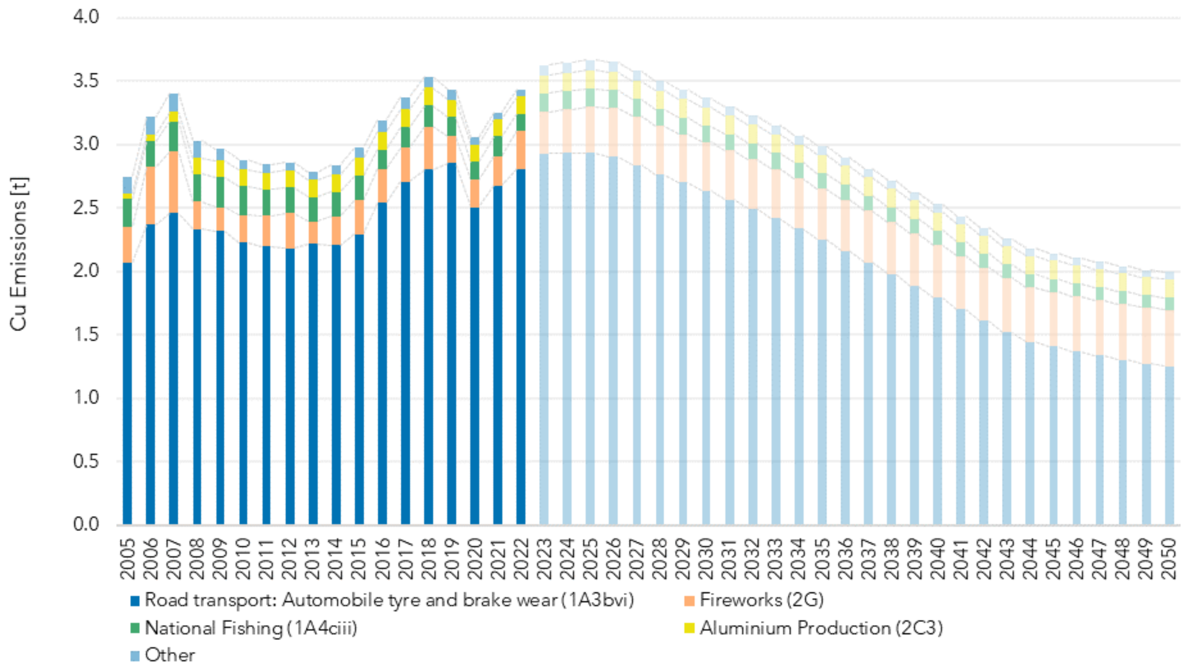


Figure 9.19 Cu emissions by main sources. Historical data and projections, 2005-2050.

9.1.13.4 Nickel (Ni)

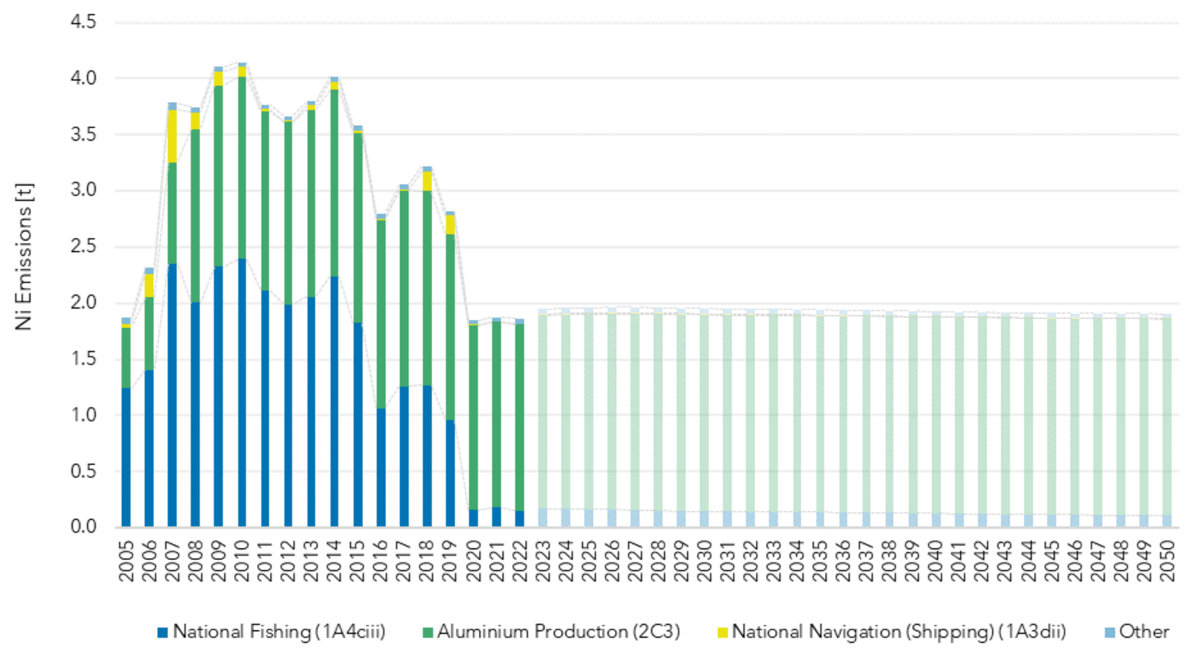


Figure 9.20 Ni emissions by main sources. Historical data and projections, 2005-2050.

9.1.13.5 Selenium (Se)

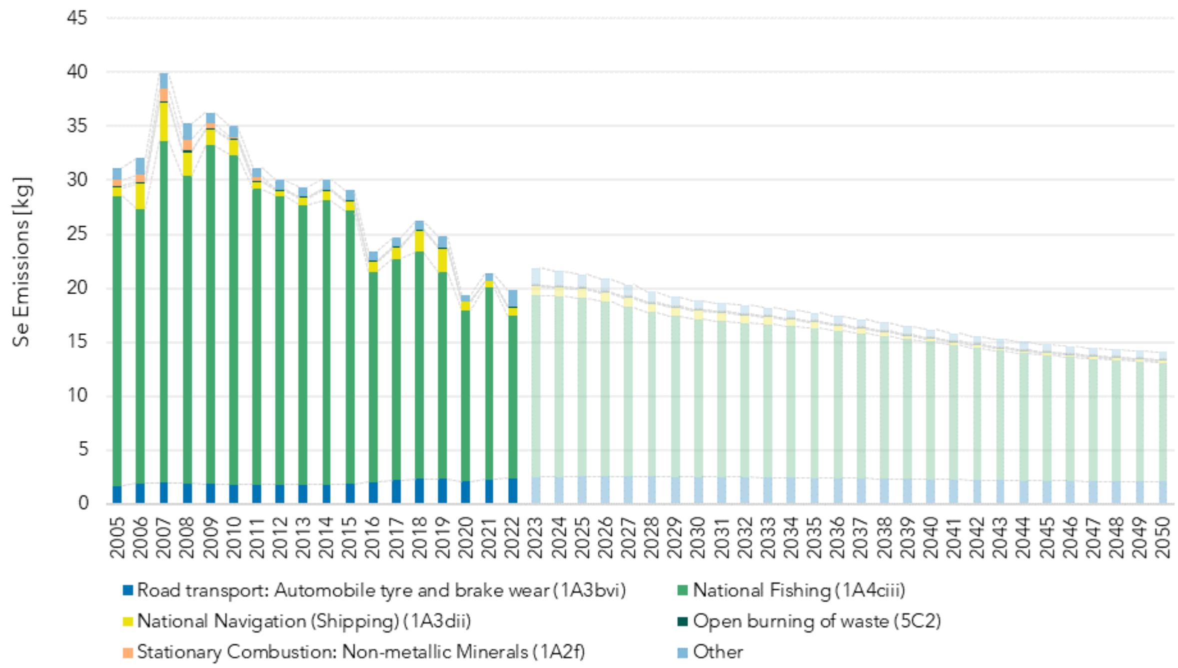


Figure 9.21 Se emissions by main sources. Historical data and projections, 2005-2050.

9.1.13.6 Zinc (Zn)

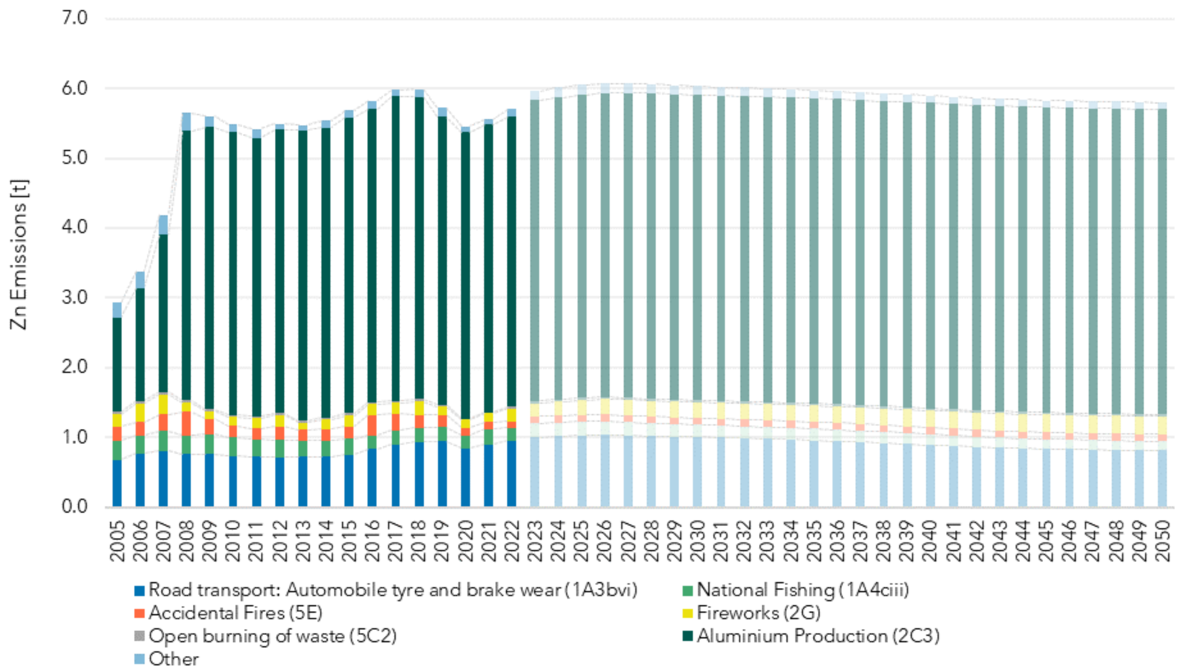


Figure 9.22 Zn emissions by main sources. Historical data and projections, 2005-2050.

9.2 Energy

9.2.1 Methodology

The methods used in the emission projections follow the methodologies for the emission inventory as described in Chapter 2.4.2.

9.2.2 Activity Data

Projections for the Energy sector are based on fuel projections generated by the National Energy Authority (NEA) (*Orkustofnun*) in the Fuel Use Projection 2022-2060 (Orkustofnun, 2022). The Fuel Use Projection 2021-2060 is based on existing projections and assumptions about economic development, energy transition, and oil use. The projection is as well based on existing laws and regulations which impact oil use, such as a recent ban on the use of residual fuel oil within Icelandic territorial waters (Orkustofnun, 2022). Fuel projections were available by fuel type and activity.

Activity data for the 1B2d Geothermal Energy is based on a geothermal energy consumption projections by the NEA.[18] The main assumptions of the projection are population growth, economic development, development of the total size of apartments, offices, and other heated spaces, and development of economic sectors using geothermal energy. Data from individual geothermal power companies about projected amounts of sulphur captured and stored was also collected for the SO_x emission projection.

Emissions from 1A3b Road Transport are estimated using COPERT 5.6.1 which follows the methodology presented in 2019 EEA/EMEP Guidebook. Projected fuel use was obtained from the Fuel Use Projection 2022-2060 while activity data on vehicle stock numbers by vehicle type and other road transport activity data for COPERT was obtained from the SIBYL baseline.[19]

9.2.3 Emission Factors

The emission factors used in the emissions projections are the same as are used for the emission inventory as described in Chapter 2.4.2 for the last historical year of the inventory.

9.3 Industrial Processes and Product Use (IPPU)

9.3.1 Methodology

The methods used in the emission projections follow the methodologies for the emission inventory as described in Chapter 4.

[18] Orkustofnun, 2021, unpublished.
[19] https://www.emisia.com/utilities/sibyl-baseline/

9.3.2 Activity Data

For the 2C2 Ferroalloys Production and 2C3 Primary Aluminium Production, the projected production amount is communicated from the individual companies. For activity within other subsectors (2A, 2D, 2G, 2H, and 2C3 Secondary Aluminium), the projected activity data is in some cases assumed to be the same as the average of the activity data in the past (appropriate range is chosen on a case-by-case basis). In other cases, where there is good correlation in the past with proxy data, the projected proxy data is used as a proxy to project the activity data. The most common proxy data is population number and GDP. The projected population is from Statistics Iceland (*Hagstofa Íslands*) (SI) (Hagstofa Íslands, 2022) and the GDP projection used by the NEA in the Fuel Use Projection 2022-2060 (Orkustofnun, 2022). See more details in chapter about IPPU in Iceland's Report on Policies and Measures and Projections.

9.3.3 Emission Factors

The emission factors used in the emissions projections are the same as are used for the emission inventory as described in Chapter 4 for the last historical year of the inventory. Communication between the EAI and the primary aluminium and ferroalloys plants was made to examine if other emission factors are expected in the future. That is not the case for this projection.

9.4 Agriculture

9.4.1 Methodology

The methods used in the emission projections follow the methodologies for the emission inventory as described in Chapter 5.

9.4.2 Activity Data

The projections on how the Agriculture sector will develop have been based on historical trends in the activity data and expert judgment. The trend in livestock populations has been predicted by extrapolation to 2050 based on the historical available data. The historical data is collected from the Ministry of Food, Agriculture, and Fisheries (*Matvælaráðuneytið*) (MFAF) and are the same numbers which are used for agriculture calculations in the latest IIR.

To assess the best possible trends considering the variability of the historical data, experts from the MFAF and the Icelandic Agricultural Advisory Centre, were consulted. Those experts determined the most representative projections for each livestock category, based on their expectation of future developments in each agricultural sector. Impacts of agricultural contracts, consumer behaviour and the level of imports of agricultural goods were also taken into consideration. The agricultural contracts will be renegotiated in 2026, at which point the projections in each livestock category may change.

The conclusion was that livestock numbers for cattle were linearly projected based on the timeseries 1980-2022 and the composition of this category (dairy cattle, other mature cattle, growing cattle) was calculated based on the average of the years 2016-2022.

Horses were also extrapolated using the available historical data (1990-2022), as were fur animals (incl. minks and rabbits). In the category sheep (mature ewes, other mature sheep, animals for replacement, lambs), the livestock numbers were projected using a 10-year trend (2013-2022) as the more recent years reflect the actual development in sheep farming better. Swine, goats, and poultry are also calculated using the 10-year trend.

All other parameters necessary for livestock characterisation (such as pregnancy rates, days on pastures/in housing, feed digestibility, weight, and age at slaughter) were kept constant over the projected time series and correspond to the values in the latest IIR submission, except for the milk yield. Because the milk yield per dairy cow has historically been increasing, the milk yield per dairy cow was projected based on the linear historical trend.

Other sources of emissions, such as the use of organic and inorganic N-fertilizers, liming, and the use of urea are predicted by linear interpolation of historical trends. The areas for the calculations of emissions from drained organic soils are communicated from the Soil Conservation Service of Iceland which is calculating projections for the LULUCF sector.

9.4.3 Emission Factors

The emission factors used in the emissions projections are the same as are used for the emission inventory as described in Chapter 5.

9.5 Waste

9.5.1 Methodology

The methods used in the emission projections follow the methodologies for the emission inventory as described in Chapter 6.

9.5.2 Activity Data

The projections in the Waste sector, for the subcategories Solid Waste Disposal (5A), Biological Treatment of Solid Waste (5B), and Incineration and Open Burning of Waste (5C) are each estimated based on the annual amount of waste handled in each sector, projected in correlation with historical data, taking into account the existing policies and operating permits of waste handling companies.

9.5.3 Emission Factors

The emission factors and parameters used in the emission projections are the same as in the emission inventory as described in Chapter 6.

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Annexes to the National Inventory Report

Annex 1 Iceland QA/QC Checks

Additionally, the following QA/QC checks have been performed on the Icelandic inventory:

- Recalculation Check – Comparing the values reported in the current (2022) and previous (2021) versions of the inventory for the base year (1990) and the most recent year covered by both versions (2021).
- Negative and Zero Values Checks – To highlight the occurrence of negative values and zero values in the inventory.
- Notation Keys Check – To summarise the occurrence of each notation key to ensure consistency and accuracy in the inventory.
- PAHs Sum Check – To ensure that the sum of the four reported PAHs equals the reported "total" PAH emissions.
- Particulate Matter Check - To ensure that reported TSP emissions are greater than or equal to PM_{10}, and similarly that reported PM_{10} emissions are greater than or equal to $PM_{2.5}$.
- Trends Check – To draw attention to large changes in emissions between any two adjacent years, from 2015 onwards.

In all cases, the findings of the checks are reviewed, not only to identify where corrections may be required, but also to consider whether there are any steps of the inventory compilation process that need improvement. In addition, reviewing the results also provides information on whether the individual checks are well designed and comprehensive.

This ensures that all results from the QA/QC process feed back into the continuous improvement programme.

Recalculation Check

This QA/QC file compares the emissions between the current and previous submissions, for the base year and the latest common year in both submissions (current year – 3). The data has been compiled in a way that changes in the data are easily identified. Justifications for change are provided where required. The current recalculation check considers all of the reported pollutants and sectors.

The recalculations check calculates the actual difference between the current and previous submission. If one or both values are notation keys, and are not the same in both submissions, then this is highlighted. If the values in both submissions are numeric but not equal, then the difference in submissions as a percentage of the current submissions is also shown. In addition, where differences occur the cells are highlighted for ease of reference. This process of identifying recalculation changes and the documentation of changes is in line with Chapter A.4 of the 2023 EMEP/EEA Guidebook regarding the reporting of recalculations. Where a recalculation change occurs, it is necessary to check that the underlying reasons are understood and considered reasonable.

Negative and Zero Values Check

Checks were performed to identify whether any negative or zero values occur in the NFR Annex I submission file.

Notation Keys Check

The number of occurrences of notation keys (NA, NE, NO, and IE) in the NFR Annex I submission file are presented. This QA/QC check is used to ensure that notation keys are applied consistently and accurately within the inventory. The occurrence of notation keys is presented as a count for each NFR code with highlighted cells for ease of reference.

PAH Sum Check

This is a sum check to identify whether the sum of the reported emissions for benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and Indeno(1,2,3-cd)pyrene equals the reported emissions for "total" four PAHs. This check is performed for each reported NFR code and year for the current submission. Where the sum of the PAHs does not equal the "total," cells are highlighted for ease of reference and where required the cause for differences are documented.

Particulate Matter Check

This check identifies any categories where the emissions reported for TSP are less than PM_{10} emissions and where PM_{10} emissions are less than $PM_{2.5}$ emissions. This enables the identification of errors in reported PM emissions based on the assumption that TSP $\geq PM_{10} \geq PM_{2.5}$. This check is performed for each reported NFR code and year for the current submission. Where errors in reported PM emissions are identified, cells are highlighted for ease of reference and where required documentation is provided.

Trends Check

This check highlights large changes in emissions between any two adjacent years from 2015 onwards, using a colour scale which makes larger percentage changes stand out. Documentation is provided where needed.

Annex 2 KCA Results for 1990 and Trends 1990-2022

NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, and CO

Table A2.1 Key categories for NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, and CO, 1990.

Component	Key Categories (Sorted from high to low from left to right and top to bottom)					Total (%)
NO_x	National Fishing	Road Transport: Passenger Cars	Road Transport: Heavy Duty Vehicles and Buses	Stationary Combustion in Manufacturing Industries and Construction (Food Processing)		81.8%
	NFR 1A4ciii	NFR 1A3bi	NFR 1A3biii	NFR 1A2e		
	59.3%	15.8%	3.7%	3.0%		
NMVOC	Road Transport: Passenger Cars	Domestic Solvent Use Including Fungicides	Manure Management - Horses	Coating Applications	Solid Waste Disposal on Land	81.7%
	NFR 1A3bi	NFR 2D3a	NFR 3B4e	NFR 2D3d	NFR 5A	
	40.0%	6.6%	6.1%	5.4%	5.2%	
	Road Transport: Gasoline Evaporation	Manure Management - Dairy Cattle	National Fishing	Manure Management - Sheep	Distribution of oil products	
	NFR 1A3bv	NFR 3B1a	NFR 1A4ciii	NFR 3B2	NFR 1B2av	
	4.6%	4.6%	4.4%	2.5%	2.1%	
SO_x	Other Fugitive Emissions from Energy Production (Geothermal Energy)	Ferroalloys Production				80.9%
	NFR 1B2d	NFR 2C2				
	71.0%	9.8%				
NH_3	Animal Manure Applied to Soils	Urine and Dung Deposited by Grazing Animals	Manure Management - Sheep	Manure Management - Dairy Cattle	Manure Management - Non-dairy Cattle	84.1%
	NFR 3Da2a	NFR 3Da3	NFR 3B2	NFR 3B1a	NFR 3B1b	
	31.0%	15.8%	14.5%	13.5%	9.2%	
$PM_{2.5}$	National Fishing	Open Burning of Waste	Construction and Demolition	Quarrying and Mining of Minerals other than Coal	Road Transport: Automobile Road Abrasion	80.7%
	NFR 1A4ciii	NFR 5C2	NFR 2A5b	NFR 2A5a	NFR 1A3bvii	
	28.7%	11.4%	8.3%	7.8%	6.8%	
	Ferroalloy Production	Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals	Road Transport: Heavy Duty Vehicles and Buses	Road Transport: Passenger Cars	Mobile Combustion in manufacturing industries and construction	
	NFR 2C2	NFR 1A2f	NFR 1A3biii	NFR 1A3bi	NFR 1A2gvii	
	4.3%	3.7%	3.4%	3.4%	2.9%	

Component	Key Categories (Sorted from high to low from left to right and top to bottom)					Total (%)
PM_{10}	Construction and Demolition	National Fishing	Quarrying and Mining of Minerals other than Coal	Road Transport: Automobile Road abrasion	Open Burning of Waste	80.6%
	NFR 2A5b	NFR 1A4ciii	NFR 2A5a	NFR 1A3bvii	NFR 5C2	
	39.2%	13.5%	10.3%	6.0%	5.8%	
	Aluminium Production	Ferroalloy Production				
	NFR 2C3	NFR 2C2				
	2.9%	2.9%				
TSP	Construction and Demolition	Quarrying and Mining of Minerals Other than Coal	National Fishing	Road Transport: Automobile Road Abrasion		83.6%
	NFR 2A5b	NFR 2A5a	NFR 1A4ciii	NFR 1A3bvii		
	61.4%	10.2%	6.3%	5.6%		
BC	Open Burning of Waste	Mobile Combustion in Manufacturing Industries and Construction	Road Transport: Passenger Cars	Road Transport: Heavy-duty Vehicles and Buses	Stationary Combustion in Manufacturing Industries and Construction (Food Processing)	81.9%
	NFR 5C2	NFR 1A2gvii	NFR 1A3bi	NFR 1A3biii	NFR 1A2e	
	29.0%	11.0%	10.5%	10.3%	8.0%	
	Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	National Fishing				
	NFR 1A4cii	NFR 1A4ciii				
	7.5%	5.6%				
CO	Road Transport: Passenger Cars	Aluminium Production				87.8%
	NFR 1A3bi	NFR 2C3				
	69.1%	18.7%				

Table A2.2 Key categories for NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC and CO, Trend 1990-2022.

Component	Key Categories (Sorted from high to low from left to right and top to bottom)					Total (%)
NO_x	Road transport: Passenger cars	Ferroalloy production	Aluminium production	International aviation LTO (civil)	Road transport: Light duty vehicles	81.1%
	NFR 1A3bi	NFR 2C2	NFR 2C3	NFR 1A3ai(i)	NFR 1A3bii	
	38.0%	21.7%	13.3%	5.0%	3.1%	
NMVOC	Road transport: Passenger cars	Domestic solvent use including fungicides	International aviation LTO (civil)	Food and beverages industry	Manure managment: horses	82.8%
	NFR 1A3bi	NFR 2D3a	NFR 1A3ai(i)	NFR 2H2	NFR 3B4e	
	39.6%	12.2%	8.1%	8.0%	4.5%	
	Manure management - Dairy cattle	Distribution of oil products	Road Transport: Gasoline Evaporation			
	NFR 3B1a	NFR 1B2av	NFR 1A3bv			
	3.9%	3.6%	2.9%			
SO_x	Aluminium production	Other fugitive emissions from energy production (Geothermal energy)	Ferroalloys Production	Stationary Combustion in Manufacturing Industries and Construction (Food Processing)		84.9%
	NFR 2C3	NFR 1B2d	NFR 2C2	NFR 1A2e		
	28.9%	22.1%	17.5%	16.4%		
NH_3	Manure management - Sheep	Manure mangement - Laying hens	Inorganic N-fertilizers (includes also urea application)	Animal manure applied to soils	Manure management - Dairy cattle	80.8%
	NFR 3B2	NFR 3B4gi	NFR 3Da1	NFR 3Da2a	NFR 3B1a	
	18.0%	17.6%	13.4%	9.0%	8.5%	
	Manure management - Non-dairy cattle	Manure management - Fur animals	Manure mangement - Broilers			
	NFR 3B1b	NFR 3B4h	NFR 3B4gii			
	5.5%	4.7%	4.1%			
$PM_{2.5}$	Aluminium Production	Road Transport: Automobile Road Abrasion	National fishing	Open burning of waste	Quarrying and mining of minerals other than coal	81.3%
	NFR 2C3	NFR 1A3bvii	NFR 1A4ciii	NFR 5C2	NFR 2A5a	
	20.5%	18.4%	13.2%	11.9%	5.4%	
	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Road transport: Automobile tyre and brake wear	Construction and Demolition			
	NFR 1A2f	NFR 1A3bvi	NFR 2A5b			
	4.2%	3.9%	3.9%			
PM_{10}	Aluminium production	Construction and demolition	Road transport: Automobile road abrasion	Quarrying and mining of minerals other than coal	National fishing	83.3%
	NFR 2C3	NFR 2A5b	NFR 1A3bvii	NFR 2A5a	NFR 1A4ciii	

Component	Key Categories (Sorted from high to low from left to right and top to bottom)					Total (%)
	23.2%	20.5%	15.2%	7.8%	7.0%	
	Open burning of waste	Road transport: Automobile tyre and brake wear				
	NFR 5C2	NFR 1A3bvi				
	6.3%	3.3%				
TSP	Construction and demolition	Road transport: Automobile road abrasion	Aluminium production	Quarrying and mining of minerals other than coal	Open burning of waste	81.8%
	NFR 2A5b	NFR 1A3bvii	NFR 2C3	NFR 2A5a	NFR 5C2	
	30.7%	20.9%	18.4%	8.3%	3.5%	
BC	Open burning of waste	Road transport: Automobile tyre and brake wear	Road transport: Automobile road abrasion	Stationary Combustion in Manufacturing Industries and Construction (Food Processing)	Road transport: Heavy duty vehicles and buses	81.8%
	NFR 5C2	NFR 1A3bvi	NFR 1A3bvii	NFR 1A2e	NFR 1A3biii	
	34.4%	13.8%	10.7%	6.7%	6.4%	
	Mobile combustion in manufacturing industries and construction	Aluminium production				
	NFR 1A2gvii	NFR 2C3				
	5.2%	4.6%				
CO	Aluminium Production	Road Transport: Passenger Cars				93.3%
	NFR 2C3	NFR 1A3bi				
	49.9%	43.4%				

Persistent Organic Pollutants (POPs)

Table A2.3 Key categories for POPs, 1990.

Component	Key Categories (Sorted from high to low from left to right)					Total (%)
Dioxin	Open Burning of Waste					97.9%
	NFR 5C2					
	97.9%					
PAH4	Open Burning of Waste					82.9%
	NFR 5C2					
	82.9%					
HCB	Open Burning of Waste	Other product use (Fireworks)				91.2%
	NFR 5C2	NFR 2G				
	47.7%	43.4%				
PCB	Open Burning of Waste	Stationary combustion in manufacturing industries and construction: Non-metallic minerals				89.8%
	NFR 5C2	NFR 1A2f				
	62.7%	27.2%				

Table A2.4 Key categories for POPs, Trend 1990-2022.

Component	Key Categories (Sorted from high to low from left to right)					Total (%)
Dioxin	Open burning of waste	Clinical waste incineration	Ferroalloys production			82.0%
	NFR 5C2	NFR 5C1biii	NFR 2C2			
	50.0%	16.2%	15.8%			
PAH4	Open burning of waste	Aluminium production	Ferroalloys production	Road transport: Passenger cars	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	87.6%
	NFR 5C2	NFR 2C3	NFR 2C2	NFR 1A3bi	NFR 1A2f	
	41.0%	14.5%	13.2%	9.9%	9.0%	
HCB	Open burning of waste	Clinical waste incineration	Other product use (Fireworks)			84.7%
	NFR 5C2	NFR 5C1biii	NFR 2G			
	37.9%	34.9%	11.9%			
PCB	Open burning of waste	Clinical waste incineration				80.8%
	NFR 5C2	NFR 5C1biii				
	41.1%	39.8%				

Priority Heavy Metals (Pb, Cd, Hg) and Additional Heavy Metals (As, Cr, Cu, Ni, Se, Zn)

Table A2.5 Key categories for heavy metals, 1990.

Component	Key Categories (Sorted from high to low from left to right and top to bottom)					Total (%)
Pb	Domestic aviation LTO (civil)	Road transport: Automobile tyre and brake wear	Other product use (Fireworks)	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Accidental fires	81.9%
	NFR 1A3aii(i)	NFR 1A3bvi	NFR 2G	NFR 1A2f	NFR 5E	
	39.3%	18.5%	10.3%	7.4%	6.4%	
Cd	Aluminium production	Open Burning of Waste	National Fishing			87.8%
	NFR 2C3	NFR 5C2	NFR 1A4ciii			
	58.4%	17.1%	12.3%			
Hg	Open Burning of Waste					90.2%
	NFR 5C2					
	90.2%					
As	National fishing	Open burning of waste	Aluminium production			87.3%
	NFR 1A4ciii	NFR 5C2	NFR 2C3			
	46.0%	22.2%	19.1%			
Cr	Road transport: Automobil tyre and brake wear	National fishing	Aluminium production			85.5%
	NFR 1A3bvi	NFR 1A4ciii	NFR 2C3			
	49.2%	29.2%	7.1%			
Cu	Road transport: Automobil tyre and brake wear	National fishing				90.5%
	NFR 1A3bvi	NFR 1A4ciii				
	77.5%	13.0%				
Ni	National fishing	Aluminium production				88.4%
	NFR 1A4ciii	NFR 2C3				
	78.3%	10.1%				
Se	National Fishing	Open Burning of Waste				86.5%
	NFR 1A4ciii	NFR 5C2				
	78.9%	7.6%				
Zn	Open burning of waste	Aluminium production	Road transport: Automobil tyre and brake wear	National fishing	Accidental fires	88.4%
	NFR 5C2	NFR 2C3	NFR 1A3bvi	NFR 1A4ciii	NFR 5E	
	28.9%	18.8%	18.7%	12.4%	9.5%	

Table A2.6 Key categories for heavy metals, trend 1990-2022.

Component	Key Categories (Sorted from high to low from left to right and top to bottom)					Total (%)
Pb	Domestic aviation LTO (civil)	Road transport: Automobil tyre	Aluminium production	Stationary combustion in manufacturing		84.9%

Component	Key Categories (Sorted from high to low from left to right and top to bottom)					Total (%)
		and brake wear		industries and construction: Non-metallic minerals		
	NFR 1A3aii(i)	NFR 1A3bvi	NFR 2C3	NFR 1A2f		
	29.4%	28.7%	20.2%	6.7%		
Cd	Aluminium production	Open burning of waste	National fishing			86.1%
	NFR 2C3	NFR 5C2	NFR 1A4ciii			
	48.9%	22.5%	14.8%			
Hg	Open burning of waste	National fishing	Cremation	Road transport: Passenger cars		86.1%
	NFR 5C2	NFR 1A4ciii	NFR 5C1bv	NFR 1A3bi		
	48.2%	21.7%	8.8%	7.3%		
As	Aluminium production	National fishing	Open burning of waste			93.6%
	NFR 2C3	NFR 1A4ciii	NFR 5C2			
	48.9%	29.4%	15.3%			
Cr	Aluminium production	National fishing	Stationary combustion in manufacturing industries and construction: Non-metallic minerals			80.4%
	NFR 2C3	NFR 1A4ciii	NFR 1A2f			
	37.6%	35.6%	7.2%			
Cu	National fishing	Other product use (Fireworks)	Road transport: Automobil tyre and brake wear	Aluminium production		82.5%
	NFR 1A4ciii	NFR 2G	NFR 1A3bvi	NFR 2C3		
	33.7%	21.7%	15.5%	11.6%		
Ni	Aluminium production	National fishing				92.6%
	NFR 2C3	NFR 1A4ciii				
	49.1%	43.6%				
Se	Road transport: Automobil tyre and brake wear	Open burning of waste	Public electricity and heat production	National fishing		84.5%
	NFR 1A3bvi	NFR 5C2	NFR 1A1a	NFR 1A4ciii		
	34.6%	26.8%	11.9%	11.1%		
Zn	Aluminium production	Open burning of waste	National fishing			81.4%
	NFR 2C3	NFR 5C2	NFR 1A4ciii			
	48.0%	25.2%	8.2%			