ENVIRONMENT AGENCY OF ICELAND

2023

Report on Policies, Measures, and Projections

Projections of Greenhouse Gas Emissions in Iceland until 2050

The Environment Agency of Iceland
Telephone +354 591 2000
E-mail: ust@ust.is
Address: Suðurlandsbraut 24, 108 Reykjavik, Iceland
Website: www.ust.is

Cover photo: Vestrahorn, Iceland. Photo by Gwenn Klabbers on Unsplash

Publication ID: UST2023:06

Authors:
Ásta Karen Helgadóttir, Environment Agency of Iceland
Sigríður Rós Einarsdóttir, Environment Agency of Iceland
Nicole Keller, Environment Agency of Iceland
Rafn Helgason, Environment Agency of Iceland
Birgir Urbancic Ásgeirsson, Environment Agency of Iceland
Inga Rún Helgadóttir, Environment Agency of Iceland
Brian C. Barr, Environment Agency of Iceland
Kristinn Már Hilmarsson, Environment Agency of Iceland
Chanee Jónsdóttir Thianthong, Environment Agency of Iceland
Arnór Snorrason, Icelandic Forest Service
Leone Tinganelli, Soil Conservation Service of Iceland
Jóhann Þórsson, Soil Conservation Service of Iceland

Reykjavík, 15 March 2023

Preface

Report pursuant to Articles 18(1) and 39 of Regulation (EU) No 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action (hereafter referred to as "the Governance Regulation"), and Articles 36, 37, and 38 of Commission Implementing Regulation (EU) 2020/1208 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999 and repealing Commission Implementing Regulation (EU) No 749/2014

Environment Agency of Iceland, Reykjavík, 15 March 2023

Table of Contents

Index of Figures

Index of Tables

List of Abbreviations

AFF	Association of Fishmeal Factories
AILA	The Association of Icelandic Local Authorities
AR4	Assessment Report 4
AR5	Assessment Report 5
BAT	Best Available Techniques
BAU	Business as Usual
CF	Cultivated Forest
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EAI	Environment Agency of Iceland (Umhverfisstofnun)
EC	Energy Consumption
ECAC	European Civil Aviation Conference
ECAs	Emission Control Areas
EEA	European Environment Agency
ES	Energy Supply
ESR	Effort Sharing Regulation (EU) 2018/842
EU	European Union
EU ETS	European Union Emission Trading System
EVs	Electric Vehicles
FEE	Foundation for Environmental Education
F-gas	Fluorinated Gas
FrF	Forest land Remaining Forest Land
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
IAAC	Icelandic Agricultural Advisory Centre (Ráðgjafarmiðstöð landbúnaðarins)
IAHP	Icelandic Association of Horticulture Producers (Samband garðyrkjubænda)
ICAO	International Civil Aviation Organization
IES	Institute of Economic Studies
ISC	Interministerial Steering Committee
IFS	Icelandic Forest Service
IPPU	Industrial Processes and Product Use
ISK	Icelandic Króna
JCD	Joint Committee Decision (EEA) 269/2019
JFA	Joint Fulfilment Agreement
kt CO_2e	Kilotons of Carbon Dioxide Equivalent
LcF	Land Converted to Forest
LPG	Liquid Petroleum Gas
LULUCF	Land Use, Land-Use Change, and Forestry
MAC	Mobile Air-Conditioning Systems
MCF	Methane Conversion Factor
MEEC	Ministry for the Environment, Energy and Climate
MFAF	Ministry of Food, Agriculture and Fisheries
MMR	Monitoring Mechanism Regulation (EU) 525/2013
NA	Not Applicable
NDC	Nationally Determined Contribution
NE	Not Estimated
NEA	National Energy Authority
NGO	Non-Governmental Organisation
NIR	National Inventory Report

NO	Not Occurring
NPC	National Power Company of Iceland (Landsvirkjun)
ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
PaMs	Policies and Measures
PFC	Perfluorocarbons
RFO	Residual fuel oil
SCSI	Soil Conservation Service of Iceland
SECAs	Sulphur Emission Control Areas
SOC	Soil Organic Carbon
SWDS	Solid Waste Disposal Sites
WAM	With Additional Measures
WEM	With Existing Measures
WOM	Without Measures
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

Iceland is submitting this report on greenhouse gas (GHG) policies and measures (PaMs) and projections in line with the reporting obligations described in the Section 1.1. A list of improvements which have been concluded or are in progress/planned for the next submission is included in Section 1.4. Iceland's National System, including legal and institutional arrangements, main institutions and data providers, improvements undertaken or planned to the national system, and stakeholder engagement are described in Section 3.

The Ministry of the Environment, Energy, and Climate (MEEC)[1] published an updated Climate Action Plan in 2020, which forms the basis for the PaMs reported here. The Action Plan included 50 PaMs, all of which are described under the relevant chapters in this report. Section 2 provides a brief introduction to the current (2020) and previous Action Plans. The most recent Progress Report on the progress of the 2020 Action Plan was published in 2022 and the PaMs reported here were updated accordingly.

Six further PaMs which have had or are expected to have a significant impact on GHG emissions from Iceland have been included: the MAC Directive, best available techniques for ferrous metal production, industries and the manufacture of glass, a new gas and compost plant, a pay-as-you-throw system, and an extended manufacturer's warranty.

GHG emissions savings from the following PaMs have been quantified for this submission:

- Electrification of Fishmeal Plants (Section 5.3.3),
- Ban on Use of Heavy Fuel Oil (Section 5.3.4)
- Carbon Capture from Geothermal Energy Plants (Section 5.3.5)
- Ban of new registrations of diesel and gasoline passenger cars after 2030 (Section 6.3.1)
- Electrification of Ferries (Section 6.3.5),
- Regulation on F-gases (Section 7.3.1),
- No landfilling of organic waste (Section 10.3.7),
- Enhanced action in forestry (Section 9.3.1),
- Expanding revegetation (Section 9.3.2), and
- Restorations of wetlands (Section 9.3.4).

For this submission, Iceland includes two projection scenarios: "with existing measures" (WEM) and "with additional measures" (WAM).

[1] The new Governmental Agreement between the current government took force on 1 February 2022. Consequently, the title of the Ministry, previously called *The Ministry for the Environment and Natural Resources*, was changed to *The Ministry of the Environment, Energy, and Climate*.

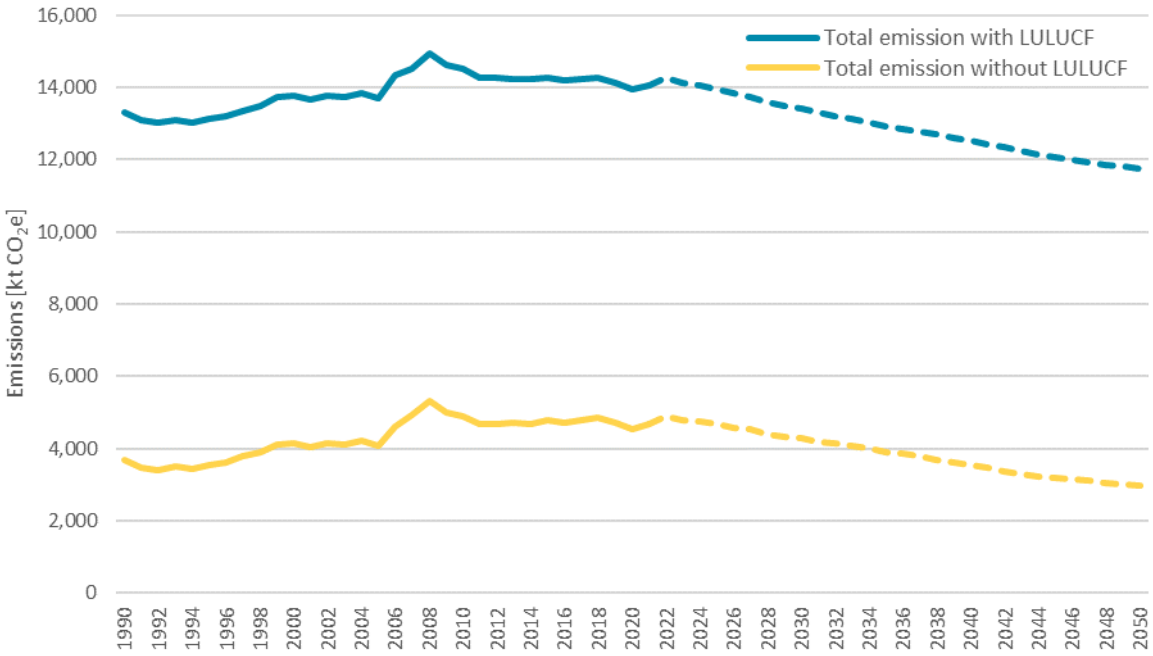

Figure ES.1 Total historical and projected GHG emissions, excluding and including LULUCF, for the WEM scenario 1990-2050, [kt CO_2e.

Based on the Environment Agency of Iceland's (*Umhverfisstofnun*) (EAI) calculations and assumptions, total emissions from Iceland, excluding LULUCF, are expected to increase between 2021 and 2022, after which the total emissions begin to decrease until 2050 (see Figure ES.1 and Table ES.1). The same trend is observed for total emissions including LULUCF.

Table ES.1 Total historical and projected GHG emissions, excluding and including LULUCF, in the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
Total with LULUCF	13,292	14,278	13,942	13,958	13,409	12,927	12,518	12,065	11,725
Total without LULUCF	3,682	4,773	4,521	4,680	4,274	3,913	3,535	3,180	2,979

1 Introduction

1.1 Legal Basis for Reporting Obligations

For the second commitment period of the Kyoto Protocol (2013-2020), Iceland concluded a bilateral agreement[2] in 2015 with the European Union (EU) and its Member States concerning Iceland's participation in the Joint Fulfilment Agreement (JFA). Therein the Parties agreed to jointly fulfil their emission reduction commitments inscribed in the third column of Annex B to the Kyoto Protocol. According to Article 4 of the bilateral agreement the legal acts listed in Annex I shall be binding upon Iceland. This included Regulation (EU) No 525/2013, Commission Implementing Regulation (EU) No 749/2014 and other delegated and implementing acts based on Regulation (EU) No 525/2013.

For the Paris Agreement period, from 1 January 2021 to 31 December 2030, Iceland and Norway joined the EU in their commitment to a 40% reduction in greenhouse gas emissions, according to the EEA Joint Committee Decision (JCD) No 269/2019[3], that amends Protocol 31 to the EEA Agreement on cooperation in specific fields outside the four freedoms[4]. The JCD extends the cooperation on climate change by including GHG emissions and removals from LULUCF in the EEA Agreement. According to JCD 269/2019, Regulation (EU) 2018/842 (hereafter referred to as the Effort Sharing Regulation (ESR)[5]), Regulation (EU) 2018/841 (hereafter referred to as the LULUCF Regulation[6]), and relevant provisions of the Governance Regulation (all provisions replacing Regulation (EU) No 525/2013, which was repealed by the Governance Regulation by 1 January 2021) were incorporated to the EEA Agreement.

Work is underway to finalise the legal implementation of Iceland's joint commitment with the EU Member States and Norway under the Paris Agreement. Iceland, through its Parliament (*Alþingi*), has implemented the LULUCF Regulation and the ESR through the Climate Act No 70/2012 (*lög um loftslagsmál nr. 70/2012*)[7]. Commission Implementing Regulation (EU) 2020/1208 and Commission Delegated Regulation (EU) 2020/1044, are now incorporated into the EEA Agreement through the EEA Joint Committee Decision no 223/2021[8]. At the time of this writing, work is still ongoing to write a new regulation aiming at implementing the Joint Committee Decision No 223/2021 into Icelandic legislation. The same regulation will also serve as a recast of Regulation No 520/2017, on data collection and information from institutions related to Iceland's inventory of greenhouse gas emissions and carbon removal, that implemented Regulation (EU) No 525/2013.

Iceland's reporting obligations are stipulated in the aforementioned regulations. In accordance, Iceland reports the greenhouse gas (GHG) emissions by sources or enhanced removals by sinks, the information on national systems, policies and measures (PaMs) regarding climate change mitigation,

[2] *Council of the European Union.* http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%2010941%202014%20INIT

[3] *EFTA.*https://www.efta.int/sites/default/files/documents/legal-texts/eea/other-legal-documents/adopted-joint-committee-decisions/2019%20-%20English/269-2019.pdf

[4] *EFTA.* https://www.efta.int/EEA/Policy-Areas-2422

[5] Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013.

[6] Regulation (EU) 2018/841on the inclusion of greenhouse gas emissions and removals from land use, land-use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU

[7] *Parliament (Alþingi)*. https://www.althingi.is/lagas/nuna/2012070.html

[8] *EFTA*.https://www.efta.int/media/documents/legal-texts/eea/other-legal-documents/adopted-joint-committee-decisions/2021%20-%20English/223-2021.pdf

and national projections of anthropogenic GHG emissions by sources and their removal by sinks for a sequence of four future years ending with zero or five immediately following the reporting year, to the European Commission.

Table 1.1 Legal (EU) basis for the reporting on National Systems, Policies and Measures, and Projections.

Reporting Obligation	Governance Regulation	Implementing Regulation (EU) 2020/1208
National Systems for policies and measures and projections	Art. 39	Art. 36, Annex XXIII
National greenhouse gas policies and measures	Art. 18(1)(a)	Art. 37, Annex XXIV
National projections of anthropogenic greenhouse gases	Art. 18(1)(b)	Art. 38, Annex XXV

The report structure and provided information is pursuant to Commission Implementing Regulation (EU) 2020/1208 of 7 August 2020 on structure, format, submission processes, and review of information reported by Member States pursuant to the Governance Regulation. The Articles and Annexes for the reporting are summarised in Table 1.1.

The legal basis for the national system for the GHG inventories, including the reporting on National Systems for PaMs and projections, national GHG PaMs and national projections of anthropogenic GHG emissions, is found in the Icelandic Climate Act No 70/2012, which describes the roles and responsibilities of the relevant government agencies in this sector. The Act ensures that enough capacity is available for reporting.

1.2 About this Report

This report presents information on Iceland's national system for reporting on climate mitigation PaMs, Iceland's GHG PaMs, as well as anthropogenic GHG emission projections until 2050 pursuant to Article 39, Article 18(1)(a) and Article 18(1)(b) of the Governance Regulation and under Article 36 (and Annex XIII), Article 37 (and Annex XXIV) and Article 38 (and Annex XXV) of Implementing Regulation (EU) 2020/1208 (see Table 1.1).

In accordance with these articles, this report contains the following items:

- Description of the legal basis and national system related to reporting on PaMs and projections.
- Description of climate mitigation PaMs that are implemented, adopted, and planned.
- Projections of future anthropogenic GHG emissions for the following scenario:
    - With existing measures (WEM), the national base scenario that includes all measures implemented or adopted.
    - With additional measures (WAM), the national scenario that includes all measures implemented, adopted, or planned.

According to Art. 18 of Regulation No 2018/1999, Member States are required to report on GHG PaMs and projections every other year, on odd years. The same article stipulates that member states shall inform about any substantial changes to the information reported on odd years in subsequent years.

According to Annex VII of the Governance Regulation, the report should include total GHG projections, as well as disaggregated projections by the scope of following regulations:

- Emissions falling under EU ETS Directive 2003/87/EC
- Emissions falling under the ESR (Regulation 2018/842)
- Emissions and Removals Under the LULUCF Regulation (Regulation 2018/841)

1.3 Overview of Reporting on Emission Projections

Iceland has completed WEM projections for the sectors: Energy (1), Industry (2), Agriculture (3), LULUCF (4), and Waste (5), as outlined in Table 1.2**.** Furthermore, Iceland has completed WAM projections for the sectors: Energy (1), and LULUCF (4).

Table 1.2 Greenhouse gas source and sink categories for emission projections.

Sector	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NF_3
Total excluding LULUCF	✓	✓	✓	√	√	√	NO
Total including LULUCF	✓	✓	✓	✓	✓	✓	NO
1A1a Public Electricity and Heat Production	✓	✓	✓	NA	NA	NA	NA
1A1b Petroleum Refining	NO	NO	NO	NA	NA	NA	NA
1A1c Manufacture of Solid Fuels and Other Energy Industries	NO	NO	NO	NA	NA	NA	NA
1A2 Manufacturing Industries and Construction	✓	✓	✓	NA	NA	NA	NA
1A3a Domestic Aviation	✓	✓	✓	NA	NA	NA	NA
1A3b Road Transportation	✓	✓	✓	NA	NA	NA	NA
1A3c Railways	NO	NO	NO	NA	NA	NA	NA
1A3d Domestic Navigation	✓	✓	✓	NA	NA	NA	NA
1A3e Other Transportation	NO	NO	NO	NA	NA	NA	NA
1A4 Other Sectors	✓	✓	✓	NA	NA	NA	NA
1A5 Other	NO	NO	NO	NA	NA	NA	NA
1B1 Solid Fuels	NO	NO	NO	NA	NA	NA	NA
1B2 Oil and Natural Gas and Other Emissions from Energy Production	✓	✓	✓	NA	NA	NA	NA
1C CO_2 Transport and Storage	NO	NA	NA	NA	NA	NA	NA
2A Mineral Industry	✓	NA	NA	NA	NA	NA	NA
2B Chemical Industry	NO	NO	NO	NO	NO	NO	NO
2C Metal Industry	✓	✓	NO	NO	✓	NO	NO
2D Non-Energy Products from Fuels and Solvent Use	✓	NO	NO	NA	NA	NA	NA
2E Electronics Industry	NA	NA	NA	NO	NO	NO	NO
2F Product Uses as Substitutes for ODS(2)	NA	NA	NA	✓	✓	NO	NO
2G Other Product Manufacture and Use	✓	✓	✓	NO	NO	✓	NO
2H Other (please specify)	NO	NO	NO	NO	NO	NO	NO
3A Enteric Fermentation	NA	✓	NA	NA	NA	NO	NA
3B Manure Management	NA	✓	✓	NA	NA	NA	NA
3C Rice Cultivation	NA	NO	NA	NA	NA	NA	NA
3D Agricultural Soils	NA	NO	✓	NA	NA	NA	NA
3E Prescribed Burning of Savannahs	NA	NO	NO	NA	NA	NA	NA
3F Field Burning	NA	NO	NO	NA	NA	NA	NA
3G Liming	✓	NA	NA	NA	NA	NA	NA
3H Urea Application	✓	NA	NA	NA	NA	NA	NA
3I Other Carbon-Containing Fertilisers	✓	NA	NA	NA	NA	NA	NA
3J Other (please specify)	NO	NO	NO	NA	NA	NA	NA
4A Forest Land	✓	✓	✓	NA	NA	NA	NA
4B Cropland	✓	✓	NO, NA	NA	NA	NA	NA

Sector	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NF_3
4C Grassland	✓	✓	✓	NA	NA	NA	NA
4D Wetlands	✓	✓	NO, NE, NA	NA	NA	NA	NA
4E Settlements	✓	NE	✓	NA	NA	NA	NA
4F Other Land	NE, NA	NA	NA	NA	NA	NA	NA
4G Harvested Wood Products	✓	NA	NA	NA	NA	NA	NA
4H Other	NO	NO	NO	NA	NA	NA	NA
5A Solid Waste Disposal	NA	✓	NA	NA	NA	NA	NA
5B Biological Treatment of Solid Waste	NA	✓	✓	NA	NA	NA	NA
5C Incineration and Open Burning of Waste	✓	✓	✓	NA	NA	NA	NA
5D Wastewater Treatment and Discharge	NA	✓	✓	NA	NA	NA	NA
5E Other (please specify)	NO	NO	NO	NA	NA	NA	NA

Note: NO = not occurring, NA = not applicable, NE = not estimated

1.4 Improvement Actions

The 2023 submission is the fourth time Iceland is reporting on its GHG mitigation PaMs, Projections of anthropogenic GHG emissions, and National System under the Governance Regulation (previously under the MMR). Information on the improvements which were planned for this submission are listed in Table 1.3 below. Not all the planned improvements were completed for this submission, and therefore, those improvements will remain on the improvement plan and be prioritised for the next submission.

Table 1.3 Improvement actions for PaMs and Projections from the Improvement Plan.

Improvement ID	Improvement Action	Priority	Status
Cross-cutting	Use quantified WAM PaMs to create a WAM GHG projections scenario.	High	Completed
	Set a target for quantifying more PaMs for the 2023 GHG Projections submission.	High	Partially completed
	Improve and add sensitivity analyses for all sectors	High	Partially completed
Energy (other)	Iceland does not currently have any information on the future consumption of LPG within the energy sector. Stakeholder engagement is required to inform projections of LPG.	Medium	Not started
	Acquire ex-post analysis of ongoing PaMs.	Medium	Started
	Increase number of ex-ante evaluated PaMs.	High	Started
	Investigate CCS quantification possibilities.	High	Completed
Transport	Facilitate discussions with stakeholders to determine the most appropriate activity data for the WEM and WAM scenario as well as the impact of PaMs on the projections.	Medium	Started
	Increase number of ex-ante evaluated PaMs.	Medium	Started
	Expand ex-ante analysis to more ferries when more measures have been confirmed.	Low	Not started
Agriculture	Collect country specific projections for the Agriculture sector – livestock numbers, yields, MCF, nitrogen excretion, feed characteristics, manure management systems, area of arable land and fertiliser application.	High	Partially completed
Waste	Improve wastewater projections.	Medium	Partially completed
	Revise mass balance waste allocation.	Medium	Completed

2 Policy Background

2.1 Iceland's Climate Action

2.1.1 Note on Terminology

Iceland is part of the EU ETS, and the EU ETS Directive 2003/87/EC, establishing a system for GHG emission allowance trading within the Community, was incorporated into the EEA Agreement with EEA Joint Committee Decision No 146/2007. The EU ETS Directive was implemented into Icelandic legislation through the Climate Change Act No 70/2012, and the directive has been applied in Iceland since 2013.

For the EU Member States, emissions (outside of LULUCF) not covered by the EU ETS are referred to as ESR emissions, with reference to the Effort Sharing Regulation 2018/842.

2.1.2 Iceland's National Emission Reductions Target

Iceland, along with Norway, is part of a joint commitment with the EU Member States to reduce greenhouse gas emissions by 55%[9] by 2030 in comparison with 1990 levels under the Paris Agreement and will apply key pieces of EU climate legislation accordingly.

Iceland submitted an updated Nationally Determined Contribution (NDC) under the Paris Agreement in February 2021. According to the NDC, Iceland is a part of a joint fulfilment of a -55% emissions target for 2030 (compared to 1990 emissions) with the EU and its Member States. The intention to deliver the target in cooperation with the EU is stated in Iceland's latest NDC[10]. The cooperation entails that Iceland will take part in three key climate mitigation legislative frameworks:

a. Emissions Trading System (ETS), which includes emissions from the heavy industry and aviation sectors in Iceland;
b. Effort Sharing Regulation (ESR), which sets binding targets for non-ETS emissions determined by the same methodology as applied to EU Member States; and
c. LULUCF, which covers emissions and carbon removals from the Land Use, Land-Use Change, and Forestry sector.

The Effort Sharing target for Iceland within the collective target with the EU and Norway of 40% lower emissions in 2030 compared to 1990, had been set at -29% in 2030 compared to 2005, according to JCD No 269/2019. The target for Iceland within the updated collective delivery of -55% has not been set.

The Icelandic government has furthermore announced more ambitious targets than set forth for Iceland by the EU. In the 2018 and 2020 Climate Action Plans, the government announced goals to achieve at least a 40% reduction in non-ETS emissions in 2030 compared to 2005. In November 2021, the then newly formed government announced an independent, more ambitious target of 55%

[9] On 14 July 2021 the European Commission presented the Fit for 55 package, which contains a set of legislative proposals to make the EU's climate, energy, land use, transport, and taxation policies fit for reaching the European Green Deal's objective of reducing net greenhouse gas emissions by at least 55% by 2030. The final text of the deal still needs ratification by the European Parliament and by EU ministers at the Council.

[10] Iceland's Intended Nationally Determined Contribution, Submission by Iceland to the ADP. *UNFCCC*. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Iceland%20First/Iceland_updated_NDC_Submission_Feb_2021.pdf

reduction for ESR emissions in 2030 relative to 2005 in the governmental agreement[11]. Furthermore, Iceland has implemented a national carbon neutrality target through law No 95/2021, amending the Climate Act 70/2012[12], stating that Iceland is to achieve carbon neutrality no later than 2040.

2.1.3 Past Action Plans

Iceland ratified the 1992 United Nations Framework Convention on Climate Change (UNFCCC) in 1993. In 1995, the government of Iceland adopted an implementation strategy based on the commitments of the Framework Convention. The domestic implementation strategy was revised in 2002, based on the commitments of the Kyoto Protocol and the provisions in the Marrakech Accords.

A new climate change strategy was adopted by the Icelandic government in February 2007 (Ministry for the Environment and Natural Resources, 2007). The Ministry of the Environment, Energy and Climate formulated the strategy in close collaboration with the ministries of Transport and Communications, Fisheries, Finance, Agriculture, Industry and Commerce, Foreign Affairs, and the Prime Minister's Office. The long-term strategy was to reduce net GHG emissions of Iceland by 50-75% by 2050, compared to 1990 levels. In the shorter term, the strategy aimed to ensure that emissions of GHGs would not exceed Iceland's obligations under the Kyoto Protocol. In November 2010, the Icelandic government adopted a Climate Action Plan (Ministry for the Environment and Natural Reources, 2010) to execute the strategy. However, little funding followed the plan, and its implementation was not entirely successful.

In 2012, the Climate Act No. 70/2012 introduced the legal requirement for a Climate Action Plan. In 2016, in light of the Paris Agreement and the ongoing second commitment period of the Kyoto Protocol, the government published a new Climate Action Plan (Ministry for the Environment and Natural Resources, 2016) presenting 16 climate-related projects, with eight projects specifically aimed at reducing GHG emissions. This plan included funding earmarked for specific projects.

2.1.4 The 2018 Climate Action Plan

In 2018, Iceland's government published a new Climate Action Plan spanning the years 2018-2030 (Ministry for the Environment and Natural Resources, 2018); this time in association with significant funding earmarked for the implementation of- and follow-through on the actions. This plan was developed with the aim to achieve two major emission targets: Reaching Iceland's international 2030 target and carbon-neutrality in 2040. At that time, the approximate non-ETS emission reduction target was a 29% reduction compared to emissions in the year 2005 (see also Section 2.1.1 on Iceland's commitment for 2030)) and reaching carbon neutrality by the year 2040.

The plan includes 34 actions across all sectors. The actions listed in the plan are mostly centred around two main strategies:

1. Electrification of the energy sector by substituting fossil fuel combustion with the use of renewable electricity.
2. Enhanced carbon removal by better land use and increased efforts in afforestation/reforestation.

The Climate Action Plan (2018) was submitted to public consultation in the fall of 2018. It was consequently updated; taking into account results from public consultation, further implementation

[11] *Government of Iceland (Stjórnarráð Íslands).* https://www.stjornarradid.is/library/05-Rikisstjorn/Agreement2021.pdf
[12] *Parliament (Alþingi).* https://www.althingi.is/thingstorf/thingmalalistar-eftir-thingum/ferill/?ltg=151&mnr=711

work by the Climate Council, and the Interministerial Steering Committee (ISC) for Climate Action, as well as results of the calculations shown in the 2019 report on Policies, Measures, and Projections (Environment Agency of Iceland), resulting in the publication of the 2020 Action Plan (Ministry for the Environment and Natural Resources).

2.1.5 The 2020 Climate Action Plan

In 2020, the government of Iceland published an updated Climate Action Plan spanning the years 2020-2030 (Ministry for the Environment and Natural Resources, 2020). The Climate Action Plans are Iceland's main instrument to meet its commitments to the Paris Agreement; specifically, the emissions reduction goals for 2030. They are also the main instrument to meet Iceland's goal of carbon neutrality by 2040.

In the 2020 Climate Action Plan, the government planned to allocate a minimum of 46 billion ISK to climate mitigation measures over a five-year period, from 2020 to 2024. According to the government's Fiscal Policy 2022-2026 (Ministry of Finance and Economic Affairs, 2021) funding for climate action will continue to increase. In addition to previously determined climate funding (Ministry of Finance and Economic Affairs, 2020), climate action will receive an additional one billion ISK per year of funding from 2022-2031.

The plan includes 48 measures across all sectors that aim to reduce GHG emissions and 7ncreasee carbon sequestration. Fifteen measures were added since the 2018 action plan. The main sectoral changes that are expected to impact Iceland's GHG emissions until 2030 are the phaseout of fossil fuels in transport and an increase in carbon sequestration in LULUCF through restoration of woodlands and wetlands, revegetation, and afforestation.

2.1.6 The 2021 Progress Report

According to the Climate Act, the government shall, in consultation with stakeholders, review and update the Climate Action Plan every fourth year based on international commitments and the government's goals. Climate measures shall be developed and put in motion by an ISC. The ISC shall also prepare an annual progress report on the status of implementation of the Climate Action Plan and its measures, emissions development and whether the development is in accordance with the plan. The first such progress report was published in September 2021 (Ministry for the Environment and Natural Resources) to follow up on the progress of the 2020 Climate Action Plan. Besides the 48 PaMs put forth in the 2020 Climate Action Plan, two new GHG mitigation measures are introduced in the progress report: 1) energy change in the production sector; 2) increased knowledge and research to improve the LULUCF sector of the GHG inventory. According to the progress report, thirty PaMs (out of fifty in total) have currently been implemented, seventeen are in progress and three are in preparation stages.

2.1.7 The 2022 Progress Report

A new progress report was published in 2022 (Ministry of the Environment, Energy and Climate), containing updated information on the status of the PaMs reported in the 2020 Climate Action Plan. As can be seen in Figure 2.1, thirty-four PaMs (out of fifty) have currently been implemented, fifteen are in progress and one is in the preparation stages, according to the progress report.

The ISC sees the energy transition in transport as the greatest opportunity to reduce GHG emissions in Iceland. The committee emphasizes the importance of including heavy transport and rental cars in this

transition, as tourism in Iceland continues to grow. In addition, the committee concludes that PaMs in fishing and agriculture are necessary, and continued improvements in land use need to be ensured.

The ISC considers it timely that the Climate Action Plan should be reviewed in an organized manner. The focus should not be on individual PaMs, but rather on creating solutions that will work well together and reduce GHG emissions holistically.

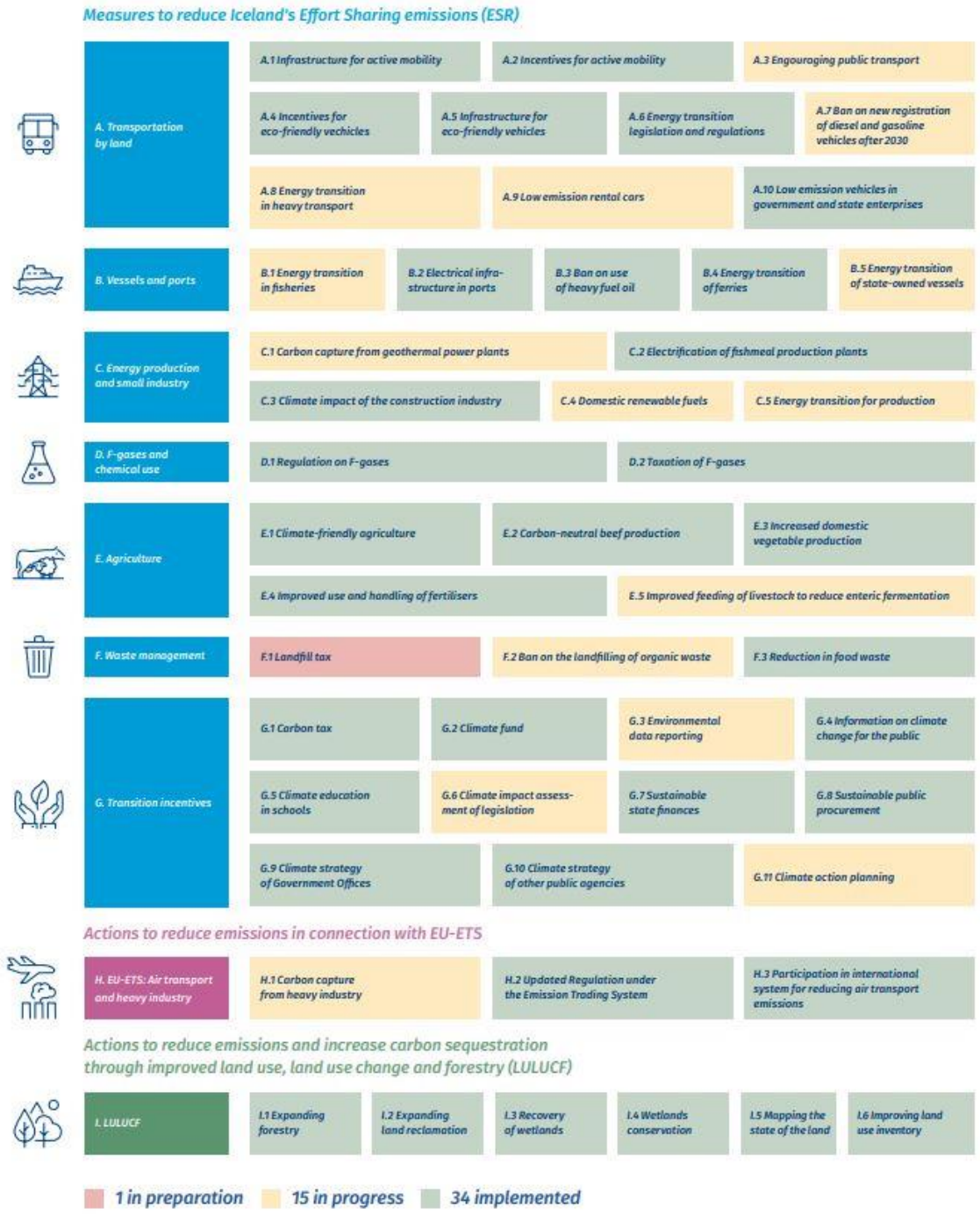

Figure 2.1 Summary of measures in Iceland's 2020 Climate Action Plan, 2021 and 2022 Progress Reports, indicating whether they are new and whether at the time of publication they were being implemented, in progress or in preparation.

2.1.8 LULUCF Mitigation Plan

In July 2019, the Icelandic government published a mitigation plan in the LULUCF sector (Government of Iceland, 2019), outlining concrete measures and funding in accordance with the 2018 Climate Action Plan. The LULUCF mitigation plan outlines efforts to increase carbon sequestration and to decrease carbon emissions from soils and vegetation.

Iceland is using land (ecosystem) restoration, reforestation, and afforestation as mitigation efforts against climate change. These efforts are carried out in collaboration with farmers and other landowners, NGOs, and local authorities and include restoring native vegetation in degraded areas, restoring drained wetlands, and afforestation to create a woodland resource.

The Icelandic government has increased these efforts with the aim to restore ecosystems to conserve and enhance biological diversity, increase ecosystem resilience against natural disasters and increase the potential of rural societies -relying on these ecosystems to sustain their livelihoods.

2.1.9 Iceland's Long-Term, Low-Emission Development Strategy

Iceland communicated its first Long-Term Low Emission Development Strategy "On the Path to Climate Neutrality" (hereafter called "Strategy"), based on the encouragements in the Paris Agreement, in October 2021 (Government of Iceland). The Strategy declares that Iceland is committed to reducing its overall GHG emissions and reaching climate neutrality no later than 2040 and abolishing the usage of all fossil fuels by 2050, which should set Iceland on a path to net negative emissions. The foundation and various milestones that have been reached on the path to climate neutrality are described in the Strategy. Key documents and policies are introduced, and insights are given into context and framing of overarching climate targets and commitments.

2.1.10 Updated ETS for Aviation and CORSIA

Iceland is part of the EU Emissions Trading System (EU ETS) through its commitments under the EEA agreement. The revised legal framework for the ETS Phase IV from 2021 to 2030 will be adopted in accordance with the Joint Commitment Decision No 112/2020. The ETS is an important tool for reducing GHG emissions cost-effectively and is designed to reduce European GHG emissions by 55%[13] by 2030 as compared to 2005. As of today, it is mainly heavy industries and aviation which are covered by the EU ETS, in Iceland.

The regulations and implementation of the EU ETS in Iceland are being adjusted in accordance with the new period. Aviation in the EU ETS is in revision, as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) takes place from 2021. The revision is to implement CORSIA by the EU in a way that it will be consistent with the EU's 2030 climate objectives. Initially, CORSIA is based on voluntary participation; Iceland is taking part in the system from the beginning and participated in the baseline period from 2019-2020 with all other European Civil Aviation Conference (ECAC)[14] states.

2.1.11 Business and industry collaboration

The work to review the Climate Action Plan and its structure has begun, in line with the emphasis placed in the 2022 Progress Report (Ministry of the Environment, Energy and Climate). The focus is

[13] *European Commission*.https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en

[14] The European Civil Aviation Conference (ECAC) is an intergovernmental organisation which was established by the International Civil Aviation Organization (ICAO) and the Council of Europe. The ECAC now totals 44 members, including all 27 EU members. ECAC promotes the continued development of a safe, efficient and sustainable European air transport system.

being shifted from individual PaMs, to creating solutions that will work well together and reduce GHG emissions holistically. Iceland has reached out to business and industry with the objective of engaging the private sector in the efforts needed to achieve the national climate targets and objectives. The main business sectors in Iceland have been defined and grouped together. Each business sector has started an internal dialogue, facilitated by the ISC and MEEC, to frame their sector's GHG emissions scope. The next steps will be for each sector to assess and determine the most impactful, as well as practical, PaMs to reduce GHG emissions from their sector.

This work by the business and industry sectors will be reviewed and considered when measures for a new Climate Action Plan will be developed in 2023. A new Climate Action plan is expected to be published in the end of 2023.

2.1.12 The Impact of GHG Mitigation Policies: A Cost-Benefit Analysis

In March 2021, the MEEC commissioned the Institute of Economic Studies (IES) to undertake a cost-benefit analysis of its most recent Climate Action Plan (2020). Of the 48 PaMs in the plan, the impacts of 22 PaMs were analysed in the cost-benefit analysis of GHG mitigation policies (Institute of Economic Studies, 2022). In addition to the cost-benefit analysis, the policies' impacts on different social groups were also examined.

The most important assumption for the cost-benefit analysis was how to estimate the value of GHG emissions. The analysis assumes that the price of emissions corresponds to the price of EU ETS emissions allowances in the EU market in the last few years.

The main conclusions of the analysis are that PaMs regarding revegetation, afforestation and rewetting of wetlands are among the most cost-effective policies. In most cases, PaMs which have direct impacts on their subject are the most effective, such as improved infrastructure in ports, taxes and import quotas on F-gases, energy transition in ferries, carbon-capture from geothermal power plants and the carbon tax. Less cost-effective PaMs included incentives to buy electric vehicles, the ban on landfilling biodegradable waste and increased domestic vegetable production.

The results from the cost-benefit analysis have not been reported in Iceland's PaMs submission by the EAI, because the IES used different ex-ante emission impact estimates for the policies which were analysed than those calculated and reported by the EAI. Therefore, the EAI's ex-ante estimates for the emission impact of PaMs and the IES costs and benefits for corresponding PaMs are not comparable.

2.1.13 Policy Background

One of the actions listed in the Climate Action Plan (2020) (Ministry for the Environment and Natural Resources) includes the continuation of Iceland's participation in the ETS (measure **307**). Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018, that amends Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, was incorporated into the EEA Agreement with EEA Joint Committee Decision No 112/2020 and implemented into Icelandic legislation through amendments of the Climate Change Act No 70/2012. The Directive lays down the provisions for the fourth trading period in the EU ETS (phase IV).

Two other actions in the Climate Action Plan (2020) fall outside of the scope of ESR emissions: Carbon capture from heavy industry (measure **306**) and participation in the international system for mitigating emissions from aviation (ETS and CORSIA) (measure **705**). The rest of the actions cover ESR or LULUCF emissions.

2.1.14 Historical Split Between ETS and Joint Fulfilment

In recent years, the share of emissions falling under the scope of the EU ETS has been just below 40% of the total annual emissions excluding LULUCF and international bunkers, with just over 60% contributing to Iceland's emissions falling under the scope of the JFA with the EU.

Emissions from stationary operators falling under the scope of the EU ETS originate for the most part from metal production (primary aluminium, ferroalloys, and silicon production). These emissions are largely dominated by process emissions from metal production, i.e., emissions related to the oxidation of carbon-containing fuels which in turn is linked to the reduction of raw materials into metal. Only a very small percentage belongs to emissions solely coming from fuel combustion.

In recent years, approximately two thirds of the emissions falling under the JFA with the EU, originated from the Energy sector. Half of the emissions from this sector were from road transport, while the fishing industry accounted for a large part of the rest. Approximately one fifth of the non-ETS emissions come from the Agriculture sector, whereas F-gas emissions and solid waste disposal make up most of the rest of the emissions.

3 Information on National Systems for Policies, Measures, and Projections

3.1 Legal Arrangements

The legal basis for the national system for the GHG inventories, including the reporting on National Systems for policies and measures and projections, national GHG policies and measures and national projections of anthropogenic GHG emissions, is found in the Icelandic Climate Act No 70/2012, which describes the roles and responsibilities of the relevant government agencies in this area. The law ensures that enough capacity is available for reporting. The objectives of the Climate Act are the following:

- To reduce GHG emissions efficiently and effectively;
- To increase carbon sequestration from the atmosphere;
- To promote mitigation and adaptation to the consequences of climate change, and;
- To create conditions for the government to fulfil its international obligations regarding climate change.

The Climate Act establishes the national system for the estimation of GHG emissions by sources and removals by sinks, a national registry and the legal basis for installations and aviation operators participating in the EU ETS. It also serves as the legal basis for the development of national Climate Action Plans and Progress Reports.

Article 5 of the Climate Act describes the obligation of the Minister of the Environment, Energy, and Climate to see to the production of a Climate Action Plan; it also establishes the ISC for Climate Action composed by members nominated by the Minister of the Environment, Energy, and Climate as well as ministers from other ministries.

Article 6 of the Climate Act addresses Iceland's GHG inventory. It states that the Environment Agency of Iceland (*Umhverfisstofnun*) (EAI) is the competent authority for the national accounting as well as for the inventory of emissions and removals of GHGs according to Iceland's international obligations. The Climate Act establishes the form of relations between the IEA and other bodies concerning data handling. The article also serves as the legal basis for Regulation No 520/2017 on data collection and information from institutions related to Iceland's inventory of greenhouse gas emissions and carbon removal. Regulation No 520/2017 is currently being revised in accordance with the new legislation for the Paris Agreement period.

Regulation No. 520/2017 serves both as the description of the EAI's and data providers' obligations related to the GHG inventory, and the implementation of Regulation (EU) No 525/2013. It specifies the obligations of the EAI in terms of reporting and information related to GHG emissions to other institutions, as well as lists the obligations of other agencies, institutions, or other data providers to the EAI; in particular, it attributes the responsibility of the LULUCF sector to the Icelandic Forest Service (*Skógræktin*) (IFS) and the Soil Conservation Service of Iceland (*Landgræðslan*) (SCSI) (see below). In addition, it specifies the timelines for data collection and reporting to the EU and gives the EAI the right to request additional data from any stakeholder provided it is necessary to produce the GHG inventory. A recast of this regulation is ongoing.

Provisions on reporting on PaMs and projections were first included in the Climate Act in 2019 through law No 86/2019[15]. Another notable change is the legal establishment of Iceland's Climate Council and the definition of its role in advising the government regarding Iceland's Climate Action Plans. The Act was amended again in 2020 where ESR and LULUCF regulation were implemented. Consequently, Regulation No 520/2017 is also being revised in order to reflect the changes in the Act and spell out more specifically the data requirements linked to reporting on PaMs and projections. This updated regulation will also serve as the implementation of Implementing Regulation (EU) 2020/1208 and Delegated Regulation (EU) 2020/1044, as these two regulations have been incorporated into the EEA Agreement through JCD 233/2021. Any future delegated and implementing regulations based on Regulation (EU) 2018/1999 that will be incorporated into the EEA Agreement will also be implemented in Icelandic legislation.

3.2 Main Institutions and Data Providers

The main institutions and organisations playing a role in climate policy and international reporting include:

The Ministry of the Environment, Energy, and Climate (*Umhverfis-, orku- og loftslagsráðuneytið*) (MEEC), which holds responsibility for activities related to the development and implementation of the national PaMs in climate change prevention.

The EAI is under the jurisdiction of the MEEC and is designated as the national entity with the overall responsibility for:

- The climate change policy evaluation and reporting on PaMs;
- The development and reporting on projections of anthropogenic GHG emissions;
- Reporting on national systems for policies and measures and projections.

The Inventory Team (*Teymi losunarbókhalds*) which falls within the Department for Climate and the Circular Economy (*Svið loftslags og hringrásarhagkerfis*) at the EAI, is also responsible for the submission of the national GHG Inventory for each year. The same experts complete the reporting on PaMs, projections of anthropogenic GHG emissions, and the historical GHG inventory. The Inventory Team also performs the QA/QC and sensitivity analysis internally, with some external checks done by consultants from Aether ltd. The same team is also responsible for the air pollutant inventory, reported to the Convention on Long Range Transport of Atmospheric Pollutants (CLRTAP).

The Icelandic Forest Service (IFS) and the Soil Conservation Service of Iceland (SCSI) are responsible for reporting on PaMs and projections of Land Use, Land-Use Change, and Forestry (LULUCF). The IFS and SCSI report the information to the EAI, which submits everything together to the European Environment Agency (EEA). The same experts are also responsible for the LULUCF sector in the historical GHG inventory.

The main data providers include:

- The National Energy Authority (*Orkustofnun*) (NEA) provides energy use projections, including electricity use, fuel use, and geothermal heat use. To maintain consistency between the energy and GHG projections, the same GDP and population projections which are used by the NEA to produce the energy projections are used for the GHG projections;

[15] Amendment to the Climate Act 70/2012. *Althingi*. https://www.althingi.is/altext/stjt/2019.086.html

- Statistics Iceland (*Hagstofa*), provides production statistics;
- EU ETS operators provide production projection plans;
- The IFS and SCSI provide the majority of LULUCF data;
- Various Ministries, companies and organisations have provided projected activity data.

All data providers are listed and described in the relevant chapters.

3.3 Institutional Arrangements

The main institutions involved in the preparation of the PaMs and Projections reporting and responsible for the process of submission are:

- Ministry of the Environment, Energy, and Climate (MEEC)
    - Environment Agency of Iceland (EAI)
- Ministry of Food, Agriculture and Fisheries (MFAF)
    - Soil Conservation Service of Iceland (SCSI)
    - Icelandic Forest Service (IFS)
- Data Providers

Figure 3.1 below shows a flow chart of the institutional arrangements in place for this year's submission of information on PaMs and projections.

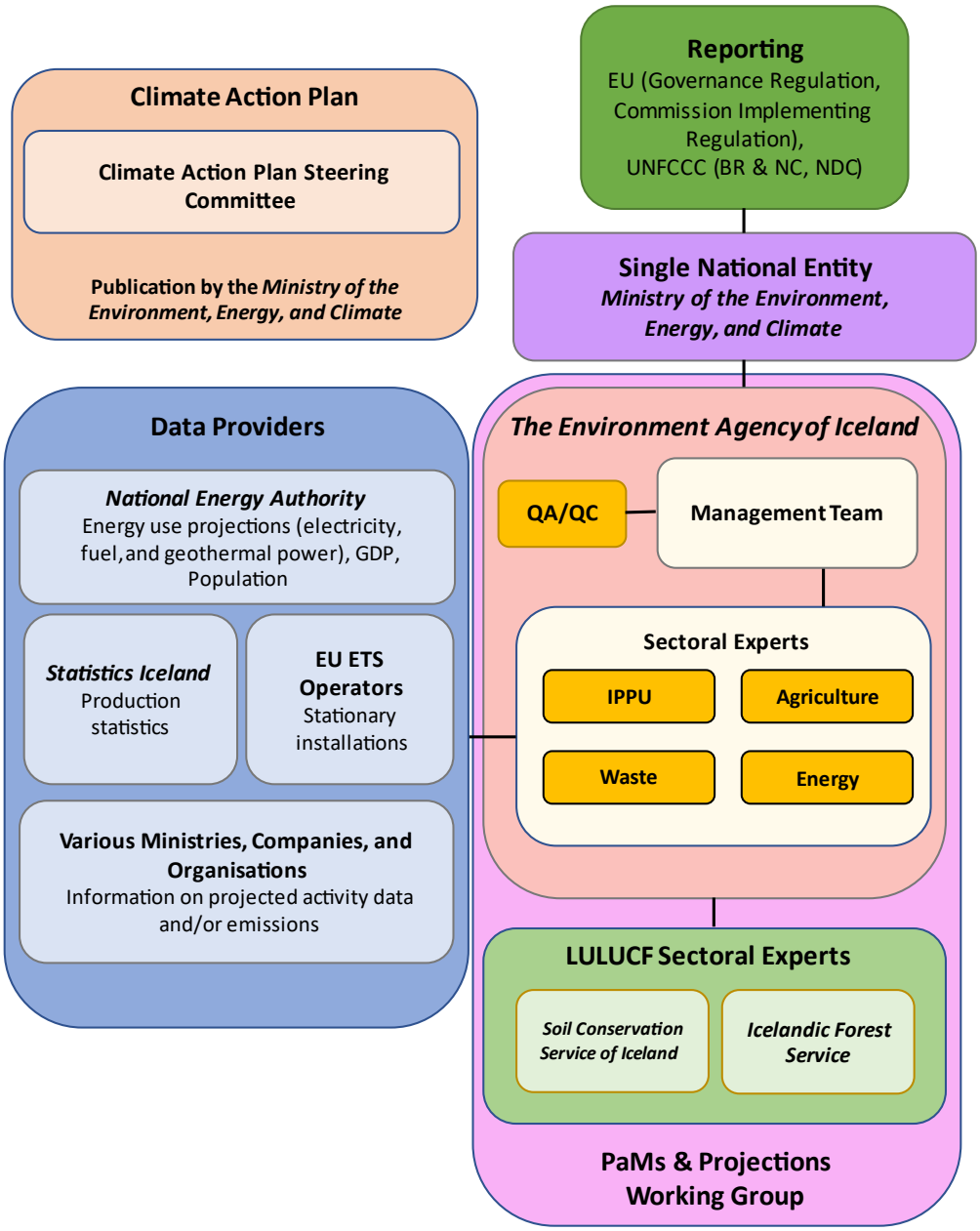

Figure 3.1 Information flow chart of institutional arrangements for PaMs and Projections reporting in Iceland.
Note: BR = Biennial Review, NC = National Communication, NDC = Nationally Determined Contribution

The MEEC is responsible for implementation of national climate policy. However, climate policy is a cross-sectoral matter, particularly regarding measures for reducing emissions and adapting to climate change. This is acknowledged on a cross-sectoral level and reflected in the implementation of climate policy.

According to the Climate Act, the MEEC is responsible for publishing a Climate Action plan with policies and measures to reduce anthropogenic greenhouse gas emissions and increase carbon sequestration, which shall be updated every four years at a minimum. The MEEC appoints an Interministerial Steering Committee (ISC) that formulates proposals for climate measures and oversees their implementation. The following ministers nominate one representative each:

- the minister in charge of governance in general and coordination within the government of Iceland;
- the minister in charge of public funding and finances;
- the minister in charge of industry;
- the minister in charge of education and the sciences;
- the minister in charge of transport;
- the minister in charge of fisheries and agriculture.

The Association of Icelandic Local Authorities (*Samband íslenskra sveitarfélaga*) (AILA) also has a representative in the ISC.

The ISC shall report annually to the Minister of the Environment, Energy and Climate on the progress of the Climate Action Plan. The report shall review emissions trends and whether they are in accordance with plans and make recommendations for improvement.

The EAI, under the MEEC, has the overall responsibility for the national system of GHG inventory preparation as well as of PaMs and projections reporting. Project management of the PaMs and Projections report is organised by national inventory experts in the Inventory Team at the EAI. Those inventory experts form a PaMs and Projections working group with inventory experts at the IFS and the SCSI, which are under the MFAF, to coordinate the reporting of all sectors. The EAI team is responsible for the overall coordination of the PaMs and GHG projections preparation process regarding the following:

- Collection of information from data providers on the currently implemented, adopted or planned policies and measures in different sectors (Energy, Industrial Processes and Product Use (IPPU), Agriculture, and Waste) and preparation of the final report.
- Collecting projected relevant activity data from data providers.
- Preparing GHG emissions projections for different sectors (Energy, IPPU, Agriculture, and Waste) and providing information on them in the final report.
- Receiving an official consideration, QA, and approval of the GHG emissions projections report by the MEEC.
- Timely submission of the PaMs and GHG emission projections reports to the European Commission.
- Coordination of the process in Iceland during the QA procedure of the EEA.
- Keeping of archive and publication of the official submissions to the European Commission.
- Informing of the responsible institutions on preparation process of PaMs and GHG emission projections and relevant requirements for the national system.

The SCSI is responsible for calculations of emissions and removals as well as estimating GHG emissions projections in the LULUCF sector (land use and land-use change parts only).

The IFS is responsible for calculations of emissions and removals as well as estimating GHG emissions projections in the LULUCF sector (forestry part only).

3.4 Procedural and Administrative Arrangements

The Environment Agency of Iceland (EAI) is responsible for ensuring the timeliness, transparency, accuracy, consistency, comparability, and completeness of the information reported on policies and measures and projections.

A kick-off meeting between the PaMs and Projections working group members, including inventory experts from the EIA's Inventory Team and inventory experts from the SCSI and the IFS, is organised in September/October prior to the next 15 March submission date to launch the work. A date is set by which the PaMs and Projections working group members provide a list of their respective policies and measures to be included in the reporting, along with a division between the projections scenarios to be included in the reporting (currently WEM and WAM scenarios).

The Reporting is prepared in a transparent and complete manner. The Reporting is predominantly based on the latest version of Iceland's Climate Action Plan (2020), which is updated no less frequently than every four years, and the latest Progress Report (2022), which is published annually unless a new Climate Action Plan is published that year. Policy measures are described and published in the Climate Action Plan, including the entity responsible, a performance indicator (where available), funding (where available), and impact on emissions (where available). All PaMs in the Climate Action Plan are included, but other relevant PaMs may be approved by the PaMs and Projections working group and included as well, if deemed appropriate. To classify policies and measures under the WEM and WAM scenarios, a cut-off date is agreed upon by the PaMs and Projections working group. Across the different sectors, the reported PaMs that are implemented on or before the cut-off date belong to the WEM projections and those implemented after the cut-off date or which are still in the planning phase belong to the WAM projections.

To further ensure completeness, the projections follow the greenhouse gas source and sink categorisations recommended by the European Commission (based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and revised UNFCCC CRF tables for inventory reporting); ensuring that all relevant categories are described in the reporting.

The reporting uses publicly available data to the extent possible, the main provider being the NEA, which publishes energy (fuel/electricity/geothermal) projections on a regular basis. The same parameters (GDP, population, etc) as the NEA uses for the energy projections (which are published in a separate parameter report by the NEA) are used for the GHG emissions projections to the extent possible. Not all data can be published, however, due to confidential reporting by companies. Out of the assumptions, methods, and models used by the expert organisations (the EAI, SCSI, IFS, and NEA) in evaluating policies and measures or used in making the projections, many are publicly available or have been described in public sources.

Accuracy is ensured through several measures. First, all the expert organisations preparing information are well-established. Second, the reporting uses publicly available data and assumptions to as large an extent as possible, and most of the methods and models have been used before in national and international reporting. Third, projections follow the greenhouse gas source and sink categorisation recommended by the European Commission (based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and revised UNFCCC CRF tables for inventory reporting).

Consistency and comparability are ensured through several measures. The PaMs reported are primarily based on the Climate Action Plan and Progress Report. Inventory experts from the EAI are involved in the PaMs quantification and projections calculations for the Climate Action Plan and Progress Reports to a certain degree to facilitate the consistency and comparability with the PaMs and Projections Report.

The same inventory experts from the EAI, SCSI, and IFS who prepare the historical GHG inventory, are involved in the PaMs and projections reporting, ensuring consistency and comparability between the historical and projected GHG emissions in each sector.

GHG emissions projections for Energy are based on the NEA's energy projections as much as possible to ensure consistency in national reporting. The EAI and NEA work closely together to streamline the projected activity data and projection scenarios for fuel combustion, which is one of the most significant sources of GHG emissions in Iceland.

In the case that the Reporting requires extending or updating assumptions affecting several sectors, the PaMs working group members agree on these together. Sector-specific assumptions are selected based on the expertise of the PaMs working group members or the expert organisations and rely on relevant plans and research reports as much as possible.

Regular meetings between the Ministry of the Environment, Energy, and Climate (MEEC) and the inventory experts at the EAI, as well as biweekly meetings between the project manager of the PaMs and Projections working group and the project manager of the Climate Action Plan ensure that both parties are kept up to date on developments and are in agreement on the PaMs and Projections reporting. Based on issues raised during these meetings, the MEEC facilitates communications between other relevant ministries and the EAI where applicable. For example, experts on Agriculture from the Ministry of Food, Agriculture, and Fisheries provided expert judgment on the development of livestock numbers for the agriculture GHG emissions projections, after the EAI provided them with a few different projected activity data scenarios.

A month before the deadline of the reporting, the PaMs and Projections working group members provide their respective information concerning the policies and measures and projections to the project manager of the working group, which compiles all the information into the reporting tools and a single paper report. This schedule leaves enough time to perform the remaining QA/QC activities.

3.5 Reporting Process and QA/QC

3.5.1 Description of the Information Collection Process

The base year for projections is the latest year for which there is a NIR. Because the historical and projected GHG emissions are prepared by the same inventory experts, the experts can prepare the calculations of both inventories in parallel. Therefore, for example, the 2023 PaMs and Projections use 2021 as a base year. Measures which have been introduced before the time of projection preparation are considered as existing measures (WEM). Measures expected to be implemented later are considered as additional (WAM) and are currently not included in a projection scenario.

The policies and measures included in the report are predominantly based on the government's most recent Climate Action Plan and Progress Report. According to the Climate Act No 70/2012, the government is required to update their Climate Action Plan (which includes national GHG mitigation policies and measures) no less frequently than every four years. The Progress Report is updated annually unless a new Climate Action Plan is published that year. Other significant policies and measures are included as much as capacity allows and where data is available before the time of projection preparation.

The projected general baseline activity data, such as population and GDP, is in line with the NEA's latest energy projections assumptions. The EIA bases the energy GHG emissions on the NEA's energy

projections, and, therefore, it is important that the same underlying baseline assumptions are used in proxy projections in other sectors to ensure consistency.

The emission estimates in the IPPU sector are based on various factors. For the mineral and metal industries, activity data is predominantly provided directly by the production companies. Where direct activity data is unavailable, historical trends are used. In the "non-energy products from fuels and solvent use" and "other product manufacture and use" categories, activity data is projected, using either historical trends or GDP or population as proxy. F-gas projections are based on the import quota legislation, which places a ceiling on F-gas imports.

The projections of GHG emissions in the Agriculture sector are based on trends in the activity data used in the emission inventory calculation. Animal population (particularly cattle and sheep population) and the amount of fertiliser applied to agricultural soils are the most important activity datasets. The projections of animal numbers, fertiliser use, and crop production are based on historical trends. The animal number projections are approved by experts in the Ministry of Food, Agriculture, and Fisheries. The livestock characterisation parameters are for the greatest part the same as those used in the latest historical GHG inventory. For a few parameters, such as annual milk yield per dairy cow, historical trends are used.

The Waste sector projections contain four source categories - emissions from landfills, emissions from wastewater handling and emissions from waste incineration and emissions from biological treatment of waste. The projections of GHG emissions in Waste are based on projections of the total amount of waste going to landfill and composting, using population projections as proxy data and considering methane gas collection and waste export plans. New policies which will impact waste production and allocation are also taken into consideration. Data on waste incineration is based on the operating licence of Iceland's only waste incinerator.

The emission estimates in the LULUCF sector are to a large degree determined by development of land areas categorised by their use. Therefore, the LULUCF emission estimates and their projections must primarily methodologically solve the issue of land areas. The actual development of six major IPCC land-use categories as reported in the latest emission inventory is used. The projections are based are on the observed trends and anticipation of increased soil reclamations and rewetting of wetlands. The projections related to forestry are prepared by the IFS based on a model projecting the development of C stock change in Forest Land. Future harvesting was estimated by comparing wood production to potential harvesting of forest defined as available for wood supply.

Data for evaluation of PaMs are collected from projects and programs supported by various institutions, ministries, companies, and associations. All PaMs which are evaluated are included in the reported WEM or WAM scenario. Some PaMs are assumed to be included the WEM scenario projections, although it was not possible to quantify them specifically.

3.5.2 Description of the Alignment with the National Inventory System

The same inventory experts from the EAI, SCSI, and IFS who prepare the historical GHG inventory are involved in the PaMs and projections reporting, ensuring consistency and comparability between the historical and projected GHG emissions in each sector. Data for policies and measures and projections is stored on the same drives as data for the historical GHG inventory.

3.5.3 Description of QA/QC Procedures

All the expert organisations providing information for the reporting have their own quality assurance and quality control (QA/QC) procedures. The EAI is responsible for collecting and combining all the information and for ensuring that further quality checks are performed. External QA/QC of the final draft submission is performed by the relevant ministry or external consultants to increase the reliability and ensure the completeness of the reporting.

Sensitivity analyses for projections are carried out for factors being especially significant in terms of greenhouse gas emissions, and they are described in the report accompanying each round of the Reporting. For the reporting on projections, various sensitivity analysis scenarios were carried to assess the reliability of the projections.

After the reporting tools and paper report have been compiled by the EIA, they are sent to the Ministry of the Environment, Energy, and Climate for final approval.

3.5.4 Description of the Process for Selecting Assumptions, Methodologies, and Models for Making Projections of Anthropogenic GHG Emissions

Sectoral experts from the EAI, SCSI, and IFS are responsible for selecting the assumptions, methods, and models to use for the projections. The EAI's experts work closely and interact regularly with other key experts in order to establish an appropriate set of assumptions and methods. The EAI, SCSI, and IFS experts transparently document the data sources, methods, and assumptions.

3.5.5 Description of Procedures for the Official Consideration and Approval of the Member States National System for Policies, Measures, and Projections

The Ministry of the Environment, Energy, and Climate has tasked EAI with the overall responsibility of the work related to the reporting on Policies and Measures and Projections in accordance with the EU legislations implemented by the decision of the EEA Joint Committee No 269/2019 and transposed into Icelandic law by an amendment to the Climate Act No 70/2012. The PaMs report is sent to the Ministry for approval before its submission to EU.

3.6 Description of the Links to Arrangements on Integrated National Energy and Climate Reports Pursuant to Art. 17 of Regulation (EU) 2018/1999

According to the EEA Joint Committee Decision No 269/2019, Iceland implements only the provisions of the Governance Regulation relating to climate reporting. Art. 17 is not implemented, but according to the Declaration on national plans[16], related to the EEA Joint Committee Decision No 269/2019[17], Iceland will, on a voluntary basis, develop a national plan describing how Iceland intends to fulfil the commitments undertaken in relation the implementation of Regulation (EU) 2018/841 and Regulation (EU) 2018/842. The first National Plan on Climate was published in 2020 (Government of Iceland, 2020).

[16] *EFTA*: https://www.efta.int/sites/default/files/documents/legal-texts/eea/other-legal-documents/adopted-joint-committee-decisions/2019%20-%20English/269-2019%20-declaration.pdf

[17] *EFTA*. https://www.efta.int/sites/default/files/documents/legal-texts/eea/other-legal-documents/adopted-joint-committee-decisions/2019%20-%20English/269-2019.pdf

According to the Declaration, the plan must contain following main elements:

- An executive summary of the plan;
- An overview of current national climate policies;
- A description of the national Effort Sharing target and LULUCF commitment;
- A description of the main existing and planned policies and measures foreseen to achieve the Effort Sharing target and LULUCF commitment;
- A description of the current national greenhouse gas emissions and removals as well as projections of the Effort Sharing target and LULUCF commitment based on already existing policies and measures;
- An assessment of impacts of the planned national policies and measures to meet the Effort Sharing target and LULUCF commitment, comparing with the projections based on existing policies and measures and describing interactions between existing and planned policies and measures.

Reporting on PaMs in the National Plan is based on the PaMs and Projections report, submitted by the EAI.

3.7 Information on Relevant Institutional Administrative and Procedural Arrangements for Domestic Implementation of the EU's Nationally Determined Contribution, or Changes to Such Arrangements

According to the Climate Act, the Minister of the Environment, Energy, and Climate is responsible for publishing a Climate Action plan with policies and measures to reduce anthropogenic greenhouse gas emissions and increase carbon sequestration. The plan shall be updated every four years at a minimum and consider international commitments and declared domestic goals.

The Minister of the Environment, Energy, and Climate appoints an ISC that formulates proposals for climate measures and oversees their implementation. The following ministers nominate one representative each: The minister in charge of governance in general and coordination within the government of Iceland, the minister in charge of public funding and finances, the minister in charge of industry, the minister in charge of education and the sciences, the minister in charge of transport, and the minister in charge of fisheries and agriculture. The AILA also has a representative in the ISC.

The preparation of the Climate Action plan is done in consultation with stakeholders and with public participation. The ISC shall report annually to the Minister of the Environment, Energy, and Climate on the progress of the Climate Action Plan and publish a Progress Report. The report shall review emissions trends and whether they are in accordance with plans and make recommendations for improvement.

3.8 Description of the Stakeholder Engagement Undertaken in Relation to the Preparation of Policies, Measures, and Projections

After Iceland's first submission of the PaMs and Projections reporting in 2019, the Environment Agency of Iceland (EAI) organised expert review meetings for the sectors (Energy, IPPU, Agriculture, and Waste) to get feedback and constructive criticism from external experts in order to improve future reporting. Consequently, the EAI gained some valuable insights and contacts that have been maintained throughout the preparation stage of subsequent reporting.

After Iceland's first PaMs and Projections report was submitted, Energy experts from the EAI have strengthened the collaboration with the NEA. The two government agencies have worked closely together since, with the aim of streamlining the projected fuel activity data and projection scenarios for fuel combustion, which is one of the most significant causes of GHG emissions in Iceland. The latest fuel projections were published by the NEA in the autumn of 2022.

The IPPU and F-gas experts from the EAI have been in contact with the main industry manufacturers in Iceland again to make the projections as accurate as possible. There was also regular collaboration with the Ministry of the Environment, Energy, and Climate (MEEC), which was updating the F-gas import quota regulation during this time. Experts from the EAI assisted the ministry in the process of calculating the expected impacts of different import quotas, one of which was implemented in December 2020 with Icelandic Regulation No 1425/2020, which alters regulation No 1066/2019 on Fluorinated GHGs.

Experts from the EAI, SCSI, and IFS had a kick-off meeting to organise the Land Use, Land Use Change, and Forestry (LULUCF) projections submission of 2023 in the autumn of 2022. A timeline for the 2023 submission was established in consultation with the LULUCF experts and collaboration has been maintained throughout the preparation period of the 2023 submission.

In 2022, a new Working Group on Climate Action in Agriculture and LULUCF was established by the Ministry of Food, Agriculture and Fisheries, with the goal of improving and strengthening climate mitigation PaMs in these sectors. The working group has representatives from the EAI, SCSI, and IFS, as well as the MEEC, the Agricultural University of Iceland, the Farmer's Association of Iceland, and the Icelandic Agricultural Advisory Centre. The representatives from the EAI, SCSI and IFS have communicated and discussed the information on Agriculture and LULUCF PaMs and projections provided in this report to the group.

The Waste experts from the EAI had meetings with experts from the biggest waste provider in Iceland, as well as other waste management stakeholders, throughout the process of developing the projections. Furthermore, the EAI has established a Waste Expert Group inside the Agency, with experts from different departments who work on various waste related issues; from operating permits, surveillance, data gathering, circular economy projects to GHG inventories. The assumptions for the waste projections were presented to the group and approved.

3.9 Improvements Undertaken or Planned to the National System

The Minister for the Environment, Energy and Climate has presented plans to merge many of the ministry's government agencies over the next year. This may result in some changes in the internal structure of the agencies, although the responsibilities of the agencies should not change overall.

As mentioned in Section 3.1, changes are underway in the legislation to facilitate data acquisition for PaMs and projections reporting. Furthermore, improvements are being implemented in the archiving of information and documenting of the decision-making processes, as well as the general work process. Since the first PaMs and Projections report produced by Iceland, the provisions of Regulation (EU) No 525/2013 have provided for the improvement of the process of information gathering, calculations and reporting in future submissions. Furthermore, the ever-increasing importance and visibility of climate change matters in Iceland is expected to lead to increased staff capacity in the various teams participating in the compilation of future inventory and PaMs and Projections reports.

4 Summary of Projections

4.1 Methodology Overview

The methodologies used to calculate GHG projections are consistent with Iceland's latest NIR. For information on the sectoral methods see the NIR (Environment Agency of Iceland, 2023). Where methodologies are not described within the sectoral chapters, the method from the NIR has been followed.

4.2 Emission Projections – WEM Scenario

Iceland's total historical and projected emissions of GHGs, including LULUCF emissions, are presented for the WEM scenario in Table 4.1 and Figure 4.1. The total emissions, including LULUCF, are expected to have decreased by 12% in 2050 compared to emissions in 1990, and 18% in 2050 compared to emissions in 2015. Carbon sequestration due to Forest Land has increased significantly in recent years and is projected to continue to increase rapidly.

Table 4.1 Total historical and projected GHG emissions including LULUCF for the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
1 Energy	1,841	1,854	1,664	1,761	1,475	1,209	874	569	409
2 IPPU	903	1,970	1,975	2,063	1,970	1,893	1,871	1,838	1,812
3 Agriculture	695	659	617	613	605	596	587	578	570
4 LULUCF	9,610	9,506	9,421	9,279	9,135	9,014	8,983	8,885	8,746
5 Waste	244	289	266	243	223	214	203	194	189
Total, with LULUCF	13,292	14,278	13,942	13,958	13,409	12,927	12,518	12,065	11,725

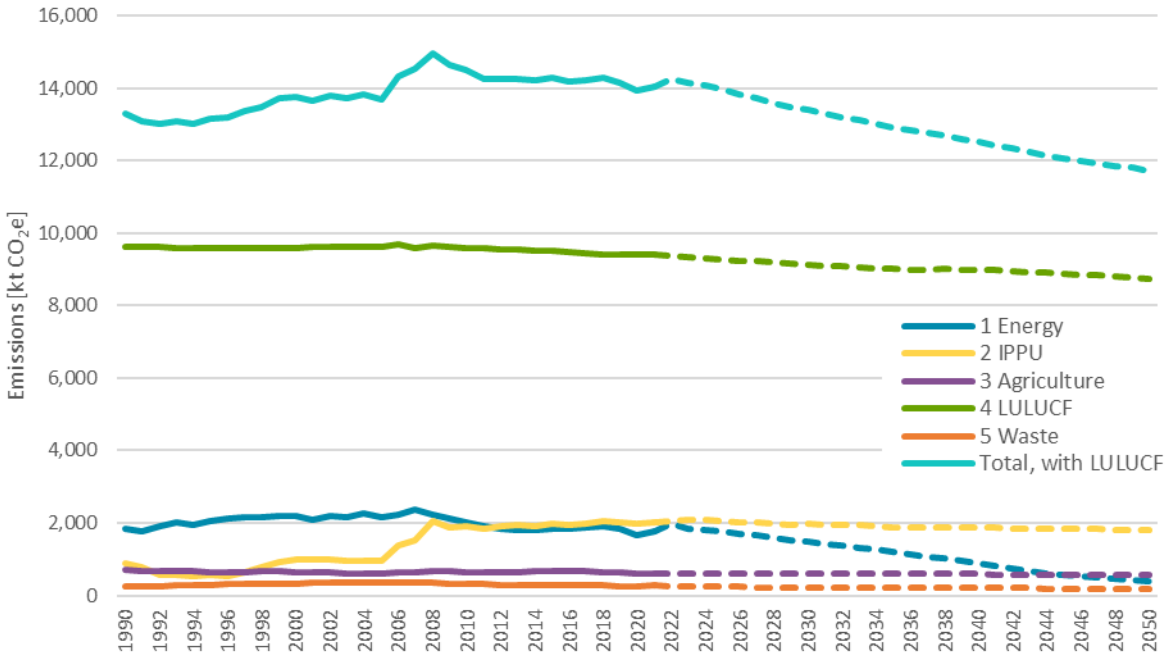

Figure 4.1 Total historical and projected GHG emissions including LULUCF for the WEM scenario 1990-2050, [kt CO_2e].

Iceland's total historical and projected emissions of GHGs, excluding LULUCF, are presented for the WEM scenario in Figure 4.2 and Table 4.2 below. The total emissions decreased in 2020 and 2021 due to the Covid-19 pandemic. Therefore, emissions are expected increase again slightly in 2022, after which they are projected to follow a downward trend until 2050. Iceland's GHG emissions are projected to be 19% lower in 2050 compared to what they were in 1990, and 38% lower compared to what they were in 2015.

The main cause for the projected decrease in emissions from the Energy sector is the impact of the energy transition in Road Transportation, which is changing rapidly from predominantly fossil fuel vehicles to electric vehicles, as well as a substantial decrease in emissions from fishing. IPPU will mainly change because of a projected decrease in emissions from F-gases, due to the newly implemented F-gas regulation, which limits the import of F-gases. Emissions reductions from IPPU will remain relatively low, however, due to no significant changes in emissions from the Metal Industry. Agriculture emissions will decrease because of a projected decrease in some livestock population numbers. Waste emissions are expected to peak in 2021 and decrease over the projected timeseries due to better practices in solid waste disposal and the treatment of biological waste.

Table 4.2 Total historical and projected GHG emissions excluding LULUC for the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
1 Energy	1,841	1,854	1,664	1,761	1,475	1,209	874	569	409
2 IPPU	903	1,970	1,975	2,063	1,970	1,893	1,871	1,838	1,812
3 Agriculture	695	659	617	613	605	596	587	578	570
5 Waste	244	289	266	243	223	214	203	194	189
Total, without LULUCF	3,682	4,773	4,521	4,680	4,274	3,913	3,535	3,180	2,979

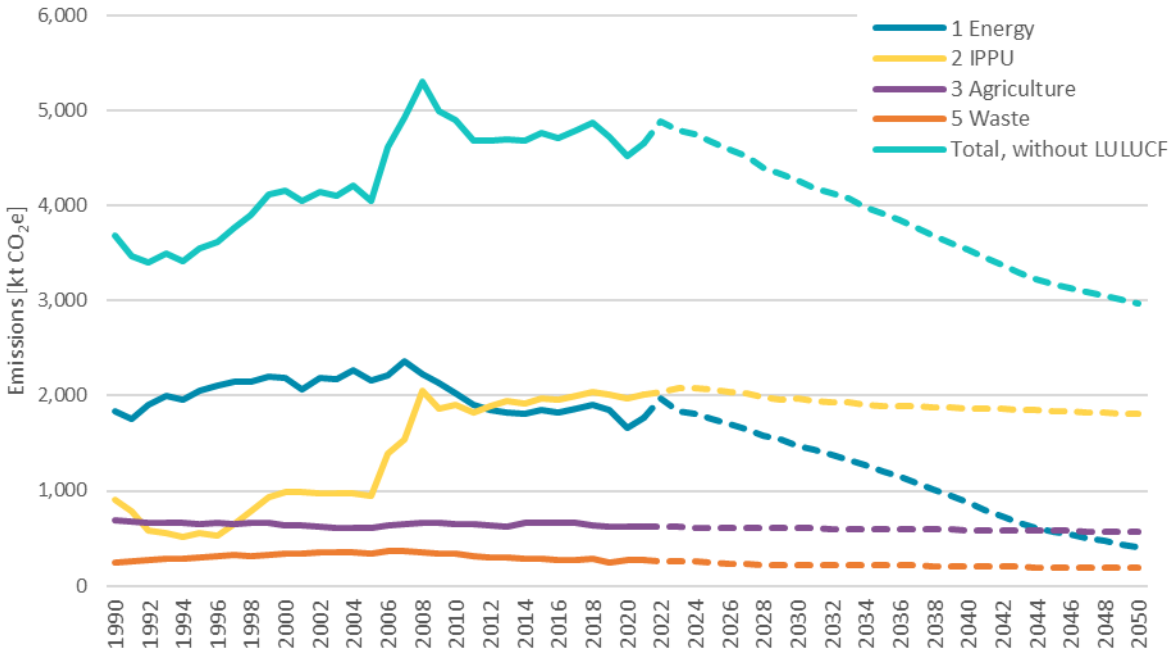

Figure 4.2 Total historical and projected GHG emissions excluding LULUCF for the WEM scenario 1990-2050, [kt CO_2e].

Iceland's total historical and projected emissions, split into ETS and effort sharing ("ESR"), can be seen for the WEM scenario in Table 4.3 and Figure 4.3 below. In Iceland, all CO_2 emissions currently generated from the Production of Iron and Steel and Non-Ferrous Metals (1A2a and 1A2b) and CO_2 and PFC emissions from the Metal Industry (2C) are covered under the EU ETS.

Emissions from ETS industry have remained relatively steady from 2015. Based on the current projections, ETS emissions increase by 109% between 2005 and 2050. ESR emissions are, however, expected to decrease by 62% between 2005 and 2050.

Table 4.3 ETS and ESR GHG projections for the WEM scenario, [kt CO_2e].

	2005	2015	2020	2025	2030	2035	2040	2045	2050
Total ESR	3,180	2,951	2,738	2,727	2,349	2,026	1,692	1,371	1,200
Total ETS	853	1,802	1,770	1,927	1,899	1,869	1,840	1,809	1,778

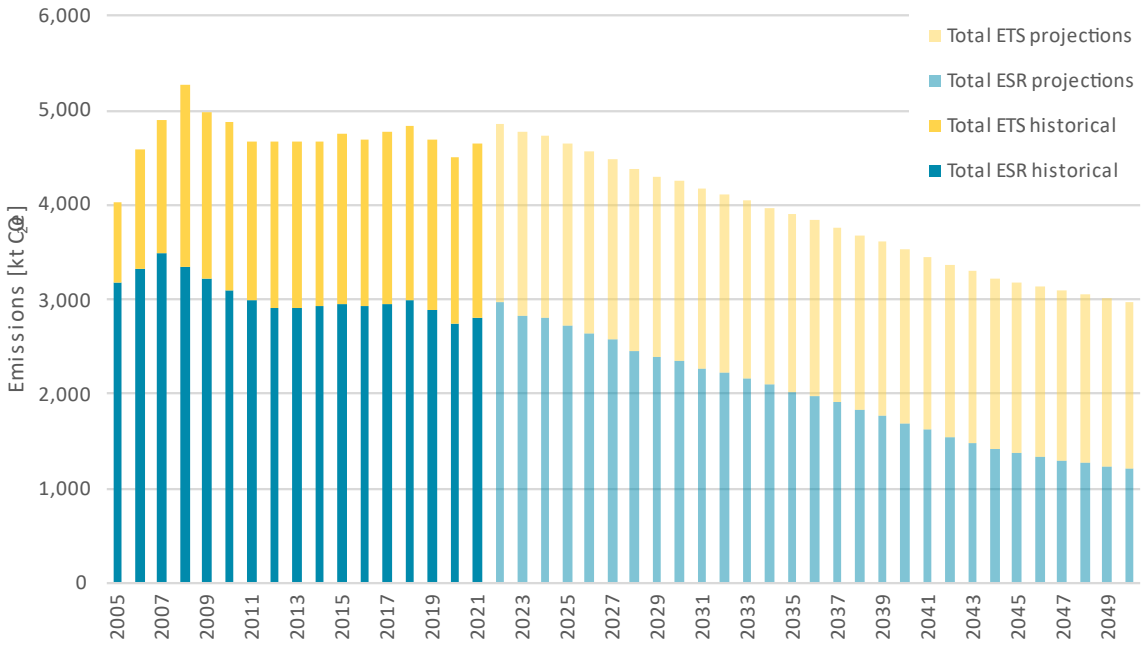

Figure 4.3 ETS and ESR GHG projections for the WEM scenario, [kt CO_2e].

ESR emission projections per sector can be seen in Figure 4.4. Most of the emission reduction until 2050 occurs in the Energy sector, and a proportionally high emission reduction can also be observed in the IPPU sector (the reduction is predominantly derived from reduced F-gas imports). Lower emission reductions occur in Agriculture and Waste.

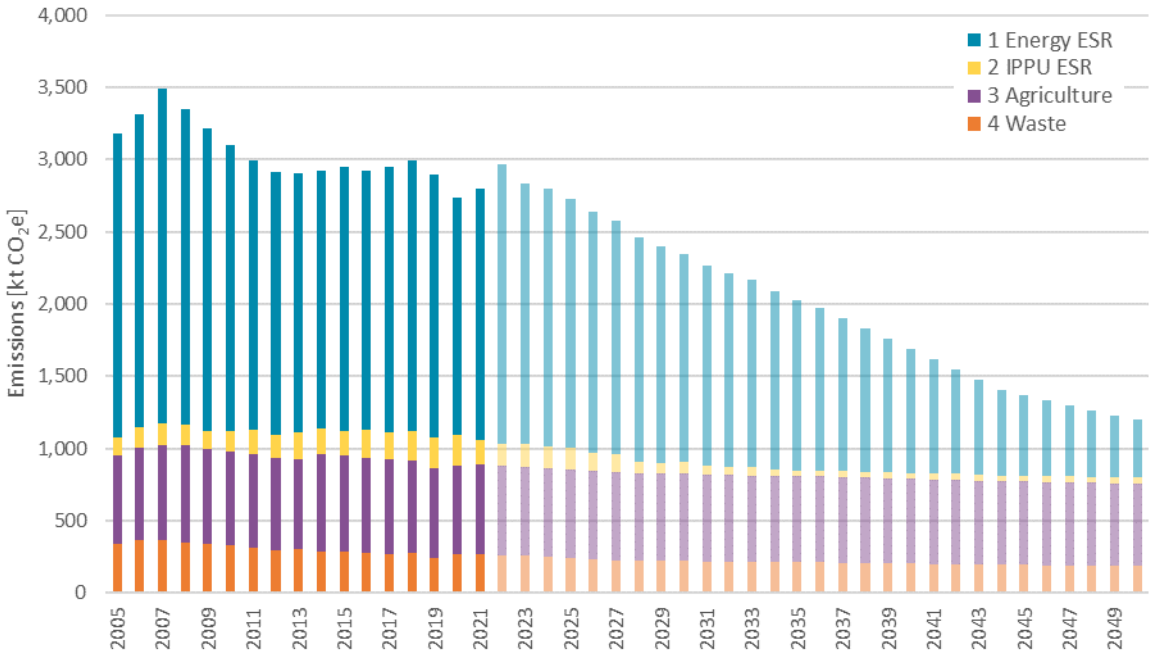

Figure 4.4 ESR emission projections split by sector for the WEM scenario 2005-2050, [kt CO_2e].

4.3 Emission Projections – WAM scenario

The WAM scenario includes measures in Energy and LULUCF that are not accounted for in the WEM scenario. For other sectors the WEM and WAM scenarios are identical.

Iceland's total historical and projected emissions of GHGs including LULUCF emissions are presented for the WAM scenario in Table 4.4 and Figure 4.5. The total emissions, including LULUCF, are expected to have decreased by 21% in 2050 compared to emissions in 1990, and 27% in 2050 compared to emissions in 2015.

Table 4.4 Total historical and projected GHG emissions including LULUCF for the WAM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
1 Energy	1,841	1,854	1,664	1,743	1,439	1,164	829	567	407
2 IPPU	903	1,970	1,975	2,063	1,970	1,893	1,871	1,838	1,812
3 Agriculture	695	659	617	613	605	596	587	578	570
4 LULUCF	9,610	9,506	9,421	9,225	8,916	8,581	8,311	7,947	7,509
5 Waste	244	289	266	243	223	214	203	194	189
Total, with LULUCF	13,292	14,279	13,942	13,887	13,153	12,449	11,802	11,125	10,486

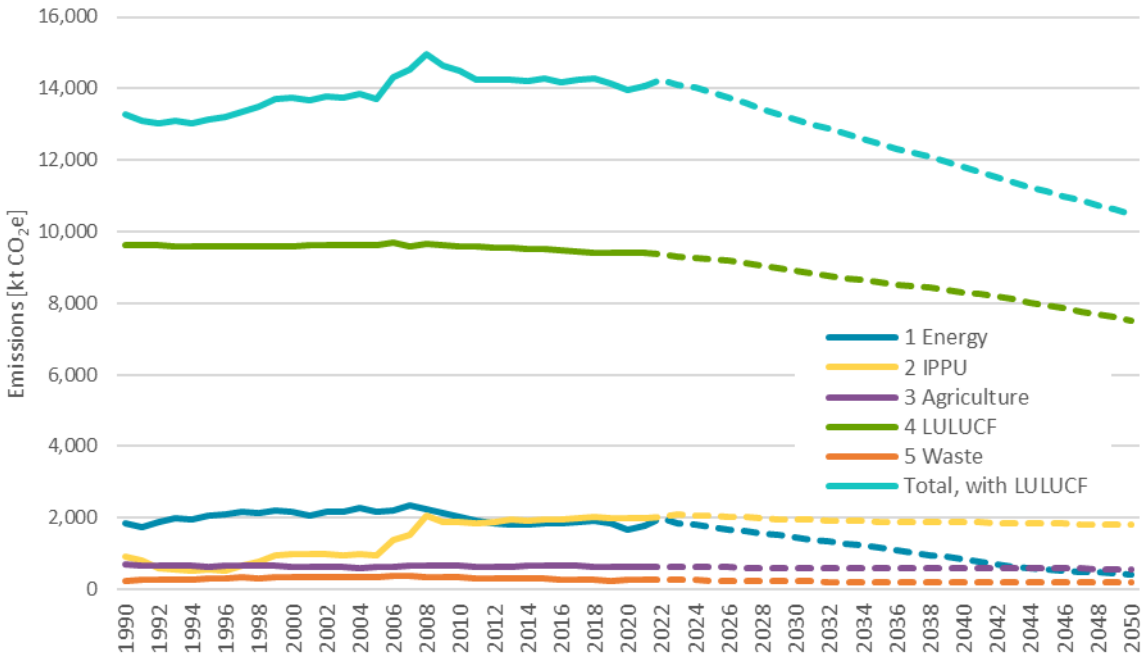

Figure 4.5 Total historical and projected GHG emissions including LULUCF for the WAM scenario 1990-2050, [kt CO_2e].

Iceland's total historical and projected emissions of GHGs, excluding LULUCF, are presented for the WAM scenario in Figure 4.6 and Table 4.5. The increased emission reduction in Energy compared to the WAM scenario are due to the ban of new registrations of fossil fuel cars in 2030. The increased emission reductions in LULUCF are due to increased afforestation and revegetation rates, in addition to more extensive reclamation of wetlands. Other sectors are identical in the WEM and WAM scenarios.

Table 4.5 Total historical and projected GHG emissions excluding LULUCF for the WAM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
1 Energy	1,841	1,854	1,664	1,743	1,439	1,164	829	567	407
2 IPPU	903	1,970	1,975	2,063	1,970	1,893	1,871	1,838	1,812
3 Agriculture	695	659	617	613	605	596	587	578	570
5 Waste	244	289	266	243	223	214	203	194	189
Total, without LULUCF	3,682	4,773	4,521	4,662	4,237	3,868	3,490	3,178	2,977

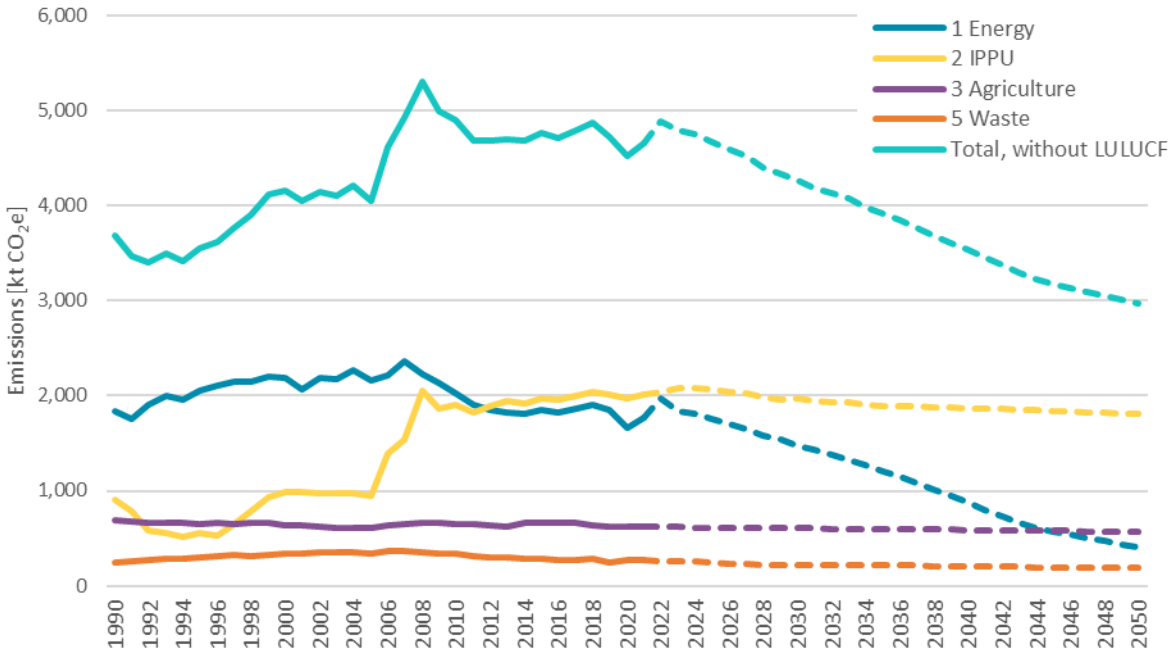

Figure 4.6 Total historical and projected GHG emissions excluding LULUCF for the WAM scenario 1990-2050, [kt CO_2e].

4.4 Comparison of WEM and WAM scenarios

The comparison of projected emissions in the WEM and WAM scenarios can be seen in Table 4.6 and Figure 4.7. The WAM scenario, which includes a ban of new registrations of fossil fuel cars in 2030, as well as increased afforestation, revegetation and wetland reclamation, shows a slightly faster decrease in GHG emissions by 2050 compared to the WEM scenario. The WAM scenario is 2% lower than the WEM scenario in 2030, and 11% lower in 2050.

Table 4.6 Projected GHG emissions including LULUCF 2020-2050 (WEM and WAM scenarios) and the difference, [kt CO_2e].

Sector	2020	2025	2030	2035	2040	2045	2050
WEM	13,942	13,958	13,409	12,927	12,518	12,065	11,725
WAM	13,942	13,887	13,153	12,449	11,802	11,125	10,486
Difference	-	-72	-256	-478	-717	-940	-1,239

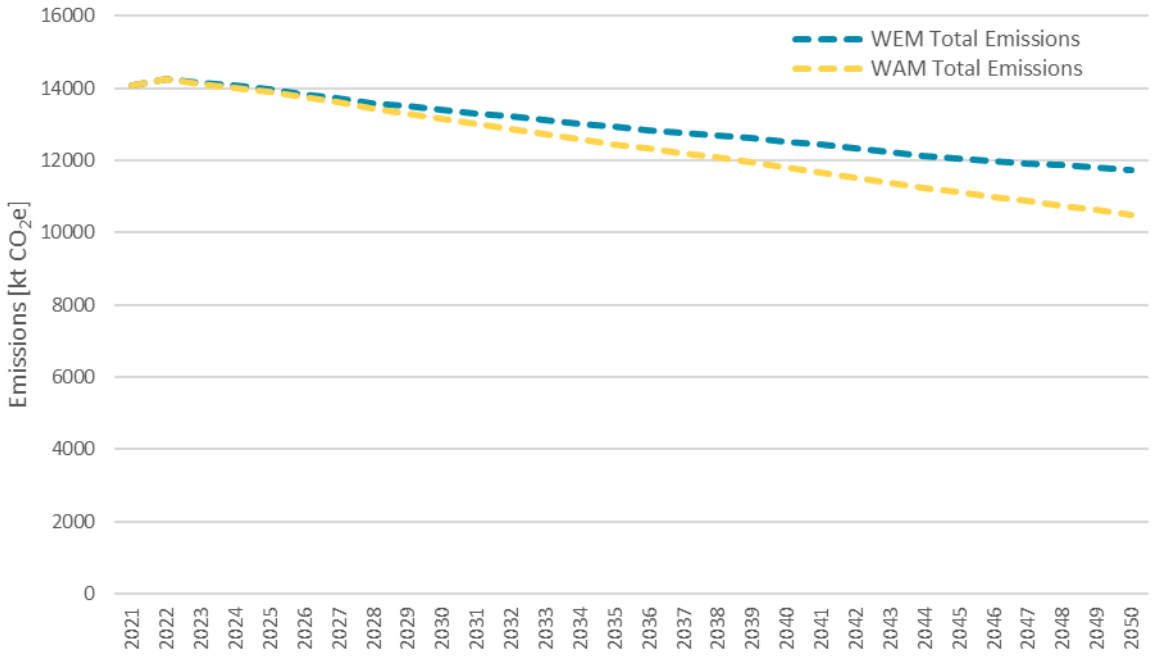

Figure 4.7 Projected GHG emissions including LULUCF 2020-2050 for the WEM and WAM scenarios, [kt CO_2e].

4.5 Annual Emission Allocations (AEAs) and 2030 Commitment

The Decision of the EEA Joint Committee No 29/2022 amending Protocol 31 to the EEA Agreement (JCD 29/2022) sets out the annual emission allocations (AEAs) for the period 2021 to 2030 and states the ESR emission number for 2005 which those AEAs are based on. The AEAs, and the 2005 ESR emission figure, were calculated according to Art. 4 of Regulation (EU) 2018/842 as incorporated into the EEA Agreement with JCD 269/2019.

The projected ESR emissions in the WEM scenario for the year 2030 amount to approximately 2,349 kt CO_2e. which corresponds to 24% lower emissions compared to 2005, based on Iceland's commitment stated in JCD 29/2022. The projected ESR emissions in the WAM scenario for the year 2030 amount to approximately 2,312 kt CO_2e. which corresponds to 26% lower emissions compared to 2005. Iceland's current commitment for the year 2030 is to decrease ESR emissions by 29% under the ESR, which is reflected in the AEAs.

As can be seen in Table 4.7 it is projected, in both scenarios, that Iceland will have more emissions than AEAs in the years 2022-2030. This is also presented in Figure 4.8.

Table 4.7 ESR emissions (WEM and WAM scenarios) compared with AEAs for 2021-2030, [kt CO_2e].

Sector	2005	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
WEM ESR emissions	3,109*	2,738	2,798	2,973	2,831	2,796	2,727	2,638	2,578	2,461	2,400	2,349
WAM ESR emissions	3,109*	2,738	2,798	2,973	2,826	2,786	2,709	2,612	2,547	2,435	2,371	2,312
AEAs			2,876	2,803	2,730	2,657	2,584	2,510	2,437	2,364	2,291	2,218
Difference in AEAs and WEM			78	-170	-101	-139	-143	-128	-141	-97	-109	-131
Difference in AEAs and WAM			78	-170	-97	-129	-125	-102	-110	-71	-80	-94

*2005 ESR number as stated in JCD 29/2022

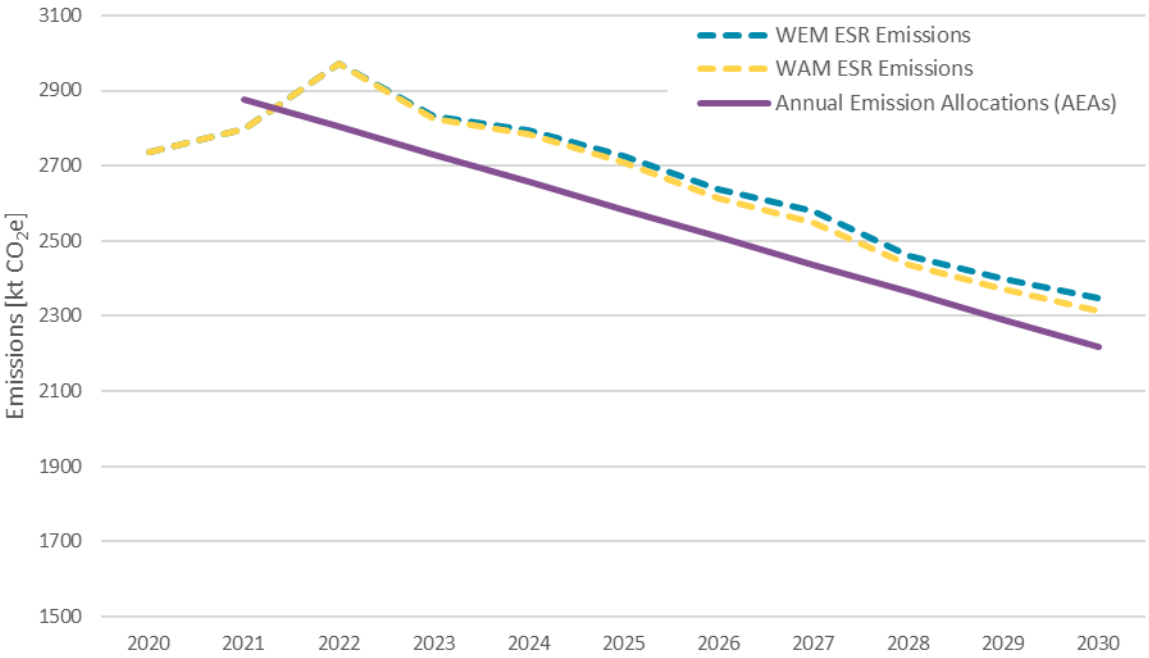

Figure 4.8 ESR emissions for the WEM and WAM scenarios compared with AEAs, [kt CO_2e].

It should be noted that the 2005 ESR emission figure, as stated in JCD 29/2022, differs from the calculated ESR emissions in the inventory. This is because the inventory is reviewed and updated regularly, for instance when updated activity data becomes available, or a more refined or appropriate methodology is used. This can cause changes in emission values for a part of- or all of the time series. In contrast, the 2005 ESR number as per JCD 29/2022 is "set in stone" and, therefore, discrepancies occur between the ESR official 2005 figure and the inventory calculations. When comparing projected emissions to AEAs or to the ESR target, it is deemed more useful to use the official 2005 number stated in JCD 29/2022 since the 2030 target is based upon that number.

5 Energy (Excluding Transport)

The Energy sector contains all emissions from fuel combustion, energy production, and distribution of fuels. Historically, Transport (1A3) has contributed to approximately one fifth of Iceland's GHG emissions (excl. LULUCF) and is therefore reported in a separate chapter. An overview of the historical and projected total emissions for the Energy sector within Iceland is given within Table 5.2.

Iceland almost exclusively uses renewable energy sources (hydropower, geothermal energy, and wind power) for electricity and heat production, and therefore emissions from Public Electricity and Heat Production (1A1) are low (< 1% of Iceland's emission from Energy) compared to other countries that utilise a higher share of fossil fuels.

The largest contributor of GHG emissions from the Energy sector (excl. Transport (1A3)) is Fishing (1A4c). Emissions from fishing ships have accounted for approximately a third of total emissions from the Energy sector in recent years, however emissions have been steadily decreasing over the past years.

Manufacturing Industries and Construction (1A2) and Residential Stationary Combustion (1A4b) combined, account for approximately a third of emissions from the Energy sector in Iceland in recent years.

The projections for the Energy sector are based on fuel projections which were published by the NEA in November 2022 (National Energy Authority, 2022), except for geothermal projections which are based on projected emission obtained from the three geothermal energy companies in Iceland (see Table 5.1).

5.1 Methodology of Projections

The methodology used to generate projections for the Energy sector (excluding Transport) are based on the historical inventory, see chapter 3.1.1 in the NIR (2023) and fuel projections from the NEA (2022).

5.1.1 Data and Assumptions

An overview of the data and assumptions used as a basis for the energy projections is presented in Table 5.1.

Table 5.1 Activity data basis for Energy projections.

Energy	Basis for Projections
1.A.1 Energy Industries	Fuel projections (2022)
1.A.2 Manufacturing Industries and Construction	Fuel projections (2022)
1.A.4 Other Sectors	Fuel projections (2022)
1.B.1 Solid Fuels	Not relevant in Iceland
1.B.2 Oil and Gas and Other Emissions from Energy	Emission projections from all operators of geothermal power plants in Iceland

Projections for the energy sector are based on fuel projections generated by the NEA, except for emission projections for geothermal power. Fuel projections were available by fuel type and activity.

Policies reported for the energy sector are presented in Table 5.3, where it is listed which policies are included in the fuel projections and are therefore included in the WEM projection scenario. Three policies were quantified (103, 104 and 105) and the description and results for each policy are presented in chapter 5.3

5.2 Emission Projections

5.2.1 WEM projection scenario

The historical and projected trend for the WEM scenario for the Energy sector (excl. Transport) can be seen in Table 5.2 and Figure 5.1. Overall, emissions from the Energy sector (excl. Transport) have declined by 31% between 1990 and 2021. Emissions are projected to decrease by 71% in 2050 compared to 1990. Within the Energy sector (excl. Transport) the largest sources are Manufacturing Industries and Construction (1A2), Fishing and Agriculture (1A4c), and Geothermal Energy Production (1B2d).

Emissions are projected to peak in 2022, and to steadily decline from 2022 to 2050. No major changes are expected in the sector for the time period. Some emission savings are reported mostly due to an increased share of renewable energy used in fishing. In the projections, it is assumed that biodiesel will replace fossil fuels and the emissions have been calculated based on that assumption.

Emissions from Energy Industries (1A1) are projected to remain steady. This is because even though almost all electricity in Iceland is produced with renewable energy there is still the need for back-up generators which use fossil fuels and some remote areas of Iceland, such as Grímsey, are not connected to the grid.

Emissions from Manufacturing Industries and Construction (1A2) have been decreasing over the historical time series but are projected to decrease slightly until 2050. The largest subsector of 1A2 is Off-road machinery in construction, which is projected to increase the use of other energy than fossil fuels. For this report it is assumed that the sector will use biofuels, but it is likely that electricity will also be used.

Emissions from Commercial/Institutional (1A4a) and Residential (1A4b) are projected to remain steady.

Emissions from Fishing and Agriculture (1A4c) have been steadily decreasing since 1996, with some annual variations. About 90% of the emission are from fishing ships while the rest is from off-road machinery used in agriculture. These emissions are projected to keep decreasing until 2050 mostly due to energy transitions in fishing ships, which will start to have a significant effect on emission in the last decade of the projected time period. It is assumed that the energy transition in fishing ships will be with biofuel, but there are high uncertainties about which fuels will be used. Smaller boats will most likely also use electricity.

Emissions from Geothermal Energy (1B) have historically been increasing but are projected to decrease significantly up until 2030 with a very slight gradual decrease until 2050 due to projected increase of injections of CO_2 into basaltic rock[18].

[18] *Carbfix*. https://www.carbfix.com/

Table 5.2 Total historical and projected Energy emissions (excluding Transport) in the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
1A1 Energy Industries	14	4.2	1.8	3.2	3.2	3.2	3.2	3.2	3.2
1A2 Manufacturing Industries and Construction	302	117	54	89	78	65	54	45	37
1A4a Commercial/Institutional	8.1	2.1	1.6	1.9	1.9	2.0	2.0	2.1	2.1
1A4b Residential	28	5.9	6.7	4.9	4.5	4.4	4.4	4.4	4.4
1A4c Fishing and Agriculture	842	669	544	590	515	470	391	288	199
1B Geothermal	62	168	180	136	112	112	112	112	112
Energy (excluding transport)	**1,256**	**966**	**789**	**824**	**715**	**656**	**566**	**454**	**358**

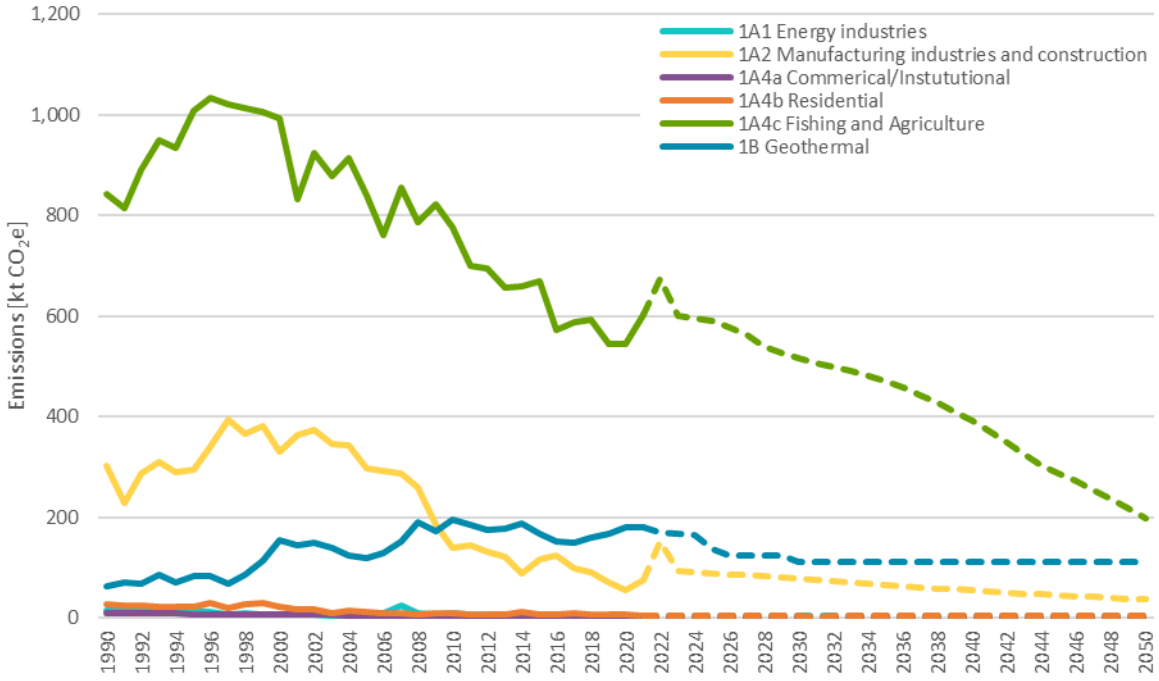

Figure 5.1 Total historical and projected Energy emissions (excluding Transport (1A3)) in the WEM scenario 1990-2050, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

5.2.2 ESR vs EU ETS Emissions in Energy

In Iceland, all CO_2 emissions from the production of Iron and Steel and Non-Ferrous Metal (1A2a and 1A2b) are accounted for under the EU ETS, including emissions from fuel combustion for energy. Overall, these sectors contribute less than 1% of the total emissions from Energy (excl. Transport). The share of ETS emission in the energy sector are projected to go to 2% by 2050 as the ESR sector is projected to decrease emissions more rapidly than the ETS sector (see Figure 5.2)

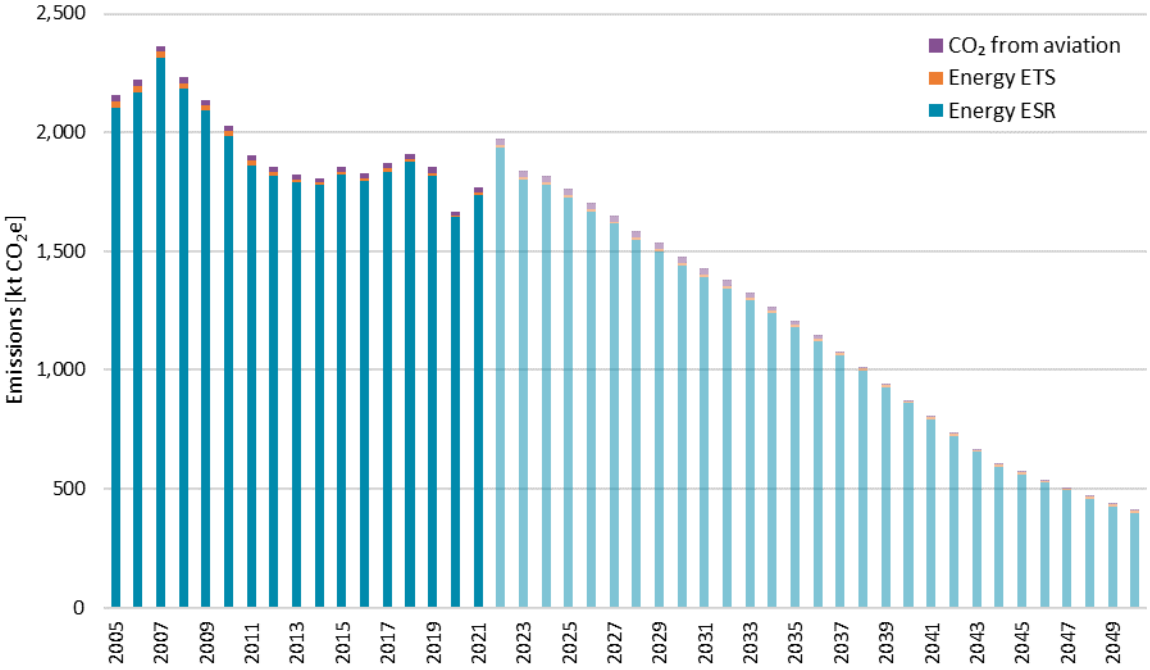

Figure 5.2 ETS and ESR GHG projections in the Energy sector (excl. Transport), WEM scenario, [kt CO_2e].

5.2.3 WAM projection scenario

There are currently no WAM PaMs that can be quantified in this sector and, therefore, the WEM and WAM scenarios are identical.

5.3 Policies and Measures

Nine energy consumption (EC) PaMs are currently implemented or adopted, with the objective of reducing GHG emissions (see Table 5.3). Currently there are no specific energy supply (ES) PaMs.

Table 5.3 Energy Policies and Measures.

PaM Name	GHG(s)	Instrument Type	Status	Scenario	Ex-ante	Description
Energy transition in fisheries (101)	CO_2, CH_4, N_2O	Economic, Planning, Regulatory, Research, Voluntary/ negotiated agreements	Planned	Not Included in projection scenario	No	Emissions from the fisheries sector will be reduced through various incentives.
Electrical infrastructure in ports (102)	CO_2, CH_4, N_2O	Fiscal, Planning	Implemented	WEM	No	Further electrification of Icelandic ports will be supported through improving infrastructure.
Electrification of fishmeal production plants (103)	CO_2, CH_4, N_2O	Economic, Planning, Voluntary/ negotiated agreements	Implemented	WEM	Yes (1.A.2.e)	Further electrification of fishmeal production plants will be supported.
Ban on use of heavy fuel oil (104)	CO_2, CH_4, N_2O	Regulatory	Implemented	WEM	Yes (1.A.4.ciii, 1.A.3.d)	A regulation will be issued tightening fuel requirements which

PaM Name	GHG(s)	Instrument Type	Status	Scenario	Ex-ante	Description
						effectively bans the use of heavy fuel oil in the territorial sea of Iceland.
Carbon capture from geothermal energy plants (105)	CO_2	Planning, Research	Implemented	WEM	Yes (1.B.2.d)	CO_2 emissions from geothermal power plants will be reduced trough carbon capture, for example the *CarbFix* method.
Energy transition in manufacturing industries (106)	CO_2, CH_4, N_2O	Economic, Planning, Voluntary	Implemented	WEM	No	Changing from fossil fuels in manufacturing industries by subsidising new equipment which uses renewable energy.
Carbon tax (701)	CO_2	Fiscal	Implemented	WEM	No	The carbon tax will be increased to reduce fossil fuel use and the resulting CO_2 emissions.
Domestic renewable fuels (702)	CO_2, CH_4, N_2O	Planning, Research	Implemented	WEM	No	Domestic renewable fuel production will be reviewed for environmental benefit and cost effectiveness. Small-scale production is present now, including rapeseed oil and recycled cooking oil.
Climate impact of the construction industry (710)	CO_2 CH_4, N_2O	Planning, Regulatory	Implemented	Not included in projection scenario	No	CO_2 emissions from the construction industry will be reduced through various incentives.

All of the PaMs described above, that are included in the WEM scenario, will impact emissions. The PaMs that are marked positively for ex-ante have been quantified; electrification of fishmeal production plants (103), Ban on use of heavy fuel oil (104) and Carbon capture from geothermal energy plants (105). Additional information on PaMs, including qualifications where available, is provided in the next chapters. For more detailed information on PaMs, see the Climate Action Plan (2020) and the Progress Report (2022).

The impact of seven PaMs (102, 103, 104, 105, 106, 701, and 702) in the Energy sector are represented in the WEM scenario produced by the NEA. These results are represented as the WEM scenario for the Energy sector in this report.

Three PaMs (103, 104, and 105) were quantified individually due to the availability of data on specific developments within the relevant sectors. These data sets were acquired from the relevant companies and associations, which formed the foundation for the analysis of these sectors.

The measure relating to the climate impact of the construction industry (710) has been implemented. However, since most of the emissions saving from that measure does not happen in Iceland, its potential impact on domestic emissions has not been estimated nor included in the WEM scenario projections.

One measure related to the Energy sector, energy transition in fisheries (101), is still planned and therefore not included in a projection scenario.

5.3.1 Energy Transition in Fisheries (101)

Systematic measures will be undertaken to achieve an energy change in the fishing industry to reduce GHG emissions. The Icelandic fishing sector has already achieved significant results in reducing emissions in recent years, but there are still many opportunities for improvement. It is crucial to seize those opportunities in order for Iceland to reach its climate targets. Creating a defined framework for the sector to be able to do its part to reduce GHG emissions is a joint venture between the government and the fishing sector.

A working group with representatives from five ministries, led by the Ministry of Finance and Economic Affairs, has been appointed to work towards this goal. This working group finished a report in 2021 on green steps in fisheries proposing a target 50% decrease in emissions from fishing ships in 2030 compared to 2005 (Government of Iceland). The measures proposed in that report to reach that target are still being reviewed by the responsible ministry, which currently is the MFAF.

Energy transition in fisheries is still planned and therefore not included in a projection scenario.

5.3.2 Electrical Infrastructure in Ports (102)

In 2020 grants were distributed for infrastructure projects regarding electrical connection and connection to district heating whilst ships are at harbour, in order to reduce reliance on fossil fuels while ships are at harbour. This will be useful for medium sized ships, large trawlers, ferries, and service boats.

Tourism companies will also have the opportunity to apply for grants as there are many possibilities for electrification in that sector. Whale watching boats and other smaller boats, which sail shorter distances with tourists, to and from the same port, could, for example, possibly be electrified. Unlike the larger fishing ships, tourism boats which do many trips a day, would need access to fast charging stations, which are currently not very common.

It has been proposed that projects regarding alterations to the ships and land-based infrastructure will also have the possibility to apply for grants. The grants will be up to 33% of the start-up costs. The goal is that electrical connections can meet the electrical demand to run the general operations of ships while at harbour by 2025.

Until now, the main focus for the electrification of ports has been to set up low voltage infrastructure, which most fishing ships and other small ships can use whilst at harbour. There is, however, not much infrastructure in place for ships with a power requirement above 500 kW, such as cruise ships. The possibilities for setting up high voltage infrastructure at ports need to be analysed, based on the cost and benefit potential of such infrastructure, because there is more uncertainty based around the cost efficiency of such projects. Furthermore, the cost-efficiency of reserve power to offset volatile demand needs to be analysed. Possibly, it could be met by hydrogen.

A report on the status of electrification of harbours and next steps was published in 2021 (Verkís). It concluded that the status of electrification is generally good, but there are certain types of ships that cannot use electricity while at port. Future grants should focus on building infrastructure for those types of ships.

The measure is managed by the project management group on energy change in collaboration with municipalities and harbour management.

Electrical infrastructure in ports, is implemented and included in the WEM scenario.

5.3.3 Electrification of Fishmeal Plants (103)

- PaM **103**, Electrification of fishmeal production, is quantified individually. Therefore, a WOM scenario has been estimated to represent the development of emissions excluding the effects of PaM **103**, a WAM scenario estimation to represent plausible development and a WEM scenario which is based upon historical electricity utilisation ratio, historical figures of processed amount and projected total catch forecasts from the Marine Freshwater Research Institute.
- Emissions from fishmeal factories are governed by multiple variables e.g. water levels in hydroelectric dams, electricity supply, curtailable-energy contracts, infrastructure development and total catch.
- PaM 103 aims to reduce emissions from IPCC subsector 1A2, fishmeal production. This PaM aims to ensure, to the extent possible, that it will be economically beneficial for fishmeal factories to use electricity instead of fossil fuels for its processes. Furthermore, the PaM aims to facilitate infrastructure support to ensure technical availability for electrification. The goal is to complete the electrification of fishmeal factories and ensure that no setbacks occur.

This PaMs aims to finalise the energy change in fishmeal factories in collaboration with the operators. In the past years, fishmeal factories have been quite successfully electrified at the operators' own initiative. It is important to complete this switch to electricity where it is technologically feasible. Emissions from fishmeal factories are volatile in nature, but the overall trend over the last few years is downward. In 1997, emissions from fishmeal factories were at their highest, at over 209 kt CO_2e. They had, however, been reduced to 5 kt CO_2e in 2019, but have increased somewhat again since then. In 2022 the amount of fish processed doubled from the previous year and an electricity shortage, due to a water shortage in hydroelectric dams, caused the fishmeal factories to receive small amounts of electricity compared to previous years due to the curtailable nature of the contracts with the electricity supplier. Therefore 2022 is an outlier in the dataset but serves as a good indicator for what may happen in future years as electricity supply is not ensured.

One of the measures that will be taken is establishing how electricity security can be increased in the places where fishmeal factories are operating, how other technological hindrances can be overcome, and how it can be ensured that the electricity prices to fishmeal factories are cost-competitive compared to oil.

Significant development in terms of electrification of fishmeal factories has been ongoing before the existence of the Climate Action Plan, where measure 103 is introduced. Electrification of fishmeal factories has been an ongoing effort, initiated by the National Power Company and the fishmeal factories, for over a decade. In 2017, the National Power Company of Iceland (*Landsvirkjun*) (NPC) and the Association for Fishmeal Factories (AFF) signed a letter of intent to make it economically feasible to utilise electricity for fishmeal factories. Consequently, the WEM case regarding fuel use of fishmeal factories is based upon the main assumption that fishmeal factories were somewhat on a trajectory towards electrification before the Climate Action Plan's efforts were announced. Moreover, the WEM trajectory is partly due to measure 103, but also due to the abovementioned cooperation between the NPC and the AFF.

5.3.3.1 Quantification

A “without measures” (WOM) scenario has been created to contrast all measures, actions, and plans associated with the electrification of fishmeal factories. This scenario is based upon the main assumption that without all measures, both governmental and non-governmental, regarding electrification of fishmeal factories, no electricity would have been utilised throughout the timeline. To estimate the amount of fuel used in this scenario, information and data were gathered from the AFF regarding the amount of fish received for processing every year since 2010. Furthermore, the AFF provided data on the amount of electricity and oil utilised to process the fish. Subsequently, the energy used to process one unit of fish was calculated for both oil and electricity. Energy intensity was assumed to be commensurable between plants utilising electricity and those utilising oil. This assumption could be improved, however, only a few plants have run their operations purely on electricity for an entire year, and therefore, energy losses due to different energy carriers and technologies could not be analysed for this assessment. The average energy intensity over a 6-year period was 461 kWh/t of processed fish, with a standard deviation of 22 kWh/t. Subsequently, the number of fish were assumed to be processed with fossil fuels only, while the energy intensity of 461 kWh/t was used as a proxy for estimating the potential fuel use in the WOM scenario.

A hypothetical WAM scenario was created where the main assumption was that best available technology would be reached in 2025, i.e., full electrification of all fishmeal factories. Moreover, this scenario is based upon the assumption that fishmeal factories buy contracts for non-curtailable electricity or that electricity supply will never be reduced for these factories. Subsequently, all fishmeal processers that have yet to realize full electrification potential through adequate infrastructure will do so in this scenario. The WAM scenario was created to reflect technologically viable possibilities but would require significant infrastructure investments. Adequate power lines would need to be constructed to fishmeal factories that have yet to be connected to the power grid for their operations. This scenario does not reflect additional measures that have been implemented or adopted but rather a plausible outcome given general technological prospects in this sector.

The WEM scenario is based on two main factors i.e., electricity utilisation as a proportion of total energy utilisation for fish processing and amount of fish processed. These two variables are projected into the future to calculate the amount of fossil fuel use for fish processing and subsequently emissions and emission abatement relative to other scenarios. The proportion of electricity utilisation has varied significantly between the years 2010 and 2020, from 38%-94%. The maximum electricity utilisation was reached in 2014 but the lowest was in 2011. In the WEM scenario an average electricity utilisation from the years 2014-2022 is calculated as these years are more indicative of the possible electricity utilisation than the years prior; where it is assumed that today’s electrification potential had not been reached given the low utilisation of electricity, i.e., 38-60%. The average electricity utilisation rate used for the projection is 77%. In December 2021, the NPC announced that all fishmeal operations utilising interruptible electricity would cease to receive energy for and undecided amount of time due to a shortage of electricity supply which is a result of sub-optimal water level conditions in hydroelectric power plants. This explains the unusually low electricity utilisation in 2022. The projected electricity utilisation ratio of 77% under the WEM scenario reflects the possibility of some interruption in electricity supply in the future.

The amount of fish projected is based upon historical fraction of fishmeal fish in the context of total catch. The relationship between fishmeal processing and total catch is relatively strong with a $R^2 > 8$. Total catch is projected by the Marine and Freshwater Research Institute which forms the basis of total processed fish between 2023-2050. Total catch projections are utilised in the Energy Projections

(National Energy Authority, 2022). The results of the WOM and WEM scenarios show that with all current existing measures (WEM scenario) total CO_2e savings amounted to 30 to 77 kt CO_2e p.a. throughout the timeline 2010 to 2050, when compared to the WOM scenario (Figure 5.4).

The Ex-ante emission reduction impact (orange area in Figure 5.4) of the WAM scenario compared to the WEM scenario is approximately 0-20 kt CO_2e p.a, see Table 5.4. However, this abatement would rely on significant investment costs, and not only on availability of cost-competitive electricity as a few of the fishmeal factories have yet to receive sufficient electrical infrastructure.

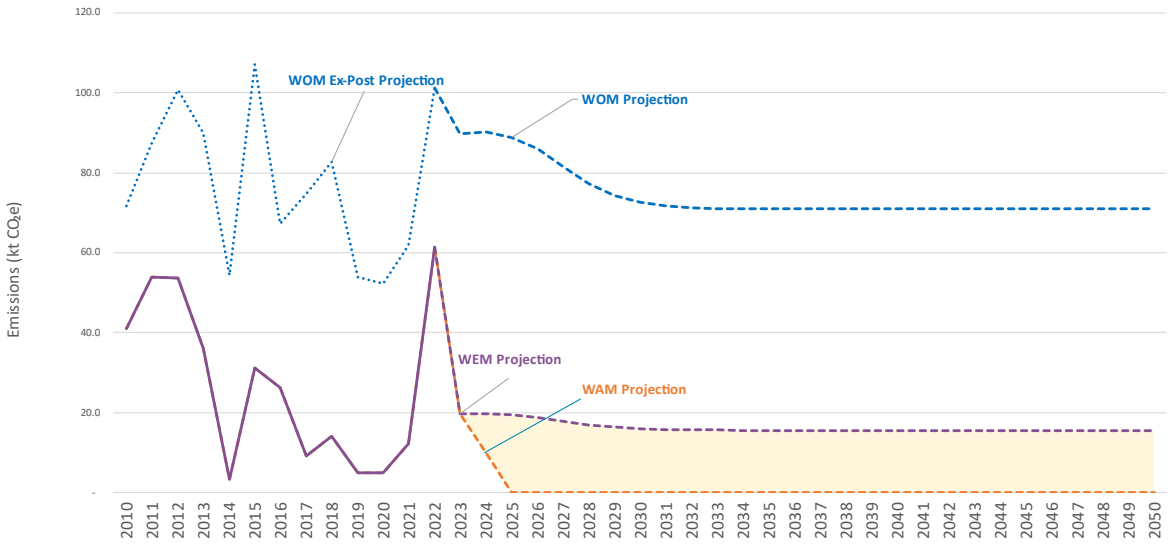

Figure 5.3 Quantified ex-ante and ex-post *emissions impact of a group of measures, including measure 103: the electrification of fishmeal factories [kt CO_2e].*

Table 5.4 Comparison of emissions between the WEM, WAM and WOM scenarios for the electrification of fishmeal factories, [kt CO_2e].

kt CO_2eq	2022	2023	2024	2025	2030	2035	2040	2045	2050
WEM	61.4	19.7	19.8	19.5	16.0	15.6	15.6	15.6	15.6
WOM	101.2	89.8	90.2	88.9	72.6	71.0	70.9	70.9	70.9
WAM	61.4	19.7	9.9	0	0	0	0	0	0
Ex-ante emission impact of WEM compared to WOM	39.9	70.1	70.4	69.3	56.7	55.4	55.3	55.3	55.3
Ex-ante emission impact of WEM compared to WAM	0.0	0.0	10.0	19.5	16.0	15.6	15.6	15.6	15.6

5.3.4 Ban on Use of Heavy Fuel Oil (104)

The requirements on fuels used in the Icelandic coastal zone will become stricter, to reduce the use of residual fuel oil. Residual fuel oil is a denominator for heavy oils with certain properties and can contain a high level of Sulphur. Fuel oil is, among other fuels, used in shipping, and when it burns a high level of soot and air pollutants are released into the atmosphere.

In December 2019, the Minster of Environment and Natural Resources (now the Minister of the Environment, Energy, and Climate) signed a regulation on the Sulphur content of particular liquid fuels.

On the 1st of January 2020, a requirement came into force in the Icelandic Coastal Zone, which is a similar requirement as the one in place in Emission Control Areas (ECAs)[19] in the Baltic and North seas, where the restrictions on fuel oil are some of the strictest. After these regulation changes, the permitted Sulphur content of marine fuel in Iceland is only 0.1% in the Icelandic Coastal Zone and internal waters. Previously, the Sulphur content was permitted to be up to 3.5%. This effectively prohibits the burning of fuel oil unless ships use approved methods to limit emissions of Sulphur dioxide[20]. The EAI has a monitoring role with this regulation and restrictions will be increased if it is deemed necessary.

Ban on use of heavy fuel oil, is accounted for in the WEM scenario in the fuel projections (2022) from the NEA. This measure has been quantified individually.

5.3.4.1 Quantification

There are two categories which are affected by the ban, 1A4ciii Fishing and 1A3d Domestic navigation.

- For the WEM scenario fuel projections from 2022 are used, as it assumes that no residual fuel oil (RFO) is used on ships from 2020 and onwards.
- For the WOM scenario:
    - The energy used is the same as in the WEM scenario, but RFO is still a part of the mix.
    - Proportion of RFO for the two CRF categories of total energy use (TJ) is calculated.
    - The average of the latest 5 years before the measure was implemented (2015-2019) is used to estimate the proportion of RFO into the future.

The GHG emission savings due to this measure can be seen in Table 5.5 and Figure 5.4. These are combined emissions for CRF categories 1A4ciii Fishing and 1A3d Domestic navigation. The annual emission savings in the WEM scenario are 0.89% compared to the WOM scenario. These emission savings are due to the fact that the emission factor in t CO_2/TJ is slightly higher for RFO than for Gas/Diesel Oil.

Table 5.5 Comparison of emissions between the WEM and WOM scenarios for the ban on use of heavy fuel oil, [kt CO_2e].

kt CO_2eq	2022	2025	2030	2035	2040	2045	2050
WEM	640.5	554.3	482.6	434.1	356.1	262.1	181.0
WOM	646.3	559.3	486.9	438.0	359.3	264.5	182.6
Ex-ante emissions impact of WEM compared to WOM	5.8	5.0	4.3	3.9	3.2	2.4	1.6

[19] Emission Control Areas (ECAs) or Sulphur Emission Control Areas (SECAs) are sea areas in which stricter controls were established to minimise airborne emissions from ships as defined by Annex VI of the 1997 MARPOL Protocol.

[20] Incorporated into Icelandic law in December 2019 through an update to Regulation No 124/2015 on the Sulphur content of certain liquid fuels. https://island.is/reglugerdir/nr/0124-2015

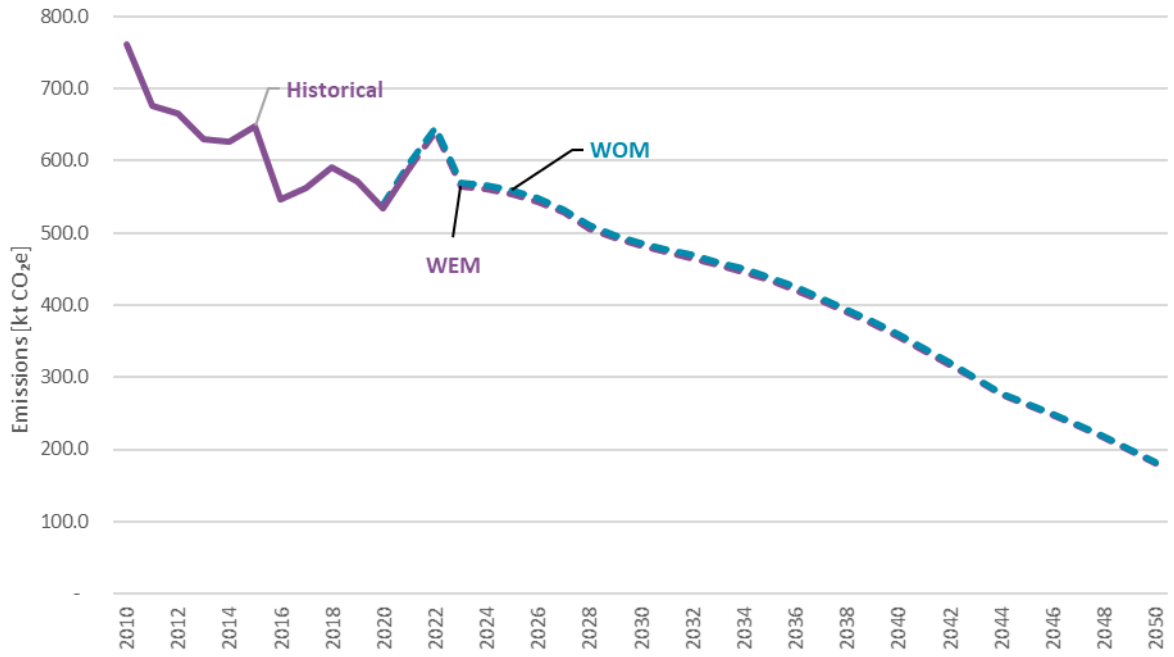

Figure 5.4 Comparison of emissions between the WEM and WOM scenarios for the ban on use of heavy fuel oil, [kt CO_2e].

5.3.5 Carbon Capture from Geothermal Energy Plants (105)

This measure aims at reducing emissions from geothermal power plants by increased carbon capture. Although fossil fuels are not used as an energy source in geothermal power plants, they still emit CO_2. The CO_2 is dissolved in the geothermal fluid but gasses out as the fluid is extracted and the pressure decreases. In 2021, geothermal power plants were the source of 6.4% of Iceland's ESR emissions.

In the past years, emissions from geothermal power plants have decreased significantly due to measures by *Orka náttúrunnar* (ON) at the geothermal plant *Hellisheiðarvirkjun*. Reykjavík Energy (*Orkuveita Reykjavíkur*) developed the "*CarbFix*," or "gas-into-rock" method[21] in collaboration with the University of Iceland (*Háskóli Íslands*) and foreign collaborators (see measure 306: Carbon capture from heavy industry) and it has received widespread interest.

ON and the NPC, have shown a great deal of initiative in their plans to reduce emissions from their power plants. As well as reducing emissions through re-injecting CO_2 into the basaltic rock, *HS Orka* has been exploring various other solutions and the possibilities to capture CO_2 and use it for producing fuel or in other types of industrial production. The companies are working on this measure on their own initiative, but the government will follow future developments and consult with them.

According to the Climate Action Plan the goal is for emissions from geothermal power plants to be reduced by at least 47% by 2030 compared with 2005. This measure relates to measure 306 on carbon capture from heavy industry.

Carbon capture from geothermal plants, is accounted for in the WEM scenario based on data obtained from the geothermal power companies. This measure has been quantified individually.

[21] *Carbfix*. https://www.carbfix.com/

5.3.5.1 Quantification

Only one category is affected by this measure, 1B2d Geothermal Energy.

- The WEM scenario is based on projections numbers coming directly from the power companies. However, they could not all provide concrete plans in terms of exact numbers for emission reduction. In that case the average emissions from the past 5 years was assumed to continue into the future despite there being plans to reduce emissions.
- The WOM scenario is based on if current and past re-injection did not occur and no re-injection happens in the future. For the company that has already started re-injection we use the average emissions over the earliest available 5 year period where they had full operation and little or no re-injection. In other cases we use the average for the past 5 years.
- The WAM scenario is based on if we assume that the power companies match the percentage change from the company with the greatest reduction in the WEM scenario but with a delay. The matching of percentage change starts in 2027 but with a 2 year delay in the case where the company has their own re-injection plans, otherwise a 4 year delay.

A comparison of the CO_2 quantified emission savings between the scenarios can be seen in Table 5.6 and Figure 5.5.

Table 5.6 Quantified emission impacts of the measure: Carbon capture from geothermal energy plants, CRF Geothermal Energy 1B2d, [kt CO_2e].

Carbon capture from geothermal energy plants	2015	2020	2022	2025	2030	2035	2040	2045	2050
Carbon Capture from Geothermal Energy plants WOM	163.1	174.9	177.9	177.9	177.9	177.9	177.9	177.9	177.9
Carbon Capture from Geothermal Energy plants WEM	163.1	174.9	163.5	129.7	105.3	105.0	104.7	104.4	104.1
Carbon Capture from Geothermal Energy plants WAM	163.1	174.9	163.5	129.7	43.7	10.0	8.9	7.8	6.7
Ex-ante emissions impact of WEM compared to WOM	**0.0**	**0.0**	**-14.5**	**-48.3**	**-72.6**	**-72.9**	**-73.2**	**-73.5**	**-73.8**
Ex-ante emissions impact of WAM compared to WOM	**0.0**	**0.0**	**-14.5**	**-48.3**	**-134.2**	**-168.0**	**-169.0**	**-170.1**	**-171.2**

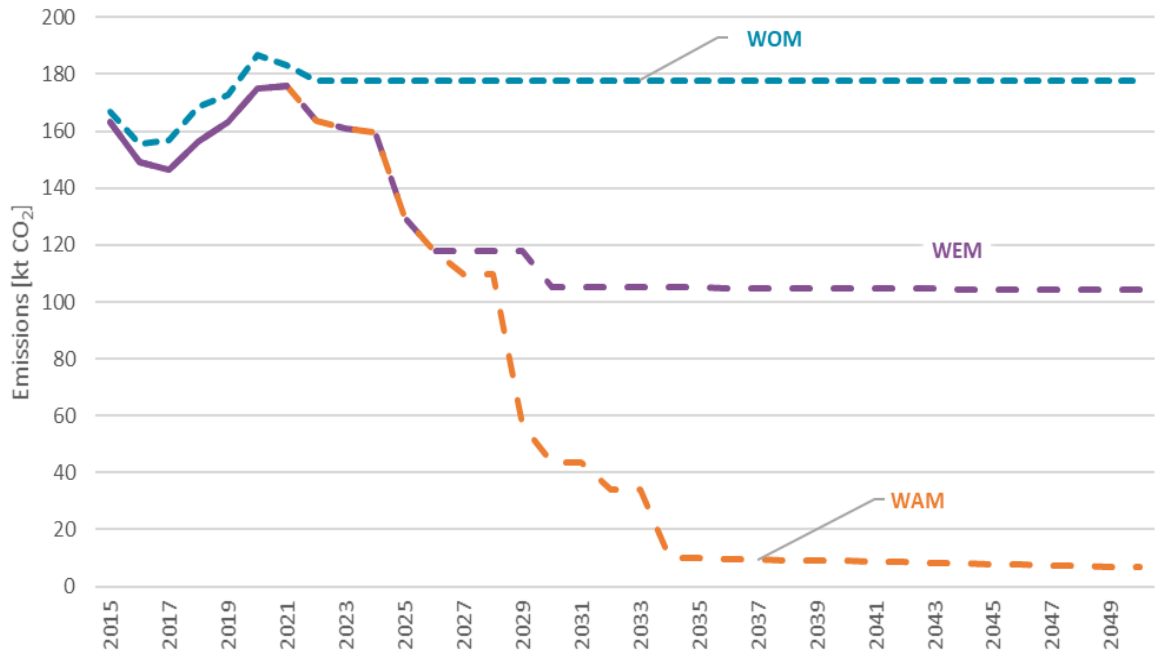

Figure 5.5 Comparison of emissions between the WEM, WAM, and WOM scenarios for the carbon capture from geothermal energy plants, [kt CO_2e].

5.3.6 Energy Transition in Manufacturing Industries (106)

There are many opportunities for energy transition from fossil fuel to renewable fuel in different sectors of manufacturing industries, such as food production and industries linked to fisheries. In 2021, the Energy Fund provided grants for 18 different projects related to manufacturing industries[22].

PaM **106,** Energy Transition in Manufacturing Industries, is accounted for in the WEM scenario of the Fuel Projections.

5.3.7 Carbon Tax (701)

There has been a carbon tax in place in Iceland since 1 January 2010, after the implementation of Law No 129/2009 on Environmental- and Natural Resource taxes[23]. The carbon tax amount, per ton CO_2, can be seen for different fuel types in Table 5.7 below.

Table 5.7 The carbon tax amount per ton CO_2 for different fuel types[24].

Carbon tax [ISK/ton CO_2]	2010	2015	2020
Petrol	1,504	2,503	4,359
Gas and diesel oil	1,499	2,561	4,460
Residual Fuel oil	1,486	2,533	4,388

As can be seen in Table 5.7 the carbon tax has been increasing over the past decade. Carbon taxes tackle carbon emissions from fossil fuels, both from transport and other sources, comprehensively. At

[22] *Energy fund (Orkusjóður).* https://orkustofnun.is/orkustofnun/rad-og-nefndir/orkusjodur/verkefni-styrkt-af-orkusjodi/verkefni-2021

[23] *Parliament (Althingi).* Law No 129/2009 on Environmental- and Resource Taxes. https://www.althingi.is/lagas/nuna/2009129.html

[24] Overview of Carbon tax from 2010 to 2021. *Parliament (Althingi).* https://www.althingi.is/altext/151/s/1220.html

the beginning of 2018 carbon taxes were raised by 50%, and in line with the government's fiscal plan for 2019 to 2023, it was raised again by 10% in January 2019, and again by another 10% in 2020.

The IFS at the University of Iceland (2020), published an analysis of the impact of a carbon tax on the fossil fuel use of Icelandic homes and businesses, at the request of the Ministry of the Environment, Energy, and Climate. The analysis indicates that it is possible to reduce the consumption of fossil fuels, and thereby GHG emissions from fossil fuel consumption, by imposing a carbon tax. According to the analysis, homes reduce their fossil fuel consumption by approximately 0.35% when the price increases by 1%. The tax results in homes using 1 to 2% less fossil fuels. Businesses reduce their fossil fuel consumption by approximately 0.3% when the price increases by 1%.

PaM **701**, Carbon tax, is accounted for in the WEM scenario of the Fuel Projections.

5.3.8 Domestic Renewable Fuels (702)

General climate measures such as a higher fossil fuel prices because of the carbon tax and concessions for climate friendly vehicles are in part aimed to increase the demand for sustainable fuels, and in that way, support the domestic production of sustainable fuels. In Measure 101 on the energy transition in the fisheries, it will be mapped out whether requiring a mixture of sustainable fuels and other fuels to be used on ships would be possible, and whether it would be possible to use domestically produced sustainable fuels for this.

An assessment will be undertaken of the cost-effectiveness and environmental benefits of domestic fuel production. In the cost-benefit analysis, an emphasis will be placed on ensuring that all EU requirements on such production, including lower GHG emissions, will be fulfilled. Hydrogen, methane, methanol, ethanol, and biodiesel are among the possibilities which will be explored.

The report on domestic fuel production by the Ministry of Industries and Innovation, which was mentioned in the first edition of the Climate Action Plan (2018), was submitted to Icelandic parliament in April 2019. It contains an overview of domestic fuel production and knowledge of the industry, and the possibilities for domestic production until 2030 were assessed[25]. In 2021, a report was published (Icefuel) which analysed the feasibility of the production of e-fuels in Iceland. An additional analysis to determine the cost-efficiency of domestic fuel production and map the obstacles to utilising it will be undertaken. The results will be used to build a foundation for a guide to sustainable fuels in Iceland, i.e., which fuels are most cost-effective to use in which industry/operation, such as heavy transport and in ships, and to determine where more research is necessary. The project management team on energy change will receive the analysis and propose the next steps.

PaM **702**, Domestic Renewable Fuels, is accounted for in the WEM scenario of the fuel projections.

5.3.9 Climate Impact of the Construction Industry (710)

In September 2020, a joint project between the government and the business sector was launched, called "Building a Greener Future" ("*byggjum grænni framtíð*")[26]. The project involved the creation of a roadmap to environmentally friendly construction until 2030. It estimated the annual emissions from the construction industry and set measures and targets for reducing GHG emissions and other environmental impacts of the construction sector.

[25] *Parliament (Althingi).* https://www.althingi.is/altext/pdf/149/s/2043.pdf
[26] *Building a Greener Future (Byggjum grænni framtíð).* https://byggjumgraenniframtid.is/

A great emphasis was placed on the project being carried out in broad collaboration between companies from the construction industry and the government. Considering this, a project group was set up, the members of which were appointed by representatives from the Federation of Icelandic Industries, the Green Building Council of Iceland (*Grænni byggð*), the EAI, the Icelandic Road and Coastal Administration (*Vegagerðin*), the Icelandic Association of Local Authorities (*Samband íslenskra sveitarfélaga*), the Ministry of Culture and Business Affairs. The purpose of the group is to manage the "Building a Greener Future" project.

The results were published in early 2022. The emissions from the construction industry were estimated, where it was concluded that building materials are the largest contributor to emission from the industry. Emissions from the construction site, use during building lifetime and end-of-life were also estimated and measures were put forth to tackle each area of emissions, a total of 74 policies and measures.

This measure has not been quantified, as there is not enough available data. As most of the emissions from the construction industry occur abroad, this measure would not have significant effect on emissions in Iceland.

PaM **710**, Climate impact of the construction industry, is accounted for in the WEM scenario of the Fuel Projection Working Group.

5.4 Sensitivity Analysis

No sensitivity analysis was performed for the energy sector. However, it is on the improvement plan for the next submission.

5.5 Stakeholder Engagement

After the submission of the PaMs and Projections reporting in 2019, the EAI organised an expert review meeting for the Energy sector to get feedback and constructive criticism from external experts in order to improve future reporting. Consequently, the EIA gained some valuable insights and contacts that were maintained throughout the preparation stage of the reporting.

Since Iceland's first PaMs and Projections report was submitted in 2019, Energy experts from the EAI have strengthened the collaboration with the NEA. Since 2020, the project manager of the PaMs working group and the main Energy national inventory expert (both from the EIA) have been a part of the fuel projection working group. The aim of this is to streamline the projected fuel activity data and projection scenarios for fuel combustion, which is one of the most significant causes of GHG emissions in Iceland, between the NEA and EIA. In 2021 the fuel projection working group held several stakeholder meetings throughout the development process of the fuel projections, for example with representatives from the fishing, transport, and aviation industries.

6 Transport

The Transport Sector (1A3) in Iceland includes road transport, domestic aviation, and domestic navigation. There are no railways in Iceland and, therefore, these are reported as not occurring (NO). Emissions from international aviation and navigation are accounted for but they do not count towards the national total.

Emissions from the transport sector have accounted for approximately half of the Energy sector's total GHG emissions in Iceland in recent years and road transport has historically accounted for approximately 95% of the emissions in the transport sector, excluding international activities.

The projections for the Energy sector are based on fuel projections until 2060 which were published by the NEA in 2022 (National Energy Authority, 2022).

The projections performed for the sector include a WEM scenario and a WAM scenario. One additional PaMs is included in the WAM scenario and that is the *Ban on new registration of diesel and gasoline passenger cars after 2030 (204)*.

6.1 Methodology of Projections

The methodology used to calculate projected emissions from transport are based on fuel projections from the NEA (2022). In addition to the Fuel Projection, data from sibyl baseline[27] was purchased to run COPERT 5.6.1 (same methodology as historical emission calculations, see chapter 3.3.3 in the 2023 NIR). The energy balance function in COPERT was used, to make sure that emission from all fuel is reported.

6.1.1 Data and Assumptions

An overview of the data and assumptions used as a basis for the transport projections can be found in Table 6.1. A further description is provided below.

Table 6.1 Activity data basis for Transport projections.

Transport	Basis for projections
1.A.3.a Domestic Aviation	Fuel projections (2022)
1.A.3.b Road transportation	Fuel projections (2022), sybil baseline data
1.A.3.c Railways	NA
1.A.3.d Domestic Navigation	Fuel projections (2022)
1.A.3.e Other transportation	Fuel projections (2022)
Memo items: international bunkers	
M. IB International Aviation	Fuel projections (2022)
M. IB International Navigation	Fuel projections (2022)

Projections for aviation and navigation are based on fuel projections generated by the NEA. Fuel projections were available by fuel type and activity. The fuel projections generated by the NEA for domestic navigation have considered the implementation of related quantified policies (see Section 6.3.5).

[27] *Emisia.* https://www.emisia.com/utilities/sibyl-baseline/

6.2 Emission Projections

6.2.1 WEM projection scenario

Figure 6.1 presents an overview of the historical and projected WEM emissions from transport. The trend in transport emissions is dominated by the increase in road transport emission between 1990 and 2007. This is followed by a decrease in road transport emissions because of the financial crisis in 2008. After 2014 there is a significant increase in emissions from road transport, mainly due to increased tourism. The effect of increased tourism can also be seen in the emissions from international aviation.

Emission projections from international bunkers (aviation and navigation), in comparison with emissions from other transport subsectors, can also be seen in Figure 6.1. As stated before, emissions from international bunkers are not included in the national total.

Historical emissions from road transport decreased significantly in 2020, mostly due to the COVID-19 pandemic. In the WEM scenario, emissions from the transport sector (excluding international bunkers) are projected to drop below 1990 levels by 2033. This reduction in emissions is mostly due to the rapid electrification of the vehicle fleet since 2015. It is predicted that the proportion of electric vehicles (EVs) of the total vehicle fleet will rise from 4% in 2020 to 78% in 2040.

A slight decline in fuel use in domestic navigation and domestic aviation has been projected between 2022 and 2050 based on increased use of alternative fuels, either biofuels or electricity.

Table 6.2 Total historical and projected Transport emissions (including international bunkers) in the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
1A3a Domestic Aviation	34	21	13	27	26	17	3.5	0.4	0.05
1A3b Road Transport	531	827	831	891	717	528	307	121	57
1A3d Domestic Navigation	33	27	25	25	24	14	3.6	0.6	0.1
1A3 Transport	**597**	**874**	**869**	**943**	**767**	**559**	**314**	**122**	**58**
International Aviation (memo)	221	679	263	997	1,046	1,046	1,040	905	619
International Navigation (memo)	28	149	78	258	278	282	275	239	158

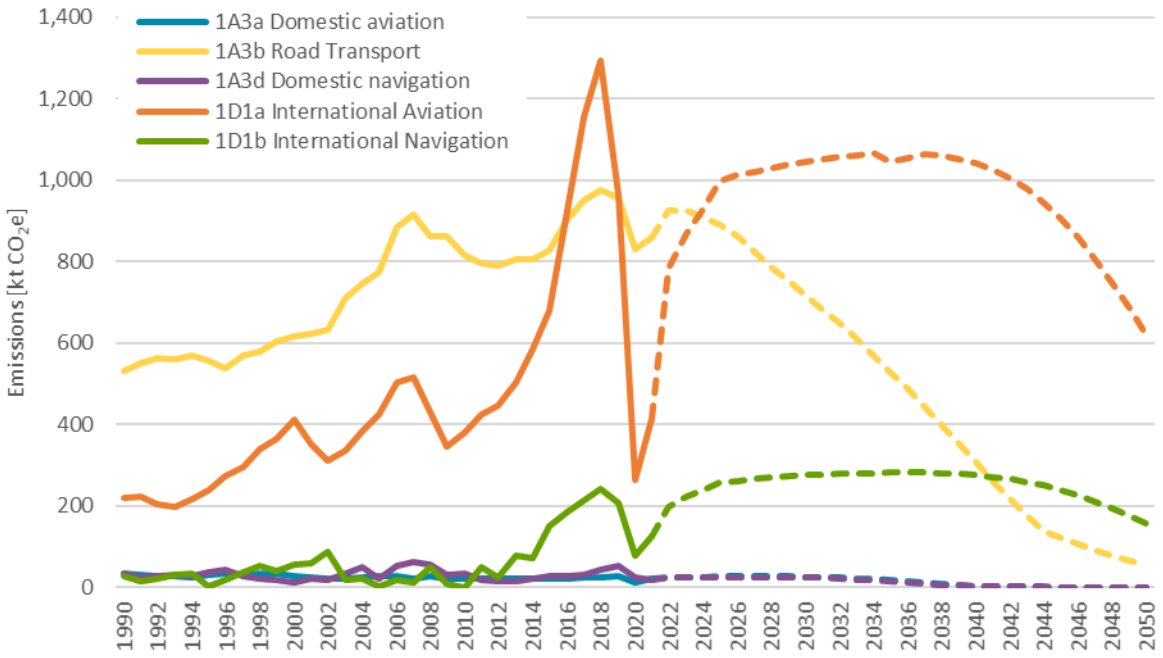

Figure 6.1 Total historical and projected Transport emissions (including international bunkers) in the WEM scenario 1990-2050, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

6.2.2 WAM projection scenario

A WAM projections scenario has been estimated for the transport sector, which includes one additional measure as is presented in Table 6.4. This is measure *204 Ban on new registration of diesel and gasoline passenger cars after 2030.* This measure was quantified individually, and that quantification can be seen in section 6.3.1., with more details on the measure.

Table 6.3 Comparison of the emissions between the WEM and WAM scenario for 1A3 Transport.

Sector	2022	2023	2024	2025	2030	2035	2040	2045	2050
1A3 Transport WEM	974	975	961	943	767	559	314	122	58
1A3 Transport WAM	974	971	951	925	730	515	269	120	56
Difference (kt CO_2e)	-	4	10	18	37	45	45	2	2
Difference (%)	-	0.4%	1.1%	1.9%	4.8%	8.0%	14.3%	1.4%	3.5%

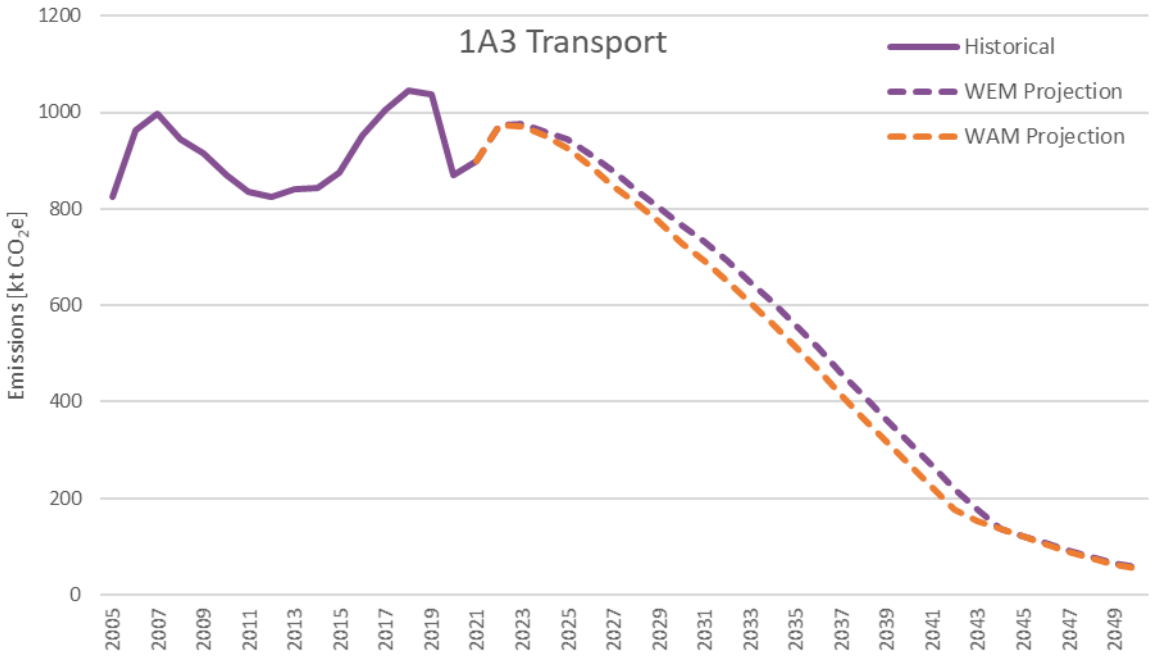

Figure 6.2 Comparison of the emissions between the WEM and WAM scenarios for 1A3 Transport, [kt CO_2e]

6.3 Policies and Measures

Thirteen transport PaMs are currently implemented or planned with the objective of reducing GHG emissions. They are summarised in Table 6.4 below. Seven PaMs are related to the electrification or fuel change of the car fleet, three are to do with promoting public transport, cycling, or walking, two are on the electrification of ferries, and the final one has to do with mitigation of emissions from aviation.

Table 6.4 Transport Policies and Measures.

PaM Name	GHG	Instrument Type	Status	Scenario	Ex-ante	Description
Participation in an international system for mitigating emissions from aviation (ETS and CORSIA) (705)	CO_2	Economic, Regulatory	Implemented	WEM	No	Iceland will partake in CORSIA, an emission mitigation approach for the global airline industry, developed by the ICAO.
Incentives for low- and zero emission vehicles (201)	CO_2, CH_4, N_2O	Economic, Fiscal, Voluntary/ negotiated agreements, Regulatory, Planning	Implemented	WEM	No	Tax incentives will be continued and expanded as necessary to increase low- and zero-emission vehicle use in Iceland. Incentives have proved to be an effective catalyst for low emission vehicles in Iceland since the adoption of these incentives in 2012.
Infrastructure for low- and zero emission vehicles (202)	CO_2, CH_4, N_2O	Economic, Fiscal, Voluntary/ negotiated	Implemented	WEM	No	Infrastructure will be increased for low- and zero-emission vehicles. Investment grants have been

PaM Name	GHG	Instrument Type	Status	Scenario	Ex-ante	Description
		agreements, Regulatory, Planning				allocated for high power recharging points widely around the country, near tourist accommodation, among other incentives.
Legislation and regulations for clean energy transition (203)	CO_2, CH_4, N_2O	Regulatory, planning	Implemented	WEM	No	The goal of this measure to ensure that legislation supports energy transition. Diverse measures have recently been taken in this regard, including a requirement that all new buildings supply EV-charging stations, and regulations facilitating setting up EV-charging stations in apartment buildings. Further measures will be adopted.
Ban on new registration of diesel and gasoline passenger cars after 2030 (204)	CO_2, CH_4, N_2O	Regulatory	Planned	WAM	Yes (1.A.3.b.i)	Registration of new diesel and gasoline vehicles will be banned after 2030. Some exceptions are expected, taking into account harsh climate and safety issues.
Infrastructure for active mobility (205)	CO_2, CH_4, N_2O	Fiscal, Planning	Implemented	WEM	No	Infrastructure will be increased for active mobility, such as cycling and walking.
Encouraging public transport (206)	CO_2, CH_4, N_2O	Economic, Regulatory, planning	Implemented	WEM	No	Public transport will be encouraged with a better public transport system in the capital area. Public transport between population centres in regional Iceland will be supported.
Low emission vehicles in government and state enterprises (207)	CO_2, CH_4, N_2O	Fiscal, Regulatory, planning	Implemented	WEM	No	Government agencies will be obliged to buy low emission and electric vehicles when renewing their vehicle fleet.
Energy transition of ferries (208)	CO_2, CH_4, N_2O	Fiscal, Planning	Implemented	WEM	Yes (1.A.3.d)	Ferries that are a regular part of the transport system will be required to use fossil free fuel.
Incentives for active mobility (209)	CO_2, CH_4, N_2O	Economic, Information, Planning	Implemented	WEM	No	Tax incentives will be adopted to encourage active mobility, such as cycling and walking.
Energy transition in heavy transport (210)	CO_2, CH_4, N_2O	Fiscal, Planning	Implemented	WEM	No	A task force that aims towards accelerating energy transition in heavy vehicle transport has been formed. Around 15% of total land transport can be traced to heavy vehicle use.
Low emission rental cars (211)	CO_2, CH_4, N_2O	Economic, Fiscal, Planning	Implemented	WEM	No	The action aims at increasing the availability of low emission and electric rental

PaM Name	GHG	Instrument Type	Status	Scenario	Ex-ante	Description
						cars. A large part of new vehicles in Iceland are imported for car rentals and addressing the issue is therefore crucial for energy transition of the car fleet.
Energy transition of state-owned vessels (212)	CO_2, CH_4, N_2O	Fiscal, planning	Planned	Not Included in projection scenario	No	The action aims to reduce the use of fossil fuel in state owned vessels other than ferries.

Measures from Table 6.4 above will impact emissions from the Transport sector. The two policies that have been quantified are described in more detail in Chapters 6.3.1 and 6.3.5. Additional information on PaMs that have not been quantified is provided below. For more information on PaMs, see the Climate Action Plan (Ministry for the Environment and Natural Resources, 2020) and the Progress Report (Ministry of the Environment, Energy and Climate, 2022).

6.3.1 Electrification or Fuel Change of the Vehicle Fleet (201-204, 207, 210, 211)

The accelerated uptake of electric vehicles or vehicles fuelled by renewable fuels has the possibility to significantly reduce Iceland's GHG emissions due to the country's heavy dependency on cars for transport. The seven PaMs that are to do with the electrification or energy change of the vehicle fleet in the 2020 Action Plan are the following: 201-204, 207, 210, 211. All except 204 are considered to fall under the WEM scenario and to contribute to the accelerated projected uptake of electric cars in the WEM scenario projections for transport. The impact of these WEM PaMs was, however, not quantified as a group due to difficulties in isolating them from the large number of other smaller actions undertaken by individual organisations, companies, and individuals to accelerate the electrification / fuel change of the vehicle fleet.

6.3.1.1 Quantification

The ban of new registrations of diesel and gasoline passenger cars after 2030, which is a WAM measure, was quantified individually.

In the WEM fuel projections from the NEA (National Energy Authority, 2022) it is projected that new registration of electric passenger vehicles used by households and companies will have reached 100% by 2030, but car rental vehicles will not reach 100% until 2042. For the quantification of this measure the year of new registration of car rental vehicles reaching 100% was set at 2030. All other factors and parameters are the same as in the WEM projections. This measure only effects emissions from 1A3bi Passenger Cars.

Table 6.5 Quantified emission impacts of the measure: Ban on new registrations of fossil fuel passenger cars by 2030, [kt CO_2e].

kt CO_2e	2022	2025	2030	2035	2040	2045	2050
1A3bi Passenger Cars WEM	599.74	566.78	421.41	267.35	117.52	22.99	7.02
1A3bi Passenger Cars WAM	599.74	553.28	395.83	238.58	91.47	21.41	5.13
Emission impact of WAM compared to WEM	0.0	-13.5	-25.6	-28.8	-26.0	-1.6	-1.9
Emission impact of WAM compared to WEM (%)	0%	-2%	-6%	-11%	-22%	-7%	-27%

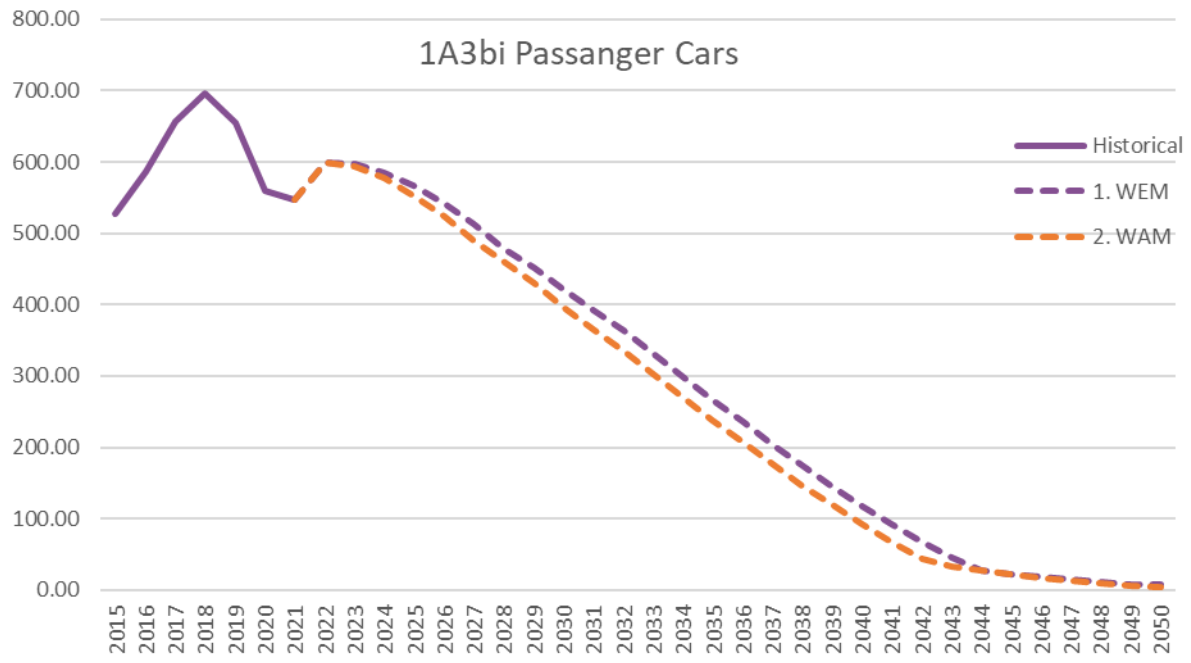

Figure 6.3 Quantified emission impacts of the measure: Ban on new registrations of fossil fuel passenger cars by 2030, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

6.3.2 Promoting Alternative Methods of Transportation (205, 206, 209)

Alongside electrification or fuel change of the vehicle fleet, there has been a parallel effort to promote alternative methods of transportation, such as public transportation, cycling and walking. Biking- and walking paths have been improved systematically, to increase the share of active modes of transportation and enable more people to choose that option. Support for biking paths has been increased, both in urban areas and to connect urban areas.

In the Capital Area, the transportation agreement between the government and six municipalities, which was signed in September 2019[28], will be followed. The agreement includes, inter alia, a substantial effort to build new biking paths in the Capital Area (approximately 70 to 100 km of paths), as well as new walking bridges and underpasses. Simultaneously, work on bike paths between urban areas will be continued according to the Transport Plan (*Samgönguáætlun*) 2020-2034 and in cooperation with the relevant municipalities[29].

Temporary tax subsidies which encourage people to use active modes of transportation, such as biking and walking, have been used to change people's commuting behaviour. Laws have already been updated and VAT on all bikes, electric bikes and electric scooters has been cancelled. The changes went

[28] *Government of Iceland (Stjórnarráð Íslands).* https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Samgongusattmali_undirritadur.pdf

[29] Transport Plan for the next 15 years 2020-2034 (Samgönguáætlun til fimmtán ára 2020-2034). *Government of Iceland (Stjórnarráð Íslands).* https://www.stjornarradid.is/verkefni/samgongur-og-fjarskipti/samgonguaaetlun/samgonguaaetlun-2020-2034/

through on 1 January 2020. The updated law states that all types of bikes should be subsidised if they will promote increased outdoor activity, improve public health, and reduce road transport.

The government and six municipalities in the capital signed a treaty in September 2019 with an ambitious plan to build up transport infrastructure and public transportation in the capital area in the next 15 years.[30] The treaty contains the most extensive transportation construction plan in the history of Iceland. The goal is to greatly boost public transport, improve transport for all modes of transportation, reduce GHG emissions to reach the government's and municipalities' climate goals, reduce traffic jams etc. *Borgarlínan*, a new public transportation system in the Capital Area, is a part of the agreement and the preparations for construction are currently underway. It is planned that the first line of *Borgarlína*n will be operational in 2026.

Three measures on alternative modes of transport have been implemented (205, 206, 209). However, since very limited data is available on the effectiveness of such measures in Iceland, their potential impact on emissions has not been estimated nor included in the WEM scenario projections.

6.3.3 Participation in an International System for Mitigating Emissions from Aviation (ETS and CORSIA) (705)

Iceland participates in the new international system, CORSIA (e. Carbon Offsetting and Reduction Scheme for International Aviation), by the International Civil Aviation Organization (ICAO), which is meant to reduce greenhouse gas emissions from aviation. The goal of CORSIA is to achieve a carbon neutral growth in international aviation from 2020 with carbon offsetting through certain project certifications. The scope of CORSIA encompasses flight operators which emit more than 10 kt CO_2 from international aviation from aircrafts, with a maximum take of weight of over 5,700 kg.

CORSIA will be implemented in a few steps. Participation is voluntary, and Iceland will choose to participate from the beginning along with other countries that are a part of the European Civil Aviation Conference (ECAC). First, emissions from 2019 will be used as a baseline for emissions, and it will be mandatory to carbon offset all emissions that are in excess of the baseline in the following years. Then two three-year periods begin (2021-2023 and 2024-2026) when all countries can participate voluntarily before participation becomes binding. Currently, 88 countries have committed themselves to participate voluntarily from 2021 to 2026. From the start of 2019, flight operators from these countries have been monitoring CO_2 emissions from international aviation. The CORSIA system will be implemented in Iceland through the ETS with changes in legislation on climate issues.

This measure has not been quantified.

6.3.4 Energy Transition of State-Owned Vessels (212)

The aim of this measure is to reduce fossil fuel use by state owned ships, other than ferries. The use of fossil fuels in state owned ships will be systematically reduced and ways to improve sustainability will be evaluated. The possibilities for energy change in the Icelandic Coast Guard (*Landhelgisgæsla Íslands*) patrol ship *Þór* are already being analysed. The analysis consists of looking at possible alterations to the equipment, so that the electricity production of the ship can be used to power its

[30] A Treaty on Transport in the Capital Area (Sáttmáli um samgöngur á höfuðborgarsvæðinu). *Government of Iceland (Stjórnarráð Íslands).* https://www.stjornarradid.is/verkefni/samgongur-og-fjarskipti/samgonguaaetlun/sattmali-um-samgongur-a-hofudborgarsvaedinu/

sailing. The goal of this is to change the patrol ship to a hybrid. The share of sustainable fuels, such as biodiesel will also be increased.

Furthermore, a decision has been taken on building a new marine research ship and the tender for its build is currently being prepared. An emphasis was put on saving energy and limiting the environmental impact in the design process, among others, by designing the ship in the most favourable length and width proportions and checking which sources of energy other than fossil fuels can be considered for the ship. Other energy saving methods in ships will also be used. It is also assumed that the ship will be equipped with engines which can be powered not only by fossil-fuels, but also by biofuels and possibly methanol. It will, however, be decided through the development process of a four-speed engine of the size required by the ship whether it will be possible to equip it with such an engine. It is also being reviewed how the propulsion equipment can be designed so that it will be relatively simple to equip the ship with batteries in the future. Land electricity will, furthermore, be used at harbour. It is expected that heat exchangers will be set up at the ships home harbour for the ship to be able to be heated with water from district heating. A plan will be prepared on energy change in other state-owned ships.

6.3.5 Electrification of Ferries (208)

The aim of this measure is to achieve an energy change in ferries which are in regular operation, and which are categorised as a part of the national highway system. Energy sources in ferries which are in regular operation will be switched out for more sustainable non-fossil fuelled options where technological development allows it.

There are five ferries currently in operation in Iceland, three of those are state owned:

- *Herjólfur*, the ferry to Vestmannaeyjar (Westman Islands). *Herjólfur* sails multiple times per day as the primary connection between Vestmannaeyjar (which has a population of approximately 4,200) and the Icelandic mainland. The new *Herjólfur* is a hybrid, and it is expected that the ship will sail completely on electricity from the Icelandic coast to Vestmannaeyjar. The first fully electrified sailing *of Herjólfur* occurred on 22 August 2020.
- *Sævar*, the ferry to Hrísey. The ferry will be renewed as an electric ferry. It is expected that the design process can begin late in 2024.
- *Sæfari*, the ferry to Grímsey. When the ferry needs to be renewed alternative energy sources than fossil fuels will be considered.

Two ferries are privately owned:

- The ferry in Mjóifjörður. This is a small ferry which the owner is interested in electrifying.
- *Baldur*, the ferry in Breiðafjörður. This is a ferry owned by the company *Eimskip*/*Sæferðir*. The ferry trips across Breiðafjörður are supported by government funding for nine months of the year, but during the summer, *Baldur´s* operations are supported by market conditions. When the next description for tender for the sailing of the ferry will be made, energy change will be encouraged.

Herjólfur, the biggest ferry in Iceland, is operated between Landeyjarhöfn and Vestmannaeyjar. In certain weather or oceanic conditions, the ferry needs to be diverted to Þorlákshöfn instead of Landeyjarhöfn, which is a considerably longer journey. The impact of the electrification of the *Herjólfur* ferry has been considered in the fuel projections of domestic navigation (1A3d) in the WEM scenario.

6.3.5.1 Quantification

This measure has been quantified. A new ferry was constructed and started sailing regular trips between Vestmannaeyjar and the southern coast of Iceland (Landeyjarhöfn) in 2019. In 2020, the construction of charging stations at each port (Vestmannaeyjar and Landeyjarhöfn) was finished and the ferry could begin regular journeys using only electricity for fuel.

However, Landeyjarhöfn experiences relatively frequent closures throughout the year for routine dredging or for volatile, unsafe meteorological or oceanic conditions that are common in the area. During these times when the harbour is closed, *Herjólfur* must sail instead to the harbour at Þorlákshöfn, which is a significantly longer journey (three hours between Vestmannaeyjar and Þorlákshöfn compared to 45 minutes between Vestmannaeyjar and Landeyjarhöfn). During these trips, the ferry needs to run the hybrid engine on diesel, as the journey is too long to only use electricity.

For the quantification of this measure, data was obtained from the operator of *Herjólfur*, both for historical fuel use, from before the ferry started using electricity, and future projections of fuel use. The historical data for 2011-2018 represent the fuel used on the old *Herjólfur* ferry, which was not electric/hybrid. In 2019, the new ferry started operating but did not start using electricity until 2020. In 2019, it used diesel fuel to power the hybrid engines. From 2022 (WEM scenario) and onwards it is expected to use some amount of diesel annually, due to regular trips to Þorlákshöfn.

Historical data on the old *Herjólfur* ferry's fuel use from 2011 was used to calculate the WOM scenario to 2050. Fuel use was projected to increase linearly to 2031 when it would reach the maximum possible fuel usage. The maximum possible fuel usage was calculated based on the maximum number of trips that the ferry could possibly make. Emissions from ferry trips running on gas/diesel oil were calculated following the Tier 1 IPCC (2006) methodology as is applied in the historical and projected GHG inventory. The impact of this policy on emissions from the *Herjólfur* ferry is presented in Figure 6.4. Emissions are projected to increase across the time series as the number of trips has been assumed to increase until it reaches a maximum in 2031.

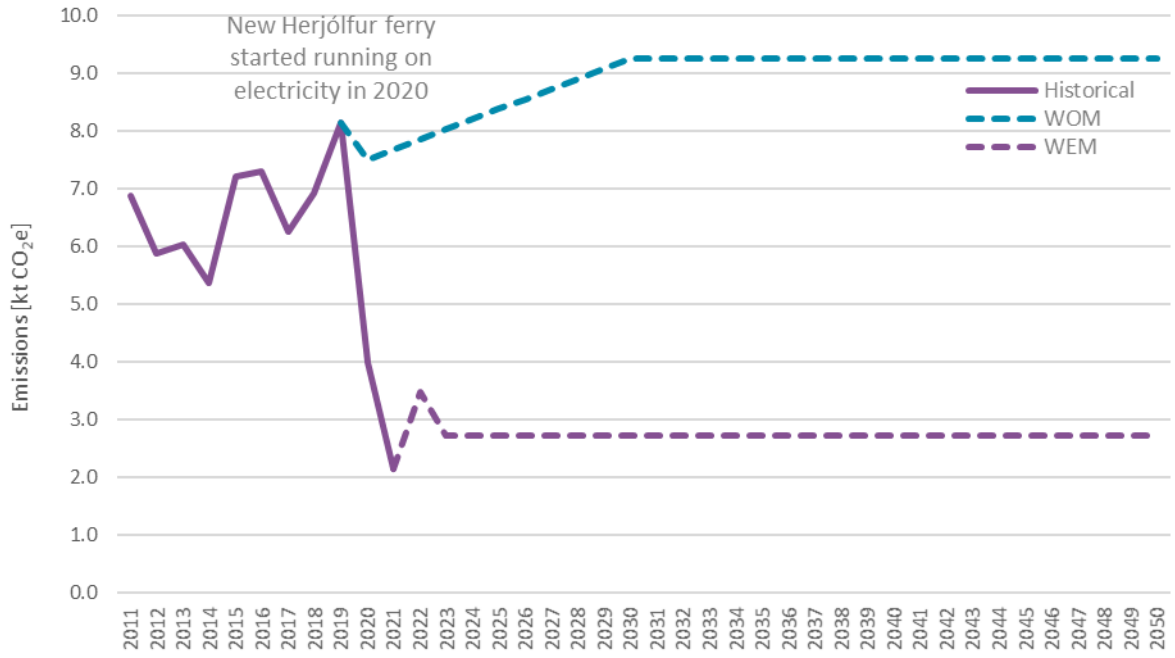

Figure 6.4 Quantified ex-ante emissions impact of the electrification of ferries on emissions from 1A3d Domestic Navigation, [kt CO_2e].

Emission savings in CO_2e and % from WOM can be seen in Table 6.6. Emissions for the WEM scenario for 2020 and 2021 are based on data received from the operator of *Herjólfur*, and it shows that the emissions savings in 2021 are estimated at 5.5 kt CO_2e.

Table 6.6 Quantified ex-ante emissions impact of measure 208 with emissions savings, [kt CO_2e].

kt CO_2e	2015	2020	2025	2030	2035	2040	2045	2050
Herjólfur ferry WOM	7.2	7.5	8.4	9.2	9.2	9.2	9.2	9.2
Herjólfur ferry WEM	7.2	4.0	2.7	2.7	2.7	2.7	2.7	2.7
Emission impact of WEM compared to WOM	0.0	-3.5	-5.7	-6.5	-6.5	-6.5	-6.5	-6.5
Emission impact of WEM compared to WOM (%)	0%	-47%	-68%	-71%	-71%	-71%	-71%	-71%

The plan is to switch all ferries which are operated by the government to electricity or renewable fuels by the next renewal of the fleet. Based on information received from the Icelandic Road and Coastal Administration, it is, however, still unknown when the other ferries which are operated will be renewed. Therefore, the calculation of this measure currently only considers the electrification of *Herjólfur*.

6.4 Sensitivity Analysis

No sensitivity analysis was performed for the transport sector. However, it is on the improvement plan for the next submission.

6.5 Stakeholder Engagement

After the submission of the PaMs and Projections reporting in 2019 expert review meetings were organised to get feedback and constructive criticism from external experts in order to improve future

reporting. Consequently, the EAI gained some valuable insights and contacts that were maintained throughout the preparation stage of the reporting.

The Transport experts from the EAI had meetings with stakeholder in the transport sector, including experts from the *Ministry of Infrastructure*, the NEA, and the Road Transport Authority (*Samgöngustofa*). The stakeholders had a chance to review and discuss the 2019 submission of the Policies, Measures and Projections report and the EAI gained some valuable insights from the experts.

7 Industrial Processes and Product Use (IPPU)

Emissions, including projected emissions, from IPPU are dominated by the metal industry (2C), specifically ferroalloys and aluminium production. The use of fluorinated gases (F-gases) in products as substitutes for Ozone Depleting Substances (ODS, 2F), mostly in the fishing industry, industrial refrigeration, and commercial refrigeration, also contributes significantly to emissions from the IPPU sector. An overview of the historical and projected total emissions for the IPPU sector within Iceland can be found in Table 7.2. There is no electronics industry (2E) in Iceland and therefore this is reported as NO.

This chapter documents the assumptions and methodologies used for the projections. It also describes and explains the observed trends in projected emissions for the IPPU sector, details relevant Policies and Measures (PaMs), including their interlinkages with projections.

7.1 Methodology of Projections

The methodology used to generate WEM projections for the IPPU sector are based on the historical inventory, meaning the activity data is projected and the same methodology is used to calculate emissions as in the historical inventory. Please refer to the latest edition of the NIR where information about activity data and emission factors is collected. Only a WEM scenario has been calculated for the entire IPPU sector. Only for the sector 2F a comparison between WEM, WOM, and WAM was carried out (Figure 7.4).

7.1.1 Data and Assumptions:

An overview of the activity data and assumptions used as a basis for the IPPU projections can be found in Table 7.1. The emission are calculated following the methodology in the historical inventory. Where the application of default or tier 3 facility specific emission factors was not possible due to the lack of data, averages of historical data were used to provide implied emission factors. A further description is provided below.

Table 7.1 Activity data basis for IPPU projections.

IPPU	Basis for Projections
2.A Mineral Industry	Activity data provided by the stakeholders
2.B Chemical Industry	Not relevant in Iceland
2.C Metal Industry	Activity/emission data provided by the stakeholders
2.D Non-Energy Products from Fuels and Solvent Use	GDP, population, fuel projection, trends over the past years
2.E Electronics Industry	Not relevant in Iceland
2.F Product Uses as Substitutes for ODS	Legislation (import quota), mass balance to allocate imported amounts to different sectors.
2.G Other Product Manufacture and Use	GDP and population projection, trends over the past years

7.1.1.1 2.A Mineral Industry and 2.C Metal Industry

The main companies (mineral wool, ferroalloys, and aluminium) were asked to provide a production and emission estimate. This data has been used. Slight emission reduction is projected but no big changes are expected in these subsectors.

There are currently no plans for adding new aluminium smelters, ferroalloys plants, or for resuming production of cement, fertiliser, diatomite, or steel. Therefore, the projections are based on the current production and the production amounts communicated by the individual companies, also taking into account the maximal permitted allowance according to the operation permits.

7.1.1.2 2.F Fluorinated Substitutes for Ozone Depleting Substances

The projected emissions deriving from F-gases (sector 2F1) are based on the maximum allowed import quota for each year starting with 2022. This sector has a WAM and WOM scenario, see Section Policies and Measures7.3 for details.

For sector 2F4 the projections are projected using GDP as a proxy.

7.1.1.3 2.D Non-Energy Products from Fuels and Solvent Use and 2.G Other Product Manufacture and Use

The projected emissions from these subsectors are mostly based on trends using GDP, population, or fuel projections as proxy. Where there is no clear trend or correlation with the proxy data we assume activity data to be constant as an average of previous years.

7.2 Emission Projections

7.2.1 WEM scenario

The historical and projected emissions trend in IPPU is presented in Table 7.2 and Figure 7.1.

Emissions from the Metal Industry (2C) have increased considerably during the past 30 years due to the expansion of existing aluminium smelters and the addition of new smelter facilities. Currently, there are two ferroalloy plants and three aluminium smelters operating in Iceland. It has been assumed that the number of aluminium and ferroalloy plants remains at current levels for the projected years. Permits for more plants have been released, but due to a lack of information on whether or when these plants will begin operating, they are not included in the WEM projections.

The effects of the EU ETS (307) are included in the WEM scenario but the carbon capture and storage (306) is not included. The ETS aspires to an emission reduction for the whole European region, by giving emission allowances to companies. In case of higher emissions, the companies can trade for other emission allowances, so overall the emissions are reduced, but this cannot be quantified for the Icelandic companies separately. Provisions on the carbon capture and storage (306) was implemented into Icelandic legislation (amendment to Climate Act No 70/2012 and Act No. 7/1998) by adapting Directive 2009/31/EC (the CCS Directive) with the aim to enable the EU ETS industry in Iceland to utilise the *Carbfix* method within the CCS. The utilisation of this technique within the industry is still in a developmental stage.

The most recent aluminium smelter started operating in 2007 and CO_2 emissions from Aluminium Production increased in a strong correlation with production. In contrast, perfluorocarbon (PFC) emissions occur mostly during the first years of operation, causing the spike in emissions in 2008. They also occur in case of increased voltage in the production line (anode effect). Two aluminium facilities are already producing close to the maximal operating allowance. The projections show only a slight increase in emissions compared to 2021 emissions and relatively constant PFC emissions. The aluminium smelters in Iceland are currently operating using the best available technology, following the best practices set out in the Directive 2006/21/EC (BAT Directive). The BAT Directive (303) for non-ferrous metals is included in the WEM projections. Aluminium producers, therefore, do not foresee

any possibilities to reduce emissions until there is a change in technology. The ELYSIS technology, developed through a partnership between aluminium industry giants *Alcoa* and *Rio Tinto*, has the potential to drastically reduce GHG emissions from the aluminium industry worldwide. This technology is still in the development stage. The aim is to scale-up the process and demonstrate the technology commercially in 2023[31].

The Ferroalloys industry currently has two operating plants which produce ferrosilicon and silicon metal. The previously mentioned BAT Directive 2006/21/EC also covers the manufacture of ferroalloys. One plant has been in operation since 1979, but the other one started operation in 2018. There is a silicon metal plant which is currently not operating and there are currently no plans to resume operation for the foreseeable future. This plant is excluded from the projections. The ferroalloys industry shows a decrease in emissions, primarily due to the efforts of one company to become carbon neutral by 2040[32].

F-gases are mostly used for refrigeration and air conditioning in Iceland. The biggest source in F-gas emissions derives from transportation, which relies on HFCs for the cooling and freezing systems. Trends in projected emissions from ODS are presented in Figure 7.4. As can be seen from the graph the emissions show some variation which can be explained by the nature of the calculation method. All 2F1 subcategories have different lifetimes, so the emissions occur a certain number of years after the import of the gases. The calculation is also based on the import amounts of one calendar year. If a shipment is coming late in the year, the F-gases might be stockpiled and not used immediately in the same year, even though it appears so from the calculation method. Regulation (EU) 517/2004 is implemented into Icelandic legislation with Regulation No 1066/2019, defining a quota system on the amount of F-gases to be imported each year and steps for phasing it out. This quota system was revised in 2020, and revised Regulation No 1066/2019 defines a new quota with a quicker phase out of these compounds. A comparison between the two regulations can be seen in Table 7.4. The WEM scenario includes the revised regulation along with the MAC directive 2006/40/EC. The taxation of F-gases (305) is however not included in a projection scenario. A quantification of this policy along with calculations and comparison for a WAM and WOM scenario are found in Section 7.3.1.

The Mineral Industry (2A) has seen a big drop in emissions as the only cement production plant in Iceland closed in 2011. The projections are based on a single facility producing mineral wool, which is having a fairly constant production target (based on communication from the facility), and therefore, constant emissions over time. This facility operates using the best available technology set out in the BAT directive for manufacture of glass (304) which is included in the WEM scenario. The Chemical Industry (2B) is insignificant in the Icelandic inventory, with no emissions reported under this sector since 2005. In the past, there was a fertiliser production plant, which stopped production in 2001, and a diatomite production plant, which stopped production in 2004. There is no information on plans of opening new production facilities in these two sectors.

[31] *ELYSIS*. https://www.elysis.com/en
[32] *Elkem* (2019). https://www.elkem.is/frettir/elkem-island-fagnar-40-ara-afmali/

Table 7.2 Total historical and projected IPPU emissions in the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
Mineral Industry (2A)	52	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Chemical Industry (2B)	42	NO	NO	NO	NO	NO	NO	NO	NO
Metal Industry (2C)	795	1,797	1,766	1,921	1,894	1,864	1,835	1,804	1,774
Non-Energy Products from Fuels and Solvent Use (2D)	7.2	6.2	6.3	6.7	6.6	6.2	6.0	6.1	6.1
Electronics Industry (2E)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Product Use as Substitutes for ODS (2F)	0	161	196	129	63	17	24	22	25
Other Product Manufacture and Use (2G)	6.6	4.6	5.8	5.5	5.5	5.5	5.6	5.6	5.6
Other (2H)	NO	NO	NO	NO	NO	NO	NO	NO	NO
IPPU (2)	**903**	**1,970**	**1,975**	**2,063**	**1,970**	**1,893**	**1,871**	**1,838**	**1,812**

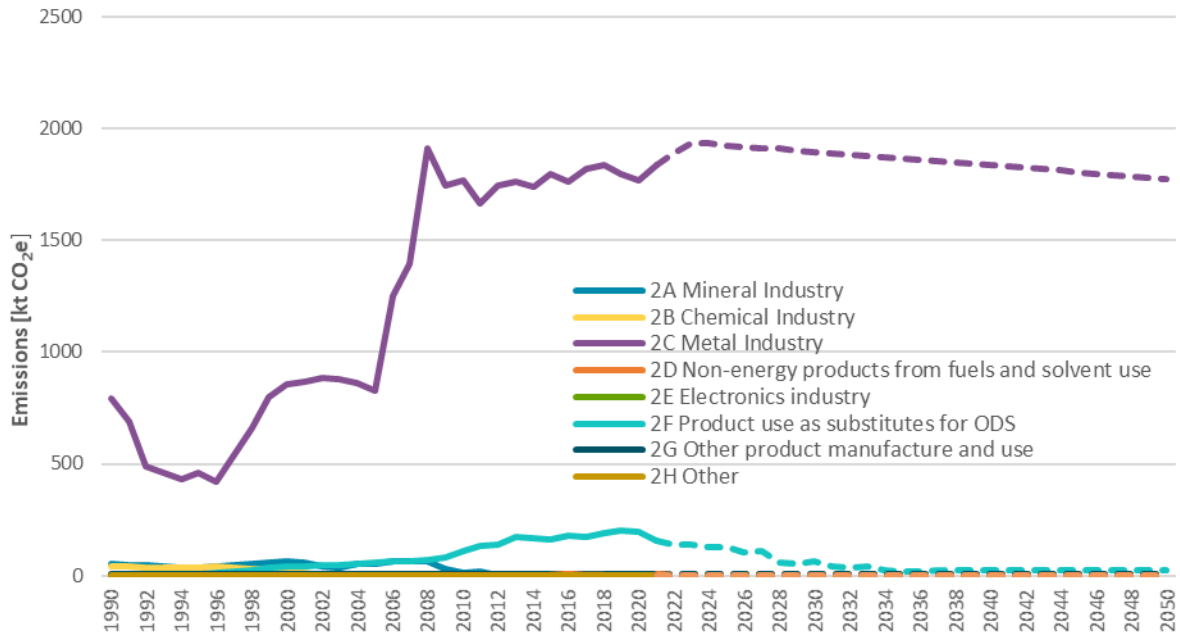

Figure 7.1 Total historical and projected IPPU emissions in the WEM scenario 1990-2050, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

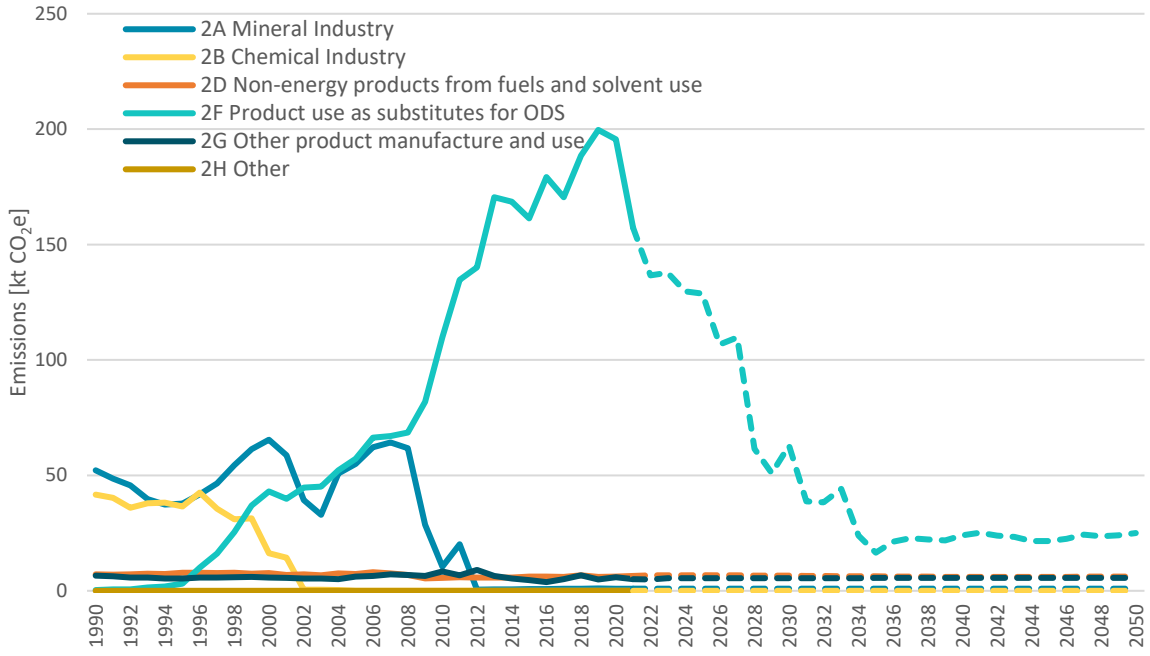

Figure 7.2 IPPU Emissions of greenhouse gases without the metal sector (2C) WEM scenario, 1990-2050, [kt CO_2e]. Broken lines represent projected emissions.

7.2.2 WAM scenario

There are currently no WAM PaMs, based on formal policy or measure, that can be quantified in this sector and, therefore, the WAM scenario is not calculated for the whole sector.

7.2.3 ESR vs EU ETS Emissions in Industry

In Iceland, process emissions from the 2C Metal Industry, that is Ferroalloys and Aluminium Production are accounted for under the EU ETS (Directive 2003/87/EC). Overall and historically, this contributes to approximately 90% of the total emissions from the IPPU sector. The projections under the WEM scenario show that the EU ETS contribution will increase up to 98% as the emissions for the Metal Sector (2C) are fairly constant while the ESR part, especially the F-gases (2F) are expected to decrease substantially (Figure 7.3).

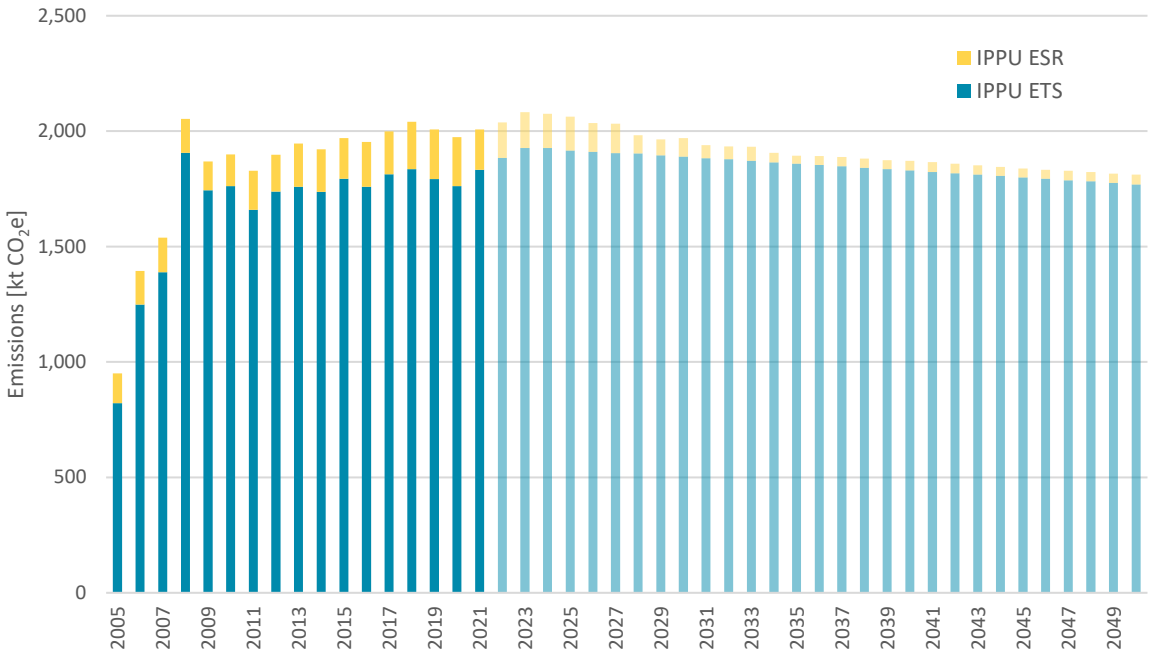

Figure 7.3 ETS and ESR GHG projections in the IPPU sector, WEM scenario, [kt CO_2e].

7.3 Policies and Measures

PaMs with the objective of reducing greenhouse gases emissions relevant for the IPPU sector, both implemented and adopted, are summarised in Table 7.3.

Table 7.3 IPPU Policies and Measures.

PaM Name	GHG	Instrument type	Status	Scenario	Ex-ante	CRF code	Description
Regulation on F-gases (301)	HFC	Economic, Regulatory	Implemented	WEM	Yes	2F	A regulation on F-gases implements Regulation (EU) No 517/2014 which contains provisions that stipulate for, i.e., import quota on F-gases.
MAC Directive 2006/40/EC (302)	HFC, PFC	Regulatory	Implemented	WEM	No	2F1e	Gradual ban of F-gases in passenger cars by enforcing the use of gases with a GWP lower than 150. Implemented in Icelandic legislation with Regulation No 822/2004.
BAT for Non-Ferrous Metals Industries (303)	GHGs	Regulatory	Implemented	WEM	No	2C	Operating permits for non-ferrous metals industries are required to include the Best Available Techniques (BAT) Reference Document (Art. 31(1) of the Directive 2010/75/EU on industrial emissions).
BAT for Manufacture of Glass (304)	GHGs	Regulatory	Implemented	WEM	No	2A	Operating permits for the manufacture of glass are required to include the BAT Reference Document

PaM Name	GHG	Instrument type	Status	Scenario	Ex-ante	CRF code	Description
							(Art. 31(1) of the Directive 2010/75/EU on industrial emissions).
Taxation of F-gases (305)	HFC, PFC	Fiscal	Implemented	Not included in a projection scenario	No	2F	F-gases will be taxed to reduce further the use of F-gases. (Art. 13 implemented in Icelandic legislation with Act No 129/2009 on Environmental and Resource Taxes in 2020).
Carbon capture from heavy industry (306)	CO_2	Regulatory	Adopted	Not included in a projection scenario	No	2	CO_2 emissions from heavy industry will be reduced through carbon capture, for example using the *Carbfix* method.
Updated Regulation under the Emission Trading System (ETS) (307)	CO_2, PFC	Regulatory	Implemented	WEM	No	2C	Updated regulation for the EU ETS was adopted for the fourth trading period.
Environmental data reporting (708)	GHGs	Regulatory	Adopted	WEM	No		Regulation will be issued for better environmental data reporting, on, e.g., material use, GHG emissions among other pollutants.

The PaMs on reducing greenhouse gases emissions from IPPU in the 2020 Action Plan (Ministry for the Environment and Natural Resources) and the 2022 Progress Report (Ministry of the Environment, Energy and Climate) are predominantly focused on achieving the phasing out of F-gases.

The phasing out of F-gases is primarily achieved through the implementation of the F-gas regulation (see Section 7.3.1) and the MAC directive (both included in the WEM scenario). Further measures to reduce the use of F-gases are the implementation of a taxation system based on the GWP of the F-gases imported in bulk. This was implemented into Icelandic legislation with an amendment (Act No 135/2019) to Act No 129/2009 on Environmental and Resource Taxes. The effect of the taxation, however, has not been calculated in the projections.

7.3.1 Regulation on F-Gases (301)

This measure has been expanded since the first Climate Action Plan in 2018 Climate Action Plan and has become a separate measure. The goal was the implementation of EU Regulation No 517/2014 on F-gases with import quotas to reduce gradually the amount of F-gases coming to the country until 2036. This regulation limits the total amount of the most significant F-gases which can be sold, banning the use of F-gases in many new types of equipment where less harmful alternatives are available, and preventing emissions of F-gases from existing equipment. The F-gas regulation is adapted to Icelandic conditions and the import quota differs from the values stated in the Annex V of the Regulation. The first regulation was adopted in December 2018 (Icelandic Regulation No 1279/2018) and repealed in 2020 with Icelandic Regulation No 1425/2020 which applies a quicker phase out of imported F-gases as can be seen in Table 7.4. Certain other provisions are made in the regulation which aim to further

reduce F-gas emissions, such as limits on their marketing and use. Refilling big systems with F-gases which have a very high global warming potential (maximum 2,500 GWP) are banned since 1st of January 2020. This regulation is an important step in reducing greenhouse gas emissions from the use of F-gases in Iceland. The EAI is in charge of monitoring the regulation in line with provisions in the chemical law. Restrictions will be further increased if deemed necessary.

Table 7.4 Comparison between steps in phasing out the bulk import of F-gases between Regulation No 1279/2018 and Regulation No 1425/2020.

Steps	*Regulation No 1279/2018 (repealed)*			*Regulation No 1425/2020 (in force)*		
	Years	Percentage compared to baseline	kt CO_2e	Years	Percentage compared to baseline	kt CO_2e
1 step	2019-23	90%	243.9	2019-20	90%	243.9
2 step	2024-28	60%	162.6	2021-23	35%	94.9
3 step	2029-33	30%	81.3	2024-26	24%	65.0
4 step	2034-35	20%	54.2	2027-29	19%	51.5
Final/ 5 step	2036	15%	40.6	2030-35	17%	46
Final				2036	12%	32.5
Baseline			271			271

7.3.1.1 Quantification

Measure 301 was quantified individually, and a comparison made between the import quota according to Regulation No 1425/2020 (WEM), no import quota (WOM), and a complete ban on import (WAM). The calculation and results are presented below.

The recently adopted F-gas regulation, Regulation (EU) No 517/2014 (implemented into Icelandic legislation with Regulation No 1066/2019), is the measure (301) which causes the biggest shift in the trend of emissions in the non-ETS IPPU emissions (see Figure 7.4).

The WOM, WEM, and WAM scenarios are described as follows:

- The WOM scenario assumes that there was no regulation put in place on the import of F-gases. This means that the WOM scenario starts deviating from the WEM scenario in 2018. The import of F-gases is projected based on calculating the line that best fits the import data from 2008-2017 using the "least squares" method for each blend.
- The WEM scenario takes into account the effect of Regulation No 1425/2020 which phases out the import of F-gases as seen in Table 7.4. We assume all the quota is used and that the allocation of blends is the average percentage for each blend for the past 3 years (i.e. percentage of the total import for those years). We also note that for WEM we cannot predict which blends will be imported in the future, and in light of quick developments in this sector (low GWP drop-ins and replacements), the average of all imported blends for 2019-2021 was calculated and the allowed import quota was distributed accordingly; the import quota is expressed as CO_2e, and no further indications are given.
- The WAM scenario assumes that the import of F-gases is banned so there is no import of F-gases after 2021.

For all scenarios the methodology for the calculation of the greenhouse gas emissions is the same as applied for the historical emissions as explained in the most recent edition of the NIR.

Figure 7.4 shows the comparison between all scenarios and clearly illustrates that a rapid phasing out of F-gases, achieved by Regulation No 1425/2020 amending Regulation No 1066/2019, will drive further emission reductions from this category. Under all scenarios, some increase is still expected in certain years, due to the import fluctuations in the past and different lifetime of equipment. Table 7.5 the quantified emission impacts and the difference between the scenarios.

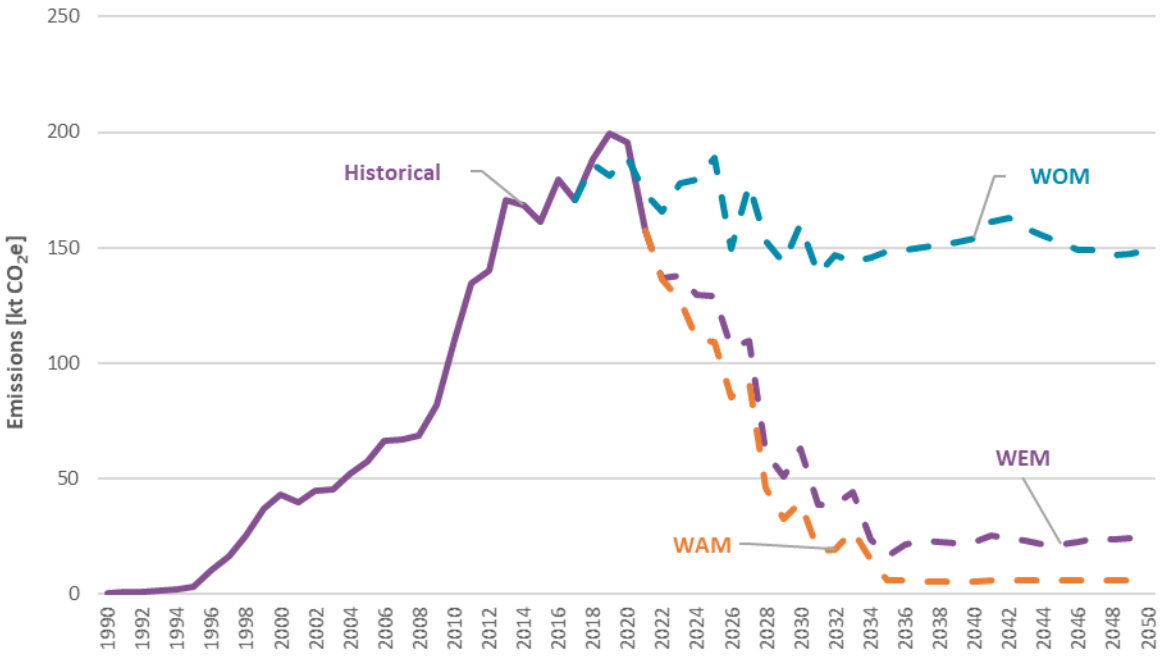

Figure 7.4 Greenhouse gas emissions from Product Uses as Substitutes for ODS (2F) due to the use of F-gases, WEM scenario compared to WOM and WAM scenario, [kt CO_2e].

Table 7.5 Quantified emission impacts of the policy: Regulation on F-gases, Product Uses as Substitutes for ODS (2F), [kt CO_2e].

Regulation on F-gases	2018	2020	2022	2025	2030	2035	2040	2045	2050
Regulation on F-gases WOM	186.2	188.7	165.8	188.7	160.1	148.4	154.0	152.5	148.8
Regulation on F-gases WEM	188.6	195.7	136.7	128.8	62.9	16.5	22.3	21.6	25.0
Regulation on F-gases WAM	188.6	195.7	136.5	108.8	39.7	5.8	5.6	5.7	5.9
Ex-ante emissions impact of WEM compared to WOM	**2.4**	**7.0**	**-29.1**	**-59.9**	**-97.2**	**-131.9**	**-131.7**	**-130.9**	**-123.8**
Ex-ante emissions impact of WAM compared to WOM	**2.4**	**7.0**	**-29.3**	**-79.9**	**-120.4**	**-142.5**	**-148.4**	**-146.8**	**-142.9**

7.3.2 MAC Directive 2006/40/EC (302)

Gradual ban on F-gases in passenger cars by enforcing the use of gases with a GWP lower than 150. The MAC directive is implemented into Icelandic law with regulation 377/2013.

The Mobile Air-Conditioning Systems (MAC) Directive (302) has been in force since 2008 and is therefore considered to be part of the WEM projections scenario. Data collected directly from the main car importers carried out in 2020 showed that since R-134a has been replaced by lower GWP HFOs (Halo olefines) if the cars are aimed for the European market, a development which started in 2016. However, some cars are imported to Iceland from non-EU countries, so a small percentage of cars using F-gases (3% of yearly new registrations) are still considered in both historical and projected emission calculations. This measure has not been quantified separately.

7.3.3 BAT for Non-Ferrous Metals Industries (303)

Operating permits for non-ferrous metals industries are required to consider the Best Available Techniques (BAT) Reference Document (Art. 31(1) of the Directive 2010/75/EU on industrial emissions). This measure has not been quantified separately.

7.3.4 BAT for Manufacture of Glass (304)

Operating permits for the manufacture of glass are required to consider the Best Available Techniques (BAT) Reference Document (Art. 31(1) of the Directive 2010/75/EU on industrial emissions). This measure has not been quantified separately.

Measures 303 and 304, that is the application of BAT for the non-ferrous metal industry and the glass industry, respectively, are part of the WEM scenario, as the best available techniques are part of the current operation permits. The BAT directive aims to reduce negative environmental impact, which includes minimizing emissions of greenhouse gases. Emission limits are set based on the BAT and emissions should not exceed these limits.

7.3.5 Taxation of F-Gases (305)

The policy has been expanded since the first publication of the Climate Action Plan (2018) and has become a separate measure. The goal of this measure it to accelerate the process of phasing out F-gases by taxing imports of F-gases. The taxation was implemented into Icelandic legislation with Act on environmental and resource taxes in 2020. The tax is based on the polluter pays principle which stipulates that those who are responsible for pollution pay for the consequences of it. A similar approach is used in Iceland as has been used in Denmark, where a certain price is added per kilogram of F-gases for every tonne CO_2e that it emits, up to a price ceiling of 10,000 ISK per kilogram. A taxation on F-gases can have a significant impact in a short span of time because more sustainable solutions are already available and it is fairly simple to phase out F-gases, technologically. This measure is not a part of a projection scenario and has not been quantified separately.

7.3.6 Carbon Capture from Heavy Industry (306)

The *Carbfix*[33] method will be explored further to determine whether it is a realistic option to capture CO_2 emissions from heavy industry in Iceland. Reykjavík Energy (*Orkuveita Reykjavíkur*) has developed the method in collaboration with the University of Iceland and foreign stakeholders and it has received

[33] *Carbfix*. https://www.carbfix.com/

widespread attention around the world. The method involves capturing CO_2 from geothermal emissions. The CO_2 dissolves in water under pressure and the water is subsequently pumped to a depth of 500-800 meters into the basalt strata, where the CO_2 is permanently mineralised. The gas is, in this way, turned into rock. ON, a subsidiary of Reykjavík Energy, has used the method for the last years to reduce emissions from *Hellisheiðarvirkjun* with good results.

According to a declaration of intent[34], which was signed in 2019 by *Reykjavík Energy*, *Elkem*, *Alcoa Fjarðaál*, *Rio Tinto Iceland*, *Norðurál*, *PCC Bakki*, and the government, an analysis of the possibilities to use the same method in heavy industries in Iceland will be undertaken to see if it is possible for them to capture CO_2 directly from their processes and pump it into basalt strata. The project is extensive and will span five to ten years. Development of methods is planned to separate the density of CO_2 in emissions from heavy industry so that similar cleaning measures can be used as in the *Hellisheiðarvirkjun*. Equipment to experiment with the filtering and pumping down of CO_2 from heavy industry must be designed and built, and consequently real, full-scale equipment must be made. Recently, parliament implemented into law (No 12 from 18 March 2021) an Icelandic adaptation of Directive 2009/31/EC (the CCS Directive) with the aim of enabling the EU ETS industry in Iceland to utilise the *Carbfix* method within the CCS. The development of capturing CO_2 from heavy industry is still in early stages and therefore this measure is not a part of a projection scenario and has not been quantified separately.

7.3.7 Updated Regulation Under the EU ETS for the Fourth Trading Period (307)

Iceland will continue to participate in the ETS. New regulations took effect when the fourth period (2021-2030) of the system started in 2021. The stricter rules were designed to return a 43% decrease in emissions within the ETS in 2030 compared to 2005, start of the EU ETS. The goal has been further increased to 62% with the Fit for 55 package in December 2022. The trading system is the EU's main instrument in climate issues and is meant to create an economic incentive to reduce greenhouse gas emissions.

The ETS is based on making certain operations in the European Economic Area (EEA) dependent on emission allowances. A certain limited total of emission allowances is allocated to the whole EEA per year, and the total allowances decrease each year. Emission allowances are in part allocated to operators and flight operators for free, and in part auctioned off. If operators and flight operators have managed to reduce their emissions to the extent that they have more emission allowances than they need, they can sell the excess allowances on the market. In the same way they have to buy emission allowances if their emissions exceed their allocated free emission allowances. In this manner, the trading system creates a financial incentive to reduce greenhouse gas emissions from operations, for example by investing in more environmentally friendly technology or optimising operations in other ways.

Since the ETS was set afoot, it has been expanded every few years so that more sectors are included in the system and the rules have become stricter. The third period of the ETS came to an end by the end of 2020 and the fourth period, which covers the next 10 years, has taken over. With Act No

[34] Declaration of intent by the Government, the heavy industry sector and Reykjavík Energy on carbon sequestration (Viljayfirlýsing stjórnvalda, stóriðjunnar og OR um hreinsun og bindingu kolefnis). *Government of Iceland (Stjórnarráð Íslands).* https://www.stjornarradid.is/library/01--Frettatengt---myndir-og-skrar/FOR/Fylgiskjol-i-frett/VIljayfirl%c3%bdsing%20undirritu%c3%b0.pdf

35/2021 the relevant changes on the Climate Act No 70/2012 were made to implement the appropriate EU regulations regarding the fourth period.

Measure 307, that is being part of the EU ETS is also estimated in the WEM scenario, as all main industrial emitters fall into the ETS system. Within the whole ETS system, emissions from installations declined by about 35% between 2005 and 2019[35]. Currently, no significant decrease is occurring within the EU ETS Industry in Iceland and in general the emissions are quite steady. The reason is the start-up of new installations during the time Iceland has participated in the EU ETS and the fact that most of the emissions comes from the industrial processes themselves but not the burning of fossil fuels. The possibilities that the operators in EU ETS industry must decrease emissions lies within the use of renewable energy/biofuels but first and foremost in the permanent removal of emitted CO_2 from the source streams. This measure has not been quantified separately.

Since the technology to reduce emissions within the industrial processes themselves is not available, the possibilities to reduce emissions from EU ETS industries in Iceland lies mostly within carbon capture and storage (CCS), measure 306. Recently, Iceland implemented into Icelandic law Act No 12/2021, an Icelandic adaptation of Directive 2009/31/EC (the CCS Directive), with an amendment to Climate Act No 70/2012 and Act No. 7/1998, with the aim to enable the EU ETS industry in Iceland to utilise the *Carbfix* method within the CCS. Although the utilisation of this technique within the industry is still in a developmental stage, it is of great relevance to speed up the process since a large part of Iceland's emissions are from this sector.

7.3.8 Environmental Data Reporting (708)

The measure has been expanded since the first edition of the Climate Action Plan (2018). The aim of this measure is to improve reporting on environmental data and information by operators in Iceland, including data on the use of raw materials, air pollutant- and greenhouse gas emissions. A regulation on the reporting of environmental data will be developed to coordinate information and simplify the reporting process for operators. In 2019, Act No 7/1998 on Public Health and Pollution Prevention was amended; an obligation to report a special "green account" (*grænt bókhald*), is planned to be cancelled and instead operators have to report certain environmental data. This environmental data includes similar information as was previously reported through the "green accounting," such as emissions of polluting substances and resource use. The work on this regulation has already begun. The goal with this amendment is to receive more detailed data from the operators that are bound to report environmental data, to have better information on resource use and pollution in Iceland.

A regulation on "emissions accounts" (*útstreymisbókhald*), Regulation No 990/2008, will build on the same base as the Regulation on Green Accounts No 851/2002 and weave in further provisions to ensure that all data that the EAI needs to fulfil its legal obligations, such as reporting to EFTA's regulatory agency and the UNFCCC, is gathered and reported. The reporting obligation contained within the Regulation on Environmental Data is expected to apply to businesses that currently fall under the Act on Public Health and Pollution Prevention. This includes metal production, chemical industry, energy industry, fish-meal factories, asphalt plants, oil warehouses, power plants, sewage treatment plants, poultry and pig farming, and smaller operations, such as dry cleaners and gas stations. The plan is that the draft on the Regulation on Environmental Information reporting to be

[35] *European Commission*. https://ec.europa.eu/clima/policies/ets_en

presented in the government's consultation portal. This measure has not been finalised yet. This measure has not been quantified separately but is included in the WEM scenario.

7.3.9 Other Ongoing Initiatives

Besides the abovementioned PaMs, there are other smaller initiatives being prepared or already underway that may reduce GHG emissions from the industry sector in the future. Among those worth mentioning is a report about Nordic criteria of Green Public Procurement (GPP) for the refrigeration and air conditioning sector. The aim of the publication, funded by the Nordic Council of Ministers, is to provide resources and guidance for the public administration to avoid the purchase or to find alternatives to appliances containing F-gases with high GWP[36].

7.4 Sensitivity Analysis

Sensitivity analysis was not performed for this sector. The projections in this sector are not based on models involving many input variables so a sensitivity analysis was deemed not necessary.

7.5 Stakeholder Engagement

The stakeholder workshop on IPPU, organised by the EAI in May 2018, was well attended by representatives from the industrial sector in Iceland. The largest industrial plants (aluminium and ferroalloy) all fall under the EU ETS have strong incentives to minimise their GHG emissions. The majority of companies have set environmental and or climate strategies, which will be included in the future as more information on direct actions to be undertaken becomes available.

After the completion of the first PaMs and Projections report, the environmental managers of the main industrial facilities (metal sector), representatives from the Ministry of Environment and Natural Resources and from other departments within the EAI were invited to a meeting, during which the report was presented, calculation methods explained, and collaboration consolidated. The meeting was held at the EAI in October 2019.

There was also regular collaboration with the Ministry for the Environment and Natural Resources, which was updating the F-gas import quota regulation during this reporting cycle. Experts from the EAI assisted the ministry in the process of calculating the expected impacts of different import quotas, one of which was implemented in Icelandic legislation in December 2020 with Icelandic Regulation No 1425/2020 which amended Regulation No 1066/2019 on fluorinated greenhouse gases.

[36] *Nordic criteria for Green Public Procurement for alternatives to high GWP HFCs in refrigeration, air conditioning, and heat pump products*. https://pub.norden.org/temanord2020-512/#

8 Agriculture

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 an ancient Nordic origin with one breed for each species. These animals are generally smaller than the breeds common elsewhere in Europe, and therefore, the calculated emissions from these breeds, based on default IPCC (2006) emission factors, might be slightly overestimated. 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, although potatoes, barley, beets, and carrots are grown on limited acreage. The projections encompass emissions from Enteric Fermentation (3A), Manure Management (3B), Agricultural Soils (3D), Liming (3G), Urea (3H), and Other Carbon-Containing Fertilisers (3I). A number of Agriculture categories are not occurring in Iceland and have therefore not been included in the projections, e.g., Rice Cultivation (3C), Prescribed Burning of Savannas (3E), and Field Burning of Agricultural Residues (3F).

The total GHG emissions from Agriculture in 2021 were 11% below the 1990 level. The main sources of GHG emissions in Agriculture are CH_4 emissions from enteric fermentation and manure management, and N_2O emissions from agricultural soils. Emissions of CH_4 and N_2O have historically accounted for over 99% of the total emissions from agriculture in Iceland, with less than 1% arising from CO_2. In 2021, 83% of CH_4 emissions were caused by enteric fermentation, the rest by manure management. In the same year, 94% of N_2O emissions were caused by agricultural soils, the rest by manure management, i.e., storage of manure.

The projections performed for the agricultural sector include only a WEM scenario. There is currently not enough data on additional PaMs available to perform projections for a WAM scenario.

8.1 Methodology of Projections

The methodology used to generate projections for the Agriculture sector is based on the historical inventory. For more detail, refer to the latest edition of the National Inventory Report (NIR) where information about activity data and emission factors is collected. Only a WEM scenario has been calculated for the entire Agriculture sector, no data on WAM PaMs were available to calculate a WAM scenario.

8.1.1 Data and Assumptions

The projections on how the Agriculture sector will develop in Iceland are based on historical trends and expert judgement.

An overview of the activity data and assumptions used as a basis for the Agriculture projections can be found in Table 8.1. All parameters necessary for livestock characterisation (such as pregnancy rates, days on pasture/in housing, weight) were kept constant over the projected time series and correspond to the values used in the 2023 NIR submission, except a historical trend is used to predict feed digestibility and ash content of feed for the Tier 2 livestock categories cattle and sheep. The milk yield per dairy cow is projected based on the linear historical trend (expert judgement, the Icelandic Agricultural Advisory Centre). The emission factors are the same as those which are used in the historical inventory and could not be projected due to a lack of data and their high uncertainty.

Table 8.1 Activity data basis for Agriculture projections.

Agriculture	Basis for Projections
Livestock population projections	Linear extrapolation of historical trends, expert judgement
3.A Enteric Fermentation	Linear extrapolation of historical trends, expert judgement
3.B Manure Management	Linear extrapolation of historical trends
3.C Rice Cultivation	Not relevant in Iceland
3.D Agricultural Soils	Linear extrapolation of historical trends
3.E Prescribed Burning of Savannahs	Not relevant in Iceland
3.F Field Burning	Not relevant in Iceland
3.G Liming	Linear extrapolation of historical trends
3.H Urea Application	Linear extrapolation of historical trends
3.I Other Carbon-Containing Fertilisers	Linear extrapolation of historical trends

The trend in livestock populations has been predicted by extrapolation to 2050 based on the available historical data. The historical data is collected from the Ministry of Food, Agriculture, and Fisheries (MFAF) and are the same numbers as are used for agriculture calculations in the latest NIR.

To assess the best possible trends considering the variability of the historical data, agricultural experts at MFAF and Iceland's Agricultural University were consulted. Those experts determined the most representative livestock projections for the Tier 2 livestock categories, cattle and sheep, based on their expectation of future developments in these agricultural sectors. Impacts of agricultural contracts, consumer behaviour and the level of imports of agricultural goods were also considered. The agricultural contracts will be reviewed again in 2023 and renegotiated in 2026, at which point the projections in these livestock categories may change. The conclusion was that livestock numbers for both cattle and sheep were linearly projected based on the historical timeseries (1990-2021).

The number of horses was also extrapolated using the available historical data (1990-2021), as were fur animals including minks and rabbits, and poultry. Swine and goats were calculated using the 10-year (2012-2021) trend (expert judgement, MFAF).

Table 8.2 Livestock number projections [number].

Category	2015	2020	2030	2040	2050	% change '15-'50
Cattle total	78,776	81,030	80,817	82,573	84,328	7%
Sheep total	752,515	635,832	585,765	548,758	511,751	-32%
Goats total	1,476	2,367	3,795	5,257	6,718	355%
Horses total	79,392	73,397	74,553	73,485	72,417	-9%
Swine total	42,542	39,253	46,917	51,268	55,618	31%
Poultry total	674,698	801,961	958,246	1,103,908	1,249,655	85%

The livestock projections in Table 8.2 and Figure 8.1 show that, even though the number of dairy cattle decreases, the number of growing cattle and other mature cattle for meat production increases so that the total number of cattle increases by 7% in 2050 compared to 2015. Sheep numbers decrease by 32% and horses by 9%. Goats, if linearly projected into the future show a 355% increase in numbers, i.e., they increase from around 1,500 animals to approximately 6,700. This trend does not have a big impact on GHG emissions, as the number of goats is still low. This projected significant increase can be

explained by government subsidies for goat farming established in recent years. In fact, before 2010 the number of goats did not reach 1,000. Poultry populations also increase substantially, or by 85%.

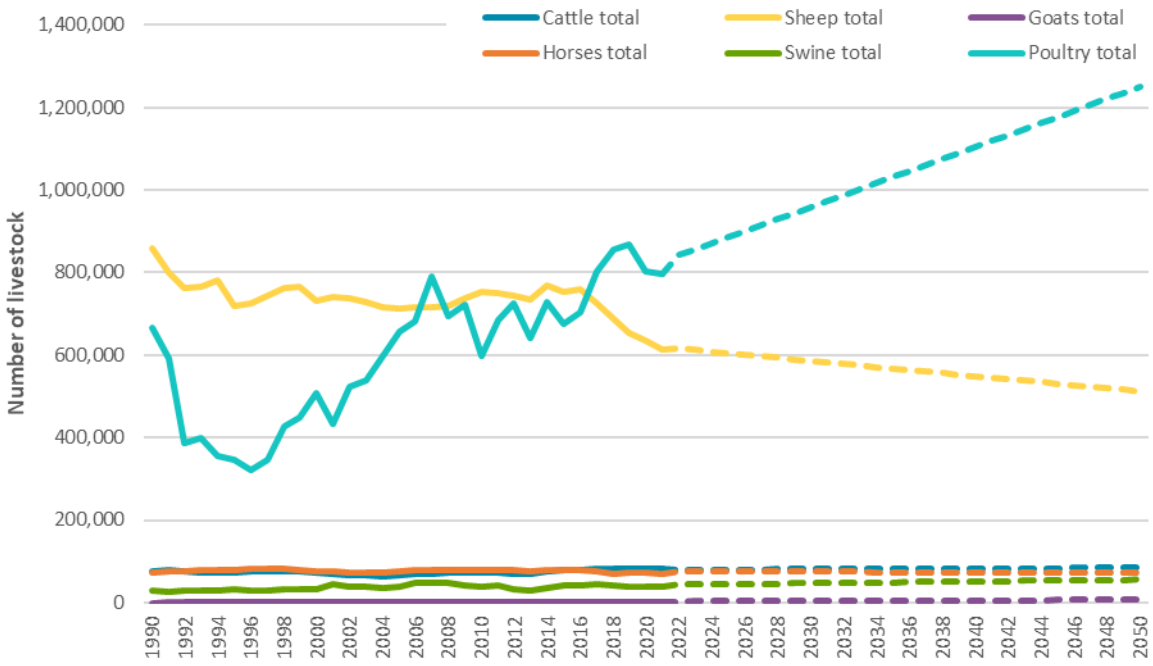

Figure 8.1 Livestock population projections [number], WEM scenario, [kt CO_2e].

For the 2023 NIR submission (Environment Agency of Iceland), the historical data for the Tier 2 livestock categories, cattle and sheep, were improved greatly. The historical data on feed intake, livestock parameters (for example, weight, birth rates, age at slaughter, etc.) and manure management practices was updated significantly with real data and expert judgment. Consequently, the projected parameters *digestible energy* (DE) and *ash content of feed* are no longer projected as a constant equal to the latest historical year (now 2021) but based on historical trends.

In addition, the projected milk yield per dairy cow has been updated and is no longer projected to reach a plateau in the next few years. High producing dairy cows in Iceland are already producing 9,000 kg/year and the EU-27 average is 7,682 kg/year. Based on expert judgment, taking into consideration genetic improvements, improved feeding practices, and more, the historical trend (1990-2021) is used to predict the development of annual milk yield per dairy cow. Changes in outside factors, such as increased prices of feed and fertiliser, import restrictions, climatic changes etc. could, however, impact this projection significantly.

The number of dairy cattle, as shown in Table 8.3 and Figure 8.2, is projected to decrease by 25% from 2015 until 2050, while the average annual milk yield per dairy cow is projected to increase by 50%. These two parameters developing contrary to each other, results in emissions from dairy cattle decreasing less rapidly than just the livestock numbers would predict.

Table 8.3 Dairy cattle projections [number] and milk yield per dairy cow [kg/year].

Category	2015	2020	2030	2040	2050	% change '15-'50
Dairy Cattle	27,441	25,896	24,076	22,341	20,607	-25%
Milk Yield	5,851	6,384	7,142	7,948	8,754	50%

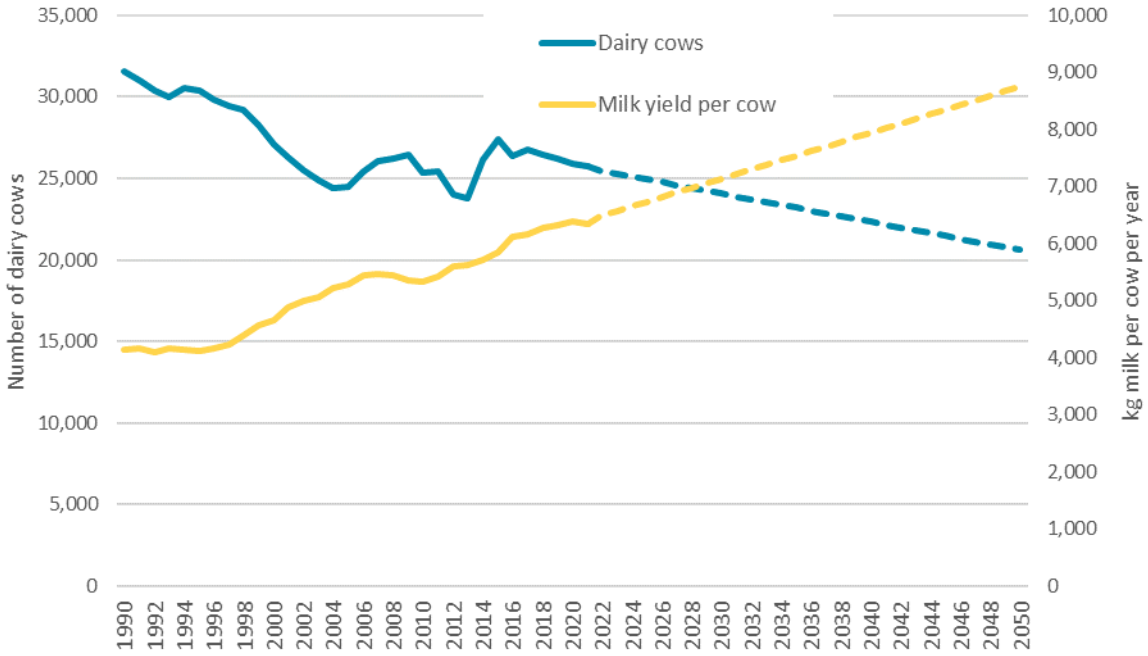

Figure 8.2 Dairy cattle projections [number] and milk yield per dairy cow [kg/year].

Other sources of emissions, such as the use of organic and inorganic N-fertilisers, liming, and the use of urea are predicted by linear interpolation of historical trends. The areas in hectares [ha] for the calculations of N_2O emissions from drained organic soils are communicated from the SCSI, which calculates projections for the LULUCF sector.

8.2 Emission Projections

8.2.1 WEM scenario

Historically the biggest source of GHG emissions from the Agriculture sector in Iceland is enteric fermentation, although manure management and agricultural soils are also significant sources. The decrease of GHG emissions since 1990 is mainly due to a decrease in the sheep livestock population, reducing methane emissions from enteric fermentation, and reduced fertiliser application, reducing N_2O emissions from agricultural soils. The historical and projected trend can be seen in Figure 8.3. Emissions from agriculture are projected to decrease by 16% (111 kt CO_2e) in 2050 as compared to 2015. This is due to a projected decrease in livestock numbers, mostly sheep and dairy cattle, which are key categories in methane emissions from enteric fermentation and nitrous oxide emissions from manure management.

CH_4 emissions from enteric fermentation are projected to decrease by 20% in 2050 compared to 2015, and the total CH_4 and N_2O from manure management are projected to decrease by 20% as well. Emissions from the category agricultural soils are projected to increase by 8% in 2050 compared to 2015. Projections for CO_2 emissions from liming and the use of urea and other carbon containing fertilisers were based on the historical emissions 1990-2021 interpolated linearly to reach 2050. These emissions are predicted to increase by 53% in 2050 compared to 2015.

Table 8.4 Total historical and projected Agriculture emissions in the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
3A Enteric Fermentation	391	357	325	318	311	305	299	292	286
3B Manure Management	99	83	77	77	75	73	70	68	66
3D Agricultural Soils	205	214	206	211	212	211	210	210	209
3G Liming	0.5	3.3	5.3	4.1	4.4	4.7	5.0	5.3	5.5
3H Urea Application	NO	0.0	1.7	1.6	1.6	1.6	1.6	1.6	1.6
3I Other Carbon-Containing Fertilisers	NO	2.1	1.9	1.8	1.7	1.5	1.4	1.2	1.1
3 Agriculture	**695**	**659**	**617**	**613**	**605**	**596**	**587**	**578**	**570**

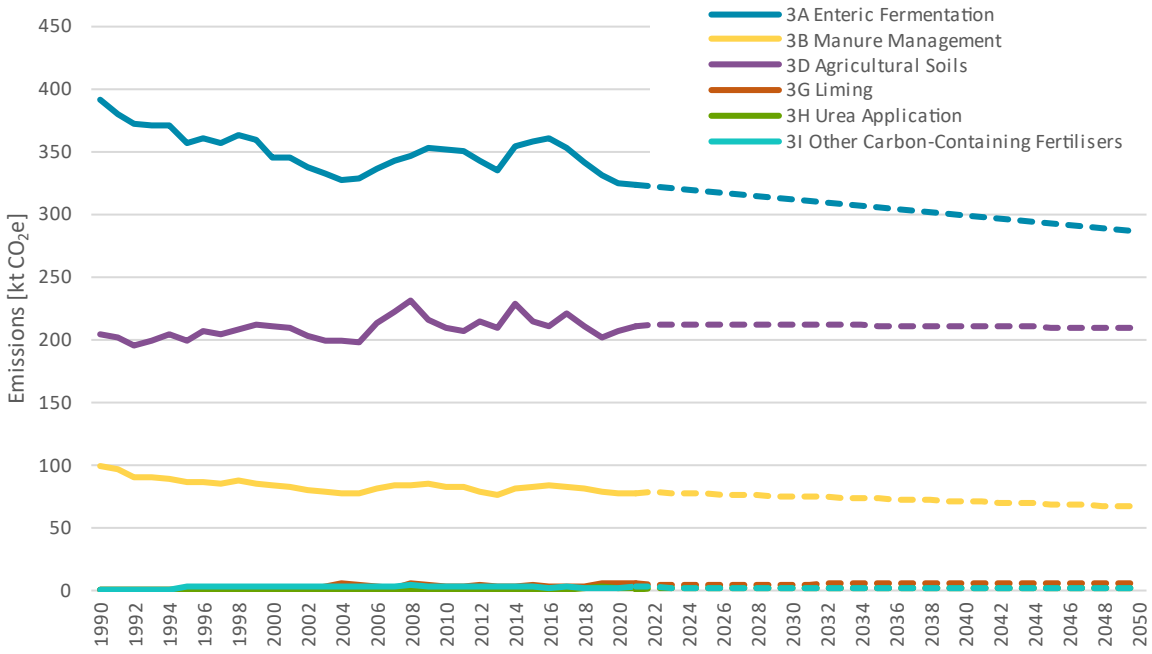

Figure 8.3 Total historical and projected Agriculture emissions in the WEM scenario 1990-2050, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

8.2.2 WAM scenario

There are currently no WAM PaMs that can be quantified in this sector and, therefore, the WEM and WAM scenarios are identical.

8.3 Policies and Measures

Five Agriculture PaMs are currently planned with the objective of reducing GHG emissions, summarised in Table 8.5.

Table 8.5 Agriculture Policies and Measures.

PaM Name	GHG	Instruments	Status	Scenario	Ex-ante	Description
Climate-friendly agriculture (401)	CO_2 CH_4 N_2O	Information Education Planning	Implemented	WEM	No	Comprehensive education and counselling for farmers on how to reduce GHG emissions and increase carbon sequestration from their farm and land.
Improved feeding of livestock to reduce enteric fermentation (402)	CO_2 CH_4 N_2O	Research	Adopted	Not included	No	Research shows that supplements can reduce enteric fermentation in livestock, resulting in lower CH_4 emissions; these possibilities will be explored in the Icelandic context.
Improved use and handling of fertilisers (403)	CO_2 CH_4 N_2O	Education Planning Regulatory	Adopted	WEM	No	Knowledge building and access to information for farmers about the use and handling of manure and synthetic fertiliser.
Carbon-neutral beef production (404)	CO_2 CH_4 N_2O	Education Planning Regulatory	Implemented	WEM	No	Emissions arising from beef production will be reduced and carbon sequestration enhanced to aim for carbon neutral beef production in 2040.
Increased domestic vegetable production (405)	CO_2 CH_4 N_2O	Planning Regulatory	Implemented	WEM	No	Domestic vegetable production will be increased and the objective of carbon neutral vegetable production set for 2040.

The PaMs described in the table above are all from the 2020 Climate Action Plan (Ministry for the Environment and Natural Resources) and the 2022 Progress Report (Ministry of the Environment, Energy and Climate).

The PaMs in this sector, as proposed by the Climate Action Plan (2020), are mostly regarding education for farmers to reduce their GHG emissions within their daily farming activities and/or through carbon sequestration (401, 404). Therefore, a quantification in terms of emissions, as calculated in the historical inventory, is difficult and any efforts of carbon sequestration by rewetting drained wetlands or increase afforested areas on farmland would fall into the LULUCF sector. Nevertheless, the MEEC plans to measure the effects of these educational policies with the number of participating farms.

8.3.1 Climate-Friendly Agriculture (401)

The measure has been expanded since the first Climate Action Plan (Ministry for the Environment and Natural Resources, 2018), where it was called “Collaboration with sheep farmers on carbon

sequestration/Carbon neutral sheep". The aim of this measure is to provide farmers with comprehensive counselling and education on how they can reduce their GHG emissions and increase carbon sequestration on their farms and land through a project called "Climate-Friendly Farming" (*Loftslagsvænni landbúnaður*). The goal is to reduce GHG emissions from farming and land use and increase carbon sequestration in soils and vegetation. In the first edition of the Climate Action Plan (2018), a collaboration project with sheep farmers, with the goal to reduce GHG emissions and increase carbon sequestration in farming and land use, was described. The preparation of the project has been managed by the Icelandic Agricultural Advisory Centre (*Ráðgjafarmiðstöð landbúnaðarins*) (IAAC), the IFS and the SCSI, in collaboration with the Icelandic Sheep Farmers Association (*Landssamtök sauðfjárbænda*), the Icelandic Farmers Association (*Bændasamtök Íslands*), the MEEC and the MFAF.

The Climate-Friendly Farming project began in February 2020 with an open meeting for all farmers. Voluntary participants receive guidance on future planning, that focuses on reducing the carbon footprint of their farms and is based on data from each individual farm. Participation starts with an introductory course which covers the basics of climate issues in agriculture, following by monthly remote lectures and participators and advisors also meet annually at on-site workshops. Each participating farm sets its own climate action plan in which its conditions, capabilities and possibilities are considered. The action plans are revised annually and includes a list of actions divided into three categories, A) actions to reduce emissions, B) actions on carbon sequestration and C) other actions. Actions in category A include improved use of fertilisers, consideration of growing N-binding plants, less fossil fuel use, soil conservation, wetland restoration and reduction of enteric fermentation. Actions in category B include revegetation, reforestation, forestry and cultivation of shelterbelts and grazing forests. As for the category C, farmers are encouraged to think outside the box and come up with new actions. The aim is to gradually expand the "toolbox" (the action plan).

The MEEC is responsible for the project, including its funding. By 2022, the MEEC has allocated 20 million ISK to the project. Additionally, the MEEC allocates up to 500,000 ISK as a support payment annually to each participating farm.

In 2020, 13 sheep farms participated in the project. In 2021, the project became available to cattle farmers. In 2022, the number of participators has reached to 54. The project aims to include different types of farms in the future and reach around 100 participating farms in 2023. This measure is interlinked to measure 404 on Carbon-Neutral Beef Production.

It is currently impossible to estimate the impact this measure has on GHG emissions. The potential reduction in emissions is expected to come from the improved use and handling of fertiliser, improved livestock feeding and managing, improvement in the use of machines and equipment, carbon sequestration projects and improved land use.

8.3.2 Improved Feeding of Livestock to Reduce Enteric Fermentation (402)

The measure has the aim to reduce GHG emissions from enteric fermentation in ruminants through improved feeding. The goal is set at 23 kt CO_2e reduction by 2030. The measure is still in preparation and is neither included in the projection scenario nor being quantified.

Reduced emissions from the enteric fermentation of ruminants will be achieved by improved feeding practices, which will be carefully monitored. Enteric fermentation is the process that causes CH_4 emissions from the digestive system of livestock. It is the main source of GHG emissions from livestock and animal husbandry. When the livestock chew and process food they belch out CH_4. Research, that has been conducted abroad, indicates that it is possible to reduce CH_4 production in the digestive

system of livestock in various ways, such as through using substances made from algae. Whether it is possible to reduce emissions from enteric fermentation in Iceland through such means will be explored, and domestic research and development will be supported. The implementation of this policy is aligned with policy 401 on climate-friendly agriculture and policy 404 on carbon-neutral beef production, part of which is to assess the status and development of research on enteric fermentation. The project management team on the progress of climate action in agriculture will consequently be in charge of monitoring developments in this field and recommending measures that are suitable for Icelandic conditions when appropriate.

Measure 402 proposes to look into innovative feeding systems to reduce CH_4 emissions from enteric fermentation from ruminants, e.g., with the use of seaweed. This is only on an experimental level and is not included in any projections. The Icelandic Food and Biotech R&D (*Matís*) is participating in the research project *SeaCH4NGE*, financed by EIT Food. However, according to first results from December 2022, seaweed collected in Iceland does not seem promising for reducing CH_4 emissions from enteric fermentation (Matís, 2021)[37].

8.3.3 Improved Use and Handling of Fertilisers (403)

This measure has been expanded since the first edition of the Climate Action Plan (2018). The measures "reduced use of non-organic fertiliser" and "improved manure management" have been combined into one policy. The aim is to reduce GHG emissions (CH_4 and N_2O) from fertiliser use in agriculture through improvement in manure management practices and reduction in the use of inorganic fertilisers. An emphasis will be placed on increasing farmers' knowledge and access to information on how best to reduce GHG emissions from their practices. The goal is set at 10% less emissions in 2030 compared to the WOM scenario, which would mean approximately 25 kt CO_2e less cumulative GHG emissions up to that point from fertiliser use. The measure is interlinked with Climate-Friendly Agriculture (401), Carbon-Neutral Beef Production (404) and Increased Domestic Vegetable Production (405). At this point, the measure is part of measure 401 and 404.

An important aspect of this effort is to enforce the regulation on protection against water pollution due to nitrogen compounds (NO_x) from agriculture and other operations (Icelandic regulation No 796/1999). According to the regulation, the size of a manure storage should be based on a holding capacity of at least six months of manure, or the possibility of using the manure in a reasonable manner as organic fertiliser on soil. The policy scope includes the fertiliser use of all farmers, starting with cattle and sheep farmers since measures in those fields have already begun (see policies 401 and 402). Through those measures, farmers will, among other things, be provided with advice that aims to improve the use of manure, and it will be researched systematically how farmers use their manure. Knowledge and experience from this work will highlight the possibilities that exist to reduce GHG emissions with improved fertiliser use and lay a foundation for increased training and information sharing to other farming sectors. Consequently, it will be the responsibility of the project management group on climate action in agriculture to implement the policy for all farmers.

In 2020, a working group on climate and beef production (see section 8.3.4) prepared a number of measures and recommendations for carbon-neutral beef production. Regarding fertiliser use, the group proposed an improvement in the registry of fertiliser use in agriculture. The registration would potentially give an overview on fertiliser use which would highlight the opportunities for

[37] The Matís reðprt on *Seaweed supplementation to mitigate methane (CH_4) emissions by cattle (SeaCH4NGE-PLUS)* is closed until 12 December 2023.

improvements. According to the regulation on the general support in agriculture (Icelandic regulation No 430/2021), registration on fertiliser is one of the conditions for farmers to receive agricultural subsidies.

As for progress, special effort in providing counselling on fertiliser use and for making fertilising plan was launched in 2021 following the increase in fertiliser price. In 2022, the fertiliser registration had been established and there is on-going strategic planning to improve the utilisation of organic resource (e.g. for fertiliser use).

It is currently not deemed reasonable to force a 10% decrease in fertiliser emissions in 2030 in the WEM scenario. Therefore, a historical trend is used to predict emissions from fertiliser use and this PaM is not quantified. The potential reduction in emissions is expected to come from the improved use and handling of fertiliser, including better manure storage.

8.3.4 Carbon-Neutral Beef Production (404)

This measure aims to reduce the GHG emissions from beef production and increase carbon sequestration. The target carbon-neutral beef production by 2040. An emphasis will be placed on reducing GHG emissions from cattle breeding and increasing carbon sequestration at cattle farms. To reach the target, research, counselling, and education for farmers will be increased, starting with building up knowledge for farmers on carbon emissions and sequestration, improved feeding, and manure management techniques. The foundation will be knowing the possibilities of each plot of farmland and to build up a transparent and certified framework for the project. This measure is interlinked with the Climate-Friendly Agriculture (401), Improved Feeding of Livestock to Reduce Enteric Fermentation (402); and Improved Use and Handling of Fertilisers (403).

The beef production agreement (*nautgripasamningur*), an agreement on the operation conditions in beef production, was reviewed and signed in 2019[38]. The agreement includes the target for carbon-neutral beef production by 2040. A working group on climate and beef production was formed in February 2020 following the signing of the agreement, with representatives from the MFAF, the MEEC and the Farmer Association of Iceland (*Bændasamtök Íslands*) appointed by the Minister of Fisheries and Agriculture. The group received the task of making a project and financial plan targeting carbon-neutral beef production. In May 2020, the group, in consultation with the IAAC, the Agricultural University of Iceland (*Landbúnaðarháskóli Íslands*), Icelandic Food and Biotech R&D and other, has proposed seven measures and eight recommendations for the achievement of carbon-neutral beef production. The group emphasised that until the next review of the agricultural contracts (*búvörusamningar*) in 2023, available funds should be utilised in two matters, to improve the foundational data for the carbon inventory for cattle farming and to increase training and education for farmers on the possibilities to reduce their GHG emissions. The group also emphasised that the funds that would be available after the 2023 review should be utilised in direct climate measures on the farms. The project management team on the agricultural contracts will be responsible for the financial allocation and will follow through on the projects.

On the progress, according to the Climate Action Plan 2022 Status Report (Ministry of the Environment, Energy and Climate), the registration of fertiliser use has been established, cattle farmers are now

[38] *Government of Iceland (Stjornarráð Íslands). https://www.stjornarradid.is/efst-a-baugi/frettir/stok-frett/2019/10/25/Endurskodun-nautgripasamnings-i-hofn-Islensk-nautgriparaekt-verdi-ad-fullu-kolefnisjofnud-og-greidslumark-afram-vid-lydi/*

among participants in the Climate-Friendly Agriculture project[39] and a research facility has been set up at the Agricultural University of Iceland for the study on the emissions from the Icelandic cattle.

The number of participating cattle farms in the Clime-Friendly Agriculture project is used as an indicator to monitor and evaluate progress of this measure. The project launched in 2020 and became available for cattle farmers to apply in 2021. 14 cattle farms participated in 2021 and 27 in 2022.

It is currently impossible to estimate the impact this measure has on GHG emissions. The potential reduction in emissions is expected to come from the improved use and handling of fertiliser, improved livestock feeding and management, improvement in the use of machines and equipment, carbon sequestration projects and improved land use.

8.3.5 Increased Domestic Vegetable Production (405)

This measure has the aim to increase vegetable production in Iceland and promote carbon neutrality in Icelandic horticulture. Three climate goals were agreed upon during the review of the horticulture contract[40] (*garðyrkjusamningur*) in May 2020[41]. The goals include a 25% increase in the production of Icelandic vegetables between 2020-2023 compared to the average production between 2017-2019, increase in financial support for organic vegetable production as well as making efforts for carbon neutral Icelandic horticulture by 2040.

To support the goal of carbon neutrality in Icelandic horticulture, a part of the funding for the horticulture contract will be spent specifically on climate action. A work has begun on building up knowledge on GHG emissions and sequestration, improving the treatment and use of resources and fertilisers, reducing waste, and strategic cultivation. An emphasis will be placed on effective agriculture, increased sustainability, and other actions that support the target of carbon neutral farming. Furthermore, a holistic approach will be undertaken where climate policy, energy, employment, regional affairs, food production and other significant factors will coincide with climate actions. Farmers' knowledge on climate issues, possibilities for reduction of GHG emissions, and increased carbon sequestration will be further improved, e.g., by increased access to direct council and education. The emphasis will be on knowing the possibilities of each individual horticultural farm directly, and to build up a transparent and certified framework for the project.

Regarding the financing, additional 200 million ISK is allocated to the horticulture contract yearly between 2020-2026 to support this measure, e.g. for direct payment for electricity, climate actions, development projects and more diverse vegetable cultivation. Simultaneously, another 15 million ISK is allocated to the horticulture contract to directly support the project on carbon neutral Icelandic horticulture. The executive committee of the agricultural contracts is responsible for the allocation of the funds and will base the allocation on the recommendation from the Icelandic Association of Horticulture Producers (*Samband garðyrkjubænda*) (IAHP). At the end of 2020, the MFAF and the IAHP agreed to fund two specific projects. One involves vegetation in the city while the other involves carbon sequestration. Both projects focus on increasing knowledge, public interest, and participation in cultivation in order to increase carbon sequestration. The IAHP is responsible for project management.

[39] *Icelandic Agricultural Advisory Centre (RML).* https://www.rml.is/is/radgjof/loftslag-og-umhverfi/loftslagsvaenn-landbunadur

[40] *The horticulture contract (garðyrkjusamningur) is a contract for the operation conditions of horticulture production.*

[41] *Government of Iceland (Stjornarráð Íslands).* https://www.stjornarradid.is/library/01--Frettatengt---myndir-og-skrar/ANR/Landbunadur/r04siol_22.5.2020_08-43-29.pdf

The amount of vegetables produced is used as an indicator to monitor and evaluate the progress of this measure. Although being implemented in 2020, the evaluation started in 2021 as it was the first full executive year of measure. The total amount of produced vegetable in 2021 was 12,903 tons which is 8% lower than the average amount between 2017-2019. The decrease in total amount is due to crop failure in potato and turnip.

The measure has not been quantified, as greenhouses for vegetable farming do not produce any GHG emissions (except for very low fugitive emissions from geothermal power production) according to the National Inventory Report. Greenhouses in Iceland are heated by geothermal heat and the electricity derives from renewable sources; that is hydropower plants and geothermal power plants. It can be assumed that fertiliser use might increase slightly, but in comparison to the animal farming sector, vegetable production in Iceland is very small and should not lead to significant increases of GHG emissions. On an international level, increased domestic vegetable production in Iceland may reduce the need for international transportation of goods to Iceland, thus reducing emissions.

8.4 Sensitivity Analysis

8.4.1 Livestock Activity Data

Livestock population projections are based on historical trends or the trend of the past 10 years for all major livestock categories, using linear extrapolation. These projections are the main determinants of GHG emissions from the Agriculture sector. A sensitivity analysis has been performed to assess the impact on emissions from agriculture of applying different trends to project livestock numbers.
For the various sheep subcategories, livestock projections based on the 10-year trend were used for the sensitivity analysis. Projections based on 10-year trend show smaller livestock number compared to projections based on historical trend. The differences grew larger as the projections stretched further into the future, reaching about 20% difference in 2050 (see Table 8.6). A visual comparison between different sheep projection scenarios can be seen in Figure 8.4.

Table 8.6 Projected number of sheep (1,000s) using linear extrapolation: 10-year trend versus historical trend.

	Sceenario	2021	2025	2030	2035	2040	2045	2050
Mature sheep	Sensitivity Analysis: 10-year trend	301	290	273	255	238	220	203
	WEM: Historical trend	301	295	284	274	263	253	242
	Difference %	0%	-1.4%	-4.0%	-6.7%	-9.6%	-12.8%	-16.3%
Rams	Sensitivity Analysis: 10-year trend	11	11	10	10	10	10	9
	WEM: Historical trend	11	10	10	10	9	9	9
	Difference %	0%	0.5%	1.4%	2.4%	3.4%	4.6%	5.7%
Young sheep	Sensitivity Analysis: 10-year trend	74	70	65	60	54	49	43
	WEM: Historical trend	74	73	73	73	72	72	71
	Difference %	0%	-4.1%	-10.9%	-17.9%	-24.9%	-32.0%	-39.2%
Lambs	Sensitivity Analysis: 10-year trend	227	222	208	194	180	167	153
	WEM: Historical trend	227	226	219	211	204	197	189
	Difference %	0%	-1.7%	-4.8%	-8.1%	-11.6%	-15.3%	-19.4%
Total	**Sensitivity Analysis: 10-year trend**	**613**	**593**	**556**	**519**	**482**	**445**	**408**
	WEM: Historical trend	**613**	**604**	**586**	**567**	**549**	**530**	**512**
	Difference %	**0%**	**-1.8%**	**-5.0%**	**-8.5%**	**-12.1%**	**-16.0%**	**-20.2%**

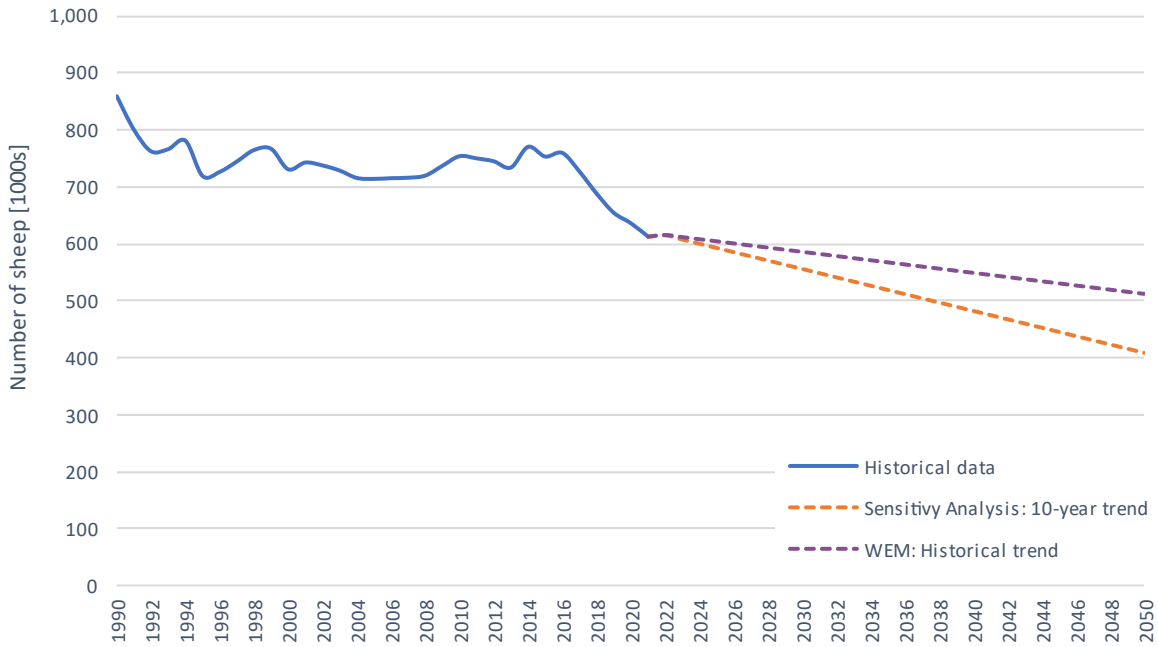

Figure 8.4 Comparison between the number of sheep projected by using the historical trend versus the 10-year trend.

For the various cattle subcategories, livestock projections based on the 10-year trend were also used for the sensitivity analysis. Projections based on 10-year trend show larger livestock number compared to projections based on historical trend. The differences grew significantly larger as the projections stretched further into the future, reaching about 41% difference in 2050 (see Table 8.7). A visual comparison between different sheep projection scenarios can be seen in Figure 8.5.

Table 8.7 Projected number of cattle (1,000s) using linear extrapolation: 10-year trend versus historical trend.

	Sceenario	2021	2025	2030	2035	2040	2045	2050
Dairy cows	Sensitivity Analaysis: 10-year trend	25.8	26.7	27.6	28.4	29.3	30.2	31.0
	WEM: Historical trend	25.8	24.9	24.1	23.2	22.3	21.5	20.6
	Difference %	0%	7.2%	14.6%	22.6%	31.2%	40.4%	50.5%
Heifers	Sensitivity Analaysis: 10-year trend	6.6	6.0	5.7	5.3	4.9	4.6	4.2
	WEM: Historical trend	6.6	5.3	4.7	4.2	3.6	3.0	2.5
	Difference %	0%	14.1%	20.1%	27.8%	37.9%	51.7%	71.9%
Steers	Sensitivity Analaysis: 10-year trend	22.4	25.0	28.5	32.0	35.6	39.1	42.6
	WEM: Historical trend	22.4	22.9	23.7	24.5	25.3	26.1	26.9
	Difference %	0%	9.1%	20.3%	30.8%	40.6%	49.8%	58.5%
Calves	Sensitivity Analaysis: 10-year trend	22.2	23.8	25.8	27.7	29.7	31.7	33.6
	WEM: Historical trend	22.2	23.3	24.5	25.6	26.7	27.8	28.9
	Difference %	0%	1.9%	5.3%	8.4%	11.2%	13.8%	16.2%
Total	**Sensitivity Analaysis: 10-year trend**	**77.0**	**81.5**	**87.5**	**93.5**	**99.5**	**105.5**	**111.5**
	WEM: Historical trend	**77.0**	**76.5**	**76.9**	**77.4**	**77.9**	**78.4**	**78.9**
	Difference %	**0%**	**6.6%**	**13.7%**	**20.8%**	**27.7%**	**34.6%**	**41.3%**

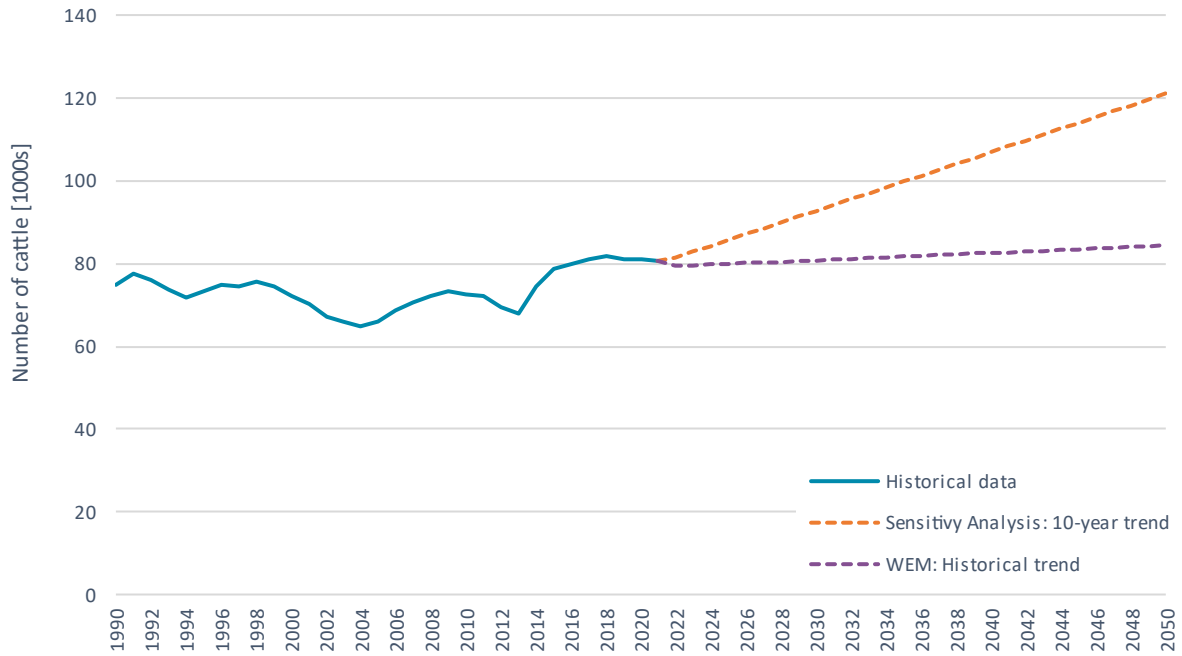

Figure 8.5 Comparison between the number of cattle projected by using the historical trend versus the 10-year trend.

Table 8.8 below shows the results of the sensitivity analysis. In the sensitivity analysis scenario, emissions from the Agriculture sector are projected to be 9.1% higher in 2050 compared to the WEM projections scenario used for the sector (see Table 8.8). The total emissions from the Agriculture sector in the different scenarios can be seen in Figure 8.6 and Figure 8.7 below. The sensitivity analysis scenario, emissions from the Agriculture sector remain very stable throughout the projected time series. The impact of the increase in the number of cattle counteracts the impact of the reduction in the number of sheep, resulting in a minimal change in emissions.

Table 8.8 Sensitivity analysis results: total GHG emissions from Agriculture by projections scenarios, [kt CO_2e].

Scenario	2021	2025	2030	2035	2040	2045	2050
Sensitivity Analysis: 10-year trend	621.0	580.2	581.2	581.1	581.1	581.3	581.6
WEM: Historical trend	621.0	572.2	565.3	557.2	549.1	541.1	533.1
Difference in kt CO_2e	**0**	**8.0**	**15.9**	**23.9**	**32.0**	**40.2**	**48.5**
Difference in %	**0%**	**1.4%**	**2.8%**	**4.3%**	**5.8%**	**7.4%**	**9.1%**

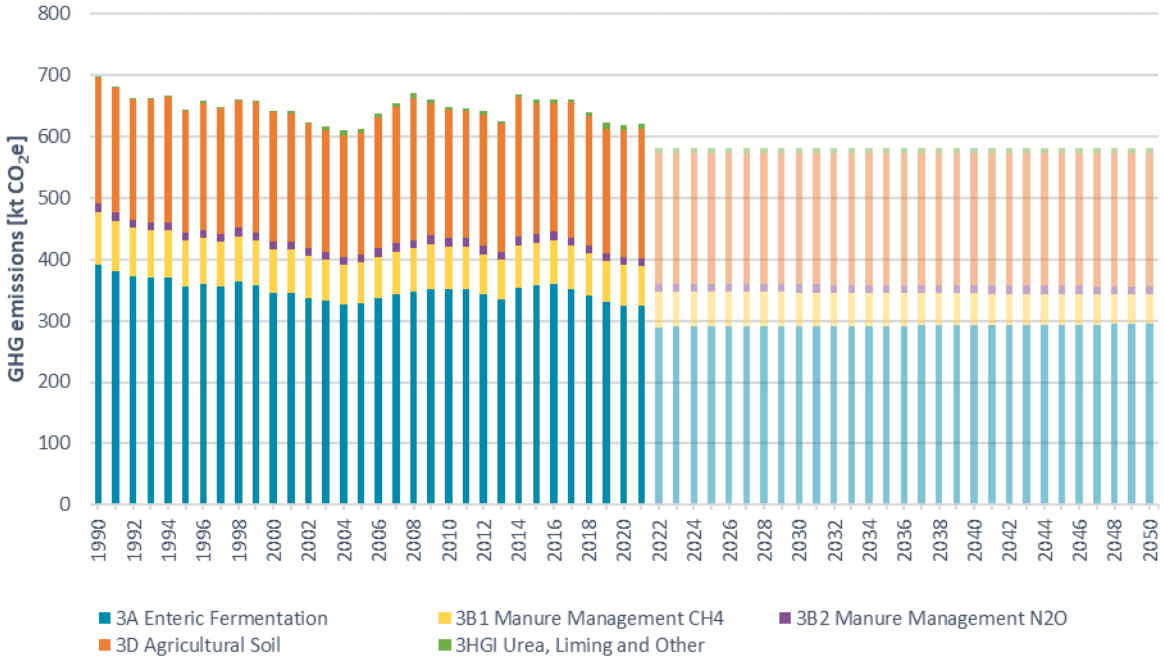

Figure 8.6 Historical and projected GHG emissions from the Agriculture sector in the Sensitivity Analysis scenario, [kt CO_2e].

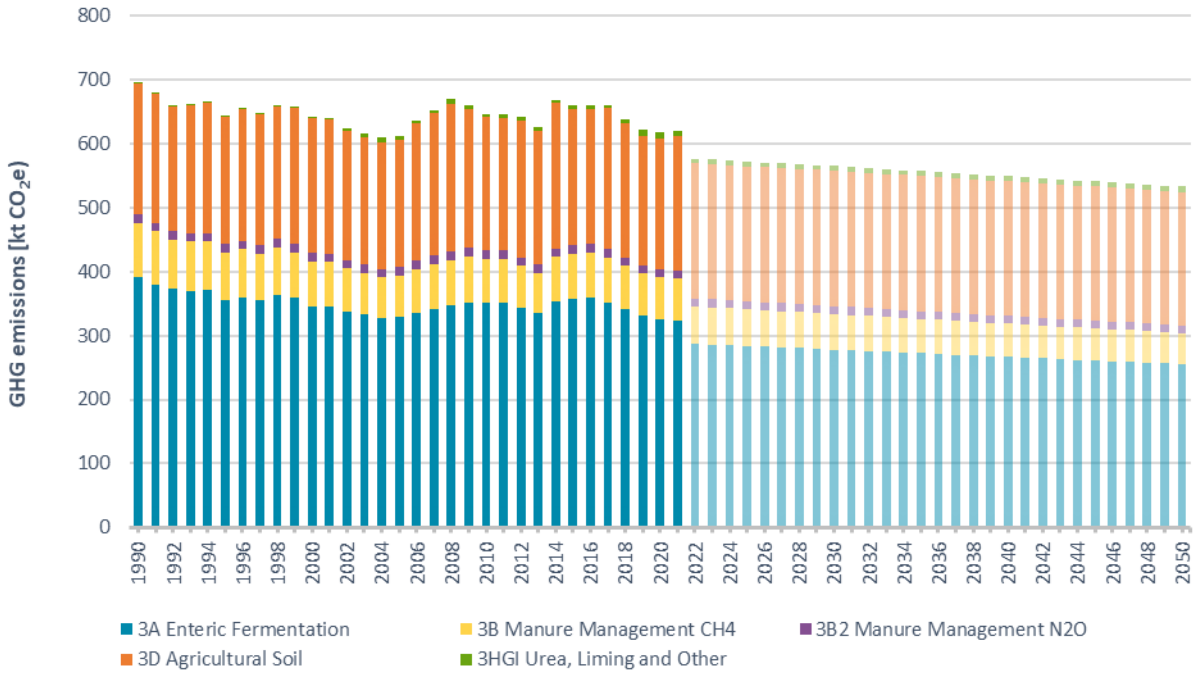

Figure 8.7 Historical and projected GHG emissions from the Agriculture sector in the WEM scenario, [kt CO_2e].

In the WEM scenario, emissions from the Agriculture sector are projected to decrease due to the impact of the reduction in the number of sheep which outweighs the impact of the increase in the number of cattle.

8.4.2 Inorganic N-Fertilizer Activity Data

For the Agriculture sector, Inorganic N-Fertilizer alone is responsible for approximately 8% of GHG emissions from the sector in 2021 and is projected to increase to 10%. For this submission, the projection is based on historical trend, using linear extrapolation. In this chapter, a sensitivity analysis has been performed to assess the impact on emissions from Agriculture of applying different trend, i.e. 10-year trend, to the amount of inorganic N-fertilizer use.

The projection based on 10-year trend shows smaller amount of inorganic N-fertilizer use compared to the projection based on historical trend. The differences grew significantly larger as the projections stretched further into the future, reaching 29.6% difference in 2050 (see Table 8.9). A visual comparison between different fertilizer use projection scenarios can be seen in Figure 8.8.

Table 8.9 Projected use of inorganic N-fertilizer [t] using linear extrapolation: 10-year trend versus historical trend.

Sceenario	2021	2025	2030	2035	2040	2045	2050
Sensitivity Analaysis: 10-year trend	11,408	11,367	10,838	10,308	9,778	9,248	8,718
WEM: Historical trend	11,408	12,259	12,284	12,308	12,332	12,356	12,380
Difference %	**0%**	**-7.3%**	**-11.8%**	**-16.2%**	**-20.7%**	**-25.2%**	**-29.6%**

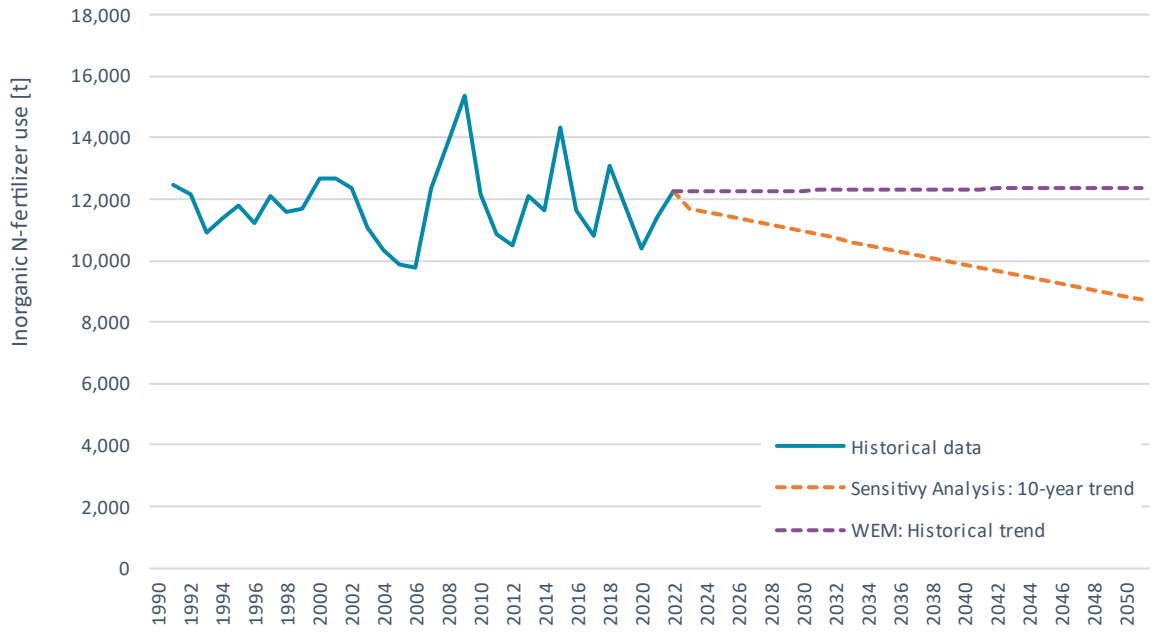

Figure 8.8 Comparison between the projected use of inorganic N-fertilizer: Historical trend versus 10-year trend.

Table 8.10 below shows the results of the sensitivity analysis. Both the sensitivity analysis and WEM scenario show a decrease in emissions from the Agriculture sector throughout the projected time series with the sensitivity analysis showing slightly lower emissions in general, or down to 3.6% lower in 2050. The total emissions from the Agriculture sector in the sensitivity analysis can be seen in Figure 8.9 below while the total emissions in the WEM scenario have already been shown in previous chapter (Figure 8.7).

Table 8.10 Sensitivity analysis results: total GHG emissions in the inorganic N-fertilizer use projections scenarios, [kt CO_2e].

Sceenario	2021	2025	2030	2035	2040	2045	2050
Sensitivity Analaysis: 10-year trend	621.0	567.5	557.7	546.7	535.8	524.8	513.9
WEM: Historical trend	621.0	572.2	565.3	557.2	549.1	541.1	533.1
Difference %	**0**	**-4.7**	**-7.6**	**-10.5**	**-13.4**	**-16.3**	**-19.2**
Difference in %	**0%**	**-0.8%**	**-1.3%**	**-1.9%**	**-2.4%**	**-3.0%**	**-3.6%**

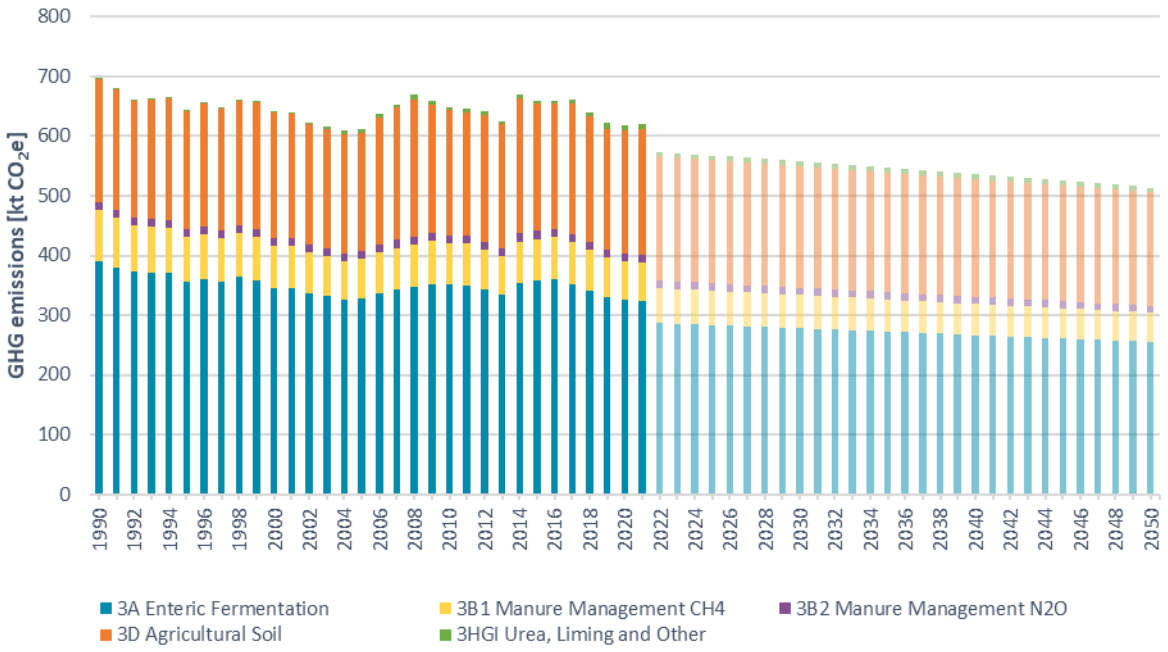

Figure 8.9 Historical and projected GHG emissions from the Agriculture sector in the Sensitivity Analysis scenario, [kt CO_2e].

8.5 Stakeholder Engagement

In 2022, a new Working Group on Climate Action in Agriculture and LULUCF was established by the Ministry of Food, Agriculture and Fisheries, with the goal of improving and strengthening climate mitigation PaMs in these sectors. The working group has representatives from the EAI, SCSI, and IFS, as well as the MEEC, the Agricultural University of Iceland, the Farmer's Association of Iceland and the IAAC. The representative from the EAI has communicated and discussed the information on Agriculture PaMs and projections provided in this report to the group, and incorporated feedback into the assumptions.

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

In this sector emissions and removals related to Land Use, Land-Use Change, and Forestry (LULUCF), are reported. The categorisation of land use is in accordance with the 2006 IPCC guidelines (IPCC, 2006). This defines six main land-use categories and conversions between them. Emissions and removals of GHGs are reported for all managed lands within these categories according to guidelines given in Volume 4: Agriculture, Forestry, and Other Land Use of the 2006 Guidelines (IPCC, 2006), hereafter named AFOLU Guidelines, and the 2013 Supplement to the 2006 Guidelines: Wetlands (IPCC, 2014), hereafter named 2013 Wetland Supplement. The SCSI and the IFS are responsible for preparing the inventory for this sector.

Almost 90% of the total area of Iceland is included in two land-use categories, i.e. Other Land and Grassland. Land categories were changed considerably in the 2021 submission, when the Other Land category was partly transferred to Grassland (See also Chapter 6.7 Grassland (CRF 4C) of NIR 2023 (EAI, 2022)). Figure 9.1 shows the relative division of the area of Iceland to the six main land-use categories reported.

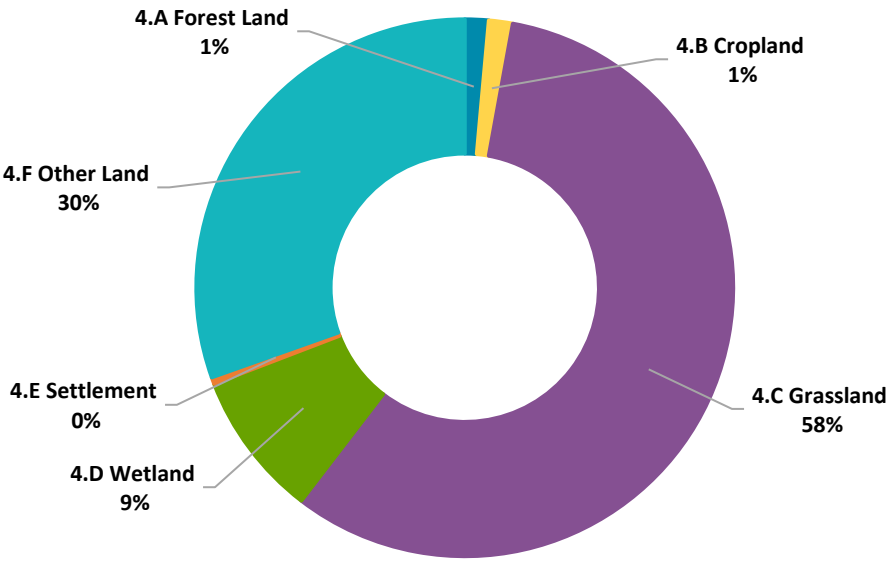

Figure 9.1 Relative size of land-use categories in Iceland according to IGLUD land-use map 2021 and other land-use estimates available for the reporting.

Both emissions from sources and removals by sinks are reported for this sector. The net contribution of the main land-use categories is summarised in Figure 9.2. More information on historical emissions and removals of the land-use categories is reported in the NIR 2023 (Environment Agency of Iceland).

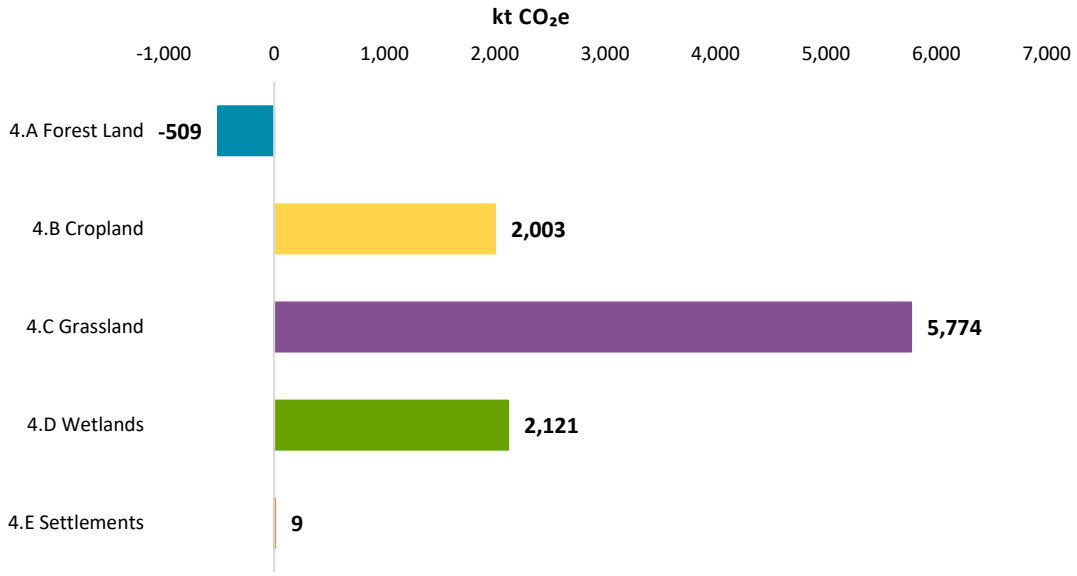

Figure 9.2 The net emissions/removals of land-use categories [kt CO_2e] in 2021. Emissions from Other Land (4F) are not included in this graph. Since 2020 submission, the N_2O emission from Cropland and Grassland management of organic soils are reported under the Agricultural sector and not included here.

A large part of the government's Climate Action Plan (Ministry for the Environment and Natural Resources, 2020) and Land and life - Land reclamation and national forestry plan (*Land og líf - Landgræðsluáætlun og landsáætlun í skógrækt*), published in 2022 (Ministry of Food, Agriculture and Fisheries , 2022), concerns LULUCF. Sustainable management practices in the LULUCF sector can contribute to climate change mitigation in several ways, by reducing emissions and maintaining and enhancing sinks and carbon stocks. Furthermore, the government has implemented through law that Iceland is to achieve carbon neutrality by the year 2040; this underlines the importance of enhanced carbon sequestration and GHG reduction action.

9.1 Methodology of Projections

For the 2023 submission, three projection scenarios were generated for the LULUCF sector: WEM, WAM and WAM – Wetlands Drainage Stopped (WAM [WDS]) (section 9.2). A WOM scenario has not been calculated for this submission.

The methodologies used to generate WEM and WAM projections are based on the historical inventory (see NIR 2023) and Government's Climate Action Plans, with the exception of the Settlements land category (sections 9.1.1). In the case of WAM [WDS], the scenario was generated assuming that from the year 2022 there is no drainage activity of wetlands (see section 9.2.3).

Please refer to the latest edition of the National Inventory Report, where information about activity data and emission factors is presented (Environment Agency of Iceland, 2023). For the categories 4.A, 4.C.2.5 and 4.D.2.3.3, a comparison between WOM, WEM and WAM scenarios was carried out (section 9.3).

9.1.1 Data and Assumptions

An overview of the data and assumptions/methods used as a basis for the LULUCF projections can be found in Table 9.1.

Table 9.1 Activity data basis for LULUCF projections.

LULUCF	Basis for Projections
Forest Land (4.A)	Historical trend, model projecting C stock change, Government´s action plans
Cropland (4.B)	Linear extrapolation of historical trends
Grassland (4.C)	Linear extrapolation of historical trends, Government´s action plans
Wetlands (4.D)	Linear extrapolation of historical trends, Government´s action plans
Settlements (4.E)	Linear extrapolation based on population projection 2022-2073 *
Other Land (4.F)	Linear extrapolation of historical trends

** (Statistics Iceland, 2022)*

The emission estimates in the LULUCF sector are to a large degree determined by the development of land areas categorised by their use. Therefore, the LULUCF emission estimates and their projections must primarily methodologically solve the issue of land areas. The actual development of six major IPCC land-use categories as reported in the latest emission inventory (Environment Agency of Iceland, 2023) is used. The projections are based on the observed trends and anticipation of increased afforestation, soil reclamation and rewetting of wetlands. However, the projection of emissions from the land category Settlements for the period 2022 – 2050 is based on the expansion of inhabited areas and roads in correlation with the increase in Iceland's population from 1 January 2022 to 1 January 2051, projected by Statistics Iceland, which forecasts an increase in population of < 21% by 2051 (Statistics Iceland, 2022).

In this fourth submission of the PaMs and Projections Report, improvements of the model projecting the development of C stock change in Forest Land has been undertaken. Instead of using plantation statistics to estimate species and age structure of cultivated forest, a sample plot statistic of the national forest inventory was used in a similar way as in the Icelandic National Forestry Accounting Plan (Snorrason, Kjartansson, & Traustason, 2020). A more realistic approach to estimate future harvesting was used by comparing wood production of the period 1996-2020 to potential harvesting of forest defined as available for wood supply. Only 13% of potential harvesting was carried out in this period. In accordance with this year's UNFCCC submission, more complete estimation of Carbon losses due to harvest was introduced in this year's PaMs and Projections Report, together with improved estimation of the dead wood pool and its Carbon stock changes.

The methodology used for the projection of emissions from Cropland, Grassland, Wetlands, Settlements, and Other Land is in line with the model adopted for the national inventory, which is in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC). However, greater emphasis was placed on increasing carbon capture and storage in land reclamation and wetland recovery and conservation, with potentiate action plans designed on behalf of the Icelandic government in line with the increased flexibility afforded by higher financial contributions.

9.2 Emission Projections

Historical emissions from the LULUCF sector have decreased slightly during the last decade, according to the latest inventory. The WEM and WAM emissions projections have decreasing trends as well.

However, the comparison between the WEM and WAM projections highlights a more substantial reduction in emissions in the WAM scenario, which is explained by enhanced afforestation and more extensive restoration activities for disturbed wetlands and disturbed land.

An additional WAM scenario (WAM – Wetlands Drainage Stopped [WDS]) was produced, assuming that drainage activities have completely ceased during the period 2022 – 2050, in addition to the additional measures used to generate the WAM scenario (see section 9.2.3). Historical and projected emissions trends in LULUCF for the WEM, WAM and WAM [WDS] scenarios are presented in Figure 9.3 and in Table 9.2.

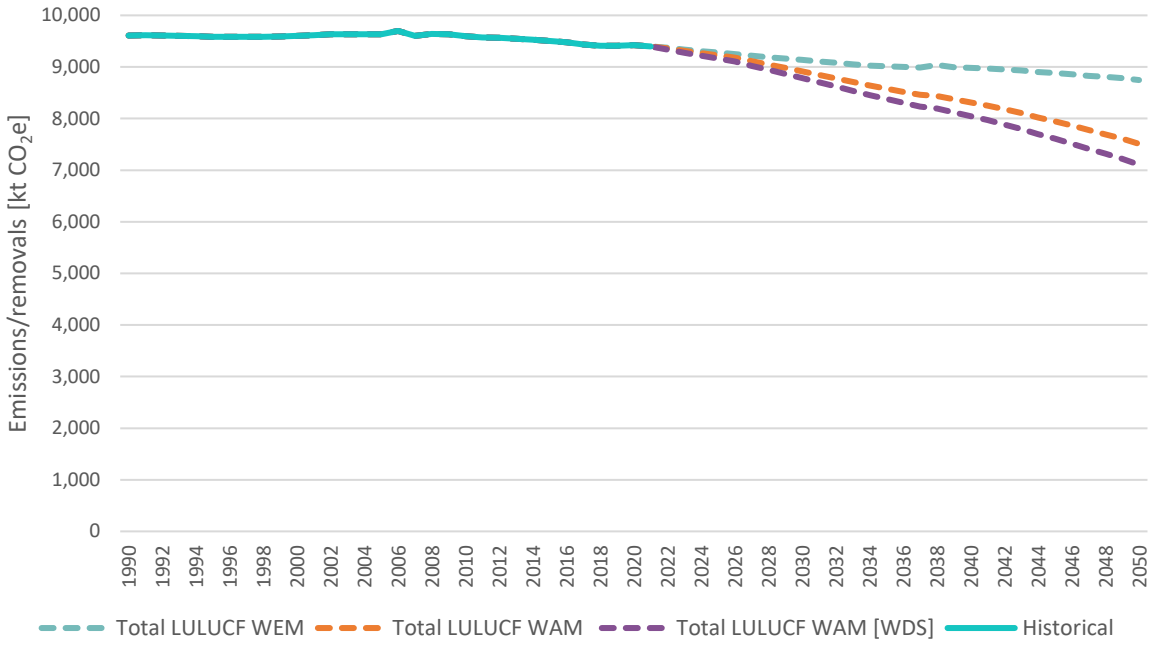

Figure 9.3 LULUCF Emissions Total GHGs [kt CO_2e] trends. WEM and WAM scenarios.

Table 9.2 LULUCF Emissions Total GHGs [kt CO_2e] values. WEM and WAM scenarios.

Scenarious	1990	2015	2020	2025	2030	2035	2040	2045	2050
Total LULUCF WEM	9,610	9,506	9,421	9,279	9,135	9,014	8,983	8,885	8,746
Total LULUCF WAM	9,610	9,506	9,421	9,225	8,916	8,581	8,311	7,947	7,509
Total LULUCF WAM [WDS]	9,610	9,506	9,421	9,162	8,785	8,382	8,044	7,611	7,105
Differences between WAM and WEM	**0**	**0**	**0**	**-54**	**-219**	**-433**	**-672**	**-938**	**-1,237**
Differences between WAM [WDS] and WEM	**0**	**0**	**0**	**-116**	**-350**	**-632**	**-939**	**-1,274**	**-1,641**

9.2.1 WEM scenario

In the government's Climate Action Plan (Ministry for the Environment and Natural Resources, 2020) and Land and life - Land reclamation and national forestry plan (*Land og líf -Landgræðsluáætlun og landsáætlun í skógrækt*) (Ministry of Food, Agriculture and Fisheries , 2022), there is great emphasis on increasing carbon capture and storage in forests through afforestation, expanding revegetation through restoration of ecosystems on disturbed land, wetlands conservation and restoration of disturbed wetlands.

The WEM scenario is consequently mostly generated using government's action plans reported in Land and life (Ministry of Food, Agriculture and Fisheries , 2022) and Climate Action Plan (Ministry for the Environment and Natural Resources, 2020).

Enhanced Action in Forestry

For the quantification of enhanced afforestation, afforestation was to increase from 1,100 ha in 2018 to 2,300 ha in 2022. The plan was reiterated and enhanced in the fiscal policy of the government for the years 2021 to 2025, where afforestation is planned to increase to 2,500 ha annually in the year 2025 (Ministry of Finance and Economic Affairs, 2020, bls. 290).

Expanding revegetation

For the quantification of expanding revegetation, the Land and life plan (2022) includes restoration of 10,000 ha of disturbed grassland per year, starting from the year 2022 (Table 9.6).

Restoration of Wetlands

For the quantification of restoration of disturbed wetlands, values reported in the fiscal policy (2021-2023), which proposes the restoration of 610 ha of disturbed wetlands areas per year from 2022 (Table 9.6), were used.

Wetlands Conservation

In Land and life (Ministry of Food, Agriculture and Fisheries , 2022), as in the Climate Action Plan (Ministry for the Environment and Natural Resources, 2020), the importance of preventing further drainage of undisturbed wetlands and protecting wetland ecosystems that are still undisturbed is highlighted. Wetlands are protected by law and there is a major focus to prevent further draining of wetlands unless absolutely necessary. Nevertheless, drainage of undisturbed wetlands is still ongoing. Therefore, it is assumed that drainage activities are ongoing in the WEM scenario and the extrapolated time series is calculated based on historical data.

The historical and projected emissions trends for the LULUCF WEM scenario are presented in Figure 9.4 and Table 9.3 below.

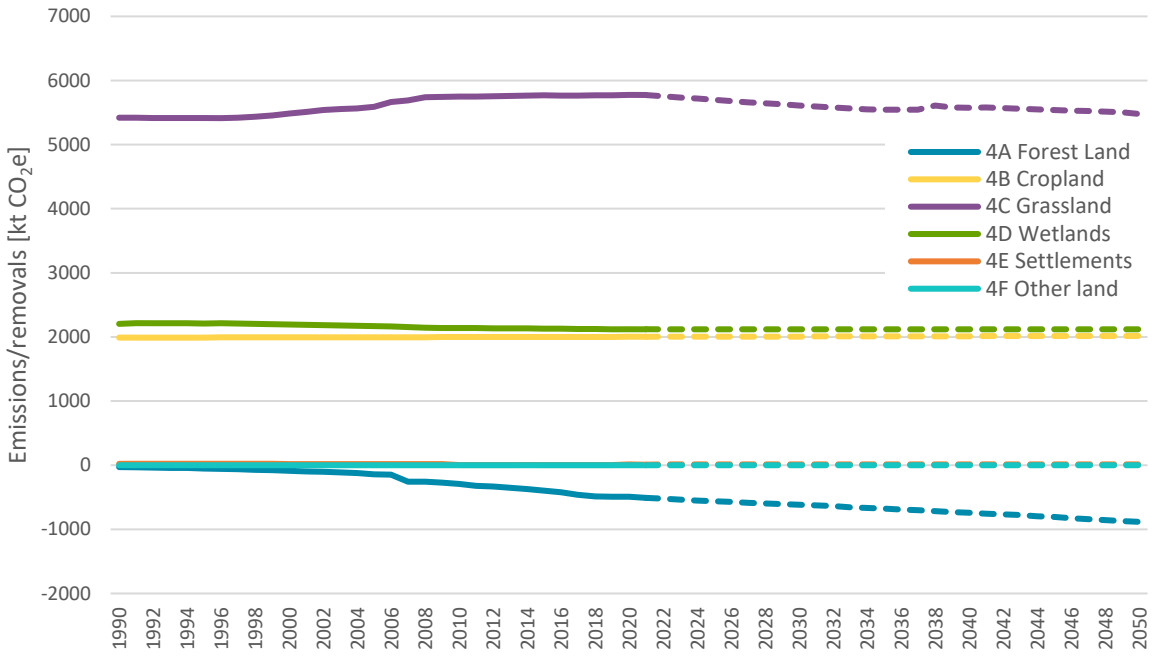

Figure 9.4 Total historical and projected LULUCF emissions in the WEM scenario 1990-2050, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

Table 9.3 Total historical and projected LULUCF emissions in the WEM scenario, [kt CO_2e].

Land categories	1990	2015	2020	2025	2030	2035	2040	2045	2050
4A Forest Land	-29	-398	-493	-559	-615	-675	-740	-804	-883
4B Cropland	1,991	2,001	2,003	2,005	2,007	2,010	2,012	2,015	2,017
4C Grassland	5,420	5,769	5,776	5,699	5,611	5,546	5,577	5,541	5,479
4D Wetlands	2,206	2,131	2,121	2,121	2,120	2,120	2,120	2,121	2,121
4E Settlements	22	4	14	12	12	12	13	13	13
4F Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO
4G Harvested Wood Products	NO	0.2	0.3	-0.1	-0.2	-0.3	-0.3	-0.3	-0.3
4H Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 LULUCF	**9,610**	**9,506**	**9,421**	**9,278**	**9,135**	**9,014**	**8,982**	**8,885**	**8,746**

9.2.2 WAM scenario

As described in section 9.2.1 WEM scenario, a great emphasis is placed on increasing carbon capture and storage in forests through afforestation, expanding revegetation through revegetation and restoration of ecosystems on disturbed land, wetlands conservation and restoration of disturbed wetlands.

The WAM scenario of Forest Land is generated based on the current draft of the fiscal policy, based on which the IFS predicts the annual afforestation rate to increase from 2,500 ha to 5,000 ha per year in 2028. The main reason for this expected increase is a rapid increase in interest and participation by private entities to offset carbon footprints through validated and certified carbon credits.

The WAM scenario for revegetation and rewetting of wetlands is generated based on the government's action plans, similarly to the WEM scenario. However, the WAM scenario differs from the WEM scenario by assuming additional measures with larger restored areas of disturbed wetlands and disturbed land compared to the WEM scenario.

Enhanced Action in Forestry

The quantification for further expanding afforestation was based on the current draft of the fiscal policy. Corresponding to the fiscal policy, the IFS predicts the annual afforestation rate to increase from 2,500 ha to 5,000 ha annually in 2028. The annual area of afforestation was projected to rise from 2,500 ha in 2025 to 5,000 ha per year in 2028, with intermediate activity in 2026 (3,200 ha) and 2027 (4,100 ha).

Expanding Revegetation

For the quantification of expanding revegetation, fiscal policy (2021-2023) values were used. The action plan consists of the restoration of 12,200 ha of disturbed grassland per year, starting from the year 2022 (Table 9.6).

Restoration of Wetlands

For the quantification of restoration of disturbed wetlands, values reported in the Land and life plan (2022) were used, consisting of the restoration of 1,060 ha of disturbed wetlands areas per year during the period 2022 – 2026. From the year 2027, the action plan intends to achieve a restoration rate of 2,060 ha of disturbed wetlands per year (Table 9.6).

Wetlands Conservation

In Land and life (Ministry of Food, Agriculture and Fisheries , 2022), as in Climate Action Plan (Ministry for the Environment and Natural Resources, 2020), the importance of preventing further drainage of undisturbed wetlands and protecting wetland ecosystems that are still undisturbed is highlighted. Wetlands are protected by law and there is a major focus to prevent further draining of wetlands unless absolutely necessary. Nevertheless, drainage of undisturbed wetlands is still ongoing. Therefore, it is assumed, identically to the WEM scenario, that drainage activities are ongoing in the WAM scenario and the extrapolated time series is calculated based on historical data.

The historical and projected emissions trends for the LULUCF WAM scenario are presented in Figure 9.5 and Table 9.4.

9.2.3 WAM [WDS] scenario

An additional scenario was created in addition to the WAM scenario. The WAM [WDS] scenario is generated based on the same government's action plans as the WAM scenario (section 9.2.2), but while in the WAM scenario drainage of undisturbed wetlands is ongoing until the year 2050 (see section 9.2.2), in the WAM [WDS] scenario it is assumed that drainage activities cease completely from the year 2022.

A more significant decrease in emissions is observed in the land category Grassland in the WAM [WDS] scenario, compared to the WAM scenario. This category includes 80% of drained organic soils in the LULUCF sector, where 92% are included in the sub-category Grassland remaining grassland – Wetlands drained for more than 20 years, 7% in the sub-category Wetlands converted to grassland and 1% under Cropland converted to grassland. Consequently, stopping all drainage activities of wetlands in addition to the restoration activities of disturbed wetlands explains the decrease in emissions.

In contrast, in the category Wetlands, there is a more accentuated increase in emissions. This development is to be attributed to the assumption that wetlands drainage activities have ceased, which results in no further conversion of wetlands to other categories. Additionally, restoration activities of disturbed wetlands increase areas of mires, increasing consequently, CH_4 emissions.

The historical and projected emissions trends for the LULUCF WAM [WDS] scenario is presented in Figure 9.5 and Table 9.5 below. However, only trends for Cropland [WDS], Grassland [WDS], and Wetlands [WDS] are shown in Figure 9.5, being the categories for which wetland drainage significantly affects emissions from the LULUCF sector.

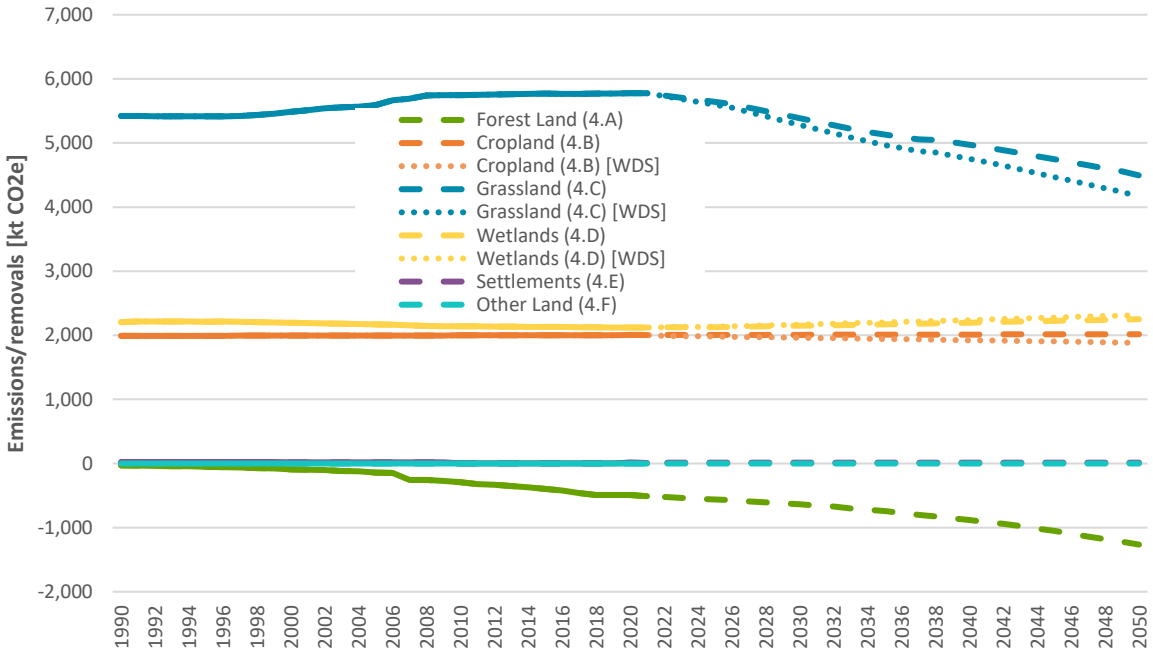

Figure 9.5 Total historical and projected LULUCF emissions in the WAM scenario 1990-2050, [kt CO_2e]. WAM [WDS] trends are only for land categories where wetland drainage/non-drainage affects emissions. Unbroken lines represent historical emissions, broken lines projected emissions.

Table 9.4 Total historical and projected LULUCF emissions in the WAM scenario, [kt CO_2e].

Land categories	1990	2015	2020	2025	2030	2035	2040	2045	2050
4A Forest Land	-29	-398	-493	-559	-635	-743	-882	-1,049	-1,264
4B Cropland	1,991	2,001	2,003	2,005	2,007	2,010	2,012	2,015	2,017
4C Grassland	5,420	5,769	5,776	5,639	5,384	5,129	4,971	4,745	4,493
4D Wetlands	2,206	2,131	2,121	2,127	2,148	2,172	2,196	2,224	2,251
4E Settlements	22	3.7	13.9	12.3	12.1	12.5	13.1	13	13
4F Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO
4G Harvested Wood Products	NO	0.2	0.3	-0.1	-0.2	-0.3	-0.3	-0.3	-0.3
4H Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 LULUCF	**9,610**	**9,506**	**9,421**	**9,225**	**8,916**	**8,581**	**8,311**	**7,947**	**7,509**

Table 9.5 Historical and projected LULUCF emissions in the WAM [WDS] scenario, [kt CO_2e].

Land categories	1990	2015	2020	2025	2030	2035	2040	2045	2050
4A Forest Land	-29	-398	-493	-559	-635	-743	-882	-1,049	-1,264
4B Cropland	1,991	2,001	2,003	1,980	1,961	1,942	1,922	1,903	1,884
4C Grassland	5,420	5,769	5,776	5,593	5,280	4,968	4,753	4,469	4,160
4D Wetlands	2,206	2,131	2,121	2,136	2,167	2,202	2,237	2,275	2,314
4E Settlements	22	4	14	12	12	12	13	13	13
4F Other Land	NO	NO	NO	-	-	-	-	-	-
4G Harvested Wood Products	NO	0.2	0.3	-0.1	-0.2	-0.3	-0.3	-0.3	-0.3
4H Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 LULUCF	**9,610**	**9,506**	**9,421**	**9,162**	**8,785**	**8,381**	**8,044**	**7,611**	**7,105**

Table 9.6 Values defined in Land and life (2022), Draft of fiscal policy (2028-2050) and fiscal policy (2021-2023) as action plans for Enhanced Action in Forestry, Expanding revegetation and Restoration of wetlands, and used to generate the WEM and WAM scenarios.

Mitigation activities	WEM ha/yr	*Source / projection period*	WAM ha/yr	*Source / projection period*
Enhanched action in Forestry	2,500	*Land and life and Climate action plan [2022-2050]*	5,000	*Draft of fiscal policy [2028-2050*]
Expanding revegetation	10,000	*Land and life [2022-2050]*	12,200	*Fiscal policy [2021-2023]*
Restoration of wetlands	610	*Fiscal policy [2021-2023]*	1,060	*Land and life [2022-2026]*
Restoration of wetlands	-	-	2,060	*Land and life [2027-2050]*

9.3 Policies and Measures

Six LULUCF PaMs are currently ongoing with the objective of reducing GHG emissions and increasing removals and are summarised in Table 9.7. The PaMs on reducing GHG emissions from LULUCF in the 2022 Land and life (2022) and Climate Action Plan (2020) are predominantly focused on enhancing carbon sequestration through afforestation, land reclamation and restoration of wetlands, and reduction in carbon emissions through recovery and conservation of wetlands.

Table 9.7 LULUCF Policies and Measures.

PaM Name	GHGs	Instrument type	Status	Scenario	Ex-ante	Description
Enhanced Action in Forestry (601)	CO_2, CH_4, N_2O	Fiscal	Implemented	WEM	Yes (4.A.)	Efforts in forestry will be enhanced leading to increased net carbon sequestration.
Expanding Revegetation (602)	CO_2, CH_4	Fiscal	Implemented	WEM	Yes (4.C.2.5)	Revegetation efforts will be increased for increased carbon sequestration. Efforts will also be made to halt and reverse land degradation and decrease emissions from degraded land.
Wetlands Conservation (603)	CO_2, CH_4	Fiscal, Planning, Regulatory	Implemented	WEM	No, but additional efforts included in WAM [WDS] (4.D.1)	Increased efforts will be made for wetland conservation making sure existing wetlands are not drained and degraded.
Restoration of Wetlands (604)	CO_2, CH_4	Research, Planning, Fiscal	Implemented	WEM	Yes (4.D.2.3.3)	Efforts in wetland restoration will be increased as well as research on the effect of such measures on carbon emissions.
Improved Mapping of Grazing Land and Land Use (605)	CO_2, CH_4	Information, Research, Planning	Implemented	WEM	No	The state of grazing land will be mapped and used for grazing management.
Improvement Plan for the LULUCF Inventory (606)	CO_2, CH_4, N_2O	Research	Implemented	Not included in projections scenario	No	Increased capacity in the LULUCF inventory and increased research to improve the foundation for estimating emissions and sequestration from the LULUCF sector.

All of the PaMs in Table 9.7 will impact emissions and removals due to land use. Three of the PaMs; Enhanced Action in Forestry (601), Expanding Revegetation (602), and Restoration of Wetlands (604) have been quantified and are described in more detail in section 9.2. Additional information on the PaMs that have not been quantified (Wetland Conservation (603), Improved Mapping of Grazing Land and Land Use (605), and the Improvement Plan for the LULUCF Inventory (606)) is provided below. For more information, see the Climate Action Plan (2020) or the Progress Report (2022).

9.3.1 Enhanced Action in Forestry (601)

In the government's updated Climate Action Plan (Ministry for the Environment and Natural Resources, 2020) a great emphasis was placed on increasing carbon capture and storage in forests through afforestation. Forestry and afforestation were reinforced through increased government funding. A plan on afforestation was prepared on behalf of the government in line with the increased flexibilities afforded by higher financial contributions. Particular consideration was given to how sheep farmers and other farmers could be included in the afforestation efforts and other efforts that affect land use, in line with the provisions of the government's policy statement.

In the plan, afforestation was to increase from 1,100 ha in 2018 to 2,300 ha in 2022. These plans have been reiterated and enhanced in the fiscal policy of the government for the years 2021 to 2025 where afforestation is planned to increase to 2,500 ha annually in the year 2025 (Ministry of Finance and Economic Affairs, 2021, bls. 290).

Additional measures (WAM) were generated based on the current draft of the fiscal policy. The IFS predicts that the annual afforestation rate will increase from 2,500 ha to 5,000 ha annually in 2028. The main reason for this expected increase is a rapid increase in interest and participation by private entities to offset carbon footprints through validated and certified carbon credits.

The IFS has estimated how the government funding described above, in addition to increased private participation, will affect the future net annual emissions/removals of GHGs. The projected impacts are a more than doubling of annual afforestation from the year 2022 and a more than redoubled afforestation rate of expected measures in 2028.

By running a WOM scenario with an unchanged annual afforestation rate of 1,100 ha from 2022, the effect of the Climate Action Plan was estimated as shown in Figure 9.6.

Projected removals with expected measures (WEM) and additional measures (WAM) compared to projections without measures (WOM) are shown in Figure 9.6.

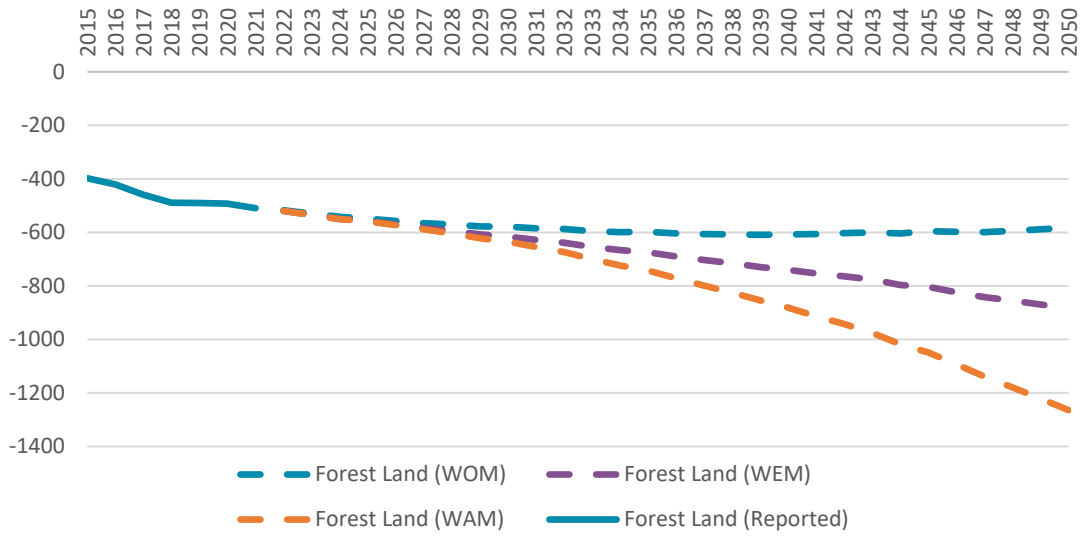

Figure 9.6.WOM, WEM and WAM projected net removals projections of Forest Land in the period 2022-2050. Reported net removals are shown in period 2015-2021, [kt CO_2e].

Table 9.9 WOM, WEM and WAM projected net removals of Forest Land values in the period 2025-2050 with reported values for 2015 and 2020, [kt CO_2e].

Enhanced Action in Forestry (4.A.)	2015	2020	2025	2030	2035	2040	2045	2050
Forest Land WOM (kt CO_2e)	-398	-493	-549	-579	-598	-607	-595	-584
Forest Land WEM (kt CO_2e)	-398	-493	-559	-615	-675	-740	-804	-883
Forest Land WAM (kt CO_2e)	-398	-493	-559	-635	-743	-882	-1049	-1264
Ex-ante emissions impact of PaMs WEM (kt CO_2e)	**0**	**0**	**-10**	**-36**	**-76**	**-133**	**-209**	**-299**
Ex-ante emissions impact of PaMs WAM (kt CO_2e)	**0**	**0**	**-10**	**-56**	**-145**	**-275**	**-454**	**-681**

9.3.2 Expanding Revegetation (602)

The goal of the measure is to promote increased soil reclamation to increase carbon sequestration from the atmosphere, stop soil erosion, and reduce greenhouse gas emissions from land. Soil reclamation will be supported to increase carbon sequestration from the atmosphere, reduce greenhouse gas emissions from land, and simultaneously support biodiversity. An emphasis will be placed on acting on land which is emitting carbon from the soil.

An extensive plan on improved land use in favour of climate change was presented in June 2019 (government of Iceland, June 2019). In addition to carbon sequestration the actions are meant to work against land degradation and to support biodiversity. According to the plan land reclamation should increase to 12,200 ha per year, starting from the 2022, without taking natural succession into account. The scope of the project "Farmers Heal the Land" *(Bændur græða landið)*[42] should have tripled and the scope of projects supported by the "Land Improvement Fund" (*Landbótasjóður*)[43] should have doubled.

A new action plan in favour of climate change was presented in August 2022 (Ministry of Food, Agriculture and Fisheries , 2022). The plan includes increased recovery of degraded grassland and other disturbed dry land and aims for the area of new recovery areas to be around 100 thousand ha in the period 2022-2031, of which around 70 thousand ha is eroded grassland.

Collaboration projects between the IFS and the SCSI will be reinforced, with an emphasis on reclaiming natural woodlands and heathland, such as in Hekluskógar. Land reclamation will be increased around the whole country and support for NGOs will be increased.

Figure 9.6 and Table 9.8 show projected WOM, WEM and WAM scenarios for carbon sequestration from soil conservation and land reclamation quantified by SCSI. The WOM scenario does not include PaMs defined by the Icelandic government. The WOM scenario is, therefore, based on the average annual ha restored during the revegetation activities that took place in the period 2017-2021 (Table 9.9**Error! Reference source not found.**). The WEM scenario is constructed based on projections which include PaMs defined in Land and life (2022), where land reclamation is planned to increase to 10,000 ha per year starting from the year 2022. The WAM scenario is generated on projections which include PaMs defined in the fiscal policy (2021-2023) where land reclamation should increase to 12,200 ha per year, starting from 2022 (Table 9.6).

[42] *Soil Conservation Service of Iceland (Landgræðslan).* https://land.is/heim/malaflokkar/baendur-graeda-landid/
[43] *Soil Conservation Service of Iceland (Landgræðslan).* https://land.is/heim/malaflokkar/landbotasjodur/

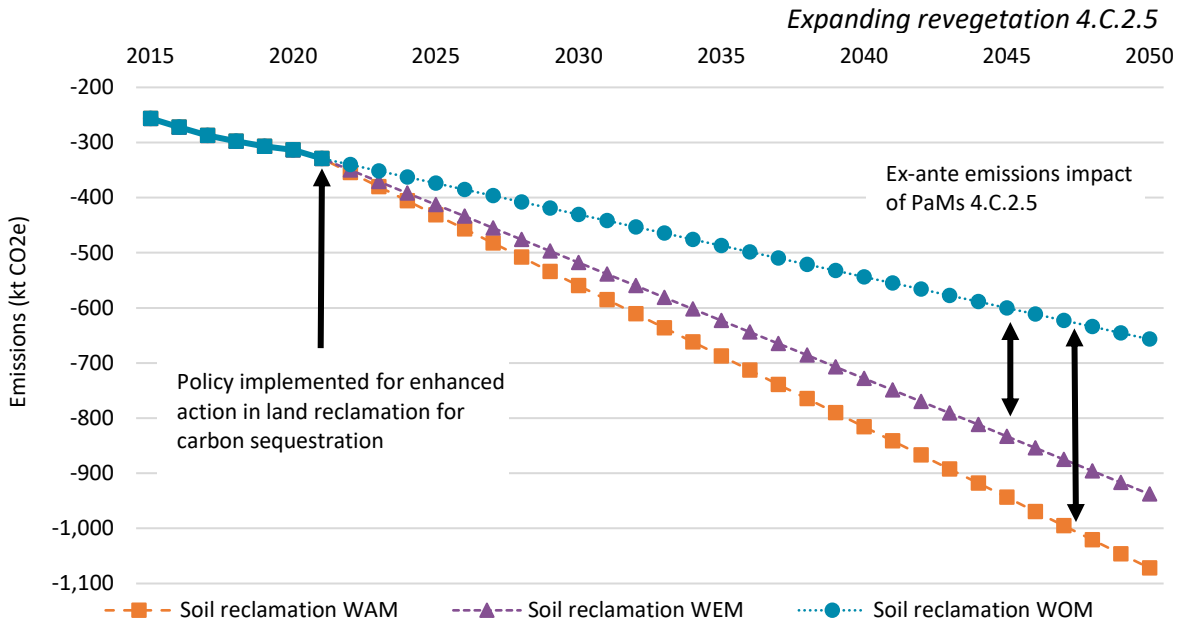

Figure 9.6 WOM, WEM WAM projected net emissions/removals trends through soil reclamation in the period 2015-2050 [kt CO_2e].

Table 9.8 WOM, WEM WAM projected net emissions/removals values through soil reclamation in the period 2015-2050.

Expanding revegetation 4.C.2.5	2015	2020	2025	2030	2035	2040	2045	2050
Soil reclamation WOM (kt CO_2e)	-256	-313	-374	-431	-487	-544	-600	-657
Soil reclamation WEM (kt CO_2e)	-256	-313	-413	-518	-623	-728	-833	-938
Soil reclamation WAM (kt CO_2e)	-256	-313	-431	-559	-688	-816	-944	-1,072
Ex-ante emissions impact of PaMs WEM (kt CO_2e)	**0**	**0**	**-39**	**-87**	**-136**	**-184**	**-233**	**-281**
Ex-ante emissions impact of PaMs WAM (kt CO_2e)	**0**	**0**	**-57**	**-129**	**-200**	**-272**	**-344**	**-415**

9.3.3 Wetland Conservation (603)

Law provisions on the protection of wetlands will be adhered to more strictly and monitoring of new draining will be increased further by requiring a construction permit from municipalities. The measure will be a collaboration project between farmers, landowners, municipalities, NGOs, companies, and others. Wetlands are protected by law. There is a major focus on reclaiming wetlands in Iceland and it is thus vital to prevent further draining of wetlands unless necessary.

Collaboration between farmer's associations, municipalities, and government organisations needs to be improved to ensure that the protection of wetlands is organised properly and that it will become the main rule that wetlands are protected instead of disturbed. The EAI and SCSI have been given the responsibility of proposing policies and measures to improve processes regarding this matter. Furthermore, the organisations will make proposals on how best to improve monitoring and data collection because of the measures which will be undertaken.

This measure has not been quantified separately but is included to different degrees in the WEM, WAM and WAM [WDS] projection scenarios. In the WEM and WAM scenarios, it is assumed that some

drainage of undisturbed wetlands will continue to take place, while in the WAM [WDS] scenario, it is assumed that draining of wetlands stops completely in 2022.

9.3.4 Restoration of Wetlands (604)

Wetland reclamation to reduce greenhouse gas emissions from land will be increased. Wetland reclamation will be supported, as well as research on the impact of wetland reclamation and the draining of wetlands on greenhouse gas emissions. The benefits of wetland reclamation are not only reduced greenhouse gas emissions from land, but also, for example, better water distribution and more diverse birdlife. In the first publication of the Climate Action Plan (Ministry for the Environment and Natural Resources, 2018) it was put forward that an extensive effort is required to restore wetlands, birch forests and scrubland, stop soil erosion and support further soil reclamation and afforestation in Iceland. Subsequently, the MEEC trusted the task of implementing this extensive effort to the IFS and the SCSI, in close collaboration with the Ministry.

An extensive plan on improved land use in favour of climate change was presented in June 2019. The plan spans four years and actions described in it have already been started correspondingly. According to the plan, wetland reclamation should be increased to 610 ha starting from 2022. This will be done through the project “Wetland Reclamation” (“*Endurheimt votlendis*”), run by the SCSI.

According to the 2023 NIR submission 351,446 hectares of wetlands have been drained in Iceland since the latter half of the last century until the present day. This constitutes approximately 36% of all wetlands in Iceland. This proportion is much higher in the lowlands than the highlands. The goal of the project “Wetland Reclamation” is to support the reclamation of previously drained wetlands.

Figure 9.7 and Table 9.9 WOM, WEM WAM projected net emissions/removals values through the recovery of wetlands in the period 1990-2050, [kt CO2e]. show projected WOM, WEM and WAM scenarios for carbon storage from the recovery of wetlands quantified by SCSI. The WOM scenario does not include policies and measures defined by the Icelandic government. The WOM scenario is, therefore, based on the average of ha restored during the revegetation activities that took place in the period 2017-2021 (**Error! Reference source not found.**Table 9.6). The WEM scenario is instead c onstructed based on projections which include PaMs defined in the fiscal policy (2021-2023), where recovery of wetlands is planned to increase to 610 ha per year from the year 2022. The WAM scenario is generated based on projections which include PaMs defined in the Land and life plan (Ministry of Food, Agriculture and Fisheries , 2022), consisting of an increase in wetlands restoration to 1,060 ha per year during the period 2022 – 2026. From 2027, wetland restoration should increase to 2,060 hectares per year ().

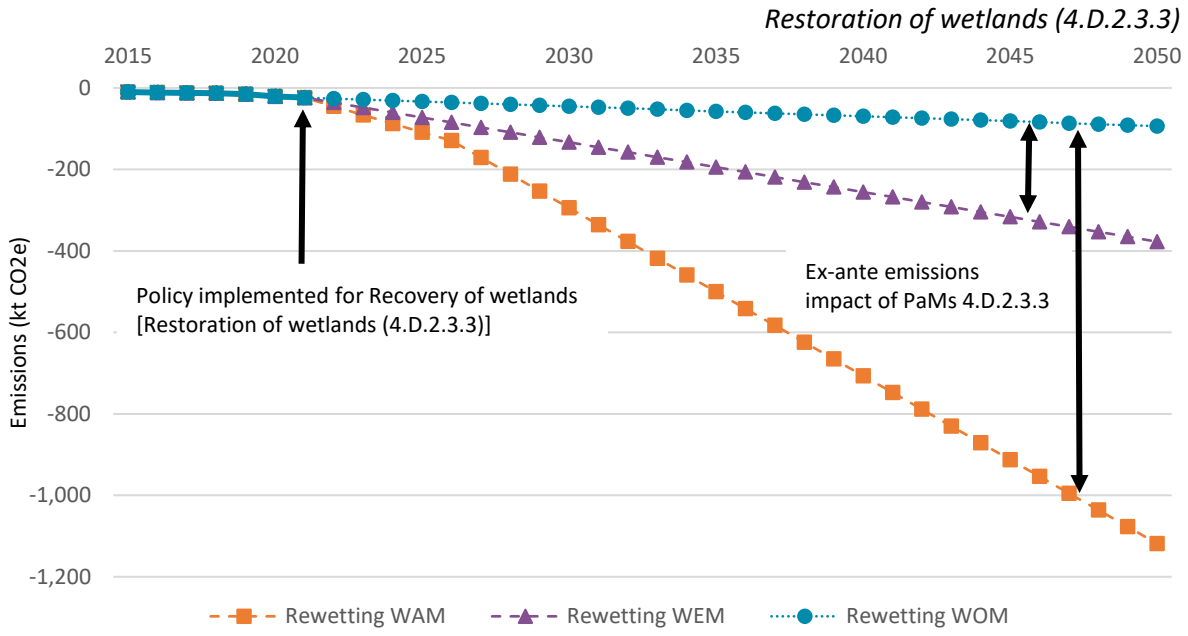

Figure 9.7 WOM, WEM WAM projected net emissions/removals trends through the recovery of wetlands in the period 2015-2050, [kt CO_2e].

Table 9.9 WOM, WEM WAM projected net emissions/removals values through the recovery of wetlands in the period 1990-2050, [kt CO_2e].

Restoration of wetlands (4.D.2.3.3)	2015	2020	2025	2030	2035	2040	2045	2050
Rewetting WOM (kt CO_2e)	-10	-21	-33	-45	-57	-70	-82	-94
Rewetting WEM (kt CO_2e)	-10	-21	-72	-133	-194	-255	-316	-377
Rewetting WAM (kt CO_2e)	-10	-21	-108	-294	-500	-706	-912	-1,118
Ex-ante emissions impact of PaMs WEM (kt CO_2e)	**0**	**0**	**-39**	**-88**	**-137**	**-186**	**-235**	**-284**
Ex-ante emissions impact of PaMs WAM (kt CO_2e)	**0**	**0**	**-75**	**-249**	**-443**	**-637**	**-831**	**-1,025**

9.3.5 Improved Mapping of Grazing Land and Land Use (605)

Holistic mapping of the condition of grazing land and its use needs to be undertaken in order to evaluate the sustainability of current land use practices. The condition of the flora and soils on grazing land in Iceland have been mapped out. The goal was to perform such a complete mapping of the condition of grazing land regularly and develop sustainability indicators for the utilisation of the flora and soil resources of the country. The aim is for the result to be useful to manage grazing of land so that it ensures the protection of carbon in soils and flora and encourages increased carbon sequestration where carbon has been lost. The mapping occurs based on the project *GróLind*. The first part of the project has been to set up monitoring systems for the vegetation cover of land. Pastures have among others been mapped and a first edition of the mapping of grazing land was published in June 2020[44]. A draft report on the status of soils and flora in Iceland was published at the same time[45].

[44] *Grólind*. https://grolind.is/wp-content/uploads/2020/06/Kortlagning-beitilanda-2020.pdf
[45] *Grólind*. https://grolind.is/wp-content/uploads/2020/06/GroLind_stodumat_18_06_2020.pdf

The project is based on the collaboration between the SCSI, the Sheep Farmers Association, the IFS, and the MFAF. It is financed through agricultural contracts, although the SCSI takes care of its execution. The purpose is, among others, to better support the science behind grazing management to ensure that grazing remains sustainable into the future. Knowledge gained from this effort will be useful as a basis for the future strategic planning efforts in farming and farming land use, as well as other work that relates to land use. Changed land use can be a significant measure to improve the condition of the land.

9.3.6 Improvement Plan for the LULUCF Inventory (606)

The aim of this measure is to improve the capacity in the LULUCF inventory and increase research to improve the premise for estimating emissions and sequestration from the LULUCF sector. An improvement plan, published in 2021[46], for the period 2020 to 2023, containing 20 improvement actions is ongoing. The goal of the plan is to strengthen the NIR and to ensure that Iceland fulfils its obligations to the UNFCCC and EU. A new improvement plan for the period 2024 to 2026 has already been drafted and it will be published in the end of 2023.

9.4 Sensitivity Analysis

9.4.1 Biomass Removals of Forest Land

Forest Land has two categories, Forest Land Remaining Forest Land (FrF) and Land Converted to Forest (LcF). The main sink of CO_2 is the gain of biomass in the Cultivated Forest (CF) with reported value -295 kt of CO_2 in the year 2020. The projections for the biomass gain of the CF were done by a biomass growth model considering differences in the growth of tree species with age and harvest intensity same as historical (1996-2020). The model did simulate biomass gain of the CF well, but the level of the model output was adjusted/calibrated by the ratio of modelled versus reported figures for the historical period of 2007-2020 that turned out to be 0.85. Secondly, the model was adjusted to the reported value of 2020, which is the second latest reporting year with a more accurate estimate than the latest reporting year of 2021. The average adjustment rate for the whole prediction period (2022-2050) was 1.11. Both steps give an average adjustment rate of modelled biomass gain of 0.94. Different predictions with and without calibration is shown in Table 9.10 and Figure 9.8 below. The WEM scenario with calibration was used for the projections.

Table 9.10 Sensitivity analysis results showing the effects of the calibration on removals of biomass gain of Cultivated forest of the Forest Land category, [kt CO_2e].

Scenario	2022	2025	2030	2035	2040	2045	2050
WEM with calibration [kt CO_2e]	-317	-341	-378	-412	-454	-507	-579
WEM without calibration [kt CO_2e]	-331	-357	-396	-432	-478	-550	-644
Difference [kt CO_2e]	14	17	18	19	24	42	64
% Difference	4%	5%	5%	5%	5%	8%	11%

[46] Improvement plan for the LULUCF inventory 2020-2023 (Umbótaáætlun 2020-2023 - Vegna bókhalds Íslands um losun gróðurhúsalofttegunda og bindingu kolefnis vegna landnotkunar). *Government of Iceland (Stjórnarráð Íslands).* https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Umb%C3%B3ta%C3%A1%C3%A6tlun%202020-2023.pdf

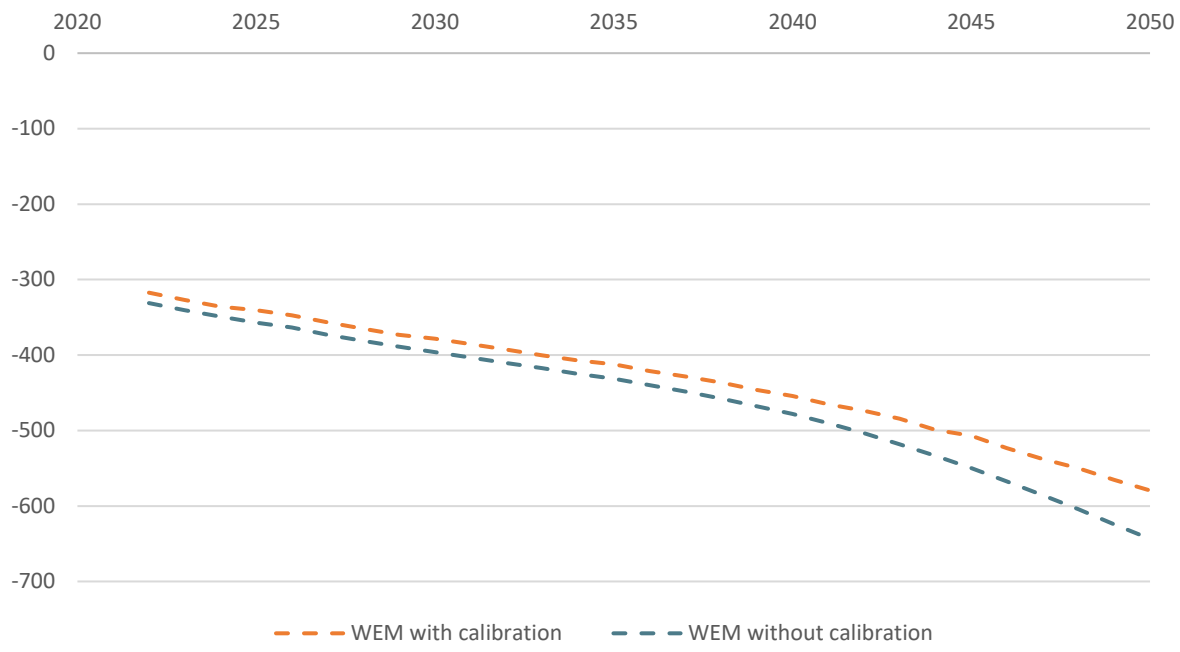

Figure 9.8 Prediction of the development of removals of biomass gain in Cultivated forest for WEM-with-calibration and WEM-without calibration scenarios, [kt CO_2e].

9.5 Stakeholder Engagement

In 2022, a new Working Group on Climate Action in Agriculture and LULUCF was established by the MFAF, with the goal of improving and strengthening climate mitigation PaMs in these sectors. The working group has representatives from the SCSI, IFS and EAI, as well as the MEEC, the Agricultural University of Iceland, the Farmer's Association of Iceland and the Icelandic Agricultural Advisory Centre. The representatives from the SCSI and IFS have communicated and discussed the information on LULUCF PaMs and projections provided in this report to the group.

10 Waste

This sector includes emission projections from Solid Waste Disposal (5A), Biological Treatment of Solid Waste (5B), Incineration and Open Burning of Waste (5C), and Wastewater Treatment and Discharge (5D).

For most of the 20th century, Solid Waste Disposal Sites (SWDS) in Iceland were numerous, small, and located close to the locations of waste generation. In 1991, the SWDS Álfsnes was opened, which is currently the biggest SWDS in Iceland and is serving the Capital Region, where approximately two thirds of the population of Iceland lives. A new biogas and composting plant called GAJA has been built at Álfsnes and started operating in the second half of 2020. According to the operation permit[47] issued by the EAI, the plant is expected to turn up to 30-40 kt of waste into compost and methane gas annually. The methane will mostly be used as fuel for vehicles, and therefore the emissions from methane produced in GAJA is included in the Road Transport sector (see section 6). There was a trial to produce electricity from the recovered methane, but this could not compete with the cheaper electricity production from geothermal or hydropower plants, so the methane is mostly used for vehicle fuel. Other plans to utilise the methane produced in GAJA include asphalt production, where it would be replacing diesel oil, and coffee roasting, where it would be replacing propane gas[48].

Until the 1970s, the most common form of waste management outside the Capital Region was open burning of waste. However, this practice was banned in 1999 and is non-existent today. In the beginning of 2012, a total of four waste incinerators were operating. However, by the end of 2012 all incineration plants except one (Kalka) had closed; therefore, emissions from the single plant are reported from 2013. Kalka mostly handles mixed general waste from the four municipalities that own it and from Iceland's main international airport. To a smaller extent it handles clinical waste, hazardous waste, slaughterhouse waste, and other waste categories.

Biological treatment of waste started in the 1990s and has increased slowly but steadily since then.

In the early 1990s only a small percentage of reported waste was recycled or reused. Their share of total waste management increased steadily since then and has been around 80% for the last five years. However, the total reported waste amounts in the last five years are also 3-4-fold compared to the 1990 amount.

Wastewater treatment in Iceland consists mainly of basic treatment with subsequent discharge into the sea. In recent years, more advanced wastewater treatments have been commissioned in some smaller municipalities, but their share of total wastewater treatment systems in Iceland does not exceed 2% of domestic wastewater and 9% of industrial wastewater.

The projections performed for the sector include only a WEM scenario. There is currently not enough data on additional PaMs available to perform projections for a WAM scenario.

10.1 Methodology of Projections

The methodology used to generate projections for the Waste sector is based on the historical inventory. Please refer to the latest edition of the NIR where information about activity data and emission factors is collected. Only a WEM scenario has been calculated for the entire Waste sector, no

[47] *EAI*. https://ust.is/library/sida/atvinnulif/starfsleyfi-og-eftirlitsskyrslur/Starfsleyfi%20undirrita%c3%b0.pdf, in Icelandic
[48] *Sorpa*. https://www.sorpa.is/frettir/malbikstodin-og-sorpa-undirrita-viljayfirlysingu-um-kaup-a-metani, https://www.sorpa.is/frettir/sorpa-og-te---kaffi-undirrita-samning-um-kaup-a-metani, in Icelandic

data on WAM PaMs was available to calculate a WAM scenario. Only for the sectors Solid Waste Disposal (5A) and Biological Treatment of Solid Waste (5B) a comparison between WOM and WEM was carried out (Figure 10.4).

10.1.1 Data and Assumptions

An overview of the data and assumptions used as a basis for the Waste projections can be found in Table 10.1. A further description is provided below.

Table 10.1 Activity data basis for Waste projections.

Waste	Basis for Projections
5A Solid Waste Disposal	Population projections (Statistics Iceland), methane recovery projections from stakeholders, waste export plans of Iceland's largest waste management company and the plans of almost only landfilling inert waste at the SWDS Álfsnes after 2023. National plan to collect separately: food waste, paper, and plastics. Ban on landfilling separately collected waste. Allocation based on mass balance and average past allocations taking export plans and separate collection into account.
5B Biological Treatment of Solid Waste	Mass balance allocation, which is coupled to projections for 5A, data from the first years of operation (2020 and 2021) and the operation permit of the gas and composting plant, GAJA, methane collection communicated by operating company.
5C Incineration and Open Burning of Waste	Operation permit of incinerator
5D Wastewater Treatment and Discharge	Population projections (Statistics Iceland) and projections for fish processing in Iceland
5E Other (please specify)	Not relevant in Iceland

Waste management in Iceland is changing drastically, which mainly affects subcategories Solid Waste Disposal (5A) and Composting (5B1). The largest landfill site in Iceland, Álfsnes, intends to mostly landfill inert waste after the year 2023, though some burnable waste might be landfilled as well. This will be accomplished by exporting all mixed waste abroad for incineration with energy recovery, diverting separately collected organic household waste to the gas and compost plant GAJA, and other organic waste not suitable for composting to incineration or meat meal and fat production.

Alongside these changes, a ban on landfilling separately collected waste, was enacted on 1 January 2023. Unfortunately, most municipalities were not ready to implement the ban at that time, so the effects of the ban will probably only be slightly visible until 2024. This ban will move more organic waste to composting.

The effects of the separate collection of food waste from homes will depend on people's participation. As a first assumption the food waste in the mixed household waste is estimated to decrease by 30% and that number is increased by 1% a year. This assumption will be used until real data is available.

Slaughterhouse waste is also not supposed to be landfilled. However, because of a lack of other treatment pathways, it is assumed in the projections that part of it will have to be landfilled.

The projections for the subcategories Anaerobic Digestion at Biogas Facilities (5B2) and Incineration and Open Burning of Waste (5C) are based on operation permits as well as communications between the EAI and the companies in question regarding planned operation into the future.

The category Wastewater Treatment and Discharge (5D) is mostly based on the projection of population numbers. However, the methane emissions from Industrial Wastewater (5D2) are based on projections of fish processing in Iceland.

In Waste there are two calculated scenarios, WOM and WEM. The same approach is used for emission calculations in both scenarios. However, the scenarios differ in input data assumptions, as shown in Table 10.2. The WOM scenario does not include the gas and compost plant, GAJA, nor the ban on landfilling organic waste. In the WOM scenario, the waste amount going to SWDS until 2050 is estimated by correlating historical waste amounts going to SWDS, as reported in the NIR (2012-2021), with population projections. A population projection until the year 2060 was made available by Statistics Iceland. Waste amounts going to anaerobic digestion is kept zero throughout the projected period.

The waste amounts going to SWDS according to the WOM scenario are used as input into the WEM scenario. The WEM scenario's projected waste amounts going to SWDS are estimated by assuming a 30% decrease of food waste in mixed waste as a result of the ban of landfilling separately collected waste and organic waste going to GAJA (5B2) and mixed waste exported abroad from the capital area is subtracted. The remaining difference between the WOM and WEM scenario amounts, including exported waste and amounts going to anaerobic digestion (5B2), are added to the WOM scenario amount for composting (5B1) to create the composting amounts used in the WEM scenario.

A graphical representation for the WEM scenario waste allocation, excluding reused, recycled and exported waste, which falls outside the scope of these projections, is given in Figure 10.1. Allocation of generated waste to the subcategories is as reported in Table 10.4. Application of greenhouse calculations is according to the approach described in the latest National Inventory Report; the same parameters and emission factors are applied throughout the whole projected time series 2022-2050.

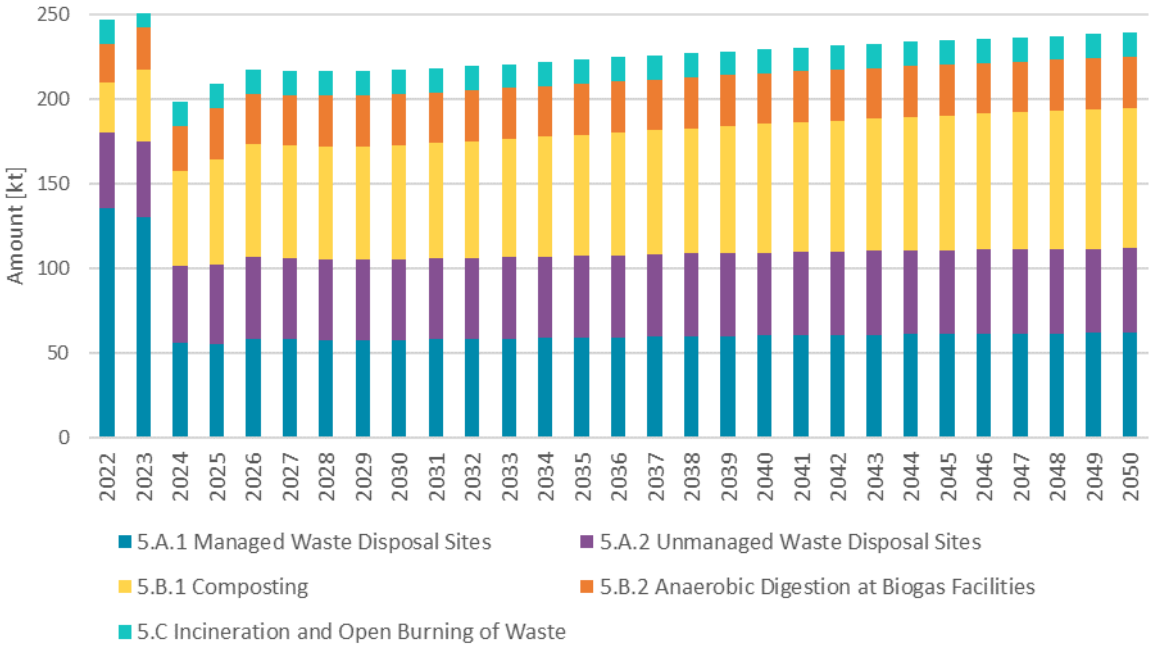

Figure 10.1 Waste allocation to different waste disposal streams following the basis for projections in Table 10.1. The decrease due to the closure of the SWDS Álfsnes is clearly visible in the first years of prediction.

Table 10.2 Waste allocation for each waste subsector in the WOM and WEM scenarios.

	WOM	WEM
5.A.1 Solid Waste Disposal Managed	The amount of waste landfilled in managed landfills the last 10 years is used as the basis for the projections and population projections are used as a proxy dataset.	The WOM waste allocations are taken as the baseline and the WEM allocations are formed by taking into account the waste export plans of Iceland's largest waste management company and the plans of mostly landfilling inert waste at the SWDS Álfsnes after 2023. Alongside, the National plan to collect separately: food waste, paper, and plastics and the ban on landfilling separately collected waste. The created difference in food waste amount by the separate collection is allocated to 5B.
5.A.2 Solid Waste Disposal Unmanaged	The amount of waste landfilled in unmanaged landfills the last 10 years is used as the basis for the projections and population projections are used as a proxy dataset.	The WOM waste allocations are taken as the baseline and the WEM allocations are formed by taking into account the National plan to collect separately: food waste, paper, and plastics and the ban on landfilling separately collected waste. The created difference in food waste amount by the separate collection is allocated to 5B.
5.B.1 Composting	The amount of waste composted the last 10 years is used as the basis for the projections and population projections are used as a proxy dataset.	The created difference in food waste amount by the separate collection is added the 5B WOM scenario amounts.
5.B.2 Anaerobic Biodigester	Not included	Start of operations in the second half of 2020 according to operation permit[49] (action **504**) which contains data of stepwise increase of allocated waste.
5.C Incineration and Open Burning of Waste	Use of total capacity of the only incinerator present in the country according to operation permit[50]	Same as WOM scenario

10.2 Emission Projections

10.2.1 WEM scenario

Historically, 80-90% of GHG emissions from the Waste sector in Iceland have come from Solid Waste Disposal (5A). In recent years, the emissions from SWDS have been decreasing due to reduced landfilling and increased methane collection. The projected total emissions from the Waste sector show a decrease until 2050 (-51% compared to 2015 emissions), predominantly due to the imminent closure of the SWDS Álfsnes and two major policies and measures which have been quantified in the current report (507, GROUP 501&504). The historical and projected emissions are reported in Table 10.3.

Figure 10.2 reports the emission trends for all Waste subsectors. The emissions from Solid Waste Disposal (5A) are projected to decrease rapidly until 2028, after which they will decrease more slowly until 2050. The decrease until 2028 is driven by the decision to export all mixed waste from the capital area for incineration abroad, to almost landfill inert waste only at Álfsnes after 2023, as well as the

[50] *EAI*. https://www.ust.is/atvinnulif/mengandi-starfsemi/starfsleyfi/urgangur-og-efnamottaka/sudurnes/kalka-sorpeydingarstod-adur-sorpeydingarstod-sudurnesja/

increased operation of the new gas and composting plant, GAJA (see PaM 504), and the subsequent ban on landfilling organic and biodegradable waste (see PaM 501). These actions will decrease the amount of waste that is landfilled. During that time, there is also a steady methane recovery from the landfill sites. These two factors (less waste and high methane recovery) coupled together cause the steep decrease in emissions from solid waste disposal.

After 2028, there is a slower decrease in emissions due to a rapidly decreasing methane recovery from the two largest SWDS, as less methane is produced there. However, lower amounts of organic waste landfilled will lead to lower emissions further along the projected timeline.

Figure 10.2 shows historical and projected emissions from the Waste sector, and Figure 10.3 shows historical and projected emissions from the Waste sector excluding emissions from Solid Waste Disposal (5A). Emissions from Biological Treatment of Waste (5B) are projected to increase due to the addition of GAJA and an increase in composting. The small step change between 2019 and 2020 is due to the beginning of operations at GAJA, which began operating at a small scale in the second half of 2020. The plant was unable to operate fully in 2021, and consequently the expected step wise increase in its operational scale was delayed slightly. From 2025 the plant is expected turn 30 kt of waste into compost and methane gas annually.

In Iceland, only one incineration plant is operative, and no additional plants are expected to be built during the projected timeline. The current incineration plant is already running at full capacity. Therefore, it is expected that the emissions in the subcategory Incineration and Open Burning of Waste (5C) will be stable over the projected timeline. The emissions of Wastewater Treatment and Discharge (5D) are projected to slightly increase in accordance with the expected increase in population.

Table 10.3 Total historical and projected emissions Waste emissions in the WEM scenario 1990-2050, [kt CO_2e].

Sector	1990	2015	2020	2025	2030	2035	2040	2045	2050
5A Solid Waste Disposal	168	224	208	172	150	140	127	117	110
5B Biological Treatment of Solid Waste	NO	3.7	5.6	12	13	13	14	15	15
5C Incineration and Open Burning of Waste	16	7.6	7.0	7.9	7.9	7.9	7.9	8.1	8.3
5D Wastewater Treatment and Discharge	60	55	46	51	52	53	54	54	55
5E Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO
5 Waste	**244**	**290**	**266**	**243**	**223**	**214**	**203**	**194**	**189**

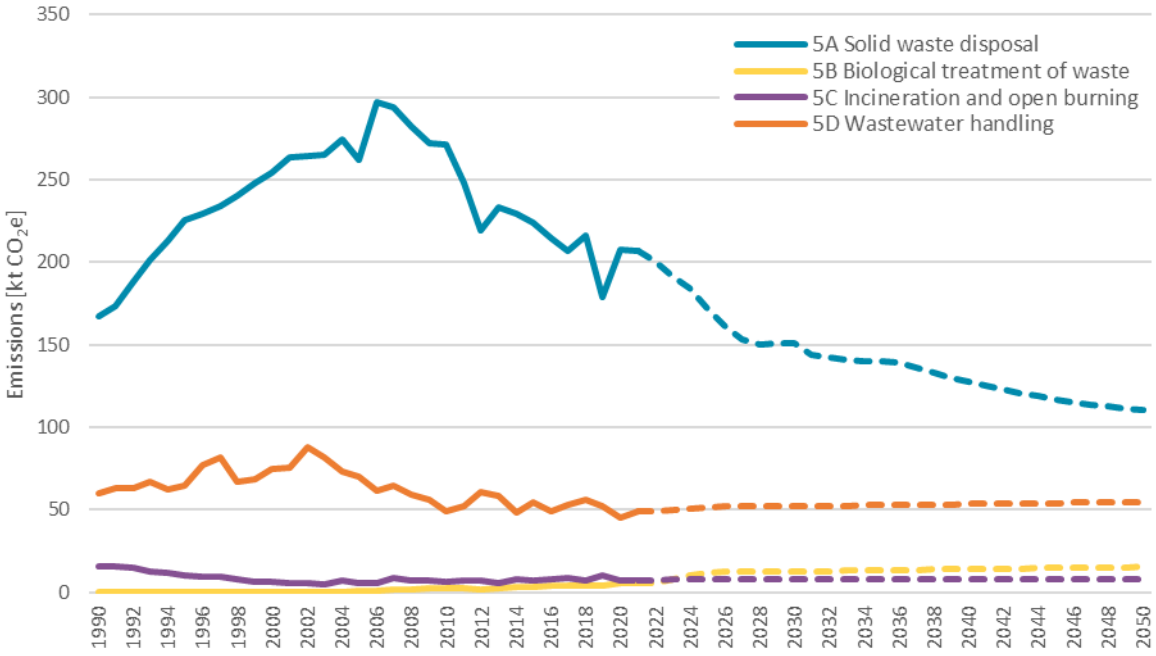

Figure 10.2 Total historical and projected Waste emissions in the WEM scenario 1990-2050, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

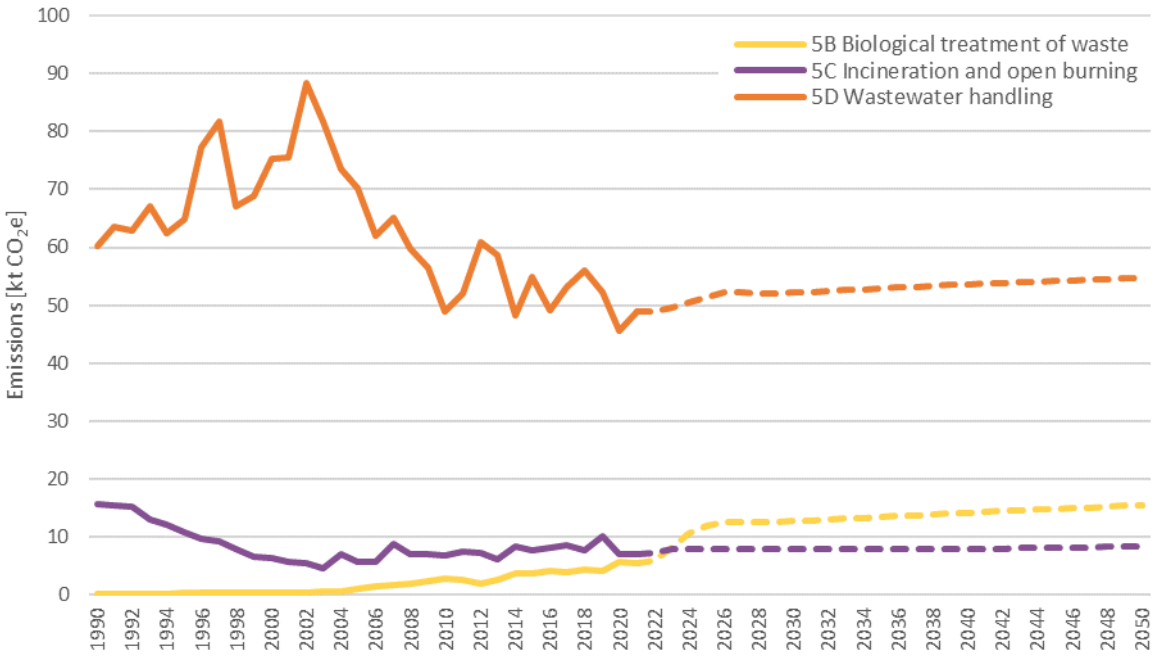

Figure 10.3 Historical and projected Waste emissions excluding 5A Solid Waste Disposal Sites in the WEM scenario 1990-2050, [kt CO_2e]. Unbroken lines represent historical emissions, broken lines projected emissions.

10.2.2 WAM scenario.

There are currently no WAM PaMs that can be quantified in this sector and, therefore, the WEM and WAM scenarios are identical.

10.3 Policies and Measures

Five waste management PaMs are currently implemented or planned with the objective of reducing GHG emissions and are summarised in Table 10.4

Table 10.4 Waste Policies and Measures.

PaM Name	GHG	Instrument type	Status	Scenario	Ex-ante	CRF	Description
Ban on landfilling of organic waste (501)	CH_4	Regulatory	Adopted	WEM	Yes (507)	5A	Landfilling of separately collected organic waste will be banned from 2023 and a ban on landfilling all biodegradable waste will be added at a later date, assumed to start from 2025.
Landfill tax (502)	CH_4	Economic, Regulatory	Planned	Not included	No	5A	Greenhouse gas emissions from landfills will be reduced with the application of a tax on landfilling.
Reduction in food waste (503)	CH_4	Fiscal	Adopted	Not included	No		Various projects will be conducted with the aim of reducing food waste.
Gas and compost plant (504)	CH_4	Other	Implemented	WEM	Yes (507)	5B	A new gas and composting plant GAJA started operating at Iceland's largest landfill site in 2020.
Pay-as-you-throw system (505)	CH_4	Economic, Regulatory	Adopted	Not included	No		Local authorities are obliged to collect a fee as close as possible to the actual cost of waste treatment.
Extended manufacturer's warranty (506)	CO_2, CH_4	Economic, Regulatory	Adopted	Not included	No		Extended manufacturer's warranty on all packaging and many plastic products.
No landfilling of organic waste (507, GROUP 501&504)	CH_4	Regulatory, Other	Implemented	WEM	Yes	5A, 5B	No landfilling of organic waste due to a ban on landfilling of organic waste (501), gas and compost plant (504) and the expiration of the SWDS operation permit.

Three PaMs are from the 2020 Action Plan (501, 502 and 503) and two are from the waste strategy, *Towards a Circular Economy*, from 2021 (Ministry for the Environment and Natural Resources) (505 and 506). The measures listed here from the Action Plan, and many others, are also included in the waste strategy. Twelve measures from the waste strategy were incorporated into legislation in 2021 with an amendment to Act No 55/2003 on Waste Management [51]. Most of them aim to decrease waste production and improve sorting, which will in turn decrease greenhouse gas emissions.

The ban on landfilling of organic waste (501) and the gas and compost plant (504) are included in the projected WEM scenario for the Waste sector and have been quantified together as a group (507).

Currently, methane is processed at two landfill sites in Iceland by Sorpa and Norðurorka, and the resulting fuel is mainly used for passenger cars. Two other sites collect and flare landfill gas. More

[51] *Parliament (Alþingi).* https://www.althingi.is/lagas/nuna/2003055.html

detailed descriptions of these planned PaMs can be found in the sections below, in the Climate Action Plan (Ministry for the Environment and Natural Resources, 2020), the Progress Report (Ministry of the Environment, Energy and Climate, 2022) and in Towards a Circular Economy (Ministry for the Environment and Natural Resources, 2021).

10.3.1 Ban on Landfilling of Organic Waste (501)

The measure has been expanded upon since the first edition of the Climate Action Plan (Ministry for the Environment and Natural Resources, 2018) and is now an individual measure. The measure is twofold. The first part announces a separate collection of bio waste and a ban on landfilling any waste that has been collected separately. Bio waste contains food-, kitchen- and garden waste which can biodegrade. The second part declares that landfilling all biodegradable waste will be banned in Iceland as a main rule. The first part of the measure is implemented from 1 January 2023, according to an amendment in 2021 to Act No 7/1998 on Public Health and Pollution Control and Act No 55/2003 on the Treatment of Waste[52]. However, since the communities around Iceland were mostly not ready for this change, a nationwide separate collection of food waste will probably not be afoot until late 2023 or early 2024.

The measure is meant to lead to the sorting of bio waste from other waste in the whole country and it being prepared for reuse or recycling, in line with how the treatment of waste is prioritised. In the capital area, bio waste will be partly diverted to the gas and composting plant GAJA, but in rural areas it is more likely that bio waste will be used for composting as a rule. The measure also includes banning the landfilling of biodegradable waste, though that regulation has not been approved yet by the Icelandic parliament. Biodegradable waste contains all waste that can decompose through the agency of microorganisms, such as waste from slaughterhouses, fishing, breweries, domestic animals, timber, fish oil, paper, sewage, and bio waste. Local authorities will also be obliged to set up a separate collection of household waste, which shall cover at least paper and cardboard, metals, plastics, glass, organic waste, textiles, and hazardous waste. Individuals and legal entities will be required to sort household waste. A general prohibition will be on landfilling or incineration of the types of waste that have been collected separately, except for waste residues that are not suitable for reuse or recycling.

10.3.2 Landfill Tax (502)

This measure has been expanded since the first Climate Action Plan (Ministry for the Environment and Natural Resources, 2018) and defined as an individual measure. Waste sent to landfills will be taxed, to direct it to other treatment pathways which release less GHG emissions. The purpose of the tax is to encourage a decrease in the amount of waste that is currently sent to landfill in Iceland. The aim of the tax is to decrease total waste generation as well as encourage sorting. It is proposed that the tax should be 15 ISK/kg of landfilled general waste, with the exception of inert waste for which 0.5 ISK/kg of landfilled waste is proposed. The Ministry of Finance and Economic Affairs is currently collaborating with the Ministry of the Environment, Energy, and Climate on a bill to change the law on environmental and resource taxes, under which the tax on landfilling waste will be legislated. The Association of Icelandic Local Authorities will be consulted on the issue.

The landfill tax (502) measure has not been implemented yet in the legislative system and is also not quantifiable due to a lack of data, thus, it is not included in the WEM or WAM projections scenarios.

[52] *Parliament (Alþingi)*. https://www.althingi.is/altext/stjt/2021.103.html

10.3.3 Reduction in Food Waste (503)

The goal of this measure is to systematically reduce food waste by encouraging several short-term and long-term projects. In the past years, several projects have been undertaken by the government, NGOs, and companies to reduce food waste, such as the creation of various educational material, the organisation of events to raise public awareness, school projects and discount systems in stores for food products that are nearing the expiration date, innovation in using by-products from food production, a defined government policy, and courses on the better use of food products.

The EAI will continue to raise awareness on how much food is currently going to waste, education on food waste received 15 million ISK per year in funding in 2020-2023. The continued running of the Icelandic website on food waste[53] will be ensured and an analysis will be undertaken of possible unnecessary regulatory requirements on food products that have no impact on food safety but may be causing food waste. A survey on Icelanders' attitudes towards food waste has been undertaken to track changes in local public opinion. Additionally, the EAI is currently conducting an investigation into food waste in the Icelandic food value chain, as requested by regulation 2008/98/EU, to be better able to reduce food waste in the value chain. The results should be published in August 2023.

The Minister of the Environment and Natural Resources formed a project team on food waste to create a holistic plan on effective measures against food waste. The team (which consists of representatives from consumers, the business sector, NGOs, young people, and the government) submitted a report including 24 proposed food waste reduction measures in June 2020[54]. Out of the propositions, the government will be responsible for implementing 14 of the measures and the business sector will be responsible for the remainder. The goal is to reduce food waste throughout the entire value chain by 30% in 2025 and by 50% in 2030.

The measures to reduce food waste (503), the pay-as-you-throw system (505), and the extended manufacturer's warranty (506) have been adopted. However, since very limited data is available on the effectiveness of such measures in Iceland, their potential impacts on emissions have not been estimated nor included in the WEM scenario projections.

10.3.4 Gas and Compost Plant (504)

A new gas and composting plant, GAJA, started operating at a small scale in the second half of 2020. It is the first plant of its kind in Iceland, and it will process municipal solid waste from households from the entire Capital Region, which contains around two thirds of Iceland's population. From 2025, the plant should process 30 kt of organic waste every year (max capacity: 40 kt, of which 10 kt is liquid waste) and produce 10 to 12 kt of compost and 850,000 Nm^3 of CH_4 each year.

10.3.5 Pay-as-you-Throw System (505)

Local authorities will be obliged to collect a fee for waste treatment as close as possible to the actual cost of the service in question, e.g., by targeting the amount of waste, type of waste, frequency of discharge, waste disposal or other factors affecting the cost of waste treatment. At the same time, municipalities will be allowed to transfer real costs between waste categories in order to promote a circular economy. In this way, municipalities could encourage increased recycling by transferring the

[53] *Food Waste (Matarsóun).* https://samangegnsoun.is/matarsoun/

[54] Proposals for actions against food waste ("Tillögur um aðgerðir gegn matarsóun"). *Food Waste (Matarsóun)*. https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Minni%20matars%C3%B3un%20-%20A%C3%B0ger%C3%B0a%C3%A1%C3%A6tlun%20gegn%20matars%C3%B3un.pdf

costs of collection and other treatment of recyclables to charging for the treatment of mixed waste. If a waste holder reduces his waste volume or sorts it properly, it will lead to a lower cost for him. This measure is included in an amendment in 2021 to Act No 7/1998 on Public Health and Pollution Control and took effect in January 2023.

10.3.6 Extended Producer's Responsibility (506)

In January 2023, an extended manufacturer's warranty was introduced to all packaging that is not already under extended manufacturer's warranty, as well as on many other plastic products. These new items are, e.g., glass and metal packaging not intended for beverages, all timber packaging, and single-use plastics.

10.3.7 No Landfilling of Organic Waste (507, GROUP 501&504)

There are two quantifiable PaMs included in the Waste sector which are the new biogas and composting plant (504) and the ban on landfilling of organic waste (501). As these two PaMs are linked, e.g., organic waste which cannot be landfilled anymore due to the ban needs to go to the anaerobic digester; the effect of both measures was calculated together as a group (507). The closing of the SWDS Álfsnes is included in them WEM scenario and not in the WOM scenario since it is coupled with measure 501. Though the main reason for the closure is that the municipality closest to the site is not willing to extend the SWDS' operation permit in the form it is now, it is likely that a new SWDS would have been established if the ban would not be in place.

At all times we make sure that projections are in harmony with the mass balance and treatment pathway/plant capacities. Methane production data is obtained from GAJA and is, alongside GAJA's operation permit, used to estimate the future methane emissions from GAJA.

The comparison between the WOM and WEM scenarios is best seen in Figure 10.4, where the changes for category 5A Solid Waste Disposal Sites and 5B Biological Treatment of Solid Waste is reported in separate graphs. While the emissions in 5A show a significant decrease by 2050 (173 kt CO_2e lower than the WOM scenario emissions in 2050), the emissions in 5B increase, due to increased composting and the addition of GAJA. The increase in this category, however, is rather limited (+6 kt CO_2e by 2050 when compared with the WOM scenario). Table 10.5 reports the emissions decrease and increase for both categories over the projected time series.

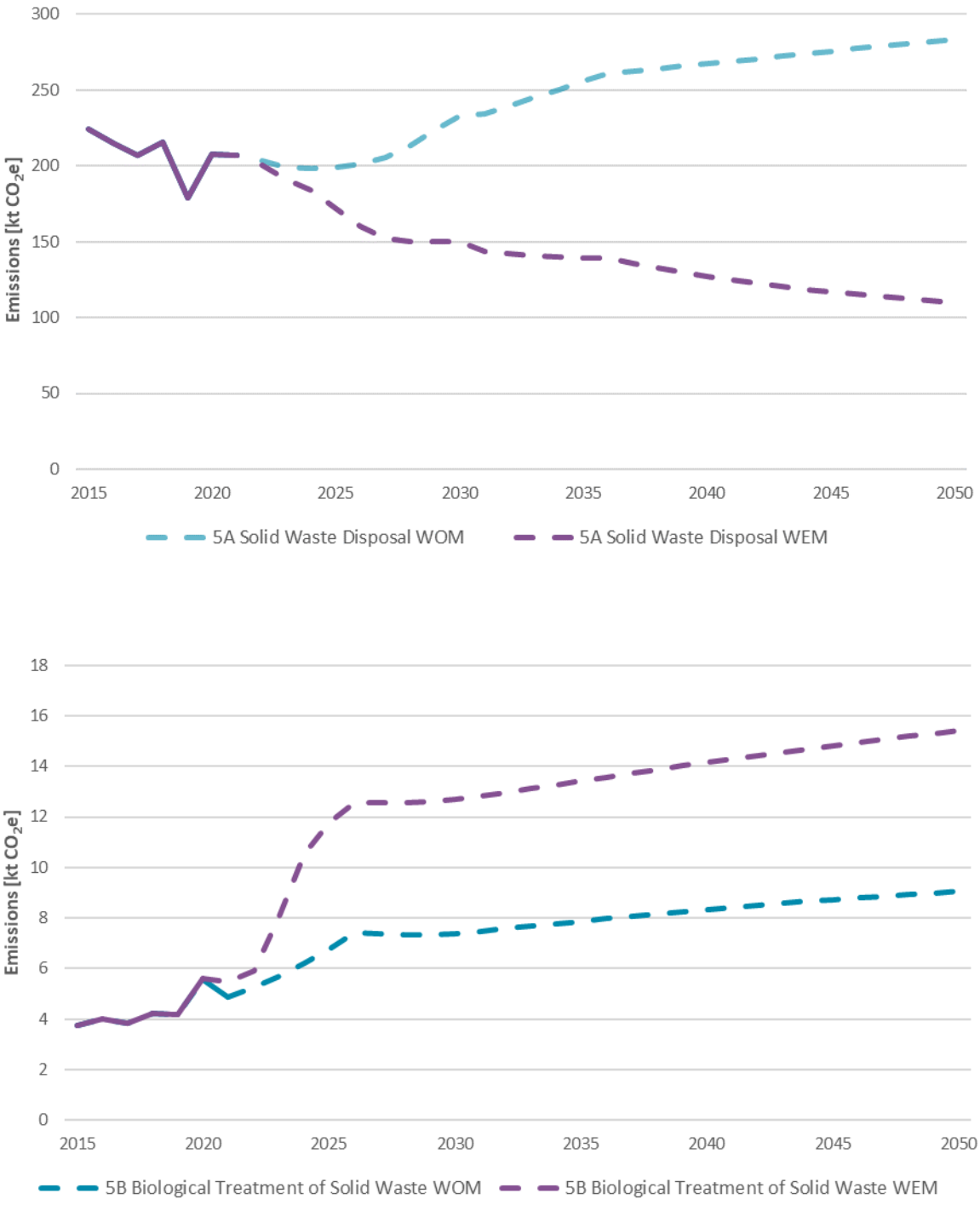

Figure 10.4 Quantified ex-ante impact of the GROUP of PaMs (507), consisting of PaMs 504 and 501 and the closing of the SWDS Álfsnes. The top graph shows the impact on GHG emissions from Solid Waste Disposal Sites (5A), while the bottom graph shows the impact on Biological Treatment of Waste (5B), [kt CO_2e].

Table 10.5 Comparison of emissions from 5A – Solid Waste Disposal sites and 5B – Biological Treatment of Solid waste, ex-ante impact of the GROUP of PaMs (507) and the closing of the SWDS Álfsnes, WOM and WEM scenarios.

Sector	Emissions [kt CO_2e]							
	2015	2020	2025	2030	2035	2040	2045	2050
5A Solid Waste Disposal WOM	224	208	199	232	255	267	275	283
5A Solid Waste Disposal - WEM	224	208	172	150	140	127	117	110
Difference WEM-WOM	0	0	-28	-82	-116	-140	-158	-173
% Difference	0%	0%	-14%	-35%	-45%	-52%	-57%	-61%
5B Biological Treatment of Solid Waste - WOM	3.7	5.6	6.8	7.4	7.9	8.3	8.7	9.1
5B Biological Treatment of Solid Waste - WEM	3.7	5.6	11.8	12.7	13.4	14.2	14.8	15.4
Difference WEM-WOM	0.0	0.0	5.0	5.3	5.6	5.8	6.1	6.4
% Difference	0%	1%	74%	72%	71%	70%	70%	70%
5A, 5B – WOM	228	213	206	240	263	275	284	292
5A, 5B – WEM	228	213	184	163	153	141	132	126
Difference WEM-WOM	0	0	-23	-77	-110	-134	-152	-166
% Difference	0%	0%	-11%	-32%	-42%	-49%	-54%	-57%

10.3.8 Other Ongoing Initiatives

Besides the abovementioned PaMs, there are several other smaller initiatives being prepared or already underway that may reduce greenhouse gas emissions from the Waste sector in the future. A few of these initiatives are outlined in Table 10.6.

Table 10.6 Other initiatives that may impact GHG emissions from the Waste sector.

Initiative	Description
The Green Steps Program[55]	This program is developed for government agencies in Iceland with the overall aim of minimising the environmental impact of daily operations in the public sector. The program was established in 2014 and the EAI oversees it and assists and guides government agencies in its implementation. Waste sorting and waste reduction is one category of this program.
Together Against Waste[56]	This initiative has been run by the EAI since 2016 with the goal of prioritising a circular economy. It focuses on better efficiency, creating less waste as well as increasing education to prevent waste generation. Every couple of years the focus is on a particular waste category such as: food, plastic, textiles, electronics, construction, or paper.
Bokashi experiment in the Rangárvellir municipality	In 2020, *Jarðgerðarfélagið*, the Rangárvallasýsla waste processing plant and the SCSI started working on an experimental project to see if Bokashi composting can work on a municipal level. The compost created from the process can subsequently be used to fertilise plants and in

[55] *Green Steps Program ("Græn skref").* https://graenskref.is/english/
[56] *Together against waste ("Saman gegn sóun").* https://samangegnsoun.is/

Initiative	Description
	soil conservation efforts. If this experiment is successful, other municipalities may follow suit.
Decreased GHG emissions with increased treatment of wastewater	In 2021, the EAI had an analysis done on the scope of emissions from wastewater in Iceland and the possibilities of decreasing those emissions. The results showed that there are opportunities in increased wastewater treatment and the use of sludge for land reclamation and restoration. [57] A regulation on grants for municipalities to improve wastewater treatment systems was implemented in 2020.[58]
Other measures in Towards a Circular Economy	Funds were allocated by the Ministry of the Environment, Energy, and Climate to a number of other initiatives, i.e., for the development of necessary infrastructure that can contribute to the implementation of a circular economy in Iceland, the promotion of domestic waste recycling, support for home composting, the strengthening of repair and maintenance services, abolition of VAT on the resale of used goods, improved waste statistics, support for infrastructure development for waste incineration and more. Some of these measures have already begun while others are still in planning.
Waste Management Handbook and website	A handbook on waste management was published in 2022. It is mainly intended for municipality leaders and explains how municipalities can and should improve their waste management according to the measures in Towards a Circular Economy.[59] The EAI also created a website, which is supposed to work in junction with the handbook as well as providing general information and statistics on waste management in Iceland.[60]

10.4 Sensitivity Analysis

10.4.1 Waste amount proxy data

In the Waste sector, Solid Waste Disposal (5A) and Biological Treatment of Solid Waste (5B) is accountable for 79% of GHG emissions from the sector in 2021. In this chapter, a sensitivity analysis has been performed to assess the impact of applying different proxy data to project the total amount of generated waste, which is one of the key parameters when calculating emissions from the waste sector. For this submission, the total amount of waste is projected using a proxy data tool where the projected population growth is used as a parameter, but in the sensitivity analysis the projected GDP is used as a parameter instead.

In the sensitivity analysis scenario, the emissions are projected to be higher than in the WEM scenario. This is because the GDP is projected to keep growing through the timeline, whereas the rate of

[57] *EAI*. https://ust.is/library/sida/haf-og-vatn/Greinarger%c3%b0%20um%20aukna%20s%c3%b6fnun%20seyru%20og%20losun%20GHL%20161220%20-%20Copy%20(1).pdf, in Icelandic

[58] *Ministry of Environment, Energy and Climate*. https://island.is/reglugerdir/nr/1424-2020, in Icelandic.

[59] *VSÓ on behalf of The Association of Icelandic Local Authorities and the EAI*. https://ust.is/library/sida/graent/Handb%C3%B3k%20%C3%BArgangur_j%C3%BAn%C3%AD2022.pdf?, in Icelandic.

[60] The EAI. https://urgangur.is, in Icelandic.

population growth is projected to slow down after 2026. As the proxy data tool assumes that the amount of generated waste will either follow the trend of GDP or the population growth, the sensitivity analysis scenario resulted in a higher amount of generated waste and, therefore, higher projected emissions.

The differences between scenarios grow larger as the projections stretch further into the future, reaching about a 37% difference in 2050 (see Table 10.7). A visual comparison between the two projection scenarios can be seen in Figure 10.5.Figure 10.5 Comparison of the projected GHG emissions from Solid Waste Disposal (5A) and Biological Treatment of Solid Waste (5B) using GDP in the sensitivity analysis instead of population as in the WEM scenario for proxy data, [kt CO2e]. Table 10.8 shows the results of the sensitivity analysis for the Solid Waste Disposal (5A) and Biological Treatment of Solid Waste (5B). In the sensitivity analysis scenario, emissions from 5A and 5B are projected to be 51% higher in 2050 compared to the WEM projections scenario used.

Table 10.7 Comparison of the projected GHG emissions (kt CO_2e) from Solid Waste Disposal (5A) and Biological Treatment of Solid Waste (5B) using GDP in the sensitivity analysis insted of population as in the WEM scenario for proxy data.

	Scenario	2021	2025	2030	2035	2040	2045	2050
5A1 Managed waste disposal sites	Sensitivity Analysis	184.4	154.6	138.2	135.7	133.4	134.7	140.8
	WEM	184.4	153.0	135.2	126.9	116.4	107.4	101.6
	Difference %	0%	1%	2%	7%	15%	25%	39%
5A2 Unmanaged waste disposal sites	Sensitivity Analysis	22.7	18.7	15.2	12.7	11.1	9.9	9.1
	WEM	22.7	18.7	15.2	12.7	10.9	9.6	8.6
	Difference %	0%	0%	0%	0%	2%	4%	6%
5B1 Composting	Sensitivity Analysis	4.9	10.1	11.8	13.8	16.0	18.5	21.2
	WEM	4.9	11.0	11.8	12.6	13.3	14.0	14.6
	Difference %	0%	-8%	0%	10%	21%	32%	45%
5B2 Anaerobic Digestion	Sensitivity Analysis	0.6	0.9	0.9	0.9	0.9	0.9	0.9
	WEM	0.6	0.9	0.9	0.9	0.9	0.9	0.9
	Difference %	0%	0%	0%	0%	0%	0%	0%
Total	**Sensitivity Analysis**	**213**	**184**	**166**	**163**	**161**	**164**	**172**
	WEM	**213**	**184**	**163**	**153**	**141**	**132**	**126**
	Difference %	**0%**	**0%**	**2%**	**7%**	**14%**	**24%**	**37%**

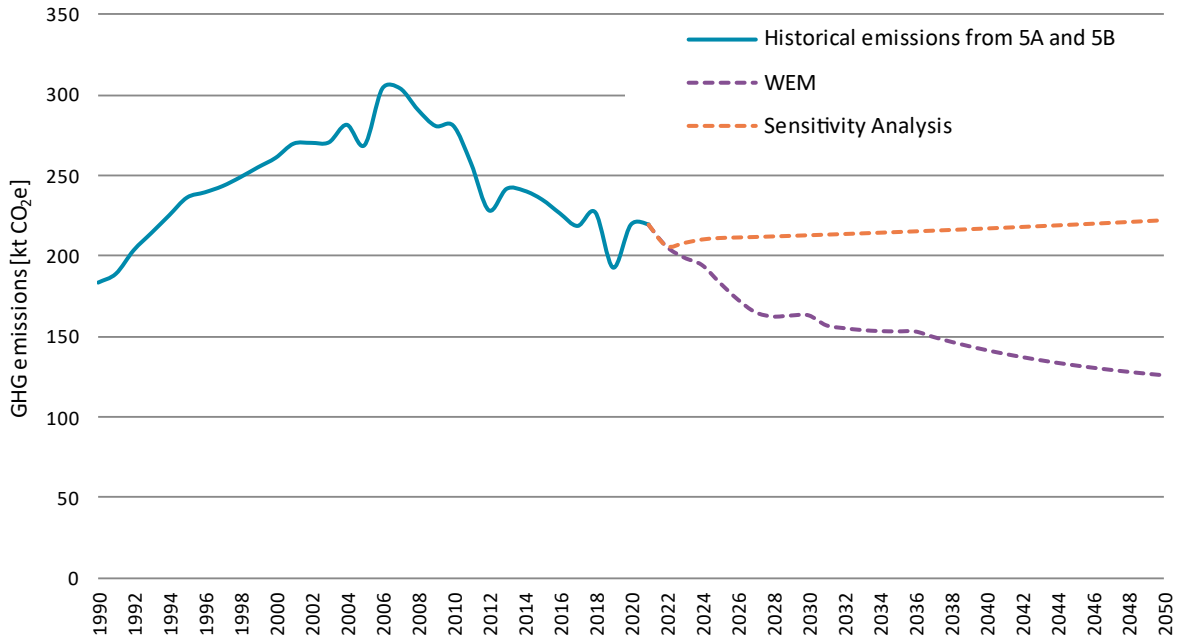

Figure 10.5 Comparison of the projected GHG emissions from Solid Waste Disposal (5A) and Biological Treatment of Solid Waste (5B) using GDP in the sensitivity analysis instead of population as in the WEM scenario for proxy data, [kt CO_2e].

Table 10.8 Sensitivity analysis results: total GHG emissions [kt CO_2e] for the Waste sector.

	2021	2025	2030	2035	2040	2045	2050
Sensitivity Analysis:	268.4	270.4	273.0	275.7	278.6	281.9	285.3
WEM:	268.4	242.7	223.2	213.8	202.9	194.1	188.6
Difference in kt CO_2e	0	27.7	49.8	61.9	75.8	87.8	96.7
Difference in %	0%	11.4%	22.3%	28.9%	37.3%	45.2%	51.3%

10.4.2 Wastewater Activity Data

Projections from Wastewater Treatment and Discharge (5D) are based predominantly on population and on wastewater treatment. As the allocation of treatment pathways is a big determinant of GHG emissions from 5D, a sensitivity analysis has been performed to assess the impact on emissions of applying different trends to the allocation of treatment pathways. In the WEM scenario the allocation of treatment pathways is kept the constant, based on the numbers in the 2020 status report on wastewater treatment in Iceland (EAI, 2022), whereas projections based on the historical trend of wastewater pathways is used in the sensitivity analysis.

In the sensitivity analysis, the emissions are lower than the WEM scenario as the linear trends are towards better treatment systems. In the WEM scenario population growth results in higher emissions in the future. The differences grew larger as the projections stretched further into the future, reaching about 19% difference in 2050 (see Table 8.6). A visual comparison between the two projection scenarios can be seen in Figure 8.4. Table 8.6 shows the results of the sensitivity analysis for Wastewater Treatment and Discharge (5D). In the sensitivity analysis scenario, emissions from 5D are projected to be 4% lower in 2050 compared to the WEM projections scenario used.

Table 10.9 Comparison of the projected CH_4 emissions from Wastewater Treatment and Discharge (5D), using data from the last historical year and historical tend (using linear extrapolation).

	Scenario	2021	2025	2030	2035	2040	2045	2050
5D1 Municipal wastewater kt CH_4	Sensitivity Analysis	0.805	0.713	0.676	0.684	0.699	0.711	0.689
	WEM	0.805	0.889	0.916	0.937	0.957	0.974	0.989
	Difference %	0%	-20%	-26%	-27%	-27%	-27%	-30%
5D2 Industrial wastewater kt CH_4	Sensitivity Analysis	0.741	0.717	0.712	0.706	0.701	0.695	0.689
	WEM	0.742	0.723	0.723	0.723	0.723	0.723	0.723
	Difference %	0%	-1%	-2%	-2%	-3%	-4%	-5%
Total	**Sensitivity Analysis**	**1.546**	**1.431**	**1.388**	**1.390**	**1.400**	**1.407**	**1.379**
	WEM	**1.547**	**1.612**	**1.639**	**1.660**	**1.680**	**1.697**	**1.712**
	Difference %	**0%**	**-11%**	**-15%**	**-16%**	**-17%**	**-17%**	**-19%**

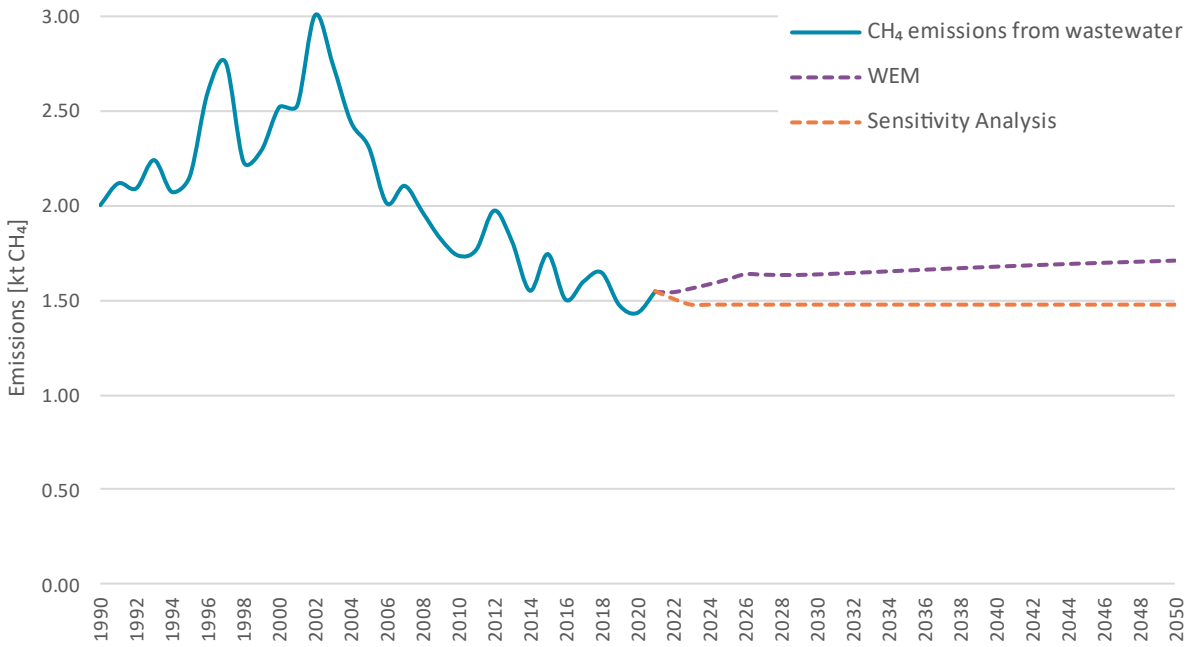

Figure 10.6 Comparison of the projected CH_4 emissions from Wastewater Treatment and Discharge (5D) using data from the last historical year (Sensitivy Analysis scenario) and historical tend (WEM scenario), using linear extrapolation, [kt CH_4].

Table 10.10 Sensitivity analysis results: total GHG emissions [kt CO_2e] for the Waste sector.

	2021	2025	2030	2035	2040	2045	2050
Sensitivity Analysis [kt CO_2e]	268.4	238.5	218.1	208.0	196.4	187.0	181.0
WEM [kt CO_2e]	268.4	242.7	223.2	213.8	202.9	194.1	188.6
Difference [kt CO_2e]	0	-4.2	-5.1	-5.8	-6.5	-7.1	-7.6
Difference in [%]	0%	-1.7%	-2.3%	-2.7%	-3.2%	-3.7%	-4.0%

10.5 Stakeholder Engagement

After the first submission of the PaMs and Projections reporting in 2019, expert review meetings were organised to get feedback and constructive criticism from external experts in order to improve future reporting. Consequently, the EAI gained some valuable insights and contacts that were maintained throughout the preparation stage of the current reporting.

The Waste experts from the EAI had meetings with experts from the biggest waste management company in Iceland, *Sorpa*, who has recently opened the country's first gas and composting plant. *Sorpa* provided the EAI with projections for the future operations of the gas and composting plant which were used in the waste projections.

The projections were introduced to a cross-departmental waste expert group within the EAI and the projections fixed according to the feedback given.

11 Cross-Cutting

The PaMs from the 2020 Climate Action Plan (Ministry for the Environment and Natural Resources) which are cross-cutting and will affect more than one of the sectors presented in the previous chapters are listed in Table 11.1 below. Short descriptions of each policy or measure are provided, with more information on all the PaMs provided in separate subchapters below. Currently, the majority of the policies have been implemented, although none of them have been quantified or included in the WEM projections scenario.

Table 11.1 Policies and Measures included in Cross-Cutting.

PaM Name	GHG(s)	Instrument Type	Status	Scenario	Description
Climate Fund (703)	GHGs	Economic	Implemented	Not included	Climate projects will be supported through the Icelandic Climate Fund, which has been allocated to grant 500 million ISK in 2019-2023.
Climate Strategy of Government Offices (704)	GHGs	Economic, Planning	Implemented	Not included	A climate strategy has been introduced for government offices. Various measures aim to reduce GHG emissions and remaining emissions will be offset.
Climate Education in Schools (706)	GHGs	Education	Implemented	Not included	Climate education in schools will be reinforced.
Information on Climate Change for the Public (707)	GHGs	Economic, Education	Implemented	Not included	Information on climate issues, the effects of climate change, mitigation and adaptation will be supported through various means.
Climate Action Planning (709)	GHGs	Planning	Implemented	Not included	Climate issues will be addressed through Iceland's National Planning Strategy.
Issuing of Green Bonds (711)	GHGs	Economic	Adopted	Not included	Evaluation will be made on the feasibility of issuing green bonds in order to raise green investor interest in traditional state loans.
Sustainable Public Procurement (712)	GHGs	Economic, Planning	Implemented	Not included	Environmental and climate issues will be evaluated in all government purchasing with a new policy on sustainable public procurement.
Climate Strategy of Other Public Agencies (713)	GHGs	Regulatory, Voluntary/ Negotiated agreement	Implemented	Not included	All other public agencies will need to set a Climate Strategy. The same applies to local government.
Climate Impact Assessment of Legislation (714)	GHGs	Regulatory	Implemented	Not included	The climate impact of all new legislation will be evaluated.

11.1 Climate Fund (703)

In the first edition of the Climate Action Plan (2018) a measure on the establishment of a Climate Fund (*Loftslagssjóður*) was proposed. This action was continued in the 2020 Climate action plan. The fund formally started operating in 2019 and the Climate Act (Law no. 70/2012) has been updated and

altered to further define and formalise its purpose. The Icelandic Centre for Research (*Rannís*) has been entrusted with the management of the fund, a board has been established and allocation rules have been defined. The main purpose of the fund is to support and encourage climate education, research, and innovation.

The fund began accepting applications in November 2019 and the first grants were allocated to 10 innovation and 22 education projects in May 2020. The Climate Fund received 158 applications for the second allocation of funding in 2021. In total, 170 million ISK was allocated in grants to 24 projects: 12 educational projects and 12 innovation projects. In 2022 the fund received 85 applications, of which 12 projects were funded. The total amount allocated was 88 million ISK.

The fund was allocated 500 million ISK in grants to various such educational and climate innovation projects for the years 2019-2023[61].

For previous allocations, the grants have been focused on innovation and educational projects but for the allocation in 2023 there has been a change is it emphasis. It will now focus on funding projects that will:

- result in a reduction in emissions which contribute to Iceland's independent national goal of reducing Iceland's effort sharing emissions by 55%.
- utilize existing knowledge that has the potential to be used as widely as possible and are aimed at entities that have considerable potential to reduce emissions.

An overview of the projects which received grants from the fund in 2020-2022 can be seen in Table 11.2. This measure is connected to policy 706 and 707 on education on climate issues for the public and in schools.

Table 11.2 Overview of allocations from the Climate fund from 2020

	2020	2021	2022
Total Amount (million ISK)	165	170	88
Number of Innovation projects	10	12	6
Number of Education projects	22	12	6

11.2 Climate Strategy of Government Offices (704)

The government aims to set an example in climate policy and be a positive role model for organisations, businesses, and the public. The government's Climate Strategy (*Loftslagsstefna Stjórnarráðsins*) is designed to reduce GHG emissions from all government operations and Ministries significantly and carbon offset the remaining emissions generously.

The Icelandic government approved their Climate Strategy in April 2019 (Government of Iceland) and there is an emphasis on reducing emissions from flights, vehicles, waste, energy use and cafeteria meals. The preparation for an updated Climate Strategy has started.

The policy directs the spotlight to the importance of organisations and companies reducing their carbon footprint and developing a climate policy. Furthermore, it increases demand for climate friendly solutions, such as sustainable taxis and rental cars, and effective transport contracts. A portal

[61] Further information on the Climate Fund can be found on its website: https://www.rannis.is/sjodir/rannsoknir/loftslagssjodur/

to connect emissions from flights to goals regarding reducing GHG emissions is also being developed and will be available to all government agencies. This measure is directly connected to the climate strategy of other public agencies (see measure 713).

11.3 Climate Education in Schools (706)

Since the first edition of the Climate Action Plan (2018) was released the education material which is already available in Iceland has been mapped, with the goal of determining what kind of material is missing and where improvements can be made. The Ministry of Education and Children will use the mapping and further direct it to the Directorate of Education to use it to develop and revise education materials. It is expected that various educational projects will be presented in the near future (see measure 707 on climate education for the public), and that a part of them will be useful for the entire educational system. NGO's such as *Landvernd* and The Icelandic Youth Environmentalist Association (*Ungir Umhverfissinnar*) have, furthermore, been effective sustainability and environmental educators and have provided educational materials and presentations around the country.

When the education system's curricula are reviewed next, climate change education will be made a priority and educational grants will be allocated by the Ministry of Education and Children to climate education projects. Education on climate change will be increased at all educational levels and provided through various educational channels. The goal is for schools to be able to offer varied and comprehensive education on climate change, its consequences and what we can do to combat it, in line with the sustainability principle which lays at the core of all education. Sustainability education, environmental awareness, community spirit, and climate issues are all important issues for educators to raise in schools. Climate matters are complex and overlap with many other societal issues. It is important to ensure that quality education material, which touches on the science behind climate change and the impacts of a changing climate on the environment, communities, democracy, equality, and human rights, exists. It is also essential that the education material is appropriate or adjustable for different education levels.

The young generation has already made a difference in climate issues in Iceland and has been active in climate panels and protests. A contract has been signed with the NGO *Landvernd* on creating educational material on climate change and climate issues for schools, in light of its experience in creating education material on sustainability and environmental issues. The education material is connected to the project Eco-Schools Iceland (*Skólar á grænni grein*)[62], which has been running in Iceland since 2001 and currently reaches over 200 schools at all education levels, ranging from preschools to universities. The distribution of participating schools around the country can be seen in Figure 11.1 below. *Landvernd's* education on climate issues is for all schools, independent of whether they are participating in Eco-Schools Iceland or not. The goal is for more schools to participate in the project in the future. The project is part of to the world's largest environmental education organisation, the Foundation for Environmental Education (FEE)[63].

[62] *Landvernd – Icelandic Environment Association*. https://landvernd.is/graenfaninn/
[63] *The Foundation for Environmental Education*. https://www.fee.global/

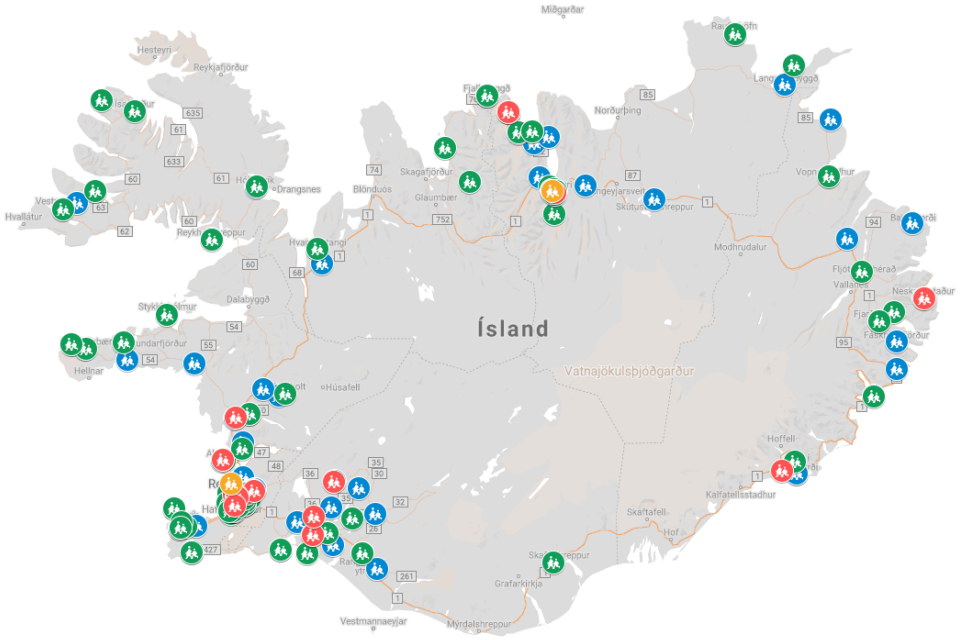

Figure 11.1 Schools participating in the Eco-Schools Iceland project. Green represents preschools, blue represents primary schools, red represents secondary schools, and orange represents universities.[64]

11.4 Information on Climate Change for the Public (707)

Education on climate issues will be supported in a variety of ways. Since the first edition of the Climate Action Plan (Ministry for the Environment and Natural Resources, 2018) was published, several new projects have been set afoot. The education system plays an important role in raising awareness in the younger generations and collaboration with education authorities is essential. Ways to further support education on climate issues, the impacts of consumerism and waste, will be explored. A mapping of the education material that is currently available to the public in Iceland has been undertaken by the Ministry of Education and Children and will lay the foundations for this.

One of the roles of the Climate Fund, which was established in the autumn of 2019 (see measure 703), is to support education on climate issues and the impacts of climate change. When project grants were being allocated by the Ministry of the Environment, Energy, and Climate for the second time in February 2020, an emphasis was placed on supporting collaboration projects between NGOs, the public and others regarding strengthening the circular economy and supporting climate issues, in line with the aims of the previous Climate Action Plan (2018).

In the Science and Technology Policy for the years 2020-2022 (Prime Minister's Office, 2020), there is a measure aimed at creating a framework and plan for how the public's access to evidence-based information and science is guaranteed in Iceland in the long term. Special efforts will be made to communicate knowledge in the field of climate issues with the aim to developing methods that can later be used in other fields.

[64] *Landvernd – Icelandic Environment Association*. https://landvernd.is/graenfaninn/um-skola-a-graenni-grein/

The government has, furthermore, directly funded several educational projects on climate issues and will continue to do so. This includes the television series "What have we done?" ("*Hvað höfum við gert?*") which was shown on national television (*RÚV*) in 2019[65]. A second season, "What can we do?" ("*Hvað getum við gert?*") was subsequently aired on national television in 2021[66]. The emphasis of the second season is on what actions individuals, businesses, and the government can undertake to combat climate change.

The project "Retreating glaciers" ("*Hörfandi jöklar*") also received funding from the government. The impacts of climate change on glaciers in Iceland is well known and has been monitored and researched by scientists for decades. The impacts on Vatnajökull, Europe's largest glacier, can be seen in Figure 11.2 below. The Retreating glaciers project aims to increase awareness of the impact of climate change in Iceland and in the rest of the world. Information on the retreating glaciers in Iceland, based on monitoring by the Icelandic Meteorological Office (*Veðurstofa Íslands*) and the University of Iceland's Institute of Earth Sciences (*Jöklahópur Jarðvísindastofnunar Háskóla Íslands*), through Vatnajökull National Park (*Vatnajökulsþjóðgarður*), has been made more accessible for the public through their educational website[67].

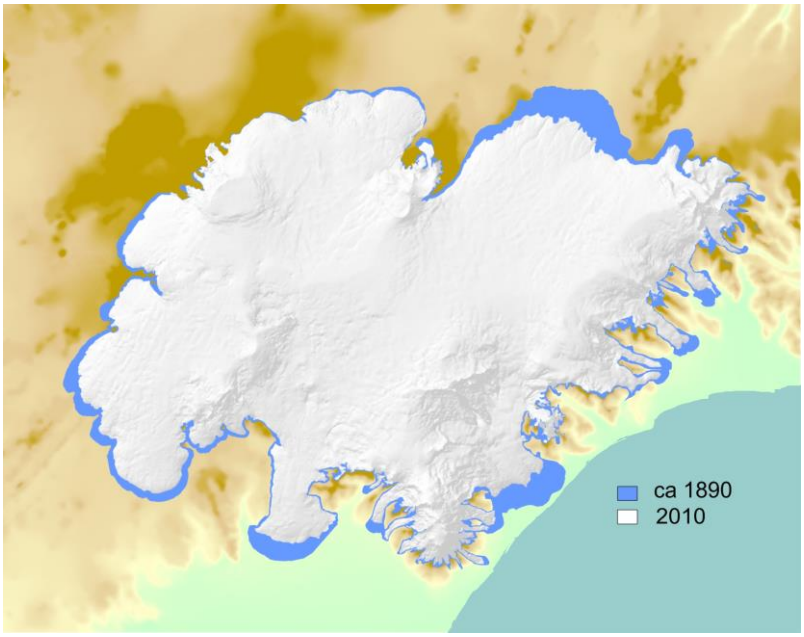

Figure 11.2 The outline of Vatnajökull Glacier, c.a. 1890 and 2010. Sources: The Icelandic Meteorological Office and the University of Iceland's Institute of Earth Sciences[68].

Many education projects, organised by the government, organisations, NGOs, youth organisations, the media, and others are well underway. The EAI, for example, manages extensive environmental education for the public, other organisations and businesses which is directly connected to climate issues. The Icelandic Climate Council (*Loftslagsráð*) has a monitoring role of the dissemination of information and education.

[65] *RÚV*. https://www.ruv.is/sjonvarp/spila/hvad-hofum-vid-gert/27624
[66] *RÚV*. https://www.ruv.is/sjonvarp/spila/hvad-getum-vid-gert/30574
[67] *Vatnajokull National Park (Vatnajökulsþjóðgarður).* https://www.vatnajokulsthjodgardur.is/is/svaedin/horfandi-joklar
[68] *Vatnajokull National Park (Vatnajökulsþjóðgarður).* https://www.vatnajokulsthjodgardur.is/is/svaedin/horfandi-joklar/joklarannsoknir/43-utlinur-jokla-og-yfirbordskort

11.5 Climate Action Planning (709)

In 2018, the Minister of the Environment, Energy, and Climate entrusted the National Planning Agency (*Skipulagsstofnun*) with proposing an update to the National Planning Strategy (*Landsskipulagsstefna*) 2015-2026 (National Planning Authority, 2016), where a clearer policy on climate issues, landscape and public health would be defined in regard to planning operations. The National Planning Agency's proposal was presented to the minister in the spring of 2021 (National Planning Authority, 2021).

The National Planning Strategy contains the government's policy and guidance for municipalities' planning. The policy update focuses on how the planning of municipalities can purposefully support the achievement of the government's climate, landscape, and public health targets. In the update, guidance is proposed on how municipalities can use long-term planning strategies to shape the development of land use and the built environment, both in rural and urban areas. The policy expects municipalities to form a policy on climate focused planning, for planning to support the achievement of carbon neutrality, and to strengthen resilience against climate change through various adaptation measures. In climate focused planning, climate goals are prioritised when settlements and land-use changes are being planned. In this way, planning can be used to support improved commuting behaviour, climate friendly construction, and the preservation and sequestration of carbon in soils and flora, for example[69].

The measure is connected to various other measures in the Action Plan, such as Measures 601, 602, and 604 on supporting forestry, land, and wetland reclamation, and measures 205, 206, and 209 on changed travel habits, active modes of transportation, and the strengthening of the public transport system.

During the changes in the cabinet in 2021, planning issues were transferred to the Ministry of Infrastructure. The Minister of Infrastructure has decided to review the National Planning Policy 2015-2026 and has proposed annex on climate, landscape, and public health.

11.6 Issuing of Green Bonds (711)

The feasibility of issuing green government bonds and opening pathways to green investors for conventional government loans will be explored. There are possibilities to finance well defined sustainable projects through issuing certain green government bonds. This would send a clear signal to investors about the importance of environmental issues and how the finance sector could support climate change prevention. Issuing green bonds is for the most part similar to issuing other bonds. The main difference is, however, that the money goes to environmentally friendly projects. The issuing of green bonds has been increasing on international markets in the past years and there has been more pressure on investors to direct investment to projects that support reaching long term sustainability and climate targets.

The Icelandic Treasury has hitherto not issued green bonds, but a project management group set up by the Minister of Finance and Economic Affairs is now assessing what possibilities are available. The group was set up in June 2020 and consists of representatives from the Ministry of Finance and Economic Affairs, the Ministry for Foreign Affairs, the Ministry of the Environment, Energy, and Climate, the Prime Minister's Office, and the Central Bank of Iceland. Furthermore, the group will

[69] *National Planning Authority (Skipulagsstofnun).* https://www.landsskipulag.is/um-landsskipulagsstefnu/frettir/landsskipulagstillaga-afhent-umhverfis-og-audlindaradherra

participate in work on an independent Environmental, Social, Governance (ESG) investment certification for the Icelandic treasury, if that is the course that is decided to be taken. This is an international certification that focuses on emphasising environmental and social issues as well as good management practices and can possibly facilitate green investment in traditional government bonds. Although the Icelandic Treasury has not yet issued green bonds, the City of Reykjavík has become the first party to design a Green Bond Framework in Iceland in 2019[70] to fund projects that align with its climate policy[71].

In 2021, the Ministry of Finance and Economy issued a financing framework for sustainable financing of the treasury and received a "dark green" rating from CICERO, an internationally recognized and independent certification body. Issuance of green treasury bonds under the sustainable financing framework is under consideration.

11.7 Sustainable Public Procurement (712)

Sustainability will be taken into account in all public procurement as a main rule. The Central Public Procurement (*Ríkiskaup*) developed a new public procurement policy on sustainable procurement (*Sjálfbær innkaup – Stefna ríkisins*) which was published in January 2021 (Government of Iceland, 2021). The government procures goods and services for 117 billion ISK every year, which allows for many opportunities to form a clear environmental policy regarding procurement. Creating a demand for more environmentally friendly goods and services can have significant direct and indirect effects on the market and help pave the way for other businesses or organisations to do the same thing.

The key topics regarding sustainable public procurement policy for the next years are:

1. To achieve economical and sustainable procurement that ensures long-term sustainability;
2. To increase the professional capacity of public procurers to support an efficient performance of government services;
3. To ensure sufficient competition in the market and stimulate recruitment and innovation through increased cooperation with the market;
4. Use digital procurement solutions and information technology systematically for data analysis and joint procurement.
5. Ensure that the public and companies have easy access to information on government procurement.

It is possible to be more environmentally conscious in the purchasing of several procurement categories, such as in contracts for purchasing painting and construction material, cleaning supplies, paper goods, writing equipment, printing, electronics, and other machinery. The carbon footprint can also be significantly decreased by improving the design of buildings, using sustainable concrete, and improving other construction practices.

The Icelandic government furthermore purchases food for approximately 3 billion ISK per year and can, as a big buyer, have a significant impact on food demand, support sustainable procurement, reduce the carbon footprint, and support innovation. In the procurement policy for food for government agencies (government of Iceland, March 2019), which the Ministry of Higher Education, Science and Innovation published in May 2019, an emphasis is placed on altering procurement

[70] *City of Reykjavík (Reykjavíkurborg).* https://reykjavik.is/graen-skuldabref-green-bonds
[71] *City of Reykjavík (Reykjavíkurborg).* https://reykjavik.is/sites/default/files/reykjavik_green_bond_framework_2019_-_baeklingur.pdf

processes so that cafeterias have access to package free food and that a public calculator for the carbon footprint of food will be designed. It has been declared that the goal is to keep the consumption of red meat in moderation. It has been ensured that the procurement policy for food and the policy on sustainable government purchasing will work together.

The Ministry of Finance and Economy issued a new procurement policy in April 2021[72]. It stipulates that the government's procurement is progressive and sustainable and takes environmental and climate considerations into account.

11.8 Climate Strategy of Other Public Agencies (713)

All government and public entities will be exemplary in climate policies. The government's climate policy, which was approved in May 2019, puts a requirement on all government agencies, which was expanded further with updated climate legislation in June 2019. All government agencies, municipalities and government majority owned companies shall, by law, develop a climate policy and set itself a GHG emission reduction target.

The EA has set out guidelines for the creation and implementation of climate policies for government agencies and companies majority owned by the state. The instructions are divided into three parts:

- Making climate policy with an overarching goal
- Target setting for each emission sector
- Creation of an action plan to ensure that emission reduction targets are met

Government organisations and government majority owned companies have the possibility to sign up for the project "Green steps in government operations" ("*Græn skref í ríkisrekstri*")[73]. The EA has integrated the creation of a climate policy with the project *Green steps in government operations* and provides advice to government bodies on that level. Green accounting is useful with making a climate strategy, as government bodies can get a estimate of the emission of greenhouse gases in their operations. Various other aids have also been published on the Green Steps website to facilitate the process.

By August 2021, 24 out of 199 government bodies had completed the creation of a climate policy, or 12%. The action was further strengthened last year, and in June 2022, 68 parties have submitted fully completed climate policies with target setting for each emission sector.

A similar project has been developed for municipalities[74]. The Association of Icelandic Municipalities in collaboration with the EA published the "Municipal Climate Toolkit" in September 2021. The purpose of the toolkit is to promote and support municipalities in working out action-oriented climate policy for their operations, follow it up and monitor their results to prepare guidelines for municipalities on the creation of a climate policy for the operation of individual municipalities. The project is carried out in connection with the amendment of law no. 70/2012 on climate matters from June 2019, when local governments were obliged to adopt a climate policy and targets for the reduction of greenhouse gas

[72] *Innkaupastefna ríkisins.* https://www.rikiskaup.is/is/innkaup_og_utbod/samfelagslega-abyrg-innkaup/vistvaen-innkaup/innkaupastefna-rikisins
[73] *Grænskref*. https://graenskref.is/
[74] *Loftslagsvænni sveitarfélög.* https://loftslagsstefna.is/sveitarfelog/um-verkfaerakistuna/

emissions. There are opportunities in greater cooperation between the state and local governments on actions.

11.9 Climate Impact Assessment of Legislation (714)

Legislative proposals will be specifically assessed based on their climate impact. To begin with, this will be done with selected bills in the Ministry of Environment and Natural Resources, but later it is aimed that this will apply to all bills that will be submitted to the parliament.

Currently, ministries must assess the impact of the legislation that are being proposed. It considers a variety of factors, such as financial factors for the government, changes in income, changes in expenditure and whether the financial effects that may result from the approval of the bill have been anticipated. The economic impact of the bill is assessed, its impact on the finances of municipalities, non-governmental organizations, administration, the status of certain social groups and more. Likewise, the impact of the bill on gender equality is assessed, according to a guide for assessing equality effects. Effects on the environment and sustainable development are also assessed, but climate effects are not specifically assessed.

It is important that the impact of legislation on the climate is assessed, and in this measure, it is assumed that bills will be assessed specifically with regard to their climate impact, which includes a more detailed assessment of the impact on the environment and sustainable development.

The Ministry of the Environment, Energy and Climate has begun work on guidance criteria that are expected to be used to assess the climate impact of bills. It is proposed that each ministry evaluates its bills with regard to their impact on the emission of greenhouse gases. Thresholds, guidelines and methodologies that will be used to estimate annual greenhouse gas emissions will be established.

12 References

Environment Agency of Iceland. (2019). *Report on Policies, Measures and Projections - Projections of Greenhouse Gas emissions in Iceland til 2035.*

Environment Agency of Iceland. (2023). *National Inventory Report.*

Government of Iceland. (2019). *Climate strategy of government offices (Loftslagsstefna stjórnarráðsins).* Retrieved from https://www.stjornarradid.is/library/01--Frettatengt---myndir-og-skrar/FOR/Fylgiskjol-i-frett/STJ_UAR_LoftslagsstefnaStjornarradsins_lokautgafa.pdf

Government of Iceland. (2019). *LULUCF Mitigation Plan (Bætt landnýting í þágu loftslagsmála).* Retrieved from https://www.stjornarradid.is/lisalib/getfile.aspx?itemid=f8c0433d-9cca-11e9-9443-005056bc4d74

Government of Iceland. (2020). *Iceland's National Plan.* Retrieved from https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Iceland%20National%20Plan%202020.pdf

Government of Iceland. (2021). *Green steps in fisheries (Græn skref í sjávarútvegi).* Retrieved from https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Gr%c3%a6n%20skref%20%c3%ad%20sj%c3%a1var%c3%batvegi%20-%20sk%c3%bdrsla%20starfsh%c3%b3ps.pdf

Government of Iceland. (2021). *On the Path to Climate Neutrality - Iceland's Long-Term Low Emission Development Strategy.* Retrieved from https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Iceland_LTS_2021.pdf

Government of Iceland. (2021). *Sustainable public procurement (Sjálfbær innkaup: stefna ríkisins).* Retrieved from https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Sj%c3%a1lfb%c3%a6r%20innkaup%20-%20stefna%20r%c3%adkisins%20(002).pdf

Icefuel. (2021). *The Feasibility of Producing E-Fuels in Iceland (Fýsileiki þess að framleiða rafeldsneyti á Íslandi).* Retrieved from https://www.stjornarradid.is/library/01--Frettatengt---myndir-og-skrar/ANR/Orkustefna/Fysileiki%20Rafeldsneytisframlei%c3%b0slu%20Skyrsla%20Jun%202021.pdf

Institute of Economic Studies. (2020). *The impact of a carbon tax on the fossil fuel use of homes and businesses (Áhrif kolefnisgjalds á eldsneytisnotkun).*

Institute of Economic Studies. (2022). *The Impact of GHG Mitigation Policies: A Cost-Benefit Analysis (Áhrif aðgerða í loftslagsmálum; Kostnaðar- og ábatamat).*

IPCC. (2006). *IPCC Guidelines for National Greenhouse Gas Inventories.* IGES.

IPCC. (2014). *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands.* IGES.

Matís. (2021). *Seaweed supplementation to mitigate methane (CH4) emissions by cattle (SeaCh4NGE-PLUS).* Retrieved from https://matis.is/en/skyrsla/seaweed-supplementation-to-mitigate-methane-ch4-emissions-by-cattle-seach4nge-plus/

Ministry for the Environment and Natural Reources. (2010). *Climate Action Plan (Aðgerðaáætlun í loftslagsmálum).*

Ministry for the Environment and Natural Resources. (2007). *Climate Change Strategy (Stefnumörkun í loftslagsmálum).*

Ministry for the Environment and Natural Resources. (2016). *Climate Change Strategy (Sóknaráætlun í loftslagsmálum - stöðuskýrsla um framgang verkefna).*

Ministry for the Environment and Natural Resources. (2018). *Climate Action Plan 2018-2030 (Aðgerðaáætlun í loftslagsmálum 2018-2030).*

Ministry for the Environment and Natural Resources. (2020). *Climate Action Plan (Aðgerðaáætlun í loftslagsmálum).*

Ministry for the Environment and Natural Resources. (2021). *Progress Report on the Climate Action Plan (Stöðuskýrsla aðgerðaáætlunar í loftslagsmálum).*

Ministry for the Environment and Natural Resources. (2021). *Towards a Circular Economy (Í átt að hringrásarhagkerfi: Stefna umhverfis- og auðlindaráðherra í úrgangsmálum).* Retrieved from https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/UAR_stefnaI_att_ad_hringrasarhagkerfi.pdf

Ministry of Finance and Economic Affairs. (2020). *Iceland's Fiscal Policy 2021-2025.*

Ministry of Finance and Economic Affairs. (2021). *Iceland's Fical Policy 2022-2026.*

Ministry of Food, Agriculture and Fisheries . (2022). *Land og líf - Landgræðsluáætlun og landsáætlun í skógrækt. Stefna og framtíðarsýn í landgræðslu og skógrækt til ársins 2031.*

Ministry of the Environment, Energy and Climate. (2022). *Progress Report on the Climate Action Plan (Stöðuskýrsla aðgerðaáætlunar í loftslagsmálum).*

National Energy Authority. (2022). *Energy Transition Projections (Orkuskiptaspá).* Retrieved from https://www.orkuskiptaspa.is/

National Planning Authority. (2016). *National Planning Strategy 2015-2026 (Landsskipulagsstefna).* Retrieved from https://www.landsskipulag.is/media/pdf-skjol/Landsskipulagsstefna2015-2026_asamt_greinargerd.pdf

National Planning Authority. (2021). *Proposal for an Annex to the National Planning Strategy 2015-2026 (Tillaga að viðauka við landsskipulagsstefnu).* Retrieved from https://www.landsskipulag.is/media/pdf-skjol/Landsskipulagsstefna2015-2026_asamt_greinargerd.pdf

Prime Minister's Office. (2020). *Science and Technology Policy 2020-2022 (Vísinda- og tæknistefna).* Retrieved from https://www.stjornarradid.is/library/03-Verkefni/Visindi/V%C3%ADsinda-%20og%20t%C3%A6knistefna%202020-2022.pdf

Snorrason, A., Kjartansson, B., & Traustason, B. (2020). *Forest Reference Level 2021-2025: Iceland National forestry accounting plan.* Mógilsá, Reykjavík: Icelandic Forest Research. Retrieved from https://www.skogur.is/static/files/utgafa/nfap_iceland_october_2020.pdf

Statistics Iceland. (2022). *Hagstofa Íslands*. Retrieved from http://px.hagstofa.is/pxis/pxweb/is/Ibuar/Ibuar__mannfjoldaspa/MAN09012.px/table/tableViewLayout1/?rxid=25c7c5b2-7766-49fb-9f66-f67d44060a7d

Verkís. (2021). *Electrification of Harbours in Iceland (Rafvæðing hafna á Íslandi).* Retrieved from https://www.stjornarradid.is/library/01--Frettatengt---myndir-og-skrar/ANR/Orkustefna/Rafv%C3%A6%C3%B0ing%20hafna%20%C3%A1%20%C3%8Dslandi.pdf