GREENHOUSE GAS INVENTORIES FOR ENGLAND, SCOTLAND, WALES AND NORTHERN IRELAND: 1990-2024

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National Atmospheric Emissions Inventory

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RICARDO Member of WSP

UKCEH

Forest Research

Aether

Gluckman Consulting specialists in refrigeration and climate change

ADAS

Customer:
Department for Energy Security and Net Zero (DESNZ), The Scottish Government, The Welsh Government and The Northern Ireland Department for Agriculture, Environment and Rural Affairs

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Contact:
Science policy enquires should be directed to:
Steve Densley
Department for Energy Security and Net Zero
3-8 Whitehall Place
London
SW1A 2AW
T: +44 7762 001 977
E: steve.densley@energysecurity.gov.uk

Technical enquires should be directed to:
Roxy Cottey,
Aether Ltd,
Blue Boar Court, 9 Alfred Street, Oxford,
OX1 4EH, UK
T: + 44 1865 259200
E: roxy.cottey@aether-uk.com

Author:
Batchelor A, Bert N, Cottey R, Miles J, Mitchell J, Putman S, Shams F (Aether Ltd), Richmond B, Willis D (Ricardo (Member of WSP)[1])

With Contributions from:
Anthony S, Aston C, Bahou J, Barber R, Blannin L, Broomfield M, Brown P, Buys G, Cardenas L, Carnell E, Carswell A, Clilverd H, Del Vento S, Dragosits U, Elliott M, Gibbs, M, Gilhespy S, Gluckman R, Gorji, S, Hamilton N, Hampshire K, Henshall P, Hobson M, Hows S, Ingledew D, Karagianni E, Kelsall A, King K, Levy P, MacCarthy J, Manning A, Marshall O, Matthews R, Milne A, Mullen P, Nickerson R, O'Doherty S, Passant N ,Pang Y, Pearson B, Pitt J, Raine B, Redington A, Rose R, Richardson J, Sandars D, Sidhu N, Skirvin D, Stanley K, Stewart R, Thistlethwaite G, Thomson A, Thornton A, Tomlinson S, Vaughan A, Wakeling D, Walker C, Watterson J, Wong J, Young D, Young H

Approved by:
Hampshire, K.

Ricardo reference:
ED18140/2024/4.6/REC

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[1] Ricardo is a member of WSP following WSP's acquisition of Ricardo on 9th of October 2025. Hereafter in this report, Ricardo (Member of WSP) is referred to as 'Ricardo'.

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SUMMARY

This report presents an overview of the data, methods, and results of the analysis to derive greenhouse gas (GHG) emission inventories for England and the Devolved Governments (DGs): Scotland, Wales, and Northern Ireland (hereafter referred to collectively as the ‘DG inventories’)[2]. The DG inventories data are presented in a separate Microsoft Excel file published on the NAEI website at:

https://naei.energysecurity.gov.uk/greenhouse-gases/devolved-government-greenhouse-gas-emissions

Scope of the Inventories

The 1990-2024 GHG inventories for England, Scotland, Wales, and Northern Ireland presented in this report are based on the latest UK GHG inventory, which covers territorial GHG emissions, meaning emissions occurring within the UK’s borders. The DG GHG inventories cover the following items:

- Emissions are presented for years 1990, 1995 and every year from 1998 to 2024.
- The Base Year is calculated by taking the sum of emissions for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in 1990, and the sum of emissions for all F-gases (HFCs, PFCs, SF_6 and NF_3) in 1995.
- GHG emissions are expressed in terms of carbon dioxide equivalent (CO_2e). This is the unit of measurement that standardises the climate impact of the GHGs mentioned above.
- Emissions are categorised into ‘Territorial Emissions Statistics’ (TES) Sectors, which is a UK classification system to define the sectors where emissions occur in the UK. These sectors are: Electricity supply, Fuel Supply, Domestic Transport, Buildings and Product Uses, Industry, Agriculture, Land use, land use change and forestry (LULUCF) and Waste.
- Emissions are also categorised into Common Reporting Tables (CRT) categories, in accordance with the Paris Agreement reporting. This ensures the emissions presented in DG inventories are categorised in a transparent and comparable way, consistent with the international community.
- Carbon dioxide data are based on the net emissions of carbon dioxide, including net emissions/removals of carbon dioxide in the LULUCF sector.
- Emissions are consistent with international and UK GHG inventory reporting protocol and exclude emissions from international aviation and shipping for England and Northern Ireland, which are reported as “memo items”. Emissions for Scotland and Wales are reported including international aviation and shipping as they are included in national targets.
- Emissions in the UK GHGI from offshore oil and gas exploration and production activities are not allocated to any country and are reported as ‘Unallocated’. In addition, process emissions from vessels serving the oil and gas sector (e.g. from oil loading onto shuttle tankers) are also reported as “Unallocated”.

The GHG emission estimates are presented in three different ways:

- *By Source*: emissions are accounted for in the country and source sector in which they are emitted.
- *End User*: emissions related to energy supply are reallocated to the sectors where the “end use” of the energy occurred. This re-allocation of the upstream energy supply sector emissions to the ultimate consumers of the energy provides a much better representation of the sector-specific consumption patterns.

[2] The England and DG inventories are collectively referred to as the “DG inventories” throughout this report, although it is acknowledged that England does not have a devolved government. This term is for ease of reference only. Four separate inventories are produced each year, one for each country, but they are compiled together and share the same approach.

- *Traded / Non-Traded*: Traded refers to emissions that are controlled under the EU Emission Trading System and UK's Emissions Trading Scheme (ETS), and non-traded are all the emissions that are outside the scope of the ETS.

Recalculations

Each year, the DG inventories are extended and updated – i.e. the previous inventories covered the years up to and including 2023, whilst this year's inventories give emission estimates for the years up to and including 2024.

While preparing the new inventory year, the entire time series is also updated to include the latest data available. Improvements to the methodology are backdated as necessary to ensure a consistent time series. The nature of inventories is such that ongoing improvements to data collection or estimation techniques will inevitably lead to some revisions of historical data and our understanding of the trends.

Uncertainties

The DG inventories aim to use the best data available. However, due to a lack of data in some sectors and/or low-quality data, the DG inventories are based on a wide range of data sources which will include statistical differences, assumptions, proxy datasets, modelled data and some expert judgement. This introduces some uncertainty into the inventories, which means there is potential for inaccuracy (over- or under-estimating the true value of emissions or removals) and imprecision. Therefore, it is necessary to quantify uncertainty to be transparent, and to help identify areas for future improvement.

The analysis of the DG inventories indicates that the 95% confidence intervals around each country's 2024 GHG emissions total are in the range of ±3% to ±6%.

By Source Summary

- In 2024, England's total emissions were 278.7 million tonnes ($MtCO_2e$). England has seen a decrease of 55% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 2%.
- In 2024, Scotland's total emissions were 39.0 $MtCO_2e$ – including international aviation and shipping. Scotland has seen a decrease of 50% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 1%.
- In 2024, Wales' total emissions were 30.1 $MtCO_2e$ – including international aviation and shipping. Wales has seen a decrease of 44% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 9%.
- In 2024, Northern Ireland's total emissions were 18.4 $MtCO_2e$. Northern Ireland has seen a decrease of 29% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 0.04%.

End User Summary

- England had a 77.5% share of total net End User GHG emissions in 2024 (compared to a 74.6% share of By Source emissions). End User emissions were 9% lower than the By Source estimates in 2024 as a result of emissions attributed to England in the End User inventories that come from energy production activities (e.g. electricity generation) outside England in the By Source inventories. End User emissions have declined by 54% since 1990.
- Scotland had a 10.3% share of total net End User GHG emissions in 2024 (compared to a 9.8% share of By Source emissions, excluding memo items). End User emissions were 5% higher than the By Source estimates in 2024. The carbon intensity of energy generated at Scottish power stations has been lower than the remainder of the UK across much of the time series, a reflection of the early phase out of coal-powered generation, with the closure of Longannet marking the cessation of coal-fired energy generation in Scotland in 2016. End User emissions have declined by 54% since 1990.
- Wales had an 7.1% share of total net End User GHG emissions in 2024 (compared to an 7.9% share of By Source emissions, excluding memo items). End User emissions were 11%

lower than the By Source estimates in 2024 as a result of a net export of emissions attributed to energy production activities from Wales (e.g. exported electricity and refined oils that are generated in Wales and used in other parts of the UK). End User emissions have declined by 51% since 1990.

- Northern Ireland had a 5.1% share of total net End User GHG emissions in 2024 (compared to a 4.9% share of By Source emissions). End User emissions are only 1% higher than By Source emission. End User emissions have declined by 30% since 1990.

Traded/ Non Traded Summary

- England's share of ETS (traded) emissions comes from a number of categories, principally power generation, iron and steelworks, and refineries. England's traded emissions are estimated to be 18.3% of its total GHG emissions in 2024.
- Scotland has a slightly lower share of ETS emissions to that in England, with traded emissions mainly arising from categories such as refineries, upstream oil and gas and chemicals. Scotland's traded emissions are estimated to be 16.6% of its total GHG emissions in 2024.
- In Wales, the coverage of the ETS is higher than the rest of the UK, reflecting the high share of heavy industry (e.g. emissions from power stations, refineries and integrated iron and steelworks. Wales' traded emissions are estimated to be 40% of its total GHG emissions in 2024.
- Northern Ireland has a lower share of the ETS emissions compared to Great Britain, reflecting the absence of refineries, iron and steelworks, and oil and gas terminals. Northern Ireland's traded emissions are estimated to be 14.4% of its total GHG emissions in 2024

Legal Context

The United Kingdom has a legal obligation to reduce GHG emissions over time.

The UK is a party to the United Nations Framework Convention on Climate Change (UNFCCC), which has the objective to stabilise GHG emissions to the atmosphere and reduce the impacts of human activity on the climate. The UK has also ratified the Paris Agreement, and is therefore required to set emission reduction targets every five years.

It is the UK's Climate Change Act (2019 amendment) which establishes the legal requirement to reduce net GHG emissions by 100% in 2050 (i.e. Net Zero), compared to the baseline year of 1990. The Climate Change Act 2008 also introduced carbon budgets, legally binding limits on the total amount of greenhouse gas emissions the UK can emit over five-year periods. In addition to the UK targets, each DG government has their own legal targets:

- The Climate Change (Emissions Reduction Targets) (Scotland) Act 2024[3] sets out Scotland's ambition to achieve net-zero GHG emissions by 2045. It sets the following interim targets: for 2026 to 2030 an average 43% of baseline, for 2031 to 2035 an average 31% of baseline, for 2036 to 2040 an average 20% of baseline, and for 2041 to 2045 an average 6% of baseline.
- The Environment (Wales) Act 2016[4] introduced a statutory emission reduction framework for Wales, including a 2050 target, interim targets for 2020, 2030 and 2040 and a system of five-yearly carbon budgets to support the target delivery. Subsequent Regulations update the original 80% reduction by 2050, to commit Wales to achieving net zero by 2050. They also set the interim targets[5] for 2020 (27% reduction); 2030 (63% reduction), and 2040 (89% reduction), as well as the limit for carbon budgets 1 (2016-2020), CB2 (2021-2025), CB3 (2026-2030) and CB4 (2031-2035).

[3] https://www.legislation.gov.uk/asp/2024/15
[4] https://www.legislation.gov.uk/anaw/2016/3/contents
[5] https://www.legislation.gov.uk/wsi/2018/1304/regulation/2

- The Climate Change Act (Northern Ireland) 2022[6] sets a target of an at least 100% reduction in GHG emissions by 2050, along with interim targets including an at least 48% reduction in net emissions by 2030.

The DG inventories help to support evidence-based development of climate change policy by the Scottish Government, Welsh Government and the Northern Ireland Executive. The DG inventories help track progress towards these country-specific GHG emission reduction targets.

[6] https://www.legislation.gov.uk/nia/2022/31/contents/enacted

ABBREVIATIONS

Abbreviation	Definition
CAA	Civil Aviation Authority
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CRT	Common Reporting Tables
DGs	Devolved Governments
DEFRA	Department for Environment, Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
DEC	Display Energy Certificate
DfT	Department for Transport
DomCom	Domestic Combustion
DUKES	Digest of UK Energy Statistics
EFs	Emission Factors
EPC	Energy Performance Certificate
ETS	Emissions Trading Scheme
GDP	Gross Domestic Product
DG	Devolved Government
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
GHGIIP	Greenhouse Gas Inventory Improvement Programme
GVA	Gross Value Added
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
HGV	Heavy Goods Vehicle
HWP	Harvested Wood Products
IDBR	Inter-Departmental Business Register
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
ISSB	Iron and Steel Statistics Bureau
LDVs	Light-Duty Vehicles
LESSE	Low Emissions Slurry Spreading Equipment
LULUCF	Land use, land use change and forestry
NAEI	National Atmospheric Emissions Inventory
NC	National Communication
NDCs	Nationally Determined Contributions
NID	National Inventory Document
NF_3	Nitrogen trifluoride
N_2O	Nitrous oxide
NRMM	Non-Road Mobile Machinery
OPG	Other Petroleum Gases
PFCs	Perfluorocarbons
PI	Pollution Inventory
SCA	Smoke Control Area
SF_6	Sulphur hexafluoride
TES	Territorial Emissions Statistics
UK	United Kingdom of Great Britian and Northern Ireland
UNFCCC	Framework Convention on Climate Change
WDI	Waste Data Interrogator

1. INTRODUCTION

This report presents an overview of the data, methods, and results of the analysis to derive greenhouse gas (GHG) emission inventories for England and the Devolved Governments (DGs): Scotland, Wales, and Northern Ireland (hereafter referred to as the DG inventories). The DG inventories data are presented in a separate Microsoft Excel file published on the NAEI website at:

https://naei.energysecurity.gov.uk/greenhouse-gases/devolved-government-greenhouse-gas-emissions

This report provides a summary of the reported emission trends for the large source categories within each DG, including high-emitting source categories and those that have a notable impact on the overall reported emission trends by DG. A description of how the inventory estimates have been derived and any notable changes in the inventory data and methods compared to previous inventory cycles are provided in the appendices, including where changes to the UK GHG Inventory (GHGI) data have led to revisions for DG estimates.

1.1 LEGISLATION AND POLICY CONTEXT

The GHG inventories for England, Scotland, Wales and Northern Ireland help to support evidence-based development of climate change policy by the Scottish Government, Welsh Government and the Northern Ireland Executive. The inventories help track progress towards country-specific GHG emission reduction targets.

The implementation of new UK and country-specific legislation means that the requirements of the GHG inventories for the DGs is evolving, with a much greater focus on (i) sector-specific data accuracy, and (ii) sensitivity to policy impacts

1.1.1 The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC was ratified by the United Kingdom in December 1993 and came into force on the 21st March 1994. The objective of the Convention is to stabilise GHG emissions to the atmosphere and reduce anthropogenic interference with the climate system. In order to achieve this, the international community needs to monitor progress, which requires accurate information on trends of emissions of GHGs, and the collective ability to alter these trends.

The UK, as an Annex I Party to the Convention, having ratified the Kyoto Protocol, where the final submission was published in 2022, is required to submit to the UNFCCC Secretariat net national GHG inventories, including all anthropogenic emissions of GHGs By Sources and removals by sinks. Parties are required to submit information on their national inventories on an annual basis and within National Communications (NC) periodically, according to dates established in the Conference of the Parties.

The UK has also ratified the Paris Agreement, which has now superseded the Kyoto Protocol. A requirement of the Paris Agreement is to set emission reduction targets every five years known as Nationally Determined Contributions (NDCs). For its First NDC, the UK has committed to reduce total net GHG emissions by at least 68% in 2030, compared to 1990 level. For its Second NDC, the UK has committed to reduce total net GHG emissions by at least 81% in 2035, compared to 1990 levels.

The UK Climate Change Act (2008) established new legal requirements to monitor and report UK GHG emission reductions. The CCA established a long-term legally binding framework to reduce total UK net GHG emissions by at least 100% below 1990 levels by 2050. The Act also introduced a Carbon Budgeting System whereby emission caps are set over 5-year periods, to map out the emission trajectory to 2050. The UK has met its first, second and third Carbon Budgets covering the periods 2008-12, 2013-17 and 2018-22 respectively.

1.1.2 Devolved Government's Climate Change Commitments

Powers to implement measures to deliver reductions in emissions of GHGs in Scotland, Wales and Northern Ireland are devolved to the Scottish Government, Welsh Government and the Northern Ireland Executive. Each of the DGs has developed national climate change legislation or strategies establishing targets for reductions in GHG emissions together with accompanying national climate change policy frameworks:

- The Climate Change (Emissions Reduction Targets) (Scotland) Act 2024
- The Environment (Wales) Act 2016 and Climate Change (Wales) Regulations 2021
- The Climate Change Act (Northern Ireland) 2022

1.1.2.1 Scotland

The Climate Change (Emissions Reduction Targets) (Scotland) Act 2024[7] builds on the Climate Change (Scotland) Act 2009[8] and 2019[9], demonstrating Scotland's increased ambition to achieve net-zero GHG emissions by 2045. It includes a carbon budget target framework, requiring that every year between 2026 and 2045 is covered by a budget. The budgets[10] are expressed as an average percentage of the baseline emissions level as defined in the 2009 Act:

- 2026 to 2030: average 43% of baseline
- 2031 to 2035: average 31% of baseline
- 2036 to 2040: average 20% of baseline
- 2041 to 2045: average 6% of baseline

The 2019 Act removed the emissions accounting adjustments related to the operation of trading schemes such as the UK-Emissions Trading Scheme (ETS), and also imposed restrictions on the use of carbon units ("credits") to offset domestic emissions for the purposes of assessing progress to targets. The Act proposals set a default limit of zero for all future years, unless Ministers bring forward regulations subject to the affirmative procedure allowing for the possibility of credit use in specified future years.

1.1.2.2 Wales

The Environment (Wales) Act 2016[11] introduced statutory emission reduction targets for Wales, including at least an 80% reduction in emissions by 2050 against a 1990 baseline, interim targets for 2020, 2030 and 2040 and a system of five-yearly carbon budgets to support the target delivery.

The Climate Change (Wales) Regulations 2021[12] provides an update on this target, committing to achieve net zero by 2050. It also sets the following interim targets: emissions reduction of 27% against the baseline by 2020; 63% reduction by 2030, and 89% reduction by 2040. In addition, the Climate Change (Carbon Budgets) (Wales) Regulations set the carbon budget limits for Carbon Budget 1 (2016-2020), an average reduction of 23% lower than the baseline, Carbon Budget 2 (2021-2025), an average reduction of 37% lower than the baseline, Carbon Budget 3 (2026-2030), an average reduction of 58% lower than the baseline, and Carbon Budget 4 (2031-35), an average reduction of 73% lower than the baseline.

1.1.2.3 Northern Ireland

The Climate Change Act (Northern Ireland) 2022[13] sets a target of an at least 100% reduction in GHG emissions by 2050, along with interim targets including an at least 48% reduction in net emissions by

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[7] https://www.legislation.gov.uk/asp/2024/15
[8] https://www.legislation.gov.uk/asp/2009/12/contents
[9] https://www.legislation.gov.uk/asp/2019/15
[10] https://www.gov.scot/policies/climate-change/reducing-emissions/
[11] https://www.legislation.gov.uk/anaw/2016/3/contents
[12] https://www.legislation.gov.uk/wsi/2021/332/made
[13] https://www.legislation.gov.uk/nia/2022/31/contents/enacted

2030. The Act also sets other sectoral targets, including 2030 targets of at least 80% of electricity consumption deriving from renewable sources, recycling 70% of waste, as well as a target for a minimum spend of 10% of overall transport budgets on active travel.

1.2 ABOUT THE GREENHOUSE GAS EMISSIONS INVENTORY

The 1990-2024 GHG inventories for England, Scotland, Wales, and Northern Ireland presented here are based on the latest UK GHGI[14]. The following points apply to the inventories presented in this report:

- The years in scope for the DG GHG inventories are 1990, 1995 and each year from 1998 to 2024.
- The estimates are expressed in terms of global warming potentials (GWPs) defined on a 100-year horizon (IPCC, 2006), which is explained further in **Section 1.2.1** below. The estimates and the GWPs are consistent with the UNFCCC reporting guidelines. In line with international reporting conventions, emissions are published using GWPs from the Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report (IPCC, 2014).
- Emissions are categorised into 'Territorial Emissions Statistics' (TES) Sectors. These were introduced in the 1990-2022 GHGI cycle, whereas prior to this, emissions were categorised in NC Sectors.
- Emissions are also categorised into Common Reporting Tables (CRT) categories, in accordance with the Paris Agreement[15]. This ensures the emissions presented in DG inventories are categorised in a transparent and comparable way, consistent with the international community. These were introduced in the 1990-2023 inventory cycle and supersede the previously used Common Reporting Format (CRF) categories.
- Emissions are consistent with international and UK GHGI reporting protocol and exclude emissions from international aviation and shipping for England and Northern Ireland, which are reported as "memo items". Emissions for Scotland and Wales are reported including international aviation and shipping as they are included in national targets.
- Emissions of biogenic carbon dioxide (CO_2) from the burning of biofuels are also excluded.
- Emissions in the UK GHGI from offshore oil and gas exploration and production activities are not allocated to any country and are reported as 'Unallocated'. In addition, vessels serving the oil and gas exploration and production sector are categorised in the same way.
- Estimates exclude the Crown Dependencies (Jersey, Guernsey, and Isle of Man) and those Overseas Territories joining UK instruments of ratification for the UNFCCC (Gibraltar, Bermuda, the Falkland Islands, and the Cayman Islands).

For details of the latest UK GHGI, please see the latest National Inventory Document (NID) and the Department for Energy Security and Net Zero (DESNZ) national GHG statistics, available at:

https://naei.energysecurity.gov.uk/reports/uk-greenhouse-gas-inventory-1990-2024-annual-report-submission-under-framework-convention

https://www.gov.uk/government/collections/uk-territorial-greenhouse-gas-emissions-statistics

1.2.1 Greenhouse Gases included in the Inventories

Emissions are reported for the seven direct GHGs, and these are listed in **Table 1** alongside their GWP used in the inventory. Depending on their molecular weights, radiative properties, and residence times in the atmosphere, each GHG has a different capacity to impact global warming. The GWP is an attempt to encapsulate these parameters and provide a consistent measure of the relative radiative effects of the emissions of the relevant GHGs, through the units carbon dioxide equivalent

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[14] https://naei.energysecurity.gov.uk/reports/uk-greenhouse-gas-inventory-1990-2024-annual-report-submission-under-framework-convention

[15] Decision 18/CMA.1 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement. Sets out requirement to present national inventory in common reporting tables.

(CO_2e). As gases have varying residence times in the atmosphere, consideration is given to the GWP variation across time-horizons; GWPs of gases with shorter residence times than carbon dioxide would increase if a shorter time-horizon is considered. All figures included in the following report are calculated using the Fifth Assessment Report (IPCC, 2014) as per **Table 1**.

Table 1 – Fifth Assessment Report Global Warming Potential of GHGs on a 100-year Horizon (t CO_2 equivalent/ t gas) (IPCC, 2014)

Greenhouse Gases		Global Warming Potential (t CO_2 equivalent / t gas)
Carbon Dioxide	CO_2	1
Methane	CH_4	28
Nitrous Oxide	N_2O	265
Hydrofluorocarbons	HFCs	4 – 12,400
Perfluorocarbons	PFCs	6,630 – 17,400
Sulphur hexafluoride	SF_6	23,500
Nitrogen trifluoride	NF_3	16,100

1.2.2 Inventories Sector Definitions

The GHG inventories for England, Scotland, Wales and Northern Ireland in this report are presented using TES Sectors to ensure the sum of the DG inventories is fully consistent with the UK GHG emissions statistics. A description of the TES Sectors is provided in **Table 2**.

Table 2 – Territorial Emission Statistics Sector Definitions

Sector Name	Territorial Emission Statistics (TES) Sector Definitions
Electricity Supply	Emissions from power stations for electricity generation, including incinerators generating energy from waste. Excludes emissions from organisations generating their own electricity (autogeneration) even when exported to the electricity grid. These emissions are instead included in the sector in which they occur.
Fuel Supply	Emissions from the supply of fuels, e.g. oil, gas and coal. Includes activities such as extraction, production, venting, flaring, processing (e.g. oil refining) and distribution. Excludes emissions from coke production which are instead included in the industry sector as coke is primarily used in the iron and steel industry.
Domestic Transport	Emissions from road vehicles, domestic aviation and shipping (including military), fishing vessels, and railways. Also includes emissions from transport related mobile machinery (e.g. at airports and ports) and F-gases from mobile air conditioning and refrigeration. International aviation and shipping emissions are not included in the national total, though are reported separately.
Buildings and Product Uses	Emissions from fuel combustion in residential, public, and commercial buildings, largely for heating. Also includes emissions from house and garden mobile machinery, anaesthetics, F-gases from air conditioning, refrigeration, heat pumps, aerosols as well as other product uses. Excludes emissions from industrial buildings which are instead included in the industry sector.
Industry	Emissions from fuel combustion in the manufacturing and construction industries, industrial processes, and F-gases from industrial refrigeration. Emissions from coke production are included in this sector as coke is primarily used in the iron and steel industry. Includes emissions from organisations generating their own electricity and

Sector Name	Territorial Emission Statistics (TES) Sector Definitions
	heat (autogeneration) even when exported to the electricity grid or used in heat networks.
Agriculture	Emissions from agricultural machinery and fuel combustion, livestock (enteric fermentation and manure management) and agricultural soils (excluding carbon stock changes which are included in the LULUCF sector).
Land use, land use change and forestry (LULUCF)	Net carbon dioxide emissions from carbon stock changes in forestland, cropland, grassland, wetlands, settlements and harvested wood products. Other GHG emissions from drainage (excl. croplands and intensive grasslands) and rewetting of soils, nitrogen mineralisation associated with loss and gain of soil organic matter, and fires. As carbon stock changes are included in this sector, carbon dioxide emissions of biogenic origin (e.g. CO_2 emissions from burning biomass for energy) are excluded from other sectors to avoid double counting of emissions.
Waste	Emissions from the treatment and disposal of waste, such as landfill, composting, incineration without energy recovery and wastewater handling. Excludes emissions from incinerators generating energy from waste as these are reported in the electricity supply sector.
International aviation and shipping	Emissions associated with travel/transport from a location within the geographic scope of the inventory to a location outside that scope.

To provide information that is aligned to the needs of DG policy teams, the GHGI is also provided in NC sectors at the top level, with additional detail by CRT Category.

The UK national total excludes emissions from international aviation and shipping (which are presented as memo items to national inventories, in accordance with UNFCCC reporting requirements) and of biogenic carbon dioxide from the burning of biofuels. Emission targets in Wales and Scotland do include emissions from international transport. Biogenic carbon at point of release is excluded from all inventory totals, as biogenic carbon is part of the short-term carbon cycle, having been sequestered from the atmosphere by plants. Emissions of GHGs from offshore oil and gas exploration and production, and the vessels serving this sector, are classified within this report as “Unallocated” emissions and not attributed to any of the DGs.

Figure 1 – Overview of the Categories within the DG Inventories

1.2.3 Inventories Scope

This report, and associated data, presents DG emission estimates in following three formats.

1.2.3.1 By Source Inventories

The data in this report are, unless otherwise stated, presented as emission estimates at the point of emission, also called “by source” estimates. Emissions are accounted for in the country and source sector in which they are emitted.

1.2.3.2 End User Inventories

Emissions related to energy supply are reallocated to the sectors where the “end use” of the energy occurred. The emissions reallocated include the whole of the electricity supply and fuel supply source sectors, along with a small number of sources in the industry sector (in particular, autogeneration of electricity exported to the grid and coke production). This reallocation of the upstream energy supply sector emissions to the ultimate consumers of the processed fuels provides a much better representation of the sector-specific consumption patterns that can be targeted through climate change and energy efficiency policies, improving the understanding of demand-side energy use in the UK economy.

Note that, whilst emissions from international transport (aviation and shipping) are excluded from the DG By Source inventories estimates (as they are reported as memo items), the Fuel Supply sector emissions associated with the production of international transport fuels (i.e. from upstream oil and gas extraction and oil refining) are included and attributed to the “End use outside the UK” category in the End User inventories.

The End User emission estimates at sector level are more uncertain than the country totals, and hence the absolute sector End User emission estimates and reported trends by sector since 1990 should be regarded as indicative. The methodology used for estimating the End User emissions for each DG is presented in **Appendix 5.** End User Emissions

1.2.3.3 Traded / Non-Traded Inventories

Emissions within the By Source inventory are split into two categories:

- Traded sector – emissions that are controlled under the EU's Emission Trading System and UK's Emissions Trading Scheme (ETS)[16]
- Non-Traded sector – all emissions that are outside of the scope of the UK ETS

Emissions from the traded (i.e. within the UK ETS) and non-traded sectors represent an important component of emissions reporting in the UK and DG GHG inventories. The ETS is jointly run by the UK ETS Authority which is comprised of the UK Government, Scottish Government, Welsh Government and the Department of Agriculture, Environment and Rural Affairs for Northern Ireland (DAERA). Policy levers available to the Scottish Government, Welsh Government and Northern Ireland Executive have limited influence over activities within the traded sector. Conversely, the DGs have a wide range of policy levers available for the non-traded sectors of the UK economy, which are dominated by sources such as transport, residential, commercial and small-scale industrial emissions. It is therefore important to analyse trends in emissions for the non-traded sectors of the DG inventories.

Where possible and for relevant source categories, the By Source emissions are presented with an additional split to show the relative contribution of the traded and non-traded emissions within each DG. The split is calculated by subtracting the traded emissions from the total emissions.

1.3 BY SOURCE INVENTORY ESTIMATES FOR 2024

The UK distribution of regional net[17] GHG emissions in 2024, expressed in terms of CO_2e, are presented in **Table 3**.

Table 3 – Share of 2024 UK total for the DGs, both excluding and including international aviation and shipping. Unallocated emissions are offshore and not allocated to the DG inventories.

	Share of 2024 UK total (excluding international aviation and shipping)	Share of 2024 UK total (including international aviation and shipping)
England	74.6%	76.4%
Scotland	9.8%	9.4%
Wales	7.9%	7.3%
Northern Ireland	4.9%	4.5%
Unallocated	2.7%	2.4%

The percentage change in emissions compared to the Base Year and the latest inventory year are presented below, with further details for each country presented in **Sections 2 - 5**. The Base Year is calculated by taking the sum of emissions for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in 1990, and the sum of emissions for all F-gases (HFCs, PFCs, SF_6 and NF_3) in 1995[18]. All of the carbon dioxide data are based on the net emissions of carbon dioxide, including net emissions/removals of carbon dioxide in the LULUCF sector.

[16] The UK Emissions Trading Scheme (UK ETS) replaced the UK's participation in the EU ETS on 1 January 2021. UK based operators (except for electricity generators in Northern Ireland, who will remain in EU ETS in accordance with the terms of the Northern Ireland Protocol (or Protocol on Ireland/Northern Ireland to the Withdrawal Agreement, depending on how formal the publication is)) will now report their emissions under the UK ETS. For the purposes of calculating UK emissions statistics, teams should use EU ETS data for emissions arising up to December 31st, 2020, and use UK ETS data for emissions emitted from 1st January 2021. As the UK ETS was initially designed to provide a smooth transition for relevant sectors from the EU to the UK scheme, the two data sets are compatible.

[17] Total net emissions include removals in the Land Use Land Use Change and Forestry (LULUCF) sector and exclude emissions from international aviation and shipping.

[18] As per Article 3.8 of the Kyoto Protocol.

- In 2024, England's total emissions were 278.7 million tonnes ($MtCO_2e$). England has seen a decrease of 55% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 2%.
- In 2024, Scotland's total emissions were 39.0 $MtCO_2e$ – including international aviation and shipping. Scotland has seen a decrease of 50% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 1%.
- In 2024, Wales' total emissions were 30.1 $MtCO_2e$ – including international aviation and shipping. Wales has seen a decrease of 44% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 9%.
- In 2024, Northern Ireland's total emissions were 18.4 $MtCO_2e$. Northern Ireland has seen a decrease of 29% in GHG emissions between the Base Year and 2024. Emissions between 2023 and 2024 have decreased by 0.04%.

The remaining 2.7% of UK emissions in 2024 (excluding international aviation and shipping) are offshore and hence are not allocated to the DG inventories. Emissions data at full precision can be found in the tables that accompany this report: "Devolved Government GHG Emissions 1990-2024".

1.4 UNCERTAINTIES

The 1990-2024 DG GHG emission estimates are based on a wide range of data sources and include statistical differences, assumptions, proxy datasets and some expert judgement. In addition, the natural variability in processes (e.g. emissions from farming practices under different climatic conditions and across soil types, carbon content of fuels, and performance of industrial production plant and abatement plant) that are being "modelled" introduces a degree of uncertainty.

An overall analysis of the uncertainty in latest year DG inventories totals indicates that the uncertainties are in the range of ±3% to ±6%[19] with the 2.5 and 97.5 percentiles are shown in **Appendix 4.** Uncertainties

to indicate a 95% confidence range. The overall uncertainty depends on the relative contributions to the DG inventories of more uncertain categories where the NAEI team understand less about the distribution and intensity of the estimates (e.g. nitrous oxide from agricultural soils, carbon dioxide from LULUCF, solid and liquid fuel combustion). Uncertainties for each DG in 2024 are presented within **Sections 2 to 5** below.

- Emissions of carbon dioxide typically have the lowest uncertainty due to the high contribution from fuel consumption sources where the carbon content of fuels is generally very well documented. The main source of uncertainty in carbon dioxide estimates at the DG level is the lack of detailed DG-specific energy balances. The "outlier" in carbon dioxide inventory terms is Scotland, where there is a much greater contribution from more uncertain LULUCF sources and sinks, whilst Northern Ireland carbon dioxide inventory uncertainties are somewhat higher than the UK average due to the uncertain activity data for off-gas-grid use of liquid and solid fuels outlined above. DG uncertainties in carbon dioxide inventories in the latest year are: ±2% England, ±8% Scotland, ±3% Wales and ±6% Northern Ireland.
- Emissions of nitrous oxide are associated with higher uncertainty than for other gases (±22% England, ±17% Scotland, ±17% Wales, ±23% Northern Ireland) due primarily to the high uncertainty in estimates for emissions from soils (for fertiliser application and variability of soil types).
- Emissions of methane tend to be associated with uncertainties that are between carbon dioxide and nitrous oxide (±16% England, ±13% Scotland, ±10% Wales, ±9% Northern Ireland).

Long-term trends in emissions can be estimated more accurately than short-term year-to-year differences in emissions. This is a crucial point to consider when assessing the reasons for the year-to-year changes in emissions. Year-to-year, or inter-annual trends, can be strongly influenced by

[19] Note that the Base Year uncertainty ranges between ±4% to ±6%.

short term factors such as colder winters or fuel commodity prices. Colder winters generally lead to increased fuel use relative to warmer winters, thus increasing emissions. Increases in fuel commodity prices are likely to restrict increases in fuel use and may decrease fuel use. Emissions will respond accordingly. Furthermore, there is an inherent uncertainty in the representativeness of individual surveys and other datasets that underpin inventory estimates for an individual year. Averaged over several years, these uncertainties are reduced. Over the longer-term, with larger and longer-term datasets to work with, the impact of year-to-year variability in data capture in surveys, censuses and industrial regulatory reporting is reduced and longer-term trends become more visible.

A full description of the quantitative model of uncertainty is available in the UK's NID 1990 to 2024: https://naei.energysecurity.gov.uk/reports/uk-greenhouse-gas-inventory-1990-2024-annual-report-submission-under-framework-convention

1.5 TRADED / NON-TRADED INVENTORIES ESTIMATES

The UK and EU[16] ETS data have been analysed and used to derive a split for Non-Traded estimates for the By Source DG GHG emission inventories[20]. This method takes account of observed data discrepancies for specific sectors and presents a “non-traded” component to the By Source estimates. The methodology for Traded/ Non-Traded compilation is provided in **Appendix 6.** Traded Non-Traded Methodology. Please note all figures presented below exclude international aviation and shipping.

- Across the UK, the non-traded share of total GHG emissions was 78.4% of total GHG emissions in 2024.
- England’s share of ETS (traded) emissions comes from a number of categories, principally power generation, iron and steelworks, and refineries. England’s traded emissions are estimated to be 18.3% of its total GHG emissions in 2024.
- Scotland has a slightly lower share of ETS emissions to that in England, with traded emissions mainly arising from categories such as refineries, upstream oil and gas and chemicals. Scotland’s traded emissions are estimated to be 16.6% of its total GHG emissions in 2024.
- In Wales, the coverage of the ETS is higher than the rest of the UK, reflecting the high share of heavy industry (e.g. emissions from power stations, refineries and integrated iron and steelworks. Wales’ traded emissions are estimated to be 40.0% of its total GHG emissions in 2024.
- Northern Ireland has a lower share of the ETS emissions compared to Great Britain, reflecting the absence of refineries, iron and steelworks, and oil and gas terminals. Northern Ireland’s traded emissions are estimated to be 14.4% of its total GHG emissions in 2024.

1.6 END USER INVENTORIES ESTIMATES

In the End User inventories analysis, all emissions associated with energy supply (e.g. power generation, coal mining, oil and gas extraction, refineries) are allocated to the energy consumer. There is a high level of uncertainty in the reported data, due to the limited availability of data on electricity generation and consumption, especially at the DG level in 1990. The net[21] GHG End User emissions in 2024 and emission trends in the End User inventories are summarised below. Please note all figures presented below include upstream emissions from fuel supply associated with the fuel used in International Aviation and Shipping, but not the direct emissions from the use of those fuels[22].

- England had a 77.5% share of total net End User GHG emissions in 2024 (compared to a 74.6% share of By Source emissions). End User emissions were 9% lower than the By

[20] The Traded/ Non-Traded inventories estimates exclude aviation bunkers and marine bunkers (both international and domestic).

[21] Net emissions include removals in the LULUCF sector.

[22] The percentages presented in these figures are rounded but are calculated from emission estimates calculated at full precision. Note that all percentages quoted in this report are based on net emission estimates held at full precision and they may differ slightly from those that can be calculated from summary tables presented in the report.

Source estimates in 2024 as a result of emissions attributed to England in the End User inventories that come from energy supply activities (e.g. electricity generation) outside England in the By Source inventories. End User emissions have declined by 54% since 1990.

- Scotland had a 10.3% share of total net End User GHG emissions in 2024 (compared to a 9.8% share of By Source emissions, excluding memo items). End User emissions were 5% higher than the By Source estimates in 2024. The carbon intensity of energy generated at Scottish power stations has been lower than the remainder of the UK across much of the time series, a reflection of the early phase out of coal-powered generation, with the closure of Longannet marking the cessation of coal-fired energy generation in Scotland in 2016. End User emissions have declined by 54% since 1990.
- Wales had an 7.1% share of total net End User GHG emissions in 2024 (compared to an 7.9% share of By Source emissions, excluding memo items). End User emissions were 11% lower than the By Source estimates in 2024 as a result of a net export of emissions attributed to energy supply activities from Wales (e.g. exported electricity and refined oils that are generated in Wales and used in other parts of the UK). End User emissions have declined by 51% since 1990.
- Northern Ireland had a 5.1% share of total net End User GHG emissions in 2024 (compared to a 4.9% share of By Source emissions). End User emissions are only 1% higher than By Source emission. End User emissions have declined by 30% since 1990.

For further details of the End User inventories in the 1990-2024 cycle, see **Appendix 5.** End User Emissions

1.7 REVISIONS AND UPDATES TO THE INVENTORIES

Each year, the GHG inventories for England, Scotland, Wales, and Northern Ireland are extended and updated. The time series of the inventories are extended by including a new inventory year – i.e. the previous inventory covered the years up to and including 2023, whilst this inventory submission gives emission estimates for the years up to and including 2024.

While preparing the new inventory year, the entire time series for each inventory is also updated to include the latest data available. Improvements to the methodology are backdated as necessary to ensure a consistent time series. The nature of inventories is such that ongoing improvements to data collection or estimation techniques will inevitably lead to some revisions of historical data and our understanding of the trends. Methodological changes are made to take account of new data sources, new guidance from IPCC, and new research.

For the energy sector, a number of sub-sectors in the DG GHG inventories are calculated using a top-down method (i.e. using proxy data) from the UK GHGI due to a lack of sub-national energy balances. As a result of this, the UK GHGI, and subsequently the DG GHG inventories utilise core energy statistics provided by DESNZ in their annual publication, the ‘Digest of UK Energy Statistics’ (DUKES) (DESNZ, 2025a). The DUKES data are revised annually and hence the data provided may be different in the latest edition of DUKES, compared to that used in the compilation of the previous inventories. Data revisions are generally for the latest 2-3 years, and these revisions also feed into the DG GHG inventories. In addition to DUKES, the DG GHG inventories makes use of sub-national energy statistics provided by DESNZ, which may also be revised for recent years; revisions to these only impact the DG GHG inventories and not the UK GHGI.

In addition, there may also be updates to the methodology used to allocate emissions to each of the DGs, especially where full and consistent sets of fuel use data are not available. For example, where emissions may previously have been allocated using surrogate statistics such as country-specific Gross Value Added (GVA) data or population, this methodology may be improved to use data more closely related to the activities producing these emissions, should more suitable statistics become available.

As a result of these improvements to underlying activity datasets and methods used to estimate and distribute emissions across DGs, data in this publication of the inventories are likely to differ from figures presented in previous DG GHG inventories. Some sectors have undergone large revisions, which are summarised in the following sections and in **Appendix 2.** Method Changes and Recalculations

The following changes have been made to the UK GHGI and are captured in the related sections in the NID (Brown, et al., 2026). A short summary of recalculations is provided within the sections below, and the NID should be referred to for further detail.

2. GHG EMISSIONS IN ENGLAND (1990 – 2024)

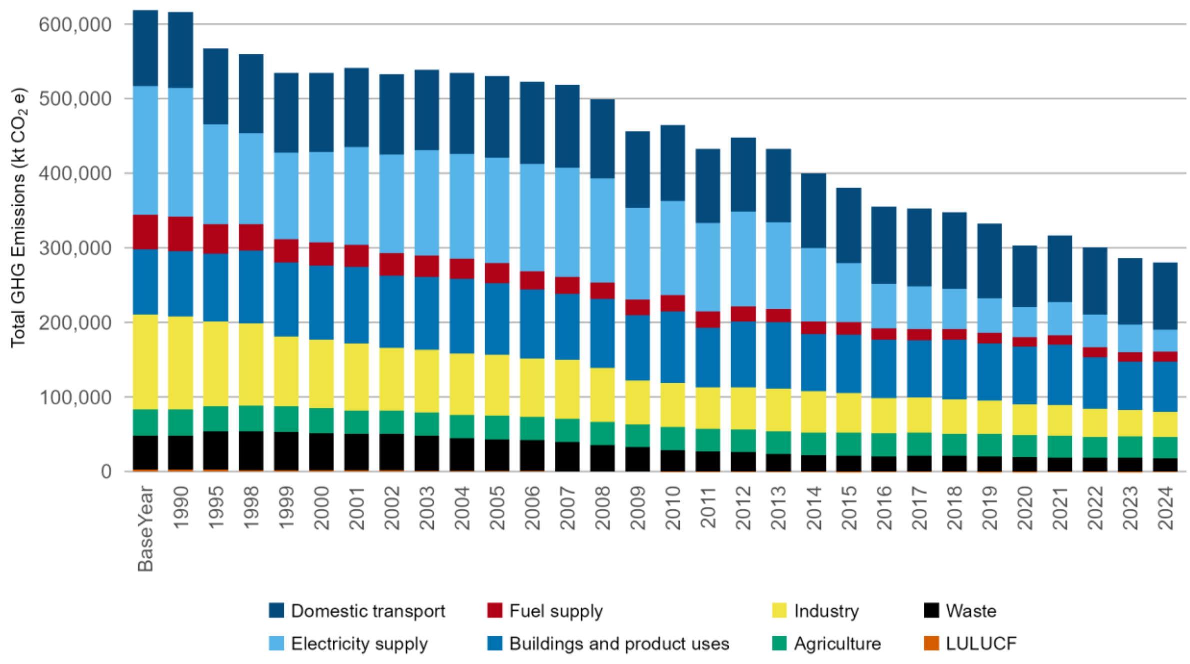

Figure 2 – England GHG Emissions 1990-2024 ($ktCO_2e$)

2.1 KEY SOURCES, SINKS AND TRENDS

Total GHG emissions (excluding international aviation and shipping) from England have declined by 55% between the Base Year and 2024, excluding international aviation and shipping. Emissions decreased by 2% between 2023 and 2024.

The key sources influencing the overall inventory trends in England are presented by TES Sectors. The analyses presented below may be further disaggregated into TES Sub-sector and TES Category, and shows proportional change over time[23].

Domestic Transport (32% of 2024 inventory)

- Despite emissions decreasing since 2020, domestic transport has remained as the largest contributor to emissions since 2014. The time series shows that road transport is the largest source of emissions in England, making up 92% of the total domestic transport emissions in 2024. Emissions from road transport were at a maximum in 2007 and a recent peak in 2017, declining by 14% between 2017 and 2024. This trend is observed across passenger cars, heavy duty vehicles and motorcycles. Passenger cars show the greatest decline (15%) since 2019, largely shaped by overall reductions in car use since 2019. The decline in 2020 was likely driven by COVID-19, however the emissions from passenger cars in 2022-2024 remain lower than 2019.

Buildings and Product Uses (24% of 2024 inventory)

- The Buildings and Product Uses sector is dominated by residential combustion which accounts for 66% of the sectors emissions in 2024. The time series shows that between the Base Year and 2024, emissions have decreased by 23% within the sector due to a switch

[23] This means the percentage change presented for one category is not comparable to the percentage change in another category. A small absolute change in a small source of emissions can have the same percentage change as a large absolute change in a large source of emissions. Actual emissions values can be found in the accompanying data tables.

from less efficient solid and liquid fuels to natural gas for heating, and improvements in energy efficiency.

- Emissions from Buildings and Product Uses in 2024 are 4% higher than in 2023. This is driven by an 8% increase in emissions from public sector buildings, and 5% increase in emissions from residential buildings. This is due to reduced energy prices across 2023-2024, inducing higher consumption of energy to heat homes and public sector buildings.

Industry (12% of 2024 inventory)

- Industrial fuel combustion remains a major emission source in Industry and England, contributing to 10% of England's total emissions in 2024. This is despite a decline in industrial fuel combustion emissions of 62% between the Base Year and 2024. The trend is mainly due to plant closures, fuel-switching to less carbon-intensive fuels, and improved production efficiency.
- Industry emissions decreased by 3% between 2023 and 2024. Emissions have decreased by 24% since 2019. This is a result of continued plant closures, more recently blast furnaces in the steel industry.
- Chemical and fluoro-chemical production installations have also fitted abatement and undergone closures, for example the one adipic acid plant in England has closed, as have several nitric acid plants.

Electricity Supply (11% of 2024 inventory)

- Power station emissions are predominantly driven by gas and municipal solid waste power stations that, when combined, produce 94% of the total power station emissions in England. Power station emissions have reduced by 83% since 1990 due primarily to the shift in fuel mix away from coal to use less carbon-intensive fuels in electricity generation, including increased use of renewables.
- Much of this decline has occurred in the latter years of the time series from the closure or conversion of major power producers, and the phasing out of coal from the fuel mix.
- Between 2023 and 2024 there was an 18% decrease in emissions from power stations. This is primarily driven by a fall in fossil fuel-based electricity generation—particularly from gas—and continued growth in renewable energy sources. There has also been an increase in other fuel used, e.g. municipal solid waste.

Agriculture (10% of 2024 inventory)

- Emissions in the agriculture sector have decreased by 20% between the Base Year and 2024. Manufactured fertiliser use and resulting nitrous oxide emissions from soils has decreased by 53% since the Base Year, and enteric fermentation in beef and dairy cattle has reduced by 21% and 32% respectively due to lower animal numbers.
- Agriculture emissions are only 1% lower in 2024 than in 2023, predominantly due to increases in emissions from agricultural combustion which increased by 19%. This was offset by a 5% increase in emissions from enteric fermentation from beef cattle, which is one of the largest sources of emissions in agriculture.

Waste (6% of 2024 inventory)

- Emissions have declined by 61% between the Base Year and 2024. This is mainly driven by emissions from landfill, which have decreased by 77% since the Base Year largely due to the progressive introduction of methane capture and oxidation systems within landfill management.
- However, this is offset by an increase in emissions from wastewater, which have increased by 55% since the Base Year.
- Between 2023 and 2024, emissions from the waste sector decreased by 4%, which is primarily driven by decreases in emissions from landfill.

Fuel Supply (5% of 2024 inventory)

- Emissions from fuel supply have decreased by 72% between the Base Year and 2024.

- Other contributors to this decrease are a 99% reduction in coal mining and handling and emissions from leakages in gas distribution falling by 72% since the Base Year.
- Emissions from fuel supply decreased by 3% between 2023 and 2024, which is primarily driven by a decrease in emissions from oil refineries.

LULUCF (a net sink with magnitude equivalent to 0.5% of 2024 inventory)

- The LULUCF sector has been a net sink since 2008. There has been an increase of 22% net carbon sink of forest land remaining forest land in 2024 since the Base Year, in addition to decreases in the conversion of land to cropland and settlements, and an increase in grassland carbon storage.
- However, between 2023 and 2024, there was a 4% increase in emissions due to the reduced Forest Land carbon sink.

2.2 UNCERTAINTY

England uncertainty in 2024 for all GHGs (±3%): England has a relatively low overall uncertainty because the inventory has the highest overall contribution from carbon dioxide and the lowest contribution from GHGs that are dominated by sources with higher uncertainty such as methane and nitrous oxide. Carbon dioxide emissions in England are also mainly from combustion and industrial sources which have relatively low uncertainty, as emissions from these sectors are typically well-reported and uncertainty with fuel use statistics are relatively low.

2.3 RECALCULATIONS

Compared to the previous inventory, emissions were revised upwards by 0.11% in 2023 and downwards by 2.40% in 1990. The main recalculation reasons are presented below, with further detail on DG-level recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Agriculture

At the UK level, the recalculations include:

- Recalculations to Agriculture/Forestry/Fishing Stationary fuel use in the early time series are driven by recalculation to the DUKES estimates post-2009 affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years. Recalculations in the later time series are also impacted by splitting out natural gas data from DUKES and the quantity of biogas injected into the grid.
- Recalculations to Enteric Fermentation non-dairy cattle arise from updates to milk-yield assumptions, reflecting revised provisional 2023 milk yields for England and UK. Additional recalculations result from updates to the slaughter-weight time series (2016–2019 and 2022–2023) and a correction to dairy-cow liveweight, which applies to all dairy animals across the entire time series.
- Recalculations to Manure Management non-dairy cattle are driven by changes in volatile solids (VS) excretion, reflecting the updated slaughter-weight time series and the correction to dairy-cow liveweight, both of which influence all years. Small additional changes arise from an update to the percentage of manure diverted to anaerobic digestion, with minor revisions from around 1991 onwards, increasing toward the end of the time series. Full descriptions of DG-specific recalculations in Enteric fermentation and Manure management (CRT Category 3A and 3B) can be found in **Appendix 2.** Method Changes and Recalculations

Buildings and Product Uses

Recalculations in this sector are driven by changes at a UK level and mapping grid updates:

- For commercial/institutional stationary fuel use, there are recalculations across the time series due to UK level revisions and DG-level mapping grid updates. For natural gas, the UK level revision in the later time series is due to splitting the natural gas data from DUKES based on the recalculations to the quantity of biogas injected into the grid.

- For burning oil, the UK level revision is driven by recalculation to the DUKES estimates post-2009 affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years.
- For residential stationary fuel use, at the UK level, the main contributors are revisions to DUKES in later years, and incorporating the improvement to separate natural gas into fossil and bio components based on the quantity of biogas injected into the grid.
- There were DG level revisions too as a result of oil mapping grid updates and minor ETS data revisions, as well as updates to use the most recent domestic fuel use mapping grids from 2005, particularly for oil-based fuels.

Domestic Transport

There are large shipping recalculations at the DG and UK level due to updating the shipping model to use 2019 as the base year (instead of 2014). This is a result of implementing the Greenhouse Gas Inventory Improvement Project (GHGI IP) shipping improvement, incorporating 2019 international Automatic Identification System (AIS) data, revised emission factors and assumptions from the Department for Transport's (DfT) Maritime Emissions Model (MEM), and a fundamental shift from a "fuel used" to "fuel sold" approach.

More details on the shipping recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Electricity Supply

There were recalculations to the UK gas use data from DUKES.

Fuel Supply

At the UK level, calculations were revised for some sites to use ETS reported fuel use as opposed to Environmental and Emissions Monitoring System (EEMS); thus impacting the share of emissions attributed to combustion processes in oil and gas extraction, versus those attributed to fugitive related processes, captured in oil and natural gas.

Industry

UK level recalculations to Industry include:

- For iron and steel industries fuel use there are recalculations due to the annual update of the DUKES gas data at the UK level, impacting England in the late time series.
- For chemicals industries fuel use, there are revisions to the DUKES gas data in 2023 at the UK level, impacting all DGs.
- Recalculations occur in the early part of the time series for food, drink and tobacco industries fuel use due to inconsistencies identified in the historical DUKES data. These have been addressed by applying data that are more consistent with recent years and by standardising the gap-filling approach, resulting in a more coherent time series. At the DG level, there have been recalculations, especially in 2023, due to updated food & drink gas and coal mapping grids.
- Revisions to other manufacturing industries and construction stationary fuel use due to using revised 2009-2015 DUKES estimates and extrapolating pre-2009 data in the UK inventory, and slight revisions in DUKES unclassified burning oil in 2022 and 2023.
- Revisions to commercial/institutional mobile machinery fuel use at the UK level in 2023 due to a revision to DUKES oil balance.
- Recalculations to pig iron production across the time series at the UK level due to a combination of 2013 Iron and steel best available techniques reference document (BREF)

updates to emission factors and moving away from carbon balance approach to using average historical carbon emission factors due to inconsistencies in DUKES.

- For other product manufacture and use, there was a correction to a specific plant in England in the pollution inventory database across the time series, replacing a gap filling methodology that was used previously.
- Mapping grids were updated at the DG level due to sector specific Non-Road Mobile Machinery (NRMM) methods being introduced in the spatial mapping, see more detail in detail in **Appendix 2.** Method Changes and Recalculations

LULUCF

- There were recalculations to Forest Land to Wetlands due to changes to soil carbon modelling in the CARBINE forest carbon accounting model. England also updated peatland restoration data and reclassified historic domestic peat extraction areas. There were also crosscutting recalculations to Forest land due to updates to the CARBINE model and to wood production estimates for 2023 provisional figures and planting estimates for 2023 provisional figures.
- There were updates to deforestation estimates for 2021-2023 based on revised figures on rewetted areas received from Defra.

Full descriptions of the updates and recalculations LULUCF are outlined in **Appendix 2.** Method Changes and Recalculations

Waste

At the UK level, there have been a number of recalculations that include:

- Recalculations to managed anaerobic waste disposal sites, driven by an update to the landfill model. This is described further in **Appendix 2.** Method Changes and Recalculations

  Later in the time series, there are updates to the material sent to landfill in England for 2006 - 2010, 2020 and 2022. The changes for these years reflect the updated Waste Data Interrogator (WDI) statistics.
- There are recalculations to Domestic wastewater treatment and discharge due to the implementation of the new municipal wastewater model, and recalculations to Industrial wastewater treatment and discharge. This is described further in **Appendix 2.** Method Changes and Recalculations
- There are also a smaller number of DG specific recalculations, which include:
  - Revisions to methane flaring data for all DGs for 2022 and 2023.
  - There were also minor adjustments in landfill gas data in 2022 and 2023 regional statistics for all DGs.
  - At the DG level, there has been an updated municipal wastewater treatment mapping grid, based on the data provided into the model, that has resulted in DG specific recalculations across the time series; the previous driver utilised population as a proxy for distributing municipal wastewater emissions.

3. GHG EMISSIONS IN SCOTLAND (1990 - 2024)

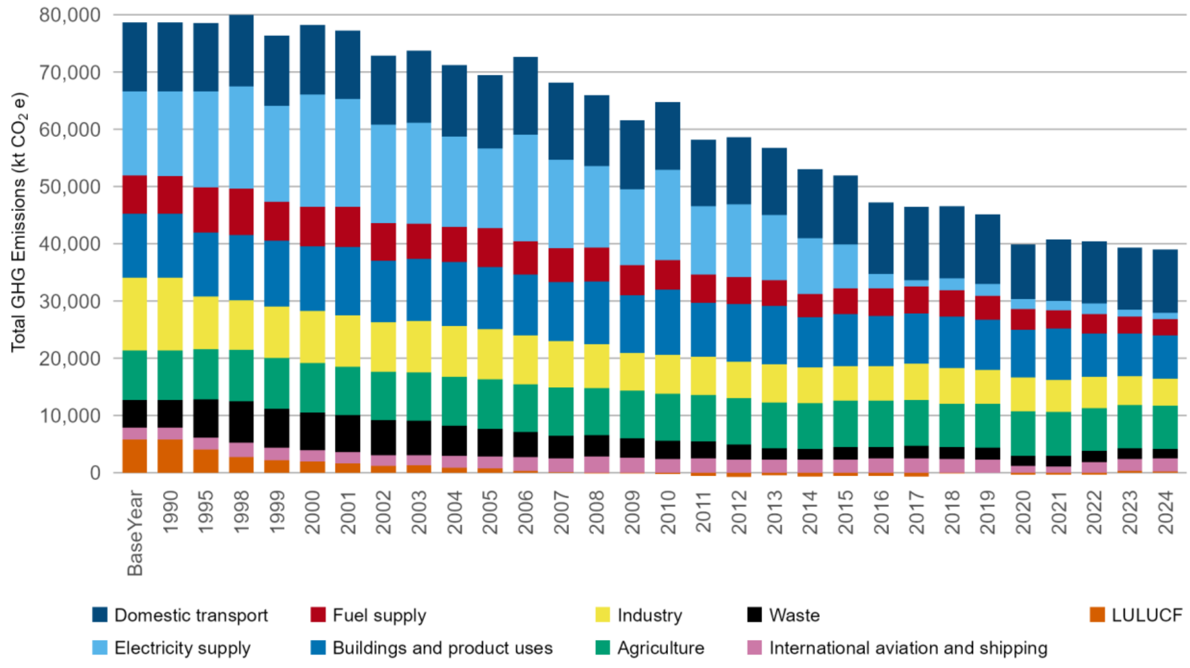

Figure 3 – Scotland GHG Emissions 1990-2024 (ktCO_2e)

3.1 KEY SOURCES, SINKS AND TRENDS

Total GHG emissions (including international aviation and shipping) for Scotland have declined by 50% between the Base Year and 2024, when including emissions from international aviation and shipping.

The key sources influencing the overall inventory trends in Scotland are presented by the TES Sectors. The analyses presented below may be further disaggregated into TES Sub-sector and TES Category, and shows proportional change over time[24].

Domestic Transport (28% of 2024 inventory)

- Domestic Transport has been the largest source of emissions in Scotland for the past decade; however, emissions from domestic transport decreased by 9% between the Base Year and 2024. Road transport alone accounts for 23% of Scotland's emissions in 2024.
- Since 2019, there has been a 13% decrease in emissions from passenger cars, primarily driven by reduced fuel consumption associated with the travel restrictions imposed during the COVID-19 pandemic.
- Road transport emissions increased between 2020 and 2022 by approximately 14%, tending towards a return to pre-COVID-19 levels, but levelled out and saw a minor increase (0.9%) between 2023 and 2024.

Agriculture (19% of 2024 inventory)

- Emissions in the agriculture sector have decreased by 14% between the Base Year and 2024. This is largely driven by a decrease in livestock numbers (particularly cattle and sheep), resulting in a 19% reduction in livestock emissions since the Base Year.

[24] This means the percentage change presented for one category is not comparable to the percentage change in another category. A small absolute change in a small source of emissions can have the same percentage change as a large absolute change in a large source of emissions. Actual emissions values can be found in the accompanying data tables.

- There was a marginal decrease in agriculture emissions between 2023 and 2024 (circa 32 kt). Emissions from agricultural and forestry mobile machinery increased by 16% between 2023 and 2024, but this was offset by reductions in several livestock categories.

Buildings and Product Uses (19% of 2024 inventory)

- Residential buildings are the largest source of emissions within Buildings and product use, accounting for 64% of emissions in 2024. Between the Base Year and 2024, emissions from residential buildings have decreased by 39% because of a switch from less efficient solid and liquid fuels to natural gas for heating, and improvements in energy efficiency.
- Buildings and product use emissions increased by 1% between 2023 and 2024. This is driven by public sector and commercial buildings increasing by 9% and 8% between 2023 and 2024 respectively, as a result of public sector and commercial buildings predominantly being heated by natural gas and challenges in scaling energy efficiency.

Industry (12% of 2024 inventory)

- Emissions from Industry decreased by 63% between the Base Year and 2024. In the Industry sector, industrial fuel combustion remains a major emission source in Scotland but shows a strong decline of 61% between the Base Year and 2024. This is due to plant closures, fuel-switching to less carbon-intensive alternatives and improvements in production efficiency.
- Consequently, industrial processes emissions have also decreased, reducing by 78% since the Base Year. Closure of the Ravenscraig steelworks in 1992 has contributed to an almost complete reduction in iron and steel sector emissions between the Base Year and 2024.
- There was a 6% decrease in emissions between 2023 and 2024, driven by a reduction in fuel use in the chemical industries.

Fuel Supply (7% of 2024 inventory)

- Fuel Supply emissions have decreased by 57% between the Base Year and 2024. Emissions from fuel supply saw a slight increase of 4% from 2021 to 2022 but returned to the usual rate of decrease in 2024, dropping 4% from the previous year.
- A major contributor to this trend is the reduction in emissions from oil refineries, which reduced by 8% between 2023 and 2024.

Waste (4% of 2024 inventory)

- Waste emissions have declined by 64% between the Base Year and 2024, largely due to the progressive introduction of methane capture and oxidation systems within landfill management and reductions in waste landfilled.
- Emissions continued to decline between 2023 and 2024, decreasing by 6%, which is largely driven by a reduction in landfill emissions.

Electricity Supply (3% of 2024 inventory)

- Power station emissions have reduced by 93% between the Base Year and 2024 due primarily to the shift in fuel mix away from coal to use less carbon-intensive fuels for generation, including increased use of nuclear and renewables.
- Between 2023 and 2024, emissions from power stations decreased by 6%, which is largely driven by a 11% decrease in emissions from gas use in power stations.

International aviation and shipping (4% and 2% of the 2024 inventory, respectively)

- Emissions from international aviation in Scotland have increased by 209% between the Base Year and 2024. Emissions from international aviation in Scotland have returned to and are now exceeding pre-COVID-19 levels, with an 11% increase in emissions between 2019 and 2024.
- However, emissions from international shipping have declined by 57% between the Base Year and 2024, with the overall trend showing a general decline throughout. Between 2023 and 2024, emissions decreased by 2%.

LULUCF (a net source worth 0.4% of 2024 inventory)

- LULUCF was a net source of GHG emissions up to 2007, after which it was reported as a net sink in between 2008 and 2022. Across the time series, Forest Land remaining Forest Land and Grassland are consistent sinks of emissions, while the principal emission sources are associated with Cropland and Peatland, particularly drained peatland categories and Cropland mineral soils.
- Between 2023 and 2024, LULUCF emissions decreased by 42%. This reduction reflects a combination of lower emissions from remaining Forest Land (4%), land converted from Forest Land (down 6%), and continued decreases across several peatland drainage categories, including forest drained peatland (down over 700%) and eroding modified bog drained (down 12%). These reductions were partly offset by small increases in emissions from rewetted peatland categories and land converted to Forest Land, reflecting ongoing restoration activity and the transitional emissions associated with land use change.

3.2 UNCERTAINTY

Scotland uncertainty in 2024 for all GHGs (±6%): Scotland has a notably higher level of overall uncertainty due to the much greater contribution to the Scotland total from sources and sinks with large uncertainties, such as LULUCF and agriculture. In addition, Scotland has a relatively high contribution to its overall GHG total from methane and nitrous oxide; these inventories are dominated by sources that are much harder to characterise, with EFs that are highly uncertain.

3.3 RECALCULATIONS

Compared to the previous inventory, emissions were revised downwards by 1.55% in 2023 and 4.20% in 1990. The main recalculation reasons are presented below, with further details on DG-level recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Agriculture

At the UK level, the recalculations include:

- Recalculations to Agriculture/Forestry/Fishing Stationary fuel use in the early time series are driven by recalculation to the DUKES estimates post-2009, affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years. Recalculations in the later time series are also impacted by splitting out natural gas data from DUKES and the quantity of biogas injected into the grid.
- Recalculations to Enteric Fermentation non-dairy cattle arise from updates to milk-yield assumptions, reflecting revised provisional 2023 milk yields for UK averages (AUK). Additional recalculations result from updates to the slaughter-weight time series (2016–2019 and 2022–2023) and a correction to dairy-cow liveweight, which applies to all dairy animals across the entire time series.
- Recalculations to Manure Management non-dairy cattle are driven by changes in volatile solids (VS) excretion, reflecting the updated slaughter-weight time series and the correction to dairy-cow liveweight, both of which influence all years. Small additional changes arise from an update to the percentage of manure diverted to anaerobic digestion, with minor revisions from around 1991 onwards, increasing toward the end of the time series.
- A small recalculation occurs for Scotland in 2023, where nitrogen application rates for the Dairy farm type are now derived from a rolling three-year average, consistent with the current methodological approach. Further details in Enteric fermentation and Manure management (CRT Category 3A and 3B) can be found in **Appendix 2.** Method Changes and Recalculations

Building and Product Uses

Recalculations in this sector are driven by changes at a UK level and mapping grid updates:

- For commercial/institutional stationary fuel use, there are recalculations across the time series due to UK-level revisions and DG-level mapping grid updates. For natural gas, the UK level revision in the later time series is due to splitting the natural gas data from DUKES based on the recalculations of the quantity of biogas injected into the grid.

- For burning oil, the UK level revision is driven by recalculation of the DUKES estimates post-2009, affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years.
- For residential stationary fuel use, at the UK level, the main contributors are revisions to DUKES in later years, and incorporating the improvement to separate natural gas into fossil and bio components based on the quantity of biogas injected into the grid.
- There were DG-level revisions, too, as a result of oil mapping grid updates and minor ETS data revisions, as well as updates to use the most recent domestic fuel use mapping grids from 2005, particularly for oil-based fuels.

Domestic Transport

There are large shipping recalculations at the DG and UK level due to updating the shipping model to use 2019 as the base year (instead of 2014). This is a result of implementing the Greenhouse Gas Inventory Improvement Project (GHGI IP) shipping improvement, incorporating 2019 international Automatic Identification System (AIS) data, revised emission factors and assumptions from the Department for Transport's (DfT) Maritime Emissions Model (MEM), and a fundamental shift from a “fuel used” to “fuel sold” approach.

More details on the shipping recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Electricity Supply

There are recalculations in 2023 to the points data for municipal solid waste in power stations.

Fuel Supply

At the UK level, calculations were revised for some sites to use ETS-reported fuel use as opposed to Environmental and Emissions Monitoring System (EEMS); thus, impacting the share of emissions attributed to combustion processes in oil and gas extraction, versus those attributed to fugitive-related processes, captured in oil and natural gas.

Industry

UK level recalculations to Industry include:

- For chemicals industries fuel use, there are revisions to the DUKES gas data in 2023 at the UK level, impacting all DGs.
- Recalculations occur in the early part of the time series for food, drink and tobacco industries fuel use due to inconsistencies identified in the historical DUKES data. These have been addressed by applying data that are more consistent with recent years and by standardising the gap-filling approach, resulting in a more coherent time series. At the DG level, there have been recalculations, especially in 2023, due to updated food & drink gas and coal mapping grids.
- Revisions to other manufacturing industries and construction stationary fuel use due to using revised 2009-2015 DUKES estimates and extrapolating pre-2009 data in the UK inventory, and slight revisions in DUKES unclassified burning oil in 2022 and 2023.
- Revisions to commercial/institutional mobile machinery fuel use at the UK level in 2023 due to a revision to DUKES oil balance.
- Recalculations to pig iron production across the time series at the UK level due to a combination of 2013 Iron and steel best available techniques reference document (BREF) updates to emission factors and moving away from the carbon balance approach to using average historical carbon emission factors due to inconsistencies in DUKES.

- Small recalculations affect Scotland in particular in 2023 for Petrochemical and carbon black production - Other due to a revised NAEI source and activity allocation for a specific plant in the ETS database.
- Mapping grids were updated at the DG level due to sector specific Non-Road Mobile Machinery (NRMM) methods being introduced in the spatial mapping, see more detail in detail in **Appendix 2.** Method Changes and Recalculations

LULUCF

- There were crosscutting recalculations to Forest land due to updates to the CARBINE model and to wood production estimates for 2023 provisional figures and planting estimates for 2023 provisional figures. There are updates to deforestation datasets for 2015-2023 based on revised figures on rewetted areas received from Peatland ACTION.
- There were recalculations to Forest Land converted to Wetlands due to the CARBINE model change to soil carbon.

Full descriptions of the updates and recalculations LULUCF are outlined in **Appendix 2.** Method Changes and Recalculations

Waste

At the UK level, there have been a number of recalculations that include:

- Recalculations to managed anaerobic waste disposal sites, driven by an update to the landfill model. This is described further in **Appendix 2.** Method Changes and Recalculations
- There are recalculations to Domestic wastewater treatment and discharge due to the implementation of the new municipal wastewater model, and recalculations to Industrial wastewater treatment and discharge. This is described further in **Appendix 2.** Method Changes and Recalculations
- There are also a smaller number of DG specific recalculations, which include:
    - Revisions to methane flaring data for all DGs for 2022 and 2023.
    - There were also minor adjustments in landfill gas data in 2022 and 2023 regional statistics for all DGs.
    - At the DG level, there has been an updated municipal wastewater treatment mapping grid, based on the data provided into the model, that has resulted in DG specific recalculations across the time series; the previous driver utilised population as a proxy for distributing municipal wastewater emissions.

4. GHG EMISSIONS IN WALES (1990 - 2024)

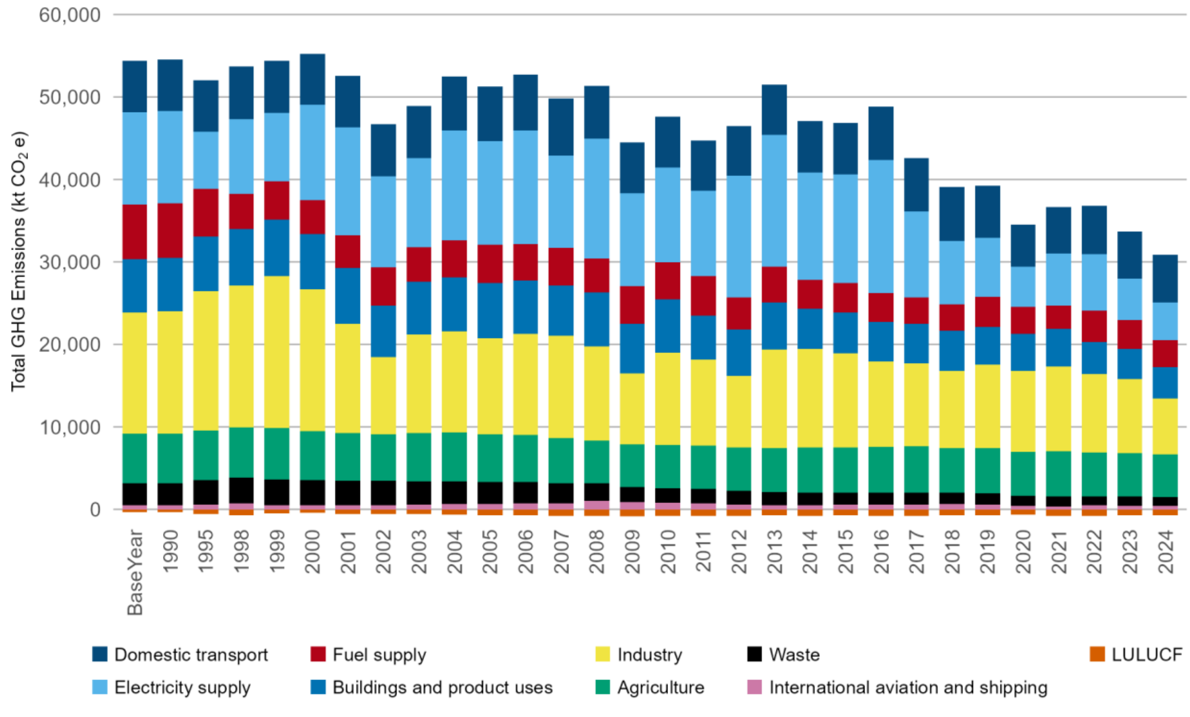

Figure 4 – Wales GHG Emissions 1990-2024 (ktCO_2e)

4.1 KEY SOURCES, SINKS AND TRENDS

Total GHG emissions (including international aviation and shipping) for Wales have decreased by 44% between the Base Year to 2024, when including emissions from international aviation and shipping.

The key sources influencing the overall inventory trends in Wales are presented by the TES Sectors. The analyses presented below may be further disaggregated into TES Sub-sector and TES Category, and shows proportional change over time[25].

Industry (22% of 2024 inventory)

- Industry emissions have decreased by 54% between the Base Year and 2024. Throughout the time series, the largest subsector for Wales is fuel combustion from iron and steel production, which has decreased by 52% between the Base Year and 2024.
- Emissions from iron and steel production and processes account for 54% of the total Industry emissions in 2024. Emissions have reduced by 36% in iron steel production between 2023 and 2024 and processes by 33%. This is due to the closure of blast furnaces at Port Talbot, where there has been a transition to the less carbon-intensive Electric Arc Furnaces.

Domestic Transport (19% of 2024 inventory)

- Domestic Transport emissions have decreased by 7% between the Base Year and 2024. The largest contributor is road transport, which alone accounts for 17% of Wales total overall emissions in 2024. Emissions from road transport decreased by 7% between the Base Year and 2024. Road transport emissions have not returned to pre-COVID-19 levels following an

[25] This means the percentage change presented for one category is not comparable to the percentage change in another category. A small absolute change in a small source of emissions can have the same percentage change as a large absolute change in a large source of emissions. Actual emissions values can be found in the accompanying data tables.

increase in activity between 2020 and 2022, although there has been a decrease in emissions of 13% between 2020 and 2024.

- Domestic Transport emissions are 1% higher in 2024 than in 2023. This is due to a minor increase in emissions across most subsectors and categories, most notably a 22% increase in emissions via coastal shipping and 3% increase in HGV emissions between 2023 and 2024.

Agriculture (17% of 2024 inventory)

- Emissions in the agriculture sector have decreased by 14% between the Base Year and 2024, mainly a result of a general decline in livestock numbers and manufactured fertiliser use, emissions for both categories have fallen by 10% and 62%, respectively, since the Base Year.
- Emissions in the agriculture sector have decreased by 1% between 2023 and 2024. This is driven by a large decrease in emissions from livestock, with a 3% decrease in beef enteric fermentation and manure management between 2023 and 2024. However, this decrease is partly offset by a 15% increase in agricultural combustion emissions between 2023 and 2024.

Electricity Supply (15% of 2024 inventory)

- Electricity supply emissions have decreased by 59% between the Base Year and 2024, following a number of closures and a switch in the fuel mix from coal to gas and renewables. Notably, since 2016 there has been a decrease in emissions from coal-fired power stations, with no emissions since 2020 following the closure of Aberthaw coal-fired power station.
- Between 2023 and 2024, emissions from electricity supply decreased by 9% due to reduced fossil fuel generation and a slight increase in renewable electricity generation in Wales along with an overall decrease in electricity generation.

Buildings and Product Uses (13% of 2024 inventory)

- Emissions from Buildings and Product Uses decreased by 41% between the Base Year and 2024. The Buildings and Product Uses sector is dominated by residential buildings, which alone represent 9% of Wales emissions in 2024. Between the Base Year and 2024, emissions have decreased by 48% in residential buildings. This is driven by the trend in domestic combustion because of a change to the fuel mix from coal to natural gas, and energy efficiency measures.
- Between 2023 and 2024, emissions from building and product uses increased by 4%, driven by emission increases of 9% in commercial combustion and 12% from public sector combustion.

Fuel Supply (11% of 2024 inventory)

- Emissions from fuel supply decreased by 50% between the Base Year and 2024. Refineries account for 68% of total fuel supply emissions, and 7% of Wales total emissions in 2024. The closure of crude oil and specialist refineries between the Base Year and 2024 has caused a 37% decrease in emissions from oil refineries.
- The closure of many deep coal mines has been a major driver of the long-term reduction in emissions from the Base Year, with coal mining and handling emissions falling by 75% between the Base Year and 2024. This overall downward trend was temporarily reversed following the expansion of operations at Aberpergwm Colliery in 2019, which resulted in a marked increase in emissions between 2018 and 2020. Since 2020, however, emissions from coal mining and handling have declined again, decreasing by 11% between 2020 and 2024. Despite this longer-term reduction, an increase of 24% was observed between 2023 and 2024.

Waste (4% of 2024 inventory)

- Emissions from the waste sector decreased by 60% between the Base Year and 2024. This is largely driven by landfill emissions which have declined by 72% since the Base Year. These reductions are largely due to the progressive introduction of methane capture and oxidation systems within landfill management.

- Between 2023 and 2024, emissions from waste decreased by 7%, driven by an 11% decrease in landfill emissions whilst other large sources such as wastewater are relatively unchanged over the same period.

LULUCF (a sink equivalent to 2% of 2024 inventory[26])

- Wales has been a net sink across the entire time series and generally an increasing trend as LULUCF net sink of emissions in 2024 are 101% higher than the Base Year. The main influences on the emissions trends are emissions from Cropland and Settlements and removals from Forest Land. The decrease in emissions from Cropland, Peatland and Settlements between the Base Year and 2024 and increased removals from Forest Land drive an overall increase in removals across the time series.

International Aviation & Shipping (0.4% & 1% of 2024 inventory, respectively)

- Emissions from international aviation have increased by 53% between the Base Year and 2024, and emissions from international shipping have decreased by 23% between the Base Year and 2024. Emissions from shipping are driven by international heavy fuel oil freight transport resulting in a steady decline in emissions since 2011 due to reduced fuel use.
- Major declines in aviation emissions between 2019 and 2022 are primarily due to reduced aviation activity as a result of the COVID-19 pandemic, although there has been a steady trend tending towards pre-pandemic levels with 2024 emissions amounting to 634% increase compared to 2021 emissions.
- Between 2023 and 2024, emissions from international aviation increased by 35% and international shipping decreased by 5%.

4.2 UNCERTAINTY

Wales uncertainty in 2024 for all GHGs (±3%): Wales has a relatively low overall uncertainty due to the high contribution of carbon dioxide emissions from well-documented emission sources such as heavy industry (power generation, oil refining and iron and steel production). Wales also has a relatively low contribution from the uncertain sources of methane and nitrous oxide.

4.3 RECALCULATIONS

Compared to the previous inventory, emissions were revised downwards by 3.60% in 2023 and 2.32% in 1990. The main recalculation reasons are presented below, with further detail on DG-level recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Agriculture

At the UK level, the recalculations include:

- Recalculations to Agriculture/Forestry/Fishing Stationary fuel use in the early time series are driven by recalculation to the DUKES estimates post-2009 affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years. Recalculations in the later time series are also impacted by splitting out natural gas data from DUKES and the quantity of biogas injected into the grid.
- Recalculations to Enteric Fermentation non-dairy cattle arise from updates to milk-yield assumptions, reflecting revised provisional 2023 milk yields for Wales and UK averages (AUK). Additional recalculations result from updates to the slaughter-weight time series (2016–2019 and 2022–2023) and a correction to dairy-cow liveweight, which applies to all dairy animals across the entire time series.

[26] Since net LULUCF emissions are a sink, their contribution to the national total is a negative percentage.

- Recalculations to Manure Management non-dairy cattle are driven by changes in volatile solids (VS) excretion, reflecting the updated slaughter-weight time series and the correction to dairy-cow liveweight, both of which influence all years. Small additional changes arise from an update to the percentage of manure diverted to anaerobic digestion, with minor revisions from around 1991 onwards, increasing toward the end of the time series. Full descriptions of DG specific recalculations in Enteric fermentation and Manure management (CRT Category 3A and 3B) can be found in **Appendix 2.** Method Changes and Recalculations
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Building and Product Uses

Recalculations in this sector are driven by changes at a UK level and mapping grid updates:

- For commercial/institutional stationary fuel use, there are recalculations across the time series due to UK level revisions and DG level mapping grid updates. For natural gas, the UK level revision in the later time series is due to splitting the natural gas data from DUKES based on the recalculations to the quantity of biogas injected into the grid.
- For burning oil, the UK level revision is driven by recalculation to the DUKES estimates post-2009 affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years.
- For residential stationary fuel use, at the UK level, the main contributors are revisions to DUKES in later years, and incorporating the improvement to separate natural gas into fossil and bio components based on the quantity of biogas injected into the grid.
- There were DG level revisions too as a result of oil mapping grid updates and minor ETS data revisions, as well as updates to use the most recent domestic fuel use mapping grids from 2005, particularly for oil-based fuels.

Domestic Transport

There are large shipping recalculations at the DG and UK level due to updating the shipping model to use 2019 as the base year (instead of 2014). This is a result of implementing the Greenhouse Gas Inventory Improvement Project (GHGI IP) shipping improvement, incorporating 2019 international Automatic Identification System (AIS) data, revised emission factors and assumptions from the Department for Transport's (DfT) Maritime Emissions Model (MEM), and a fundamental shift from a “fuel used” to “fuel sold” approach.

More details on the shipping recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Electricity Supply

There were recalculations to the UK gas use data from DUKES.

Fuel Supply

At the UK level, calculations were revised for some sites to use ETS reported fuel use as opposed to Environmental and Emissions Monitoring System (EEMS); thus impacting the share of emissions attributed to combustion processes in oil and gas extraction, versus those attributed to fugitive related processes, captured in oil and natural gas.

Industry

UK level recalculations to Industry include:

- For iron and steel industries fuel use there are recalculations due to the annual update of the DUKES gas data at the UK level, impacting Wales in the late time series.
- For chemicals industries fuel use, there are revisions to the DUKES gas data in 2023 at the UK level, impacting all DGs.
- Recalculations occur in the early part of the time series for food, drink and tobacco industries fuel use due to inconsistencies identified in the historical DUKES data. These have been addressed by applying data that are more consistent with recent years and by standardising

the gap-filling approach, resulting in a more coherent time series. At the DG level, there have been recalculations, especially in 2023, due to updated food & drink gas and coal mapping grids.

- Revisions to other manufacturing industries and construction stationary fuel use due to using revised 2009-2015 DUKES estimates and extrapolating pre-2009 data in the UK inventory, and slight revisions in DUKES unclassified burning oil in 2022 and 2023.
- Revisions to commercial/institutional mobile machinery fuel use at the UK level in 2023 due to a revision to DUKES oil balance.
- Recalculations to pig iron production across the time series at the UK level due to a combination of 2013 Iron and steel best available techniques reference document (BREF) updates to emission factors and moving away from carbon balance approach to using average historical carbon emission factors due to inconsistencies in DUKES.
- Mapping grids were updated at the DG level due to sector specific Non-Road Mobile Machinery (NRMM) methods being introduced in the spatial mapping, see more detail in detail in **Appendix 2.** Method Changes and Recalculations

LULUCF

- There were crosscutting recalculations to Forest Land due to updates to the CARBINE model and to wood production estimates for 2023 provisional data and planting estimates for 2023 provisional data. In addition, there were recalculations to Forest Land converted to Wetlands due to the CARBINE change to soil carbon.

Full descriptions of the updates and recalculations LULUCF are outlined in **Appendix 2.** Method Changes and Recalculations

Waste

At the UK level, there have been a number of recalculations that include:

- Recalculations to managed anaerobic waste disposal sites, driven by an update to the landfill model. This is described further in **Appendix 2.** Method Changes and Recalculations
- There are recalculations to Domestic wastewater treatment and discharge due to the implementation of the new municipal wastewater model, and recalculations to Industrial wastewater treatment and discharge. This is described further in **Appendix 2.** Method Changes and Recalculations
- There are also a smaller number of DG specific recalculations, which include:
    - Revisions to methane flaring data for all DGs for 2022 and 2023.
    - There were also minor adjustments in landfill gas data in 2022 and 2023 regional statistics for all DGs.
- At the DG level, there has been an updated municipal wastewater treatment mapping grid, based on the data provided into the model, that has resulted in DG specific recalculations across the time series; the previous driver utilised population as a proxy for distributing municipal wastewater emissions.

5. GHG EMISSIONS IN NORTHERN IRELAND (1990 - 2024)

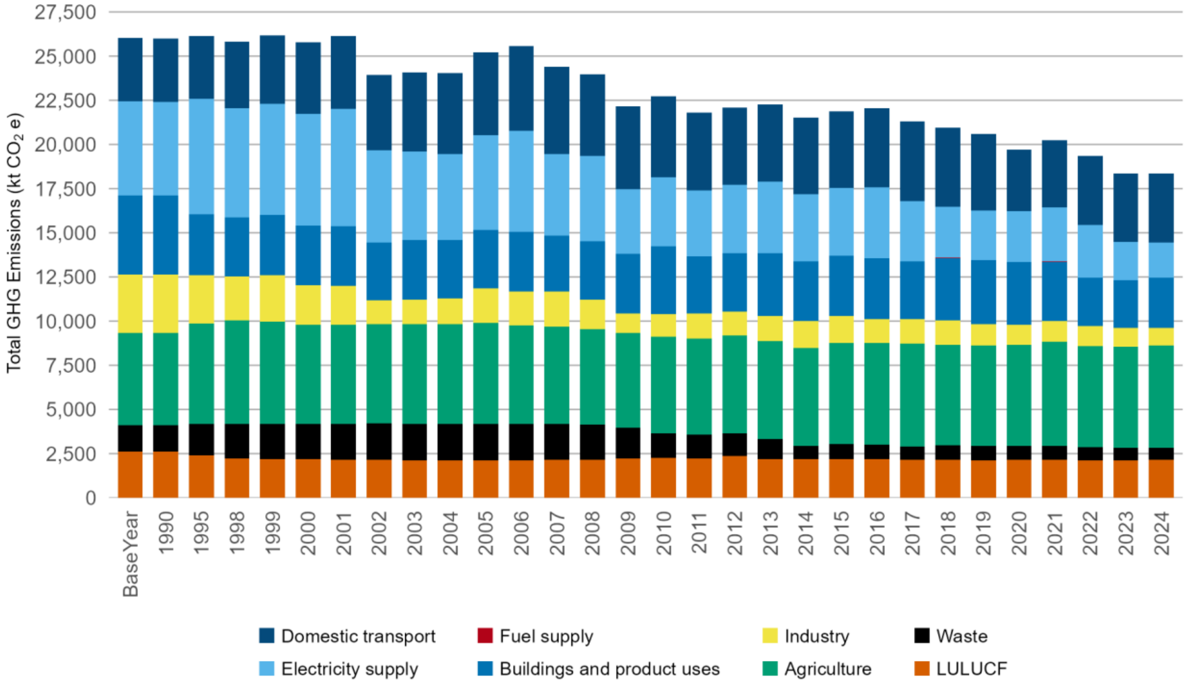

Figure 5 – Northern Ireland GHG Emissions 1990-2024 ($ktCO_2e$)

5.1 KEY SOURCES, SINKS AND TRENDS

Total GHG emissions (excluding international aviation and shipping) for Northern Ireland have declined by 29% between the Base Year and 2024.

The key sources influencing the overall inventory trends in Northern Ireland are presented by the TES Sectors. The analyses presented below may be further disaggregated into TES Sub-sector and TES Category, and shows proportional change over time[27].

Agriculture (31%[28] of 2024 inventory)

- Agricultural emissions account for a larger share of Northern Ireland's total emissions compared to the UK average, primarily because Northern Ireland has fewer industrial and energy-related emission sources, making agriculture a comparatively more dominant contributor.
- Emissions in agriculture have remained largely consistent across the entire time series and have steadily increased by 10% between the Base Year and 2024. This is due to increases in livestock numbers increasing emissions from livestock by 16%, and agricultural combustion increasing emissions by 12% over this period. Although this has been partly offset by lower emissions from agriculture soils which have declined by 10%, partly due to the decrease in manufacture fertiliser application.
- Agriculture emissions increased by 1% increase between 2023 and 2024. This is being driven agriculture NRMM (non-road mobile machinery) use which increased by 16%, and agricultural soils - inorganic N fertilisers, which increased by 21%.

[27] This means the percentage change presented for one category is not comparable to the percentage change in another category. A small absolute change in a small source of emissions can have the same percentage change as a large absolute change in a large source of emissions. Actual emissions values can be found in the accompanying data tables.

[28] Note that this summary does not include commentary on other transport and public sector combustion emissions, and so the sum of percentages does not equal 100%. Emissions from international bunkers are excluded from all figures from this section.

Domestic Transport (21% of 2024 inventory)

- Domestic Transport emissions have increased by 9% between the Base Year and 2024, with road transport accounting for 87% of domestic transport emissions in 2024. Road transport has increased by 10% since the Base Year, due to a growth in demand (cars, LDVs, HGVs), despite improvements in efficiency of vehicles.
- Between 2023 and 2024, emissions from domestic transport increased by 1%, which was driven by a 4% increase in emissions from waterborne and 1% increase from road transport.

Buildings and Product Uses (15% of 2024 inventory)

- Emissions from Buildings and Product Uses decreased by 37% between the Base Year and 2024. Residential buildings accounted for 83% of Northern Ireland's Buildings and Product Uses emissions in 2024, with emissions primarily driven by direct fuel combustion in households. Between the Base Year and 2024, residential emissions fell by 37%, largely due to a shift toward natural gas use from the late 1990s, which displaced more carbon-intensive fuels such as oil and coal.
- Emissions from Buildings and Product Uses increased by 5% between 2023 and 2024. This increase has been driven by a 7% increase in residential combustion. This increase in emissions is only partially offset by relatively minor decreases in emissions from commercial, public sector and other Buildings and Product Uses.

LULUCF (a net source worth 12% of 2024 inventory)

- Northern Ireland is a net source of GHG emissions from LULUCF activities throughout the time series however, between the Base Year and 2024 emissions from LULUCF have fallen by 18%. The main contributors to the LULUCF inventory in 2024 are emissions from Settlements and Peatlands which account for 32% and 108% of LULUCF emissions, respectively.
- Over the time series and in recent years, emissions are partly offset by removals from Forest Land (principally Forest Land remaining Forest Land) and Grasslands (either converted to or remaining Grassland). Since the Base Year, the emission sink from remaining Grassland has increased by 36% and remaining Forest Land also increased by 25%.

Electricity Supply (11% of 2024 inventory)

- Electricity supply sector emissions have decreased by 63% between the Base Year and 2024 due to fuel-switching away from coal- and oil-fired power generation. The mix of generation capacity is quite different in Northern Ireland from the rest of the UK and from 1990 to 1995 consisted entirely of coal and oil-fired stations. In 1996, the largest power station in Northern Ireland, Ballylumford, was converted from oil to use natural gas.
- The lack of nuclear and renewable generation up to 1996, together with the lack of natural gas contributed to the proportionately higher emissions from electricity generation compared to the other DGs. Moreover, the non-availability of natural gas led to a proportionately higher consumption of electricity than in the rest of the UK, also increasing emissions in the early part of the time series. Natural gas has been supplied to some industrial, commercial, and domestic users since 1999 and gas use continues to grow as the supply infrastructure is developed.
- Emissions from power stations gas use increased by 30% between 2023 and 2024, however this is offset by decreasing emissions from other fuels used in power stations, notably a 100% reduction in coal used and 67% reduction in petroleum. This decrease is primarily due to the closure of Kilroot Power Station's coal-fired units in September 2023, as part of Northern Ireland's transition away from coal and toward cleaner energy sources like natural gas.

Industry (5% of 2024 inventory)

- Emissions from Industry have decreased by 69% between the Base Year and 2024. This is driven by reductions in emissions from the cement industry, chemical industry, food and drink industries, and the cessation of nitric acid production since 1990.

- Between 2023 and 2024, Industry emissions fell by 4% driven by reduction in fuel combustion for food and drink industries and other manufacturing industries and construction stationary fuel use.

Waste (4% of 2024 inventory)

- Waste sector emissions have decreased by 53% between the Base Year and 2024. This is largely driven by landfill emissions, which decreased by 64% between the Base Year and 2024. These reductions are largely due to the progressive introduction of methane capture and oxidation systems within landfill management.
- Between 2023 and 2024, waste sector emissions fell by 2% predominantly driven by the 3% decline in landfill emissions over the same period.

Fuel Supply (0.03% of 2024 inventory)

- Northern Ireland has a much lower contribution from this sector than the UK average because, unlike the other DGs, Northern Ireland does not have any refineries, oil and gas terminals, or coal mining. A gas distribution system was introduced in Northern Ireland in 1996. The emissions from fuel supply are related to gas leakage from the distribution system.
- Between 2023 and 2024, emissions increased by 25%, which was driven by a 21% increase of emissions from gas terminals and 26% increase in emissions from gas distribution leakages.

5.2 UNCERTAINTY

Northern Ireland uncertainty in 2024 for all GHGs (±5%): The Northern Ireland inventory has a high overall uncertainty due to a relatively low contribution to the emissions total from carbon dioxide. The carbon dioxide inventory is also more uncertain than for other DGs due to a greater contribution from LULUCF sources and higher uncertainty in fuel activity data, due to the greater use of solid fuels and oils in Northern Ireland. Of all the DGs, Northern Ireland has a relatively high contribution to its overall GHG total from methane and nitrous oxide, with high emissions from sources where EFs are subject to considerable uncertainty.

5.3 RECALCULATIONS

For 1990 and 2023 the recalculations result in decreases of -2.16% and an increase of 0.82% respectively compared to the previous inventory. The main recalculation reasons are presented below, with further detail on DG-level recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Agriculture

At the UK level, the recalculations include:

- Recalculations to Agriculture/Forestry/Fishing Stationary fuel use in the early time series are driven by recalculation to the DUKES estimates post-2009 affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years. Recalculations in the later time series are also impacted by splitting out natural gas data from DUKES and the quantity of biogas injected into the grid.
- Recalculations to Enteric Fermentation non-dairy cattle arise from updates to milk-yield assumptions, reflecting updated 2022–2023 Northern Ireland milk-yield statistics to align with published sources. Additional recalculations result from updates to the slaughter-weight time series (2016–2019 and 2022–2023) and a correction to dairy-cow liveweight, which applies to all dairy animals across the entire time series.
- Recalculations to Manure Management non-dairy cattle are driven by changes in volatile solids (VS) excretion, reflecting the updated slaughter-weight time series and the correction to dairy-cow liveweight, both of which influence all years. Small additional changes arise from an update to the percentage of manure diverted to anaerobic digestion, with minor revisions from

around 1991 onwards, increasing toward the end of the time series. Further details in Enteric fermentation and Manure management (CRT Category 3A and 3B) can be found in **Appendix 2.** Method Changes and Recalculations

- Recalculations to Direct Soil Emissions – Synthetic Fertiliser result from a substantial revision to the quantity of fertiliser nitrogen applied to grassland in Northern Ireland for 2023. The previous copy-forward value has been replaced with updated data from the Farm Business Survey, leading to a large re-estimate for that year.

Building and Product Uses

Recalculations in this sector are driven by changes at a UK level and mapping grid updates:

- For commercial/institutional stationary fuel use, there are recalculations across the time series due to UK level revisions and DG level mapping grid updates. For natural gas, the UK level revision in the later time series is due to splitting the natural gas data from DUKES based on the recalculations to the quantity of biogas injected into the grid.
- For burning oil, the UK level revision is driven by recalculation to the DUKES estimates post-2009 affecting the 2009-2013 percentage split that is applied in the pre-2009 extrapolation. There are also revisions to the DUKES burning oil data in the last few years.
- For residential stationary fuel use, at the UK level, the main contributors are revisions to DUKES in later years, and incorporating the improvement to separate natural gas into fossil and bio components based on the quantity of biogas injected into the grid.
- There were DG level revisions too as a result of oil mapping grid updates and minor ETS data revisions, as well as updates to use the most recent domestic fuel use mapping grids from 2005, particularly for oil-based fuels. In addition, there were changes in 1990 for Northern Ireland specifically:
- Changes in 1990 for NI are due to revising peat energy calculations to use internally consistent parameters, notably including using a calorific value almost double the IPCC default, reviewing the moisture assumptions to align with fuel peat, and using a lower implied carbon content.

Domestic Transport

There are large shipping recalculations at the DG and UK level due to updating the shipping model to use 2019 as the base year (instead of 2014). This is a result of implementing the Greenhouse Gas Inventory Improvement Project (GHGI IP) shipping improvement, incorporating 2019 international Automatic Identification System (AIS) data, revised emission factors and assumptions from the Department for Transport's (DfT) Maritime Emissions Model (MEM), and a fundamental shift from a “fuel used” to “fuel sold” approach. More details on the shipping recalculations can be found in **Appendix 2.** Method Changes and Recalculations

Changes in Northern Ireland for road transport are due to using updated DfT data, however this only results in emissions being reallocated between petrol and DERV.

Electricity Supply

There were recalculations to the UK gas use data from DUKES.

Fuel Supply

At the UK level, calculations were revised for some sites to use ETS reported fuel use as opposed to Environmental and Emissions Monitoring System (EEMS); thus impacting the share of emissions attributed to combustion processes in oil and gas extraction, versus those attributed to fugitive related processes, captured in oil and natural gas.

Industry

UK level recalculations to Industry include:

- For chemicals industries fuel use, there are revisions to the DUKES gas data in 2023 at the UK level, impacting all DGs.

- Recalculations occur in the early part of the time series for food, drink and tobacco industries fuel use due to inconsistencies identified in the historical DUKES data. These have been addressed by applying data that are more consistent with recent years and by standardising the gap-filling approach, resulting in a more coherent time series.
- Revisions to other manufacturing industries and construction stationary fuel use due to using revised 2009-2015 DUKES estimates and extrapolating pre-2009 data in the UK inventory, and slight revisions in DUKES unclassified burning oil in 2022 and 2023.
- Revisions to commercial/institutional mobile machinery fuel use at the UK level in 2023 due to a revision to DUKES oil balance.
- Recalculations to pig iron production across the time series at the UK level due to a combination of 2013 Iron and steel best available techniques reference document (BREF) updates to emission factors and moving away from carbon balance approach to using average historical carbon emission factors due to inconsistencies in DUKES.
- At the DG level, there have been recalculations, especially in 2023, due to updated food & drink gas and coal mapping grids.
- Mapping grids were updated at the DG level due to sector specific Non-Road Mobile Machinery (NRMM) methods being introduced in the spatial mapping, see more detail in detail in **Appendix 2.** Method Changes and Recalculations

LULUCF

At the UK level, recalculations include:

- Crosscutting recalculations to Forest land (4A) due to updates to the CARBINE model and to wood production estimates for 2023 provisional data and planting estimates for 2023 provisional data.
- There were recalculations to Forest Land converted to Wetlands due to the CARBINE change to soil carbon.

Full descriptions of the updates and recalculations LULUCF are outlined in **Appendix 2.** Method Changes and Recalculations

Waste

At the UK level, there have been a number of recalculations that include:

- Recalculations to managed anaerobic waste disposal sites, driven by an update to the landfill model. This is described further in **Appendix 2.** Method Changes and Recalculations
- There are recalculations to Domestic wastewater treatment and discharge due to the implementation of the new municipal wastewater model, and recalculations to Industrial wastewater treatment and discharge. This is described further in **Appendix 2.** Method Changes and Recalculations
- There are also a smaller number of DG specific recalculations, which include:
    - Revisions to methane flaring data for all DGs for 2022 and 2023.
    - There were also minor adjustments in landfill gas data in 2022 and 2023 regional statistics for all DGs.
- At the DG level, there has been an updated municipal wastewater treatment mapping grid, based on the data provided into the model, that has resulted in DG specific recalculations across the time series; the previous driver utilised population as a proxy for distributing municipal wastewater emissions.

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APPENDIX 1. DG GHG BY SOURCE INVENTORIES COMPILATION METHODS

INTRODUCTION

The UK GHGI compiles national estimates of GHG emissions for submission to the UNFCCC under the requirements of the Paris Agreement. The UK inventory is published annually in April. This report presents separate inventories of GHG emissions for England, Scotland, Wales and Northern Ireland, and are consistent with the UK GHGI.

The seven direct GHGs are considered:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF_6); and
- Nitrogen trifluoride (NF_3)

By Source inventories allocate GHG emissions in the country that they are emitted, regardless of the end use of any fuel output or product that creates the demand for the emitting activity. The By Source estimates for each DG include emissions from fuel combustion (Energy), industrial processes and product use (IPPU), agricultural practices (Agriculture), Land Use, Land Use Change and Forestry (LULUCF) and waste disposal (Waste). It should be noted that national totals for DGs exclude emissions from international aviation and shipping (which are presented as memo items) within the inventories, but this report includes these memo items for Scotland and Wales, unless otherwise stated. Additionally, CO_2 from the burning of biofuels (which are considered to be renewable fuels from recently sequestered carbon) are also excluded, and emissions of GHGs from offshore oil and gas exploration and production are classified within this report as “Unallocated” emissions and are not attributed to any of the DGs.

REPORTING FORMAT

The DG GHG inventories are presented in Territorial Emission Statistics (TES) Sector reporting format to align with UK GHG reporting. Within the discussion of inventories compilation methodology, source data and trends, the CRT Category nomenclature is used, as this enables information to be presented at a much greater level of detail, aligned with specific emission sources.

The UK Inventory also reports emissions from international marine and aviation bunkers separately, as memo items to the main UK inventory dataset, in line with the reporting requirements of the UNFCCC. Therefore, the DG emission estimates for England and Northern Ireland for these international transport sources are not included within the DG totals in this report. They are presented for Scotland and Wales in accordance with their internal reporting requirements.

GENERAL APPROACH

The UK Inventory is based on UK statistics for activities producing GHG emissions. In principle, it would be ideal to obtain a complete set of equivalent statistics for each constituent country to compile each inventory. Such a set of statistics is not available for all sources and for all constituent countries and hence it is necessary to disaggregate UK emissions into the four constituent countries by an estimation procedure.

For most sources in the UK Inventory, the emission of a pollutant from a source is calculated from the general equation:

$$E = A \times EF \text{ [Equation 1]}$$

Where:

i. E = Emission of pollutant (tonnes)
ii. A = Activity (unit activity)
iii. EF = Emission Factor (tonnes pollutant/unit activity)

The activity unit may be fuel combustion (e.g. tonnes of gas oil), or production of product (e.g. tonnes of steel) or numbers of animals. A modified equation is used in the compilation of the DG GHG inventories:

$$E_i = \frac{d_i}{\sum_{i=1}^{5} d_i} \times (A \times EF) \text{ [Equation 2]}$$

Where:

i. E_i = Emission (in tonnes) from either England (1), Scotland (2), Wales (3), Northern Ireland (4) or “Unallocated” (5)
ii. d_i = A driver representing the contribution of the DG to UK emissions
iii. i = 1, 2, 3, 4, 5, where England = 1, Scotland = 2, Wales = 3, Northern Ireland = 4 and Unallocated = 5.

The driver, d_i can be any one of:

- The value of the activity data for the DG. [For example, consumption of specific fuels or industrial production figures for the region.];
- The fraction of the UK activity in the DG;
- The value of a surrogate activity data statistic in the DG. Where the required activity is unavailable on a DG basis, a surrogate value may be used. [For example, employment statistics or manufacturing output of a specific product, used as a surrogate for consumption data of a given fuel.]; and
- In cases where the emissions are derived from a complex model, the driver will be the actual emission for the DG calculated from the model.

The modified equation [2] ensures that the sum of the emissions from England, Scotland, Wales and Northern Ireland, plus any “unallocated” (i.e. offshore) emissions, equals the total UK emission reported within the UK inventory.

Where the driver is fuel consumption, then the sum of the drivers should add up to the UK consumption. However, in practice this may not be the case if the data are taken from different sources or may be based on the financial rather than the calendar year. The estimation procedure removes such discrepancies.

Thus, the compilation of the GHG inventories for the constituent countries of the UK reduces to the estimation of a set of drivers, each appropriate to emissions from a specific source. In compiling the DG inventories, over 300 drivers have been calculated.

APPENDIX 2. METHOD CHANGES AND RECALCULATIONS

In the derivation of the DG GHG inventories, there are recalculations to emission estimates for a number of reasons, including where there are updates to methods, input data and/or assumptions in the UK GHGI which flows down to the DG estimates. Further information on the UK GHGI recalculations are available in Chapter 10 of the latest UK NID:

https://naei.energysecurity.gov.uk/reports/uk-greenhouse-gas-inventory-1990-2024-annual-report-submission-under-framework-convention

In addition, details are also available in the statistical release accompanying the UK inventory dataset:

https://assets.publishing.service.gov.uk/media/6982292019d3abdb495f37cd/2024-final-greenhouse-gas-emissions-statistics-statistical-release.pdf

Recalculations that have a notable impact on the DG inventories totals are highlighted within the DG chapter text in this report and summarised in the accompanying MS Excel 'Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2024'.

In this appendix we summarise the changes to DG GHGI methods, input data or assumptions, e.g. where changes in data provision or assumptions applied to derive the DG shares of UK emissions totals led to recalculations between 1990 and 2023 in the dataset.

SHIPPING RECALCULATIONS (CRT CATEGORY 1A3/1A4)

There are large shipping recalculations at the DG and UK level due to updating the shipping model to use 2019 as Base Year (instead of 2014) as part of implementing the Greenhouse Gas Inventory Improvement Project (GHGI IP) shipping improvement. This includes the following updates:

- There are substantive reductions to fuel use for Domestic Shipping due to the transition from a 'fuel used' approach (modelled fuel use based on shipping movements in NAEI23) to a 'fuel sold' approach (normalising modelled shipping fuel use to national energy statistics from DUKES). It also ensures consistency with the methodological approach already used in other sectors, such as International Shipping, Inland Waterways and Non-Road Mobile Machinery (NRMM), which have always been based on a fuel-sold approach.
- Assumptions for fuel consumption and emissions at berth have been reviewed and revised. It is now assumed that as long as Automatic Identification System (AIS) messages are transmitted, vessels at berth do not switch off their auxiliary engines, where it was previously assumed that vessels switch off their engines after 24 hours at berth.
- Revised emission factors and assumptions from the Department for Transport's (DfT) Maritime Emissions Model (MEM) have been incorporated as part of the model

In addition to the UK shipping model update, the DG compilation file for shipping was also updated to use 2019 as a Base Year. The UK shipping model is used as a basis, but all years are manually adjusted to each DG using port statistics.

Table 4 – Changes to emissions estimates from CRT Category 1A3 (Transport) for each region in ktCO_2e

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	99,939	87,950	97,191	86,823
Scotland	12,733	10,784	11,372	10,517
Wales	6,168	5,489	5,965	5,569
Northern Ireland	3,507	3,794	3,375	3,778

Table 5 – Changes to emissions estimates from CRT Category 1A4 (Other sectors fuel use) for each region in $ktCO_2e$

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	91,926	64,816	91,531	64,735
Scotland	12,136	8,329	11,864	7,950
Wales	6,884	3,809	6,769	3,705
Northern Ireland	4,650	2,620	4,686	2,780

Table 6 – Changes to emissions estimates from CRT Category 1D1b (International Navigation) for each region in $ktCO_2e$

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	6,698	5,556	4,468	3,977
Scotland	768	252	1,476	651
Wales	541	305	454	367
Northern Ireland	127	159	103	139

BIOGAS INJECTED INTO THE GRID

Emissions from biogas and natural gas use from the gas distribution network have been separated for the first time. Previously, the impact of biogas was implemented via a small percentage decrease in the fossil natural gas emission factor. However, an external review of the method highlighted the previous approach was not transparent to users. Therefore, DUKES data on biogas injection into the gas distribution network is used to produce separate estimates of fossil fuel and biofuel use emissions.

The impact of this change on emissions totals is minimal. Importantly however, almost all biogas and natural gas blending occurs in the gas distribution network. This means that consumers with a more direct supply of gas, such as large-scale consumers or upstream oil and gas sites, will use natural gas only. To account for these differences, the apportionment of gas use across the industry, fuel supply, electricity supply, domestic transport, Buildings and Product Uses, and agriculture sectors has been revised.

There are currently no specific DG-level data available to reflect differences in the proportion of biogas injected into the grid between DGs.

MAPPING GRID UPDATES

Non-Road Mobile Machinery (CRT Category 1A2gviii)

At the DG level, there have been updated mapping grids due to category specific NRMM methods being introduced in the spatial mapping. There are now sector specific mapping grids for NRMM categories such as Sea Ports, Construction, Generators, Refrigerated Transport, and Other industry.

Full details on the data sources used for each NRMM category can be found in the Sub-national Residual Fuel Consumption Statistics 2005-2023 Methodology. Although the changes were made to the sub-national statistics in the previous dataset, the improvements were only incorporated at the DG level in this submission as the data were not ready in time for the previous submission. Improvements for the Agriculture category were included in the previous submission.

Table 7 – Changes to emissions estimates from CRT Category 1A2gviii (Other manufacturing industries and construction stationary fuel use) for each region in ktCO_2e

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	26,482	13,633	26,868	13,302
Scotland	2,410	1,720	2,462	1,607
Wales	1,699	1,133	1,679	1,054
Northern Ireland	1,372	394	1,388	352

Stationary fuel use (CRT Category 1A4ai and 1A4bi)

In the current submission, updates were made to the mapping grids for oil in Commercial/Institutional stationary fuel use (1A4ai) and Residential stationary fuel use (1A4bi) from 2005.

Note there are also UK level revisions due to splitting the natural gas data from DUKES based to quantity of biogas injected into the grid, which results in minor sector specific changes in emissions from natural gas. Furthermore, for Residential stationary fuel use (1A4bi), there are changes in 1990 for Northern Ireland due to revising peat energy calculations to use internally consistent parameters, notably including using a calorific value almost double the IPCC default, reviewing the moisture assumptions to align with fuel peat, and using a lower implied carbon content.

Table 8 – Changes to emissions estimates from CRT Category 1A4ai (Commercial/Institutional stationary fuel use) for each region in ktCO_2e

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	24,210	18,250	23,972	17,740
Scotland	3,079	2,256	3,074	2,090
Wales	1,485	830	1,400	866
Northern Ireland	677	340	655	334

Table 9 – Changes to emissions estimates from CRT Category 1A4bi (Stationary fuel use) for each region in ktCO_2e

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	63,291	41,685	63,294	42,440
Scotland	7,944	4,907	7,962	4,910

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
Wales	4,990	2,631	4,991	2,519
Northern Ireland	3,723	2,027	3,789	2,218

ENTERIC FERMENTATION AND MANURE MANAGEMENT (CRT CATEGORY 3A AND 3B)

Enteric Fermentation (CRT Category 3A)

There are updates to dairy cattle emissions due to a re-parameterisation of the dairy cattle growth curve using slaughter-weight data resulting in an increase in liveweight of all dairy animals and enteric CH_4 emissions. There are also updates to milk-yield assumptions, reflecting revised provisional 2023 milk yields for England and Wales and UK averages (AUK), as well as updated 2022–2023 Northern Ireland milk-yield statistics to align with published sources. These changes affect enteric emissions across all DGs for 2022 and 2023.

For sheep, there was a downward adjustment in the assumed metabolisable energy density of grazed grass, to better match survey evidence, that directly resulted in an increase in total dry matter intake to meet the energy requirements of an animal. This directly increased enteric emissions as the emissions are a function of dry matter intake. There was also a correction to the calculations of forage fresh-weight weighted estimates of the metabolisable energy content of mixed feed rations.

Manure Management (CRT Category 3B)

Manure management estimates were also impacted by the re-parameterisation of the dairy cattle growth curve using slaughter-weight data resulting in an increase in liveweight of all dairy animals and therefore changes to the volatile solids (VS) and nitrogen excretion.

Manure management estimates were also impacted by the updated the metabolisable energy content of grass in preferential grazing areas resulting in an increase in nitrogen excretion.

Small additional manure management specific changes arise from an update to the percentage of manure diverted to anaerobic digestion, with minor revisions from around 1991 onwards, increasing toward the end of the time series.

Table 10 – Changes to emissions estimates from CRT Category 3A and 3B (Enteric Fermentation and Manure Management) for each region in $ktCO_2e$

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	21,281	16,299	21,541	16,482
Scotland	5,856	4,811	5,923	4,867
Wales	4,434	4,063	4,499	4,129
Northern Ireland	3,869	4,501	3,902	4,535

WASTE RECALCULATIONS

Managed anaerobic waste disposal sites (CRT Category 5A1a)

Recalculations to 5A1a (Managed anaerobic waste disposal sites) are driven by an update to the landfill model to use gross GDP data to approximate solid waste disposal volumes where actual activity data is unavailable. Importantly, historic data on solid waste disposal at landfill sites is uncertain and unavailable before 1997. Previously, solid waste disposal volumes from 1990 to 1996 were extrapolated from 1997 data using household and employment statistics. However, an external review of this method highlighted that it is inconsistent with the IPCC Guidelines for National Greenhouse Gas Inventories. To improve consistency with IPCC guidelines, the landfill model has been updated to use GDP data as a proxy for solid waste disposal volumes. This change is exclusive to the waste sector and leads to a large decrease in landfill emissions estimates over the early portion of the historic time series.

There were also smaller DG specific changes later in the time series:

- There are updates to the material sent to landfill in England for 2006 - 2010, 2020 and 2022. The changes for these years reflect the updated Waste Data Interrogator (WDI) statistics.
- There were minor revisions to the material sent to landfill in 2022 and 2023 for Wales to include some waste codes that were previously not incorporated into the inventory.
- There were revisions to methane flaring data for England, Scotland, Wales and Northern Ireland for 2022 and 2023.
- There were also minor adjustments in landfill gas data in 2022 and 2023 regional statistics for England, Scotland, Wales and Northern Ireland.

Table 11 – Changes to emissions estimates from CRT Category 5A1a (Managed anaerobic waste disposal sites) for each region in $ktCO_2e$

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	54,882	11,741	40,857	10,449
Scotland	6,043	1,329	4,467	1,249
Wales	3,297	810	2,453	763
Northern Ireland	1,844	570	1,381	511

Domestic Wastewater (CRT Category 5D1)

There are recalculations to 5D1 (Domestic wastewater treatment and discharge) due to the implementation of the new municipal wastewater model to improve consistency with IPCC guidelines and capture UK-specific wastewater treatment practices:

- Increase to N_2O emissions in all years due to estimating emissions from aerobic treatment, which has a much higher emission factor than the emission factor for N discharged to receiving waters and represents an almost tripling in N_2O emissions estimates from this sector;
- Decrease to CH_4 emissions in the 1990s due to using a lower value for the maximum CH_4 producing capacity;
- Increase to CH_4 emissions after ~2000 due to estimating emissions associated with Biological Oxygen Demand (BOD) remaining in effluent discharged to receiving waters;

- Increase to CH_4 emissions in all years, but more in later years than the 1990s due to the 2019 methodology combined with UK-specific CH_4 capture rates resulting in higher emissions than the previous Carbon Accounting Workbook (CAW)-based method;
- Increase to CH_4 emissions in all years due to introducing an estimate of emissions from sewers; and
- New estimates of CO_2 emissions from liming and decomposition of materials with fossil Carbon content where previously no estimate was made.

At the DG level, there has been an updated municipal wastewater treatment mapping grid, based on the data provided into the model, that has resulted in DG specific recalculations across the time series; the previous driver utilised population as a proxy for distributing municipal wastewater emissions.

Table 12 – Changes to emissions estimates from CRT Category 5D1 (Domestic wastewater treatment and discharge) for each region in $ktCO_2e$

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	1,396	1,244	3,152	4,304
Scotland	166	115	232	277
Wales	99	100	126	183
Northern Ireland	80	92	59	73

Industrial Wastewater (CRT Category 5D2)

There are recalculations to 5D2 (Industrial wastewater treatment and discharge) due to:

- Estimates for CH_4 and N_2O emissions from the discharge of industrial wastewater being included in this submission where previously emissions were not estimated. Inclusion of this emissions source is now justified through its addition to the common reporting table (CRT) format used to comply with international reporting commitments.
- Estimates for CH_4 and N_2O emissions from industrial wastewater treatment for 5D2 being revised in this submission. This is primarily due to the adjustment to the activity data (e.g. the industrial production estimates for various products allocated to industry) revision to the approach to splicing and gap-filling of various datasets used.

Table 13 – Changes to emissions estimates from CRT Category 5D2 (Industrial wastewater treatment and discharge) for each region in $ktCO_2e$

Region	Previous submission		Current submission	
	Base year	2023	Base year	2023
England	786	1,244	1,001	2,058
Scotland	94	78	118	136
Wales	33	56	45	95
Northern Ireland	25	37	32	62

CRT CODE CHANGES

There were a few CRT code changes at the UK level between the previous submission and the current submission:

- 2B9aii due to the inclusion of hydrofluorocarbon (HFC) emissions from fluoropolymer production for the first time. These estimates are derived from Pollution Inventory and additional site-level data from the Environment Agency. The emissions only occur in England.
- 5C2aii relates to the inclusion of emissions estimates from bonfires.
- Removal of 5C1bii5 due to the identification that DUKES EfW reporting includes the chemical waste that was previously reported in this sector.

Note there have also been updates to the LULUCF CRT codes as the finalised CRT category mapping was not ready in time for the previous submission.

LULUCF METHODOLOGICAL UPDATES (CRT CATEGORY 4)

England

LULUCF Sector Total

Recalculations to greenhouse gas net emissions / removals from the LULUCF sector - England

Revisions since the previous inventory resulted in a net decrease in total reported greenhouse gas emissions in 1990 and the most recent comparable year 2023 (Figure 6). For 1990, there is a decrease in emissions of -0.156 Mt CO_2e (from 2.361 to 2.205 Mt CO_2e), and for 2023, a decrease of -0.553 Mt CO_2e (from -0.779 to -1.274 Mt CO_2e).

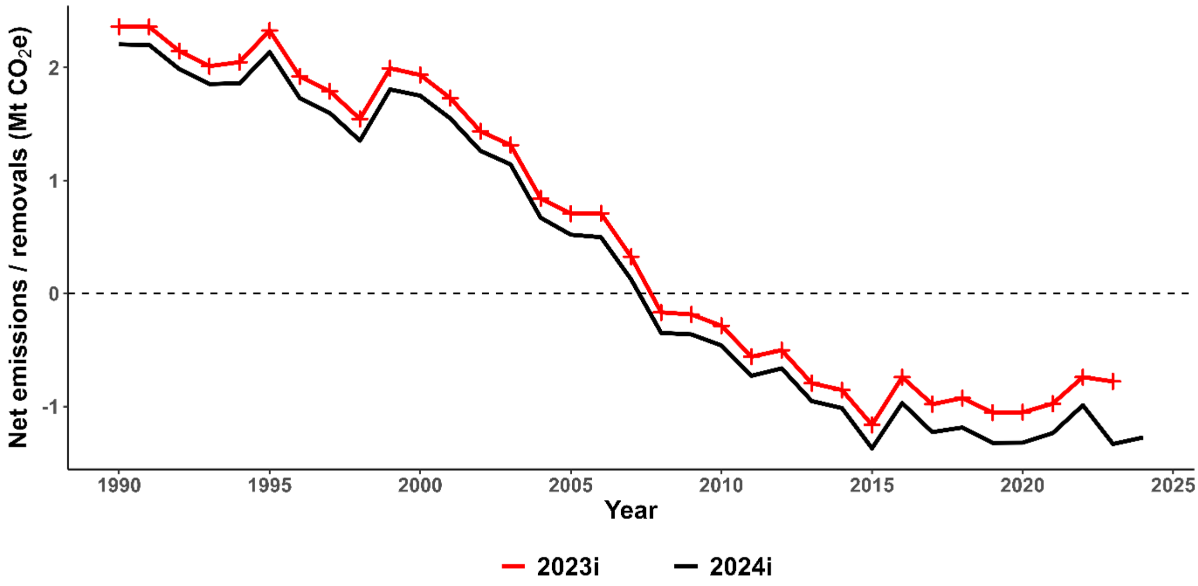

Figure 6 – Net emissions/removals in Total LULUCF Sector Mt CO_2e.

The most important changes and recalculations for England are outlined below. Note that the scales of the graphs vary. This should be borne in mind when assessing the impact of the recalculation on the LULUCF total.

Forestry

Increases in the estimate of net removals from Forestry. There is an increase in net removals of -0.083 Mt CO_2e in 1990 (Figure 7) and -0.521 Mt CO_2e in 2023. The changes are due to both model and activity data improvements, which include:

Updates to Activity Data:

- Updated new planting estimates for 2023 provisional data.
- Updated wood production estimates for 2023 provisional figures. Minor changes to wood production estimates from 1976-1995 due to an additional three decimal places of precision supplied by Forestry Statistics.
- Update to England small woodland area estimate from 2025 report NCEA: National Trees Outside Woodland Map, increasing the area of small woodlands.
- Update to the total woodland area by correcting the area of unmapped woodland for Great Britain. The total 'unmapped NFI' area found in the 2017 Forestry Commission Tree Cover Outside Woodland in Great Britain report was previously added to small woodland area. This 'unmapped NFI' data contains both 'extra' woodland area that was missed in previous surveys and 'new' woodland planted between 2014 and 2015. To remove double counting, new planting data between 2014-2015 calendar years are now summed and subtracted from 'unmapped NFI' data before being added to small woodland area to include the additional woodland area only.
- Improve the species and Yield Class (growth rate) distribution for recent (post-2011) afforestation to better reflect recent planting practices.
- Wood Product Trade Statistics:
    - Updated woodfuel supply estimates for 2022-2023.
    - Updated sawmill consumption by country estimates from 1994-2022 due to error correction.
    - Updated roundwood delivery estimates for 2023 provisional figures.
    - Updated roundwood fencing estimates from 2006-2023 due to error correction in dataset received from Forestry Statistics.
- Updates to deforestation estimates for 2023 based on woodland removal figures from Forestry Commission Key Performance Indicators 2024-2025 report.
- Updates to deforestation estimates for 2021-2023 based on revised figures on rewetted areas received from Defra.

Updates to CARBINE modelling:

- Closer match to total wood production across the time series.
- Include the transfer of carbon from branches on dead trees into the soil.
- Include inputs into the deadwood carbon pool from competition-based mortality in young (pre-first thinning age) stands.

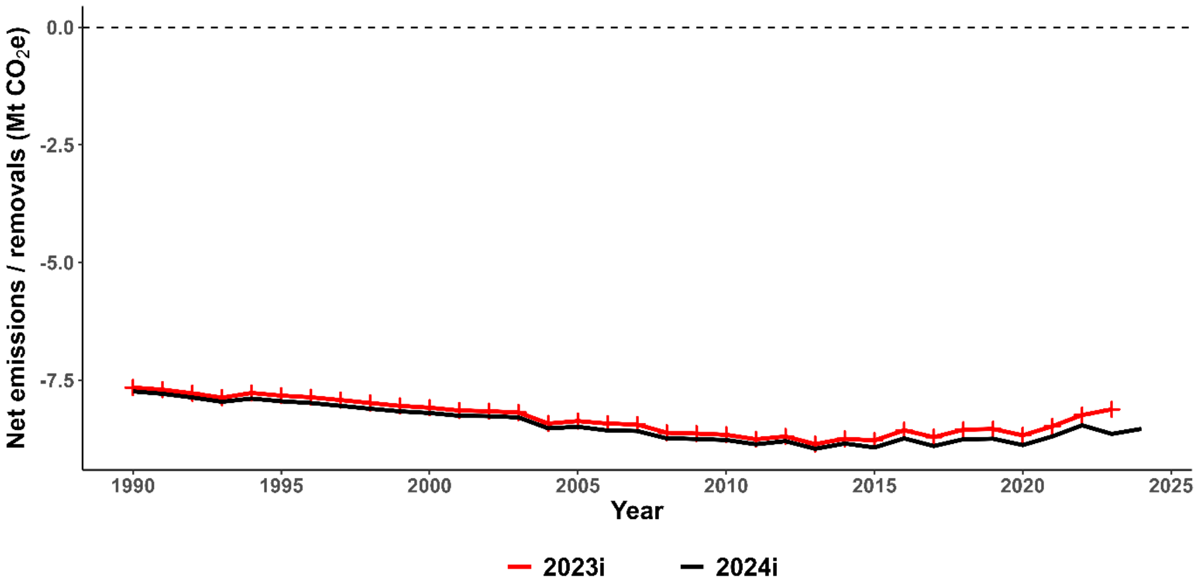

Figure 7 – Net emissions/removals within the Forestry category Mt CO_2e.

Peatland

A decrease in the estimate of net emissions from Peatland of -0.078 Mt CO_2e in 1990 and -0.050 Mt CO_2e in 2023 (Figure 8). This is due to two activity data updates and one modelling update. Historic domestic peat extraction areas have been reassigned to less degraded peatland categories (e.g., semi-natural grassland, rewetted bog, flooded land/lakes) following a Defra-funded field-based project in 2024/25 to assess the recovery of historic domestic peat extraction sites in England. New peatland restoration data for England spanning 2021-2024 have been incorporated from the Defra Peatland Register (Nature for Climate Peatland Grant Scheme - NCPGS data). These data replace the average projected rate of restoration for that period, previously derived from the 2000-2013 Peatland Compendium dataset (Evans et al. 2017). The new dataset contains a different split in the restoration of pastoral and semi-natural grassland. These two activity data updates account for approximately half of the change. The other half arises from the update to the CARBINE model to include the transfer of carbon from branches on dead trees into the soil which impacts both mineral (reported in Forestry) and organic (reported in Peatland) soil.

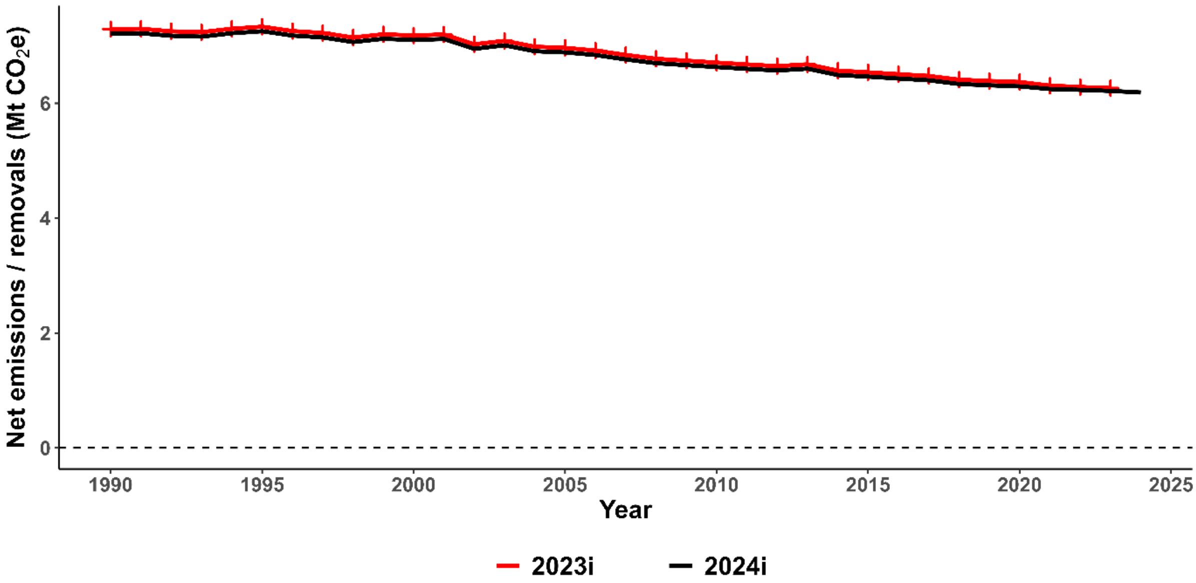

Figure 8 – Net emissions/removals within the Peatland category Mt CO_2e

Cropland Mineral Soils under LUC

There was no change to the estimates of net emissions from cropland mineral soils undergoing land use change.

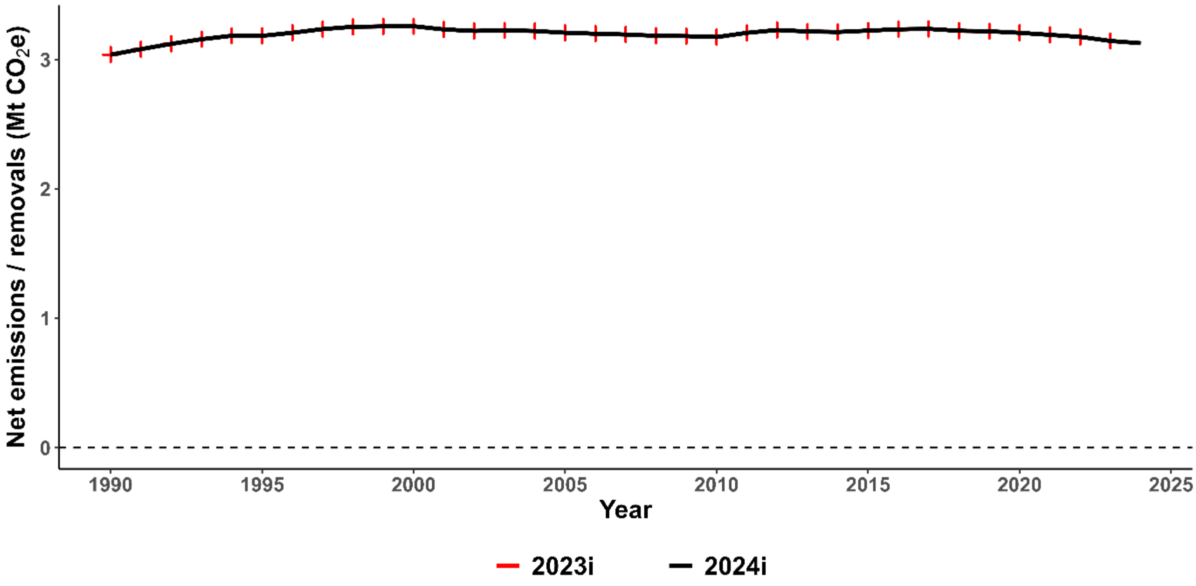

Figure 9 – Net emissions/removals within the Cropland mineral soil category. Mt CO_2e

Grassland Mineral Soils under LUC

There was no change to the estimates of net removals from grassland mineral soils undergoing land use change.

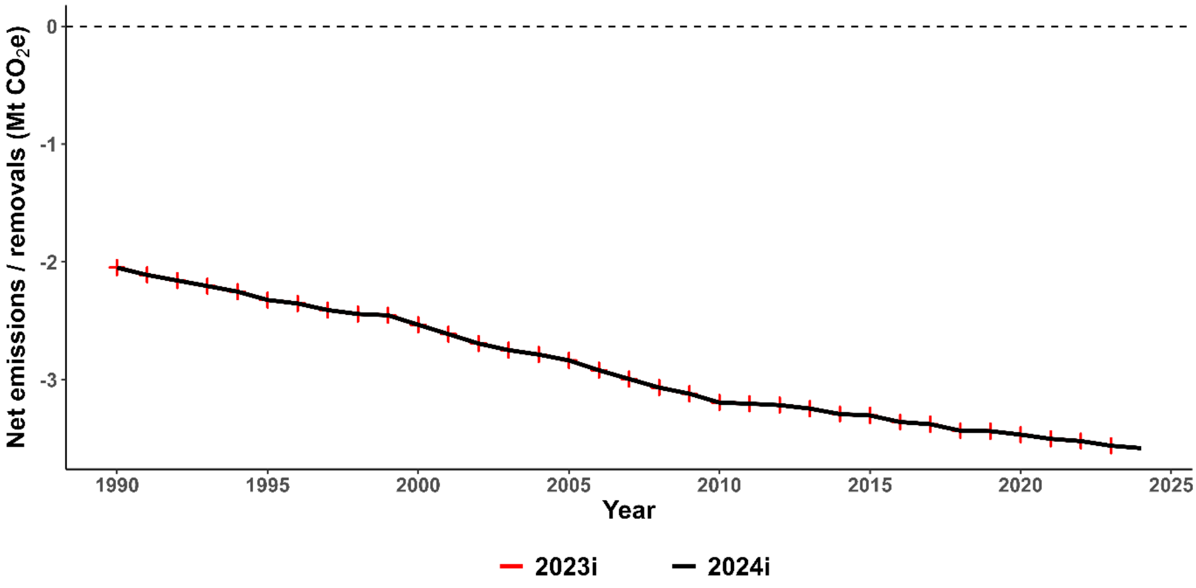

Figure 10 – Net emissions/removals within the Grassland category. Mt CO_2e

Settlement

There were no changes to the estimates of net emissions from settlement.

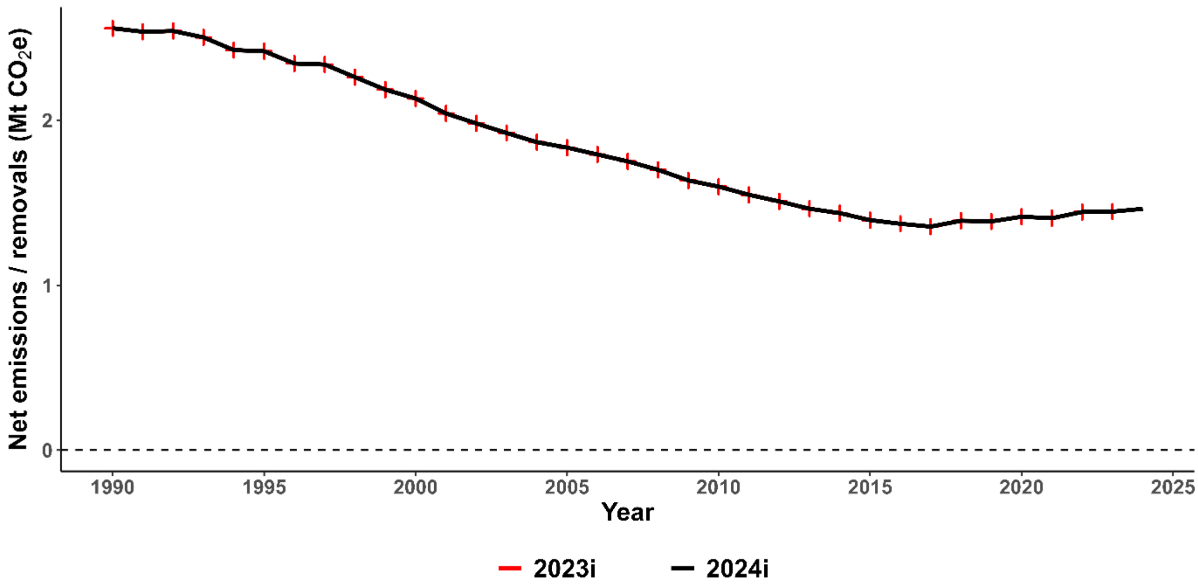

Figure 11 – Net emissions/removals within the Settlement category Mt CO_2e.

Bioenergy

There were no changes to the net emissions/removals from bioenergy crops.

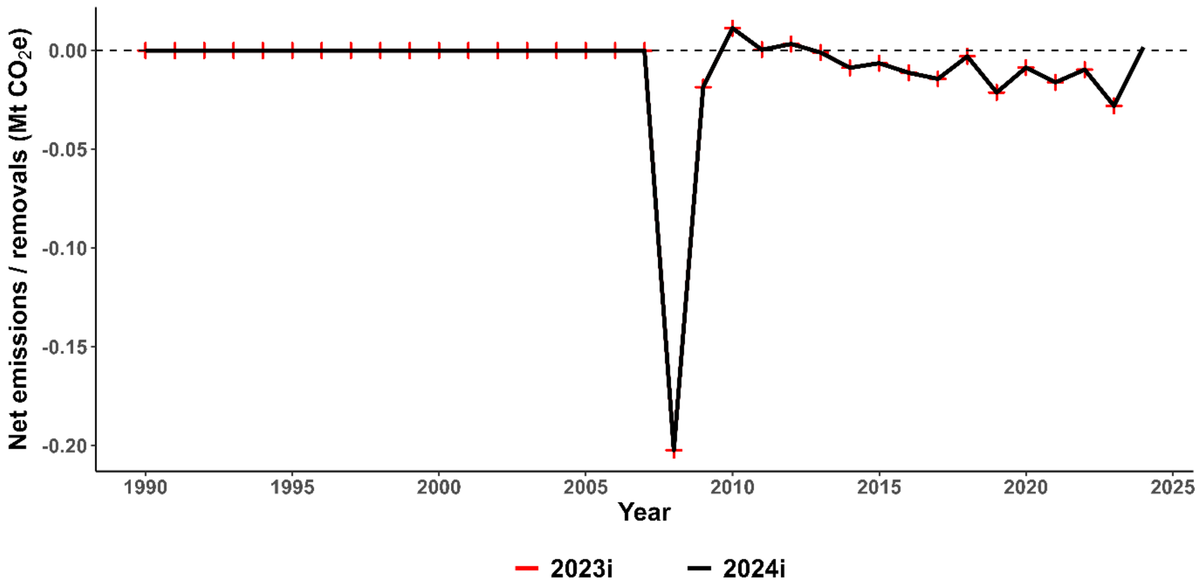

Figure 12 – Net emissions/removals within the Bioenergy category Mt CO_2e

Other LULUCF

Increases in net emissions in the other LULUCF category of 0.004 Mt CO_2e in 1990 and 0.018 Mt CO_2e in 2023 (Figure 13). These increases are predominantly due to inclusion of updated crop type areas across the time series from revisions provided in the latest Agricultural Census, which impact the calculations of carbon stock change from cropland management activities. Additionally, minor corrections were made in the England wildfire historical time series based on updated information from the Fire and Rescue Service. Information of what is included in this category is provided in the 'LULUCF TES Overview' section below.

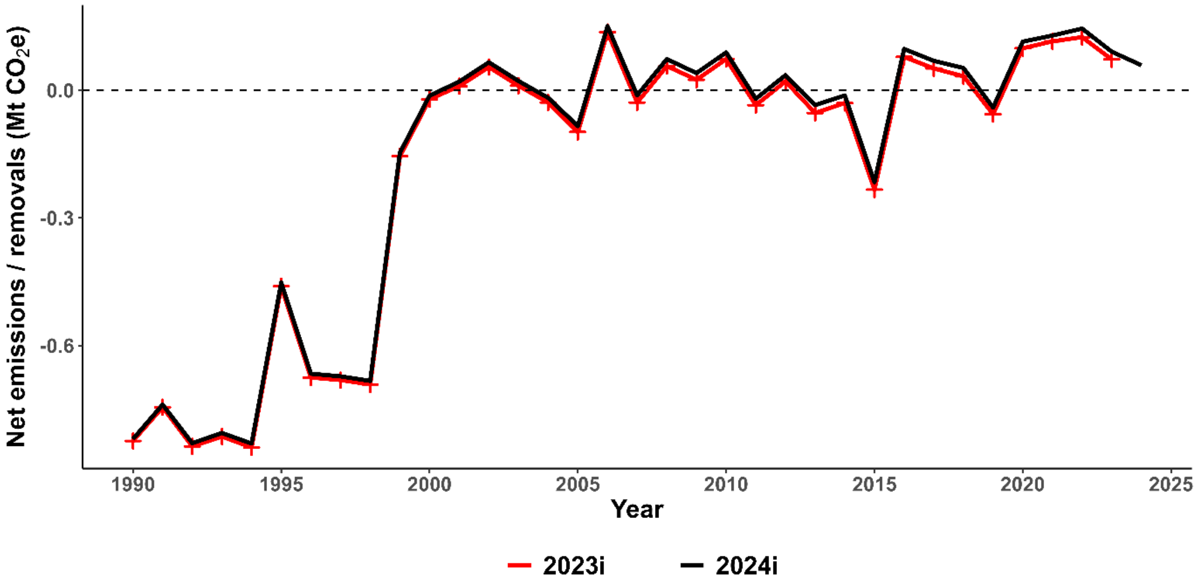

Figure 13 – Net emissions/removals within the Other LULUCF category Mt CO_2e

Table 14 – Recalculations to the LULUCF Inventory for England

Source category	Difference between previous and current submission 1990 Mt CO_2e	Difference between previous and current submission 2023 Mt CO_2e	Previous submission 1990 Mt CO_2e	Current submission 1990 Mt CO_2e	Previous submission 2023 Mt CO_2e	Current submission 2023 Mt CO_2e	Comments
Forestry	-0.083	-0.521	-7.657	-7.739	-8.122	-8.643	Updates to the CARBINE model. Use of latest Forestry Statistics activity data and updated small woodland data. Update to wood production and product type estimates. Updates to deforestation areas.
Peatland	-0.078	-0.050	7.292	7.214	6.266	6.216	Reassignment of historical domestic peat extraction areas to less degraded categories. Inclusion of new peatland restoration data for 2021-2024 from the Defra Peatland Register. Updates to the CARBINE model.
Cropland mineral soils under LUC	0.000	0.000	3.039	3.039	3.146	3.146	No change.
Grassland mineral soils under LUC	0.000	0.000	-2.049	-2.049	-3.560	-3.560	No change.
Settlement	0.000	0.000	2.559	2.559	1.447	1.447	No change.
Bioenergy crops	0.000	0.000	0.000	0.000	-0.028	-0.028	No change.
Other LULUCF	0.004	0.018	-0.824	-0.820	0.073	0.091	Inclusion of revised crop type area from the latest Agricultural Census. Minor revision to historic wildfire areas.

Scotland

LULUCF Sector Total

Recalculations to greenhouse gas net emissions / removals from the LULUCF sector - Scotland

Revisions since the previous inventory resulted in a small net decrease in total reported greenhouse gas emissions in Scotland in 1990 and the most recent comparable year, 2023 (Figure 14). In 1990, there is a decrease in emissions of -0.188 Mt CO_2e (from 6.000 to 5.811 Mt CO_2e), and in 2023, there is a decrease in emissions of -0.265 Mt CO_2e (from 0.541 to 0.277 Mt CO_2e).

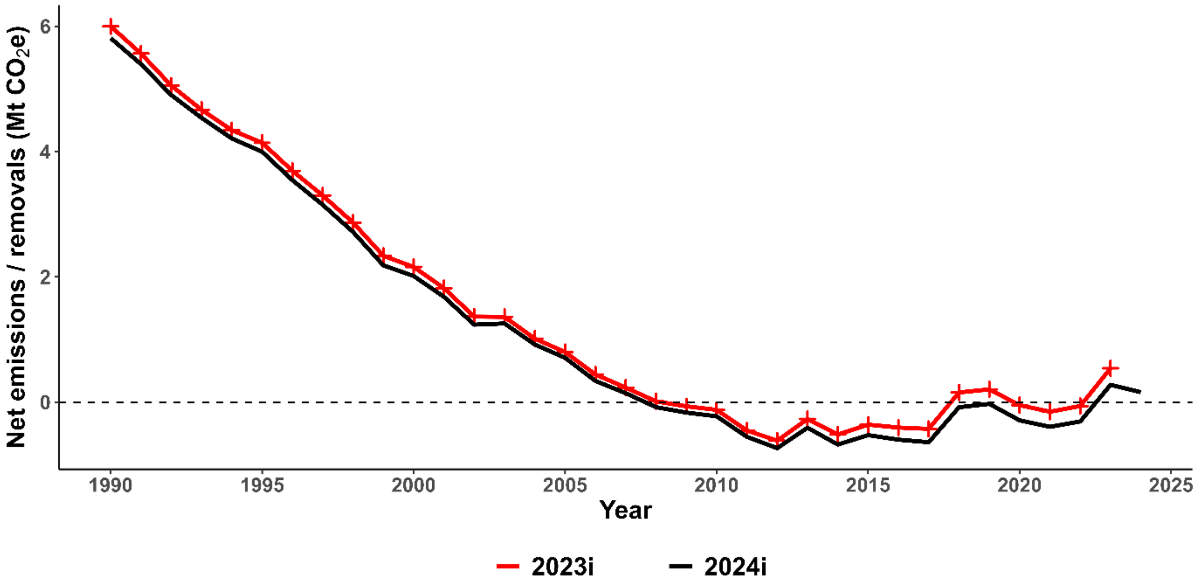

Figure 14 – Net emissions/removals in Total LULUCF Sector Mt CO_2e.

There have been several methodological changes contributing to these revisions. The most important changes and recalculations for Scotland are outlined below. Note that the scales of the graphs vary. This should be borne in mind when assessing the impact of the recalculation on the LULUCF total.

Forestry

Changes in net removals from Forestry from a decrease in net removals in 1990 of 0.090 Mt CO_2e to an increase in net removals of -0.086 Mt CO_2e in 2023 (Figure 15). The changes are due to model and activity data improvements, which include:

Updates to Activity Data:

- Updated new planting estimates for 2023 provisional data.
- Updated wood production estimates for 2023 provisional figures. Minor changes to wood production estimates from 1976-1995 due to an additional three decimal places of precision supplied by Forestry Statistics.
- Update to the total woodland area by correcting the area of unmapped woodland for Great Britain. The total 'unmapped NFI' area found in the 2017 Forestry Commission Tree Cover Outside Woodland in Great Britain report was previously added to small woodland area. This 'unmapped NFI' data contains both 'extra' woodland area that was missed in previous surveys and 'new' woodland planted between 2014 and 2015. To remove double counting, new planting data between 2014-2015 calendar years are now summed and subtracted from 'unmapped NFI' data before being added to small woodland area to include the additional woodland area only.
- Improve the species and Yield Class (growth rate) distribution for recent (post-2011) afforestation to better reflect recent planting practices.

- Wood Product Trade Statistics:
  - Updated woodfuel supply estimates for 2022-2023.
  - Updated sawmill consumption by country estimates from 1994-2022 due to error correction.
  - Updated roundwood delivery estimates for 2023 provisional figures.
  - Updated roundwood fencing estimates from 2006-2014 due to error correction in dataset received from Forestry Statistics.
- Updates to deforestation estimates for 2015-2023 based on revised figures on rewetted areas received from Peatland ACTION.

Updates to CARBINE modelling:

- Closer match to total wood production across the time series.
- Include the transfer of carbon from branches on dead trees into the soil.
- Include inputs into the deadwood carbon pool from competition-based mortality in young (pre-first thinning age) stands.

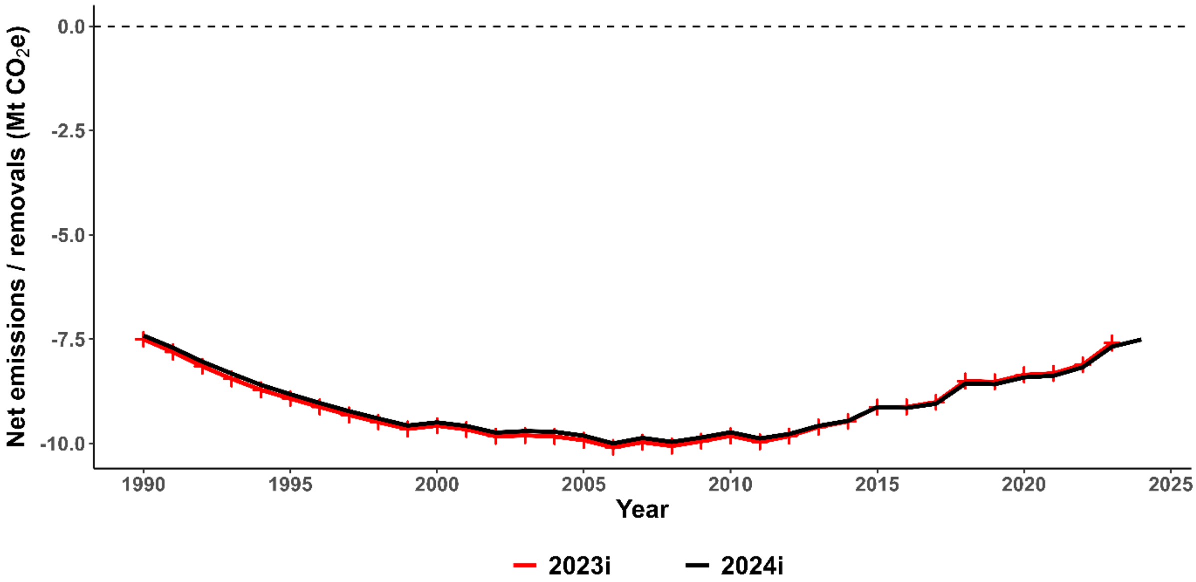

Figure 15 – Net emissions/removals within the Forestry category Mt CO_2e

Peatland

A decrease in the estimate of net emissions from Peatland of -0.278 Mt CO_2e in 1990 and -0.183 Mt CO_2e in 2023 Figure 16. This is due to modelling and activity data updates. The majority of the change arises from the update to the CARBINE model to include the transfer of carbon from branches on dead trees into the soil which impacts both mineral (reported in Forestry) and organic (reported in Peatland) soil. The remaining minor changes arise from two activity data changes. The first is a recalculation of the hydrological buffer/footprint applied by Peatland Action to the length of ditches blocked, which has reduced from 50m (biodiversity and hydrological footprint) to 30m (hydrological footprint[29,30]), to align with Peatland Code methodology, which slightly reduced the areas of restoration. Secondly, additional hectares of restoration have been added to the Scotland time series.

[29] Burke, W., 1961. Drainage investigation on bogland: the effect of drain spacing on ground water levels. *Irish Journal of Agricultural Research*, pp.31-34.

[30] Luscombe, D.J., Anderson, K., Grand-Clement, E., Gatis, N., Ashe, J., Benaud, P., Smith, D. and Brazier, R.E., 2016. How does drainage alter the hydrology of shallow degraded peatlands across multiple spatial scales?. *Journal of hydrology*, *541*, pp.1329-1339.

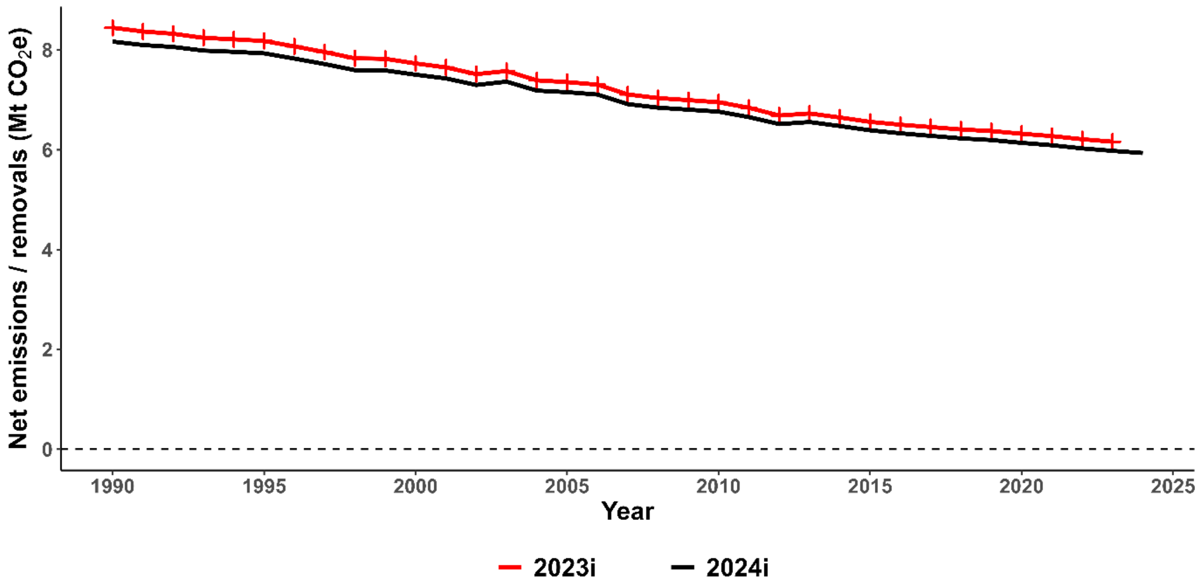

Figure 16 – Net emissions/removals within the Peatland category Mt CO_2e.

Cropland Mineral Soils under LUC

There was no change to the estimates of net emissions from cropland mineral soils undergoing land use change.

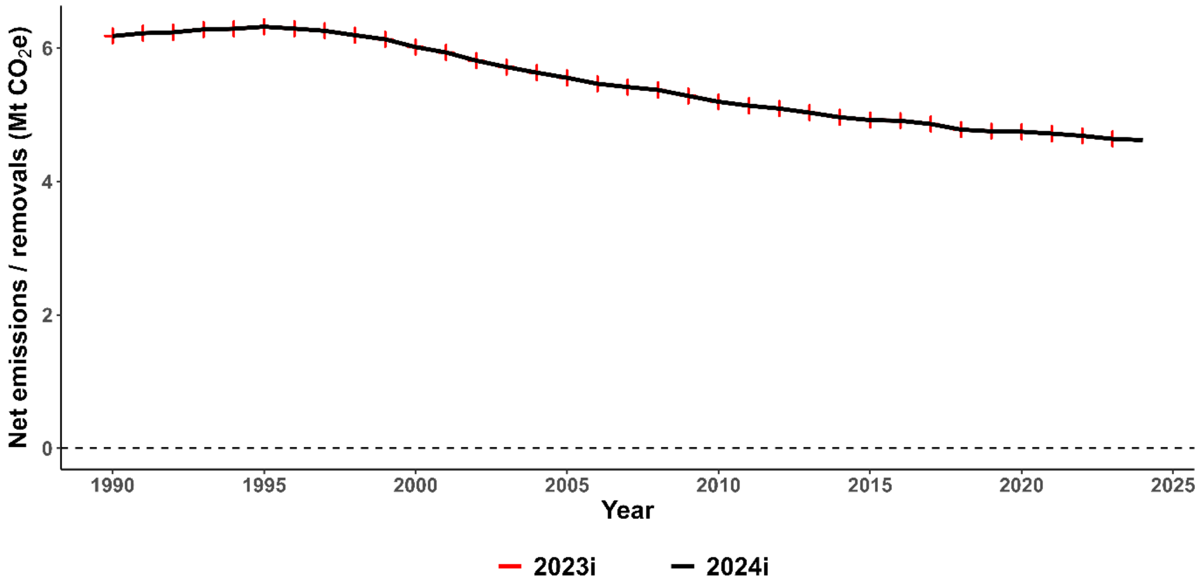

Figure 17 – Net emissions/removals within the Cropland mineral soil category Mt CO_2e

Grassland Mineral Soils Under LUC

There was no change to the estimates of net removals from grassland mineral soils undergoing land use change.

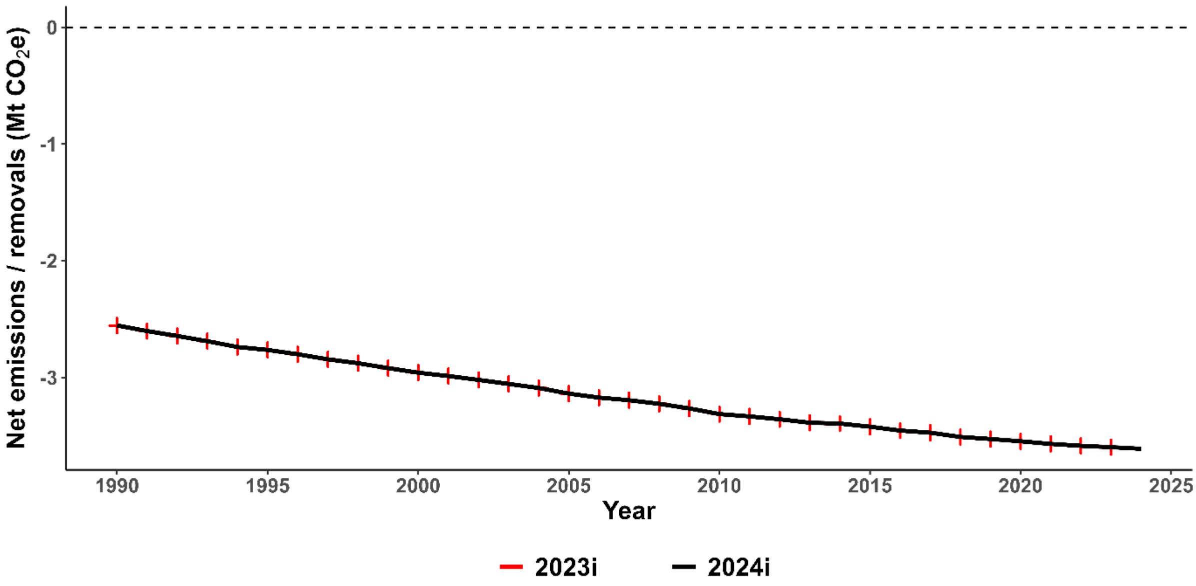

Figure 18 – Net emissions/removals within the Grassland mineral soil category Mt CO_2e

Settlement

There was no change to the estimates of net emissions from settlement.

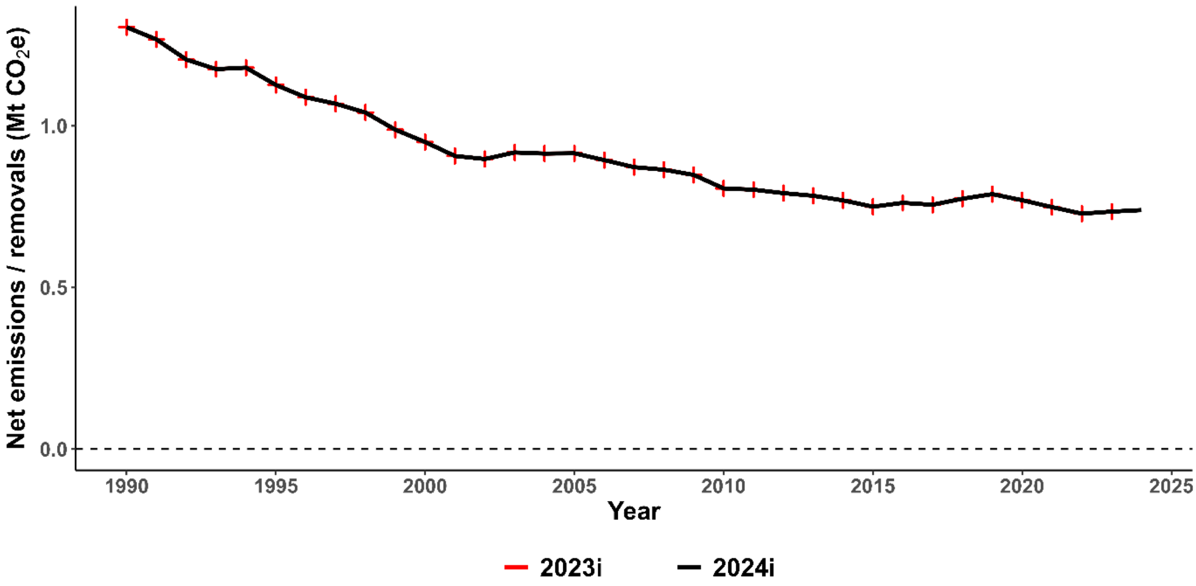

Figure 19 – Net emissions/removals within the Settlement category. Mt CO_2e.

Bioenergy

There are zero emissions/removals in the bioenergy category for Scotland (activity data for areas of bioenergy crops are not available and are thought to be very small).

Other LULUCF

There are insignificant changes in the other LULUCF category. Information of what is included in this category is provided in the ‘LULUCF TES Overview’ section below.

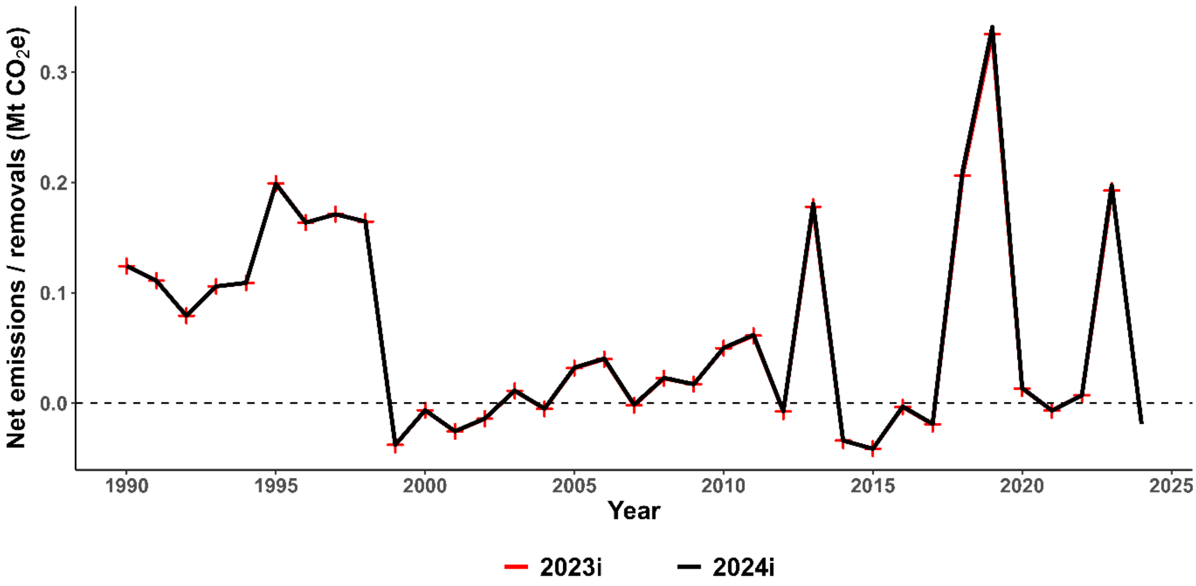

Figure 20 – Net emissions/removals within the Other LULUCF category Mt CO_2e

Table 15 – Recalculations to the LULUCF Inventory for Scotland

Source category	Difference between previous and current submission 1990 Mt CO_2e	Difference between previous and current submission 2023 Mt CO_2e	Previous submission 1990 Mt CO_2e	Current submission 1990 Mt CO_2e	Previous submission 2023 Mt CO_2e	Current submission 2023 Mt CO_2e	Comments
Forestry	0.090	-0.086	-7.503	-7.414	-7.592	-7.678	Updates to the CARBINE model. Use of latest Forestry Statistics activity data. Update to wood production and product type estimates. Updates to deforestation to Wetland areas.
Peatland	-0.278	-0.183	8.446	8.168	6.163	5.980	Updates to the peatland restoration data. Updates to the CARBINE model.
Cropland mineral soils under LUC	0.000	0.000	6.181	6.181	4.639	4.639	No change.
Grassland mineral soils under LUC	0.000	0.000	-2.553	-2.553	-3.596	-3.596	No change.
Settlement	0.000	0.000	1.305	1.305	0.735	0.735	No change.
Bioenergy crops	0.000	0.000	0.000	0.000	0.000	0.000	Zero emissions / removals.
Other LULUCF	0.000	0.005	0.124	0.124	0.193	0.197	Insignificant changes.

Wales

LULUCF Sector Total

Recalculations to greenhouse gas emissions from the LULUCF sector - Wales

The LULUCF sector is a net sink for Wales over the time series. Revisions since the previous inventory resulted in a net decrease in total reported greenhouse gas removals from the LULUCF sector in Wales in 1990 and in the most recent comparable year, 2023 (Figure 21). For 1990, net removals decrease by 0.008 Mt CO_2e (from -0.379 to -0.371 Mt CO_2e), and for 2023, net removals decrease by 0.055 Mt CO_2e (from -0.792 to -0.736 Mt CO_2e).

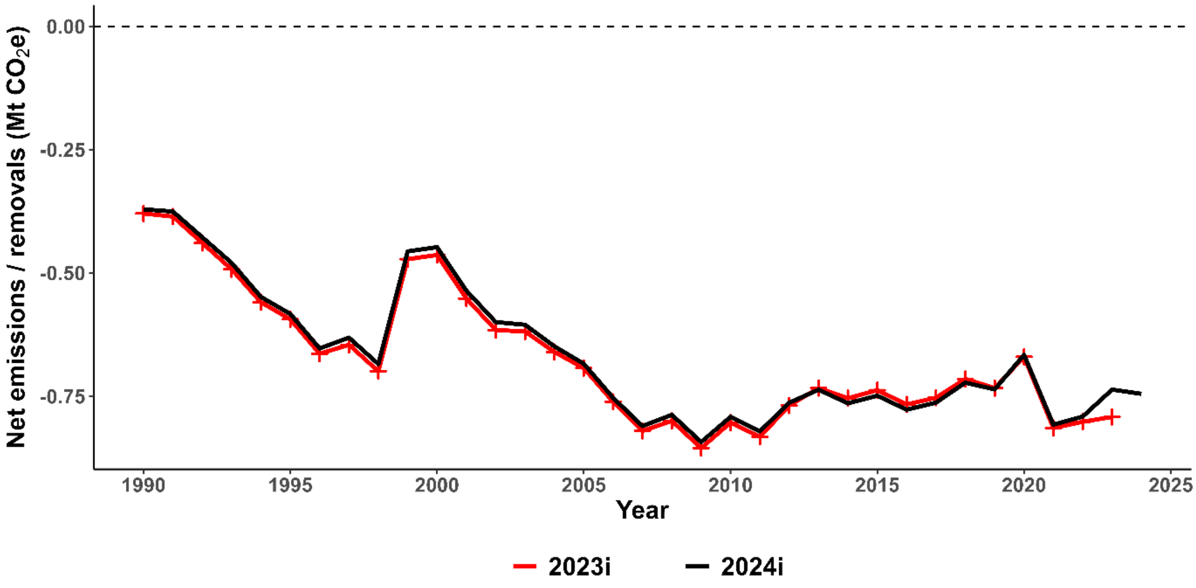

Figure 21 – Net emissions/removals in Total LULUCF Sector Mt CO_2e.

There have been several methodological changes contributing to these revisions. The most important changes and recalculations for Wales are outlined below. Note that the scales of the graphs vary. This should be borne in mind when assessing the impact of the recalculation on the LULUCF total.

Forestry

A decrease in net removals from Forestry of 0.017 Mt CO_2e in 1990 and 0.020 MtCO_2e in 2023 (Figure 22). The changes are due to model and activity data improvements, which include:

Updates to Activity Data:

- Updated new planting estimates for 2023 provisional data.
- Updated wood production estimates for 2023 provisional figures. Minor changes to wood production estimates from 1976-1995 due to an additional three decimal places of precision supplied by Forestry Statistics.
- Update to the total woodland area by correcting the area of unmapped woodland for Great Britain. The total 'unmapped NFI' area found in the 2017 Forestry Commission Tree Cover Outside Woodland in Great Britain report was previously added to small woodland area. This 'unmapped NFI' data contains both 'extra' woodland area that was missed in previous surveys and 'new' woodland planted between 2014 and 2015. To remove double counting, new planting data between 2014-2015 calendar years are now summed and subtracted from 'unmapped NFI' data before being added to small woodland area to include the additional woodland area only.
- Improve the species and Yield Class (growth rate) distribution for recent (post-2011) afforestation to better reflect recent planting practices.

- Wood Product Trade Statistics:
    - Updated woodfuel supply estimates for 2022-2023.
    - Updated sawmill consumption by country estimates from 1994-2022 due to error correction.
    - Updated roundwood delivery estimates for 2023 provisional figures.
    - Updated roundwood fencing estimates from 2006-2023 due to error correction in the dataset received from Forestry Statistics.

Updates to CARBINE modelling:

- Closer match to total wood production across the time series.
- Include the transfer of carbon from branches on dead trees into the soil.
- Include inputs into the deadwood carbon pool from competition-based mortality in young (pre-first thinning age) stands.

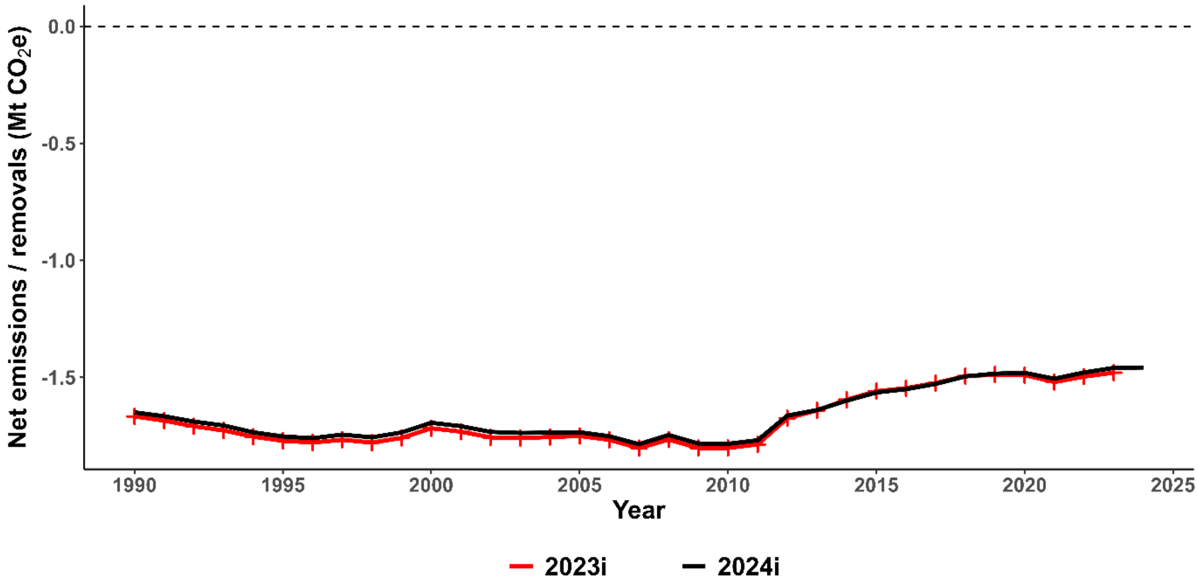

Figure 22 – Net emissions/removals within the Forestry category Mt CO_2e.

Peatland

Minor decreases in the estimate of net emissions from Peatland of -0.009 Mt CO_2e in 1990 and-0.007 Mt CO_2e in 2023 (Figure 23). This arises from the update to the CARBINE model to include the transfer of carbon from branches on dead trees into the soil, which impacts both mineral (reported in Forestry) and organic (reported in Peatland) soil.

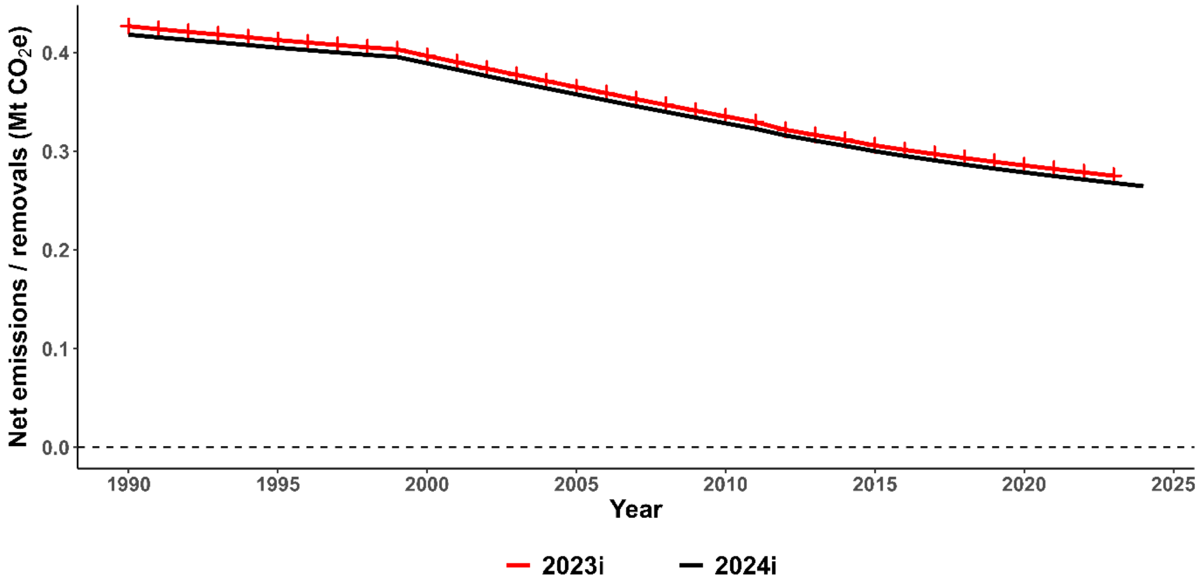

Figure 23 – Net emissions/removals within the Peatland category Mt CO_2e.

Cropland Mineral Soils under LUC

There was no change to the estimates of net emissions from cropland mineral soils undergoing land use change.

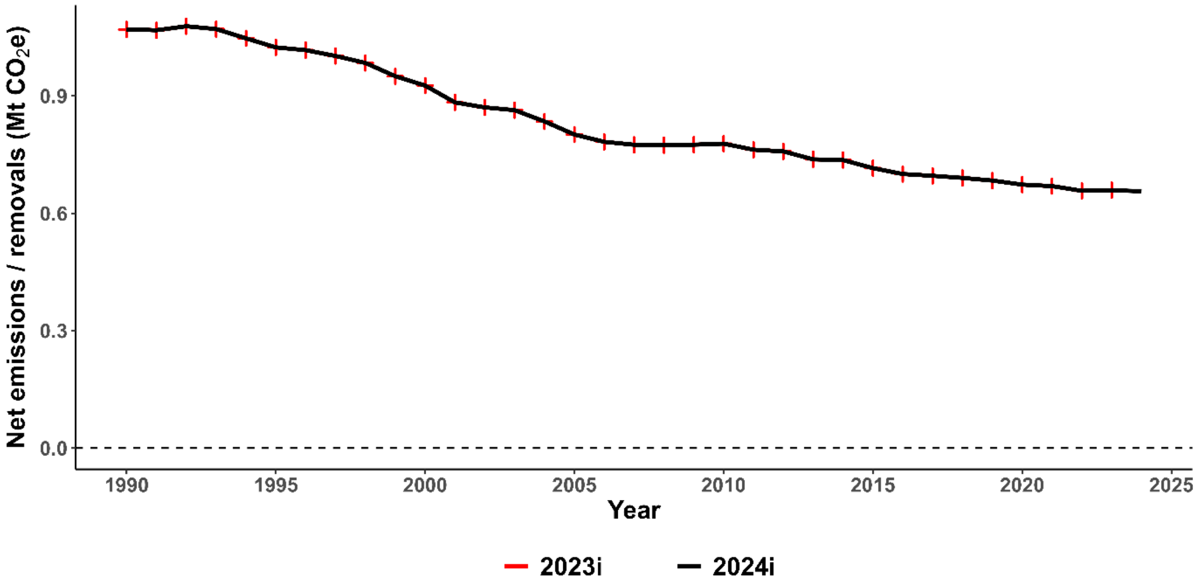

Figure 24 – Net emissions/removals within the Cropland category Mt CO_2e.

Grassland Mineral Soils under LUC

There was no change to the estimates of net removals from grassland mineral soils undergoing land use change.

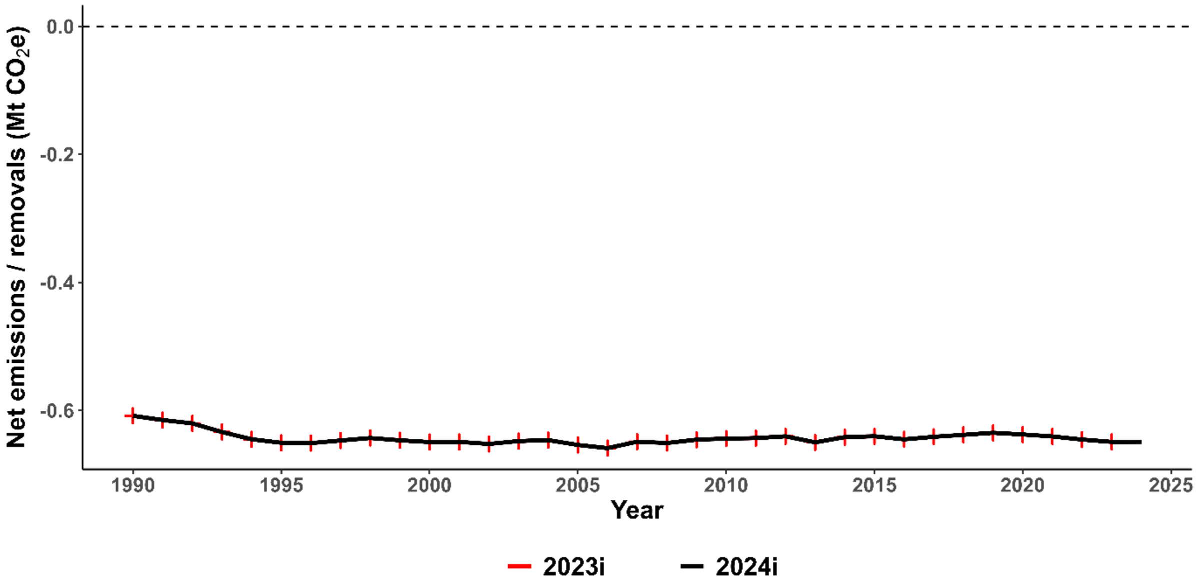

Figure 25 – Net emissions/removals within the Grassland mineral soils category Mt CO_2e.

Settlement

There was no change to the estimates of net emissions from settlement.

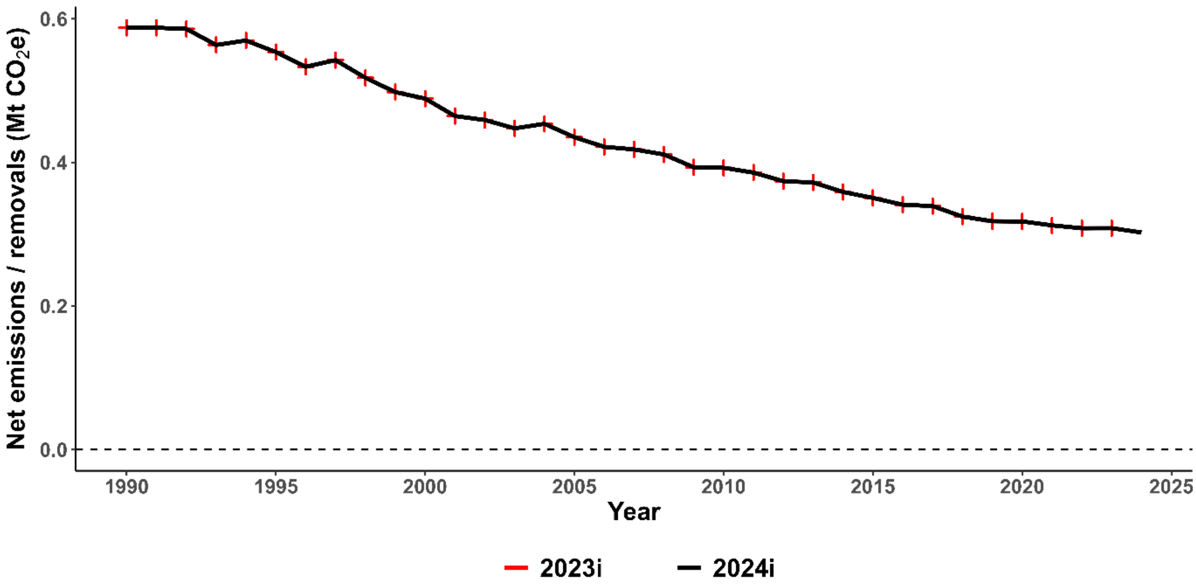

Figure 26 – Net emissions/removals within the Settlement category Mt CO_2e.

Bioenergy

There are zero emissions/removals in the bioenergy category for Wales (activity data for areas of bioenergy crops are not available and are thought to be very small).

Other LULUCF

Minor changes in the other LULUCF category at the end of the time series. There is an increase in net emissions of 0.042 Mt CO_2e in 2023. This is due to inclusion of a new year of wildfire activity data where previously this had been rolled over from the last available year. Information of what is included in this category is provided in the ‘LULUCF TES Overview’ section below.

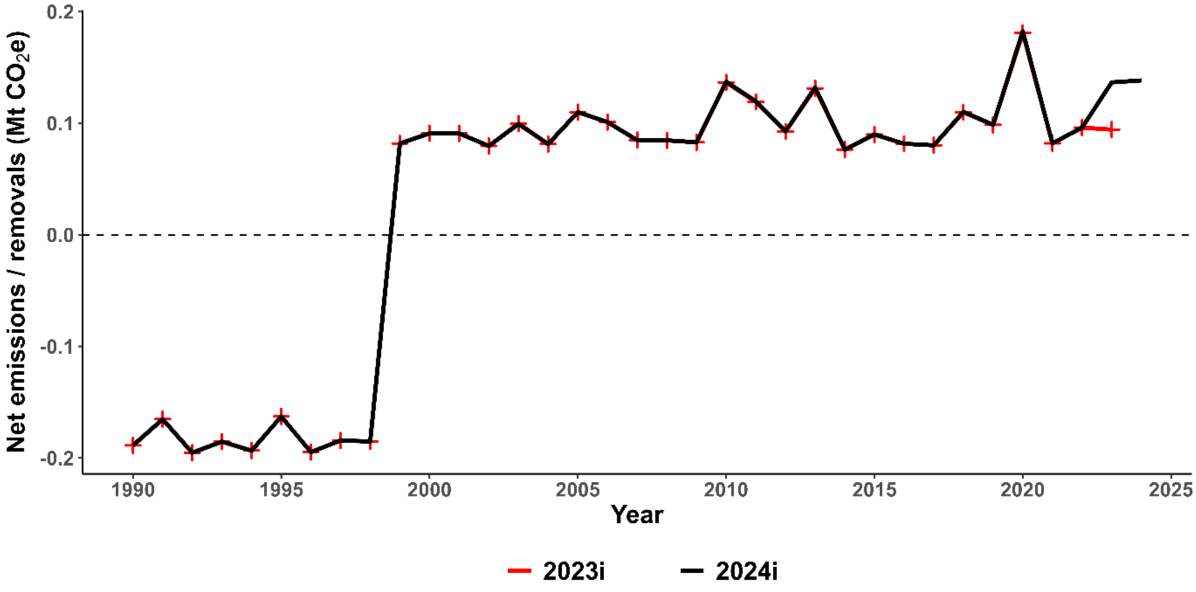

Figure 27 – Net emissions/removals within the Other LULUCF category Mt CO_2e.

Table 16 – Recalculations to the LULUCF Inventory for Wales

Source category	Difference between previous and current submission 1990 Mt CO_2e	Difference between previous and current submission 2023 Mt CO_2e	Previous submission 1990 Mt CO_2e	Current submission 1990 Mt CO_2e	Previous submission 2023 Mt CO_2e	Current submission 2023 Mt CO_2e	Comments
Forestry	0.017	0.020	-1.667	-1.650	-1.480	-1.459	Updates to the CARBINE model. Use of latest Forestry Statistics activity data. Update to wood production and product type estimates.
Peatland	-0.009	-0.007	0.427	0.418	0.275	0.268	Updates to the CARBINE model.
Cropland mineral soils under LUC	0.000	0.000	1.070	1.070	0.659	0.659	No change.
Grassland mineral soils under LUC	0.000	0.000	-0.608	-0.608	-0.649	-0.649	No change.
Settlement	0.000	0.000	0.587	0.587	0.308	0.308	No change.
Bioenergy crops	0.000	0.000	0.000	0.000	0.000	0.000	Zero emissions / removals.
Other LULUCF	0.000	0.042	-0.189	-0.189	0.094	0.137	Inclusion of new year of wildfire activity data where previously this has been rolled over from the latest available year.

Northern Ireland

LULUCF Sector Total

Recalculations to greenhouse gas emissions from the LULUCF sector – Northern Ireland

Revisions since the previous inventory resulted in a decrease in reported greenhouse gas emissions from the LULUCF sector in Northern Ireland across the time-series (Figure 28). For 1990 there is a decrease of -0.021 Mt CO_2e (from 2.643 to 2.622 Mt CO_2e), and for the most recent comparable year, 2023, there is a decrease of -0.019 Mt CO_2e (from 2.149 to 2.130 Mt CO_2e).

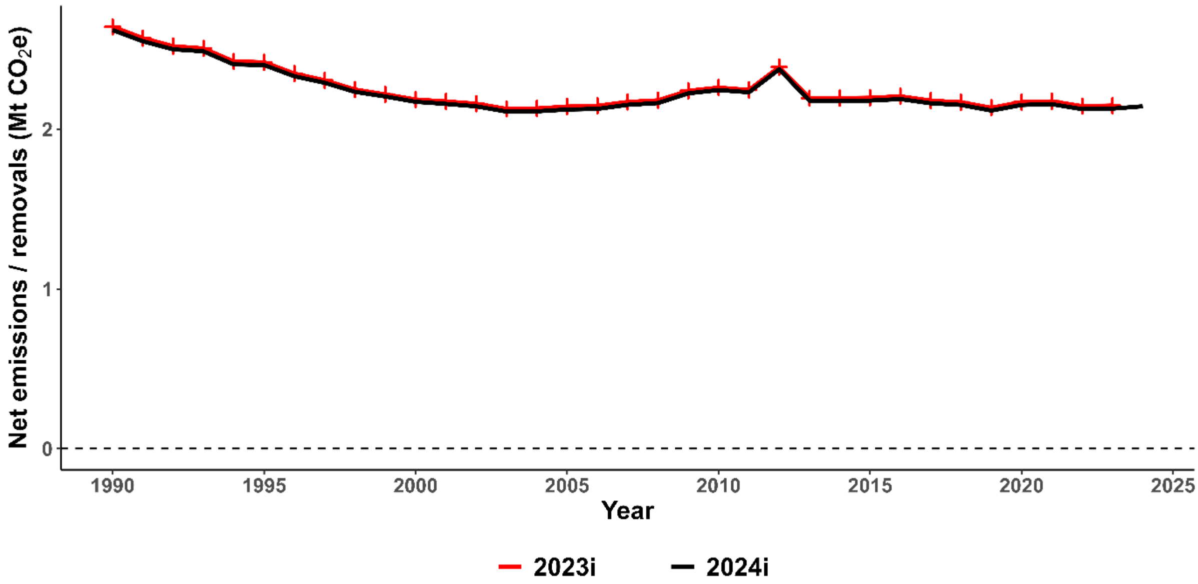

Figure 28 – Net emissions/removals in Total LULUCF Sector Mt CO_2e.

There have been several methodological changes contributing to these revisions. The most important changes and recalculations for Northern Ireland are outlined below. Note that the scales of the graphs vary. This should be borne in mind when assessing the impact of the recalculation on the LULUCF total.

Forestry

A minor decrease in net removals from Forestry of 0.002 Mt CO_2e in 1990 and 0.001 Mt CO_2e in 2023 (Figure 29). The changes are due to both model and activity data improvements, which include:

Updates to Activity Data:

- Updated new planting estimates for 2023 provisional data. New planting estimates for Northern Ireland from financial years 1900-1921 (1901-1920 calendar years) are now included.
- Updated wood production estimates for 2023 provisional figures. Minor changes to wood production estimates from 1976-1995 due to an additional three decimal places of precision supplied by Forestry Statistics.
- Improve the species and Yield Class (growth rate) distribution for recent (post-2011) afforestation to better reflect recent planting practices.
- Wood Product Trade Statistics:
    - Updated woodfuel supply estimates for 2022-2023.
    - Updated sawmill consumption by country estimates from 1994-2010 due to error correction.
    - Updated roundwood delivery estimates for 2023 provisional figures.
    - Updated roundwood fencing estimates from 2004-2023 due to error correction in the dataset received from Forestry Statistics.

Updates to CARBINE modelling:

- Closer match to total wood production across the time series.
- Include the transfer of carbon from branches on dead trees into the soil.
- Include inputs into the deadwood carbon pool from competition-based mortality in young (pre-first thinning age) stands.

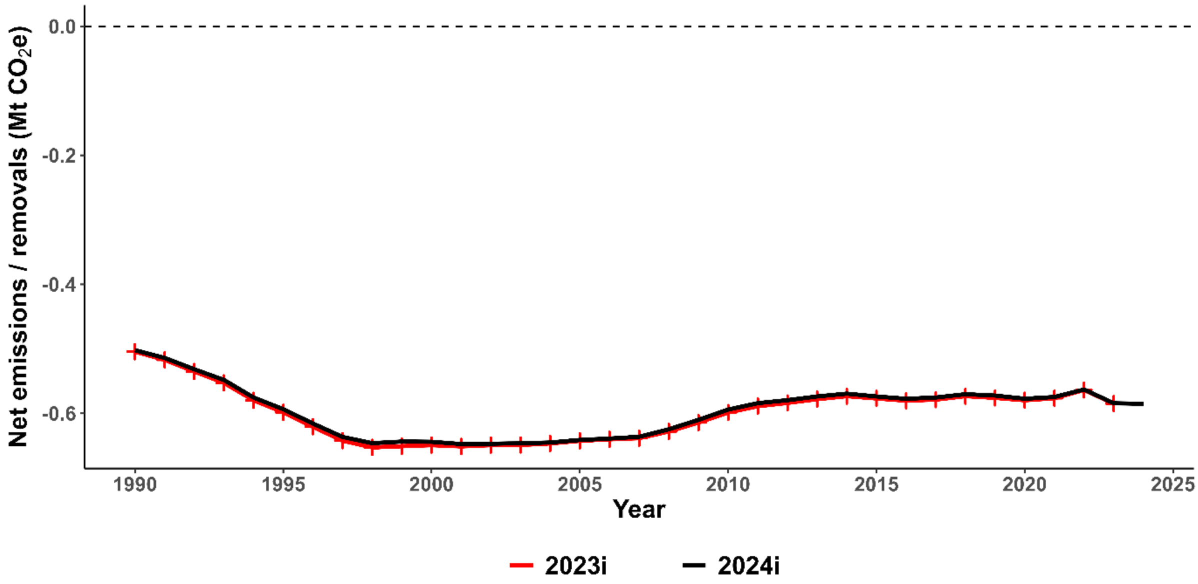

Figure 29 – Net emissions/removals within the Forestry category Mt CO_2e.

Peatland

Decreases in the estimate of net emissions from Peatland of -0.023 Mt CO_2e in 1990 and -0.020 Mt CO_2e in 2023 (Figure 30). This arises from the update to the CARBINE model to include the transfer of carbon from branches on dead trees into the soil, which impacts both mineral (reported in Forestry) and organic (reported in Peatland) soil.

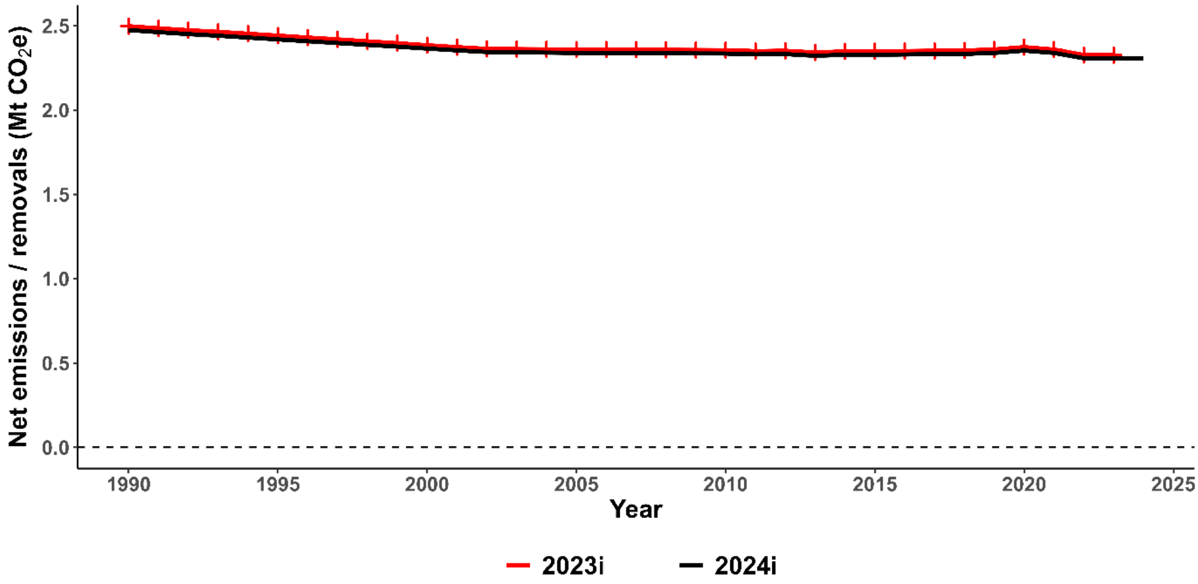

Figure 30 – Net emissions/removals within the Peatland category Mt CO_2e

Cropland Mineral Soils under LUC

There was no change to the estimates of net emissions from cropland mineral soils undergoing land use change.

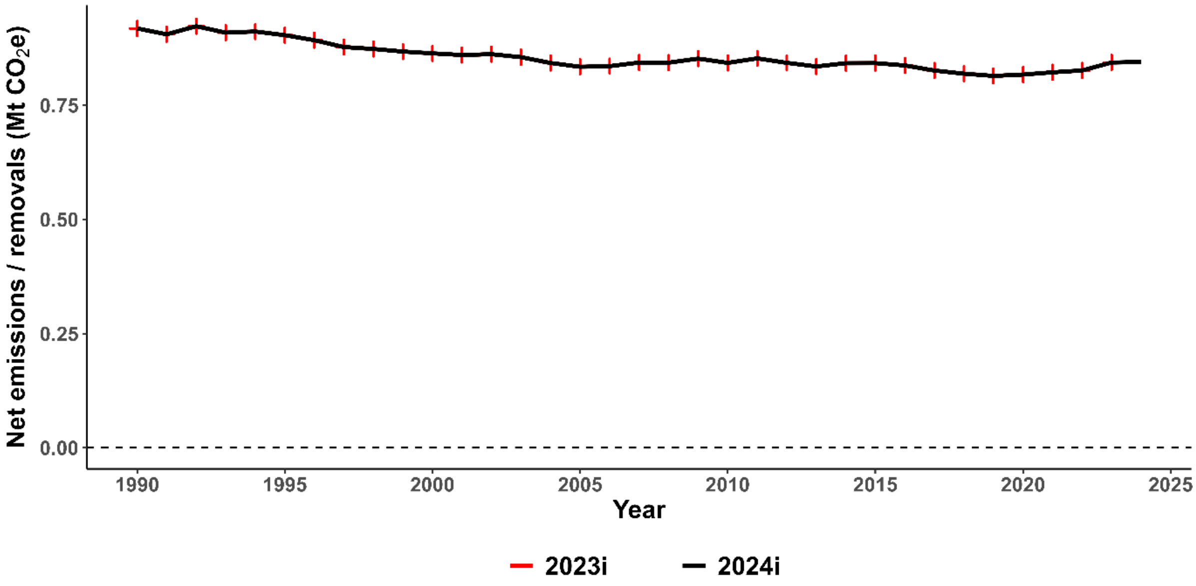

Figure 31 – Net emissions/removals within the Cropland mineral soils category Mt CO_2e.

Grassland Mineral Soils under LUC

There was no change to the estimates of net removals from grassland mineral soils undergoing land use change.

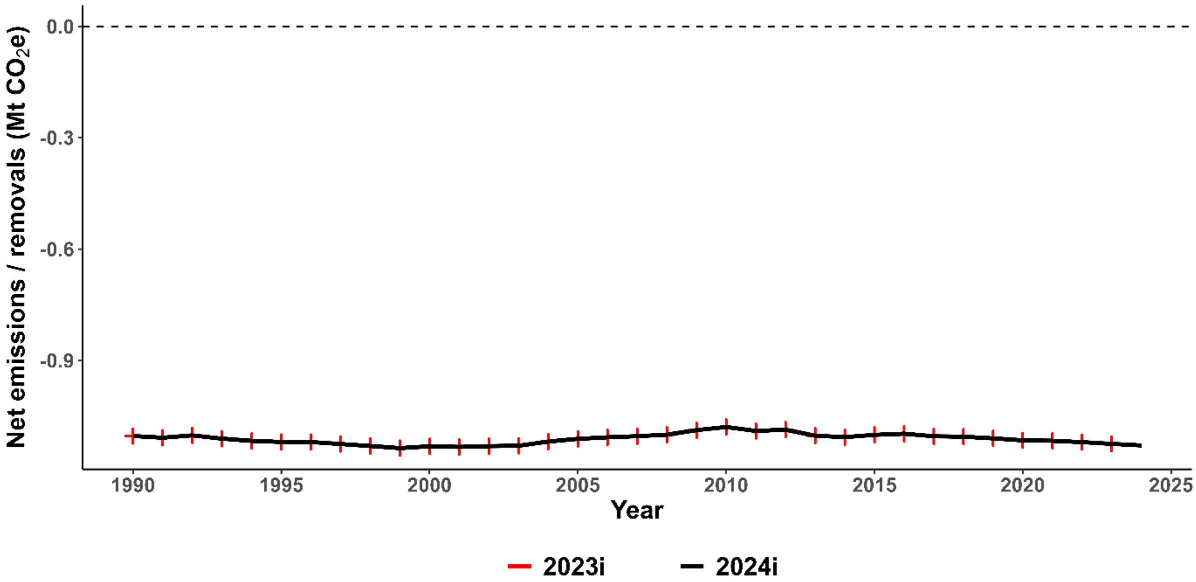

Figure 32 – Net emissions/removals within the Grassland mineral soils category Mt CO_2e.

Settlement

There was no change to the estimates of net emissions from settlement.

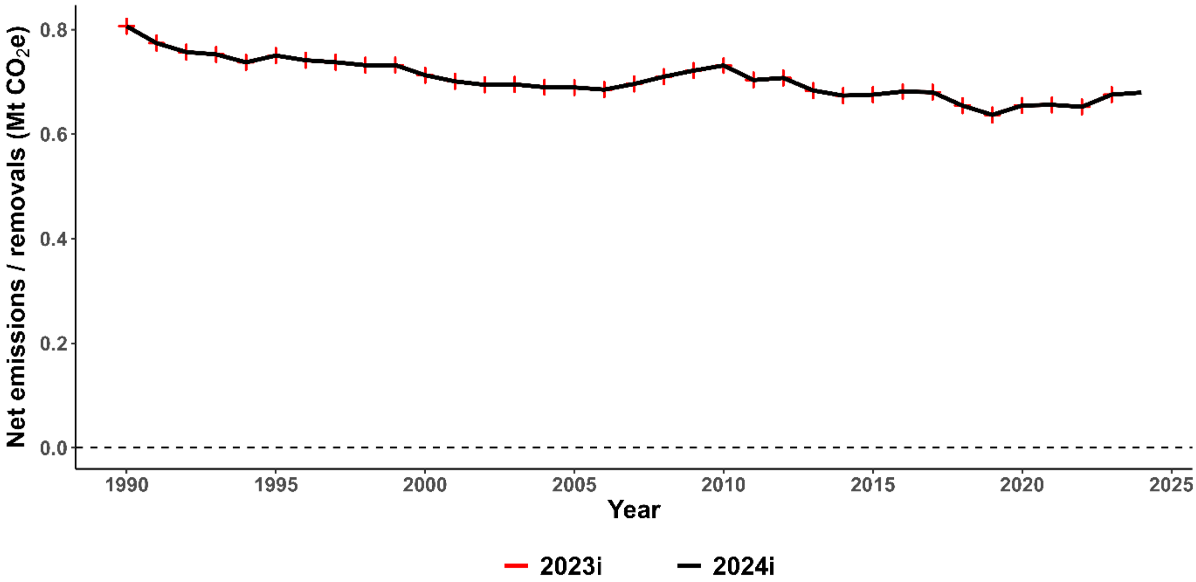

Figure 33 – Net emissions/removals within the Settlement category Mt CO_2e.

Bioenergy

There were no changes to the net emissions/removals from bioenergy.

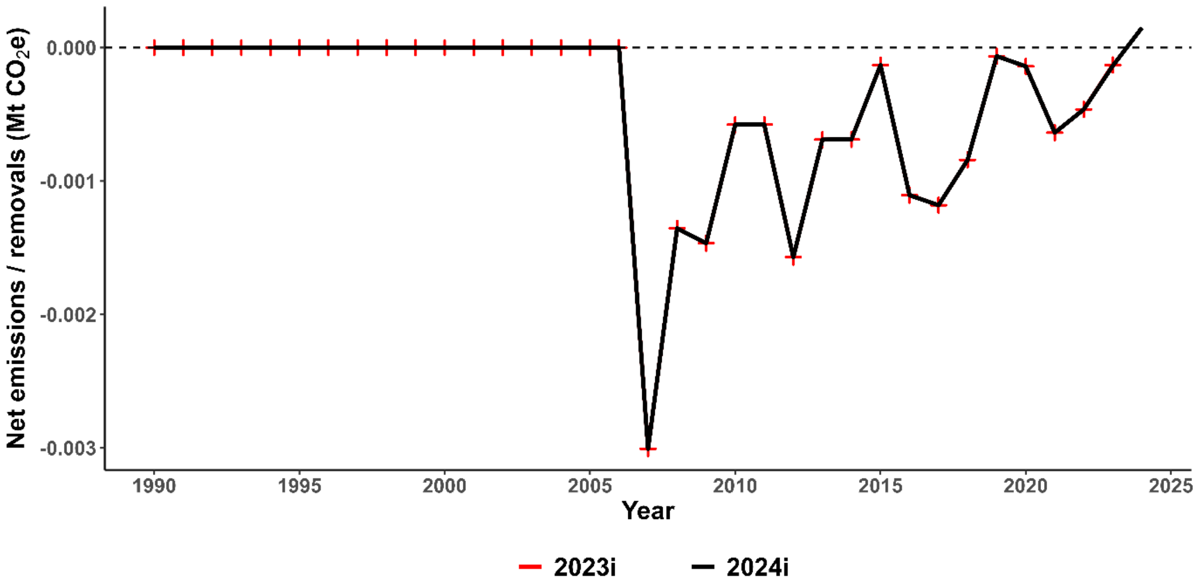

Figure 34 – Net emissions/removals within the Bioenergy category Mt CO_2e

Other LULUCF

There were no changes in the other LULUCF category. Information of what is included in this category is provided in the 'LULUCF TES Overview' section below.

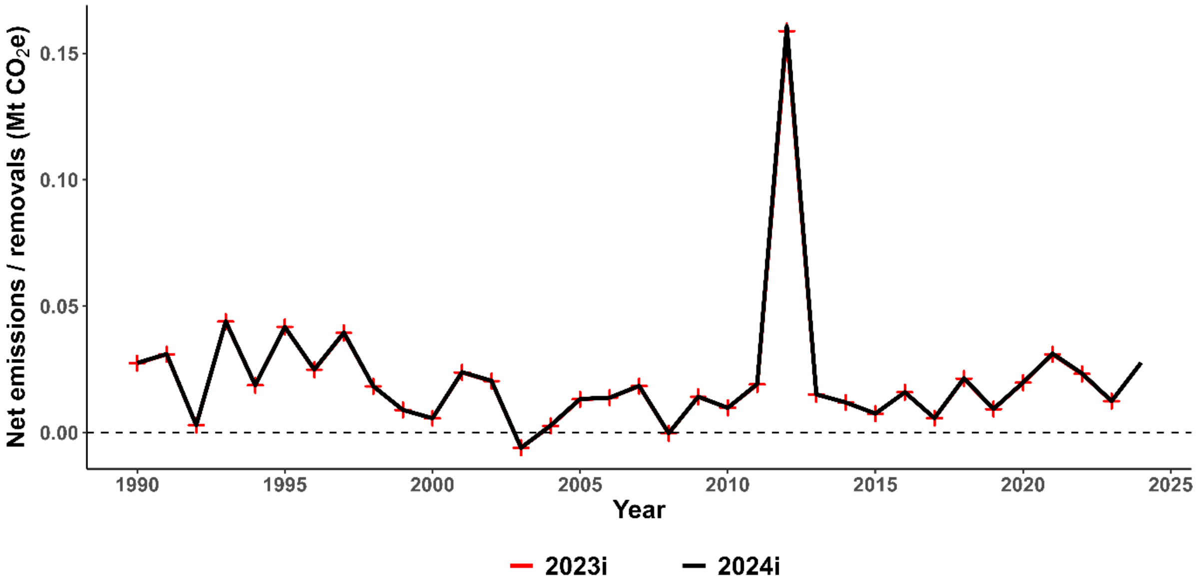

Figure 35 – Net emissions/removals within the Other LULUCF category Mt CO_2e.

Table 17 – Recalculations to the LULUCF Inventory for Northern Ireland

Source category	Difference between previous and current submission 1990 Mt CO_2e	Difference between previous and current submission 2023 Mt CO_2e	Previous submission 1990 Mt CO_2e	Current submission 1990 Mt CO_2e	Previous submission 2023 Mt CO_2e	Current submission 2023 Mt CO_2e	Comments
Forestry	0.002	0.001	-0.504	-0.502	-0.585	-0.584	Updates to the CARBINE model. Use of latest Forestry Statistics activity data. Update to wood production and product type estimates.
Peatland	-0.023	-0.020	2.498	2.475	2.327	2.307	Updates to the CARBINE model.
Cropland mineral soils under LUC	0.000	0.000	0.919	0.919	0.844	0.844	No change.
Grassland mineral soils under LUC	0.000	0.000	-1.104	-1.104	-1.125	-1.125	No change.
Settlement	0.000	0.000	0.807	0.807	0.676	0.676	No change.
Bioenergy crops	0.000	0.000	0.000	0.000	0.000	0.000	No change.
Other LULUCF	0.000	0.000	0.027	0.028	0.012	0.012	No change.

LULUCF TES Overview

TES Sub-sector	TES Category	Notes
Forestry	Forest land remaining forest land	Carbon stock change in biomass and mineral soils for forests > 20 years old. Emissions from drainage of mineral soils under forest.
	Land converted from forest land	Carbon stock change in biomass and mineral soils from deforested land. Direct and indirect N_2O emissions from soil mineralisation following deforestation. Emissions from controlled burning following deforestation.
	Land converted to forest land	Carbon stock change in biomass and mineral soils from forests < 20 years old. Direct and indirect N_2O emissions from soil mineralisation from forests < 20 years old. Direct and indirect N_2O emissions from forest fertilisation.
	Harvested wood products	Carbon stock change from harvested wood products from all forest.
Cropland mineral soils change	Cropland remaining cropland	Carbon stock change in mineral soils from cropland > 20 years old. Direct and indirect N_2O emissions from soil mineralisation from cropland >20 years old are reported in the Agriculture sector.
	Grassland converted to cropland	Carbon stock change in mineral soils from cropland < 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
	Settlement converted to cropland	Carbon stock change in mineral soils from cropland < 20 years old.
Grassland mineral soils change	Cropland converted to grassland	Carbon stock change in mineral soils from grassland < 20 years old.
	Grassland remaining grassland	Carbon stock change in mineral soils from grassland > 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
	Settlement converted to grassland	Carbon stock change in mineral soils from grassland < 20 years old.
Peatland	Cropland drained	Emissions from drained cropland on organic soils. Not including N_2O which is reported in the Agriculture sector.
	Domestic extraction	Emissions from domestic peat extraction (fuel use).
	Eroding modified bog drained	Emissions from drained eroding modified bog (bare peat).
	Eroding modified bog undrained	Emissions from undrained eroding modified bog (bare peat).

TES Sub-sector	TES Category	Notes
	Extensive grassland drained	Emissions from drained extensive grassland on organic soils.
	Forest drained	Emissions from drained forest on organic soils.
	Industrial extraction	On-site and off-site emissions from industrial peat extraction (horticultural use).
	Intensive grassland drained	Emissions from drained intensive grassland on organic soils. Not including N_2O which is reported in the Agriculture sector.
	Modified bog drained	Emissions from drained modified bog (semi-natural heather and grass dominated bog).
	Modified bog undrained	Emissions from undrained modified bog (semi-natural heather and grass dominated bog).
	Near-natural bog	Emissions/removals from near-natural bog.
	Near-natural fen	Emissions/removals from near-natural fen.
	Rewetted bog	Emissions from rewetted bog.
	Rewetted fen	Emissions from rewetted fen.
	Rewetted modified bog	Emissions from rewetted modified (semi-natural) bog.
	Settlement drained	Emissions from drained settlement on organic soils.
Settlement	Settlement remaining settlement	Carbon stock change in mineral soils from settlement > 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
	Land converted to settlement	Carbon stock change in mineral soils and biomass from settlement < 20 years old. Direct and indirect N_2O emissions from soil mineralisation.
Bioenergy crops	Miscanthus	Carbon stock change in biomass and mineral soils from the management of *Miscanthus* crops.
	Short rotation coppice	Carbon stock change in biomass and mineral soils from the management of short rotation coppice crops.
Other LULUCF	Forest miscellaneous	Emissions from wildfires on forest land.
	Cropland miscellaneous	Emissions from wildfires on cropland. Carbon stock change from non-forest biomass on land converted to cropland. Carbon stock change in biomass and mineral soils from the management of non-bioenergy crops.
	Grassland miscellaneous	Emissions from wildfires on grassland. Carbon stock change from non-forest biomass on land converted to grassland. Carbon stock change in biomass from grassland management.

TES Sub-sector	TES Category	Notes
	Wetland miscellaneous	Carbon stock change in biomass from reservoir creation.

APPENDIX 3. DG GHG BY SOURCE INVENTORIES DATA SOURCES

There are three ways to generate GHG emission estimates for the DG By Source inventories:

- **Bottom-up estimates**, which is the most robust method and subject to lower uncertainties. Usually associated with well-regulated sources (e.g. power stations). If completeness of known sites is good, we can sum the emissions in each DG and derive a % of the UK total.
- **Top down estimates**, where there are no regular source of emissions data or fuel use data available, so proxy data are used to split up the UK total, such as population, GDP, or periodic surveys. This is less accurate, but often the only option for less regulated sectors.
- **Hybrid**, where bottom-up data are used as far as possible, with proxy data used to derive remaining emissions.

This appendix sets out the key data sources and publishers/ providers used to compile the DG inventories. Citation and links to the data sources mentioned are provided in **Section 6. References**.

It should be noted that this appendix does not intend to duplicate information on data sources which are also used in the UK inventory (e.g. data for well-regulated sources such as power stations). There is extensive documentation on these data; please refer to Table 1.4 in the NID and other published NAEI reports.

This appendix focuses on data sources used specifically for the compilation of the DG inventories, and therefore only briefly references national level sources. This appendix should be read in conjunction with the NID (Brown, et al., 2026).

Table 18 – DG By Source Inventories Data Sources (1990 - 2024)

Data Source Name	Citation (Publisher, Date)	Description
NAEI Points Database	Ricardo, 2026	Covers large industrial and commercial sources that are well regulated. The NAEI Points Database is compiled from several regulatory sources, including (but not limited to): • UK ETS and EU ETS • Pollution Inventory (Environment Agency and Natural Resources Wales), Scottish Pollutant Release Inventory (Scottish Environment Protection Agency) and Inventory of Statutory Releases (Department of Agriculture, the Environment and Rural Affairs) Further data on point sources used in the inventory can be found here: https://naei.energysecurity.gov.uk/data/maps/emissions-point-sources
NAEI Mapping Grids	Ricardo, 2026	For diffuse emission sources, distribution maps are generated using appropriate surrogate statistics that indirectly indicate the spatial distribution of emissions for each sector. The method used for each source sector varies according to the data available. An explanation of the mapping grid methodology and relevant data can be found here: UK Spatial Emissions Methodology for NAEI 2023
NAEI Emissions Output	Ricardo, 2026	The DG inventories use the UK inventory as a basis.
Annual airport data 2024	Civil Aviation Authority, 2025	Number of flights per airport.
Coal mining production and manpower returns statistics 2025	Mining Remediation Authority, 2025	Regional coal production for deep mining and open mining.
Northern Ireland Waste Data Interrogator	DAERA, 2025	Landfill waste data and landfill gas collection data for Northern Ireland.

Data Source Name	Citation (Publisher, Date)	Description
Agricultural Workforce in the UK	Defra, 2025	Statistics on the number of agriculture workers (seasonal and total labour) per DG.
Port and domestic waterborne freight statistics: data tables	Department for Transport, 2025	Data about the international and domestic movement of freight by water.
Sea passenger statistics: data tables (SPAS)	Department for Transport, 2025	Data on UK international and domestic sea passengers.
Digest of UK Energy Statistics	DESNZ, 2025a	Energy trends: Electricity and generation supplied per DG, including electricity generated for own use and consumption, transfers to public supply and imported/ exported internationally Agriculture commodity balance of final consumption of electricity.
Regional and Local Authority gas consumption statistics	DESNZ, 2025b	Total gas consumption data for domestic use consumption (GWh) for Great Britain.
Regional and Local Authority electricity consumption statistics	DESNZ, 2025c	Estimates of electricity consumption at region and Local Authority levels in Great Britain.
Sub-national electricity consumption statistics in Northern Ireland	DESNZ, 2025d	Sub-national domestic and non-domestic electricity consumption statistics in Northern Ireland.
Subnational Residual Fuel Statistics	DESNZ, 2025e	Sub-national estimates of non-gas, non-electricity and non-road transport fuel consumption (in thousand tonnes of oil equivalent (ktoe)).
England Waste Data Interrogator	EA, 2025	Landfill waste data and landfill gas collection data for England.
UK sea fisheries annual statistics	Marine Management Organisation, 2025	Landings by port.
Wales Waste Permit Returns Data Interrogator	NRW, 2025	Landfill waste data and landfill gas collection data for Wales.
Regional gross value added (balanced) by industry: all ITL regions	ONS, 2025a	Table 1, ITL1 & UK current price estimates, pounds million.
Regional gross domestic product: all ITL regions	ONS, 2025b	Gross Domestic Product per DG.
Dwelling stock by tenure, UK	ONS, 2025c	Number of dwellings per DG.
Population statistics	ONS, 2025d	Mid-Year population statistics by DG.
Oil and gas production statistics in Scotland	Scottish Government, 2025	Oil and gas production volumes.

Data Source Name	**Citation** (Publisher, Date)	**Description**
Waste Data for Scotland	SEPA, 2025	Landfill waste data and landfill gas collection data for Scotland.
Compliance Report Emissions and Surrenders	UK Emissions Trading Registry	Emissions reported by Iron & Steel plants.
Abandoned mine methane emissions	WSP, 2011	Modelled projected deep mine and open cast mine methane emissions estimates.

APPENDIX 4. UNCERTAINTIES

INTRODUCTION

The uncertainties in the UK Inventory are estimated using a Monte Carlo simulation. The UK NID describes this approach in detail. The method involves estimating the uncertainties in activity data and EFs for all emission source categories and then using a Monte Carlo simulation package to calculate the uncertainty in the emission totals.

In order to apply a similar approach to the DG GHG inventories, it is necessary to estimate uncertainties for the DG activity data (i.e. fuel consumption, production data). The same EFs are used in the DG inventories as in the UK Inventory, so it is assumed that the emission factor uncertainties are the same as for the UK.

In the UK Inventory, uncertainties in the activity data are estimated on the basis of expert judgement. Making similar expert judgments for each DG would be a time-consuming activity and would be prone to inconsistency with the UK uncertainties. Moreover, for some sources, no direct activity data are available at all, and it has been necessary to distribute the UK data using surrogate data (e.g. employment statistics). In such cases, it is impossible to say whether the surrogate statistics are an accurate indicator. The uncertainties for activity in the individual DGs when expressed as a percentage should be higher than that of the total UK uncertainty. This is due to a statistical principle where, if the elements of a group have any independence from one another and are positive, the uncertainty of the sum of a group is less than the sum of the uncertainties of each element in the group.

UNCERTAINTY ANALYSIS METHODOLOGY

The uncertainties in the DG GHG inventories are also estimated using a Monte Carlo simulation. For simplicity and consistency, the source categories used are the same as those used in the UK GHGI simulation. For each of these source categories, activity uncertainties are derived for England, Scotland, Wales, Northern Ireland, and Unallocated based on the uncertainty for the UK total and the relative contributions to emissions from each of the DGs for this source category using the following equation:

$$U_{A_i} = U_A w_i \frac{\sum_i |E_i|}{\sqrt{\sum_i {w_i}^2 {E_i}^2}}$$

Where U_A is the uncertainty in the UK activity,

i is the DG,

U_{A_i} is the uncertainty in activity for DG i,

w_i is a weighting factor for DG i representing the relative uncertainty in the activity,

E_i is the emission for each of the DG i.

When independence is assumed between the DGs' activity estimates then this equation ensures that the sum of the DGs uncertainty is consistent with the UK uncertainty. For the simplest case of $w_i = 1$, for all i this equation gives the DGs the same % uncertainty each, but opting to use a weighting function attributes higher % uncertainties for small contributors and lower uncertainties to large contributors using the following equation:

$$w_i = \frac{1}{\sqrt[4]{E_i}}$$

For some key sources the calculated uncertainty was overwritten with expert judgement.

In order to estimate the uncertainty on the trend, it was necessary to make an estimate of the uncertainty in the Base Year (1990 for carbon dioxide, methane and nitrous oxide, and 1995 for the F-gases). This estimate is made for the UK Inventory, as part of the analysis presented in the NID. Therefore, it was possible to make the DG uncertainty estimates using the method described above in conjunction with the UK estimates for the Base Year.

In addition to the estimation of the uncertainty in each year, it was also necessary to consider correlations between sources across years. Similar to the UK assessment of uncertainties, EFs are assumed to be correlated between years, and activity data are uncorrelated between years.

UNCERTAINTY ANALYSIS RESULTS

As UK emissions are the sum of the DG's emissions, the estimates for the individual DGs will be more uncertain than for the UK total. The DG uncertainties are estimated independently of the UK inventory uncertainties and there are subtle differences in the calculations and assumptions made between these models, additionally any two runs of a Monte Carlo analysis will always give slightly different results (the difference reducing with more iterations). This means that the uncertainties calculated for the UK in the DG inventories will be slightly different than that for the UK in the UK inventory. Overall data quality and sector allocations are improving, but large uncertainties remain for some source sectors, even at UK level.

The uncertainty estimates for the 1990-2024 DG GHG inventories are reported in **Table 19** below. The table presents the central estimate from the Monte Carlo simulation for each GHG and for each DG, for the Base Year and the latest year and the estimated uncertainty on the total. In addition, the central estimate of the trend (expressed as the percentage change from the Base Year) is presented together with the 2.5 and 97.5 percentile estimates.

It has been observed that relative to the year specific uncertainty ranges, that the reported trend uncertainty range may be an overestimate, i.e., the correlation of uncertainties within the modelling over time may warrant review.

Please note, the totals below may not exactly match the sum of the values, due to minor rounding values.

Table 19 – Estimated Uncertainties[a] in the DG GHG Inventories: Base Year, 2024 and Trend

Gas ($ktCO_2e$)	Base Year[b]		2024		Base Year to 2024 Trend		
	Central Estimate[cd]	Uncertainty	Central Estimate	Uncertainty	Central Estimate	2.5 Percentile	97.5 Percentile
England							
CO_2	466,345	2%	224,896	2%	-241,450	-53%	-50%
CH_4	97,909	21%	33,575	16%	-64,334	-84%	-49%
N_2O	37,903	34%	14,784	22%	-23,119	-102%	-35%
HFC	15,373	10%	5,150	12%	-10,223	-77%	-56%
PFC	277	18%	95	13%	-182	-85%	-48%
SF_6	1,165	4%	213	6%	-952	-86%	-77%
NF_3	0	59%	0	68%	0	-154%	-36%
Total	618,973	4%	278,712	3%	-340,260	-59%	-52%
Scotland							
CO_2	55,916	4%	22,847	8%	-33,069	-63%	-56%
CH_4	16,270	20%	10,153	13%	-6,117	-57%	-22%
N_2O	4,286	13%	3,063	17%	-1,223	-42%	-14%
HFC	64	22%	509	29%	445	469%	931%
PFC	101	37%	37	43%	-63	-107%	-26%
SF_6	37	23%	38	23%	1	-29%	35%
NF_3	0	48%	0	46%	0	-128%	-29%
Total	76,673	5%	36,647	6%	-40,026	-57%	-48%
Wales							
CO_2	41,606	4%	22,269	3%	-19,337	-50%	-43%
CH_4	9,751	19%	5,722	10%	-4,029	-61%	-28%
N_2O	1,866	11%	1,377	17%	-489	-40%	-11%
HFC	33	31%	283	38%	250	447%	1107%
PFC	155	28%	3	124%	-152	-126%	-71%

Gas ($ktCO_2e$)	Base Year[b]		2024		Base Year to 2024 Trend		
	Central Estimate[cd]	Uncertainty	Central Estimate	Uncertainty	Central Estimate	2.5 Percentile	97.5 Percentile
SF_6	85	14%	17	20%	-68	-94%	-65%
NF_3	0	148%	0	124%	0	-256%	49%
Total	53,496	4%	29,671	3%	-23,825	-49%	-41%
Northern Ireland							
CO_2	18,204	6%	11,296	6%	-6,908	-43%	-33%
CH_4	5,897	20%	5,413	9%	-485	-31%	7%
N_2O	1,894	18%	1,473	23%	-421	-48%	3%
HFC	19	34%	166	40%	148	501%	1203%
PFC	1	247%	-	-	-1	-421%	-10%
SF_6	3	50%	6	31%	3	8%	161%
NF_3	-	-	-	-	-	-	-
Total	26,018	6%	18,354	5%	-7,663	-36%	-24%
Unallocated							
CO_2	15,618	2%	9,222	4%	-6,397	-44%	-38%
CH_4	2,187	33%	564	55%	-1,623	-99%	-55%
N_2O	265	64%	178	68%	-87	-55%	-19%
HFC	-	-	-	-	-	-	-
PFC	-	-	-	-	-	-	-
SF_6	-	-	-	-	-	-	-
NF_3	-	-	-	-	-	-	-
Total	18,071	5%	9,963	5%	-8,107	-49%	-41%
UK							
CO_2	597,690	2%	290,530	2%	-307,160	-53%	-50%
CH_4	132,015	19%	55,427	12%	-76,588	-74%	-43%
N_2O	46,213	28%	20,874	18%	-25,340	-89%	-33%
HFC	15,488	10%	6,108	11%	-9,380	-71%	-50%
PFC	533	14%	135	15%	-399	-90%	-61%
SF_6	1,291	4%	274	6%	-1,016	-83%	-75%
NF_3	0	36%	0	37%	0	-117%	-42%
Total	793,230	4%	373,348	2%	-419,882	-56%	-50%

Notes

a) Uncertainty is defined as ± 1.96×(standard deviation)/mean %, which closely approximates the 95% confidence interval.

b) Base Years are 1990 for CO_2, CH_4 and N_2O; 1995 for NF_3, HFCs, PFCs and SF_6.

c) The uncertainty model takes emission estimates by gas for each source, applies an uncertainty distribution for that source and calculates a statistical mean, presented above as the central estimate. The emissions data in this table are taken from the Monte Carlo model output. The central estimates by gas for the Base Year and the latest inventory year are very similar but not identical to the emission estimates in the DG inventories.

d) Where the central estimate says '0' this does not mean that there are no emissions, but that emissions are rounded to 0. '-' is used to represent no emissions.

APPENDIX 5. END USER EMISSIONS

INTRODUCTION

Emissions of GHGs reported under international conventions are typically on a “by source” basis. This means that the emissions are allocated to the source sector at the point of their release. For example, emissions from refining oils are allocated to the refineries, and emissions from the combustion of fuel in vehicles are allocated to the relevant transport sector.

This section of the report presents emissions on an “end user” basis. In this case, all emissions associated with energy supply (e.g. power generation, coal mining, oil and gas extraction, refineries) are allocated to the final users of the energy. In the above example, the emissions from the refineries would be reallocated to all oil users, including within the transport sector. The main usefulness of End User inventories is to present a more representative picture of emissions due to consumption, rather than production. End User inventories are needed to reflect the full impact of energy efficiency policies as they show the emissions associated with sector consumption of all fuels, including emissions associated with electricity use.

The scope of the emissions allocated within these DG End User inventories is bounded by the definition of the “UK” emissions, as applied in the main DG By Source inventories. The sum of all DG End User emissions equals the sum of all DG By Source emissions, which matches the UK total. GHG emissions associated with fuel imports (e.g. electricity imported from the EU and consumed in the UK) are not reported within these data. However, the emissions of GHGs associated with the refining of fuels that are subsequently exported are included in these DG inventories, as the emissions are produced at source within the UK energy supply industry. An example of this is for international aviation and shipping; whilst the GHG emissions from the direct use of petroleum fuels in those “memo item” sources are excluded from the End User inventories, the emissions associated with the supply of fuels to those sectors (i.e. upstream oil extraction and refinery emissions within the UK) are included in the DG End User inventories.

END USER METHODOLOGY

The End User estimates are derived from the By Source emission inventories, applying a secondary set of calculations based on additional data such as electricity use estimates by DG by sector. For some sectors, the DG estimates of electricity use are based on proxy data and introduce additional uncertainty to the End User inventories. As a result, the DG End User inventories estimates are associated with greater uncertainty than the By Source estimates and policy makers must consider this when using the End User inventories data.

In particular, the End User emission estimates for each country are associated with higher uncertainty for 1990 due to the lack of detailed electricity consumption data by country available for that year, whereas the estimates of total emissions from 2003 onwards are subject to lower uncertainty due to the development of the DESNZ sub-national energy statistics in the early 2000s. Within the End User inventories, the overall consumption of electricity by DG are reported by DESNZ whilst the sector allocations of electricity use are based on data from a range of statistical sources.

The revisions to the DG GHG By Source inventory data also affect the DG End Users data and hence impacts such as the revisions to LULUCF and agriculture estimates (see **Appendix 2.** Method Changes and Recalculations

) also have a notable impact on the reported inventories estimates and trends on an End User basis.

END USER RESULTS

The results of the DG End Users analysis for the 1990-2024 inventory cycle are presented in the spreadsheet that accompanies this report, and this includes the data resolved at the TES Sector level.

The country-specific trends of End User emissions, once the emissions attributable to exports are excluded from the totals (to give a more accurate representation of “consumption” emission trends in each DG) are as follows:

- England
    - 1990-2024 trend, emissions down 54%

    - 2023-2024 trends, emissions down 2%
- Scotland
    - 1990-2024 trend, emissions down 54%
    - 2023-2024 trends, emissions down 3%
- Wales
    - 1990-2024 trend, emissions down 51%
    - 2023-2024 trends, emissions down 10%
- Northern Ireland
    - 1990-2024 trend, emissions down 30%
    - 2023-2024 trends, emissions down 0.4%

END USER DATA FOR WALES "ELECTRICITY ONLY" EMISSIONS

The allocation of emissions from electricity use in the End User inventories was historically of specific interest for the reporting of progress against GHG reduction targets for the Welsh Government. The Climate Change Strategy for Wales (2010) established emission reduction targets that address the scope of devolved powers for the Welsh Government, and this required analysis of the impact of the operation of the UK electricity supply grid. The table below presents the End User emissions that are allocated from the use of electricity in Wales during 2006 to 2024, as the Welsh Government targets used a baseline from 2006 onwards. Note that these data exclude the By Source emission estimates and the component of the End User dataset that relates to the use of solid fuels, natural gas, and petroleum fuels.

Table 20 – Summary of Wales End User Electricity Only Emissions, 2006-2024, $MtCO_2e$

TES Sector	2006	2015	2020	2021	2022	2023	2024
Agriculture	0.30	0.20	0.10	0.10	0.10	0.08	0.07
Buildings and Product Uses	5.64	3.56	1.72	1.89	1.71	1.44	1.21
Domestic Transport	0.00	0.00	0.01	0.03	0.05	0.07	0.08
End use outside UK	0.00	0.58	0.14	0.23	0.09	0.37	0.45
Industry	5.03	3.22	1.42	1.59	1.54	1.34	1.08
Wales Total	**10.97**	**7.57**	**3.40**	**3.84**	**3.48**	**3.30**	**2.89**

APPENDIX 6. TRADED NON-TRADED METHODOLOGY

METHODOLOGY OVERVIEW

For the UK to achieve progress in emission reductions across the economy, a detailed understanding of the scope, level and trend of non-traded GHG emissions (i.e. those emission sources that are not within the UK Emissions Trading Scheme (ETS)) is needed to support evidence-based policy development within the climate change strategies and programmes implemented by the DGs. Good quality GHG emissions data by source will enable the DGs to design and implement devolved policy mechanisms that are effective and cost-effective in achieving GHG reduction targets, to complement the actions through reserved UK-level policies and measures.

Non-traded GHG emission sources in the UK comprise:

- Small-scale fuel combustion sources in the industrial, agricultural, commercial, public and residential sectors;
- Transport emissions;
- Agricultural process emissions;
- LULUCF emissions / sinks; and
- Waste sector emissions.

The small-scale fuel combustion sources are usually sources where comprehensive accurate data on energy use and / or emissions are not available at DG level. DG emissions in the traded sector are much more certain, since the mechanism for trading requires site-specific reporting of detailed emissions, activity and emission factor data. The current approach to deriving the non-traded fuel combustion emission estimates is therefore by difference from the total DG GHGI for energy emissions and the ETS emissions data:

Non-traded emissions = total emissions – traded emissions

The DG GHG inventories are derived from the UK GHGI data, which in turn is linked directly (for high emitting, energy-intensive sites, such as those within the ETS) to industry-specific fuel allocations within the DUKES. The UK GHGI integrates ETS activity and emission factor data into national energy statistics and GHGI estimates so close consistency can be achieved in the UK between the ETS and GHGI. However, some inconsistencies between the inventories and ETS remain for a number of sources.

The estimates derived for the traded and non-traded sectors of the DG GHG inventories presented in this report are for the years 2008 to 2024, as the earlier years of EU data covering 2005 to 2007 were during Phase I of the European Union (EU) scheme when a more limited scope of installations was included. Comparison of data from Phase I and Phase II/III is therefore of little value. Phase III of the EU ETS started in 2013, with a slightly increased scope of reporting compared with Phase II (2008-12). As a result, EU ETS data for 2013 onwards included emissions from some additional industrial combustion installations (e.g. roadstone coating plant) and certain industrial process sources were also included for the first time.

The UK ETS replaced the UK's participation in the EU ETS on 1 January 2021, which marks the start of Phase IV. UK based operators (except for electricity generators in Northern Ireland, who will remain in EU ETS in accordance with the terms of the Protocol on Ireland/Northern Ireland to the Withdrawal Agreement) will now report their emissions under the UK ETS. For the purposes of calculating UK emissions statistics, teams should use EU ETS data for emissions arising up to December 31st, 2020, and use UK ETS data for emissions emitted from 1st January 2021. As the UK ETS was initially designed to provide a smooth transition for relevant sectors from the EU to the UK scheme, the two data sets are compatible.

The traded and non-traded emission estimates for each of the DGs presented in the DG GHGI include:

- Annual total traded GHG emissions;
- Annual total non-traded GHG emissions;
- Annual total traded and non-traded GHG emissions per TES Sector;
- Annual total GHGI emissions; and

- Non-traded sector percentage share of the total GHGI.

DATA QUALITY AND REPORT FORMATTING

Sector activity data (fuel use, mineral use) from the ETS are analysed against the data reported in the national energy statistics from DUKES, and ETS fuel quality information by sector are used within the derivation of UK GHGI estimates for several high-emitting sectors. However, direct comparison of ETS data and alignment with DUKES sectors and the DG GHG inventories exposes a disparity between ETS and national activity statistics.

The activity data from ETS are generally considered to be of good quality, having been subject to a rigorous data checking and a third-party verification process. Comparisons with UK energy statistics are therefore potentially very useful in revealing any areas of under- or over-estimation in the national statistics. However, for most economic sectors, the ETS does not cover 100% of sites and fuel use in the UK, and therefore the sum of ETS activity data for most sectors is expected to be lower than the national statistics published by DUKES (for energy use). This is indeed what is generally found, and so we conclude there is no evidence of any problems in DUKES for these sectors. The comparison between ETS and DUKES is more informative in the case of sectors where we expect all, or nearly all sites to be covered by ETS e.g. for power stations, refineries etc. Here the ETS data should be the same or similar to that given in the UK energy statistics. In fact, there are a number of instances where the ETS fuel use data are higher than the data reported within DUKES, and so ETS data are therefore used within the UK and DG GHG inventories compilation, deviating from the national statistics. Examples include refinery and industrial use of other petroleum gases (OPG), upstream oil and gas use of liquefied petroleum gas (LPG) and OPG.

As a result of these data format and data quality issues, the derivation of traded and non-traded emission estimates requires calculation of non-traded DG GHG inventories such that the data inconsistencies between DUKES and ETS fuel use are reduced, removing the inconsistencies by (in most cases) assuming that the ETS data for a given sector are the more accurate estimates.

APPENDIX 7. AVIATION DATA IN THE ETS

GHG emissions from civil aviation are reported within the UK inventory and within the DG inventories. The emissions from domestic flights are accounted within UK inventory totals, whilst emissions from international flights are reported as memo items to the UK inventory.

Each of the DGs tailors their climate change policy legislation and policies to focus on specific local and regional priorities. The Climate Change (Scotland) Act identifies that the scope of net Scottish GHG emissions account shall include all existing anthropogenic sources and sinks of emissions in Scotland, as well as a “Scottish share” of GHG emissions from international aviation and shipping. Similarly, the scope of the Welsh statutory targets and carbon budgets include a “Welsh share” of emissions from international aviation and shipping.

The UK and DG aviation emission estimates for both domestic and international flights are based on flight data from the Civil Aviation Authority (CAA) and fuel use in the aviation sector reported within the UK energy statistics (DUKES), published annually by DESNZ.

Since 2012, aviation emissions are included within the scope of the UK ETS[31]. The scope of ETS for aviation includes flights within the UK zone to and from a wide range of countries, not only flights that originate and land within the UK. The *Stop the Clock* scope excludes emissions that are outside the scope of UK ETS, i.e. those flights to/from countries that are not within the UK ETS scope.

The tables below present analysis of the baseline level and trend of aviation emissions in the UK and Scottish inventories, including specific analysis for those flights that fall within the scope of the ETS.

UK Aviation Summary

The UK aviation emissions are presented below in **Table 21** for the Stop the Clock scope and **Table 22** for the 2014 Regulation scope.

- From 2010 onwards the *Stop the Clock* scope is between 31 - 37% of the UK aviation inventory total, with slightly variable and higher percentages in 2021 and 2022.
- Since 2010 the 2014 Regulation scope is around 28 - 31% of the UK total with slightly higher percentages in 2021 and 2022.

Table 21 – UK aviation emissions under the Stop the Clock Scope ($MtCO_2e$)

	GHG	2000	2005	2010	2015	2020	2021	2022	2023	2024
Stop the Clock	Carbon dioxide	10.855	13.343	11.131	11.040	4.864	5.292	10.579	11.146	11.871
	Methane	0.008	0.007	0.004	0.004	0.001	0.002	0.003	0.003	0.003
	Nitrous oxide	0.091	0.112	0.094	0.093	0.041	0.045	0.089	0.094	0.102
UK GHGI	Carbon dioxide	32.094	37.420	34.866	34.668	15.636	14.406	29.231	34.114	37.068
	Methane	0.010	0.008	0.006	0.005	0.002	0.002	0.004	0.004	0.004
	Nitrous oxide	0.270	0.315	0.293	0.292	0.132	0.122	0.247	0.289	0.319
Stop the clock % share	Total GHGs	33.8%	35.7%	31.9%	31.9%	31.1%	36.7%	36.2%	32.7%	32.0%

[31] Prior to 2021, UK organisations reported emissions to the EU ETS.

Table 22 – UK aviation emissions under the Stop the Clock Scope ($MtCO_2e$)

	GHG	2000	2005	2010	2015	2020	2021	2022	2023	2024
2014 Regulation	Carbon dioxide	9.471	11.902	9.637	9.635	4.274	4.378	9.049	9.556	10.108
	Methane	0.007	0.006	0.004	0.003	0.001	0.002	0.003	0.003	0.003
	Nitrous oxide	0.080	0.100	0.081	0.081	0.036	0.037	0.076	0.081	0.087
UK GHGI	Carbon dioxide	32.094	37.420	34.866	34.668	15.636	14.406	29.231	34.114	37.068
	Methane	0.010	0.008	0.006	0.005	0.002	0.002	0.004	0.004	0.004
	Nitrous oxide	0.270	0.315	0.293	0.292	0.132	0.122	0.247	0.289	0.319
2014 Regulation % share	Total GHGs	29.5%	31.8%	27.6%	27.8%	27.3%	30.4%	31.0%	28.0%	27.3%

Scottish Aviation Summary

The Scotland aviation emissions are presented below in **Table 23** for the *Stop the Clock* scope and **Table 24** for the *2014 Regulation* scope.

- From 2010 the *Stop the Clock* scope is between 71 - 76% of the Scotland aviation inventory total. In 2022, there was step change in the percentage share of Stop the Clock emissions to 86%, however in 2022 this began to return to pre COVID-19 levels.
- In 2010 and 2015 the *2014 Regulation* scope was 71 and 63% of the Scotland total respectively. As a result of the aviation market during the early stages of the COVID pandemic, 2020 and 2021 values also show a step-change, with a share of emissions at 69% and 78% of the Scotland total respectively. In 2022-2024, the share returned to pre-pandemic levels between 58%-65% of the Scotland total.

Table 23 – Scotland aviation emissions under the Stop the Clock Scope ($MtCO_2e$)

	GHG	2000	2005	2010	2015	2020	2021	2022	2023	2024
Stop the Clock	Carbon dioxide	1.208	1.490	1.239	1.299	0.525	0.596	1.151	1.313	1.402
	Methane	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	Nitrous oxide	0.009	0.010	0.008	0.007	0.003	0.004	0.005	0.005	0.005
Scotland GHGI	Carbon dioxide	1.445	1.900	1.604	1.827	0.685	0.693	1.513	1.828	2.030
	Methane	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	Nitrous oxide	0.012	0.016	0.013	0.015	0.006	0.006	0.013	0.015	0.017
Stop the Clock % share	Total GHGs	83.5%	78.3%	77.1%	70.9%	76.4%	85.9%	75.7%	71.5%	68.7%

Table 24 – Scotland aviation emissions under the 2014 Regulation Scope ($MtCO_2e$)

	GHG	2000	2005	2010	2015	2020	2021	2022	2023	2024
2014 Regulation	Carbon dioxide	1.117	1.387	1.131	1.159	0.472	0.539	0.982	1.107	1.174
	Methane	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	Nitrous oxide	0.009	0.012	0.010	0.010	0.004	0.005	0.008	0.009	0.010
Scotland GHGI	Carbon dioxide	1.445	1.900	1.604	1.827	0.685	0.693	1.513	1.828	2.030
	Methane	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	Nitrous oxide	0.012	0.016	0.013	0.015	0.006	0.006	0.013	0.015	0.017
2014 Regulation % share	Total GHGs	77.3%	73.0%	70.5%	63.4%	68.8%	77.8%	64.9%	60.5%	57.8%

National Atmospheric Emissions Inventory