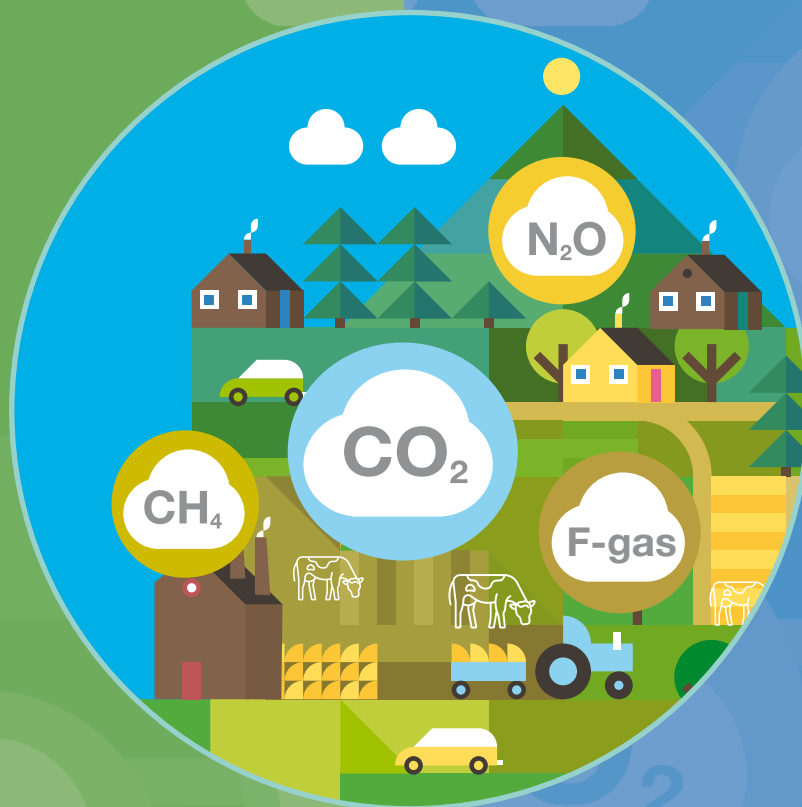


Ireland's Final Greenhouse Gas Emissions

1990-2022

May 2024



CH₄

CO₂

N₂O

F-gas

N₂O

2

CH

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Key Findings

<p>Decrease in overall GHG emissions driven by decreases in all key sectors except Transport</p>	<p>2022 total national greenhouse gas emissions (excluding LULUCF) are estimated to have decreased by 1.9% on 2021 levels to 60.60 million tonnes carbon dioxide equivalent (Mt CO₂eq). A substantial decrease in Residential sector emissions, combined with emissions decreases from Industry, Agriculture and Electricity generation outweighed increased emissions from the Transport sector. The overall emissions reduction, while welcome, falls short of the reductions required to achieve National and new EU targets.</p>
<p>EU Effort Sharing limits exceeded</p>	<p>The final estimates of greenhouse gas emissions indicate that Ireland will exceed its 2022 annual limit, without the use of flexibilities, set under the EU's Effort Sharing Regulation (ESR) by 3.54 Mt CO₂eq.</p>
<p>First Carbon Budget 2021-2025</p>	<p>National total emissions (including LULUCF) for 2021 and 2022 at 130.97 Mt CO₂eq have used 44% of the 295 Mt CO₂eq Carbon Budget for the five-year period 2021-2025. This leaves 56% of the budget available for the succeeding three years, requiring a substantial 8.1 per cent annual emissions reduction from 2023-2025 to stay within budget.</p>
<p>Sectoral Emissions Ceilings 2021-2025</p>	<p>In the Electricity sector, with 49% of the 2021-25 emissions budget already used, annual emissions reductions of 17% are now required from 2023-25 to stay within budget. Annual emissions reductions of 9%, 8%, 6% and 3% are required from 2023-25 in the Industry, Agriculture, Transport and Residential buildings sectors respectively.</p>
<p>Slightly lower electricity generation emissions but still high fossil fuel use</p>	<p>There were substantial reductions in coal, oil and peat used in electricity generation (-16%, -29% and -25% respectively). Renewable electricity generation increased from 35% in 2021, to 39% in 2022. Overall emissions from the Energy Industries sector only declined by 1.8% in 2022 however, as use of natural gas increased by 13%. The emissions intensity of power generation decreased from 348g CO₂/kWh in 2021 to 332g CO₂/kWh in 2022.</p>
<p>Less fertiliser use offsets more livestock decreasing Agriculture emissions</p>	<p>A decrease of 14% in fertiliser nitrogen use in 2022 resulted in -0.44 Mt CO₂eq less emissions from agricultural soils. Agriculture emissions overall decreased by 0.3% or 0.08 Mt CO₂eq in 2022, as increased numbers of livestock including dairy cows (+0.9%), other cattle (+0.3%) and sheep (+4.2%) partially offset the reduced fertiliser use. Total milk production increased by 0.7% in 2022, with milk output per cow decreasing slightly (-0.2%).</p>
<p>Transport emissions continue to increase strongly post COVID</p>	<p>Greenhouse gas emissions from the Transport sector increased by 6% or 0.66 Mt CO₂eq in 2022, having already increased by 6.6% in 2021. Transport emissions in 2022 are over 95% of the 'pre COVID' level from 2019 and will need to avoid returning to that level if the 2021-25 sectoral ceiling is to be achieved. Although not included in national total emissions, international aviation emissions are estimated and showed a 130% increase, resulting in an additional 1.7 Mt CO₂eq.</p>
<p>Residential emissions decrease</p>	<p>Greenhouse gas emissions from the Residential sector decreased substantially in 2022 (-15.9% or 1.09 Mt CO₂eq), as fuel use reduced driven by extremely high prices due to the Ukraine war and a milder winter compared to 2021. A shift away from more emission intensive fuels such as coal and peat, due to new, nationwide solid fuel regulations, likely also played a role as coal and peat use declined by 33.1% and 11.0% respectively.</p>

1. Introduction

The EPA is responsible for compiling the inventories of greenhouse gas emissions for Ireland and for reporting the data to the relevant European and international institutions. As such, Ireland's legal reporting obligations require that we submit data for the period 1990-2022 in January, March to the European Commission and by December 2024 to the United Nations Framework Convention on Climate Change (UNFCCC) as part of Ireland's first Biennial Transparency Report under the Paris Agreement.

The EPA published the provisional inventory data in July 2023 to facilitate the early monitoring and reporting processes associated with the National Climate Objective and associated Carbon budgets, annual review of the Climate Action Plan and greater level of sectoral reporting and more in-depth assessment and reporting of Policies and Measures.

The final estimates of Ireland's greenhouse gas figures for the years 1990-2022 are based on final energy balances provided by the SEAI in September 2023 and the latest available data from other data providers such as the Central Statistics Office and the Department of Agriculture, Food and the Marine (DAFM). These are compiled using methodologies in accordance with UNFCCC reporting guidelines. Verified emissions data from installations within the EU's Emissions Trading Scheme (ETS) are included.

Ireland's emissions targets

Ireland's EU and National legislative commitments have different emissions reduction requirements and timeframes for achievement. Ireland's revised 2030 target under the EU's Effort Sharing Regulation (ESR) is to deliver a 42% reduction of emissions compared to 2005 levels by 2030. There are also annual binding emission allocations over the 2021-2030 period to meet that target. Ireland's compliance status at 2030 can only be determined when the 2030 inventory is compiled. Under the ESR two flexibilities may be utilised (use of EU Emissions Trading Scheme allowances and credit from action undertaken in the Land use, Land use Change and Forestry (LULUCF) sector) to allow for a fair and cost-efficient achievement of the targets.

Ireland's national emission reduction objectives as set in the Climate Action and Low Carbon Development (Amendment) Act 2021, are to achieve a 51% emissions reduction (including LULUCF) by 2030 compared to 2018 and achieve a climate neutral economy by no later than the end of 2050. The Act provides for the establishment of carbon budgets to support achievement of Ireland's climate ambition. The 51% target, relative to 2018, is the primary constraint on carbon budgets over the course of the first two budget periods ending on 31 December 2030, see Table 1. The Climate Action Plan 2023 (CAP 23) sets out a major programme of policies and measures that aim to achieve significant progress towards those objectives.

Ireland's emissions inventory has been compiled using Global Warming Potentials (GWPs) as specified in the 5th IPCC assessment report (AR5)¹. Ireland's National emissions reduction objective, carbon budgets and European target under the ESR are estimated on an AR5 basis.

1 IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (<https://www.ipcc.ch/report/ar5/wg1/>)

Table 1. European Union and National GHG Targets comparison

	Base Year	Reduction required by 2030	Scope	Other key points to note
European Union Targets	2005	42% <i>The 42% reduction defines the trajectory, but it is the annual limits that are binding</i>	Sectors covered by the Effort Sharing Regulation (excludes ETS)	Annual binding emission limits (AEAs) define the permitted budget and some flexibilities are available.
National Targets	2018	51%	Economy-wide target (includes ETS)	Unlike the EU target, the national target includes LULUCF. Binding Carbon budgets set the required reduction trajectory.

This report provides a summary of the 2022 final emission estimates accompanied by an assessment of changes relative to the 2021 estimates. The recent and long-term trends in greenhouse gas emissions across key sectors, and their significance in relation to Ireland's target under the EU's Effort Sharing Regulation and Climate Action Plan 2023 are also presented.

2. Ireland's Final Greenhouse Gas Emissions in 2022

Total national greenhouse gas emissions in 2022 (excluding LULUCF) are estimated to be 60.60 million tonnes carbon dioxide equivalent (Mt CO₂eq) which is 1.9% lower (or 1.15 Mt CO₂eq) than emissions in 2021 (61.76 Mt CO₂eq) and follows a 5.1% increase in emissions reported for 2021. Emissions are 0.4% lower than pre-pandemic 2019 figures.

National total emissions including Land Use Land Use Change and Forestry (LULUCF) decreased by 2.7% to 64.59 Mt CO₂eq. ETS² emissions decreased (4.1%) and ESR emissions decreased (1.1%). LULUCF emissions are discussed in more detail in section 4.7.

Emissions per capita decreased from 12.4 tonnes CO₂eq/person in 2021 to 11.9 tonnes CO₂eq/person in 2022. Ireland's average tonnes of GHG/capita over the last ten years were 12.7 tonnes. With recent CSO 2022 census data showing a population of 5.12 million people and with population projected to increase to 5.5 million in 2030, 5.9 million in 2040 and 6.2 million by 2050, per capita emissions need to reduce significantly in order to meet reduction targets. At current per capita emission levels, each additional 500,000 people would contribute an additional 6 million tonnes of CO₂eq annually.

The inter-annual change in total greenhouse gas emissions is presented in Figure 1 and sectoral share of emissions (excluding LULUCF) in Figure 2 and Table 4. Detailed sectoral data are shown in Table A.1 in the Appendix.

Agriculture is the largest contributor to the overall emissions at 38.5% of the total (excluding LULUCF). *Transport* and *Energy Industries* are the second and third largest contributors at 19.4% and 16.6% respectively. *Residential* and *Manufacturing Combustion* emissions account for 9.5% and 7.1% respectively. These five sectors accounted for 91.2% of national total emissions in 2022. The remainder is made up by the *Industrial Processes* sector at 3.8%, *F-Gases* at 1.2%, *Commercial Services* at 1.3%, *Public Services* at 1.1% and *Waste* at 1.4%. Figure 2 shows the contributions from each of the sectors in 1990 and 2022.

2 ETS emissions in this report refers to CO₂ emissions from stationary installations and from domestic aviation. It does not include emissions from intra-EU aviation as those are not considered part of Ireland's total reportable greenhouse gas emissions.

Figure 1. Inter Annual Changes in GHG Emissions 1990-2022

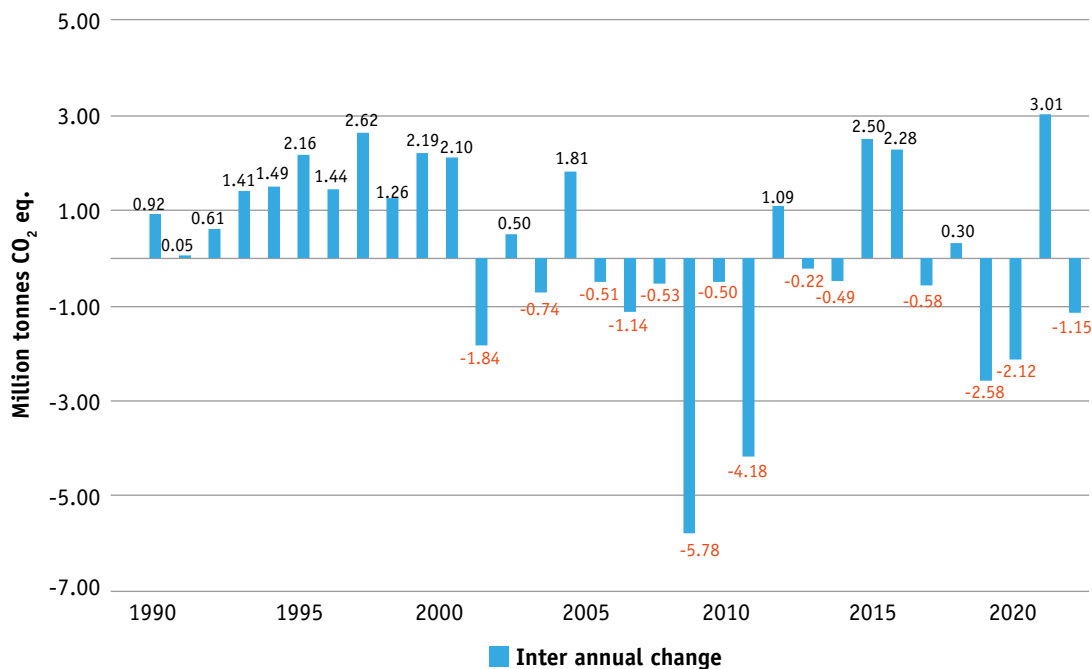
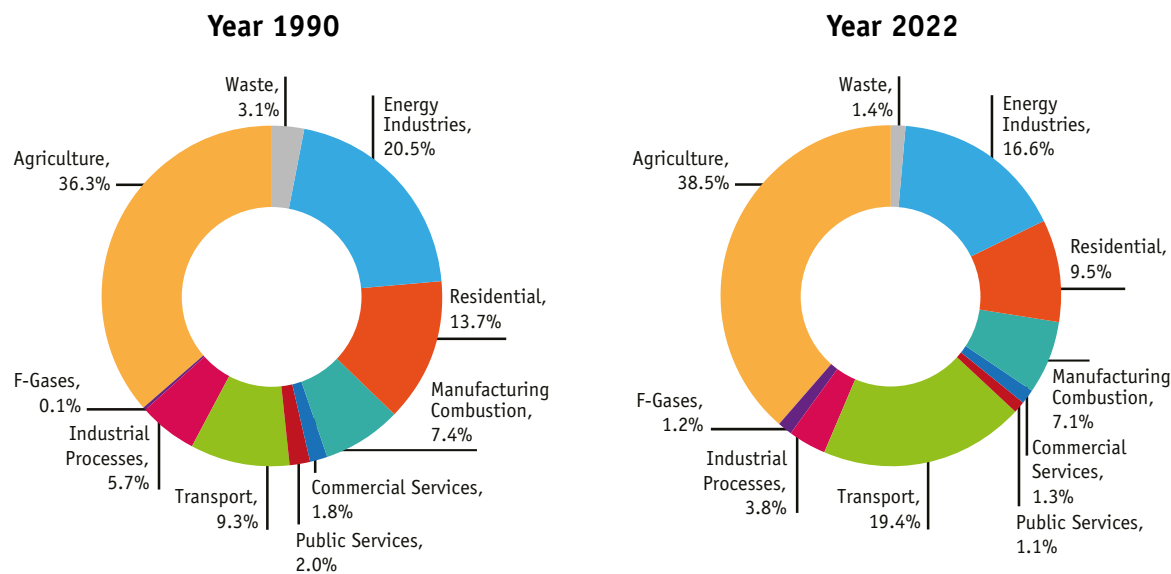


Figure 2. Profile of GHG Emissions (excluding LULUCF) in 1990 and 2022 by Sector



3. Compliance with National and EU commitments

Ireland has several greenhouse gas emission reduction commitments, both set out in National legislation and by virtue of its EU membership and commitment to UN goals under the Framework Convention on Climate Change (UNFCCC). These various commitments have different scope and interim targets associated with them, but all ultimately require Ireland playing its part in achieving the global goal of limiting global temperature rise.

3.1 National Climate Objective

The Climate Action and Low Carbon Development (Amendment) Act 2021³ sets a national climate objective of achieving a climate resilient and climate neutral economy by 2050. A key milestone in achieving this aim is the 2030 reduction target of 51% of total emissions (including LULUCF) over the period 2018 to 2030.

Climate Action Plan 2023, published in December 2022, outlines many of the policies and measures to be implemented to achieve the objective, with further measures to be developed in future plans. Progress towards Ireland's climate objective is shown in Table 2.

Carbon Budgets

The Climate Action and Low Carbon Development (Amendment) Act 2021 provides for the establishment of carbon budgets in support achieving Ireland's climate ambition. The 51% target is the primary constraint on carbon budgets over the course of the first two budget periods ending on 31 December 2030, relative to 2018. The provisional carbon budget proposed for 2031 to 2035 continues the trajectory towards climate neutrality by 2050.

Three Carbon budgets for the period up to 2035 have been approved⁴ by the Oireachtas and came into force on 6th April 2022. Figure 3 illustrates a linear emissions reduction trajectory towards achieving the 51% reduction target, along with the extent to which the first carbon budget (for the period 2021-2025) has been 'used up' based on emissions in 2021 and 2022.

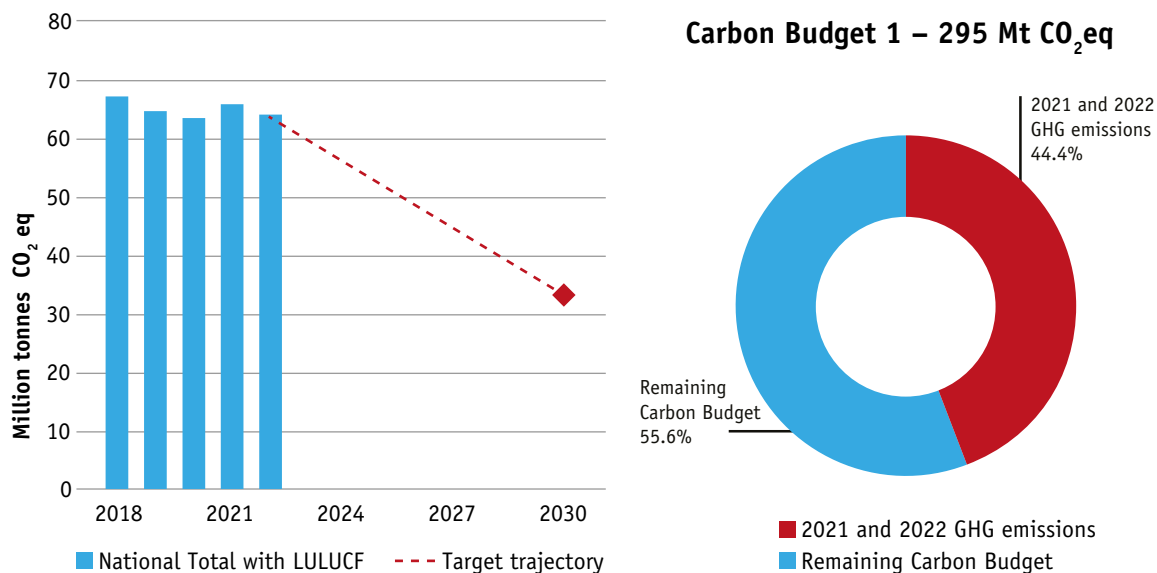
- Budget 1 from 2021-2025 has been set at 295 Mt CO₂eq.
- Budget 2 from 2026-2030 has been set at 200 Mt CO₂eq.
- Budget 3 from 2031-2035 has been set at 151 Mt CO₂eq.

National total emissions including LULUCF for 2022 and latest emissions estimate for 2021 are 130.97 Mt CO₂eq, accounting for 44.4% of the first five-year Carbon Budget of 295 Mt CO₂eq. This leaves 55.6% of the budget available for the remaining 3 years. To stay within budget for the first carbon budget period will now require a substantial 8.1 per cent annual emissions reduction from 2023-2025 or ca. 5 Mt CO₂eq emissions reductions annually. Figure 3 below highlights the amount of the first Carbon budget that has now been used with two years already passed. Section 6D – paragraph 5 of the Climate Action and Low Carbon Development (Amendment) Act 2021 states that non-achievement of the first Carbon Budget would see the excess emissions carried forward into the second budget period and the second Carbon budget would be reduced by that amount. If this occurs this would make achievement of the second budget substantially more difficult.

3 Climate Action and Low Carbon Development (Amendment) Act 2021 ([irishstatutebook.ie](https://www.irishstatutebook.ie))

4 <https://www.gov.ie/en/publication/9af1b-carbon-budgets/>

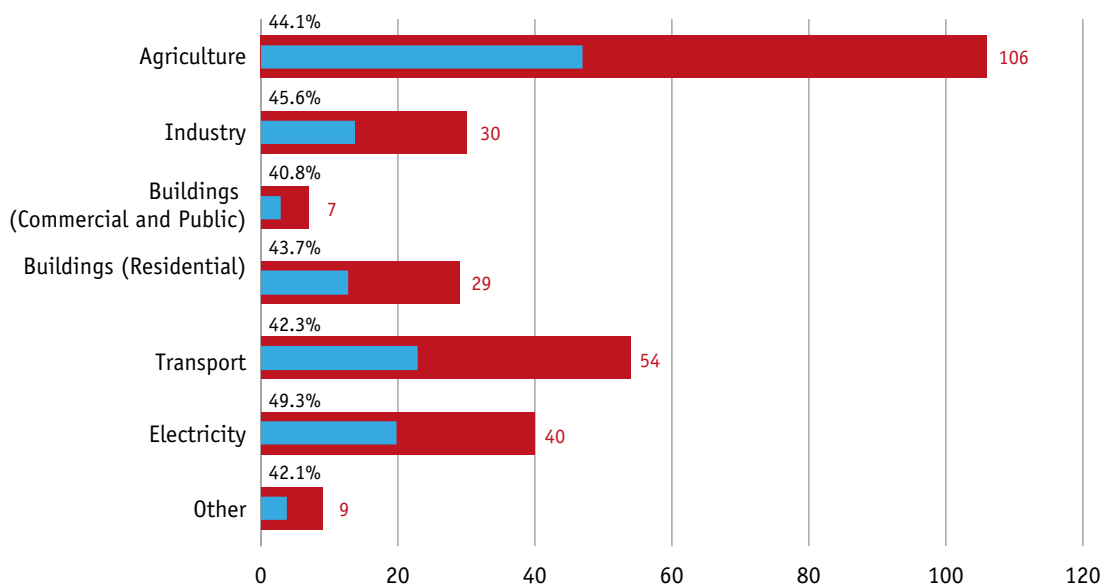
Figure 3. Climate Act Target and Carbon Budgets



Sectoral Emissions Ceilings

Sectoral Emissions Ceilings (SECs) for the two Carbon budget periods (2021-25 and 2026-30) have been approved by government to divide up the responsibility of carbon budget achievement across the key greenhouse gas emitting sectors. The sectors (Electricity, Transport, Built Environment (Residential and Commercial and Public), Industry, Agriculture and Other) do not correspond directly to the sectors defined in the Inventory as they take consideration of the division of Departmental responsibility. However, it has been possible to map the Inventory data onto the SEC sectors to assess usage of the budgets to date what is required to achieve ceiling compliance. Figure 4 below presents the Sectoral ceilings along with the amount used to date by sector.

Figure 4. First Sectoral Ceilings 2021-2025 and usage

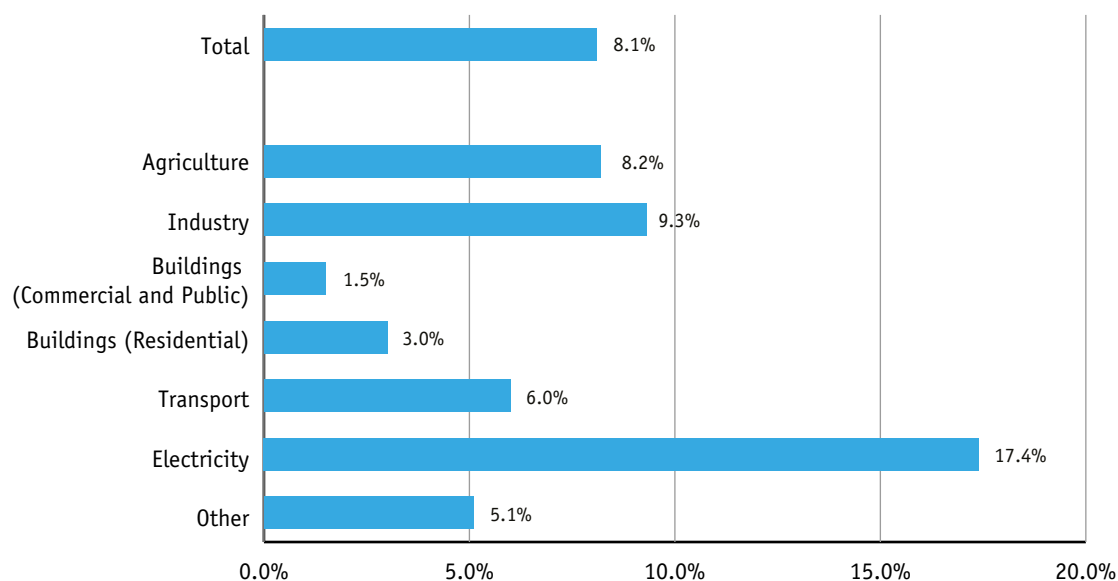


The amount of the sectoral budget already used up ranges from 41% in the case of *Commercial and Public Sector* buildings to 49% in the case of *Electricity* sector. In part the reason for the extent of the usage of the *Electricity* budget is related to continued use of coal in electricity generation. The sectoral ceilings for each sector were set with the expectation of achievement of specific emission reductions in 2030 relative to 2018 with interim target for 2025 set out in CAP 23. Sectoral emissions targets and 2022 reductions relative to 2018 are set out in Table 2, these range from a 75% reduction for the *Electricity* sector to 25% reduction for the *Agriculture* sector.

Table 2. Sectoral Emissions reduction targets and progress

Sector	2018 (Mt CO ₂ eq)	2022 (Mt CO ₂ eq)	% change 2018-2022	Indicative % reduction by 2025	Indicative % reduction by 2030
Electricity	10.33	9.77	-5.4%	~40%	~75%
Transport	12.31	11.75	-4.5%	~20%	~50%
Buildings (Residential)	6.98	5.79	-17.0%	~20%	~40%
Buildings (Commercial and Public)	1.54	1.42	-7.7%	~20%	~45%
Industry	6.98	6.59	-5.6%	~20%	~35%
Agriculture	23.18	23.36	0.8%	~10%	~25%
Other	2.14	1.93	-10.1%	~25%	~50%
LULUCF	4.19	3.98	-4.9%	NA	NA
National Total (incl LULUCF)	67.64	64.49	-4.5%		51%

The amount of each budget already used makes a significant difference to the level of emissions reduction required over the next three years to stay within budget. Across all sectors, average emission reductions of 8.1% annum is required. For example, in the *Electricity* sector, with 49% of the budget already used, annual emissions reductions of 17.4% are now required from 2023-25 to stay within the first 2021-25 budget. For *Commercial and Public Sector* buildings the corresponding required emissions reduction is 1.5% per annum as that sector is currently much closer to being on the planned trajectory. Figure 5 below highlights the emissions reductions required for each sector with a defined emissions ceiling to stay within the 2021 to 2025 budget.

Figure 5: Annual emission reductions required from 2023-2025 to achieve SEC compliance

3.2 European targets

The greenhouse gas emission inventory for 2022 is the second of ten years over which compliance with targets set in the European Union's Effort Sharing Regulation (EU 2018/842) will be assessed. This Regulation sets 2030 targets for emission reductions outside of the Emissions Trading Scheme (known as ESR emissions) and annual binding national limits for the period 2021-2030. Ireland's target is to reduce ESR emissions by 42% by 2030 compared with 2005 levels, with a number of flexibilities available to assist in achieving this.

Compliance assessment

Annual Emissions Allocation

Ireland's ESR emissions annual limit for 2022 is 42.36 Mt CO₂eq. Ireland's final 2022 greenhouse gas ESR emissions are 45.90 Mt CO₂eq, this is 3.54 Mt CO₂eq more than the annual limit for 2022, see Table 3 and Figure 6. This value is the national total emissions less emissions generated by stationary combustion, i.e., power plants, cement plants, and domestic aviation operations that are within the EU's emissions trading scheme. This indicates that Ireland is not in compliance with its 2022 Effort Sharing Regulation annual limit, exceeding the allocation by 1.63 Mt CO₂eq after using the ETS flexibility and by 0.81 Mt CO₂eq after using both ETS and LULUCF flexibilities. It should be noted that the final quantity of LULUCF flexibility available to Ireland will be finalised 2032⁵. Agriculture and Transport accounted for 76.4% of total ESR emissions in 2022.

Emissions Trading Scheme

Since 2005, emissions in the ETS sector have decreased by 34.6% or 7.75 Mt CO₂eq whereas emissions under the ESR only decreased by 5.7% or 2.80 Mt CO₂eq, considerably short of Ireland's 42% reduction commitment. Within the ETS sector, electricity generation and the cement sectors are responsible for most of the decrease. Since 2005, emissions under the ESR decreased in the *Transport, Residential, Manufacturing combustion, Public Services, Commercial Services, F-Gases and Waste* sectors, with the *Agriculture and Energy Industries* sectors increasing.

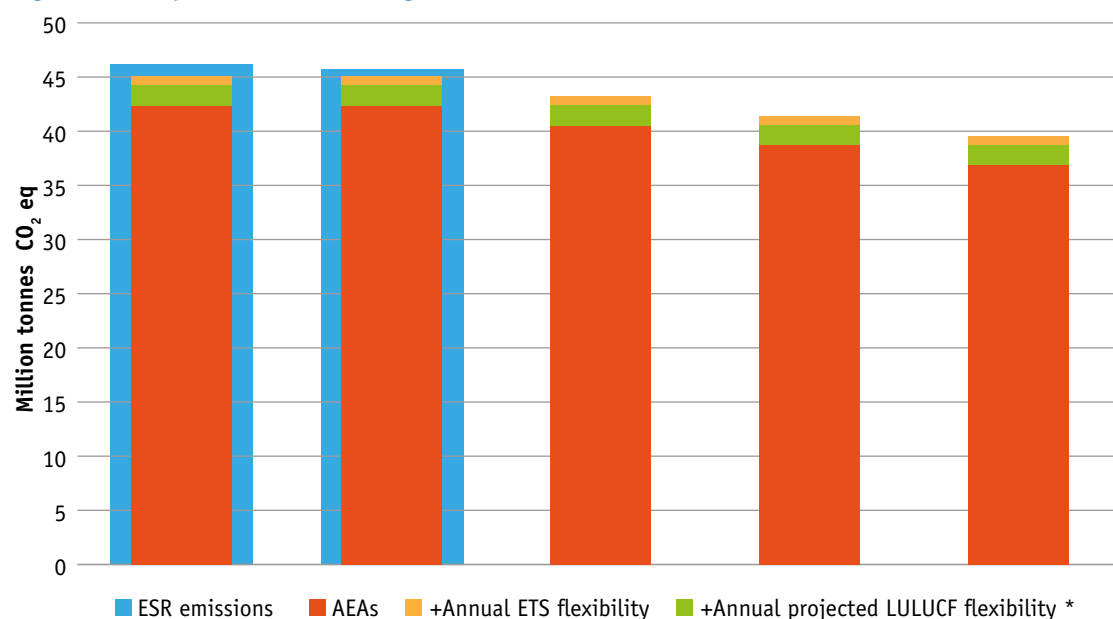
5 Article 14, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=urisrv:OJ.L_.2018.156.01.0001.01.ENG

Table 3. Compliance with EU ESR Targets 2021-2025 (all numbers in the table are rounded to the nearest kt CO₂eq)

	2021	2022	2023	2024	2025
Total greenhouse gas emissions without LULUCF	61,755	60,605			
– Total verified emissions from stationary installations under Directive 2003/87/EC	15,320	14,686			
– CO ₂ emissions from domestic aviation	20	21			
Total ESR emissions	46,416	45,897			
EU ESR Targets†	43,479	42,357	40,520	38,683	36,845
Gross distance to target	-2,936	-3,540			
+ annualised ETS flexibility†	1,908	1,908	1,908	1,908	1,908
+ annualised projected LULUCF flexibility*	822	822	822	822	822
Net distance to target	206	810			

* Flexibility projected under the EPA's "With Existing Measures" scenario⁶

† Set out in Annex II and Annex III of Commission Implementing Decision (EU) 2020/2126⁷

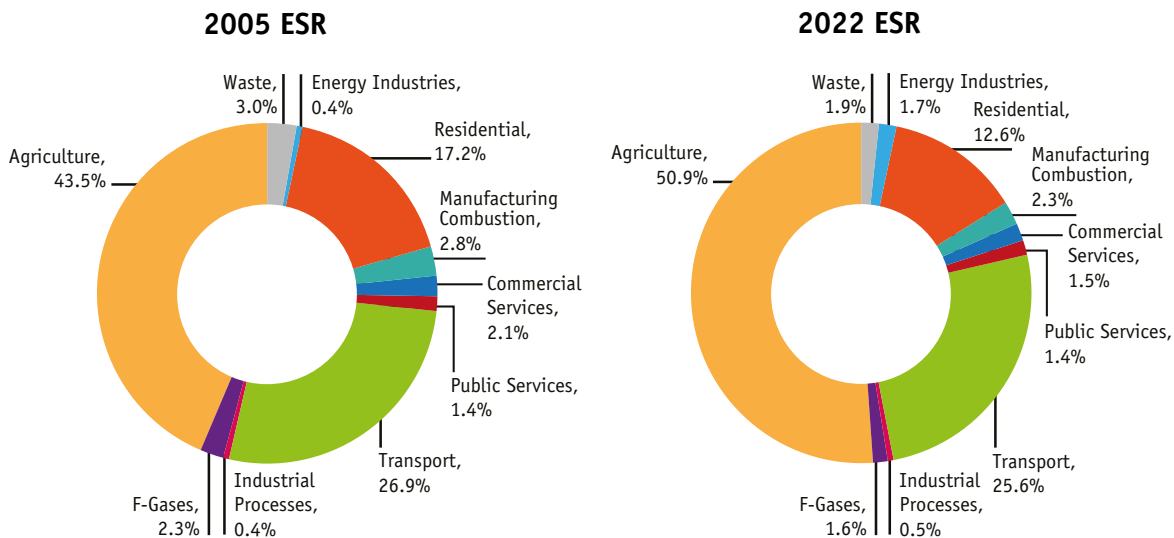
Figure 6. Compliance with ESR Targets 2021-2025

The data presented in Figure 7 shows the sectoral shares of emissions covered by the Effort Sharing Regulation in 2005 and 2022.

6 <https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-greenhouse-gas-emissions-projections-2022-2040.php>

7 <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32020D2126&from=EN#d1e32-62-1>

Figure 7. Profile of Effort Sharing Regulation relevant GHG Emissions in 2005 and 2022 by Sector



4. Greenhouse Gas Emissions by Sector

For the purposes of this report emissions are classified into ten key sectors and fluorinated gases (F-gases). Although F-gases can be emitted from any sector it is helpful to group them collectively as the emissions from any one sub-sector are seldom significant, and measures to reduce them are often cross-sectoral in nature. The sectoral breakdown used in this report, and changes in emissions for those sectors between 2021 and 2022, are presented in Table 4 below and described in more detail in the Appendix.

This sectoral breakdown is produced for national reporting purposes and is generally in alignment with the classification used for UNFCCC reporting. Key energy subcategories; *Energy Industries* (largely electricity generation), *Residential*, *Manufacturing Combustion*, *Transport*, *Commercial Services* and *Public Services* are also shown separately rather than as part of an overarching Energy category as reported to the UNFCCC. In this section, the time series since 1990 is graphically presented, as 1990 is the historical base year used for UNFCCC reporting.

Table 4. Ireland's Final Greenhouse Gas Emissions for 2021 and 2022 by Sector

Million tonnes CO ₂ eq	2021	2022	% Change
Agriculture	23.436	23.357	-0.3%
Transport	11.089	11.751	6.0%
Energy Industries (including electricity generation)	10.262	10.078	-1.8%
Residential	6.879	5.787	-15.9%
Manufacturing Combustion	4.614	4.302	-6.8%
Industrial Processes	2.472	2.288	-7.4%
F-Gases	0.745	0.741	-0.5%
Commercial Services	0.765	0.765	0.0%
Public Services	0.672	0.657	-2.2%
Waste	0.823	0.878	6.6%
LULUCF	4.628	3.983	-13.9%
Total excluding LULUCF	61.755	60.605	-1.9%
Total including LULUCF	66.383	64.588	-2.7%

4.1 Agriculture

Total emissions from the *Agriculture* sector in 2022 were 23.4 Mt CO₂eq a decrease of 0.3% on 2021. The most significant driver for the decrease in emissions

in 2022 was a decrease in use of synthetic nitrogen fertiliser of 14.0%. Livestock numbers continued to increase, dairy cows by 0.9%, other cattle by 0.3% with an increase in milk production of 0.7%.

Methane emissions originate from Enteric Fermentation, Manure Management and fuel combustion. In 2022, CH₄ emissions contribute 71.4% to the *Agriculture* sector and have increased by 0.4% since 2021.

Nitrous Oxide emissions originate from Manure Management, Agricultural Soils and fuel combustion. In 2022, N₂O emissions contribute 21.8% to the *Agriculture* sector and have decreased 7.6% since 2021, reflecting the reduction in fertiliser use.

Carbon dioxide emissions originate from Liming, Urea Application and fuel combustion. In 2022, CO₂ emissions contribute 6.8% to the *Agriculture* sector and have increased by 20.3% since 2021. In 2022, liming on soils increased by 4.4%, using 1.42 million tonnes of lime, following a 2021 usage of 1.36 million tonnes. Continued liming rates at these levels is a welcome measure in improving soil fertility, which should lead to a reduction in fertiliser nitrogen use in future years.

Agriculture emissions by source category and by gas are presented in Figures 8 and 9. Increasing methane emissions are evident in the gas share trend, 16.7 Mt CO₂eq (71.4% share) in 2022 compared to 14.0 Mt CO₂eq (69.7% share) in 1990, increasing in level by 19.2%.

This is the 12th consecutive year of increases in dairy cow numbers. Milk output per cow decreased slightly in 2022 (-0.2%), therefore increased milk production was driven by an increase in livestock numbers. In 2022, total cattle numbers increased by 0.5% and sheep numbers increased by 4.2%, pig numbers decreased by 5.9% and the poultry population decreased by 2.0%.

Total fossil fuel consumption in agriculture/forestry/fishing activities increased by 39.0% on 2021.

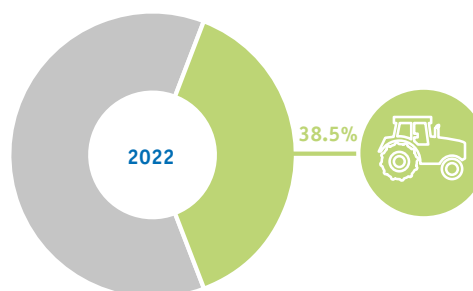


Figure 8. Trend in Agriculture 1990-2022

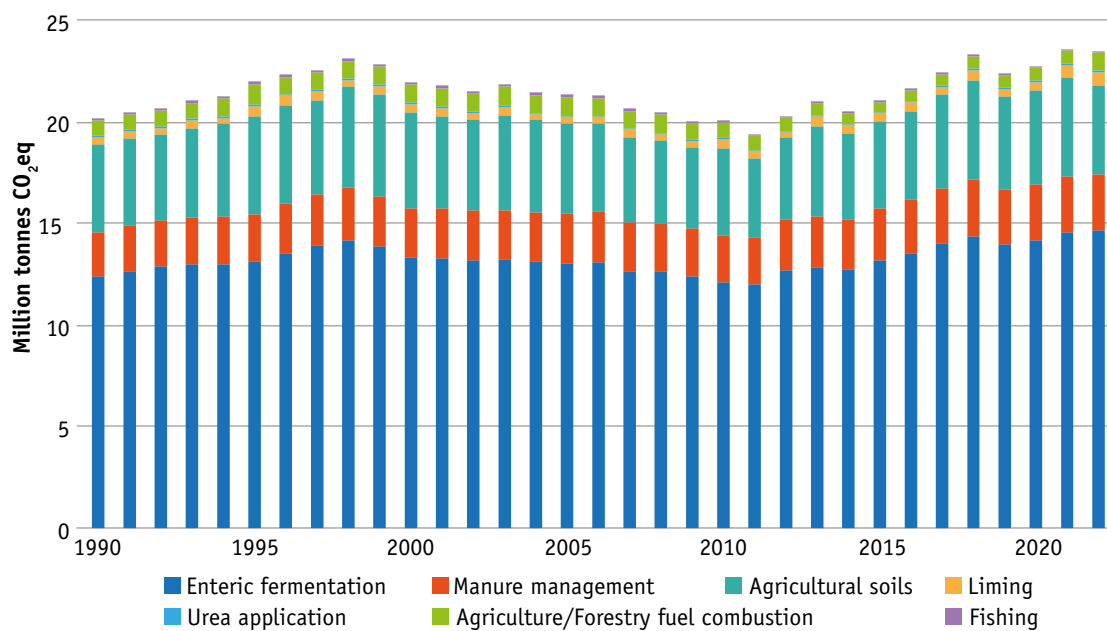
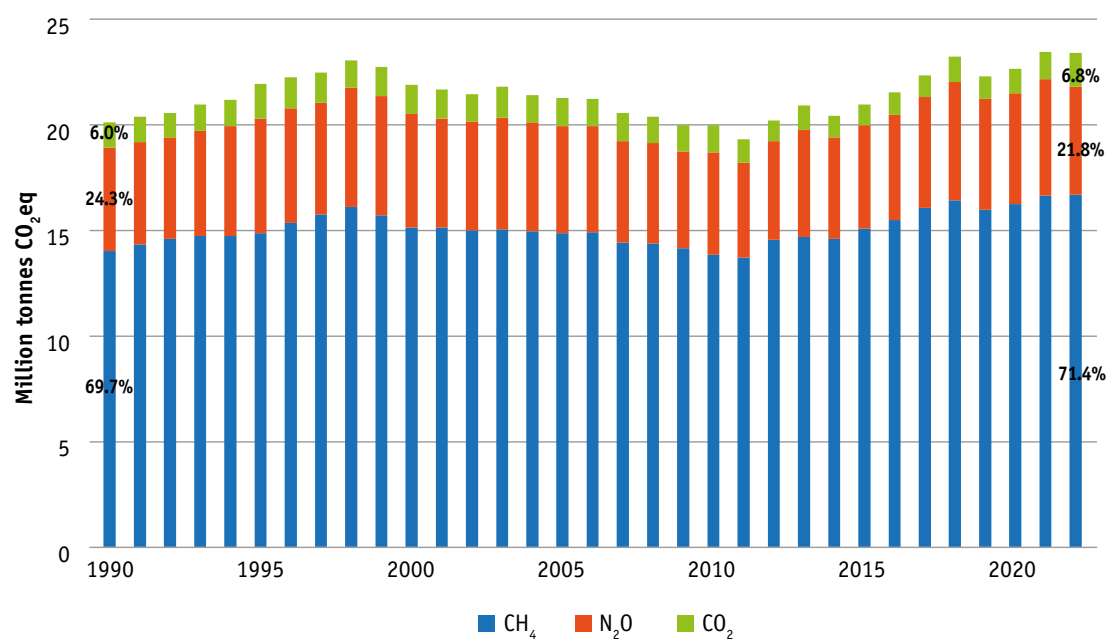
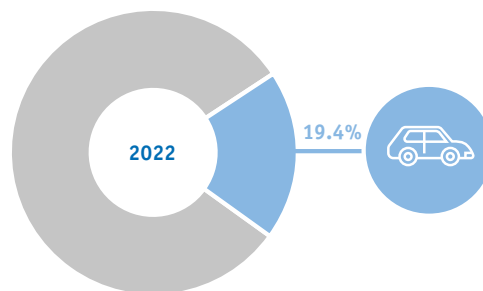


Figure 9. Trend in Agriculture, by Gas 1990-2022



4.2 Transport

Transport emissions continued to rebound in 2022 following the ending of COVID travel restrictions and are responsible for 19.4% of national total emissions. Transport emissions are 4.6% below pre-COVID levels. Emissions increased 6.0% in 2022.



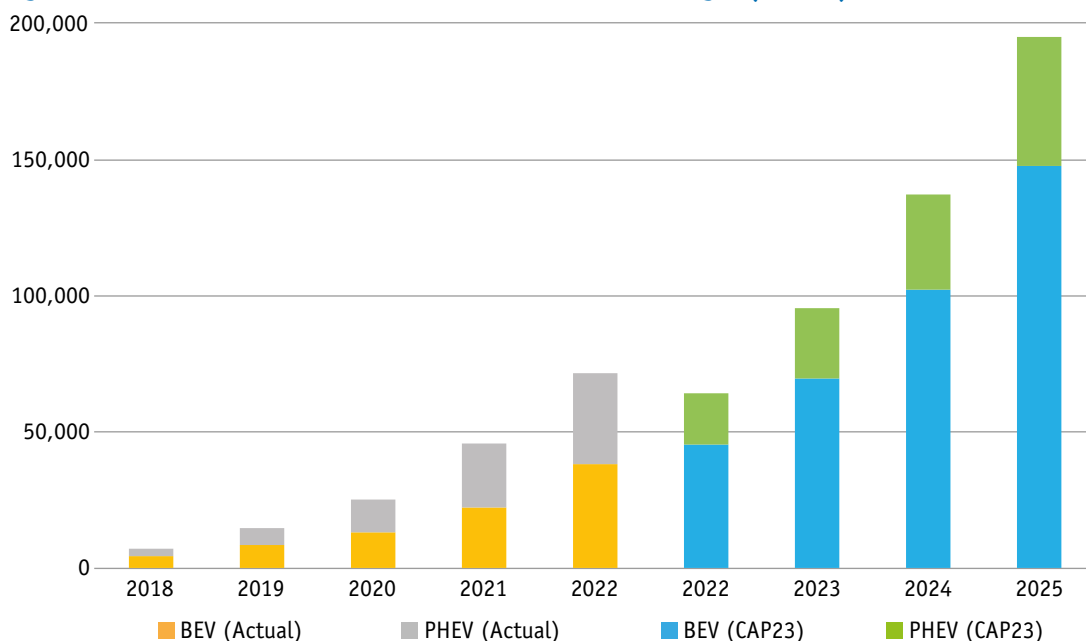
Emissions from road transport were relatively stable for the period 2015-2019, at an average 11.6 Mt CO₂eq.

but reduced to 9.8 Mt CO₂eq in 2020. However, with the easing and ending of travel restrictions in 2021/22, road transport emissions rebounded to 10.4 Mt CO₂eq and 11.1 Mt CO₂eq respectively.

Total energy consumption in road transport increased by 7.8% in 2022; petrol, +14.0%, diesel +5.1%, bioethanol +14.6% and biodiesel +26.9%.

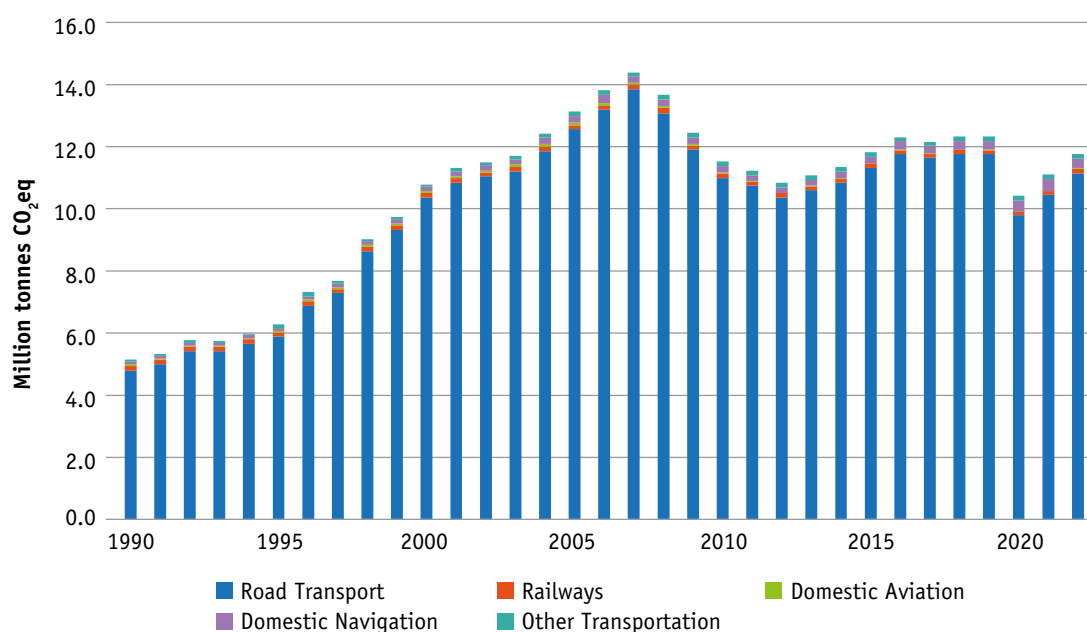
At the end of 2022, there were just under 72,000 battery electric (BEVs) and plug-in hybrid electric (PHEVs) vehicles in Ireland, approximately 37% of the Climate Action Plan target for 2025 of 195,400 or <8% of the 2030 policy target of 944,600 vehicles. As a result, the continued uptake of electric vehicles has meant the annual target in 2022 was exceeded, see Figure 10.

Figure 10. Total Electric Vehicles and Climate Action Plan target (CAP 23) 2025



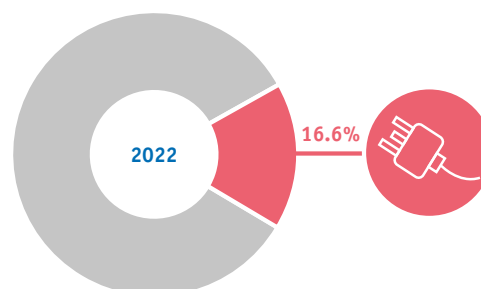
The impact of electric vehicles in reducing Transport emissions is still very small due to the low number in the vehicle fleet but they are projected to contribute substantially to emissions reductions towards the latter half of the 2020s. Evidence of this shift appears in the 2022 vehicle numbers whereby newly registered fully electric cars and plug-in electric cars accounted for approximately 19% of all new registrations in 2022.

Passenger cars were responsible for 49% of road transport emissions in 2022, with heavy goods vehicles responsible for 21%, light goods vehicles for 22% and buses 8%.

Figure 11. Trend in Transport 1990-2022

4.3 Energy Industries

Sectoral emissions in the *Energy Industries* sector show a decrease of 1.8% in 2022 which is due to reductions in coal, oil, and peat use (-16.1%, -29.1%, and -24.8%) in electricity generation. The use of natural gas increased by 12.6% in 2022 and is at its highest since 2010.



In 2022, overall electricity generated increased by 2.1%, renewable electricity share increased from 35.0% in 2021 to 38.6%, due to increased wind (up 14.6%). Electricity generated from hydro reduced by 6.4% in 2022. The increase in renewables, combined with decreases in coal, oil, and peat use, resulted in the emissions intensity of power generation in 2022 decreasing by 4.5%, 332 g CO₂/kWh compared with 348 g CO₂/kWh in 2021.

In 2022 renewables accounted for 38.6%, and natural gas 48.8% of electricity generated in 2022. Coal, oil, and peat generation accounted for 10.9% of electricity generated (see Figures 12 and 13).

Emissions from electricity generation had decreased year-on-year from 2016 to 2020, but 2021 and 2022 has seen increases in emissions of 1.4-1.5 million tonnes when compared to 2020. The return to using more carbon intensive fuel along with less renewables has played a big part in changing the trend as well as an increasing demand for electricity. The emission categories relevant under the *Energy Industries* sector are: Public electricity and heat production, Petroleum refining, Manufacture of solid fuels and other energy industries, and Fugitive emissions (Figure 14).

Figure 12. Emissions Intensity of Electricity Generation 1990-2022

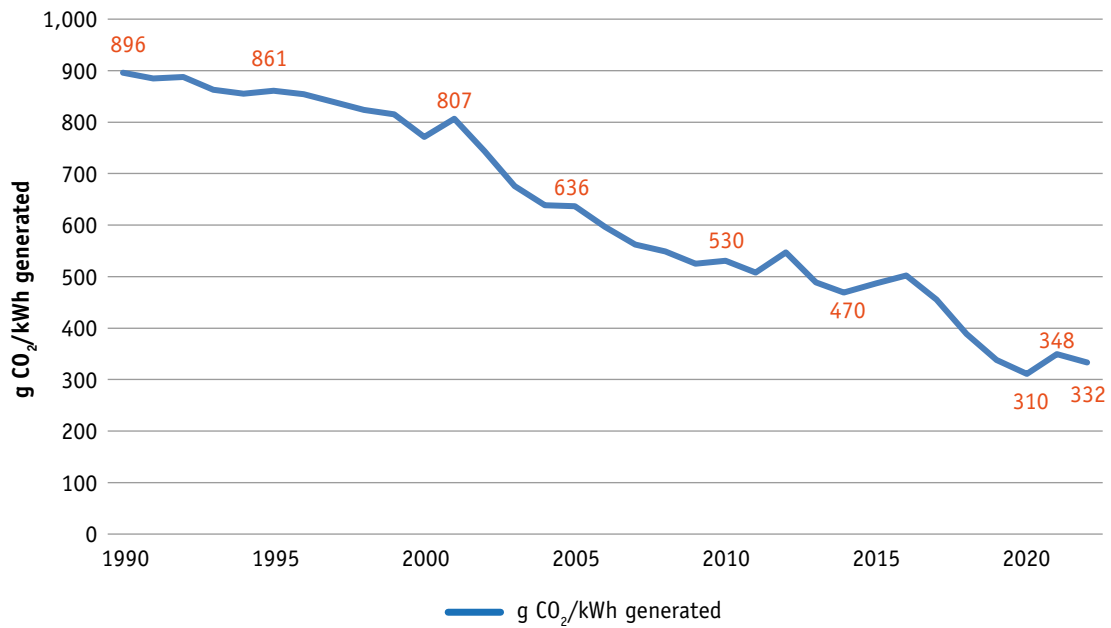


Figure 13. Electricity Generated by Fuel 1990-2022

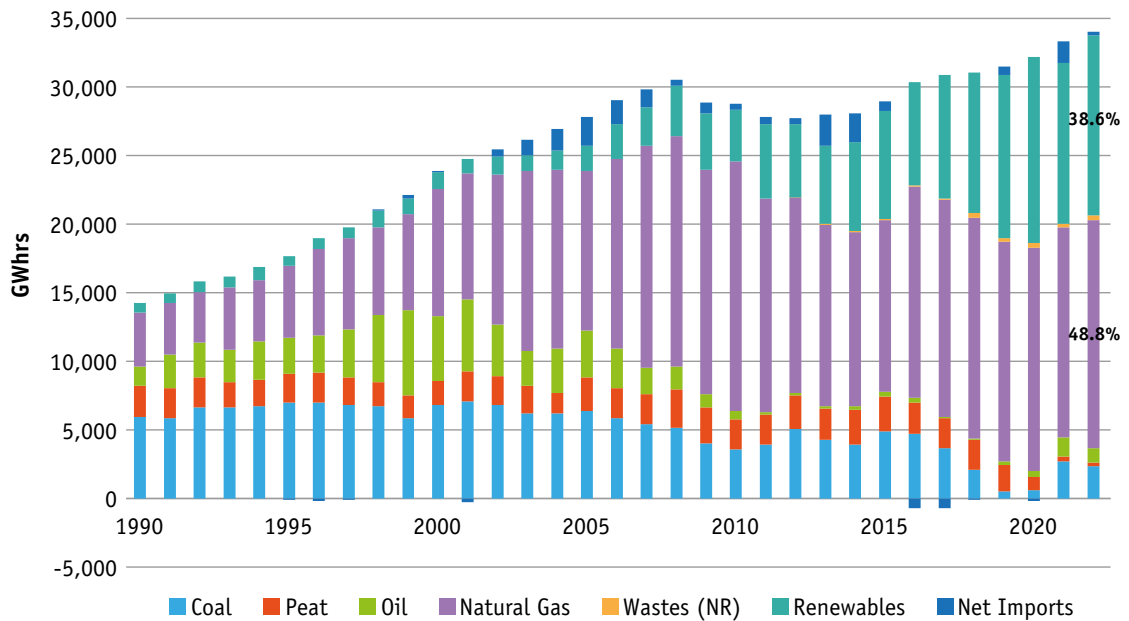
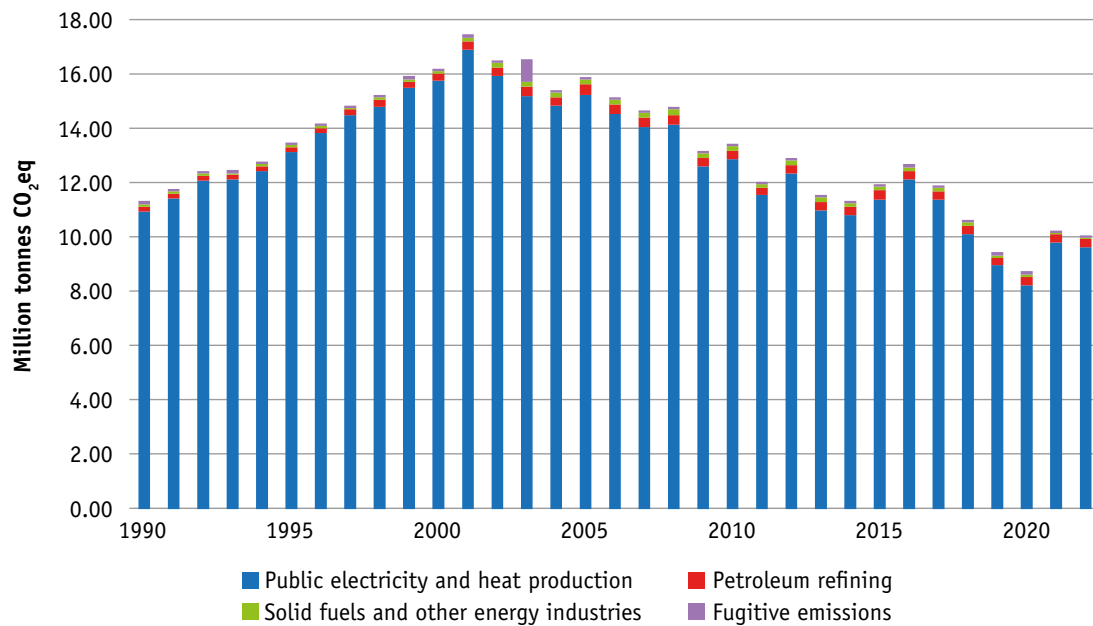
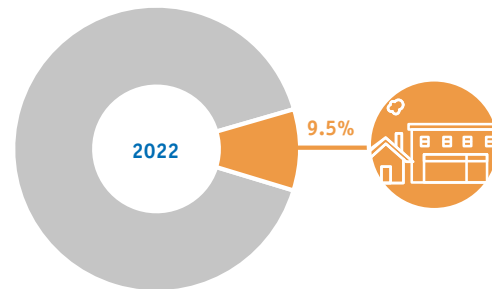


Figure 14. Trend in Energy Industries 1990-2022

4.4 Residential

Emissions in the *Residential* sector are 5.79 Mt CO₂eq or 9.5% of national total emissions in 2022 and decreased by 15.9% or 1.09 Mt CO₂eq since 2021. Within the different fuels used in household space and water heating, decreases were seen in all fuels; coal, peat, kerosene, and natural gas by 33.1%, 11.0%, 16.5%, and 9.3% respectively. High fuel prices and a mild winter were significant contributors to the reduction in fossil fuel use, in addition to the introduction of new, nationwide solid fuel regulations.



There were 4.6% less heating degree days⁸ in 2022 than in 2021. Fuel switching, from coal and peat to oil and natural gas use, as well as improvements in buildings regulations helped reduced emissions per household from 7.0 t CO₂ per year in 1990 to a low of 3.6 t CO₂ per year in 2014. Since 2014, total fuel use by households has increased by 14.9% to 2021 with CO₂ emissions per household averaging at 3.9 t CO₂ from 2015-2021. Emissions per household in 2022 are now at an historic low of 3.3 t CO₂ as fossil fuel prices increased (see Figures 15 and 16).

While weather is a key variable from year to year, the flattening of the historic downward trend in per household CO₂ emissions evident in Figure 16, indicates a need for increased energy efficiency retrofit activity in order to achieve future emissions reduction commitments.

⁸ Degree days are a measure of the heating or cooling requirement on a given day with reference to a level where neither is required (typically 15.5°C). The number of degree days in a year is a strong indicator of the annual Residential energy demand.

Figure 15. Trend in Residential 1990-2022

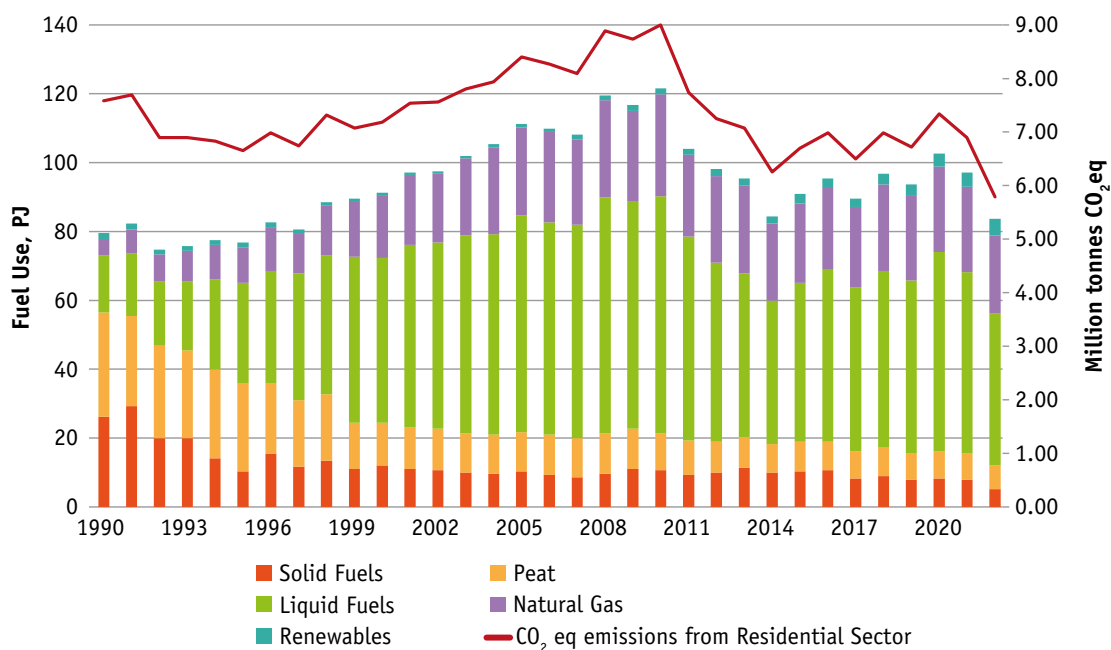
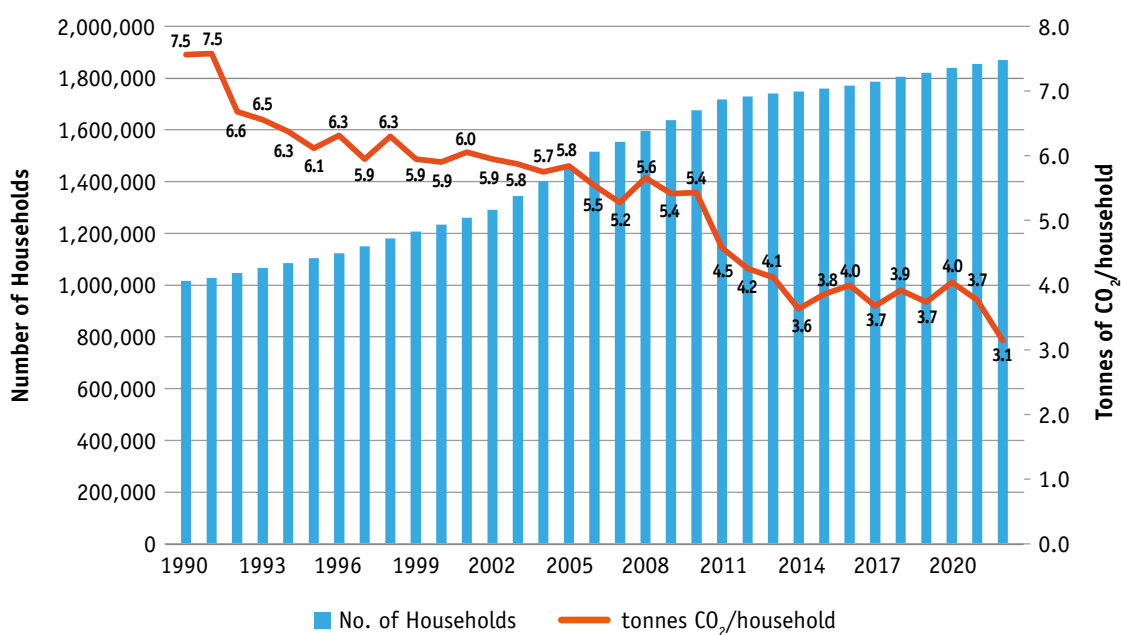
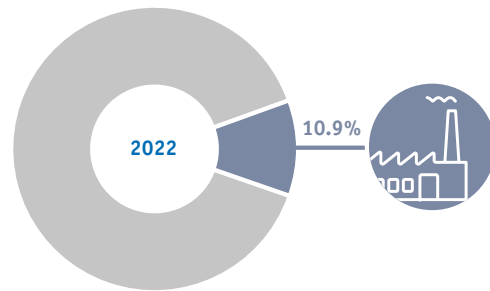


Figure 16. CO₂ emissions per Household 1990-2022



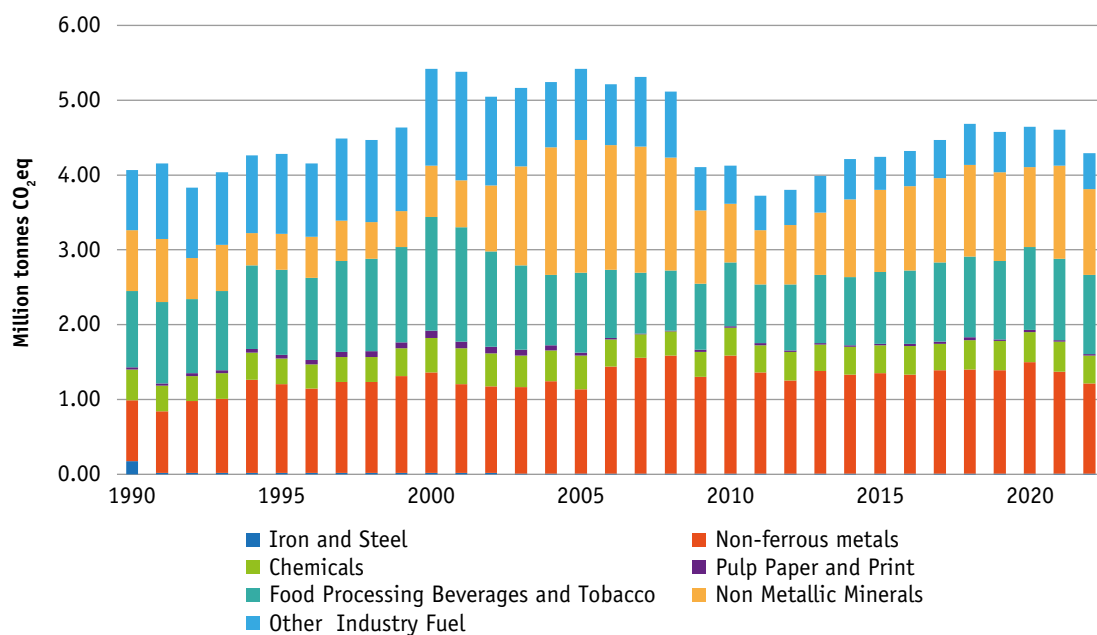
4.5 Manufacturing and Industry

Emissions relating to *Manufacturing Combustion* and *Industrial Processes* combined accounted for 10.9% of Ireland's total emissions in 2022, or 6.59 Mt CO₂eq. Emissions from the *Manufacturing Combustion* sector decreased by 6.8% or 0.31 Mt CO₂eq in 2022. There were decreases in combustion emissions from major sub sectors including non-ferrous metals, chemicals, food processing, beverages and tobacco sector and non-metallic minerals, i.e. 11.4%, 8.7%, 2.1% and 8.0% respectively.



In 2022, significant fuel reductions occurred in this sector with coal, petroleum coke and natural gas use all decreasing by 20.8%, 14.6% and 7.5% respectively. See Figure 17.

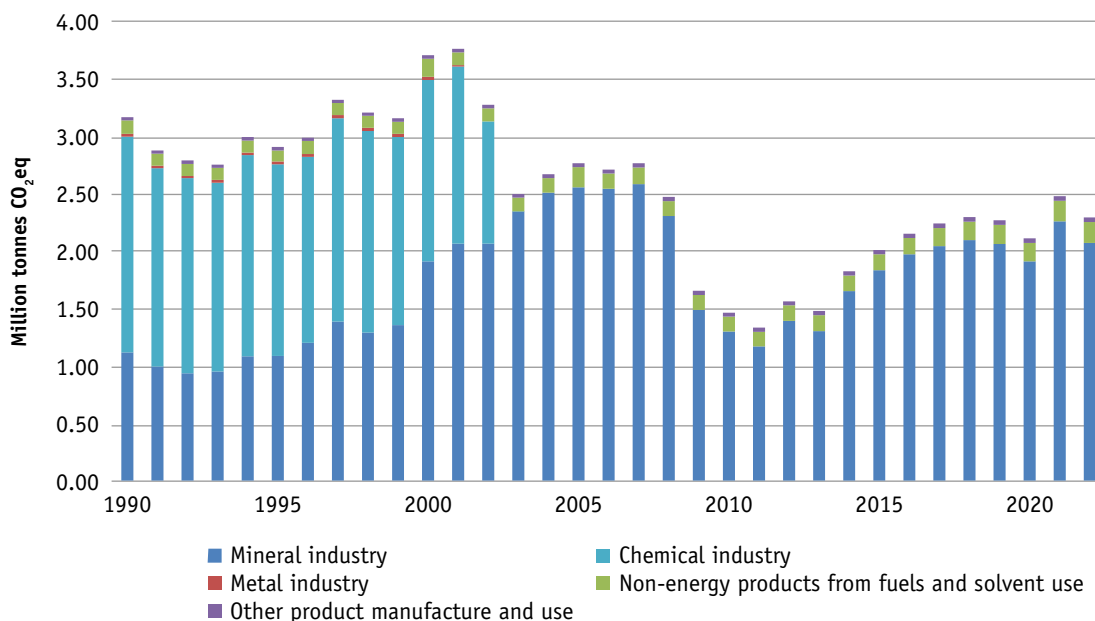
Figure 17. Trend in Manufacturing Combustion 1990-2022



Emissions from the *Industrial Processes* sector decreased by 7.5% (0.19 Mt CO₂eq) in 2022 from 2.47 Mt of CO₂eq to 2.29 Mt CO₂eq, following a 17.3% increase in 2021. Total process emissions from the mineral products subsector (including cement) decreased by 8.4%.

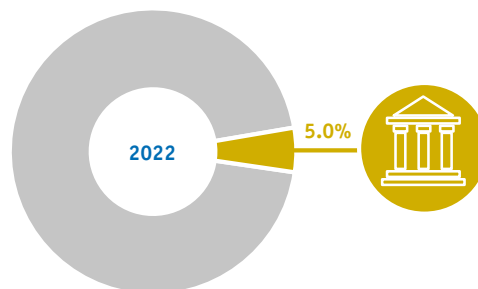
In 2022, total emissions (combustion and process) from the cement sector decreased by 8.2% and amount to 2.88 Mt CO₂eq, or 4.8% of national total emissions. Cement sector emissions are now 89.3% higher than the 2011 low during the economic recession, see Figure 18.

Figure 18. Trend in Industrial Processes 1990-2022



4.6 Other Sectors

Emissions from *F-Gases, Commercial Services, Public Services* and *Waste* account for 5.0% of total national emissions in 2022.



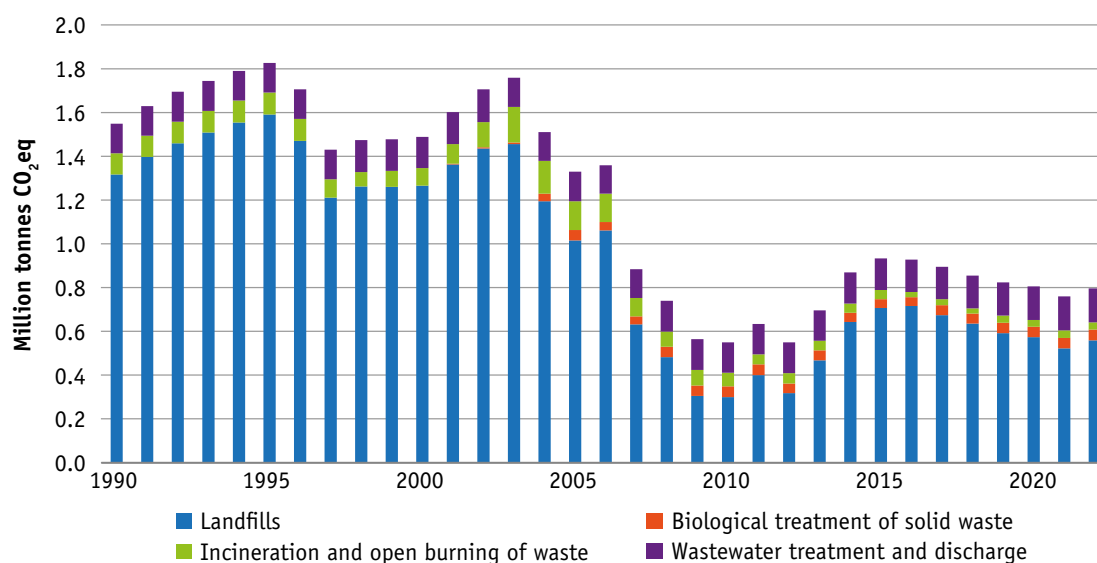
Commercial and Public Services

Emissions from *Commercial Services* remained the same and *Public Services* decreased by 2.2% in 2022. Natural gas and oil decreased by 2.5% and 2.3% within the *Public Services* sub-sector.

Waste

Emissions from the *Waste* sector, which account for 1.4% of total national emissions, increased by 6.6% in 2022, largely as a result of an increase in emissions of methane from landfills by 7.6%. Actual generation of methane at landfills fell 6.0% in 2022, but methane flared and utilised for electricity generation fell by 14.3%, with net overall increase in emissions. Waste sector emissions increased by 0.05 Mt CO₂eq. See Figure 19.

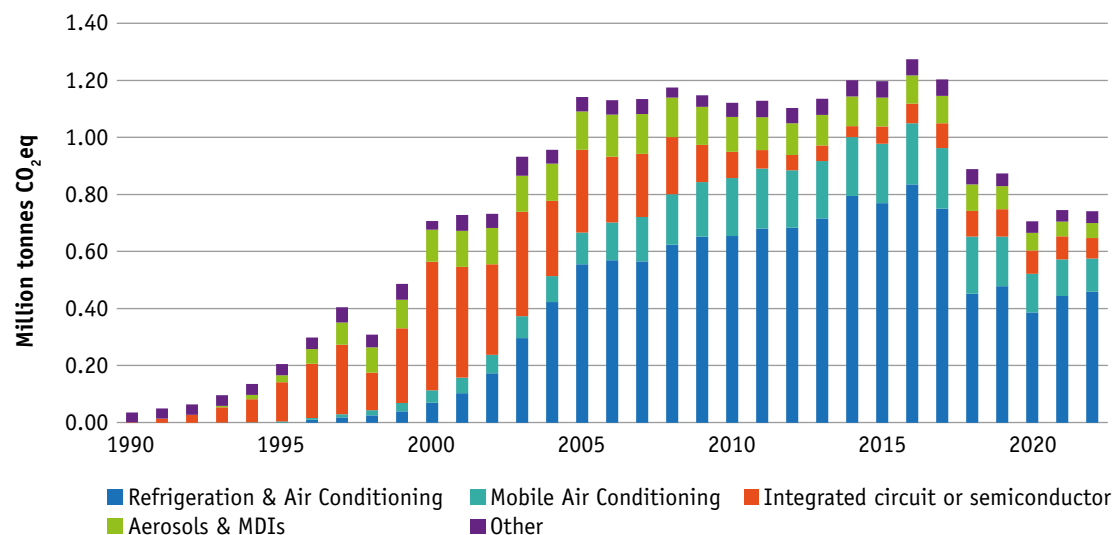
Long-term decreases are a result of decreased quantities of municipal solid wastes (MSW) disposed of at landfills which now are combusted in Waste to Energy (WtE) plants and a decrease in the proportion of organic materials (food and garden waste) in MSW as well as a diversion of paper products from landfills. A large proportion of organic food and garden waste is now treated in composting and anaerobic digestion facilities, which have significantly lower emissions than landfills. The emissions associated from combustion at WtE plants are estimated under electricity generation in *Energy Industries*. Improved management of landfill facilities, including increased recovery of landfill gas utilised for electricity generation and flaring is also a big driver in decreased emissions from the waste sector. The increasing trend of methane emissions from landfills from 2010 to 2018 is due to a decrease in landfill gas flaring as overall landfill gas volumes decrease.

Figure 19. Trend in Waste 1990-2022

Fluorinated Gas Emissions

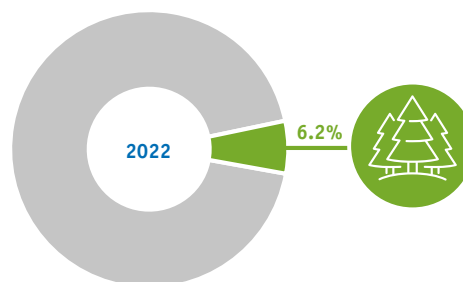
F-Gas emissions in 2022 are at similar levels to 2021, down only 0.5%, following an increase of 5.5% in the previous year. The small decrease is due to a reduction in PFCs and NF₃ use in the semiconductor industry. Emissions of F-gases (HFCs, PFCs, SF₆ and NF₃) were 0.74 Mt CO₂eq in 2022 compared to 0.04 Mt CO₂eq in 1990, a 21-fold increase over the time series, see Figure 20. However, F-gas emissions have risen from a very low base and only accounted for 1.2 per cent of the national total in 2022. F-gases include a wide range of substances that are used in a diverse range of products and manufacturing processes.

The main reason behind the more recent decreases in F-gas emissions has been the phasing out of refrigerant and air conditioning (AC) gases with high global warming potentials (GWPs), due to the implementation of the F-Gas Regulation (EU) No. 517/2014. These refrigerant gases are being replaced with products containing a blend of HFCs and hydrofluoroolefins (HFOs) with low GWPs in this subcategory, Refrigeration and Air Conditioning.

Figure 20. Composition and Trend in F-Gas Emissions 1990-2022

4.7 LULUCF

The *LULUCF* sector is made up of six land use categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land) and Harvested Wood Products. This sector accounts for 6.2% of national total emissions (including LULUCF). See Figure 21.



These categories are sub-divided into land remaining in the same category (e.g. Forest land remaining forest land) and land converted from one category into another (e.g. grassland converted to forest land).

The sector is a net source of CO₂eq emissions in all years 1990-2022. The net CO₂ emissions to, or removals from, the atmosphere are estimated with respect to overall carbon gain or loss for relevant carbon pools for the defined land categories. These pools⁹ are above-ground biomass, below-ground biomass, litter, dead wood, soils and harvested wood products. Emissions from biomass burning (wildfires), drainage of organic soils and emissions from mineralisation in soils are also estimated.

The main sources of emissions are the drainage of grasslands on organic soils and the exploitation of wetlands for peat extraction. Forest land and Harvested wood products are a carbon sink (CO₂ removal) for all years 1990-2022. See Figure 22. The carbon sink associated with Forest land is on a declining trend.

A complex dynamic exists between land use categories and the relative contributions between the carbon pools in biomass and soils lead to fluctuations in emissions and removals over the period 1990-2022. In any one year the Croplands land use can act as either a small sink (removal) or a small source of emissions. This results from the dynamic of using temporary grassland as part of cropping rotations. The Settlements and Other Land uses are comparatively less important and do not affect the absolute level of emissions or the trend over time to a significant extent.

Emissions from the *LULUCF* sector in 2022 were 20.5% below those in 1990 and decreased by 13.9% between 2021 and 2022. There has been a significant long-term decline in the area of land afforested annually and an increase on the level of harvest and increased emission from forestry on organic soils resulting in a reduction in the contribution of the forest land sector to the removal of CO₂ from the atmosphere.

Afforestation rates have declined from c. 17,000 ha annually in the 1990s to c. 2,273 ha by 2022 resulting in a decreasing carbon sink in land converted to forest land. Afforestation rates are well below those suggested in the CAP 23. For forest land remaining forest land, it is transitioning from a sink to an emission source due an increase in the level of harvest from 1.7 million m³ in 1990 to 4.1 million m³ in 2022. Further increases in the level of harvest are projected as the forest estate matures.

⁹ A carbon pool is a reservoir of carbon that has the capacity to both take in and release carbon.

Figure 21. Profile of GHG Emissions (including LULUCF) in 1990 and 2022 by Sector

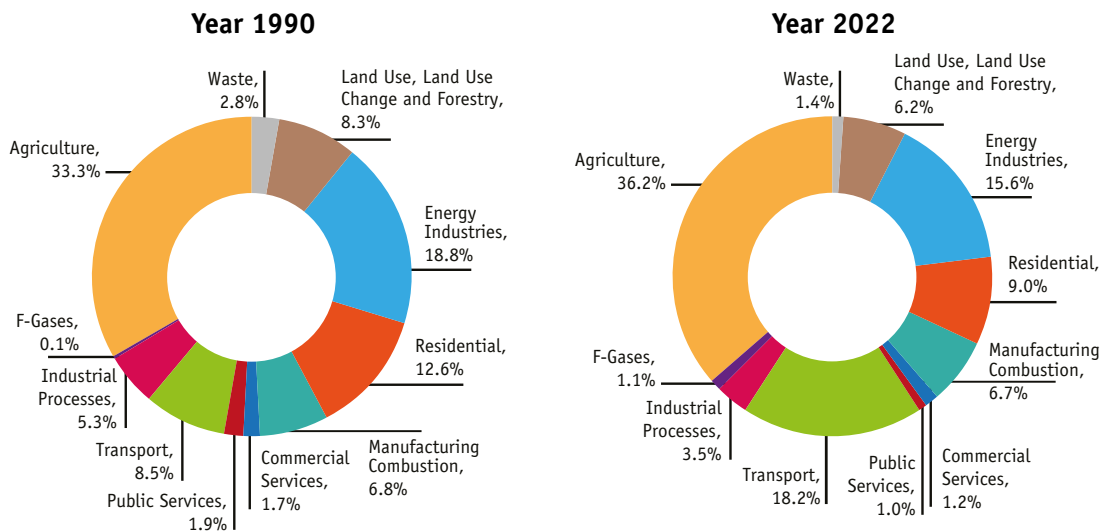
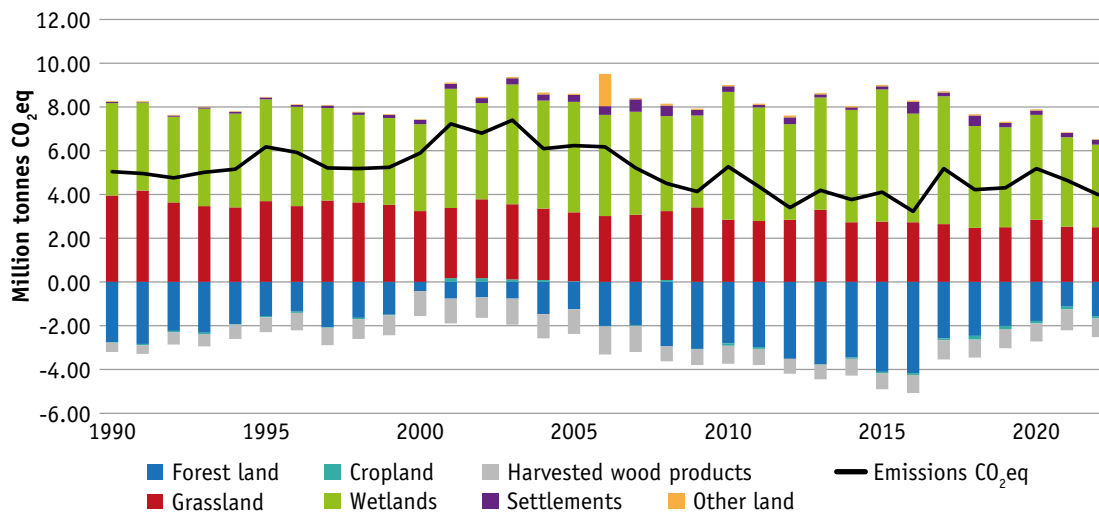


Figure 22. Trend in LULUCF 1990-2022



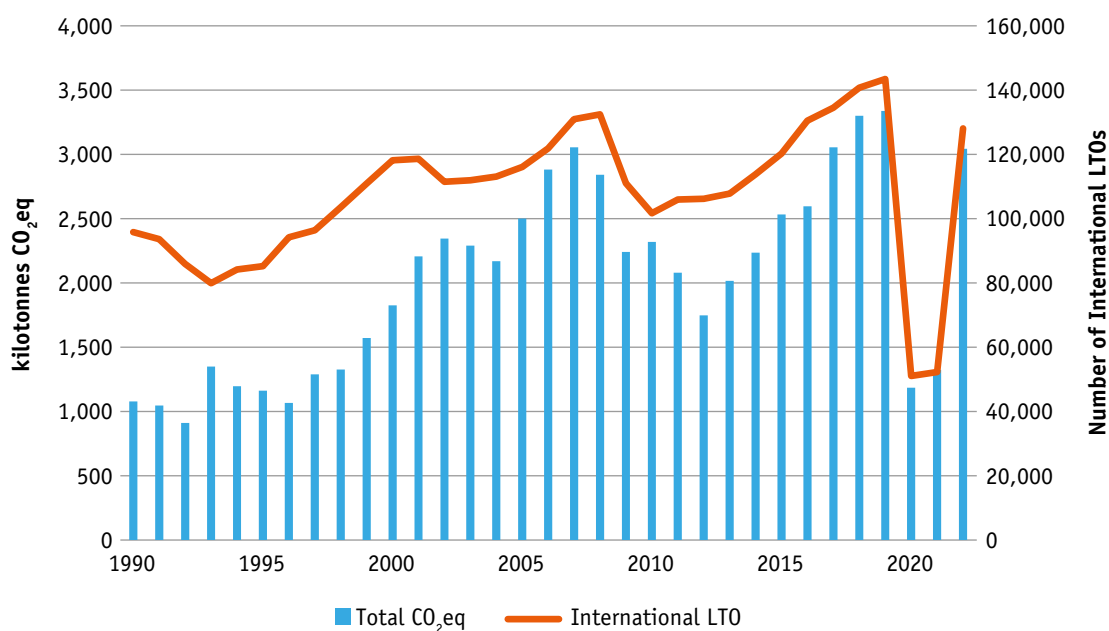
5. International Aviation and Maritime Emissions

Emissions from international aviation and maritime navigation are reported as “memo items” in the national emission inventory. This means they are not counted as part of Ireland’s national total emissions but are reported by Ireland to the UNFCCC and EU for information purposes. A substantial proportion of Ireland’s international aviation emissions is included in the EU ETS, such as all intra EU flights and flights within the European Economic Area (EEA) including; Iceland, Norway and Liechtenstein. In 2022, total international aviation contributed 3.05 Mt CO₂ from over 126,500 return flights from Irish airports, see Figure 23, a substantial increase from 1.32 Mt CO₂ in 2021. Emissions in 2022 have returned to almost pre COVID pandemic levels.

In recent years, CO₂ emissions from international aviation have increased very rapidly and it is therefore important that they are closely monitored for comparison with other sources and for the benefit of the international organisations that will have to develop control strategies for them in the future.

International marine navigation is another important source of emissions that is also excluded from Ireland’s national total emissions and any EU or UN reduction commitments. In 2022, emissions from this source amounted to 0.41 Mt CO₂eq, which is a reduction of 24.4% on 2021.

Figure 23. Trend in International Aviation 1990-2022



6. Long-term Changes in Sectoral Emissions 1990-2022

As 1990 is the historical base year used by most countries in relation to UNFCCC reporting, it is instructive to look at how emissions have evolved over the longer timeframe from 1990 to the present. The share of CO₂ in total greenhouse gas emissions has increased to 60.6% of total greenhouse gas emissions in 2022 compared to 59.6% in 1990. The share of CH₄ and N₂O emissions, primarily from the agriculture sector, have fallen from 40.3 of total greenhouse gas emissions in 1990 to 38.2% in 2022 as emissions (primarily CO₂) from other sectors grew at a faster rate. Emissions from F-gases account for 1.2% of the total in 2022. The trend in national total emissions (excluding LULUCF) from 1990 to 2022 is 9.7%, shown in Figures 24 and 25 and Table A.1 in the Appendix.

Between 1990 and 2022, **Transport** shows the greatest overall increase of GHG emissions at 128.5%, from 5,143.3 kt CO₂eq in 1990 to 11,751.3 kt CO₂eq in 2022, with road transport increasing by 132.6%. Fuel combustion emissions from Transport accounted for 9.2 per cent and 19.1 per cent of total national greenhouse gas emissions in 1990 and 2022, respectively. The increase in emissions up to 2007 can be attributed to general economic prosperity and increasing population, with a high reliance on private car travel as well as rapidly increasing road freight transport. Over the time series passenger car numbers increased by 184% and commercial vehicles increased by 170%. Both the increase in transport emissions up to 2007 and the subsequent fall during the financial crisis highlight that transport emissions have not yet been effectively decoupled from economic activity through sustainable planning or electrification.

Energy Industries show a decrease in emissions of 11.1% over the period 1990 to 2022. Over the time series, emissions from electricity generation have decreased by 12.2% whereas total electricity consumption has increased by 156%. Emissions from electricity generation increased from 1990 to 2001 by 54.3% and have decreased by 43.1% between 2001 and 2022. This decrease reflects the improvement in efficiency of modern gas fired power plants replacing older peat and oil-fired plants and the increased share of renewables, primarily, wind power along with increased interconnectivity. This year was the lowest year in the 33-year time series for peat fired electricity generation, 25% less than in 2021. These reductions reflect the gradual ending of peat fired electricity generation for market and climate policy reasons. Emissions from electricity generation had decreased year-on-year from 2016 to 2020 but increased in 2021 by 18.9% compared to 2020 due to an increase in coal and oil use, driven by a number of factors including the war in Ukraine. Whilst use of coal in electricity generation decreased in 2022, it was still at a higher level than has been the case in more recent years, slightly above what was seen in 2018.

The latest estimates show that total emissions in the **Agriculture** sector have increased by 16.4% from 1990 to 2022 mainly driven by a 18.4% increase in methane emissions from enteric fermentation and a 25.3% increase in emissions from manure management. After initially showing a rising trend in emissions in the 1990s, the Agriculture sectoral emissions began to decrease steadily between 1998 until 2011.

However, since 2011, emissions have trended upwards again with an overall peak in emissions reported in 2021. Fossil fuel combustion emissions from agriculture/forestry/fishing activities have decreased by 19.8% since 1990. In the last 10 years, dairy cow numbers have increased by 42.5% with a corresponding milk production increase of 68.6%. This reflects national plans to expand milk production under Food Wise 2025 and the removal of the milk quota in 2015. In the same 10-year period sheep numbers increased by 14.7%, pigs by 4.6% and poultry by 20.4%.

Emissions in 2022 from the **Residential** sector were 23.6% below the 1990 level and 15.9% below the 2021 level. At 7.4% below the previous lowest level in 2014, 2022 also represents a new low point for Residential sector emissions across the entire Inventory time series since 1990. Increased housing stock and a growing population had driven a gradual upward trend in the emissions after 1997 following emission reductions in the early 1990s due to fuel switching. Following a decline from 2010 to 2014, emissions had remained relatively stable from 2015 to 2021 despite increasing population. The number of households has increased by 84.2% and population by 45.5% between 1990 and 2022 with winter heating demand remaining an important annual variable driving emissions from this sector.

Figure 24. GHG Emissions by Gas 1990-2022

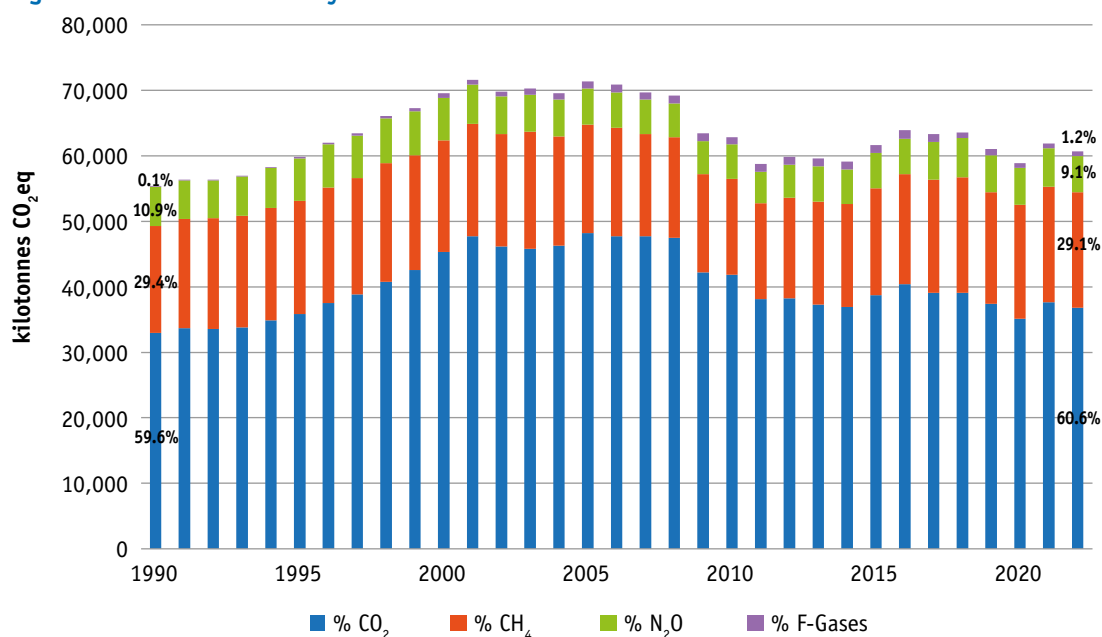
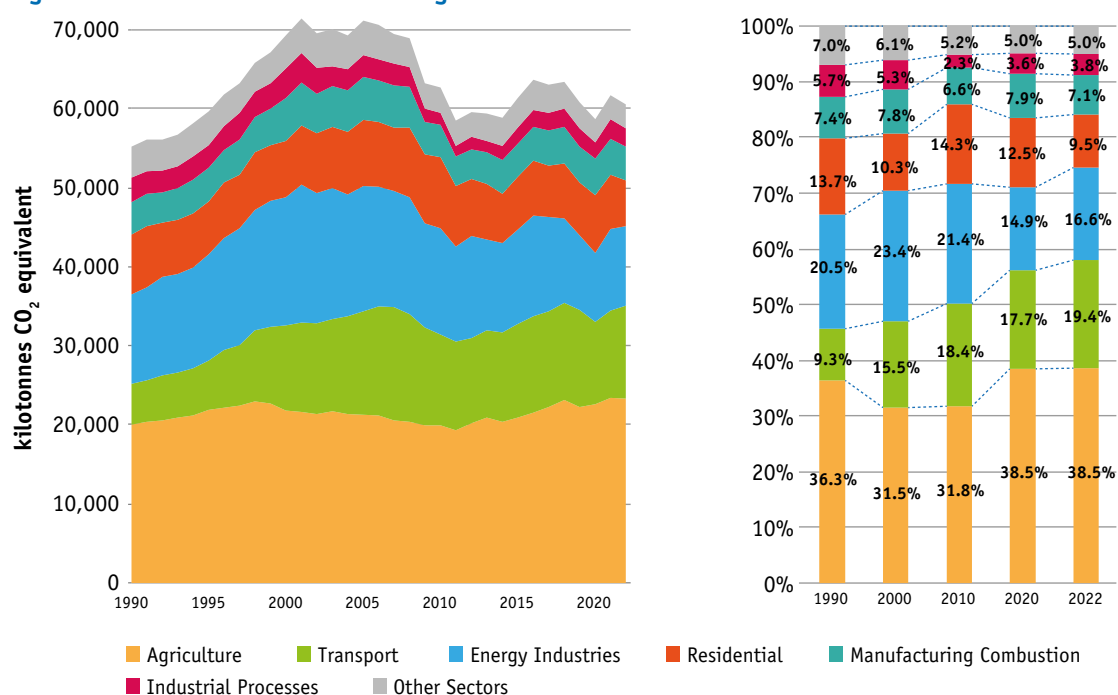


Figure 25. Trend in Emissions for Largest Sectors 1990-2022



Appendix – Additional Tables

Table A.1 Ireland's Final GHG Emissions by Sector 1990-2022 (kilotonnes CO₂ equivalent)

1990-2022 Submission 2024 Final	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	% Share 2022	% Share 2022 incl LULUCF	Annual change
Energy Industries	11335	13482	16202	15901	13461	11534	11343	11953	12675	11908	10647	9437	8737	10262	10078	16.6%	15.6%	-1.8%
Public electricity and heat production	10947	13126	15747	15235	12880	10994	10831	11380	12136	11362	10100	8954	8242	9796	9613	15.9%	14.9%	-1.9%
Petroleum refining	169	181	275	412	310	295	279	359	314	311	322	275	301	294	308	0.5%	0.5%	4.7%
Solid fuels and other energy industries	101	69	87	172	173	161	134	114	125	129	118	107	92	81	67	0.1%	0.1%	-17.1%
Fugitive emissions	119	106	93	83	97	85	98	99	100	106	107	102	102	91	90	0.1%	0.1%	-1.5%
Residential	7571	6648	7176	8395	8983	7058	6253	6691	6977	6482	6976	6702	7326	6879	5787	9.5%	9.0%	-15.9%
Manufacturing Combustion	4074	4290	5426	5427	4127	3992	4216	4248	4327	4473	4690	4579	4651	4614	4302	7.1%	6.7%	-6.8%
Commercial Services	1010	1078	1026	1082	991	963	864	973	867	803	874	843	684	765	765	1.3%	1.2%	0.0%
Public Services	1123	917	863	685	551	585	580	606	633	637	667	694	643	672	657	1.1%	1.0%	-2.2%
Transport	5143	6264	10777	13122	11526	11054	11336	11814	12296	12133	12308	12322	10401	11089	11751	19.4%	18.2%	6.0%
Domestic aviation	48	46	70	80	49	15	15	16	17	18	17	18	14	20	22	0.0%	0.0%	9.3%
Road transportation	4789	5878	10357	12543	10981	10584	10832	11319	11754	11626	11762	11750	9794	10438	11139	18.4%	17.2%	6.7%
Railways	147	123	136	135	135	130	119	121	124	128	129	135	108	116	130	0.2%	0.2%	11.8%
Domestic navigation	86	92	153	211	200	179	225	222	266	235	260	277	339	362	306	0.5%	0.5%	-15.6%
Other transportation	73	125	62	153	161	145	146	137	135	127	140	142	148	152	155	0.3%	0.2%	2.1%
Industrial Processes	3163	2902	3701	2759	1462	1474	1818	2006	2148	2236	2292	2264	2107	2472	2288	3.8%	3.5%	-7.4%
Mineral industry	1117	1084	1909	2553	1299	1302	1650	1830	1968	2040	2095	2058	1907	2257	2068	3.4%	3.2%	-8.4%
Chemical industry	1875	1668	1577	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO			
Metal industry	26	25	29	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO			
Non-energy products from fuels and solvent use	117	97	156	173	127	136	131	138	142	158	159	167	160	175	179	0.3%	0.3%	2.3%
Other product manufacture and use	28	29	30	33	36	37	37	37	38	38	39	39	40	40	41	0.1%	0.1%	1.8%
F-Gases	36	206	706	1141	1121	1134	1199	1196	1273	1202	888	873	706	745	741	1.2%	1.1%	-0.5%

1990-2022 Submission 2024 Final	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	% Share 2022	% Share 2022 incl LULUCF	Annual change
Agriculture	20067	21899	21855	21246	19950	20897	20395	20940	21513	22296	23176	22260	22613	23436	23357	38.5%	36.2%	-0.3%
Enteric fermentation	12319	13055	13251	12974	12059	12762	12676	13103	13468	13950	14278	13887	14105	14487	14584	24.1%	22.6%	0.7%
Manure management	2173	2328	2398	2438	2307	2494	2443	2542	2617	2709	2786	2692	2716	2752	2723	4.5%	4.2%	-1.0%
Agricultural soils	4312	4779	4734	4418	4235	4411	4227	4256	4321	4595	4888	4561	4600	4816	4378	7.2%	6.8%	-9.1%
Liming	355	495	366	267	428	516	391	401	434	333	461	344	399	597	624	1.0%	1.0%	4.4%
Urea application	97	86	92	61	98	47	55	64	79	84	89	92	109	102	127	0.2%	0.2%	24.3%
Agriculture/Forestry fuel combustion	723	998	900	944	746	590	529	510	535	555	590	610	624	624	866	1.4%	1.3%	39.0%
Fishing	88	158	113	145	76	78	74	65	60	71	84	73	59	58	54	0.1%	0.1%	-7.9%
Waste	1709	2020	1643	1454	589	755	949	1020	1016	979	933	898	878	823	878	1.4%	1.4%	6.6%
Landfills	1476	1784	1420	1140	337	525	722	793	803	756	714	665	644	590	634	1.0%	1.0%	7.6%
Biological treatment of solid waste	0	0	0	48	50	46	42	42	41	47	46	49	48	43	51	0.1%	0.1%	18.2%
Incineration and open burning of waste	98	101	80	133	62	45	42	42	25	27	24	33	31	35	36	0.1%	0.1%	5.1%
Wastewater treatment and discharge	135	135	143	134	140	139	143	144	147	149	150	151	155	156	156	0.3%	0.2%	0.2%
Land use, land-use change and forestry	5011	6151	5868	6212	5248	4162	3738	4082	3198	5165	4186	4282	5152	4628	3983		6.2%	-13.9%
Forest land	-2723	-1554	-428	-1238	-2790	-3757	-3450	-4081	-4151	-2556	-2463	-2009	-1769	-1135	-1575		-2.4%	38.8%
Cropland	-48	-45	1	43	-113	-5	-51	-71	-93	-92	-155	-142	-125	-101	-83		-0.1%	-17.7%
Grassland	3928	3683	3221	3121	2818	3272	2725	2734	2730	2646	2452	2482	2829	2512	2485		3.8%	-1.1%
Wetlands	4203	4638	3972	5040	5839	5126	5096	6041	4923	5820	4634	4567	4785	4081	3758		5.8%	-7.9%
Settlements	63	86	172	306	251	127	119	129	536	162	491	200	194	188	221		0.3%	17.9%
Other land	1	24	54	70	63	62	62	60	57	55	53	50	48	46	44		0.1%	-5.2%
Harvested wood products	-413	-680	-1123	-1130	-819	-662	-763	-729	-804	-869	-826	-866	-809	-963	-866		-1.3%	-10.1%
Other																		
National Total	55231	59706	69375	71214	62760	59446	58952	61448	63725	63148	63452	60871	58746	61755	60605	100.0%	100.0%	-1.9%
National Total with LULUCF	60242	65857	75243	77426	68008	63608	62690	65530	66923	68313	67639	65153	63898	66383	64588	100.0%	100.0%	-2.7%

Background Notes

Units: 1 Mt = 1,000 kilotonnes

CO₂ Equivalent: greenhouse gases other than CO₂ (i.e. methane, nitrous oxide and F-gases) may be converted to CO₂ equivalent using their global warming potentials (GWPs).

F-gases: These gases comprise HFCs (Hydrofluorocarbons), PFCs (Perfluorocarbons), SF₆ (Sulphur Hexafluoride) and NF₃ (Nitrogen Trifluoride). They are much more potent than the naturally occurring greenhouse gas emissions (carbon dioxide, methane and nitrous oxide).

Ireland's GHG Sectors: include the following eleven sectors for analysis:

1. Energy Industries (electricity generation, waste to energy incineration, oil refining, briquetting manufacture and fugitive emissions)
2. Residential (combustion for domestic space and hot water heating)
3. Manufacturing Combustion (combustion of fuels for heating, steam generation and powering machinery)
4. Commercial Services (combustion for Commercial Services space and hot water heating)
5. Public Services (combustion for Public services space and hot water heating)
6. Transport (combustion of fuel used in road, rail, navigation, domestic aviation and pipeline gas transport)
7. Industrial Processes (process emissions from mineral, chemical, metal industries, non-energy products and solvents)
8. F-Gases (gases used in refrigeration, air conditioning and semiconductor manufacture)
9. Agriculture (emissions from fertiliser application, ruminant digestion, manure management, agricultural soils and fuel used in agriculture/forestry/fishing)
10. Waste (emissions from solid waste disposal on land, solid waste treatment (composting and anaerobic digestion), wastewater treatment, waste incineration and open burning of waste).
11. Land Use Land-use Change and Forestry (LULUCF) covers the following categories; Forest land, Cropland, Grassland, Wetlands, Settlements, Other land and Harvested Wood products.

GWPs

Industrial designation or common name	Chemical formula	GWP for 100-year time horizon IPCC 4th assessment report (AR4)	GWP for 100-year time horizon IPCC 5th assessment report (AR5)
Carbon dioxide	CO ₂	1	1
Methane	CH ₄	25	28
Nitrous oxide	N ₂ O	298	265
Hydrofluorocarbons	HFCs	12 to 14,800	4 to 12,400
Perfluorinated compounds	PFCs	7,390 to 12,200	6,630 to 11,100
Sulphur hexafluoride	SF ₆	22,800	23,500
Nitrogen trifluoride	NF ₃	17,200	16,100

