Ireland's Air Pollutant Emissions

1990-2030

May 2025

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

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Contents

Key Findings

Assessment of targets	Ireland is compliant with current and future emission reduction commitments for ammonia (NH_3), non-methane volatile organic compounds (NMVOC), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and fine particulate matter ($PM_{2.5}$).
	Emissions of NH_3 in 2023 **were 6.0 per cent below 2005** emission levels and are in compliance with the 2020-2029 emission reduction commitments. Ammonia emissions are projected to be in compliance under both With Existing Measures and With Additional Measures scenarios out to 2030. In addition, ammonia emissions in 2023 were 4.1 percent, or 5.0 kilotonnes (kt) below 2022.
	Emissions of non-methane volatile organic compounds (NMVOC) exceeded the 2020-2029 emission reduction commitment in 2023. To achieve compliance, Ireland is applying an adjustment to NMVOC emissions under Article 5(1) of Directive (EU) 2016/2284 relating to the source category, which was unavailable when the emission reduction commitments were set.
Main drivers	Nitrogen oxide (NO_x) emissions decreased in 2023 due to reductions in combustion of fossil fuels for electricity generation, the increased share of renewables, along with increased interconnection, less fossil fuel use for heat in homes and improved manure management and reductions in nitrogen fertiliser use in agriculture. The road transport sector is the largest source of NO_x emissions (38.1 per cent of national total).
	Fine particulate matter ($PM_{2.5}$) emissions reduced by 11.4 per cent in 2023 compared to 2022 and continue to meet the emission reduction commitment. This is largely due to a reduction in the combustion of fossil fuels in the residential sector, as a result of a combination drivers including fuel price increases and reduced heat demand as a result of milder winter weather conditions in 2023.
	Reduced non-methane volatile organic compound emissions (down by 4.1 per cent in 2023 vs 2022) were driven largely by reduced combustion of fossil fuels in the residential sector. However, the continued expansion of spirit production in the food and beverages industry has partly offset the magnitude of reduction in emissions.
	Ammonia emissions reductions are largely driven by increased use of low emission slurry spreading techniques and a reduction in nitrogen fertiliser use, declining by 18.2 per cent between 2022 and 2023.
Future outlook	Mitigation measures to achieve compliance with emission reduction commitments out to 2030 are outlined in the National Air Pollution Control Programme (NAPCP) and Clean Air Strategy and include measures specifically to tackle air pollutants as well as greenhouse gas emission mitigation measures that have air pollutant emission co-benefits.
	The 2030 emission reduction commitment for nitrogen oxides requires full implementation of the measures in the NAPCP, Clean Air Strategy and Climate Action Plan measures which include accelerated electrification of the transport sector and increases in active and sustainable transport, replacement of fossil fuels in the residential sector with electrification of heat (heat pumps) and roll out of proposed district heating projects.
	Measures are required to mitigate increasing NMVOC emissions from a growing spirit production sector. Further research is necessary on the broader range of NMVOC sources, such as solvents and spirit production. Projections indicate that meeting future NMVOC emission reduction commitments will become increasingly challenging.
	Achievement of the 2030 emission reduction commitment for ammonia is met depends on maintaining progress in implementation of ammonia abatement measures at the farm level, as outlined in the AgClimatise plan, Teagasc Marginal Abatement Cost Curves, 2023 and 2024 Climate Action plans, and current NAPCP.
	Compliance with the 2030 emission reduction commitment continues to be projected for fine Particulate matter ($PM_{2.5}$) emissions. Accelerated transition away from solid fuels for residential heating is required to minimise $PM_{2.5}$ emissions and address air quality issues in towns and villages.

1. Introduction

This report provides details of emissions of air pollutants in Ireland in the period 1990 to 2023 and projected emissions of these pollutants for 2030. The information used to compile this report is sourced from many Agencies and Government Departments, as well as from Annual Environmental Reports submitted by industry and waste management activities licensed by the EPA. The EPA has calculated emissions using the methodologies described in EU[1] and UN[2] reporting guidelines to comply with the annual reporting requirements of the Convention on Long Range Transboundary Air Pollution (CLRTAP) and the National Emission reduction Commitments Directive (NECD).

The Revised Gothenburg Protocol to abate Acidification, Eutrophication and Ground-level Ozone was adopted in May 2012. The Protocol set national emission reduction commitments for 2020 and beyond for five pollutants: sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), ammonia (NH_3) and particulate matter < 2.5 µm ($PM_{2.5}$). The EU has implemented its provisions via the National Emission reduction Commitments Directive (Directive (EU) 2016/2284)[3], setting out emission reduction commitments for these five air pollutants.

This report provides emission projections for these air pollutants to give an indication of the likelihood of compliance with future emission reduction commitments. A summary of emission trends in air pollutants for which there are no emission reduction commitments under Directive (EU) 2016/2284 is also presented in section 4.

1 https://www.eea.europa.eu/publications/emep-eea-guidebook-2023

2 https://unece.org/DAM/env/documents/2013/air/eb/ece.eb.air.125_E_ODS.pdf

3 Transposed into Irish law via S.I. No. 232/2018

2. National Emission Reduction Commitments

The five air pollutants for which emission reduction commitments are set affect the environment and human health in different ways. SO_2, NO_x and NH_3 are primarily associated with acid deposition leading to toxicity of soils and waters[4]. The EPA water quality reports highlight many of the same drivers for Nitrate pollution as this report highlights for ammonia emissions. Ammonia is also responsible for secondary particulate matter formation and nitrogen oxides are precursors to tropospheric (ground level) Ozone formation. Fine Particulate Matter, tropospheric Ozone, NO_x and NMVOCs directly impact human health, especially in higher concentrations in urban areas. The European Environment Agency[5] estimated that in 2022, there were approximately 1,700 premature deaths in Ireland due to poor air quality. The EPA, through the LIFE Emerald project have developed air quality maps that are updated hourly alongside the 115 real time air monitoring stations, in addition to forecast and high resolution air quality maps all available on www.airquality.ie. These maps provide up to date air quality information across the entire country. The EPA's annual Air Quality in Ireland Report provides more information on air quality in Ireland[6].

The National Emission reduction Commitments Directive (Directive (EU) 2016/2284) on the reduction of national emissions of certain atmospheric pollutants, harmonises the reporting obligations to the European Union under the Convention on Long Range Transboundary Air Pollution (CLRTAP) and details emission reduction commitments for the above-mentioned air pollutants for 2020 and 2030. A full outline of the reporting obligations and submission deadlines are outlined in Article 8 and Annex I of Directive (EU) 2016/2284[7].

The emission reduction commitment for Ireland for 2020 and 2030 are as follows and are set as percentage reductions on 2005 emission levels:

	2020	2030
Sulphur Dioxide (SO_2)	-65%	-85%
Nitrogen Oxides (NO_x)	-49%	-69%
Ammonia (NH_3)	-1%	-5%
Non-Methane Volatile Organic Compounds (NMVOCs)	-25%	-32%
Particulate Matter < 2.5 µm ($PM_{2.5}$)	-18%	-41%

Additionally, emissions in 2026 should follow a linear reduction trajectory between the levels defined by the emission reduction commitments in 2020 and 2030.

4 https://www.epa.ie/publications/research/air/research-390-nitrogensulfur-critical-loads-assessment-of-the-impacts-of-air-pollution-on-habitats.php

5 Burden of disease of air pollution, European Environment Agency. Table publisher

6 https://www.epa.ie/publications/monitoring--assessment/air/Air_Quality_Report_23_v14.pdf

7 Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.

Methodological changes

Methodological changes of note include the integration of updated Teagasc sheep and beef models and a reduction in estimates of emissions from the Agriculture sector across the time series. Changes are made each year to update and improve underlying data and methods used to estimate emissions. For this report, two important changes have occurred. Estimates emissions associated with non-dairy cattle and sheep categories have been revised. This has been reported along with detailed methodologies in the Ireland's Informative Inventory Report 2025.

With respect to non-dairy cattle, additional disaggregation of production systems within the herd (to those previously modelled) have been taken on board in conjunction with detailed output from the Irish Cattle Breeding Federation (ICBF) databases. This approach allows for more detailed estimates of a larger number of production system cohorts from birth to slaughter and allows for revised live weight and average daily weight gain to be incorporated at a more refined level. The approach also tracks the changes in slaughter age that have occurred over the last decade or so. Other developments include future proofing of the approach so that changes in feed characteristics and use of feed additives can be more readily incorporated in emission estimates. With respect to sheep, a Tier 2 approach to estimating emissions from the national flock developed by Teagasc has been implemented. In comparison to the previous approach, which was based on default Guideline assumptions, country specific parameters associated with sheep production in Ireland are used including parameters such as feed characteristics, fecundity, lambing patterns, mortality, liveweights and liveweight gains.

These revisions in the Tier 2 model for CH_4 emissions from cattle and the adoption of Tier 2 CH_4 model for sheep which changes nitrogen excretion values for other cattle and sheep lead to a 0.7 kt decrease in emission per annum in ammonia emissions across the time series in comparison to the previous submission (1990-2022).

2.1 Compliance with National Emission Reduction Commitments

Current emission reduction commitments

The current emission reduction commitments to which Ireland must comply under Directive (EU) 2016/2284, are set out in Table 1 along with the latest emission estimates for 2023. Emission reduction commitments are based on percentage reductions compared to 2005 emission levels. As the reductions are relative to a base year (2005), the absolute value of allowed emissions will continue to vary as emission estimates are revised and updated.

The findings of the EPA's assessment of Ireland's air pollutant emissions for 2023 are set out in Table 1 and show that:

- Ireland complied with the SO_2, NO_x, NH_3 and $PM_{2.5}$ emission reduction commitments for 2023.
- Emissions of NH_3 decreased by 6.0 per cent compared to the required 1 per cent emission reduction commitment.
- Ireland is in compliance with its emission reduction commitments for NMVOC for 2023 but only with the application of a flexibility permitted under the NEC Directive. When this flexibility is applied, adjusted NMVOC emissions have reduced by 41.0 per cent compared to the required 25 per cent emission reduction commitment.

Table 1. Actual emissions for 2005 and 2023 and Emission reduction commitments for 2020 for NEC relevant pollutants for 2023 compared to 2005

	2005	2023
Nitrogen Oxides (NO_x) (kt)	133.72	54.98
Emission reduction commitment for 2020 (%)		-49%
Actual reduction in emissions 2023 (%)		-58.9%
Sulphur Dioxide (SO_2) (kt)	74.25	7.36
Emission reduction commitment for 2020 (%)		-65%
Actual reduction in emissions 2023 (%)		-90.1%
Non-Methane Volatile Organic Compounds (NMVOC) (kt)	76.84	63.59
Emission reduction commitment 2020 (%)		-25%
Actual reduction in emissions 2023 (%)		-17.2%*
Ammonia (NH_3) (kt)	123.79	116.36
Emission reduction commitment for 2020 (%)		-1%
Actual reduction in emissions 2023 (%)		-6.0%
Fine Particulate Matter ($PM_{2.5}$) (kt)	18.65	9.31
Emission reduction commitment 2020 (%)		-18%
Actual reduction in emissions 2023 (%)		-50.1%

* Data in red highlights where the 2020 emission reduction commitments have not been complied with.

Directive (EU) 2016/2284 has a flexibility mechanism that allows Member States to make an adjustment to their national inventory estimates for compliance purposes. This is allowed where non-compliance with national emission reduction commitments would result from applying improved emission inventory methods that have been updated in accordance with scientific knowledge. This flexibility applies to the five key pollutants and is available to all Member States, ensuring that countries are not penalised for updating estimates with information that could not have been foreseen when the emission reduction commitments were agreed in 2012.

Emissions of NO_x and NMVOCs from manure management and agricultural soils are not accounted for the purpose of compliance assessment (Article 4(3) Directive (EU) 2016/2284).

Ireland is non-compliant with national emission reduction commitments for NMVOCs for 2023 as a result of applying improved emission inventory methods, which recognised new source of emissions. As a result, and in accordance with Directive 2016/2284, Ireland is allowed to utilise the prescribed flexibility mechanism.

Adjusted total emissions for NMVOC are presented in Table 2. When the adjustment is considered, Ireland is compliant with the emission reduction commitment for NMVOC for 2020, 2021, 2022 and 2023. Detailed information relating to the use of the flexibility mechanism is outlined in Ireland's Informative Inventory Report 2025[8].

Table 2. Adjusted emission estimates for NMVOCs*

	2005	2023
NMVOC (kt)	76.84	63.59
2020 Emission reduction commitment (%)		-25%
Actual reduction in emissions (%)		-17.2%*
Adjustment (kt)	-8.38	-23.19
Adjusted NMVOC (kt)	68.47	40.40
Adjusted reduction in emissions (%)		-41.0%

* Data in red highlights where emission reduction commitment has not been complied with

Future emission reduction commitments

Ireland must implement significant mitigation measures to achieve compliance with emission reduction commitments out to 2030 as outlined in the National Air Pollution Control Programme (NAPCP) and the Clean Air Strategy[9]. Table 3 sets out the latest estimated values for the reduction commitments in 2030 along with projected emissions under two scenarios, *With Existing Measures* (WEM) and *With Additional Measures (WAM)*.

The WEM scenario assumes that no future policy actions are taken beyond those already implemented by the end of 2023, the latest inventory year.

The WAM scenario provides an alternative scenario which includes additional planned policies and measures beyond 2023, such as the effect of Ireland's Climate Action Plans (2021, 2023 and 2024) which sets out a major programme of policies and measures aimed to help Ireland achieve its decarbonisation goals. It also includes the effect of full implementation of AgClimatise[10] which is the roadmap for the agriculture sector towards climate neutrality and the latest Teagasc Marginal Abatement Cost Curve for NH_3 emissions from the agriculture sector[11]. Furthermore, the Government submitted to the EU a National Air Pollution Control Plan[12] in 2024 to meet the 2030 emission reduction commitments as assigned by Directive 2016/2284, which includes further additional measures to reduce ammonia emissions from agriculture over and above those previously identified.

8 https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-unece-submissions-2025.php

9 https://assets.gov.ie/255392/efe212df-d9a7-4831-a887-bea2703e2c64.pdf

10 gov – Ag Climatise – A Roadmap towards Climate Neutrality (www.gov.ie) http://www.gov.ie/en/publication/07fbe-ag-climatise-a-roadmap-towards-climate-neutrality/

11 https://www.teagasc.ie/publications/2023/macc-2023.php

12 https://www.gov.ie/en/publication/23bdb-national-air-pollution-control-programme-napcp/

Often similar measures exist in both scenarios, for example Low Emission Slurry Spreading or the uptake of Electric Vehicles. For both of these measures the WEM scenario represents a projected uptake of the technology that is consistent with actions already in place and committed to whereas the WAM scenario reflects a higher level of ambition as expressed in Government plans. The Clean Air Strategy[13] includes many of the measures included in the WAM scenario.

As summarised in Table 3, compliance with the Emission Reduction Commitments (ERCs) for 2030 for SO_2, NO_x, NH_3 and $PM_{2.5}$ is projected based on the continued adoption of measures in the WEM scenario. Further reductions are then seen with adoption of planned polices and measures under the WAM scenario.

Ammonia emissions are forecasted to be compliant with the 2030 ERC under both the WEM and WAM scenarios. Assumptions include continued growth in the use of low emission spreading techniques, decreased crude protein in the diet of dairy cows and pigs, slurry amendments, drying of poultry manure, and various fertiliser nitrogen measures (increased use of inhibited urea, fertiliser reduction target, cap on use of urea). Last year's projections suggested compliance with the 2020-2029 ERC in 2023 which has been affirmed by the national inventory submission this year. It is also evident that under the WEM and WAM scenario, NH_3 emission reduction commitments can be met by the widespread adoption of the measures outlined at farm level.

For NMVOC emissions, compliance is not achieved in either scenario without the inclusion of an adjustment under the flexibility mechanism in Directive (EU) 2016/2284.

13 https://www.gov.ie/en/publication/927e0-clean-air-strategy/

Table 3. Actual emissions for 2023, projected emissions for 2025 and 2030 and reduction commitments for NEC relevant pollutants

Pollutant	Emissions (kilotonnes)			2020-2029 and 2030 Reduction Commitments (% reduction compared with 2005 levels) based on latest inventory estimates	
	2023	2025	2030	2020-2029	2030
Total SO_2 *WEM*	7.36	7.48	7.29	**25.99**	**11.14**
Total SO_2 *WAM*	7.36	7.57	7.19	-65%	-85%
Total NOx *WEM**	54.98	43.85	35.18	**68.20**	**41.45**
Total NOx *WAM**	59.02	43.73	32.80	-49%	-69%
Total NMVOC *WEM**	63.59	66.87	74.17	**57.63**	**52.25**
Total NMVOC *WAM**	63.59	66.85	73.07	-25%	-32%
Adjusted NMVOC *WEM**	40.40	41.87	44.02	**51.35**	**46.56**
Adjusted NMVOC *WAM**	40.40	41.85	42.92	-25%	-32%
Total NH_3 *WEM*	116.36	116.45	116.44	**122.55**	**117.60**
Total NH_3 *WAM*	116.36	110.10	111.05	-1%	-5%
Total $PM_{2.5}$ *WEM*	9.31	9.54	10.42	**15.29**	**11.00**
Total $PM_{2.5}$ *WAM*	9.31	9.53	10.01	-18%	-41%

* Article 4(3) of the National Emission reduction Commitments Directive provides that emissions of NO_x and NMVOC from categories 3B (manure management) and 3D (agricultural soils) are not accounted for the purpose of complying with 2020 and 2030 emission reduction commitments. Data in red highlights non-compliance with emission reduction commitment.

Section 3 of this report provides insights to current and historic trends of the five pollutants for which emission reduction commitments are in place for 2020 and 2030. It also provides an assessment of projected future emissions in 2030 of these pollutants, focusing on the With Additional Measures scenario.

Other pollutants

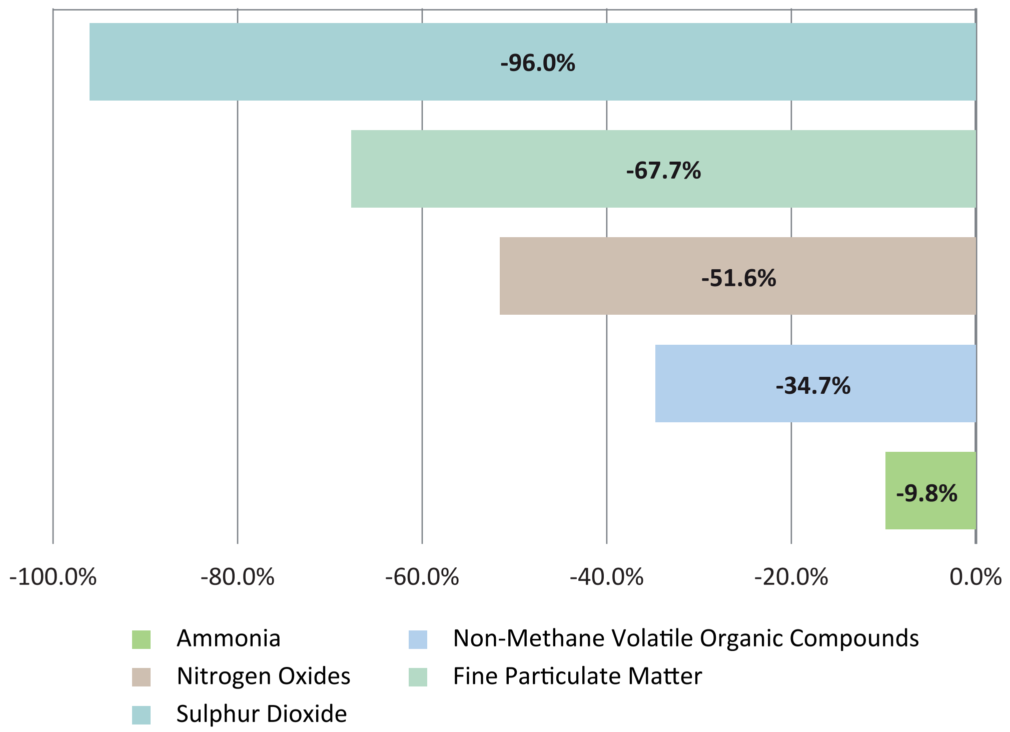
A large number of other pollutants for which no emission reduction commitments exist under Directive 2016/2284 are also reported on annually by the EPA. The general trend with these pollutants is downward, largely as a result of fuel switching from coal and peat to natural gas and kerosene in the residential sector, penetration of renewables for electricity generation and reductions in the quantities of coal and peat combusted for electricity generation. Changes in the age structure of the national vehicle fleet have also had a positive impact. Further detail on these pollutants is presented in section 4. Detailed information on these pollutants is also provided in Ireland's Informative Inventory Report 2025[14].

14 https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-unece-submissions-2025.php

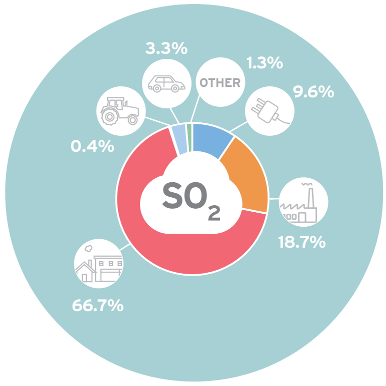
3. Key Air Pollutants under the National Emission reduction Commitments Directive

Ireland has seen large reductions in the emissions of all but one of these pollutants over the last thirty years as can clearly be seen in Figure 1 below. Despite this progress, challenges still remain to maintain decreasing trends in the face of increasing economic activity, particularly in relation to emissions from Transport, Agriculture and combustion of fossil fuels in industry. Future expansion of these sectors can result in increased emissions of all the key pollutants in the absence of decoupling, such as has occurred with emissions of sulphur dioxide from electricity generation.

Figure 1. Percentage change in key NECD Air Pollutants 1990-2023



3.1 Sulphur Dioxide (SO_2)

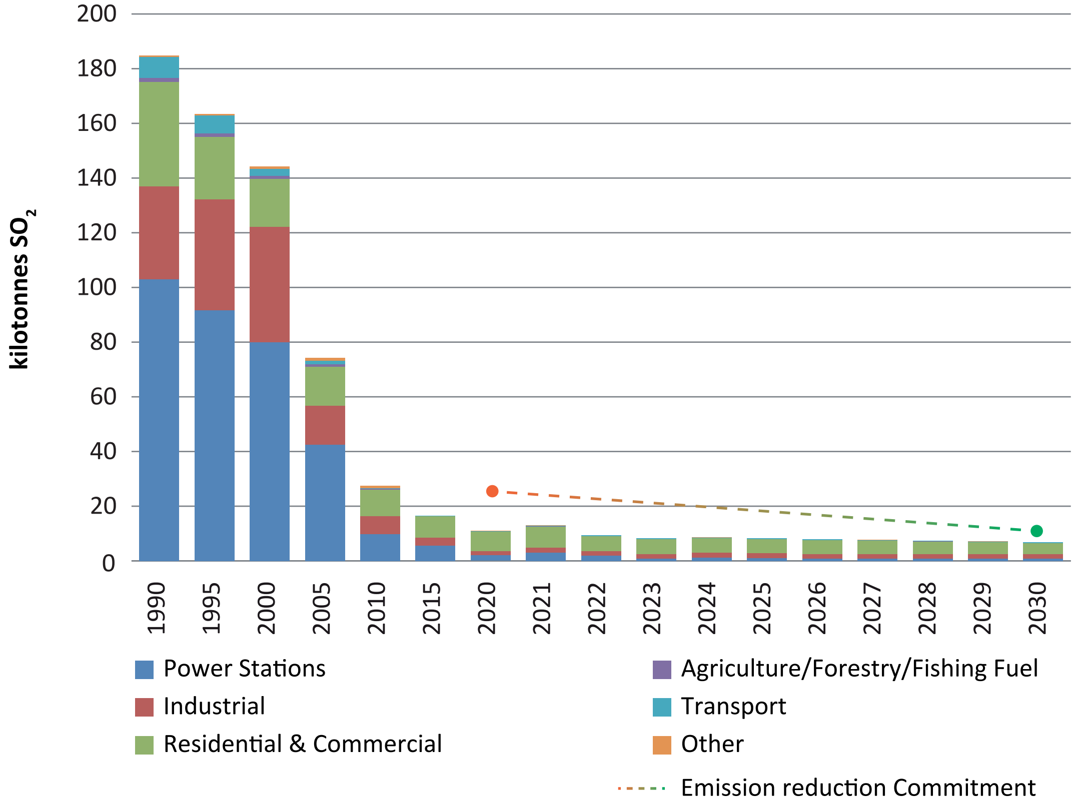


Sulphur dioxide (SO_2) is the major precursor to acid deposition, which is associated with the acidification of soils and surface waters and the accelerated corrosion of buildings and monuments. Emissions of SO_2 are derived from the sulphur in fossil fuels such as coal and oil used in combustion activities.

National Emission Reduction Commitments

Ireland's national emission reduction commitment for SO_2 under the NEC Directive is a 65.0 per cent reduction on 2005 levels to be achieved for 2020 and an 85.0 per cent reduction to be achieved for 2030. (Figure 2). Emissions have reduced by 90.1 per cent in the period 2005-2023 and therefore Ireland remains in compliance with the emission reduction commitment for 2020-2029.

Figure 2. Trend in SO_2 emissions 1990-2030 (WAM) and emission reduction commitments 2020-2030



Current and future trends in SO_2 emissions

Total national emissions of SO_2 were 21.3 per cent lower in 2023 compared to 2022 as a result of a reduction in the combustion of fossil fuels in the energy generation, residential and commercial sectors. In 2023, the combustion of coal and oil for public electricity and heat generation reduced by 44.2 per cent and 78.2 per cent, respectively, compared to 2022. Reduction in the use of fossil fuels in 2023 were driven by fewer heating degree days in 2023 than in 2022 as well as increased retrofit activity and heat pump installation in households.

Emissions from combustion in the residential and commercial sectors are the largest source of SO_2 (66.7 per cent of national total) with industrial sector being the next largest source contributing 18.7 per cent to the total in 2023. The emissions from the power stations (9.6 per cent of national total) decreased by 61.7 per cent compared to 2022 due to reduced emissions from coal (64.8 per cent), oil (84.9 per cent) and peat (27.7 per cent) and increased share of renewables, primarily wind power, along with increased in electricity imports from interconnectors.

In terms of the outlook for 2030, the emission projections indicate compliance with the 2030 emission reduction commitment which requires an 85 per cent reduction on 2005 levels. It is projected that in 2030 emissions will be 90.3 per cent below those in 2005. Key sources of SO_2 emissions in the projections include emissions from fuel combustion within the residential, commercial and manufacturing industry and construction sectors. Projected emission reductions are provided in Table 4.

Table 4. Projected SO_2 emission reduction in 2025 and 2030 compared to 2005

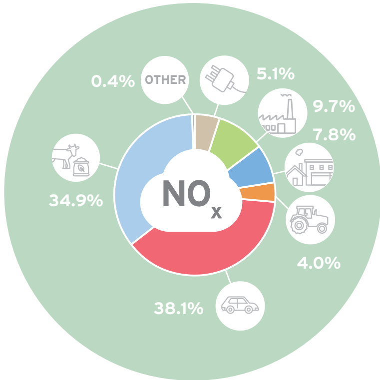
Projected SO_2 emissions	2025	2030
With Additional Measures Scenario (%)	-89.8	-90.3
Emission Reduction Commitment (%)	-65.0	-85.0

Historic SO_2 Emissions

Sulphur dioxide emissions in Ireland reduced considerably between 1990 and 2023. The latest estimates indicate a decrease of 96.0 per cent from 184.78 kt in 1990 to 7.36 kt in 2023. Emissions from Power stations and combustion in residential and commercial sectors decreased by 99.3 per cent and 87.7 per cent respectively, since 1990. The emissions from industrial sources decreased by 96.0 per cent from 1990 while the emissions in the transport sector decreased by 96.8 per cent. These large reductions reflect significant switching from the use of oil and solid fuels to natural gas, reduced sulphur content in coal and oil and implementation of abatement measures in electricity generation to meet emission limit values. Increased use of renewables rather than combustion of fossil fuels to meet increased electricity demand also contributes to this trend. Emissions from transport have decreased due to reduced sulphur content of fuels.

The remainder of SO_2 emissions are from combustion in oil refining, and combustion of fuels in agriculture, forestry, fishing. Emissions in these sectors decreased by 84.9 per cent and 97.9 per cent, respectively since 1990.

3.2 Nitrogen Oxides (NO_x)

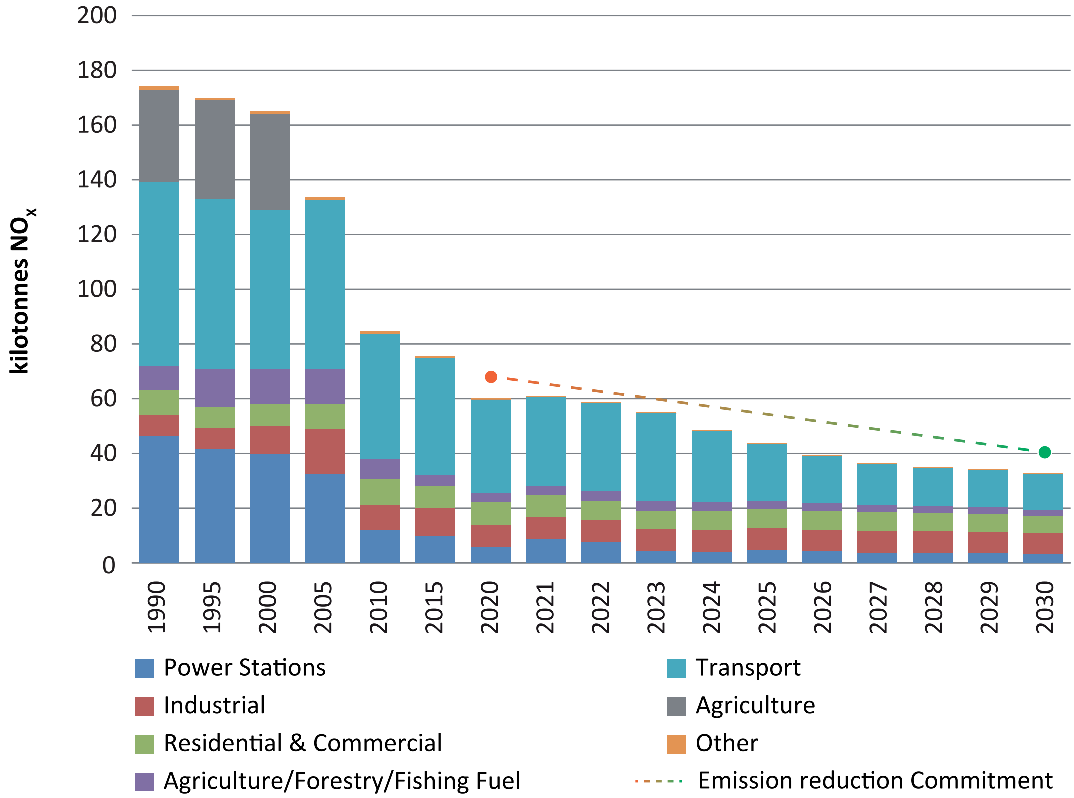


Emissions of nitrogen oxides (NO_x) contribute to acidification of soils and surface waters, ground level ozone formation and excess nitrogen or saturation in terrestrial ecosystems. Agriculture (as a result of both organic and synthetic nitrogen use) and fossil fuel combustion in power generation and transport are the principal sources.

National Emission Reduction Commitments

Ireland's national emission reduction commitment for NO_x for 2020 under the NECD was a 49 per cent reduction compared to a 2005 baseline level. Article 4(3) of Directive (EU) 2016/2284 states that emissions from manure management and agricultural soils are not accounted for the purpose of compliance assessment. On that basis emissions have reduced by 58.9 per cent in the period 2005-2023 and therefore Ireland remains in compliance with the emission reduction commitment for 2020-2029 (Figure 3).

Figure 3. Trend in NO_x emissions 1990-2030 (WAM) and emission reduction commitments 2020-2030



Current and future trends in NO_x emissions

The latest estimate is that in total 84.4 kt of NO_x was emitted in 2023, including agriculture emissions from manure management and agricultural soils that are not accounted for the purpose of the NECD compliance assessment under Article 4(3) of Directive (EU) 2016/2284.

Emissions of NO_x decreased by 7.4 per cent in 2023 compared to 2022, primarily as a result of decreased emissions from power stations due to less coal and fuel oil being used. There were also smaller decreases in emissions from manufacturing industry and construction as a result in less combustion of fossil fuels, and in the agriculture sectors as a result of decreased fertiliser use in 2023. Transport (of which road transport is the main contributor), is the largest source of NO_x contributing approximately 38.1 per cent of the 2023 total. The agriculture sector, which consists of emissions from synthetic fertiliser application and emissions from urine and dung deposited by grazing animals, is the second largest source contributing approximately 34.9 per cent of the 2023 total.

The industrial, residential/commercial and power generation sectors are the other main sources of NO_x emissions, with contributions of 9.7 per cent, 7.8 per cent and 5.1 per cent, respectively in 2023. The NO_x emissions from public electricity and heat production decreased by 42.1 per cent in 2023 compared to 2022. This reflects the significant reduction of coal, oil and peat use in this sector due to 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 interconnection. The remainder of NO_x emissions arise from combustion in the agriculture and other (refining and storage, solid fuel manufacture, fugitive emissions and waste) sectors, which together produced around 4.4 per cent of the total in 2023.

Total NO_x emissions in 2023, and projections for all subsequent years to 2030, are compliant with emission reduction commitments.

Table 5. Projected NO_x emission reduction in 2025 and 2030 compared to 2005

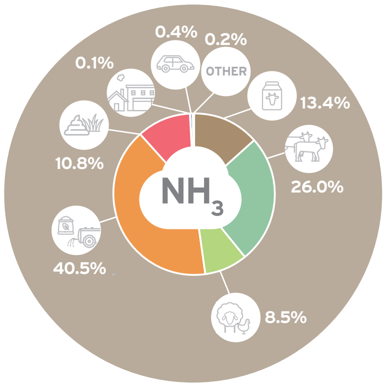
Projected NO_x emissions	2025	2030
With Additional Measures Scenario (%)	-55.0	-62.1
Emission Reduction Commitment (%)	-49.0	-69.0

Historic NO_x Emissions

NO_x emissions in Ireland have decreased by 51.6 per cent between 1990 and 2023 and emissions have decreased by 61.03 kt, or 42.0 per cent since 2008. This reduction was achieved due to improved abatement in Moneypoint power plant, reduced demand for clinker/cement and a reduction in emissions from road transportation. The application of low-NO_x burner technology in several major power stations and the increased use of natural gas have reduced NO_x emissions from electricity generation by 90.7 per cent on 1990 levels, even though electricity total final consumption has increased by 166.7 per cent over the same period. Emissions of NO_x from the coal-fired power plant at Moneypoint have decreased by 97.4 per cent between 1990 and 2023. The quantity of coal burned in Moneypoint decreased by 44.0%, falling to 0.53 million tonnes in 2023 compared to 2022. This is in line with Eirgrid's repurposing the turbines in Moneypoint in June 2025 and retention for security of supply purposes. Road transport has seen a decline in emissions of 25.7 kt, or 44.4 per cent, between 2008 and 2023 due to the economic recession initially and in later years improvements in vehicle technologies. The NO_x figures for transport reported here are based on fuel used and not fuel sold, and therefore take into account fuel tourism. This means that the impact on emissions of fuel sold in the Republic of Ireland for consumption across the border in Northern Ireland is removed as allowed for under the *Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution*[15], paragraph 23. It is estimated that fuel tourism accounted for 0.5 kt of NO_x in 2023.

15 Paragraph 23, https://unece.org/DAM/env/documents/2013/air/eb/ece.eb.air.125_E_ODS.pdf

3.3 Ammonia (NH_3)

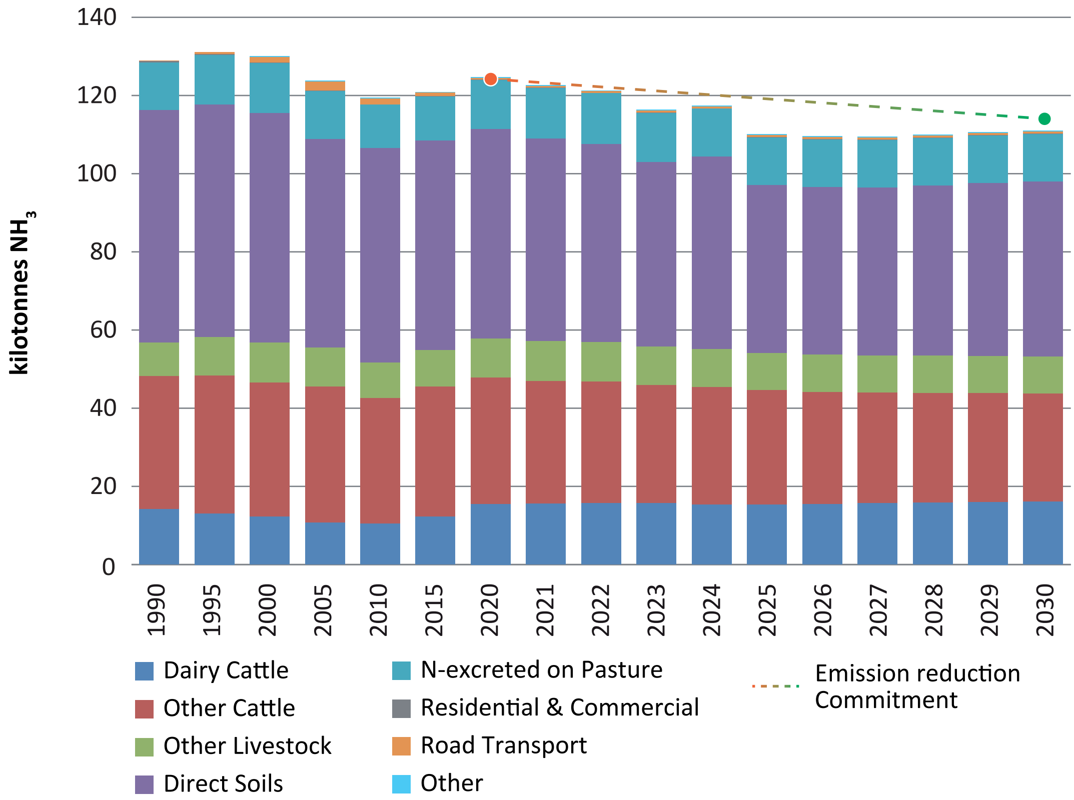


Ammonia (NH_3) emissions to air are associated with nitrogen deposition, acid rain and the formation of secondary particulate matter. The agriculture sector accounts for virtually all (99.4 per cent) of ammonia emissions in Ireland. Grasslands ultimately receive the bulk of the 40 million tonnes (Mt) of animal manures (equivalent to 512,430 tonnes of nitrogen) produced in Ireland along with nitrogen fertilisers which amounted to 280,598 tonnes (as nutrient nitrogen) in 2023. A proportion of the nitrogen in these inputs is volatilised into the air as ammonia.

National Emission Reduction Commitments

Ireland's national emission reduction commitment for NH_3 for 2020 and 2030 under the NECD is a 1 per cent and 5 per cent reduction, respectively compared to a 2005 baseline level. This is equivalent to 122.6 kt in 2020 and 117.6 kt in 2030 compared to the 2005 baseline level of 123.8 kt NH_3 (Figure 3). Ammonia is in compliance in the years 2022 and 2023. Emissions in 2023 were 116.4 kt and have decreased by 6.0 per cent in the period 2005-2023 which is below the linear reduction pathway between the levels defined by the emission reduction commitments in 2020 and 2030 target years. This decline was mainly due to the increased use of low emission slurry spreading techniques for cattle manure and a reduction in nitrogen fertiliser usage. These revisions in the Tier 2 model for CH_4 emissions from cattle and the adoption of Tier 2 CH_4 model for sheep which changes nitrogen excretion values for other cattle and sheep lead to a 0.7 kt decrease in emission per annum in ammonia emissions across the time series in comparison to the previous submission (1990-2022).In addition, the revision in the Tier 2 model for CH_4 emissions from cattle and the adoption of Tier 2 CH_4 model for sheep which changes nitrogen excretion values for other cattle and sheep led to a reduction of, on average, 0.7 kt per annum in ammonia emissions across the time series in comparison to the previous submission.

Figure 4: Trend in NH_3 emissions 1990-2030 (WAM) and emission reduction commitments 2020-2030



Current and future trends in NH_3 emissions

The emissions in 2023 were 12.6 kt or 9.8 per cent lower than emissions in 1990. Emissions in 2023 were 4.1 per cent lower than those in 2022, mainly as a result of decreased pig numbers (down 4.3 per cent) and increased use of low emission slurry spreading techniques for cattle slurry, the proportion of which was applied by these techniques increased from 59.0 per cent in 2022 to 64.0 per cent in 2023. Nitrogen fertiliser use in Ireland declined by 18.2 percent in 2023, this is due to a combination of improved farm-level practices and in reaction to higher fertiliser prices in 2022.

Emissions arising from an increase of 3.1 per cent in the total poultry populations were offset by a 4.3 per cent, 1.2 per cent and 0.7 per cent decrease in pig numbers, dairy cow numbers and in the total number of sheep, respectively. Animal manures produce about 86.0 per cent of ammonia emissions in agriculture in 2023. It is estimated that approximately 8.8 per cent of the nitrogen in animal manures is lost to the atmosphere annually as NH_3 on average. In 2023, 64.0 per cent of cattle slurry was applied using low emission techniques (59 per cent in 2022). Over 7 kt NH_3 were mitigated in 2023 as a result of the use of low emission slurry spreading techniques for cattle slurry. Under the With Existing Measures and With Additional Measures scenario, it is projected that low emission slurry spreading techniques continue to grow in use with 90 per cent of all cattle slurry applied with these techniques by 2027 (as per AgClimatise) and 100 per cent of pig slurry from 2024 onwards (as required under the Nitrates Action Plan).

Around 14 per cent of national ammonia emissions arise from the use of nitrogen fertiliser. It is estimated that 4 per cent of nitrogen contained in chemical fertilisers is lost to the atmosphere annually as NH_3. Fertiliser nitrogen sales reduced by 18.2 per cent in 2023 to 280,568 tonnes (as nutrient nitrogen). Based on fertiliser sales, 4.8 tonnes of ammonia emissions were mitigated through the use of stabilised nitrogen products in 2023. Additionally, the fertiliser replacement value of increased use of lime to address soil fertility and enhanced nutrient use efficiency is also included. These measures are outlined in the Teagasc NH_3 MACC[11], the DAFM AgClimatise[10] documents and the revised National Air Pollution Control Programme.

With Additional Measures

The With Additional Measures scenario includes the following measures: a reduction in crude protein content of concentrates fed to pigs and cattle, cattle and pig slurry amendments, covering of slurry stores, drying of poultry manure, reduced slaughter age for cattle, reduced age of beef (suckler) cows at first calving, replacement of calcium ammonium nitrate (CAN) and CAN based compounds with inhibited urea products and target nitrogen fertiliser application of 300,000 tonnes in 2030, and a limit on straight urea sales to 20,000 tonnes per annum from 2025. These measures are outlined in the Teagasc NH_3 MACC and the DAFM AgClimatise documents and the revised National Air Pollution Control Programme.

Achievement of the 2030 Emission reduction Commitment is projected under the With Additional Measures scenario and With Existing Measures scenario. This reinforces that progress in the adoption of these measures needs to be maintained to achieve compliance.

Table 6. Projected NH_3 emission reduction in 2025 and 2030 compared to 2005

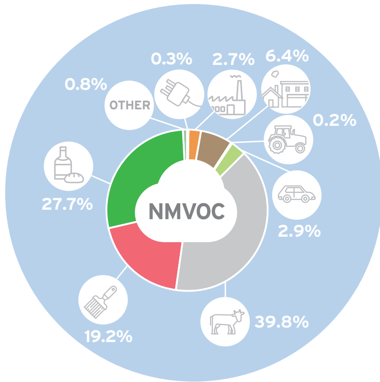
Projected NH_3 emissions	2025	2030
With Additional Measures Scenario (%)	-11.1	-10.3
Emission Reduction Commitment (%)	-1.0	-5.0

Historic NH_3 Emissions

The NH_3 emissions trend is largely determined by the cattle population and showed a steady increase up to 139.98 kt in 1998. There was some decline in the populations of cattle and sheep after 1998, as well as a decrease in fertiliser use, which contributed to a decrease in NH_3 emissions in the period 2000 to 2011.

Subsequently, increases in cattle numbers and fertiliser use have seen NH_3 emissions increase especially in response to the removal of milk quotas in 2015. NH_3 emissions increased up to 2018 to 130.4 kt, the highest emissions across the time series (response to significant drought conditions in 2018 and increase nitrogen fertiliser and concentrate feeding to bovines). Road transport produces a small proportion of emissions of ammonia (< 1 per cent) mainly from petrol passenger cars with three-way catalysts.

3.4 Non-Methane Volatile Organic Compound (NMVOC) emissions

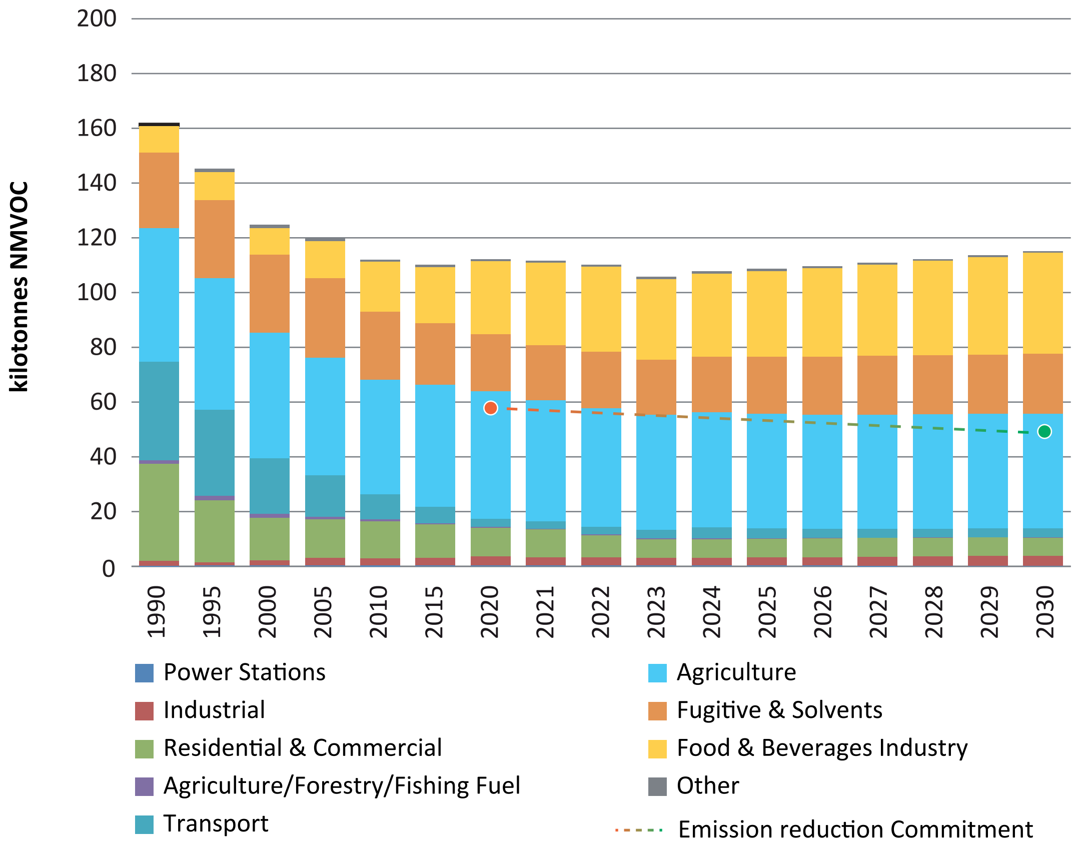


Non-methane volatile organic compounds (NMVOC) are emitted as gases by a wide array of products including paints, paint strippers, glues, cleaning agents and adhesives. They also arise as a product of incomplete combustion of fuels, from the storage and handling of animal manure and fertilisers in agriculture, and from the food and beverages industry.

National Emission Reduction Commitments

Ireland's national emission reduction commitment for NMVOC for 2020-2029 under the NECD was a 25.0 per cent reduction compared to a 2005 baseline level. As per Article 4(3) of the NECD, emissions from manure management and agricultural soils are not accounted for the purpose of compliance targets. When this is taken into account emissions have reduced by 17.2 per cent in the period 2005-2023 and therefore Ireland is non-compliant with the emission reduction commitment for 2020-2029 (Figure 5).

Figure 5: Trend in NMVOC emissions 1990-2030 (WAM) and emission reduction commitments 2020-2030



As a result of applying improved emission inventory methods updated in accordance with better scientific knowledge/inclusion of the source category, Ireland is technically non-compliant with its national emission reduction commitment for NMVOC. However, as allowed under Article 5(1) of Directive 2016/2284 in accordance with Part 4 of Annex IV, Ireland has applied an adjustment to the NMVOC emission inventory. This adjustment relates to the inclusion of emissions from spirit production in the food and beverage industry category. When this flexibility is taken into account emissions in 2023 are 41.0 per cent below 2005 levels, bringing Ireland into compliance with its emission reduction commitment.

Current and future trends in NMVOC emissions

The main sources of NMVOC emissions in Ireland are from manure management in agriculture, the food and beverages industry and solvent use. These sources produced 39.8 per cent, 27.7 per cent and 19.2 per cent, respectively of the annual total in 2023. Emissions from combustion of fossil fuels across all sectors; power stations, industrial, residential, commercial and agriculture accounted for 9.5 per cent of national total NMVOC emissions in 2023. Transport emissions accounted for 2.9 per cent of national total emissions of NMVOC, mainly from exhaust and fugitive releases from gasoline vehicles. Including emissions from manure management and fertiliser use, emissions in 2023 were 4.1 per cent below those in 2022., Technological controls for NMVOCs in motor vehicles, which have led to a significant reduction in emissions from road transport, have largely been responsible for the decrease in overall emissions 4.1 per cent in 2023 compared to 2022 along with reduced use of coal and peat as a source of heating in the residential sector.

Total NMVOC emissions under the WAM scenario are projected to be 4.9 per cent below 2005 levels in 2030. The emission reduction commitment for 2030 is a reduction of 32.0 per cent on 2005 emission levels (Table 7). The emission projections thus predict non-compliance with the 2030 emission reduction commitment. Key drivers in emissions over the projected period include solvents and other product use, and emissions from food and beverages industry.

Table 7 also presents a scenario where the NMVOC emissions from source category 2.H (spirit production) are excluded, as this source was not included in the national inventory at the time the 2020 and 2030 emission reduction commitments were established. Emissions in 2030 are projected in this case to be 37.3 per cent below emission levels in 2005. The emission reduction commitment for 2030 is a 32.0 per cent reduction, thus compliance with the emission reduction commitment is projected when the flexibility outlined in Article 5(1) of Directive 2016/2284 in accordance with Part 4 of Annex IV is applied.

Table 7. Projected NMVOC emission reduction in 2025 and 2030 and associated emission reduction commitments compared to 2005

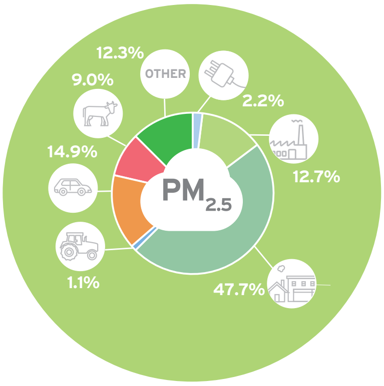
Projected NMVOC emissions	2025	2030
(excluding emissions from agricultural categories 3B and 3D)		
With Additional Measures Scenario (%)	-13.0	-4.9
Emission Reduction Commitment (%)	-25.0	-32.0
(excluding emissions from agricultural categories 3B and 3D and source category 2.H (spirit production)		
With Additional Measures Scenario (%)	-38.9	-37.3
Emission Reduction Commitment (%)	-25.0	-32.0

* Data in red highlights where emission reduction commitment has not been complied with

Historic NMVOC Emissions

Reductions corresponding to 34.7 per cent of NMVOC emissions have been achieved from 1990 to 2023. Technological controls for NMVOCs in motor vehicles, which have led to a significant reduction in emissions from road transport, have largely been responsible for the decrease in overall emissions along with reduced use of coal and peat as a source of heating in the residential sector. On the other hand, emissions from the agriculture sector have decreased by 13.9 per cent since 1990. Emissions from the food and beverage industry, mainly spirit production have increased by 204.6 per cent over the same period.

3.5 Fine Particulate matter ($PM_{2.5}$) emissions

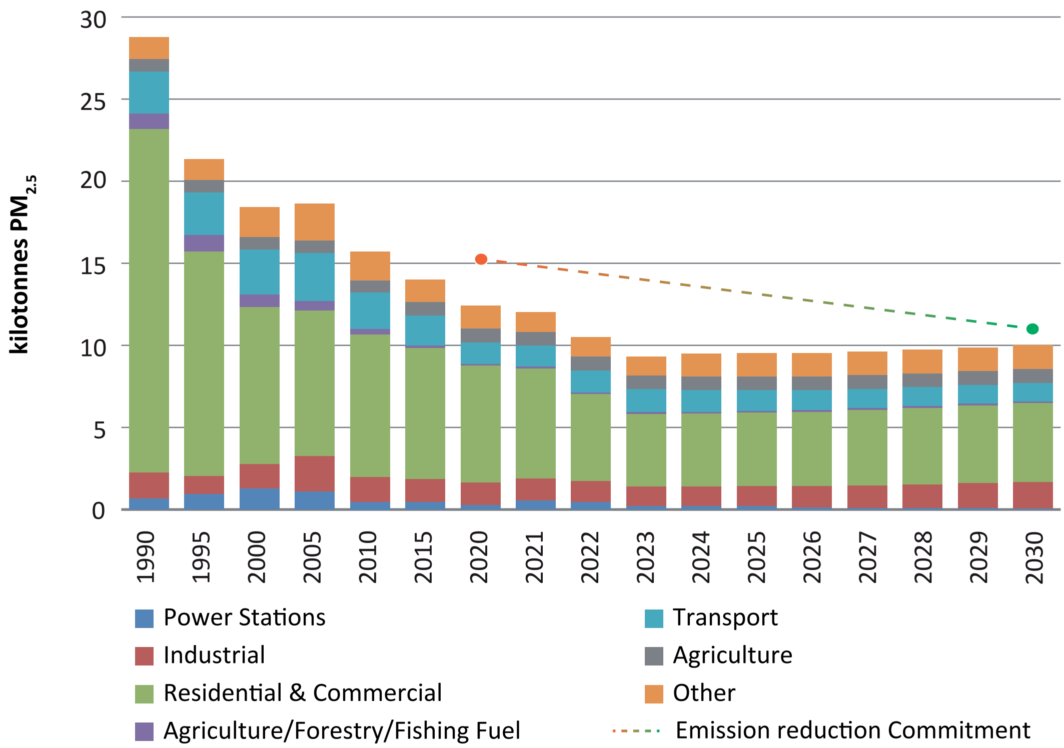


There are many sources of particulate matter (dust) including vehicle exhaust emissions, soil and road surfaces, construction works and industrial emissions. Particulate matter can be formed from reactions between different pollutant gases. Small particles can penetrate the lungs and cause damage. These are known as PM_{10} (diameter less than 10µm) and $PM_{2.5}$ (diameter less than 2.5µm). $PM_{2.5}$ is a better indicator of anthropogenic (man-made) emissions. Fine particulate matter $PM_{2.5}$ is responsible for significant negative impacts on human health.

National Emission Reduction Commitments

Ireland's national emission reduction commitment for $PM_{2.5}$ for 2020-2029 under the NECD was an 18.0 per cent reduction compared to a 2005 baseline level. Emissions have decreased by 50.1 per cent in the period 2005-2023 and therefore Ireland remains in compliance with the emission reduction commitment for 2020-2029. (Figure 6).

Figure 6. Trend in $PM_{2.5}$ emissions 1990-2030 (WAM) and emission reduction commitments 2020-2030



Current and future trends in $PM_{2.5}$ Emissions

Emissions in 2023 were 11.4 per cent below those in 2022. The main sources of $PM_{2.5}$ emissions in Ireland are from combustion of fossil fuels in the residential and commercial heating, manufacturing industries and construction sectors which produced 47.7 per cent and 12.7 per cent of the annual total, respectively in 2023. $PM_{2.5}$ emissions in the Other sectors account for 12.3 per cent of the total in 2023. These emissions arise from Manufacture of solid fuels, oil refining/storage sectors, coal mining and handling, quarrying and mining of minerals other than coal, construction and demolition, storage, handling and transport of mineral products, road paving with asphalt, fireworks, use of tobacco, storage handling and transport of agricultural products and accidental vehicle and building fires.

Transport was responsible for a 14.9 per cent share to the national total in 2023. Emissions from Agriculture arise from Manure Management and Inorganic Nitrogen fertilisers, together accounting for 9.0 per cent of the national total in 2023. Emissions from public electricity and heat production accounted for 2.2 per cent of the total.

It must be noted that while national emission levels are in compliance with the emission reduction commitment, localised air quality issues exist. Particulate matter levels recorded at ambient monitoring stations continue to be a concern in villages, towns and cities. The EPA found that $PM_{2.5}$ levels were above the safe limit at 78 per cent of the monitoring stations in Ireland in 2023. Continued reductions in solid fuel burning for residential heating is necessary to continue the reduction in particulate matter emissions and associated particulate matter concentrations in ambient air. Additionally, research is underway to better understand emissions of particulate matter from the combustion of fuels in the residential sector and the contribution of agriculture to particulate matter.

Total $PM_{2.5}$ emissions under the With Additional Measures scenario are projected to be 46.3 per cent below 2005 levels in 2030 (Table 8). The emission reduction commitment for 2030 is a 41.0 per cent reduction. It is therefore projected that Ireland will be in compliance with its emission reduction commitment for $PM_{2.5}$ in 2030 under this scenario. Key contributors to emissions over the projected period include the combustion of fossil fuels in the Residential, Commercial and Manufacturing Industry sectors.

Table 8. Projected $PM_{2.5}$ emission reduction and emission reduction commitments

Projected $PM_{2.5}$ emissions	2025	2030
With Additional Measures Scenario (%)	-48.9	-46.3
Emission Reduction Commitment (%)	-18.0	-41.0

Historic $PM_{2.5}$ Emissions

Total $PM_{2.5}$ emissions in 2023, at 9.31 kt, show a reduction of 67.7 per cent since 1990. Reduced use of coal and peat in the residential and commercial sectors, with increased use of gasoil, kerosene and natural gas has resulted in 78.8 per cent lower emissions between 1990 and 2023 in those combined sectors.

Agriculture emissions have increased by 12.0 per cent from their 1990 level largely as a result of the increased cattle herd. Emissions from Transport sector, dominated by Road Transport have been decreasing since 2005, with a 46.0 per cent reduction between 1990 and 2023. This was largely due to technological advances and the age structure of the national fleet (whereby in recent times an increasing proportion of the fleet is newer vehicles), which has in turn been offset somewhat by increases in vehicle numbers over the time series.

4. Air Pollutants with no NEC Directive emission reduction commitment

The reporting obligations outlined in Article 8 and Annex I of the Directive (EU) 2016/2284 also include the mandatory reporting of emissions to air of carbon monoxide, cadmium, mercury, lead, polycyclic aromatic hydrocarbons, dioxins and furans, polychlorinated biphenyls (PCB), hexachlorobenzene, coarse particulate matter < 10μm and black carbon. Voluntary reporting of annual emissions of arsenic, chromium, copper, nickel, selenium, Zinc and total suspended particulates (TSP) is also undertaken. Emission reduction commitments are not set for any of the aforementioned pollutants in the Directive.

A brief overview of the pollutants involved and the trend in emissions of these pollutants over time is presented below. A summary table (Table 9) indicates the relative importance of each sector to emissions of each air pollutant. If a sector is the largest source of a pollutant, this is indicated in the second column, followed in the third column by other air pollutants for which the sector is a significant source.

Table 9. Sectoral sources of Pollutants

Sector	Largest source	Significant source
Transport	Cu, Pb, Cr, Zn, BC	CO, PM_{10}, TSP, BC, As, Hg, Dioxins
Power Stations		Ni, CO, PM_{10}, TSP, Cd, Hg, As, Cr, Se, HCB
Combustion in manufacturing industries	Ni, Cd, Hg	CO, PM_{10}, BC, Cr, Zn, AS
Industrial Processes	TSP	Cu, PM_{10}, BC, Cd, Zn
Residential and Commercial Combustion	CO, PM_{10}, Se, Dioxins, PAH	TSP, Pb, Cd, Hg, Ni, Zn, BC, PCB
Agriculture	HCB	TSP, PM_{10}
Industrial waste incineration	As	Cr
Solid waste disposal (landfills)		Hg
Vehicle and building fires and waste burning	PCB	Dioxins

Carbon monoxide (CO) emissions continue to decline, driven by major reductions due to three-way catalysts in gasoline vehicles in Road Transport, and a large decrease in the use of solid fuels for space heating in the Residential sector. National total CO emissions have reduced by 85.0 per cent over the period 1990 to 2023.

Emissions of *coarse particulate matter* (PM_{10}) have reduced by 53.3 per cent since 1990. The main determinant of the trend in PM_{10} emissions is the combined total emissions from a wide range of sources including road paving with asphalt, quarrying, construction and demolition and the manufacture of products such as cement which contribute a 35.6 per cent share of the national total, and combustion in the Residential and Commercial/Institutional sectors combined with 25.2 per cent share of the total in 2023. Total suspended particulate (TSP) emissions have decreased by 33.1 per cent, since 1990. Total suspended particulates emissions are driven by a wide range of sources similar to PM_{10}. *Black Carbon* (BC) emissions have decreased by 70.0 per cent, between 1990 and 2023. The main driver of the BC trend is the transport emissions and combined emissions from Residential and Commercial/Institutional sectors which contributed 34.7 per cent and 32.9 per cent share, respectively in 2023. Over the period 1990–2023, total national *lead* (Pb) emissions have decreased by 96.0 per cent with the Pb emissions trend largely determined by the Road Transport sector. There was a marked decrease between 1999 and 2005 when the lead content of petrol was reduced. Combustion of fuels in the Transport sector is the largest source of Pb in 2023 accounting for 4.9 per cent of the national total.

Total national emissions of *cadmium* (Cd) have decreased by 62.6 per cent since 1990. Emissions of Cd are largely determined by combustion of fuels in the Manufacturing Industries and Construction sector, specifically combustion sources in Non-Ferrous Metals.

Total national emissions of *mercury* (Hg) have decreased by 69.3 per cent between 1990 and 2023. Emissions from Manufacturing Industries and Construction are the largest source of Hg. Emissions from the Residential and Commercial/Institutional and Public Electricity and Heat Production sectors are also an important source of Hg.

Emissions of *arsenic* (As) are largely dominated by incineration of hazardous and clinical wastes and crematoria. In the past Public Electricity and Heat Production was the largest however both a reduction in coal and peat power generation and move towards cleaner fuels has reduced its contribution substantially.

Emissions of *chromium* (Cr) have decreased by 34.6 per cent between 1990 and 2023. Transport, fuel combustion in the Manufacturing Industries and Construction sectors and Waste Incineration are the main sources.

Total *copper* (Cu) emissions in Ireland were steadily increasing over the 1990–2008 period and have been steadily decreasing since. Total emissions in 2023 were 5.4 per cent lower than in their peak in 2008 but they are 111.1 per cent higher than in 1990. Transport and industrial processes are the main sources.

National total emission estimates of *nickel* (Ni) were steadily increasing over the 1990–1999 period and have been generally decreasing from 1999 onwards. The main contributor to the trend is combustion of fuels in the Public Electricity and Heat Production, Residential and Commercial/Institutional and Manufacturing Industries and Construction sectors. Total emissions in 2023 were 78.3 per cent below the 1990 level. The main contributor to national *selenium* (Se) emissions has been fuel combustion in the Residential and Commercial/Institutional sectors which combined accounted for 67.7 per cent of selenium emissions in 2023. Emissions of Se were 81.2 per cent lower in 2023 compared to 1990.

National total emissions of *zinc* (Zn) have fallen by 54.8 per cent between 1990 and 2023. In the 1990–2001 period, the main determinant of the trend in zinc emissions was Metal Production. Since the closure of Ireland's only steel plant in 2001, fuel combustion in the Transport, Residential and Commercial/Institutional, Manufacturing Industries and Construction, and Public Electricity and Heat Production sectors are the largest sources.

Dioxin and *furan* emission levels decreased by 74.3 per cent between 1990 and 2023. The main contributors to national emissions are the combined Residential and Commercial/Institutional sectors, with a 67.9 per cent share of total emissions in 2023.

Hexachlorobenzene (HCB) emissions from secondary aluminum processing were the largest source of HCB emissions in Ireland up to 1996 after which the use of hexachloroethane (HCB being a contaminant of such gases) based cover gases was banned. Since then, the use of pesticides (in which HCB is a contaminant) in agriculture is the largest source, accounting for 86.1 per cent of national emissions in 2023.

Emissions of *polychlorinated biphenyls* (PCBs) have decreased by 87.2 per cent between 1990 and 2023. Emissions from the Waste sector, specifically vehicle and building fires and other burning such as bonfires and household waste are the largest sources in 2023.

Polycyclic Aromatic Hydrocarbon (PAHs) emissions, which include emissions of *benzo[a]pyrene*, *benzo[b]fluoranthene*, *benzo[k]fluoranthene*, and *indeno[1,2,3-cd]pyrene*, are dominated by combustion in the Residential and Commercial/Institutional sectors. Combined, these four pollutants decreased by 73.8 per cent between 1990-2023. Declines in the use of coal and sod peat have led to reduced emissions from these sectors across the time series.

Appendix: Emissions of key NEC Directive Air Pollutants 1990-2023

	SO_2	NO_x	NMVOC	NH_3	$PM_{2.5}$
			kilotonnes		
1990	184.779	174.276	161.797	128.981	28.786
1991	184.316	174.850	160.835	129.577	28.539
1992	171.645	182.646	155.821	132.603	25.109
1993	162.736	174.766	152.409	130.758	24.761
1994	177.380	171.883	147.616	131.007	22.697
1995	163.465	169.951	145.229	131.133	21.359
1996	150.621	174.468	145.932	134.616	21.938
1997	168.870	164.746	141.041	136.148	20.084
1998	178.912	168.734	141.615	139.980	21.140
1999	161.111	166.958	131.904	137.154	18.192
2000	144.282	165.141	124.719	130.016	18.421
2001	142.297	165.538	124.569	128.286	18.382
2002	106.656	157.442	124.139	127.663	17.628
2003	82.839	158.873	122.631	127.283	17.598
2004	73.482	162.057	121.932	125.216	17.868
2005	74.253	165.639	119.920	123.790	18.646
2006	61.993	160.484	117.436	121.010	18.158
2007	56.134	155.335	118.745	118.400	17.558
2008	46.546	145.447	117.190	118.162	17.433
2009	33.339	121.559	115.033	119.025	16.575
2010	27.417	115.177	111.952	119.410	15.714
2011	25.454	103.581	109.010	115.135	13.884
2012	24.098	105.671	109.163	114.754	13.807
2013	24.115	106.599	110.964	115.487	14.172
2014	18.122	105.470	108.556	118.085	13.626
2015	16.583	105.456	110.103	120.926	14.001
2016	15.925	107.627	111.948	126.165	14.057
2017	15.195	106.964	115.429	129.488	12.926
2018	14.294	107.634	113.931	130.429	13.325
2019	11.322	99.714	114.801	128.056	12.324
2020	11.029	93.526	112.105	124.705	12.419
2021	12.948	95.411	111.676	122.651	12.030
2022	9.355	91.158	110.234	121.316	10.509
2023	7.360	84.420	105.689	116.361	9.308

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