



Ireland's Transboundary Gas Emissions

1990-2016

March 2018

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KEY HIGHLIGHTS

- The figures show that emissions of three of the five main air pollutants increased - ammonia, nitrogen oxides and non-methane volatile organic compounds.
- Ireland exceeded its emission ceilings for nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs) for all years since 2010 and the emission ceiling for ammonia (NH₃) in 2016.
- 2016 is the first year for which the EPA has reported an exceedance for ammonia, although the EPA's Air Pollutant projections have indicated for some time that it was likely to occur if animal numbers continued to rise.
- As was the case for the 2015 Inventory, Ireland will seek to use the flexibilities allowed in Article 5(1) of the Directive, as national total emissions of NO_x and NMVOC are non-compliant with reduction commitments due to updating inventories in accordance with scientific knowledge.
- Emissions of sulphur dioxide (SO₂) continue to decrease. These were well below the required EU emission limits, substantially due to the use of lower sulphur content fuels in electricity generation and transport.
- Particulate matter (PM_{2.5}) emissions declined in 2016. Future emissions will depend largely on the quantity and quality of solid fuel used in the residential and commercial sectors.

Introduction and Background

The Directive (EU) 2016/2284 (new National Emissions Ceilings Directive) on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (old NEC Directive) entered into force on the 31st of December 2016. This new legislative act harmonises the reporting obligations to the European Union under the Convention on Long Range Transboundary Air Pollution (CLRTAP).

A full outline of the reporting obligations and submission deadlines are outlined in Article 8 and Annex I of the Directive and are summarised as follows;

Submission deadlines

- Emission inventories – 15th February 2017 and every year thereafter;

- Informative Inventory Report (IIR) – 15th March 2017 and every year thereafter;
- Emission projections – 15th March 2017 and every 2 years thereafter;
- Spatially-disaggregated emissions (gridded emissions) – 1st May 2017 and every 4 years thereafter;
- Large point source (LPS) emissions – 1st May 2017 and every 4 years thereafter;
- National air pollution control programmes – 1st April 2019 and every 4 years thereafter (DCCAIE).

Pollutants and time series

- Mandatory reporting of SO₂, NO_x, NMVOC, NH₃, CO, HM (Cd, Hg, Pb), POPs (PAHs, dioxins/furans, PCBs, HCB), PM_{2.5}, PM₁₀, (BC if available) for annual emissions, gridded data, LPS data;
- Mandatory reporting of projections for emissions of SO₂, NO_x, NMVOC, NH₃, PM_{2.5}, (BC if available) (for projection years 2020, 2025, 2030 and, where available, 2040 and 2050);
- Voluntary reporting of annual emissions of HM (As, Cr, Cu, Ni, Se, Zn), TSP.
- Time series and resubmission: 1990 to reporting year minus 2 (X-2) for all pollutants, except TSP, PM₁₀, PM_{2.5} and BC (starting year = 2000);
- Re-submissions within 4 weeks;
- Reporting of activity data and of an Informative Inventory Report (IIR);
- Possibility to use adjustment of emission inventories: reporting of notification by 15th February 2018 (including pollutants and sectors concerned, and where available, magnitude of impacts); reporting of supplementary information in the IIR by 15th March 2018.

Ceilings and Summary tables

In accordance with Article 21(1) of Directive 2016/2284, the commitments under Article 4 of the NEC Directive 2001/81/EC continue to apply until the 31st of December 2019. Ireland's emission ceilings are as follows:

- SO₂ 42 kilotonnes
- NO_x 65 kilotonnes
- NH₃ 116 kilotonnes
- NMVOC 55 kilotonnes

Article 4(1) of Directive 2016/2284 and Annex II, sets out new national emission reduction commitments for SO₂, NO_x, NMVOC, NH₃ and PM_{2.5} applicable from 2020 to 2029 and 2030 onwards. These new reduction commitments are relative to the emissions of 2005 and are presented with the latest emission estimates in Table 1 below.

This inventory submission for 1990-2016 data shows Ireland in compliance with the SO₂ emission ceilings for all years from 2010 to 2016 (Table 1). The submission also shows

Ireland exceeding its emission ceilings for NO_x and NMVOC for all years since 2010 and the emission ceiling for NH₃ in 2016.

Table 1.

kilotonnes	Article 21(1) (a)							Article 4(1) and Annex II New reduction commitments	
	2010	2011	2012	2013	2014	2015	2016	2020	2030
National Total SO ₂	26.342	24.835	23.365	23.506	16.891	15.004	13.766	25.117	10.764
NEC ceiling 2010-2019	42.000	42.000	42.000	42.000	42.000	42.000	42.000	-65%	-85%
National Total NO _x	113.321	101.351	104.722	105.434	104.142	104.393	107.300	66.186	40.231
NEC ceiling 2010-2019	65.000	65.000	65.000	65.000	65.000	65.000	65.000	-49%	-69%
National Total NMVOC	109.237	106.508	107.896	110.340	106.114	106.402	108.253	56.767	51.469
NEC ceiling 2010-2019	55.000	55.000	55.000	55.000	55.000	55.000	55.000	-25%	-32%
National Total NH ₃	108.230	104.382	106.294	107.830	108.312	111.121	116.700	112.161	107.629
NEC ceiling 2010-2019	116.000	116.000	116.000	116.000	116.000	116.000	116.000	-1%	-5%
National Total PM2.5	18.990	16.802	16.521	16.772	15.569	15.550	14.941	18.727	13.474
NEC ceiling 2010-2019	NA	NA	NA	NA	NA	NA	NA	-18%	-41%

Ireland's submission includes adjusted national emission inventories for NO_x and NMVOC, as allowed under Article 5(1) of Directive 2016/2284 in accordance with Part 4 of Annex IV, as Ireland is non-compliant with national emission reduction commitments as a result of applying improved emission inventory methods updated in accordance with scientific knowledge. Essentially this flexibility mechanism allows Member States to subtract emissions from new sources which have been included in the national inventory since the reduction commitments or ceilings were established or where the emission factors used to estimate emissions have changed significantly based on new science. Ireland's adjustments were approved following review under Article 10(3) of Directive 2016/2284 in June 2017. The adjusted total emissions for NO_x and NMVOC are presented in Table 2.

Table 2.

kilotonnes	Article 21(1) (a)						
	2010	2011	2012	2013	2014	2015	2016
National Total NO _x	113.321	101.351	104.722	105.434	104.142	104.393	107.300
Adjusted NO _x under Article 5(1)	67.691	58.981	60.947	58.123	57.257	58.345	59.468
NEC ceiling 2010-2019	65.000	65.000	65.000	65.000	65.000	65.000	65.000
National Total NMVOC	109.237	106.508	107.896	110.340	106.114	106.402	108.253
Adjusted NMVOC under Article 5(1)	55.297	51.763	50.421	50.451	48.925	47.856	46.839
NEC ceiling 2010-2019	55.000	55.000	55.000	55.000	55.000	55.000	55.000

When the adjustment is considered, Ireland is still in exceedance of the emissions ceiling for NO_x and NMVOC for 2010 only and for NH₃ in 2016.

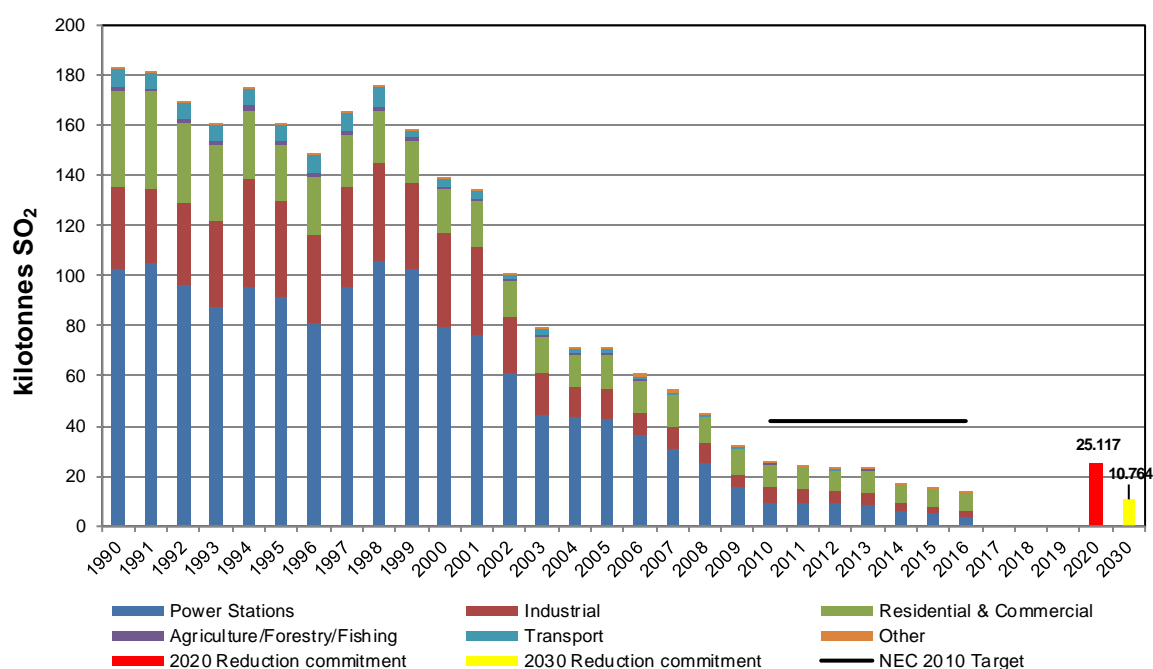
Detailed information relating to the adjustments will be outlined in Ireland's Informative Inventory Report 2018 due for publication in early Q2 2018.

Sulphur Dioxide

Sulphur dioxide (SO₂) 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 SO₂ are derived from the sulphur in fossil fuels such as coal and oil used in combustion activities.

National Emissions Ceiling

Ireland's national emission ceiling for SO₂ under the NEC Directive is 42 kilotonnes (kt) to be achieved by 2010 and in each year after until 2019. This is equivalent to a 77 per cent reduction from the 1990 baseline level of 183.6 kt SO₂.



Trends in SO₂ Emissions

SO₂ emissions in Ireland reduced considerably between 1990 and 2016. The latest estimates indicate a decrease of 92.5 per cent from 183.6 kt in 1990 to 13.8 kt in 2016. Power stations and combustion in residential and commercial sectors are the two principal sources of SO₂ emissions, contributing 27 and 50 per cent respectively to the total in 2016. Emissions in these sectors decreased by 96.4 and 82 per cent respectively since 1990. Combustion sources in the industrial sector accounted for 18.8 per cent in 2016. The remainder of emissions is from combustion in oil refining, agriculture, forestry and transport.

The emissions from industrial sources decreased by 92 per cent from 1990 while the emissions in the transport sector decreased by 96.7 per cent. Total SO₂ emissions in 2010, and all subsequent years, are compliant with the 2010 ceiling. This reflects significant

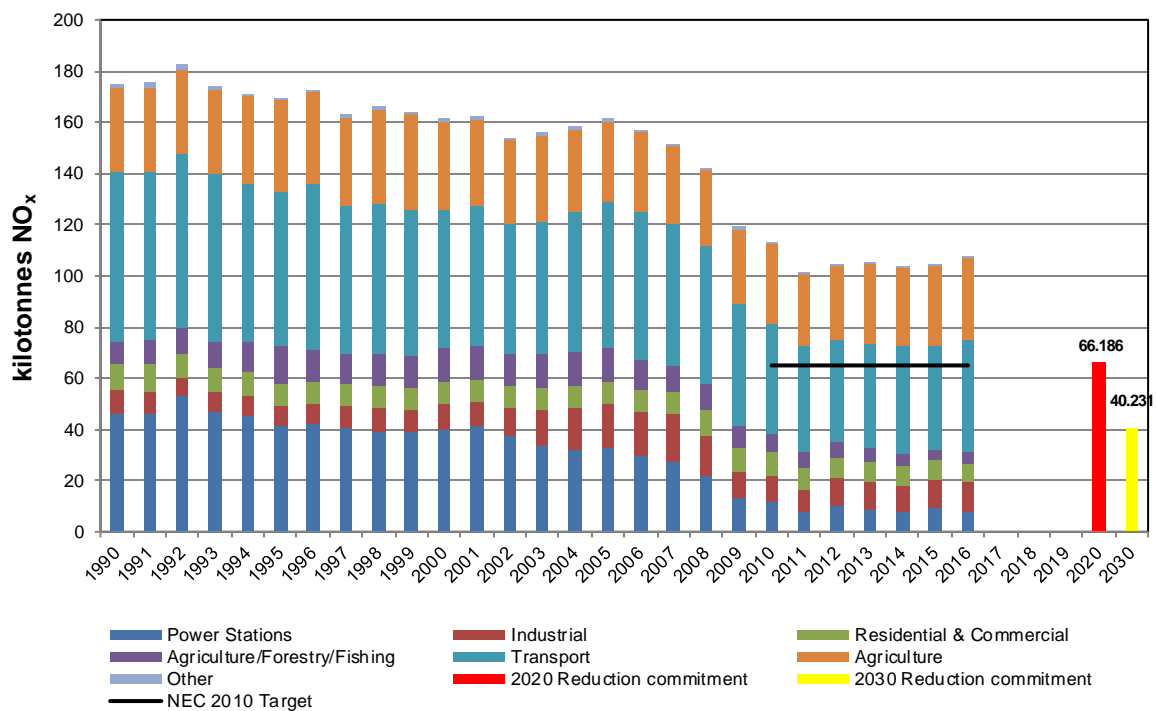
switching from the use of oil and solid fuels to natural gas, reduced sulphur content in coal and oil and implemented abatement in the power generation sector.

Nitrogen Oxides

Emissions of nitrogen oxides (NO_x) contribute to acidification of soils and surface waters, tropospheric ozone formation and nitrogen saturation in terrestrial ecosystems. Power generation plants and motor vehicles are the principal sources of nitrogen oxides, through high-temperature combustion.

National Emissions Ceiling

Ireland's national emission ceiling for NO_x under the NEC Directive is 65 kilotonnes (kt), to be achieved by 2010 and in each year after until 2019. This is equivalent to a 63 per cent reduction from the 1990 baseline level of 175.1 kt NO_x.



Trend in NO_x Emissions

NO_x emissions in Ireland have decreased by 38.7 per cent between 1990 and 2016 and emissions have decreased by 35.1 kt, or 24.7 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 latest estimates are 107.3 kt in 2016. The transport sector, which mainly consists of road transport, is the principal source of NO_x emissions, contributing approximately 41 per cent of the total in 2016. Agriculture is the second biggest source of NO_x emissions, mainly from synthetic fertiliser application and emissions from urine and dung deposited by grazing animals, contributing approximately 29.6 per cent of the 2016 total. The industrial, power generation and residential/commercial sectors are the other main source of NO_x emissions, with

contributions of 10.5 per cent, 7.5 per cent and 7.0 per cent respectively in 2016. The remainder of NO_x emissions emanates from combustion in the agriculture and other (refining and storage, solid fuel manufacture, fugitive emissions and waste) sectors, which together produced around 4.2 per cent of the total in 2016.

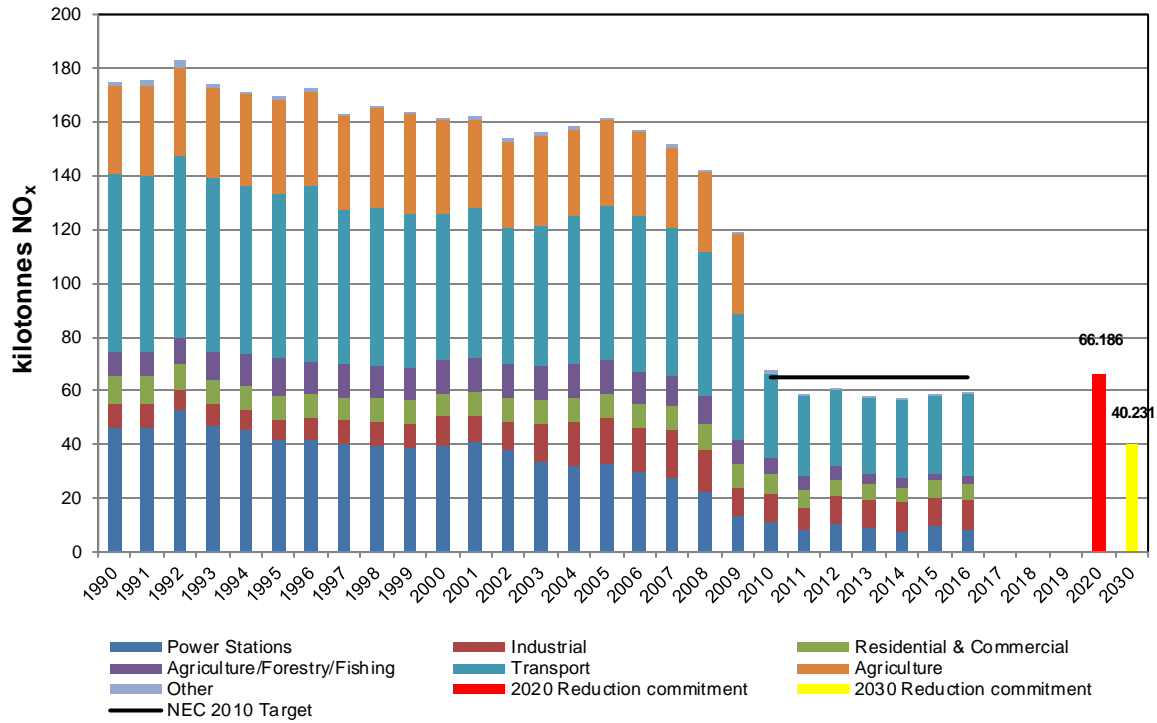
The application of low-NO_x burner technology in several major power stations and the increased use of natural gas have reduced NO_x emissions from electricity generation by 82.7 per cent on 1990 levels, even though electricity total final consumption has increased by 115.5 per cent over the same period. Emissions of NO_x from the coal-fired power plant at Moneypoint have decreased by 82 per cent between 2007 and 2016.

The increase in vehicle numbers and in road transport in general sustained emissions of NO_x through the period 2000 to 2008 even though improved technologies are reducing the emissions from individual vehicles. In recent years, however, road transport has seen a decline in emissions of 10 kt, or 18.6 per cent, between 2008 and 2016 due to the economic recession and improvements in vehicle technologies. Despite this the transport sector has shown a 7.5 per cent increase between 2015 and 2016 due to increased vehicle numbers and mileage. Progress towards limiting emissions to below the ceiling of 65 kt for NO_x in 2010 and beyond has proved difficult even with large reductions in emissions from power stations and road transport in recent years. The most recent data for 2016 show emissions have increased by 2.8 per cent since 2015 due to increased emissions from transport, agriculture, industrial and residential/commercial sectors. Ireland is 42.3 kt above the 2010 emission ceiling in 2016.

The NO_x figures reported here are based on, fuel use, and not fuel sold, and therefore take into account fuel tourism i.e. 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*,¹ paragraph 23. It is estimated that fuel tourism accounted for 5.0 kt of NO_x in 2016.

Ireland has applied an adjustment to NO_x emission inventories, as allowed under Article 5(1) of Directive 2016/2284 in accordance with Part 4 of Annex IV, as Ireland is non-compliant with national emission reduction commitments as a result of applying improved emission inventory methods updated in accordance with scientific knowledge. Adjusted NO_x emissions are shown below. Ireland exceeds the emission ceiling in 2010 and is compliant with the NO_x emission ceiling from 2011 onwards.

¹ [Paragraph 23, ECE/EB.AIR/125](#)

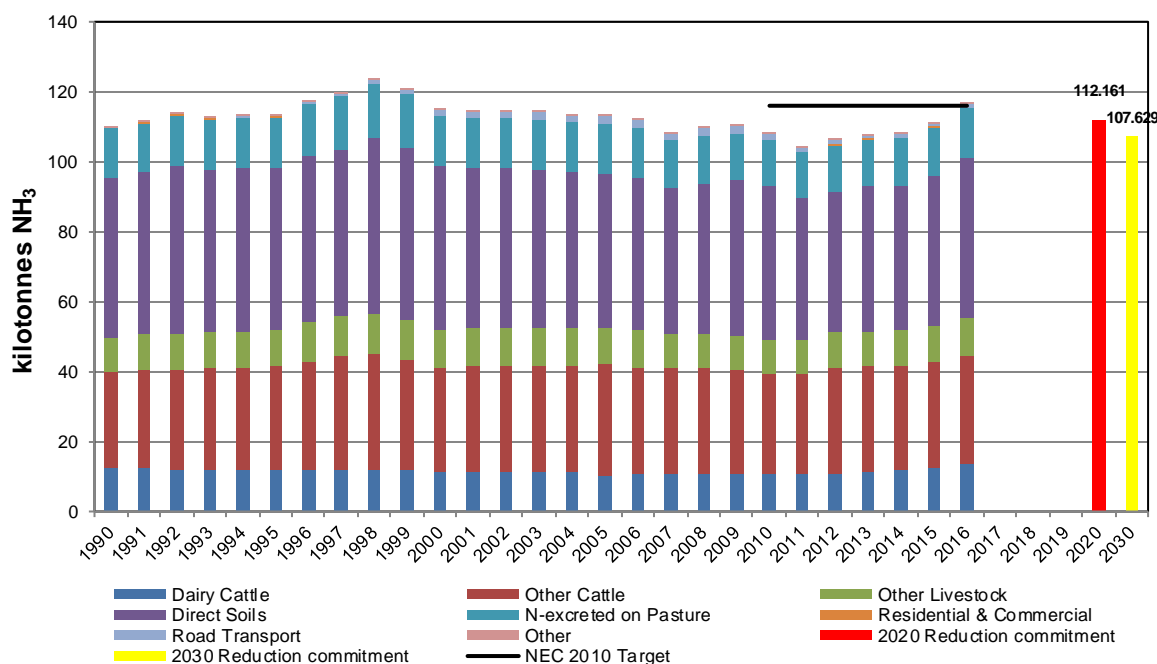


Ammonia

Ammonia (NH₃) emissions are associated with acid deposition and the formation of secondary particulate matter. The agriculture sector accounts for virtually all (99 per cent) of ammonia emissions in Ireland. Grasslands ultimately receive the bulk of the 40 million tonnes (Mt) of animal manures produced annually in Ireland along with approximately 300,000 tonnes of nitrogen in fertilisers. A proportion of the nitrogen in these inputs is volatilised into the air as ammonia.

National Emissions Ceiling

Ireland's national emission ceiling for NH₃ under the NEC Directive is 116 kilotonnes (kt), to be achieved by 2010 and in each year until 2019. This is equivalent to a 5.6 per cent permitted increase in emissions from the 109.8 kt 1990 baseline figure.



Trend in NH₃ Emissions

The emissions in 2016 were 6.9 kt or 6.3 per cent higher than emissions in 1990. Animal manures produce about 90 per cent of ammonia emissions in agriculture and chemical fertilisers and road transport account for the remainder. It is estimated that approximately 15 per cent of the nitrogen in animal manures and 2 per cent of nitrogen contained in chemical fertilisers is lost to the atmosphere as NH₃. The NH₃ emissions trend is consequently largely determined by the cattle population and showed a steady increase up to 123.5 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 NH₃ emissions in the period 2000 to 2011. Recent increases in cattle numbers and fertiliser use have seen NH₃ emissions increase for

the last five years. NH₃ emissions increased in 2016 by 5.6 kt, primarily as a result of a 6.2 per cent increase from dairy cattle and a 2.8 per cent increase from synthetic fertiliser use.

Road transport produces a small proportion of emissions of ammonia (< 1 per cent) mainly from petrol passenger cars with three way catalysts.

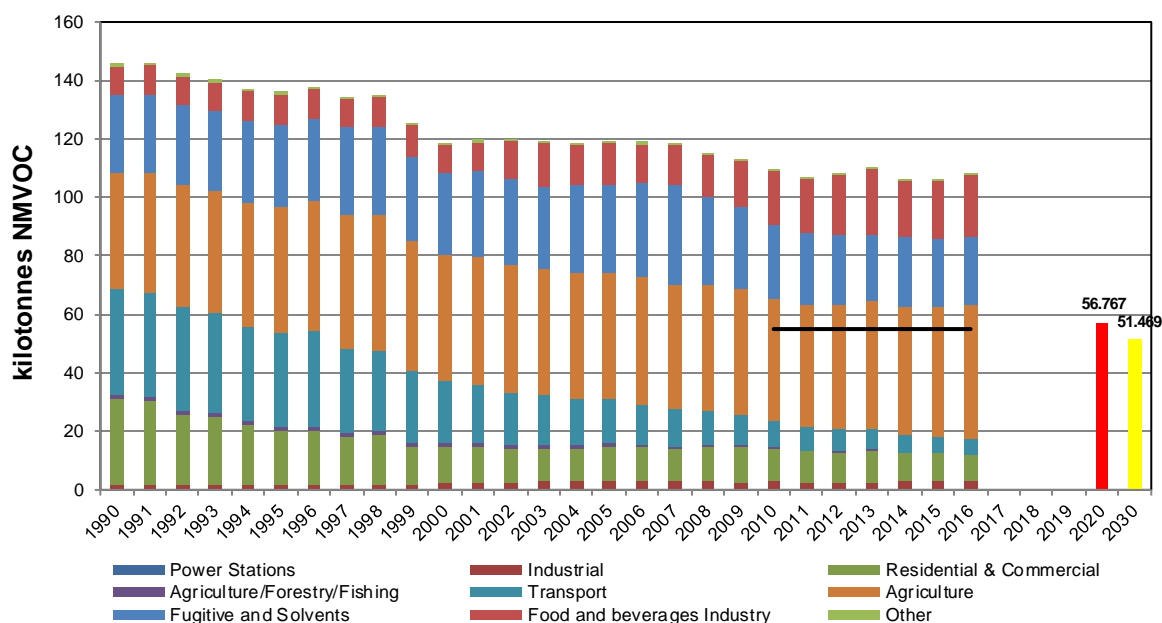
The emissions of NH₃ are compliant with the 2010 ceiling for years 2010 to 2015, however Ireland exceeds the emission ceiling in 2016 for the first time. Limiting and reducing NH₃ emissions into the future could be problematic given the strong performance of the agriculture sector in line with the ambitious targets of Food Wise 2025.

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 and from the storage and handling of animal manure and fertilisers in agriculture.

National Emissions Ceiling

The EU National Emissions Ceilings (NEC) Directive has set a target of 55 kilotonnes (kt) of NMVOC emissions in Ireland by 2010 and in each year until 2019. This is equivalent to a 62.2 per cent reduction in emissions from the 145.8 kt 1990 baseline figure.



Trend over time

The main sources of NMVOC emissions in Ireland are from manure management in agriculture, solvent use and the food and beverages industry. These sources produced 42.4 per cent, 21.3 per cent and 19.6 per cent, respectively of the annual total in 2016. Coal burning in the residential sector is another important but declining source as coal consumption decreases. Emissions from stationary combustion of fossil fuels across all sectors; power stations, residential, commercial and agriculture account for 11.2 per cent of national total NMVOC emissions. Transport emissions account for 4.9 per cent of national total emissions of NMVOC, mainly from exhaust and fugitive releases from gasoline vehicles. 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.

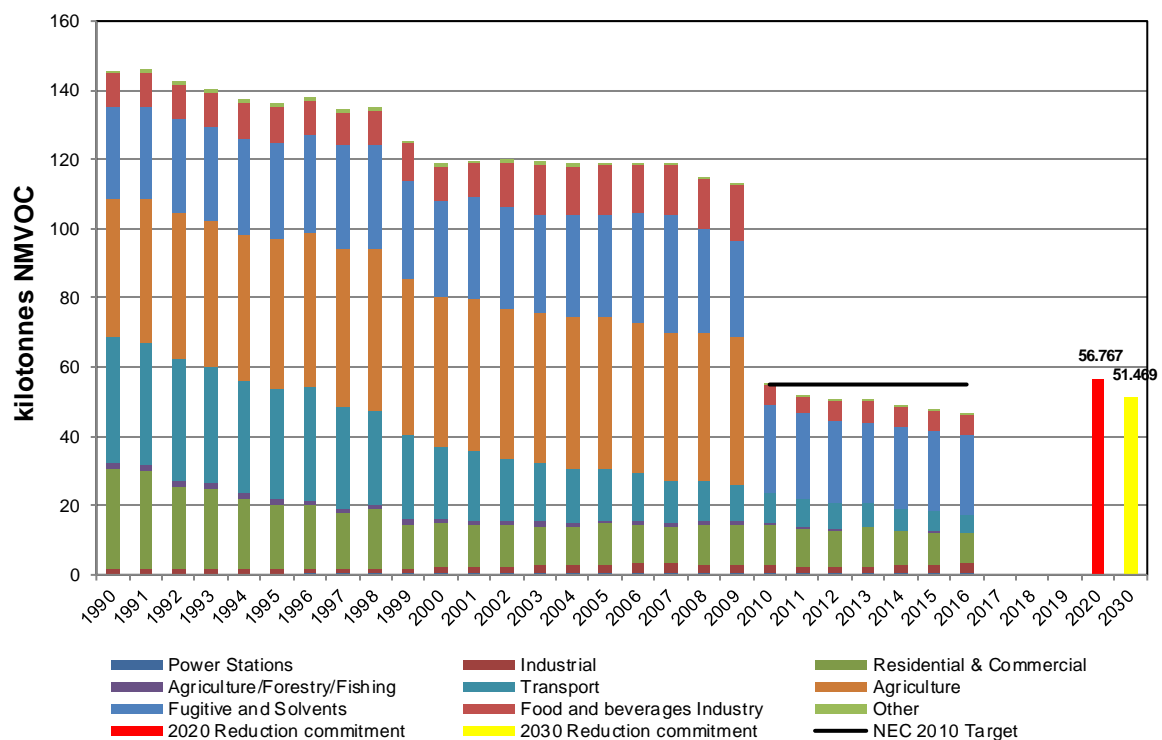
The inclusion of NMVOC emissions from manure management and fertiliser use in Ireland's previous submission, and the inclusion from the food and beverages industry have added over 57 kt of NMVOC, on average, to Ireland's national total, effectively doubling the national

emissions for this pollutant. The agriculture sector is now the principal source of NMVOC emissions, contributing 42.4 per cent of the total in 2016.

Emissions in 2016, at 108.3 kt, are not compliant with the 2010 ceiling, even though reductions corresponding to 25.8 per cent have been achieved from 1990 to 2016. National total emissions are, on average, 52.8 kt above the 2010 emission ceiling.

Future trends in NMVOC emissions depend largely on cattle numbers in the agriculture sector, solid fuel combustion in the residential sector, results from implementation of EU Directives on solvent and product uses and the levels of spirits production.

Ireland has applied an adjustment to NMVOC emission inventories, as allowed under Article 5(1) of Directive 2016/2284 in accordance with Part 4 of Annex IV, as Ireland is non-compliant with national emission reduction commitments as a result of applying improved emission inventory methods updated in accordance with scientific knowledge. Adjusted NMVOC emissions are shown below. Ireland exceeds the emission ceiling in 2010 and is compliant with the NMVOC emission ceiling from 2011 onwards.

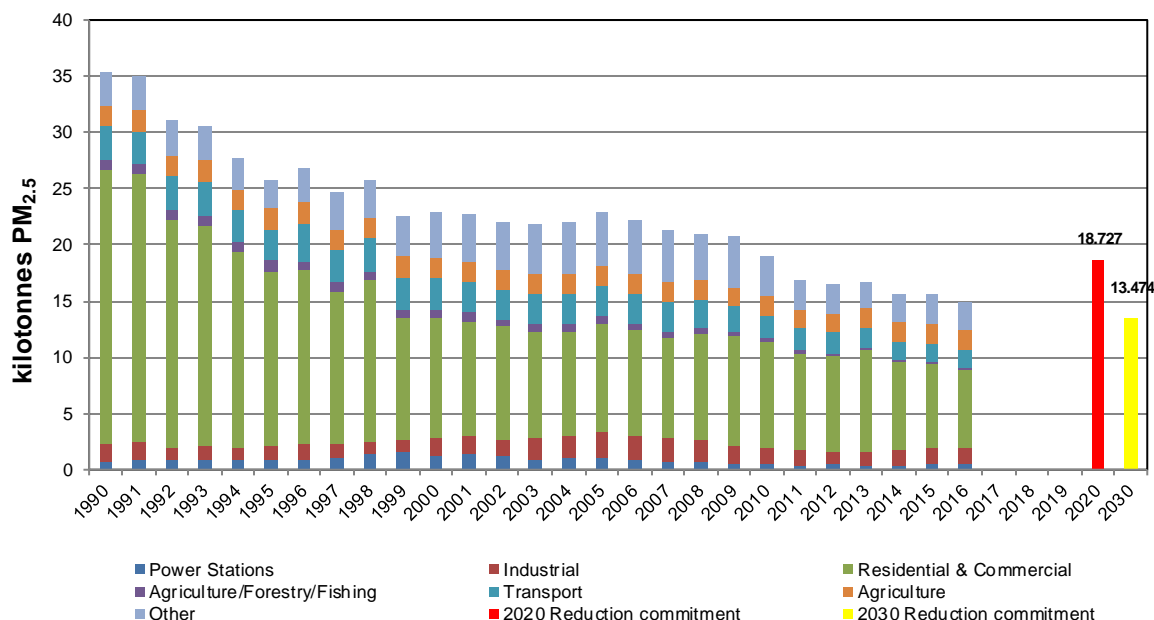


Particulate matter <2.5 µm Diameter (PM_{2.5}) emissions

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 PM₁₀ (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 Emissions Ceiling

The EU National Emissions Ceilings (NEC) Directive 2001/81/EC did not set a 2010 target for PM_{2.5} for Ireland. Article 4(1) of Directive 2016/2284 and Annex II, sets out new national emission reduction commitments for PM_{2.5} applicable from 2020 to 2029 and 2030 onwards. These new reduction commitments are relative to the emissions of 2005 and are presented with the latest emission estimates in Table 1 above and can be seen in the chart below.



Trend over time

The main sources of PM_{2.5} emissions in Ireland are from residential & commercial sectors which together produced 47.1 per cent of the annual total in 2016. Reduced use of coal and peat, with increased use of gasoil, kerosene and natural gas in these sectors has resulted in 71.3 per cent lower emissions between 1990 and 2016. PM_{2.5} emissions in the Other sector account for 16.5 per cent of the total in 2016. These emissions arise from Manufacture of solid fuels and Oil Refining/Storage sectors. For the first time in the 2018 submission as part of inventory improvements the following sectors emissions were included in the Other sector; 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.

Emissions from Agriculture arise from Manure Management and Inorganic N-fertilizers sectors that together in 2016 at 1.8 kt accounted for 12.1 per cent of the national total and indicated a 1.1 per cent decrease on their 1990 levels but a 3 per cent increase on 2015 levels. Transport contributed 1.57 kt (10.5 per cent share) to the national total in 2016. Emissions from Transport sector, dominated by Road Transport have been decreasing since 2005, with a 45.7 per cent reduction between 1990 and 2016 which is largely due to technological advances and the age structure of the national fleet which in turn have been balanced by the increases in vehicle numbers over the time series. There was a slight increase in 2016 of 1.5 per cent for the first time since 2005.

Emissions in 2016, at 14.9 kt, show reductions corresponding to 57.9 per cent between 1990 to 2016. Future trends in PM_{2.5} emissions depend largely on solid fuel combustion in the residential and commercial sectors.

National Emissions 1990-2016

	SO ₂	NO _x	NM VOC kilotonnes	NH ₃	PM _{2.5}
1990	183.570	175.050	145.814	109.802	35.461
1991	181.694	175.407	146.075	111.354	35.072
1992	169.875	182.767	142.571	113.704	31.047
1993	160.997	174.501	140.468	112.578	30.560
1994	175.252	171.168	137.328	113.156	27.723
1995	161.076	169.339	136.266	113.359	25.809
1996	149.194	172.435	137.954	117.112	26.762
1997	165.869	162.991	134.615	119.550	24.752
1998	176.281	166.183	135.233	123.463	25.857
1999	158.363	164.004	125.546	120.781	22.603
2000	139.460	161.714	118.946	114.945	22.837
2001	134.119	162.095	119.796	114.565	22.819
2002	101.139	154.161	120.077	114.443	22.038
2003	79.074	156.123	119.532	114.168	21.911
2004	71.936	158.429	118.786	113.198	22.090
2005	71.762	161.690	119.245	113.294	22.829
2006	60.831	157.303	119.085	111.949	22.267
2007	54.617	151.590	118.856	108.446	21.398
2008	45.188	142.404	114.865	109.664	21.068
2009	32.437	119.177	112.829	110.260	20.778
2010	26.342	113.321	109.237	108.230	18.990
2011	24.835	101.351	106.508	104.382	16.802
2012	23.365	104.722	107.896	106.294	16.521
2013	23.506	105.434	110.340	107.830	16.772
2014	16.891	104.142	106.114	108.312	15.569
2015	15.004	104.393	106.402	111.121	15.550
2016	13.766	107.300	108.253	116.700	14.941