



Ireland's Final Greenhouse Gas Emissions

1990-2016

April 2018

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IRELAND'S GREENHOUSE GAS EMISSIONS IN 2016

KEY HIGHLIGHTS

- The EPA has produced final estimates of greenhouse gas emissions for the period 1990 - 2016.
- For 2016, total national greenhouse gas emissions are estimated to be 61.55 million tonnes carbon dioxide equivalent (Mt CO₂eq). This is 3.6% higher (2.12 Mt CO₂eq) than emissions in 2015 and returns greenhouse gas emissions to 2009 levels.
- In 2016, emissions in the European Union's Emissions Trading Sector¹ (ETS) sector increased by 5.4% or 0.91 Mt CO₂eq and non-ETS emissions increased by 2.8% or 1.21 Mt CO₂eq.
- In the last 2 years, national total emissions have increased by 7.4% or 4.23 Mt CO₂eq. In the same period, emissions in the ETS sector have increased by 11.2% or 1.78 Mt CO₂eq and in the non-ETS sector by 5.9% or 2.45 Mt CO₂eq.
- *Agriculture* emissions increased by 2.7% or 0.53 Mt CO₂eq in 2016. The most significant drivers for the increased emissions in 2016 are higher dairy cow numbers (+6.2%) with an increase in milk production of 4.0%.
- Greenhouse gas emissions from the *Transport* sector increased by 4.1% or 0.48 Mt CO₂eq in 2016. This is the fourth successive year of increases in transport emissions. In road transport in 2016, gasoline use continued to decrease by 6.7% while diesel use increased by 8.0% and biofuels use decreased by 8.0%.
- *Agriculture* and *Transport* accounted for 73.2% of total non-ETS emissions in 2016.
- Emissions in the *Energy Industries* sector show an increase of 6.0% or 0.71 Mt CO₂eq which is attributable to an increase in natural gas use for electricity generation at power plants by 27.7% and reductions of 6.5% and 15.6% respectively for electricity generated from wind and hydro renewables. This is reflected in a 3.3% increase in the emissions intensity of power generation in 2016 (480 g CO₂/kWh) compared with 2015 (465 g CO₂/kWh). Renewables now account for 25.5% of electricity generated in 2016 (down from 27.3% in 2015). Ireland exported 2.4% of electricity generated in 2016.
- Emissions from the *Manufacturing Combustion*² sector increased by 0.07 Mt CO₂eq or 1.6% in 2016. There were minor decreases in combustion emissions for all sub sectors except cement which increased by 3.5% in 2016.
- The *Industrial Processes* sector emissions increased by 7.1% or 0.14 Mt CO₂eq, mainly from increased cement production. Cement process emissions increased by 8.6% in 2016.
- Greenhouse gas emissions from the *Residential* sector remained almost unchanged with a small increase of 0.1% or 0.01 Mt CO₂eq.
- Emissions from the *Waste* sector increased by 0.9% or 0.01 Mt CO₂eq in 2016.

¹ [The European Union's Emissions Trading Scheme](#)

² Manufacturing Combustion; includes combustion of fuels in Industry and Construction, both in ETS and non-ETS

- These figures indicate that Ireland exceeds its 2016 annual limit set under the EU's Effort Sharing Decision (ESD), 406/2009/EC³ by 0.3 Mt CO₂eq.
- Ireland's National Policy position is to reduce CO₂ emissions in 2050 by 80% on 1990 levels across the Energy Generation, Built Environment and Transport sectors, with a goal of Climate neutrality in the Agriculture and Land-Use sector. The 2016 emissions for all these sectors are heading in the wrong direction, making achievement of our long-term goals ever more difficult.

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 1990-2016 in January, March and April 2018 to the European Commission and the UNFCCC.

The final estimates of Ireland's greenhouse gas figures for the years 1990-2016, based on the SEAI's final energy balances released in January 2018 and are estimated using methodologies employed in the inventory in accordance with UNFCCC reporting guidelines and the latest available input data. In addition, verified emissions data from installations covered by the ETS are included.

The 2016 estimates are given below, followed by an account of how these differ from the 2015 estimates. The longer-term trends in greenhouse gas emissions and their significance in relation to Ireland's target under the EU's Effort Sharing Decision on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 are also assessed.

Ireland's Greenhouse Gas Emissions in 2016

For 2016, total national greenhouse gas emissions are estimated to be 61.55 million tonnes carbon dioxide equivalent (Mt CO₂ eq) which is 3.6 % higher (or 2.12 Mt CO₂ eq) than emissions in 2015 (59.43 Mt CO₂ eq) and follows the 3.7% increase in emissions reported for 2015. Emission reductions have been recorded in 7 of the last 10 years, however the last two years have seen large increases in emissions. In the last 2 years, national total emissions have increased by 7.4% or 4.23 Mt CO₂eq. In the same period, emissions in the ETS sector have increased by 11.2% or 1.78 Mt CO₂eq and in the non-ETS sector by 5.9% or 2.45 Mt CO₂eq. We are now seeing strong evidence that emissions are once again increasing in line with economic and employment growth, particularly in the *Energy Industries*, *Agriculture* and *Transport* sectors.

The inter-annual change in total greenhouse gas emissions is presented in Figure 1 and sectoral emissions in Figures 2 and 3. Detailed sectoral data are shown in Table 3.

Agriculture remains the single largest contributor to the overall emissions at 32.3% of the total. *Energy Industries* and *Transport* are the second and third largest contributors at 20.5% and 20.0% respectively. *Residential* and *Manufacturing Combustion* emissions account for 9.8% and 7.4 % respectively. These five sectors accounted for almost 90% of national total emissions in 2016. The remainder is made up by the *Industrial Processes* at 3.5%, *F-Gases* at 2.1%, *Waste* at 1.6%, *Commercial Services* at 1.6% and *Public Services* at 1.4%. Figure 2 shows the contributions from each of the sectors in 1990 and 2016.

³ [EU Effort Sharing Decision 406/2009/EC](#)

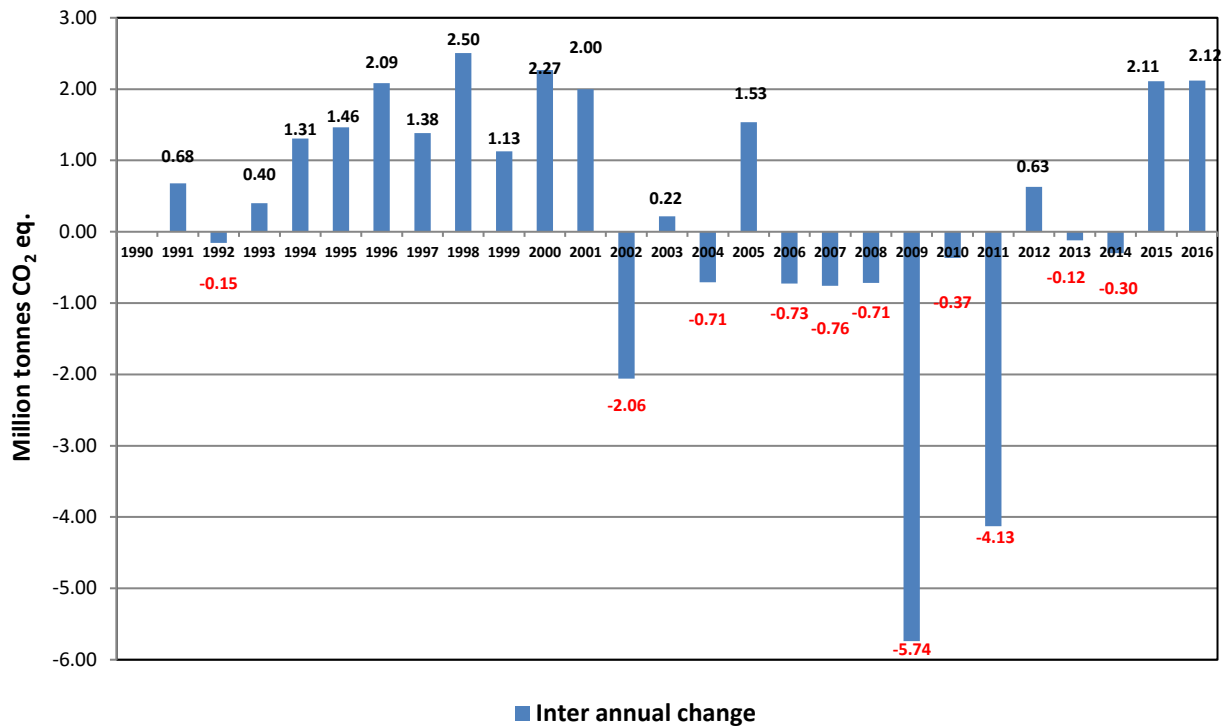


Figure 1. Inter annual changes in GHG emissions 1990-2016

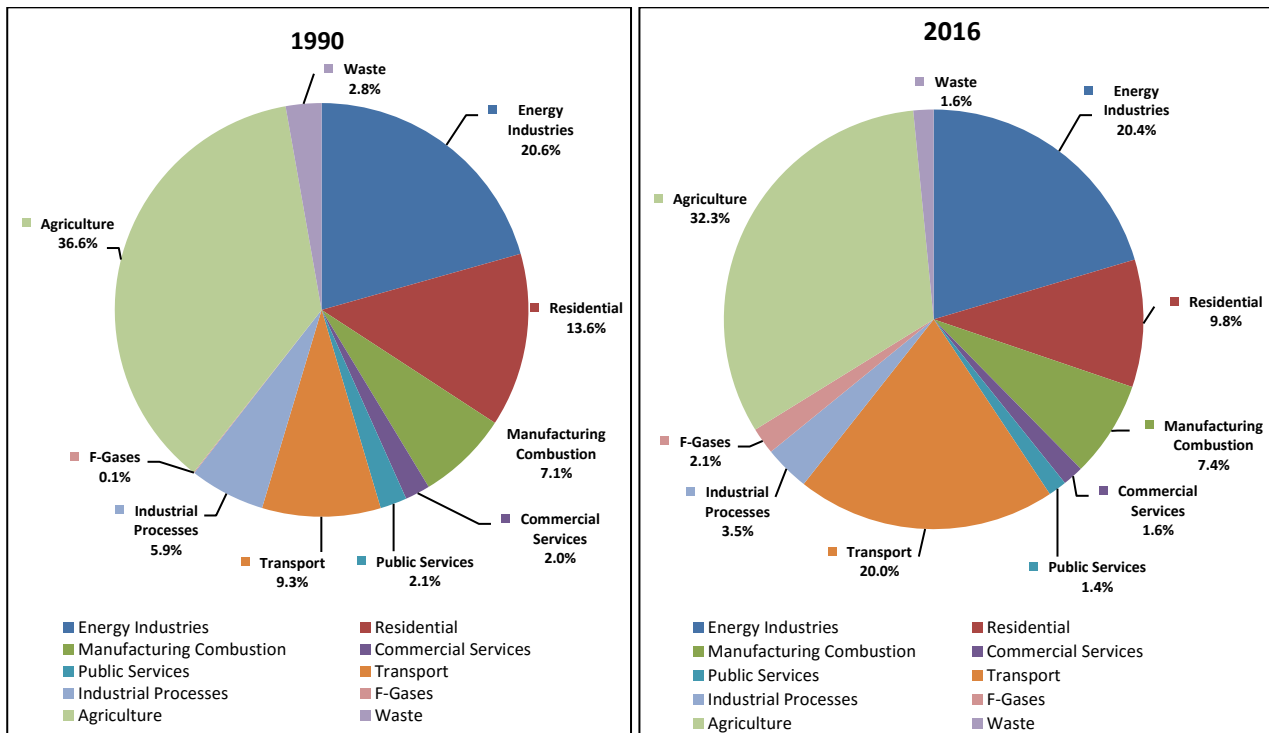


Figure 2. Greenhouse Gas Emissions in 1990 and 2016 by Sector

Changes in Emissions from Sectors between 2015 and 2016

An overview of changes in emissions since the previous year is presented in Table 1.

Table 1. Greenhouse gas emissions for 2015 and 2016 for Ireland

Mt CO ₂ eq	2015	2016	% Change
Agriculture	19.324	19.851	2.7%
Energy Industries	11.845	12.557	6.0%
Transport	11.813	12.294	4.1%
Residential	6.041	6.047	0.1%
Manufacturing Combustion	4.484	4.555	1.6%
Industrial Processes	2.007	2.150	7.1%
F-Gases	1.142	1.267	11.0%
Commercial Services	0.970	0.994	2.5%
Waste	0.949	0.958	0.9%
Public Services	0.851	0.873	2.7%
Total	59.426	61.546	3.6%

Agriculture emissions increased by 2.7% or 0.53 Mt CO₂eq in 2016 following an increase in 2015 of 1.5%. The most significant drivers for the increased emissions in 2016 are higher dairy cow numbers (+6.2%) with an increase in milk production of 4.0%. In the 5-year period 2012-2016, dairy cow numbers have increased by 22% and corresponding milk production by 27%. This reflects national plans to expand milk production under Food Wise 2025 and the removal of the milk quota in 2015. In 2016, there were also increased CO₂ emissions from liming (+8.4%) and urea (+26.5%) application. Other cattle and pig numbers increased by 3.0% and 3.7% respectively. Total fossil fuel consumption in agriculture/forestry activities increased by 5.0% in 2016.

Transport emissions increased by 4.1% in 2016 or 0.48 Mt CO₂eq. This is the fourth successive year of increases in transport emissions following five consecutive years of decreases since 2007. In road transport in 2016, gasoline use continued to decrease by 6.7% while diesel use increased by 8.0% and biofuels use decreased by 8.0%. Looking at the underlying drivers, the number of passenger diesel cars increased by 11.9% in 2016 while the number of passenger petrol cars decreased by 5.7%, commercial vehicle numbers increased by 3.5% and employment continued to grow with 3.3% growth recorded between Q4 2015 and Q4 2016.

Sectoral emissions in the *Energy Industries* sector show an increase of 6.0% which is attributable to an increase in natural gas use for electricity generation by 27.7% and reductions of 6.5% and 15.6% respectively for electricity generated from wind and hydro renewables. This is reflected in a 3.3% increase in the emissions intensity of power generation in 2016 (480 g CO₂/kWh) compared with 2015 (465 g CO₂/kWh). Renewables now account for 25.6% of electricity generated in 2016 (down from 27.3% in 2015). Ireland exported 2.4% of electricity generated in 2016. In 2016, total final consumption of electricity increased by 2%.

Emissions in the *Residential* sector are almost unchanged with a small increase of 0.1% or 0.01 Mt of CO₂eq. in 2016. Within the different fuels used in household space and water heating, kerosene use increased by 5.2%, gasoil by 5.0% and natural gas by 1.4%, whereas coal and peat use continued to decline by 13.3% and 1.9% respectively in 2016.

Emissions from the *Manufacturing Combustion* sector increased by 1.6% or 0.07 Mt CO₂eq in 2016. There were minor decreases in combustion emissions for all sub sectors except cement which increased in 2016. However, increased emissions from companies within the ETS were evident in the food and drink and cement sectors, with emissions increasing by 4.5% and 3.5% respectively. These increases were offset by reductions in other sectors, most notably, a reduction of 5.1% in emissions from non-ferrous metals industry.

Emissions from the *Industrial Processes* sector continue to increase by 7.1% (0.14 Mt CO₂eq) in 2016 following a 10.3% increase in 2015, mainly from increased cement production. Total process emissions from the mineral products subsector (including cement) increased by 7.5%. These emissions are included in the ETS sector and contribute significantly to the ETS sector increase in 2016.

In 2016, total emissions (combustion and process) from the cement sector increased by 6.8% and amount to 2.72 Mt CO₂eq, or 4.4% of national total emissions. Cement sector emissions have now increased by 79% since 2011.

Emissions from *Commercial Services* and *Public Services* increased by 2.5% and 2.7% respectively, with increases of 5.2% in natural gas use in both sectors in 2016. These increases were offset somewhat by increases in biomass/biogas use of 55.4% and 26.9% respectively.

Emissions from the *Waste* sector increased by 0.9% in 2016, with decreases in sub category; incineration and open burning (-42.8%). Overall emissions increased by 0.01 Mt CO₂eq.

Long-term Changes in Sectoral Emissions 1990 – 2016

The trend in emissions from 1990 to 2016 is shown in Figures 3 and 4 and Table 3. The share of CO₂ in total greenhouse gas emissions has increased to 64.9% of total greenhouse gas emissions in 2016 compared to 59.2% in 1990. In contrast, CH₄ and N₂O emissions, primarily from the agriculture sector, have fallen from 40.7% of total greenhouse gas emissions in 1990 to 33.1% in 2016. Emissions from F-gases account for 2.1% of the total in 2016.

Between 1990 and 2016, *Transport* shows the greatest overall increase at 139.3%, with road transport increasing by 145.4%. Emissions increased by 4.1% in 2016, the fourth year of increases in *Transport* emissions following 5 consecutive years of decreases since 2007. However, *Transport* emissions have decreased by 14.6% below peak levels in 2007 primarily due to the economic downturn, improving vehicle standards due to the changes in vehicle registration tax and the increase use in biofuels. The increase up to 2007 can be attributed to general economic prosperity, increasing population with a high reliance on private car travel as well as rapidly increasing road freight transport.

Energy Industries (mainly electricity generation) shows an increase in emissions of 9.8% over the period 1990 – 2016. Over the time series, CO₂ emissions from electricity generation have increased by 10.2% whereas total electricity consumption has increased by 115.5%. Emissions from electricity generation increased from 1990 to 2001 by 54.2% and have decreased by 28.5% between 2001 and 2016. 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.

Emissions from *Agriculture* reached a peak in 1998 and have decreased to below their 1990 level since 2002, reflecting long-term decline in livestock populations and in fertiliser use due to the Common Agricultural Policy. Emissions from *Agriculture* in 2016 are now 2.4% below their 1990 levels but have increased for 4 out of the last 5 years, 2012, 2013, 2015 and 2016. The fluctuations in *Agriculture* emissions are underpinned by higher animal numbers; in the 4-year period 2012-2016, dairy cow numbers have increased by 22% and corresponding milk production by 27%. This reflects national plans to expand milk production under Food Wise 2025 and the removal of the milk quota in 2015.

Increased housing stock drove the gradual upward trend in the emissions from the *Residential* sector after 1998 following a sharp reduction in the early 1990s that resulted from fuel switching to reach a peak in 2010. The 2016 emissions in this sector are almost unchanged on 2015 levels and are 19.6% lower than their 1990 level whereas the housing stock has increased by 74.5% in the same period. Winter heating demand is the most important variable determining emissions from this sector.

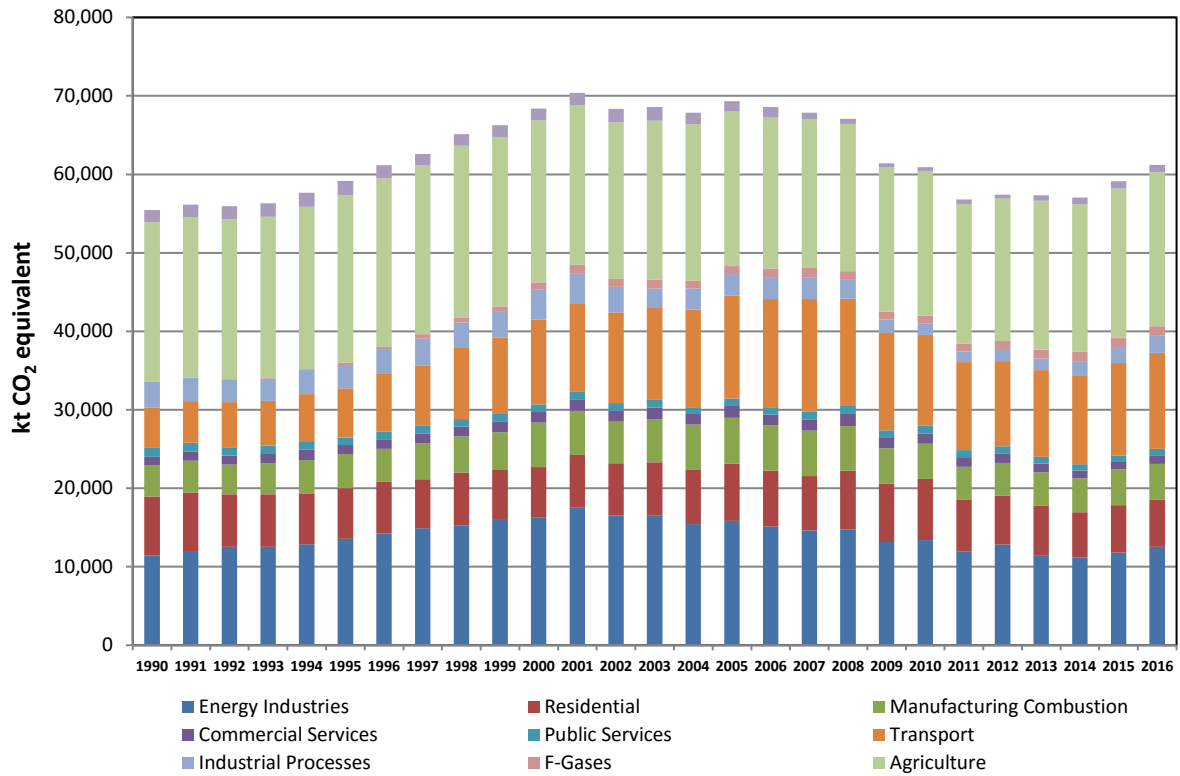


Figure 3. GHG emissions by sector 1990-2016

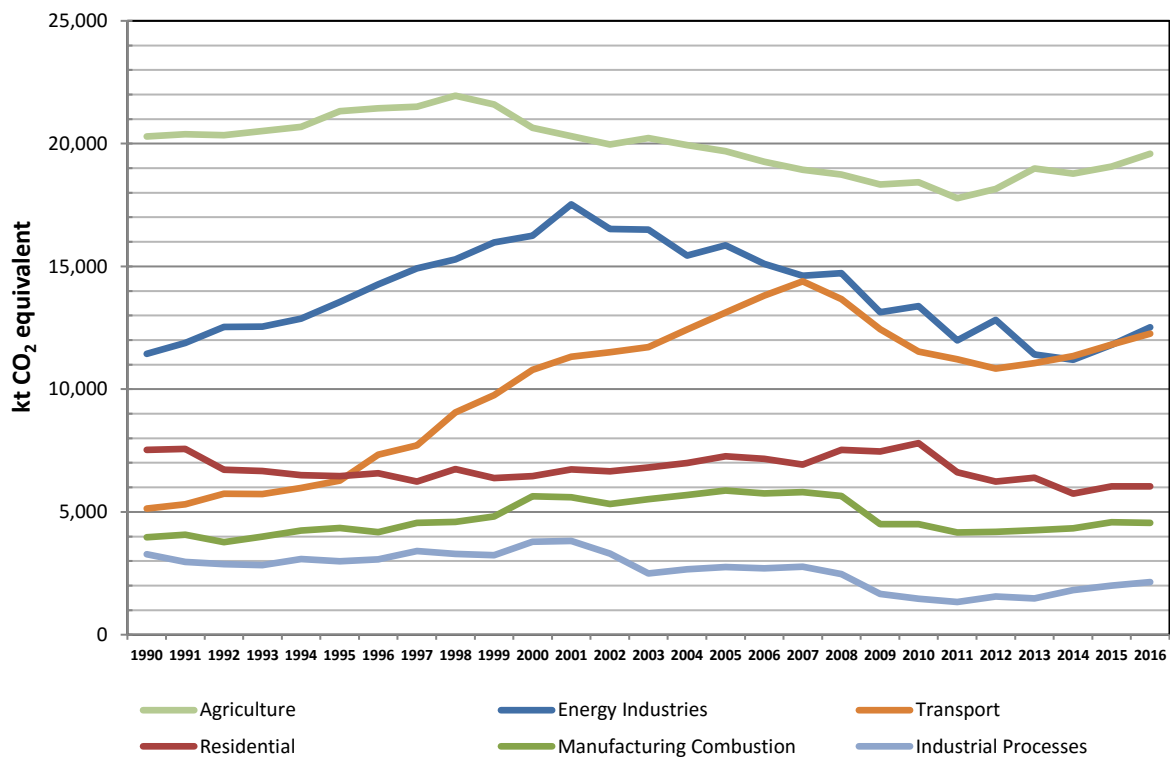


Figure 4. Trend in emissions for largest sectors 1990-2016

Note on the outcome recent research in Agriculture to the national inventory

The final estimates of emissions 1990-2016 provided here include significant changes to the agriculture sector following the outcome of recent research as part of the Agricultural GHG Research Initiative for Ireland (AGRI-I, <http://www.agri-i.ie/>) funded by the DAFM Research Stimulus Fund conducted by Teagasc, Agri-Food and Biosciences Institute (AFBI) Northern Ireland, Queens University Belfast and Reading University. The estimates differ from those submitted to the EU and UNFCCC for 1990-2015 earlier this year. This research investigated the nitrous oxide (N₂O) emission factors (EFs) for nitrogen fertiliser use and N₂O EFs for dung and urine deposited by grazing cattle on soils and was carried out between 2011 and 2015.

The outcome of this research changed the EFs used in the national inventory as follows;

- Synthetic fertiliser N₂O EF has increased from 1% loss (default in 2006 IPCC Guidelines) to 1.24% loss on average
- Urine and dung deposited by grazing cattle on soils N₂O EF has decreased from a 2% loss (default in 2006 IPCC Guidelines) to 0.86% loss on average.

The above sources accounted for almost 88% of the total level of uncertainty in Ireland's GHG emission inventory in 2015 and therefore this research was targeted to significantly improve the understanding of the level of emissions in the national inventory and reduce overall uncertainty.

The net impact of these EF changes together with new nitrogen excretion rates for other cattle (non-dairy cattle) was to reduce overall N₂O emissions from agriculture by 11.5% or a reduction of 0.79 Mt CO₂ eq per annum from 1990-2015. However, some of the reduction in N₂O emissions was offset by improving the methodology used in estimating CH₄ emissions from manure management for swine and sheep, which increased emissions by on average 92 kt CO₂ eq per annum. **Overall, agriculture emissions are now 3.6% or 0.71 Mt CO₂ eq per annum lower for all years from 1990-2015.**

Compliance with EU and international commitments

The greenhouse gas emission inventory for 2016 is the fourth year that compliance under the European Union's Effort Sharing Decision (Decision 406/2009/EC) will be assessed. This Decision sets 2020 targets for sectors outside of the Emissions Trading Scheme (known as non-ETS sector emissions) and annual binding limits for the period 2013-2020. Ireland's target is to reduce non-ETS emissions by 20% by 2020 compared with 2005 levels.

The final inventory review for 2013 and 2014 data was completed in August 2016 and the review for 2015 data was completed in April 2017 following submission of official data in March 2017 to the European Commission. Ireland has currently 10.38 Mt CO₂ eq additional annual emission allowances (AEAs) compared with greenhouse gas emissions for the period 2013 to 2015, see Table 2 and Figure 5. ESD registry compliance with respect to 2013 and 2014 was completed in 2017. ESD registry compliance for 2015 will be completed early in 2018.

Ireland's annual limit for 2016 is 43.50 Mt CO₂ eq. Ireland's final 2016 greenhouse gas emissions for non-ETS sectors are 43.80 Mt CO₂ eq, 299.3 kt CO₂ eq more than the annual limit for 2016. This value is the national total emissions less emissions covered by the EU's emissions trading scheme for stationary and aviation operators. This indicates that Ireland will **not be in compliance** with its 2016 Effort Sharing Decision annual limit. Agriculture and Transport accounted for 73.2% of total non-ETS emissions in 2016.

The revision to the national inventory for the *Agriculture* sector will provide additional headroom, approximately 3.5 Mt CO₂eq (5 x 0.70 Mt CO₂eq per annum), for Ireland to meet its annual limits for the 5-

year period 2016-2020. However, under Article 20 of the [MMR No. 525/2013](#)⁴, during the comprehensive review of the inventory data for 1990-2020 to take place in 2022, the Commission will take into account the effects of all inventory recalculations during the period 2013 to 2020 when proposing the targets for emission reductions or limitations for each Member State for the period after 2020. In this way, no Member State will benefit or be disadvantaged, from recalculations to inventories during the period 2013 to 2020.

Table 2. Compliance with EU ESD Targets 2013-2020

		2013	2014	2015	2016	2017	2018	2019	2020	
A	Total greenhouse gas emissions without LULUCF ¹	57,903.4	57,626.0	59,878.2	61,545.8	0.0	0.0	0.0	0.0	kt CO ₂ eq
B	NF ₃ emissions	0.9	1.0	1.0	1.0	0.0	0.0	0.0	0.0	kt CO ₂ eq
C	Total greenhouse gas emissions without LULUCF and without NF ₃ emissions	57,902.5	57,625.1	59,877.3	61,544.9	0.0	0.0	0.0	0.0	kt CO ₂ eq
D	Total verified emissions from stationary installations under Directive 2003/87/EC ²	15,685.7	15,952.7	16,829.7	17,737.0	0.0	0.0	0.0	0.0	kt CO ₂ eq
E	CO ₂ emissions from 1.A.3.A civil aviation	10.0	9.4	10.4	9.7	0.0	0.0	0.0	0.0	kt CO ₂ eq
F	Total ESD emissions (= C-D-E)	42,206.8	41,663.0	43,037.2	43,798.2	0.0	0.0	0.0	0.0	kt CO ₂ eq
G	EU ESD Targets	46,891.9	45,760.9	44,629.9	43,498.9	40,885.1	39,807.1	38,729.2	37,651.3	kt CO ₂ eq
	Distance to target (= F-G)	-4,685.1	-4,097.9	-1,592.7	299.3					

Note: Shaded cells show data that has been reviewed, and compliance agreed, by the European Commission under Article 19 of the MMR No. 525/2013

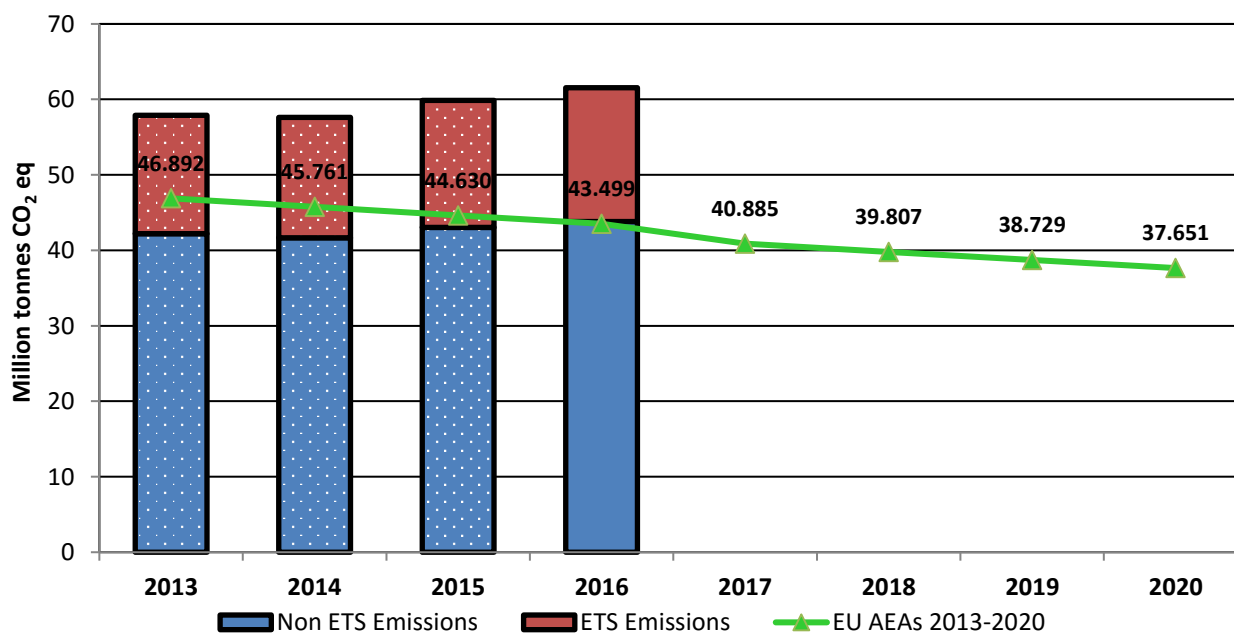


Figure 5. ESD Targets 2013-2020

⁴ REGULATION (EU) No 525/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC

Table 3. Ireland's GHG Emissions by Sector 1990-2016 (kilotonnes CO₂ equivalent)

1990-2016_Submission 2018 FINAL	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Annual change	kt CO ₂
Energy Industries	11434.98	13553.17	16245.03	15919.87	15155.89	14676.90	14790.02	13181.51	13437.80	12031.70	12864.35	11452.41	11233.22	11844.64	12556.70	6.0%	712.06
Public electricity and heat production	10953.92	13132.91	15754.35	15244.75	14527.04	14055.76	14155.13	12610.63	12895.10	11556.54	12356.28	10952.93	10771.89	11328.27	12076.43	6.6%	748.16
Petroleum refining	168.67	181.27	274.80	411.87	377.14	360.80	367.48	315.39	310.47	285.42	313.55	294.55	279.50	358.72	313.59	-12.6%	-45.13
Solid fuels and other energy industries	100.54	69.44	87.15	171.89	172.44	166.45	183.88	191.50	173.31	135.77	145.39	161.17	133.65	114.53	125.40	9.5%	10.88
Fugitive emissions	211.85	169.54	128.73	91.36	79.27	93.89	83.53	63.99	58.91	53.97	49.14	43.77	48.18	43.12	41.28	-4.3%	-1.85
Residential	7523.66	6452.05	6462.60	7271.95	7157.48	6928.53	7521.57	7467.04	7800.95	6609.75	6232.39	6395.37	5745.61	6041.41	6046.55	0.1%	5.14
Manufacturing Combustion	3961.75	4347.62	5642.37	5870.42	5752.41	5788.73	5629.34	4480.28	4476.47	4142.36	4176.49	4236.52	4322.98	4484.01	4554.61	1.6%	70.60
Commercial Services	1083.49	1165.57	1374.71	1475.69	1380.08	1414.82	1547.89	1298.07	1296.74	1195.07	1184.49	1066.27	957.05	970.23	994.45	2.5%	24.22
Public Services	1160.65	936.34	989.43	952.53	912.74	958.76	1053.03	1002.11	1021.25	913.69	930.94	871.22	815.60	850.66	873.32	2.7%	22.66
Transport	5136.71	6274.81	10792.04	13124.88	13804.92	14391.02	13661.98	12442.55	11529.22	11220.22	10836.50	11065.89	11347.03	11813.15	12293.95	4.1%	480.81
Domestic aviation	51.71	48.86	74.41	65.37	77.29	71.48	67.18	55.20	40.97	19.33	11.50	10.18	9.52	10.51	9.80	-6.7%	-0.71
Road transportation	4787.51	5890.59	10369.53	12558.47	13187.69	13842.30	13086.07	11897.96	10985.09	10735.34	10365.67	10594.17	10841.00	11314.74	11750.89	3.9%	436.16
Railways	148.87	124.51	137.65	136.58	136.58	147.71	156.54	137.36	136.31	136.52	131.93	131.38	120.53	122.83	125.10	1.8%	2.27
Domestic navigation	85.77	92.10	152.65	211.19	250.13	197.53	204.73	199.52	200.12	173.73	183.60	179.59	224.81	221.73	266.46	20.2%	44.72
Other transportation	62.86	118.75	57.80	153.27	153.23	132.00	147.45	152.50	166.74	155.30	143.80	150.57	151.17	143.34	141.71	-1.1%	-1.63
Industrial Processes	3274.18	2990.54	3788.48	2764.50	2710.07	2770.33	2471.90	1658.58	1464.59	1334.87	1561.25	1477.39	1820.34	2007.15	2149.91	7.1%	142.75
Mineral industry	1116.73	1084.18	1908.78	2552.80	2538.74	2582.80	2301.58	1486.14	1300.01	1168.75	1393.44	1301.70	1650.45	1830.36	1968.40	7.5%	138.04
Chemical industry	1985.55	1754.44	1663.30	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
Metal industry	26.08	24.80	28.80	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
Non-energy products from fuels and solvent use	114.48	94.93	153.72	174.75	133.48	148.40	130.22	131.91	123.86	125.22	126.82	134.63	128.68	135.35	138.94	2.6%	3.59
Other product manufacture and use	31.34	32.20	33.88	36.96	37.84	39.12	40.10	40.53	40.72	40.90	40.99	41.06	41.21	41.44	42.57	2.7%	1.13
F-Gases	35.23	284.29	955.35	1019.88	1178.13	1174.56	1036.58	1037.89	1011.69	1016.48	996.33	1122.77	1182.87	1142.06	1267.30	11.0%	125.24
Agriculture	20332.83	21357.31	20815.58	19852.27	19436.69	19103.91	18941.48	18517.95	18694.93	18052.25	18438.96	19256.01	19038.64	19323.94	19851.31	2.7%	527.37
Enteric fermentation	11356.97	11480.10	11260.82	10843.14	10789.48	10586.99	10539.09	10370.00	10162.10	10045.18	10379.27	10532.74	10655.91	10923.72	11247.27	3.0%	323.55
Manure management	1904.53	1937.12	1917.43	1881.76	1845.93	1809.51	1798.39	1775.00	1739.75	1736.20	1813.88	1832.21	1840.16	1877.35	1943.29	3.5%	65.94
Agricultural soils	5853.36	6239.14	6205.70	5734.17	5473.21	5318.53	5268.19	5131.16	5490.31	5092.84	5237.32	5679.43	5526.58	5522.00	5598.85	1.4%	76.85
Liming	355.04	494.60	366.38	266.73	254.86	376.77	262.21	307.32	427.93	360.68	229.40	515.69	382.32	392.51	425.60	8.4%	33.09
Urea application	44.47	39.68	42.25	27.90	29.55	23.36	30.76	40.93	45.16	32.32	21.32	21.66	25.09	28.31	35.80	26.5%	7.49
Agriculture/Forestry fuel combustion	730.62	1008.11	909.76	953.63	914.19	868.02	939.19	796.63	753.49	721.93	687.92	596.55	534.52	514.94	540.70	5.0%	25.76
Fishing	87.85	158.55	113.24	144.94	129.47	120.74	103.65	96.92	76.18	63.10	69.85	77.73	74.06	65.11	59.79	-8.2%	-5.32
Waste	1546.80	1823.02	1489.09	1290.68	1326.40	848.51	687.39	515.21	498.90	589.88	514.57	671.03	852.97	949.25	957.72	0.9%	8.47
Landfills	1318.08	1592.76	1268.16	1007.00	1049.30	615.99	463.84	284.80	278.65	381.56	302.79	460.97	648.10	742.15	767.78	3.5%	25.63
Biological treatment of solid waste	0.00	0.00	0.00	13.77	13.70	12.48	16.44	21.07	20.99	22.91	22.41	22.73	19.30	20.66	19.87	-3.9%	-0.80
Incineration and open burning of waste	92.48	94.43	75.83	131.19	128.31	83.69	62.64	64.11	54.80	42.45	45.60	43.57	39.65	40.15	22.95	-42.8%	-17.20
Wastewater treatment and discharge	136.24	135.83	145.10	138.72	135.09	136.34	144.46	145.22	144.46	142.96	143.77	143.76	145.93	146.29	147.12	0.6%	0.83
National Total	55490.29	59184.72	68554.68	69542.68	68814.81	68056.05	67341.18	61601.17	61232.52	57106.28	57736.27	57614.86	57316.31	59426.50	61545.82	3.6%	2119.32

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).

GWPs:

Industrial designation or common name	Chemical formula	GWP for 100-year time horizon
		IPCC 4 th assessment report (AR4)
Carbon dioxide	CO ₂	1
Methane	CH ₄	25
Nitrous oxide	N ₂ O	298
Hydrofluorocarbons	HFCs	12 to 14,800
Perfluorinated compounds	PFCs	7,390 to >17,340
Sulphur hexafluoride	SF ₆	22,800
Nitrogen trifluoride	NF ₃	17,200

Ireland's GHG Sectors: include the following ten 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 for Manufacturing industries in ETS and non-ETS)
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), wastewater treatment, waste incineration and open burning of waste).

Uncertainty Analysis:

The EPA uses a method described by the 2006 IPCC guidelines to assess uncertainty in the emissions inventory data. This method estimates uncertainties for the entire inventory in a particular year and the uncertainty in the trend over time by combining the uncertainties in activity data and emission factors for each source category. The estimated uncertainty on the level of emissions in 2016 is 3.7% and the trend uncertainty over the period 1990-2016 is 2.3%. The most significant contributors to the level of uncertainty are methane emissions from livestock and nitrous oxide emissions from agricultural soils.