Department
of Energy &
Climate Change

Projected emissions of non-CO_2 gases

Summer 2014 update

July 2014

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Executive summary

This report presents the Summer 2014 update to DECC's projections of methane (CH_4), nitrous oxide (N_2O) and F-gases (HFCs, PFCs and SF_6), collectively referred to as the non-CO_2 greenhouse gases (GHGs), as well as the methodologies used to derive them and the associated uncertainties. The geographical coverage of these projections is the United Kingdom and its Crown Dependencies (Jersey, Guernsey, and the Isle of Man). All emissions sources are covered, with the exception of emissions produced as a result of combustion activities, which are reported in DECC's Updated Emissions Projections (UEP) (**DECC, 2013a**).

Non-CO_2 GHGs covered by this report are now estimated to be 76 $MtCO_2e$ in 2030; representing a projected 21% decrease between 2012 and 2030. This would represent a 58% reduction on 1990 levels. The two greatest contributors to this projected reduction are CH_4 emissions from waste management, where emissions reductions of 7.6 $MtCO_2e$ are estimated at 2030 compared with 2012, and a reduction of 9.7 $MtCO_2e$ in business sector HFC emissions. Table 1.1 below summarises the projections.

Table 1.1 A summary of non-CO2 GHG emissions projections split by gas

	Summary of projected non-CO_2 emissions in the Summer 2014 update, $MtCO_2e$					
	1990	**2012**	**2015**	**2020**	**2025**	**2030**
CH_4	100	48	46	42	39	37
N_2O	66	33	34	34	34	34
HFCs	11	14	11	8	6	4
PFCs	1	0	0	0	0	0
SF_6	1	1	1	1	1	1
Total	**180**	**96**	**91**	**85**	**80**	**76**

Since the previous non-CO_2 projections was published (**DECC, 2013b**), a new GHG Inventory (GHGI) has been produced. The current projections have been rebaselined to this latest GHGI and additionally there are new modelled projections from

- Agriculture
- Land use, land use change and forestry (LULUCF)
- Road transport (transport sector)
- Off-road transport (business, residential and transport sectors)
- A new GHGI category in the business sector

Figure 1.1 compares the current and previous set of projections. The two most significant changes result from GHGI methodology changes in the Waste and Agriculture sectors. These result in significant CH_4 and N_2O emissions increases in the baseline of historical emissions which causes an increase in projected emissions. Accounting for flaring of CH_4 emitted by landfill waste caused the change in the waste sector and a change in categorisation of manure management caused the change in the Agriculture sector. There is also a GHGI methodology change in the residential sector that causes a decrease in projections. The other sectoral changes have comparatively negligible effect. Figure 1.2 highlights the magnitude of each of the sector updates for projected emissions.

Figure 1.1 A comparison of total non-CO2 GHG emissions in the previous projections from Autumn 2013 with the current Summer 2014 projections

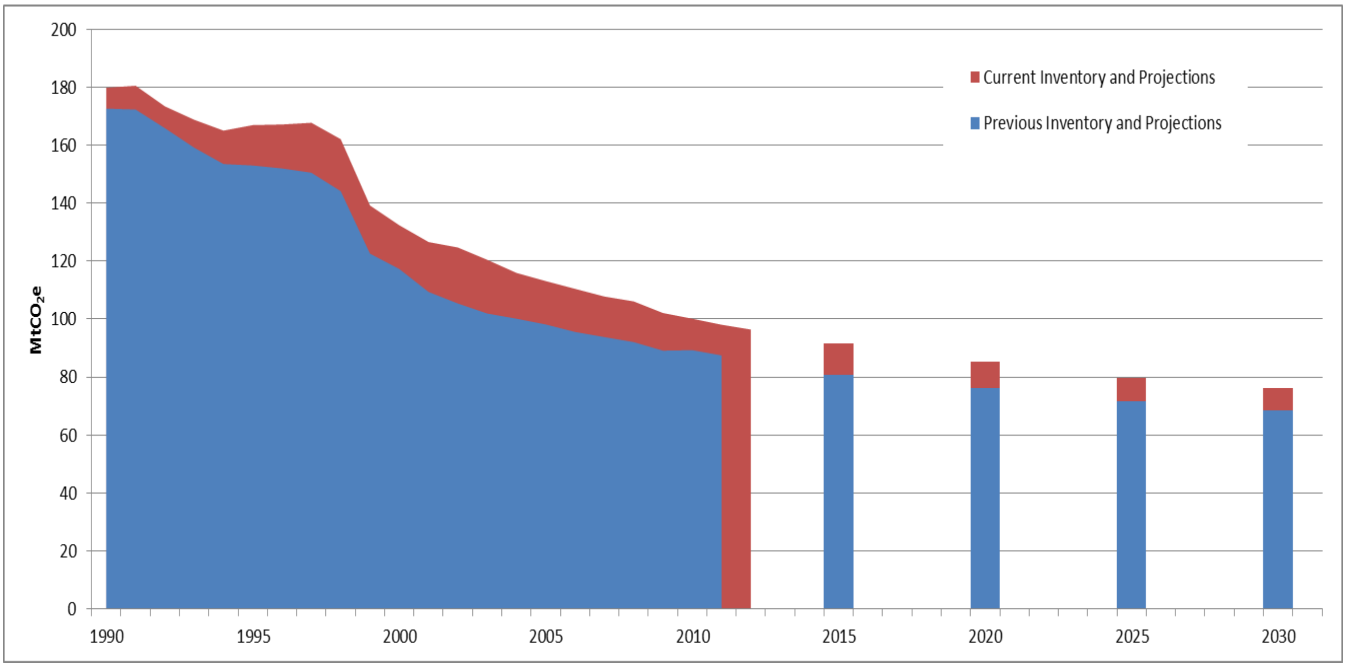
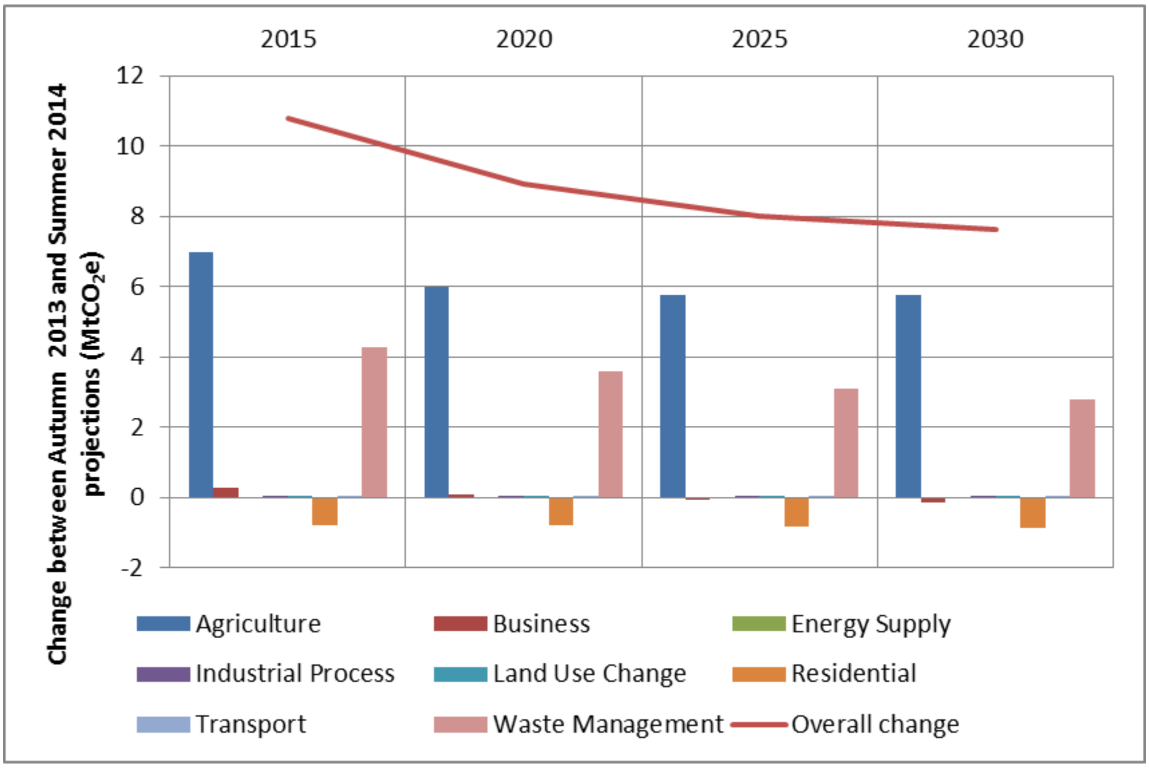


Figure 1.2 Magnitude of changes to the projected emissions between the Autumn 2013 and Summer 2014 non-CO2 projection publications.



Acknowledgements

We are grateful for the advice and support of the non-CO_2 GHG emissions projections Steering Group. We are also grateful for the contributions and support provided by Ricardo-AEA, The Centre for Ecology and Hydrology and members of staff at DECC, Defra and other government departments.

1. Introduction

1.1 Overview

Emissions projections are used as a way of monitoring progress towards the UK's emission reduction targets and in turn identifying emission sources to target with new measures. The UK government has set targets for reductions in greenhouse gas emissions out to 2050 (**DECC, 2013c**). Therefore a regularly updated set of projections is required as UK policy and understanding of likely future emissions evolves. The UK is also required to submit projected emissions of greenhouse gases biennially under the European Union Monitoring Mechanism Regulation, and periodically in the form of National Communications to the UNFCCC.

These projections were previously produced biannually in March and September. Following stakeholder consultation last year (**DECC, 2013b**), the projections have now moved to an annual publication schedule. This publication of the projections is the first on the new schedule. A major aim of moving to an annual publication schedule is to provide more resources to make improvements to the projections. The coming year will therefore see a number of improvements planned for these projections.

1.2 Scope

The projections which accompany this report are for the non-energy related, non-CO_2 component of the Kyoto Protocol's basket of greenhouse gases (GHG) and are collectively referred to as the non-CO_2 GHGs. These are:

- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and,
- Sulphur hexafluoride (SF_6).

* The HFCs, PFCs and SF_6 are also collectively known as the "F-Gases"

Projected emissions of CO_2 are reported in DECC's Updated Emissions Projections (**UEP, DECC 2013b**) and are not included within the coverage of this report or associated projections. Likewise, non-CO_2 GHG emissions which are produced as a result of combustion activities are also reported in the UEP.

This report contains projected emissions as well as descriptions of the methodologies, data and assumptions used to estimate these emissions of the above listed non-CO_2 GHG emissions from UK and Crown Dependency (CD) anthropogenic (man-made) non-energy related sources out to 2030.

Projected emissions are presented in CO_2 equivalent (CO_2e), according to Global Warming Potentials (GWP) set out in the International Panel on Climate Change (IPPC) Second Assessment Report (SAR). Note that as of 2015, the GWPs from the IPCC's Fourth Assessment Report will be adopted by the UK's Greenhouse Gas Inventory (see **IPCC, 2007**). The resultant changes to the GWPs and gases considered will therefore also be reflected in next year's non-CO_2 projections.

1.3 Current UK GHG emissions

As part of the UK's commitments for reporting its GHG emissions, a national inventory is produced each year containing estimates for the UK's GHG emissions from all anthropogenic sources. This is referred to as the GHG Inventory (GHGI) and is annually submitted to the UNFCCC. Note that the GHGI submitted to the UNFCCC has a subtly different scope to the scope considered here, in part due to the inclusion of Overseas Territories in the UNFCCC GHGI. In both DECC's National Statistics and the projections presented here, only the UK and CD portion of the GHGI is considered. All reference to the GHGI in this report refers to this UK and CD scope.

The latest National Statistics on GHGI emissions were published in February 2014 and contain estimates for emissions from 1990-2012 (**DECC, 2014a**). Total emissions in 2012 were estimated at 575.4 MtCO_2e, excluding the effects of emission trading under the European Union Emissions Trading System (EU ETS). Of these total emissions, non-CO_2 GHGs consistent with the coverage of this report represented 96.4 MtCO_2e. The current situation with each of the non-CO_2 GHGs is as follows:

- **Methane (CH_4)** – CH_4 represents 50% of non-CO_2 GHG emissions. The Agriculture sector as a whole accounts for 46% of all CH_4 emissions, while the Waste Management sector accounts for 42%. The remaining 12% of CH_4 emissions are largely attributed to the Energy Supply sector.

- **Nitrous oxide (N_2O)** – N_2O represents 35% of non-CO_2 GHG emissions. The majority of N_2O emissions, 89%, are attributed to the Agriculture sector. The remaining 11% are split approximately evenly between the Business, Transport, Waste, and LULUCF sectors, with minor contributions from the Industrial Processes and the Residential sectors.

- **F-Gases (HFCs, PFCs and SF_6)** – HFCs represent 14% of non-CO_2 GHG emissions, while PFCs and SF_6 represent less than 1%. Refrigeration and air conditioning account for 81% of HFC emissions, with the dominant source being mobile air conditioning. Other significant HFC emissions sources include aerosols and metered dose inhalers (e.g. asthma inhalers). The major sources of PFC emissions are primary aluminium production, halocarbon production and the electronics industry. SF_6 emissions are largely attributable to electrical insulation.

Further details on breakdown of each of these gases to specific activities can be found in the latest National Statistics release and the National Inventory Report (NIR) (**DECC 2014a**)

The data and compilation methods used in the GHGI are reviewed annually and where appropriate the estimation methodologies are revised and improved. Updates to the methodology used to calculate the GHGI have subsequent effects on the projections, as the historical emissions time-series provides the baseline for the emissions projections. Section 2.1 provides further details of how previous projections are rebaselined in order to account for the updated GHGI.

1.4 UK emissions reduction targets

The UK has both international and domestic targets for reducing greenhouse gas emissions. Please note that these targets encompass all GHG emissions, not just the non-CO_2 component projected in this report. Emissions reductions targets can be summarised as follows:

Kyoto Protocol target

The Kyoto Protocol set a legally binding commitment for the UK to reduce its greenhouse gas emissions to 12.5 per cent below the base year level over the period 2008-2012. The Kyoto Protocol uses a base year which is comprised of 1990 for CO_2, CH_4 and N_2O, and 1995 for F-gases. In July 2007, the UK's Kyoto base year figure was set at 779.9 million tonnes CO_2 equivalent, based on the 2006 UK GHGI submission. This means that to meet the UK's Kyoto commitment, greenhouse gas emissions must be below 682.4 million tonnes CO_2 equivalent on average per year over the first five year commitment period of the Protocol (2008-2012). In accordance with this average yearly target, the Kyoto Protocol target for the UK was then set at 3,412 million tonnes carbon dioxide equivalent over the full five year period - this is the UK's *Assigned Amount*. Final figures for the UK's emissions under the Kyoto Protocol first commitment period will not be finalised until 2015, following the end of commitment period true-up period. For more details of the UK's first Kyoto commitment, see the UK Initial Report under the Kyoto Protocol (**Defra, 2006**).

The second commitment period of the Kyoto Protocol will run for eight years, from 2013 to 2020 inclusive. The EU has made a commitment to reduce emissions by 20 per cent below base year levels on average over the period, largely consistent with its own target (see below). Any Kyoto target would cover the UK, and the relevant Crown Dependencies and Overseas Territories that wish to join the UK's ratification.

UK Climate Change Act

This Act established a legally binding target for the UK to reduce its greenhouse gas emissions by at least 80 per cent below base year levels by 2050 (**DECC, 2013c**). It also established a system of binding five-year carbon budgets to set the trajectory towards this target.

The Government set the first three carbon budgets in May 2009, covering the periods 2008-12, 2013-17 and 2018-2022. The fourth carbon budget, covering the period 2023-27, was set in June 2011. The first of these budgets requires that total UK greenhouse gas emissions do not exceed 3,018 $MtCO_2e$ over the five-year period 2008-12. The fourth carbon budget was set so as to require a reduction in emissions of 50 per cent below base year levels over the period 2023-2027.

Like the Kyoto Protocol, the Act uses a base year which is comprised of 1990 for carbon dioxide, CH_4 and N_2O, and 1995 for fluorinated compounds. However, this base year figure differs from that used for reporting against the Kyoto Protocol in that the baseline is revised each year to incorporate revisions made to 1990 and 1995 emissions data, whereas the Kyoto Protocol base year emissions are fixed. Table 1.1 below shows details of the first four carbon budgets.

Table 1.1 Summary of UK Carbon Budgets, 2008-2027

	Budget 1	Budget 2	Budget 3	Budget 4
	2008-12	**2013-17**	**2018-22**	**2023-27**
Budget level ($MtCO_2e$)	3018	2782	2544	1950
Equivalent average annual emissions ($MtCO_2e$)	603.6	556.4	508.8	390

European Union 2020 target

As part of the European Union (EU) Climate and Energy Package, the EU has committed to reducing overall greenhouse gas emissions across the EU28 member states by 20 per cent relative to 1990 levels by 2020. The EU's commitment for the second commitment period of the Kyoto Protocol is to reduce emissions by 20 per cent below the Kyoto Protocol base year during the second commitment period. Although the two targets are consistent, there are some differences such as scope and base year.

EU Member States have agreed to emissions reductions targets which will deliver this 20 per cent reduction across the EU as a whole. These targets have been agreed based on a combination of the EU Emission Trading Scheme (ETS) emissions caps, which have been set so as to give a 21 per cent reduction in emissions over the period relative to 2005 levels, together with reduction in emissions from the other sectors not covered by the EU ETS . This latter category of emissions is covered by the EU *Effort Share Decision*. Under this Decision, the UK has committed to reducing emissions from sectors not covered by the EU ETS by 16 per cent over the period relative to 2005 levels.

1.5 Structure of report and accompanying spread sheet

The next chapter of this report details the general methodology used to produce the emissions projections. This is followed by a chapter summarising the projections and then individual chapters providing a breakdown of projections for each sector. Each sector chapter will summarise the projections for that sector and state any new information feeding into this year's projections. Then it will describe for each gas:

- What has driven historical changes in emissions, what is expected to drive future changes in emissions and how this is modelled.
- Any changes in the projections since the previous publication.

After the sector chapter, the uncertainties in the projections will be presented. This is followed by the Annexes which contain a summary of projection methods, a summary of non-CO_2 gases covered by the UEP (**DECC 2013b**) and summary tables of the projections.

There are detailed tables of projections in a spread sheet that accompanies this report on the DECC website; see spread sheet *Non-CO_2 GHG emission projections summary tables Summer 2014.xls*.

2. Projections methodology

This section provides descriptions of the approaches taken and general methodology used to produce the non-CO_2 GHG emissions projections. Detailed methodologies used to project emissions from each source are available in ANNEX A of this report.

2.1 Overview of methodology

Baseline

Emissions in the historical greenhouse gas and air quality pollutant inventories are calculated by the GHG Inventory Agency (currently a consortium led by Ricardo-AEA) under contract to DECC using a central database (the NAEI database), containing activity data (e.g. fuel use, livestock numbers) and emission factors (e.g. kg pollutant / tonne fuel used, / head livestock) (**DECC, 2014b**). A new GHGI is produced each year (*x*) detailing emissions from each source from 1990 to year *x* – 2 (e.g. the GHGI produced in 2014 provides emissions from 1990 - 2012).

The historical emissions estimates are revised each year to account for new information that becomes available, and methodological improvements. In order to maintain consistency with the historical GHGI, all projected emissions are calculated with reference to the most recent GHGI data. This means that the base year for the projections is taken to be the latest year in the GHGI, 2012 in this case.

Projections

The GHGI emissions from each source under coverage of this report are then projected from the latest GHGI year up to 2030 to form the DECC non-CO_2 GHG projections. Projections are based on a number of independently produced emissions projections, available from a variety of origins. The drivers on projections emissions are source specific and are discussed in the relevant sector chapters. These drivers range from simple assumptions to complex analytical models, depending on data availability and emissions magnitude. As noted above, the baseline GHGI is defined by activity data and emission factors. The projection drivers affect future activity data and/or emissions factors and thus form the emission projections. For example:

- A change in activity data could be projected changes to livestock numbers or changes in behaviour affecting the waste sector.

- A change in emission factors could be due to improvements to technology for the abatement of emissions.

Changes to projections

There are two ways that the projections can change.

Projection driver changes

The drivers of emissions projections, future activity data or emissions factors, may be updated. This happens annually for some emission sources and less regularly for some others. Any changes in projections for each source are discussed in the relevant sector chapter.

GHGI changes

There are two sources of change in the GHGI; the first is the change in activity between consecutive years, for instance the number of vehicles on the road between 2011 and 2012, the second is the methodological changes which affect the whole time series, for instance a recalculated emissions factor for a specific activity.

All projections that form the DECC model are rebaselined against the most recent GHGI emissions estimate for that year. Projections of emissions from a source that undergo annual updating of projection drivers will undergo rebaselining as part of the annual update. Projections of emissions from a source that do not undergo annual updating of projection drivers will be rebaselined as detailed below. The 'rebaselining factor' is calculated and then applied to all future emissions estimates in that time series. Table 2.1 illustrates this process with a simple example.

Table 0.1 Simple rebaselining example

Rebaselining process (all numbers are kT CO_2e)	2011	2012	2015	2020	2025	2030
Previous GHG Inventory	1000					
Previous projections			750	400	250	150
Interpolated 2012 value (assumes a linear decrease between 2011 and 2015)		937.5				
New GHG Inventory	1000	900				
Rebaselining factor ('new' 2012 / interpolated 2012)		**0.96**				
New projections			720	384	240	144

Rebaselining of the projections is an area that will be investigated during the coming year's improvements program. The rebaselining performed to date serves a useful purpose of updating previous projections against an updated baseline. However, rebaselining does not account for the wide range of scenarios that lead to the baseline changing. Furthermore, rebaselining should be used as one of many tools to update projections, rather than a blanket approach. It is hoped that an improved, tailored methodology will be developed in its place.

The main methodological changes in the latest GHGI (1990-2012) which have an impact on the non-CO_2 GHG projections are laid out in the relevant chapters of this report. A series of more detailed descriptions of these changes are available in the NIR which is available online (**DECC, 2014b**).

The central projection estimate

The UNFCCC Guidelines for the preparation of National Communications (**UNFCCC, 1999**) require that policies and measures included in the central projection must correspond to those policies and measures that are implemented and adopted.

Implemented policies and measures are those for which one or more of the following applies: (a) national legislation is in force; (b) one or more voluntary agreements have been established; (c) financial resources have been allocated; (d) human resources have been mobilized. These are termed 'with measures' emissions projections, or sometimes referred to as "firm and funded". Adopted policies and measures are those for which an official government decision has been made and there is a clear commitment to proceed with implementation. Planned policies and measures are not included in the central projection; these are defined as options under discussion and having a realistic chance of being adopted and implemented in future.

The emissions projections included in this report are where possible based on all currently implemented and adopted policies and measures in accordance with the UNFCCC reporting guidelines. The exception is in the case of the updated EU F-gas regulations which we have not yet accounted for, though we plan to include this for next year's projections. These projections are distinct from 'with additional measures' projections that encompass planned policies and measures, and also distinct from 'without measures' projections that excludes all policies and measures implemented, adopted or planned after the base year.

2.2 Coverage of emissions in the non-CO_2 GHG projections

Geographical coverage

The projections of non-CO_2 GHG emissions in this report include the emissions from the Crown Dependencies (CDs): Guernsey, Jersey, Isle of Man, but exclude the emissions from the Overseas Territories (OTs) that have ratified the first commitment period of the Kyoto Protocol: Bermuda, Cayman Islands, Falkland Islands, Montserrat and Gibraltar. This coverage is consistent with DECC National Statistics on GHG emissions. However, it is not consistent with the geographical coverage of UK energy projections (**DECC, 2013a**), which are on a UK only basis.

Sectoral coverage

For the purposes of reporting, greenhouse gas emissions are allocated into National Communication (NC) sectors. These are a small number of broad, high-level sectors, and are as follows: energy supply, business, transport, public, residential, agriculture, industrial processes, land use land use change and forestry (LULUCF), and waste management.

These high-level sectors are made up of a number of more detailed sectors that follow the definitions set out by the IPCC for GHG inventories, and are used in international reporting tables submitted to the UNFCCC every year. A complete mapping of IPCC sectors to National Communication sectors is available on the DECC website (**DECC, 2011a**).

The sectoral assignments in this report are based on the source of the emissions as opposed to where the end user activity occurred.

Non-CO_2 sources excluded from this publication

Some categories of non-CO_2 GHG projections are excluded from the scope of this report. Where their projected trend is reliant on information within DECC's Updated Energy Projections (UEP) (**DECC, 2013b**), these categories are reported as part of that publication. This decision was taken to improve the quality and processes involved in the production of both CO_2 and non-CO_2 GHG projections. Examples of these categories include CH_4 and N_2O emissions from power stations and oil and gas production, which are driven by energy consumption, as well as a number of business categories such as 'combustion from iron and steel plants', 'auto-generators' and 'blast furnaces', which had previously been projected using UEP growth indexes as the drivers. A full list of categories which are included in DECC's UEP is given in Annex B. These projections are produced and presented in DECC's UEP publications. Categories will remain under review and additional categories may be added or removed. New categories which have been added to the latest GHGI which for methodological reasons were deemed to be better suited to production of the UEP, have also been transferred.

In order to maintain consistency and prevent a step change in the historical time series due to the removal of these categories, the transferred sectors have been removed from the time series as a whole.

The total non-CO_2 emissions in 2012 were 101.3 $MtCO_2e$, with 4.9 $MtCO_2e$ covered in the UEP publication and 96.4 $MtCO_2e$ covered in this publication. The new UEP covering this period will be published in Autumn 2014.

2.3 QA/QC procedures

A wide range of data is used in the projections and each source is quality assured. Many of the new data sources are publicly available (see references) and where possible data are subject to peer review. Data (activity data, emission factors and calculated emissions) that are part of the core GHGI are subject to rigorous QA/QC processes within the annual GHGI compilation cycle by the Inventory Agency, a consortium led by Ricardo-AEA, using a set of QC procedures developed over a number of years. These procedures are documented in Chapter 1 of the UK's latest NIR (**DECC 2014b**).

The projections have undergone significant verification and error checking by the production team. These include but are not limited to the following: consistency checks when transferring data; independent checks of every calculation; verification of workbook structure through mapping; comparison of absolute/percentage changes from the previous publication and checking final projections against source projections. The changes incorporated into this Summer 2014 update have also been quality checked, and overseen by the non-CO_2 GHG emissions projections Steering Group.

The risks surrounding the current level of QA is that errors introduced in previous year's projections would not necessarily be picked up. For this reason, a more formal, rigorous QA process will be conducted prior to next year's projections.

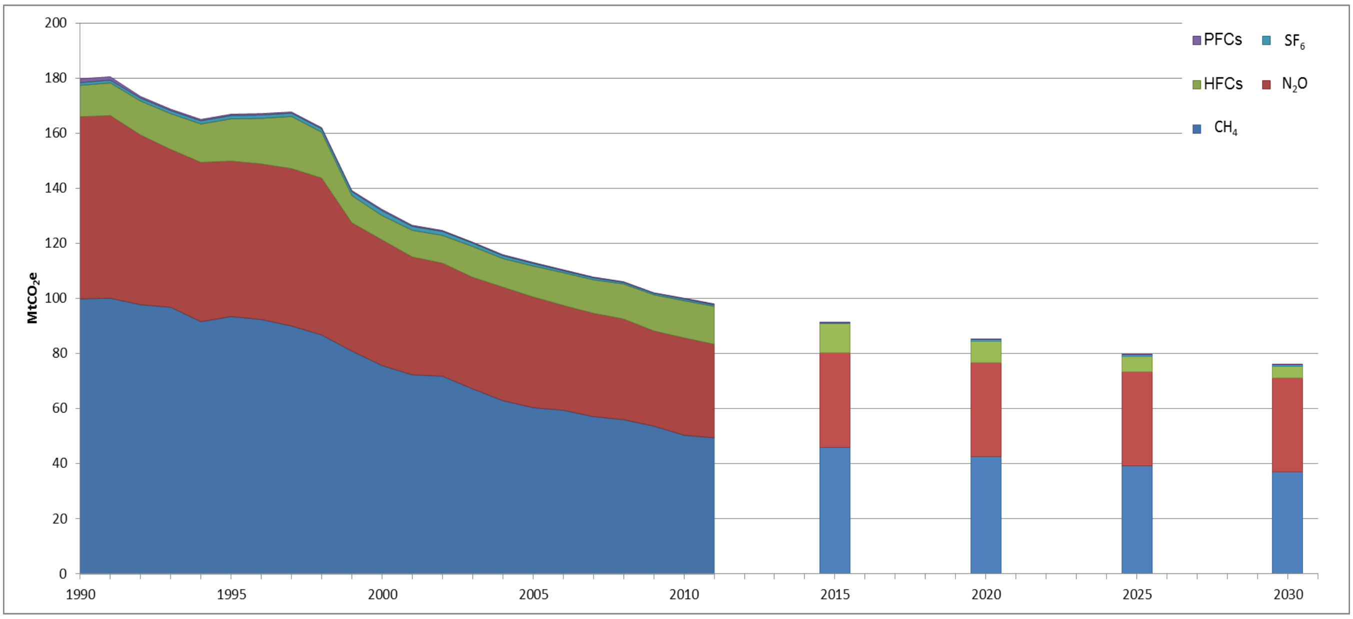
3. Summary of Summer 2014 non-CO_2 GHG projections

Summary of projections

The historical trend in non-CO_2 GHG emissions shows a significant reduction of 46% from 1990 to 2012 levels. The Summer 2014 update projects non-CO_2 GHGs to be approximately 76 $MtCO_2e$ in 2030; representing a projected 21% decrease between 2012 and 2030. This projected trend would represent a 58% reduction on 1990 levels.

The historical reduction in emissions from 1990-2012 comes largely from decreases in N_2O and CH_4 emissions (Figure 3.1) from a number of sectors (Figure 3.2) – Waste Management, Industrial Processes, Energy Supply and Agriculture have all seen large decreases in emissions since 1990**.**

Figure 0.1 Summary of projected non-CO2 GHG emissions by gas (MtCO2e)

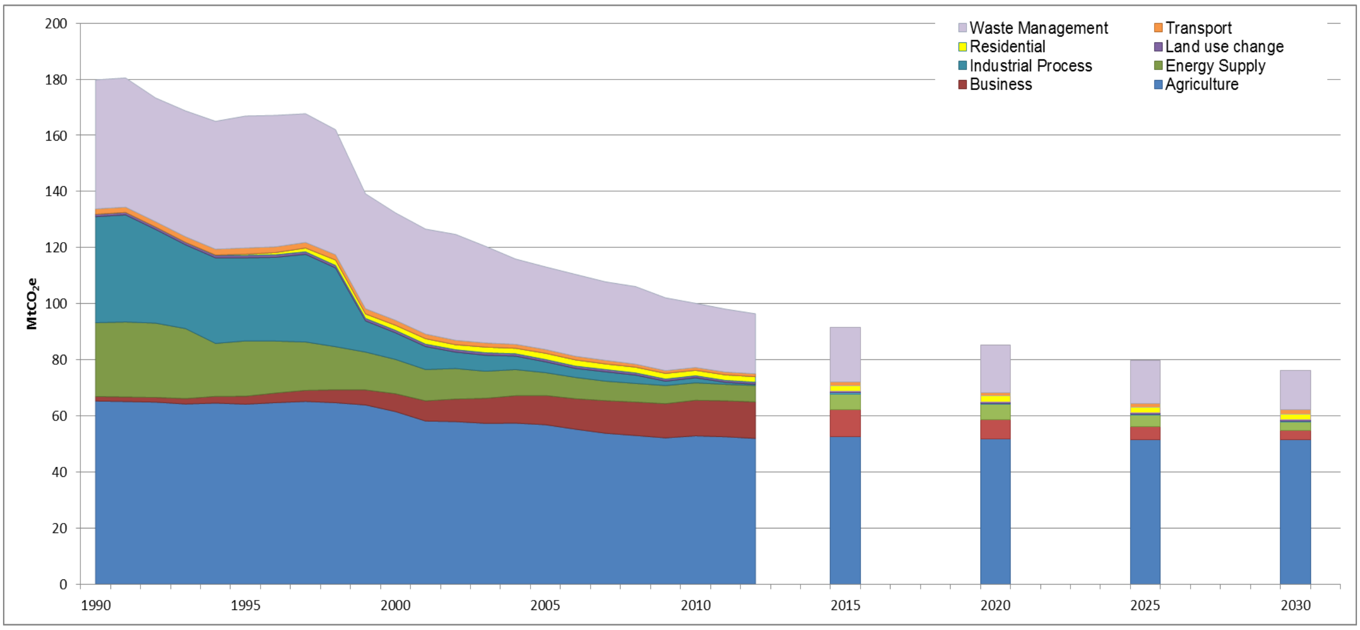


The majority of the projected reduction in emissions from 2012 to 2030 is predicted to come from decreases in CH_4 and HFC emissions, as can be seen in Figure 3.1. The sectors that these projected reductions are anticipated to come from are:

- Waste Management (a result of a decrease in the volume of waste sent to landfill and decreasing emissions from waste already in landfill);
- Business (as HFCs are replaced with lower GWP refrigerants);
- Energy Supply (as a result of the decrease in the quantity of coal produced and the replacement of cast-iron pipes with plastic in the gas distribution system).

These changes are visible in Figure 3.2.

Figure 0.2 Summary of projected non-CO_2 GHG emissions by National Communication sector ($MtCO_2e$)

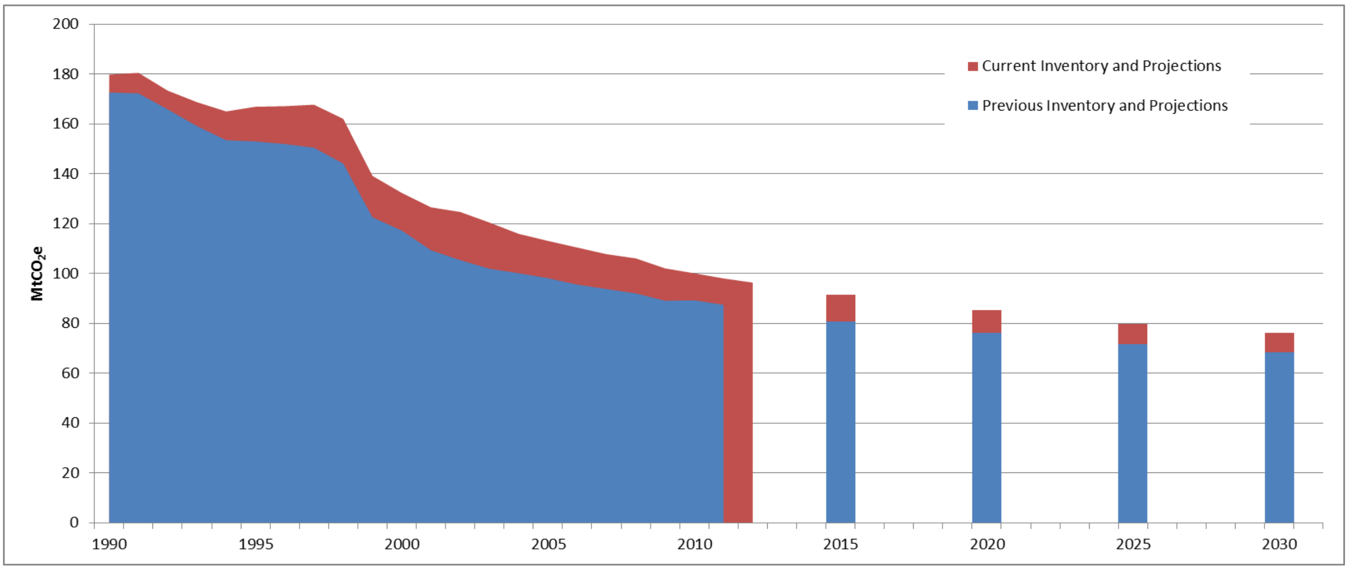


Changes since the previous projections publication

Since the last publication of non-CO_2 projections in Autumn 2013 (**DECC, 2013b**), a new GHGI has been produced. As discussed in Section 2.1, all projections in the current projections have been rebaselined to this latest GHGI. This causes changes to all the projections. In addition there are new modelled projections from

- Agriculture
- Land use, land use change and forestry (LULUCF)
- Road transport (transport sector)
- Off-road transport (business, residential and transport sectors)
- A new GHGI category in the business sector

Figure 0.3 A comparison of total non-CO_2 GHG emissions in the previous projections from Autumn 2013 with the current Summer 2014 projections

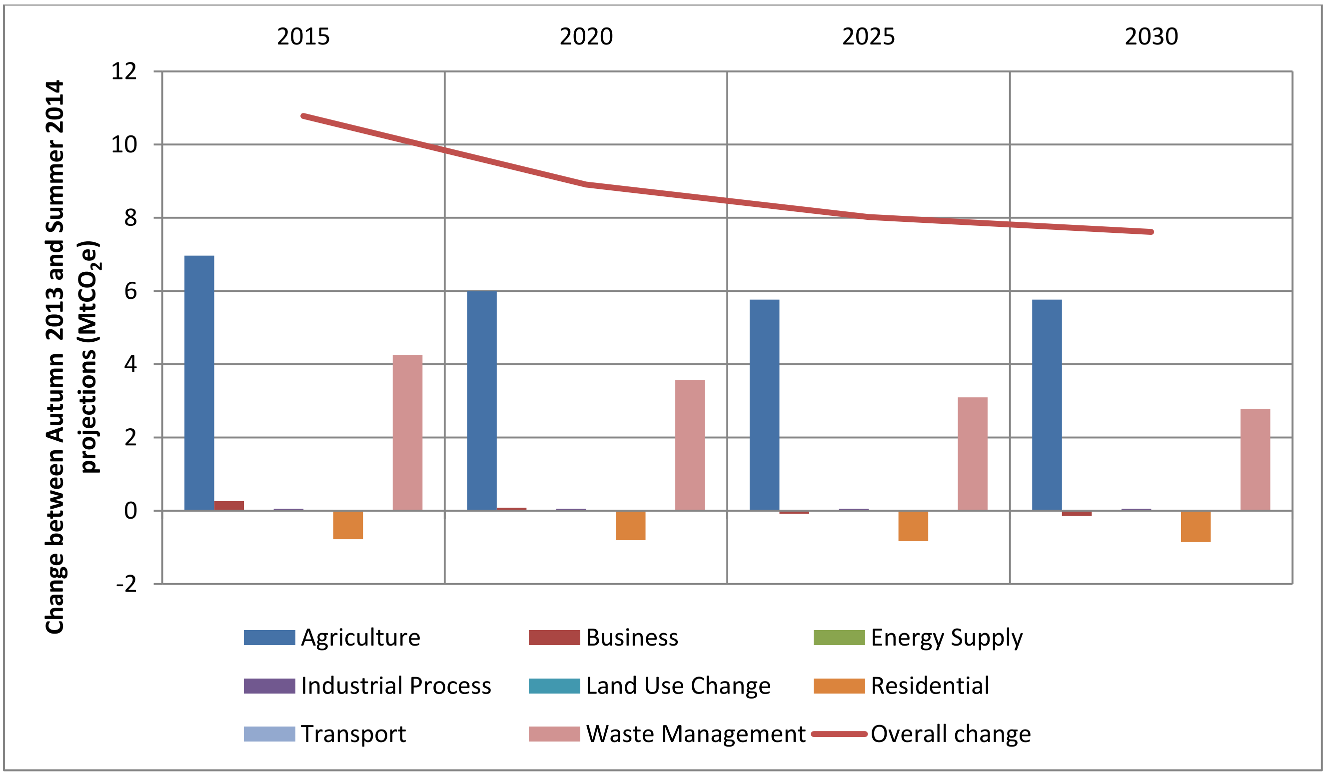


A comparison of the Autumn 2013 and Summer 2014 projections can be seen in Figure 3.3. The historical emissions are greater across the whole time series in Summer 2014 compared to

Autumn 2013 which causes a similar increase in projected emissions. The Summer 2014 projections also decrease at a 0.7% faster rate than the Autumn 2013 projections.

These changes in historical and projected emissions are caused most significantly by GHGI methodology changes affecting CH_4 and N_2O emissions in the Waste and Agriculture sectors. There is also a GHGI methodology change in the residential sector that causes a decrease in projections of residential emissions. The other sectoral changes have comparatively negligible effect. Figure 3.4 below highlights the magnitude of each of these updates on the projections. Details of all of the updates are laid out in the relevant sector specific chapters below.

Figure 3.4 Magnitude of changes to the projected emissions between the Autumn 2013 and Summer 2014 non-CO2 projection publications.



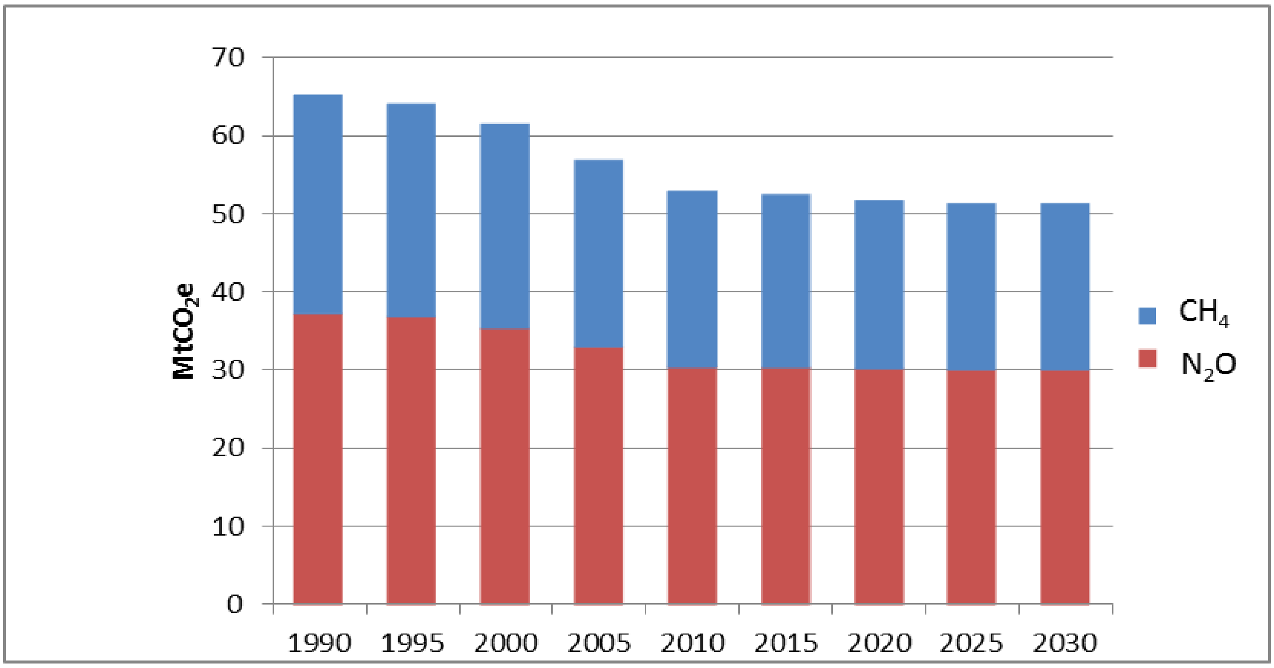
Projections of non-CO_2 GHG by National Communication Sector

4. Agriculture Sector

The Agriculture sector is the single largest contributor to overall non-CO_2 greenhouse gas emissions presented in this report. In 2012 non-CO_2 emissions from agriculture were 51.9 $MtCO_2e$ which represented 54% of the UK's total non-CO_2 emissions. Two gases represent the non-CO_2 contribution to emissions from this sector, N_2O and CH_4.

Since the Autumn 2013 update to the non-CO_2 projections, projections in this sector have been updated by Defra (**Defra 2014**) to reflect the new GHGI and a new set of agriculture activity projections. Overall emissions from the agricultural sector are projected to be 51.4 $MtCO_2e$ in 2030 which corresponds to a reduction in emissions of approximately 1% on the 2012 level. Emissions are predicted to increase slightly to 2015, then decrease slightly to 2022 at which point they remain at a constant level. The presence of the flat line in emissions is due to limitations in Defra's agriculture projections, which only projects activity from the sector out to 2022. The key drivers for the reduction in emissions over the projection period are the decline in crop areas – and corresponding fall in fertilizer application - due to continued growth in crop yields, and the anticipated fall in the beef and dairy herd in line with long-run trends and a rise in projected milk yields. Sections 4.1 - 4.3 contain more detail on the current projections and the changes since the last update for both of the gases.

Figure 4.1 – Non-CO2 GHG emissions projections for the agriculture sector

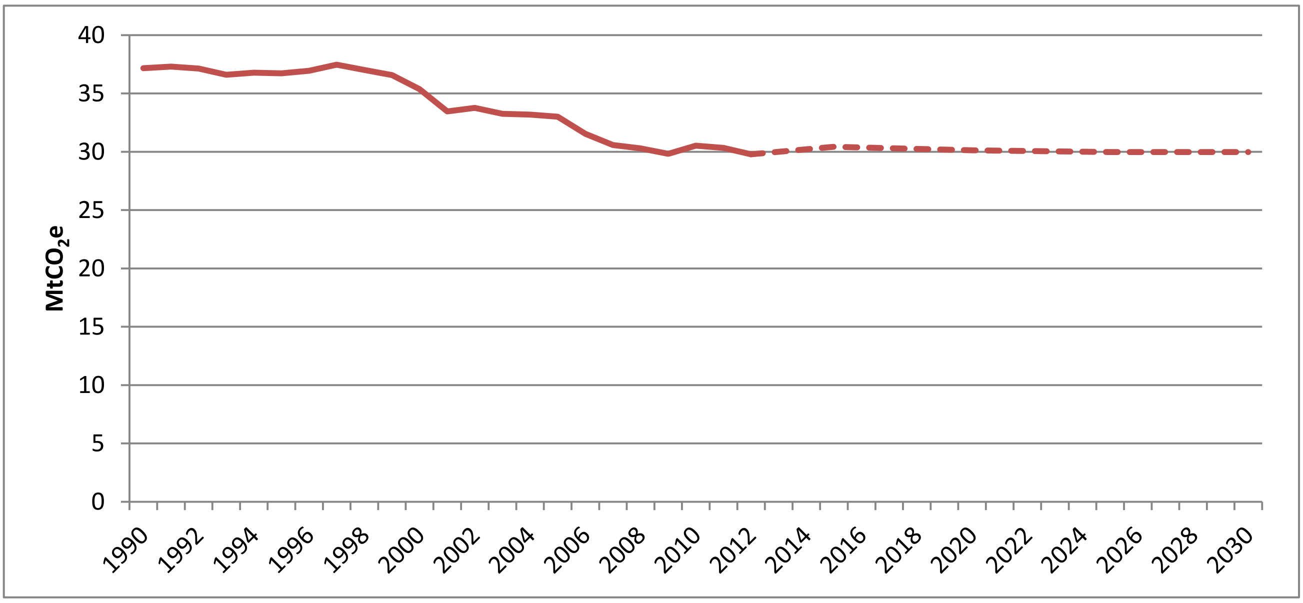


4.1 Agriculture sector nitrous oxide emissions

Agricultural N_2O represents the most significant contributor to overall UK N_2O emissions, and represents 89% of the total N_2O emissions in 2012. Emissions of N_2O in the agriculture sector come from agricultural soils and manure management systems. Field burning was also a contributing emission until 1993. The most significant contributor is agricultural soils which in 2012 represents 91% of agricultural N_2O emissions and 81% of total N_2O from all sectors covered by this report.

Nitrous oxide emissions from the agriculture sector have declined since 1990; with emissions in 2012 being 20% lower than the base year. Emissions are projected to increase from 29.8 $MtCO_2e$ in 2012 to a maximum of 30.6 $MtCO_2e$ in 2016, and then decrease to 30.0 $MtCO_2e$ in 2022. The trend then flat-lines to 2030 due to the projection time horizon of the Defra agriculture projections (see Figure 4.2).

Figure 4.2 Historical trend and projections of N_2O emissions from agriculture



Agriculture emissions projections (**Defra, 2014**) are produced by using the FAPRI-UK agriculture activity projections model (**FAPRI, 2012**) which projects agricultural activity out to 2022. The agriculture projections are converted to agriculture emissions projections (**FAPRI, 2010**) using the latest agriculture GHGI emission factors methodology (**DECC, 2014b**). Post-2022 projections are flat lined. Further details on the FAPRI-UK model are found in Annex A.

Defra's agriculture projections estimate a reduction in total UK fertiliser due to a small reduction in arable area, as well as significantly reduced application rates to grasslands through better nutrient advice. This contributes to the overall reduction in N_2O emissions from the sector. Decreases in the number of livestock (namely, cattle) also impact the level of N_2O emissions by leading to fewer N_2O emissions from manure management.

It should be noted that these projections are based on a specific set of international prices for agricultural commodities and a particular path for the sterling exchange rate. Together these factors are important determinants of the returns to farmers and hence total agricultural production. Sterling is projected to strengthen against the Euro over the period. This will affect UK agriculture in a number of ways: i) through a reduction in the prices paid to UK farmers relative to European farmers and associated relative returns; ii) through a reduction in demand for UK exports as these become less competitive with European products; and, iii) through reductions in the domestic value of the single farm payment which is set in Euros.

In line with the methodology adopted by Defra, the effects of the industry led, voluntary Agricultural Action Plan for emissions reductions have not been taken into account in these projections.

Changes in agriculture sector nitrous oxide emissions since the previous update

N_2O emissions projections for the agricultural sector depend on both the GHGI used as a baseline and Defra's agriculture activity projections. Since the Autumn 2013 update, there has been a new GHGI and a new set of agriculture activity projections. Therefore Defra have produced a new set of N_2O emissions projections for the agricultural sector (**Defra, 2014**).

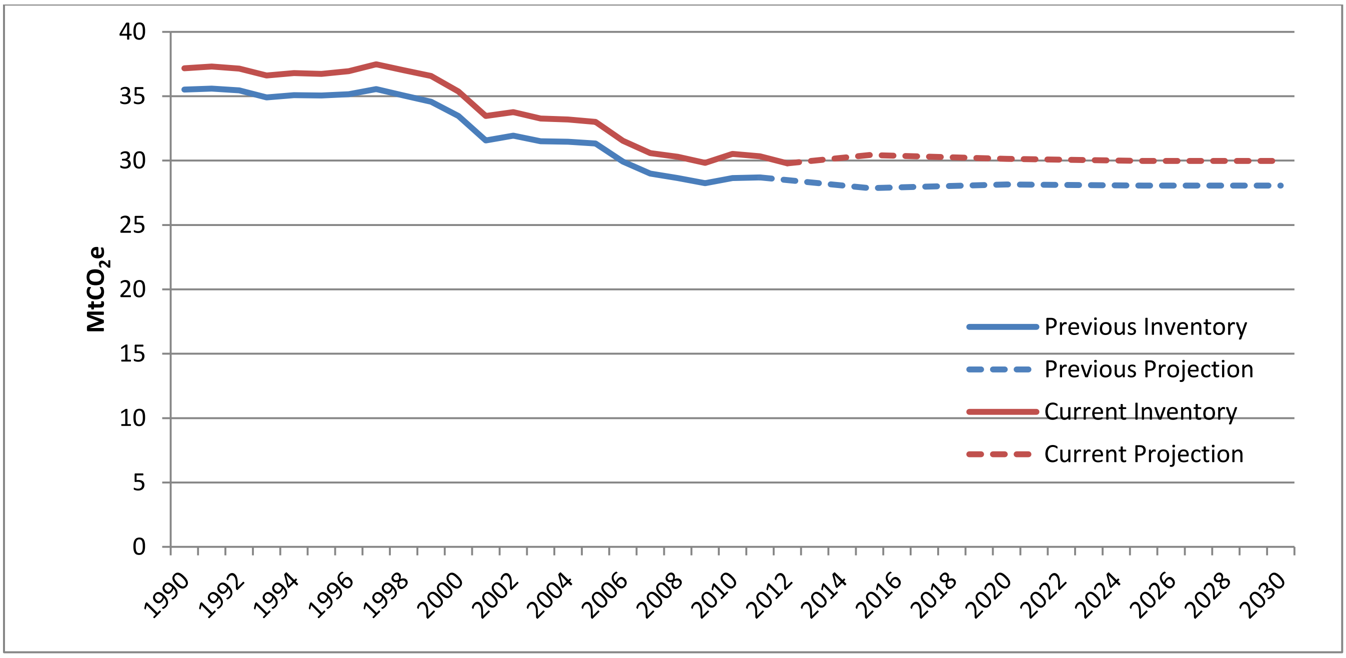
Agriculture activity data projections (livestock numbers, crop production, fertiliser N use) to 2022, including uncertainty estimates, were generated in December 2013 but have not been subjected to the normal FAPRI-UK process of stakeholder review. Whilst the projections represent a consistent set of outcomes based on the model, they may not reflect the most up-to-date view from the sector itself. Furthermore, the percentile projections were derived using a preliminary stochastic methodology. Since December 2013 the methodology has been updated, resulting in narrower 10th and 90th percentiles.

The agriculture emission projections have been revised significantly upwards due to changes in the GHGI model. These changes reflect comments from the UNFCCC Expert Review Team (ERT), in particular with regards to the categorisation of manure management and associated emission factors. To understand the change, first note that livestock excrete nitrogen which is then converted to N_2O. The degree of conversion is determined by the type of manure management system used. One major driver of GHGI change surrounds the ERT's concerns with the assumption that 'no further storage' was equivalent to 'daily spread'. Often manure will remain in house following removal of the animals and therefore although no further storage takes place, 'daily spread' is an inaccurate classification. Stored manure and the associated emissions were considered to be underestimated as a result. The introduction of 'deep litter' manure categorisation overcomes this underestimation. The result of the change to the manure management system has been to increase N_2O emissions by approximately 2 $MtCO_2e$ across the time series.

Finally, some of the Scottish crop production data were updated for 2008 to 2011 due to improved data sources. Some crop production values were also updated for England & Wales (from 2006) from improved data supplied by Defra. Also, the time series data on amounts of sewage sludge produced was updated with data provided by Ricardo-AEA in agreement with the Waste sector. These changes had a small net effect on N_2O emissions.

The total effect of these changes is to increase the projected emissions of N_2O by approximately 2 $MtCO_2e$ in 2022, before remaining at this level out to 2030 due to the flat-lining process explained above. Figure 4.3 highlights the effect that the new GHGI has had on agricultural N_2O emissions going forward.

Figure 4.3 Autumn 2013 and Summer 2014 agriculture sector N2O projections

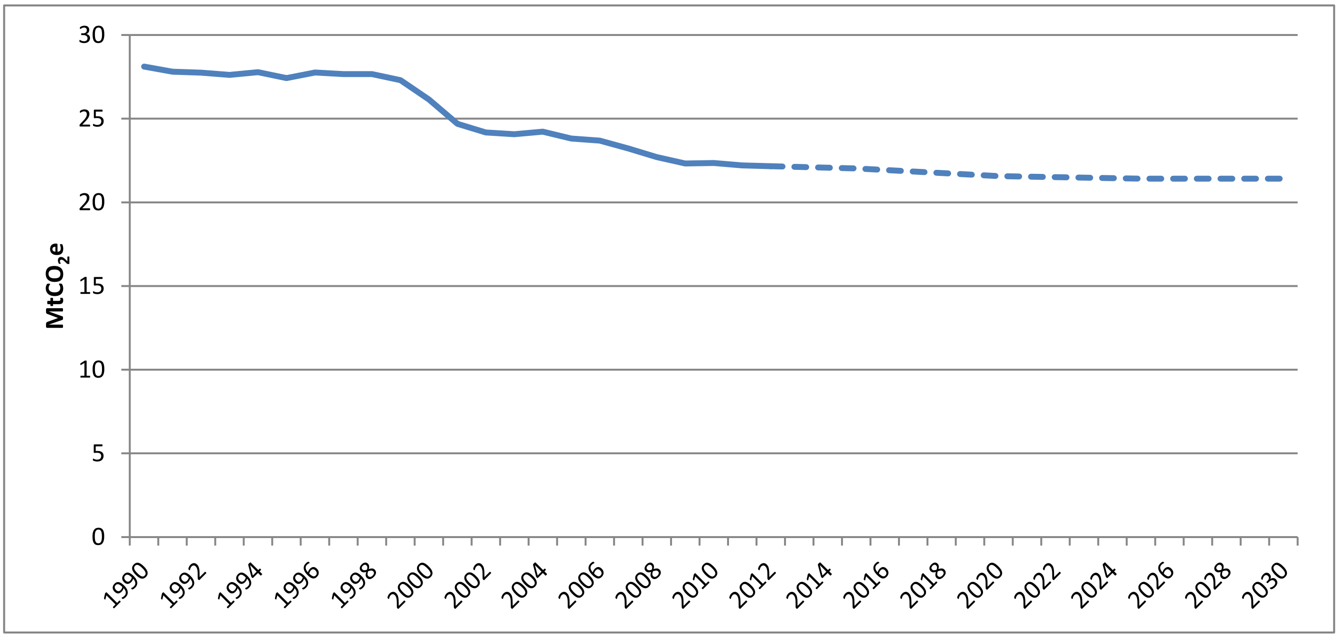


4.2 Agriculture sector methane emissions

As with N_2O emissions, agriculture is the highest contributing sector to total CH_4 emissions for the UK, representing 46% of total CH_4 emissions from the sectors considered in this report in 2012. The sources of CH_4 in the agriculture sector are enteric fermentation by livestock, particularly cattle, and livestock wastes. The split is approximately 70% due to enteric fermentation and 30% due to livestock wastes.

Methane emissions from the agriculture sector have declined since 1990; with emissions in 2012 being 21% lower than the base year. Emissions are projected to decline from 22.2 $MtCO_2e$ in 2012 to 21.4 $MtCO_2e$ in 2022, a reduction of just over 3% (see Figure 4.4).

Figure 4.4. Historical trend and projections of CH_4 emissions from agriculture



As with N_2O, agriculture CH_4 emissions projections are produced using the FAPRI agriculture activity projections with the agriculture GHGI emission factors. Similarly, the trend flat lines from 2022 to 2030 due to projection time horizon of the Defra FAPRI-UK model.

The projected trend in CH_4 emissions is due to an anticipated reduction in the size of livestock herds and therefore their associated enteric fermentation and waste emissions.

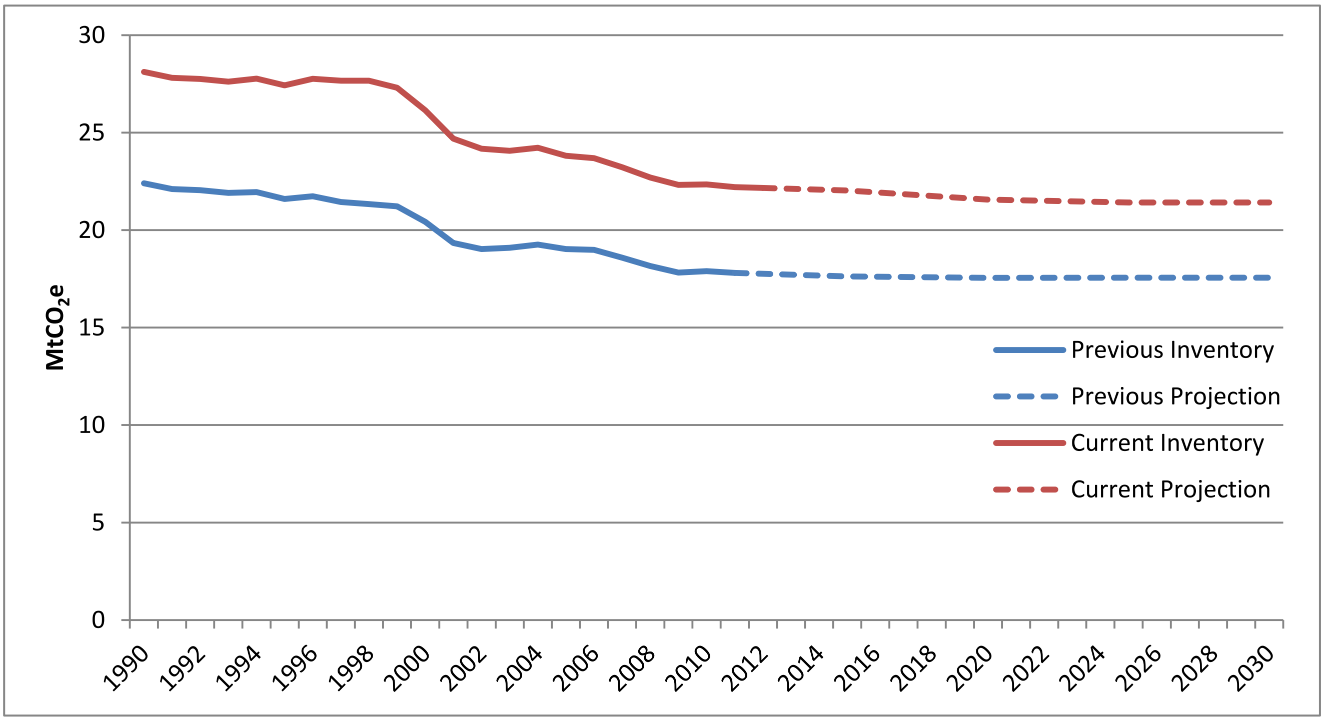
Changes in agriculture sector methane emissions since the previous update

The GHGI categorisation changes in manure management system that affected N_2O emissions have an even greater effect on CH_4 emissions. The same change as described in the N_2O section also applies here and there is an additional effect that the CH_4 conversion factor (MCF) for 'deep litter' is estimated to be 39%, as opposed to the 'solid storage' MCF of 1%. The result of the change to the manure management system has been to significantly increase CH_4 emissions across the time series.

Finally, activity data for horses has been revised to include both agricultural and non-agricultural horses for the whole time series which causes an increase in emissions throughout. The change in manure management categorisation is the dominant effect on the change in projections though.

The total effect of these changes is to increase the projected emissions of CH_4 by approximately 4 $MtCO_2e$ in 2022, before remaining at this level out to 2030 due to the flat-lining process explained above. Figure 4.5 highlights the effect that the new GHGI has had on agricultural CH_4 emissions going forward.

Figure 4.5 Autumn 2013 and Summer 2014 agriculture sector CH4 projections

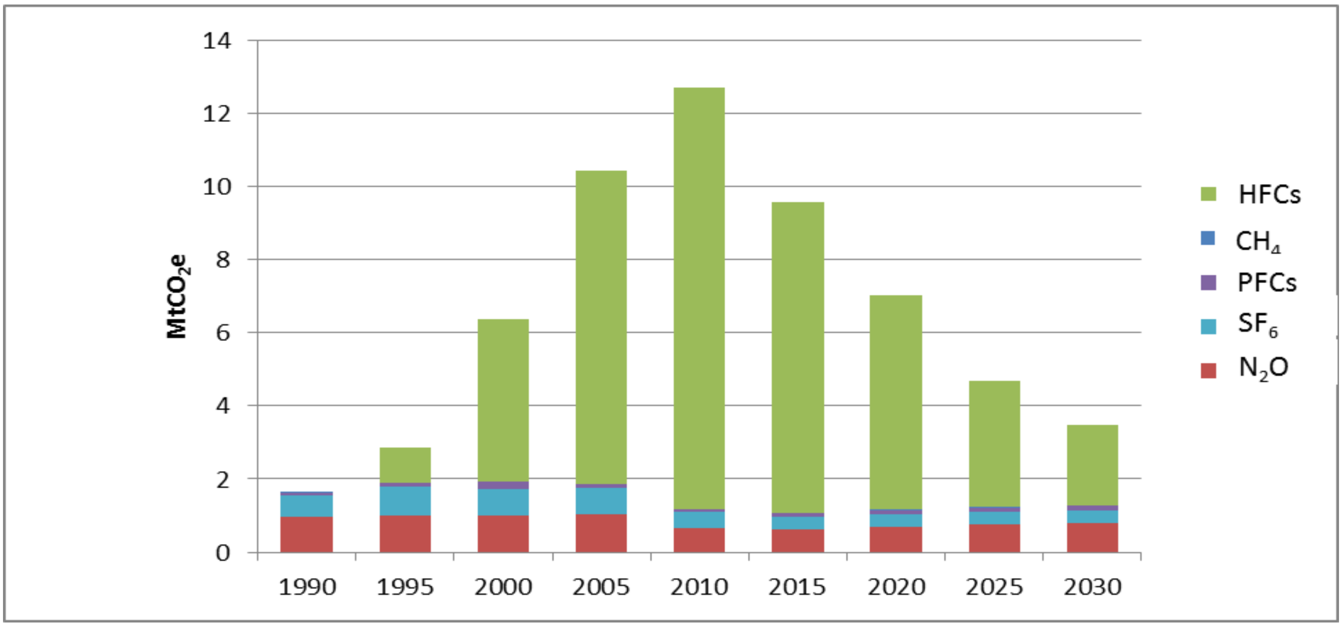


5. Business Sector

In 2012 non-CO_2 emissions from the business sector were 13 $MtCO_2e$, representing around 14% of the UK's total non-CO_2 emissions. All non-CO_2 GHGs contribute to emissions from this sector: N_2O, CH_4 and the F-gases (HFCs, PFCs & SF_6). Historically, business sector emissions have increased by 11.4 $MtCO_2e$ since 1990, reaching their highest point in 2012. This resulted from a replacement of CFCs with HFCs as a result of the Montreal Protocol.

Since the Autumn 2013 update to the projections, projections from this sector have been updated to reflect the changes in the new GHGI. Furthermore, new projections of emissions from industrial off-road mobile machinery have been included. Overall emissions from the business sector are projected to be 3.5 $MtCO_2e$ in 2030 which will correspond to a decrease in emissions of 73% from 2012 (See Figure 5.1). The projected emissions are strongly affected (i) by EU F-gas regulation driving the replacement of HFCs with other refrigerants with a lower Global Warming Potential (GWP), and (ii) because leakage rates from refrigeration equipment are now much better controlled than in the 1990s. Sections 5.1 - 5.3 contain more detail on the current projections and the changes since the last update for each of the gases.

Figure 5.1 – Non-CO2 GHG emissions projections for the business sector



5.1 Business sector F-Gas emissions

F-gas emissions were estimated to be 12.4 $MtCO_2e$ in 2012, representing 95% of non-CO_2 GHG emissions from the business sector. The vast majority of F-gas emissions, 96%, are **HFCs**. The majority of these emissions were from refrigeration and air conditioning (RAC), with contributions also from foams, fire fighting and solvents. Emissions of HFCs can occur at various stages of the RAC product life-cycle:

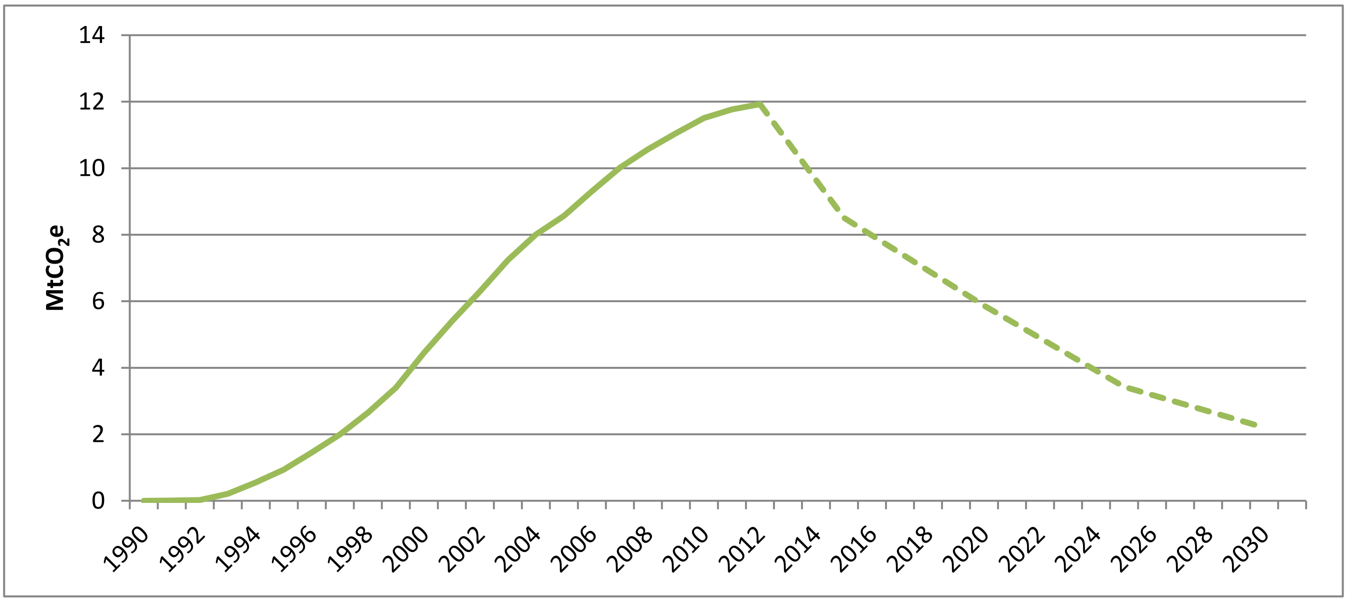
- During the refrigeration equipment manufacturing process;
- Over the operational lifetime of the refrigeration or air-conditioning unit; and
- At disposal of the refrigeration or air-conditioning units.

Emissions of **SF_6**, which are attributable to electrical insulation, the electronics industry, sporting goods manufacture and use as a tracer gas, were 0.4 $MtCO_2e$ in 2012. Emissions of **PFCs**, which are attributable to the electronics industry and sporting goods manufacture, were 0.08 $MtCO_2e$ in 2012.

Emissions of HFCs have increased rapidly since 1990 due to the phasing out of CFCs as a result of the Montreal Protocol, and the use of HFCs as replacement gases in a growing refrigeration and air conditioning sector. However, HFC emissions are projected to decline by 9.7 $MtCO_2e$, or 82%, between 2012 and 2030. The historical trend for HFC emissions is showing a levelling off in trajectory, consistent with its expected future decreasing trend (Figure 5.2). A major driver of this reduction is EU F-gas regulation which limits the use of high GWP F-gases and aims to replaces them with lower GWP refrigerants. Another driver is the fact that leakage rates from refrigeration equipment are now much better controlled than in the 1990s. This means older equipment is replaced by newer equipment with lower leakage rates, thus reducing fugitive emissions.

Note that the effects of the recent update to the EU F-gas regulation have not been included in these projections but will be included in next year's publication.

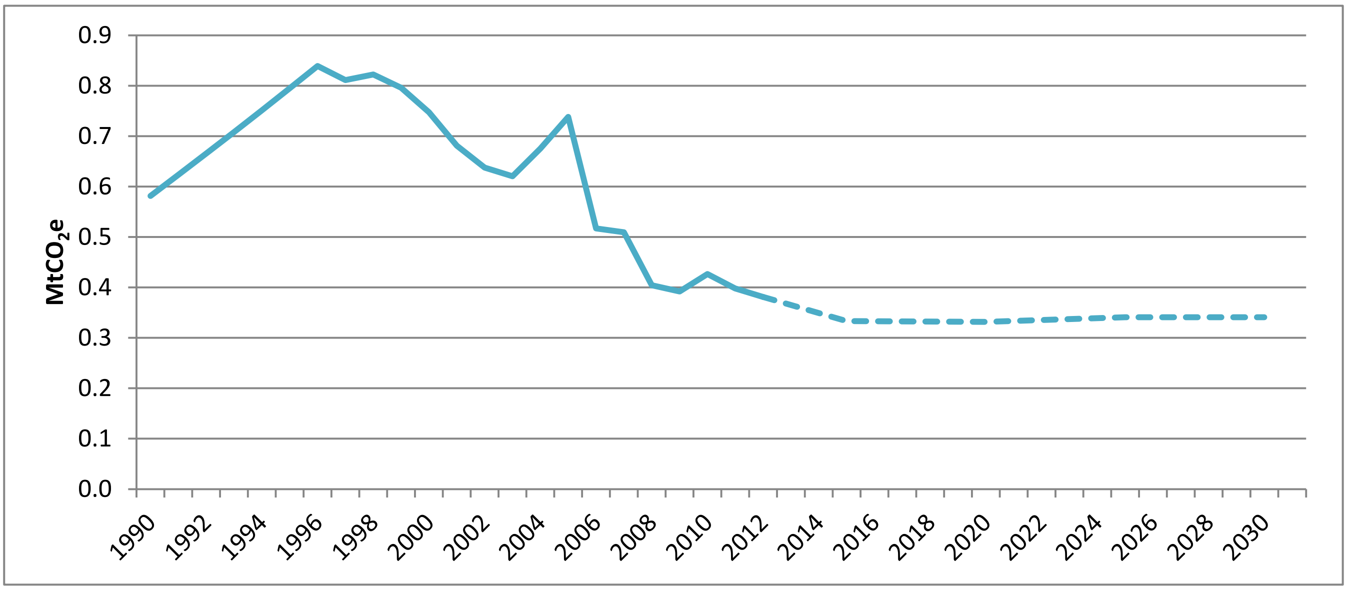
Figure 5.2 – Historical trend and projections of HFC emissions for the business sector



RAC emissions are estimated using a model developed by ICF International (**ICF, 2011**), based on industry input and a modelling approach consistent with IPCC guidance. The model is organized into 13 end-uses, and uses a bottom-up approach based on equipment stocks and average charge size from available market data. The model has been validated by comparing estimated refrigerant consumption (calculated as the amount of refrigerant used to manufacture new equipment produced in the UK plus the amount used to service leaking equipment) with annual refrigerant sales data from the British Refrigeration Association (BRA). Projections of HFC emissions from the other sources derive from work carried out in 2010 (**AEA, 2010a**). As such, projections from these sources may be outdated and will undergo significant revision before next year's publication. Further details on all of the f-gas projections methodologies are found in Annex A.

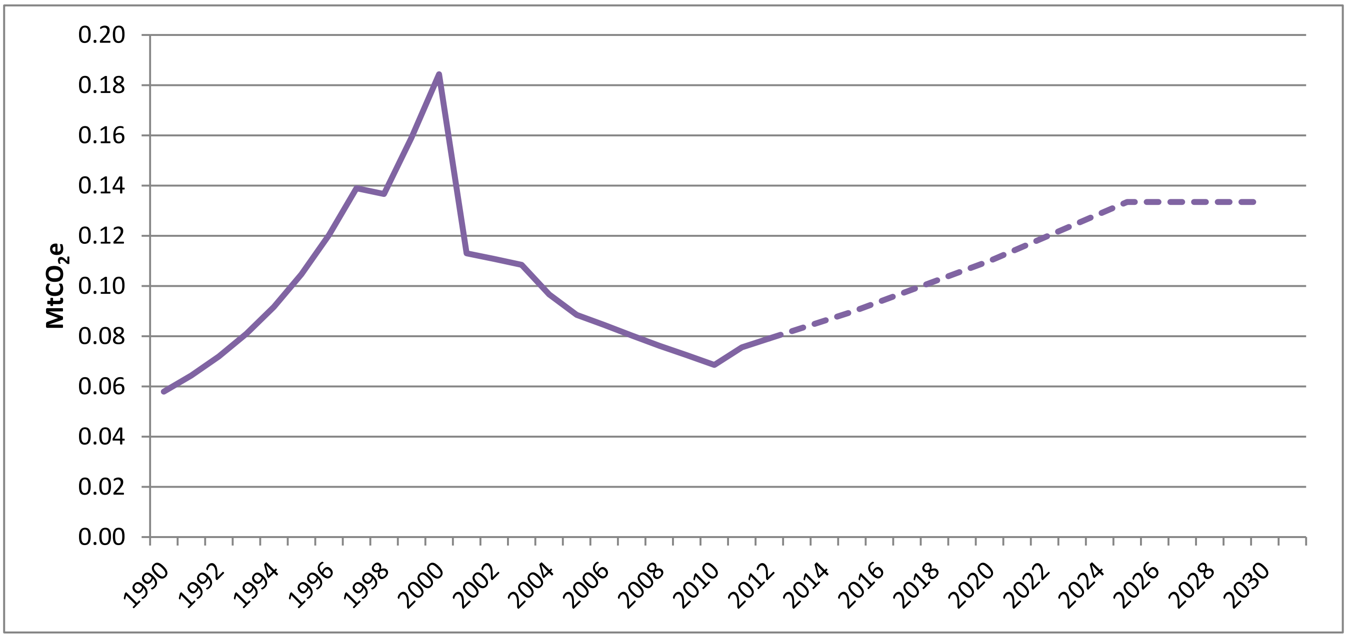
SF_6 emissions are projected to decrease by 11% between 2012 and 2030 (Figure 5.3). These projections derive from work carried out in 2008 (**AEA, 2008**), which projected emissions up to 2025. The period from 2025 – 2030 is then flatlined. Therefore similarly to HFC emission projections, SF_6 projections here may be outdated and will undergo significant revision before next year's publication.

Figure 5.3 – Historical trend and projections of SF6 emissions for the business sector



PFC emissions are projected to increase by 69% between 2012 and 2030 based on assumptions about market growth (Figure 5.4). Projections were only out to 2025 and so the period from 2025 – 2030 is again flatlined. These projections derive from work carried out in 2008 (**AEA, 2008**). Therefore similarly to HFC and SF_6 emission projections, PFC projections here may be outdated and will undergo significant revision before next year's publication.

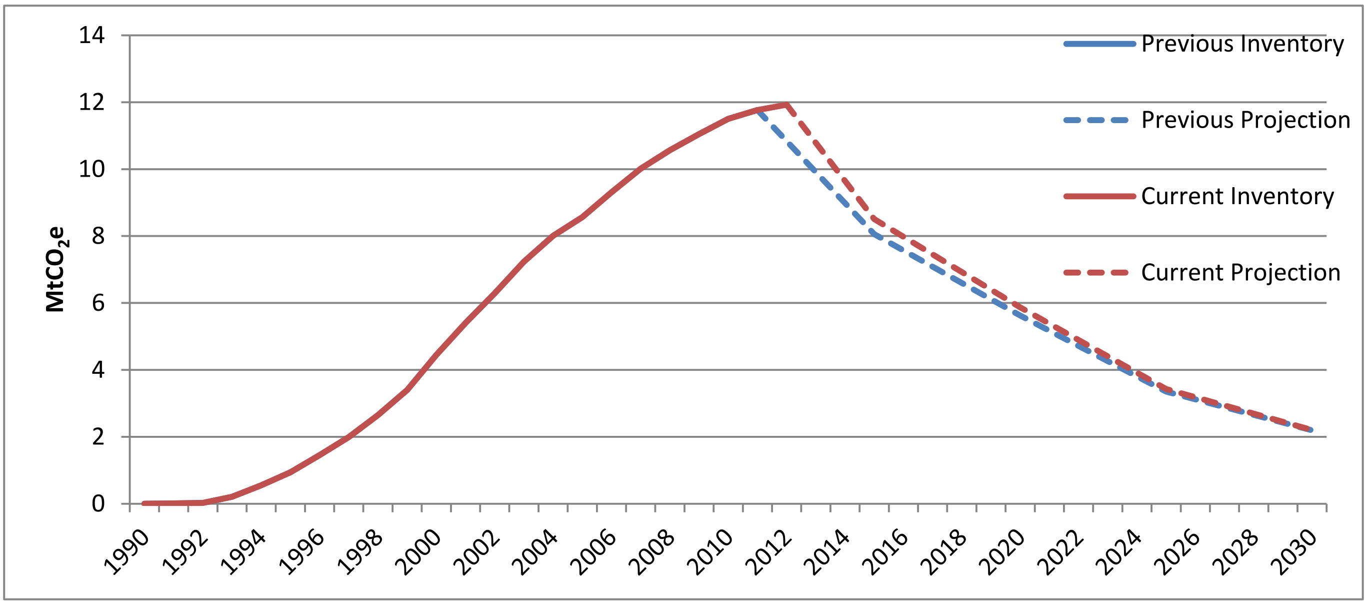
Figure 5.4 – Historical trend and projections of PFC emissions for the business sector



Changes in business sector F-gas emissions since the previous update

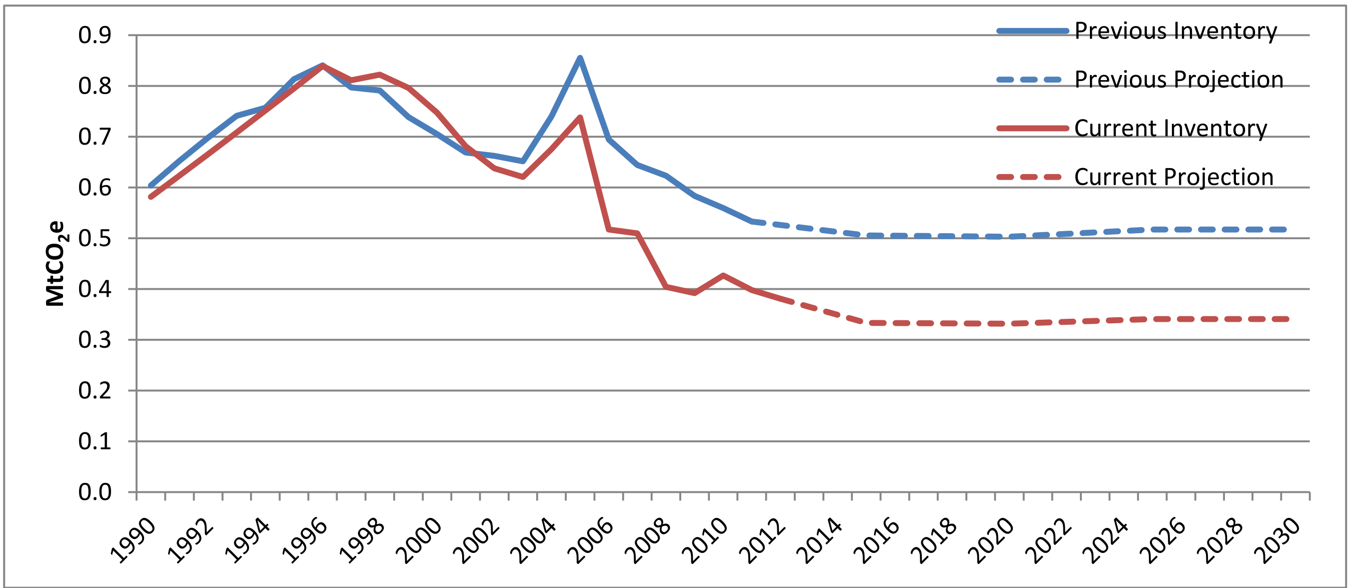
The only source of change between the business sector f-gas projections in the Autumn 2013 update and this set of projections has been the inclusion of the new GHGI. Rebaselining to the new GHGI has a noticeable effect on HFC emissions projections from refrigeration and air conditioning sources. The projections published in Autumn 2013 had predicted that the new GHGI would show the start of the downward trajectory, whereas the new GHGI actually shows this not to be the case. The new GHGI shows the emissions trajectory to have further flattened and given the updated EU F-gas regulation that has come into force, we still expect the downward trajectory to start soon. However, there is uncertainty around the start date of the downward trajectory. As noted above, the projections methodology will be reviewed in the coming year, though the overall projected trend of emissions decreasing rapidly is not expected to change. The result of these revisions is that emissions for HFCs are now projected to be higher than in the Autumn 2013 update, by 5% in 2015 and less than 1% in 2030 (Figure 5.5).

Figure 5.5 Comparison of Autumn 2013 and Summer 2014 business sector HFC projections



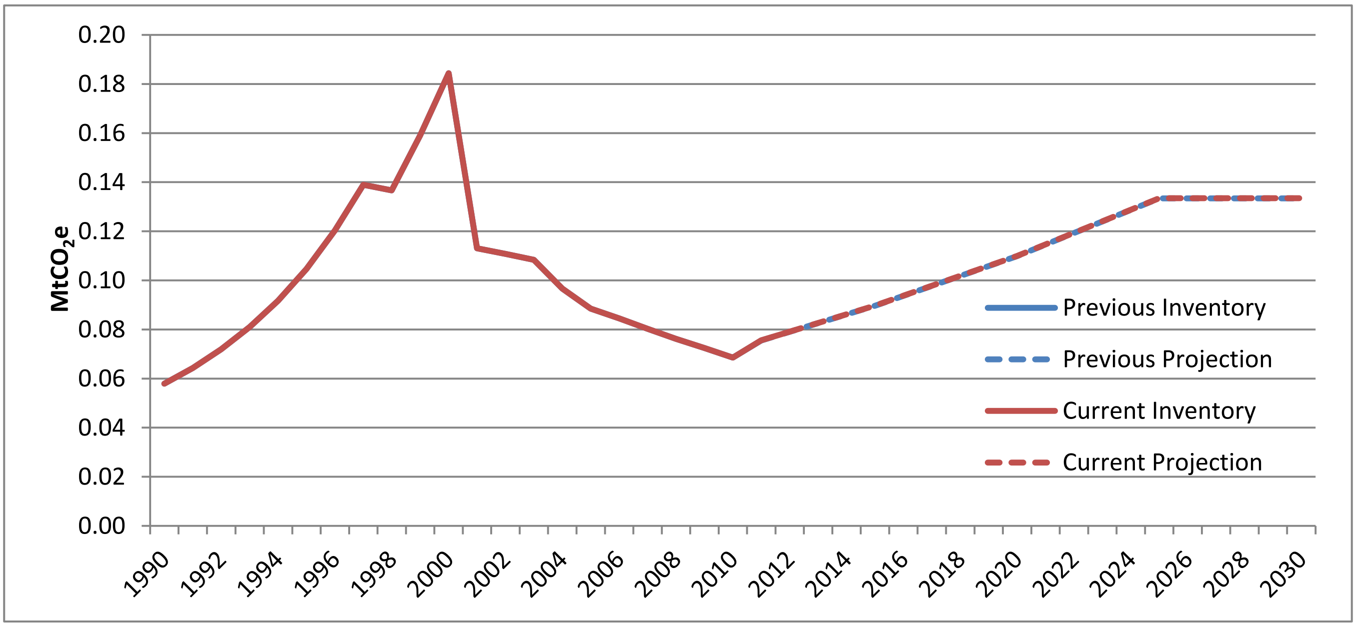
There is a new GHGI category for SF_6 use as a tracer gas. However, SF_6 use for this purpose ceased in Dec 2013 and so it is not included in projections. There was also a revision to the historical GHGI estimates of SF_6 use in electrical insulation which caused a significant decrease in the recent portion of the SF_6 emission time series. This causes a significant decrease in SF_6 projections. Emissions of SF_6 are now projected to be lower than in the Autumn 2013 update, by 34% in both 2015 and 2030 (Figure 5.6).

Figure 5.6 Comparison of Autumn 2013 and Summer 2014 business sector SF6 projections



There is a negligible increase to PFC projections from rebaselining to the current GHGI (Figure 5.7).

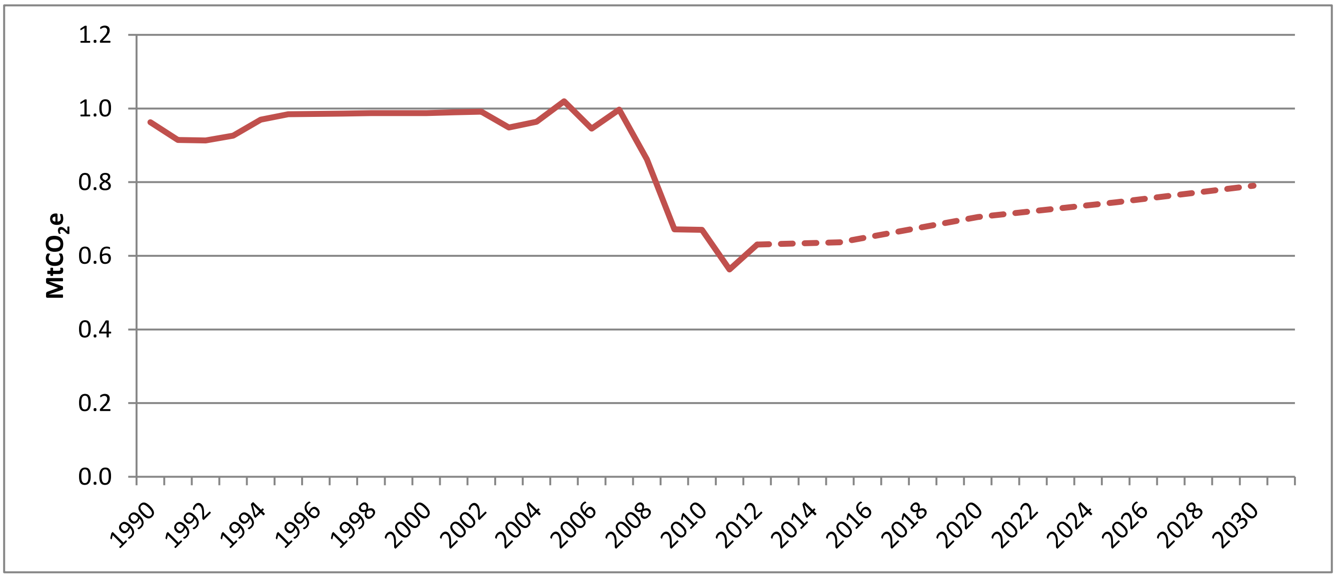
Figure 5.7 Comparison of Autumn 2013 and Summer 2014 business sector PFC projections



5.2 Business sector nitrous oxide emissions

Emissions of N_2O in the business sector, which are in line with the coverage of this report, are entirely as a result of industrial off-road mobile machinery. This includes construction, quarrying and general industry. Emissions were estimated to be 0.6 $MtCO_2e$ in 2012, representing 5% of non-CO_2 GHG emissions from the business sector. Emissions have generally been flat since 1990 with a sharp downturn from 2008 (Figure 5.8). As year-on-year fluctuations in emissions are small in terms of absolute values, it is difficult to attribute the changes to a particular cause. Emissions are projected to increase by 0.16 $MtCO_2e$, or 25%, between 2012 and 2030.

Figure 5.8 – Historical trend and projections of N2O emissions for the business sector

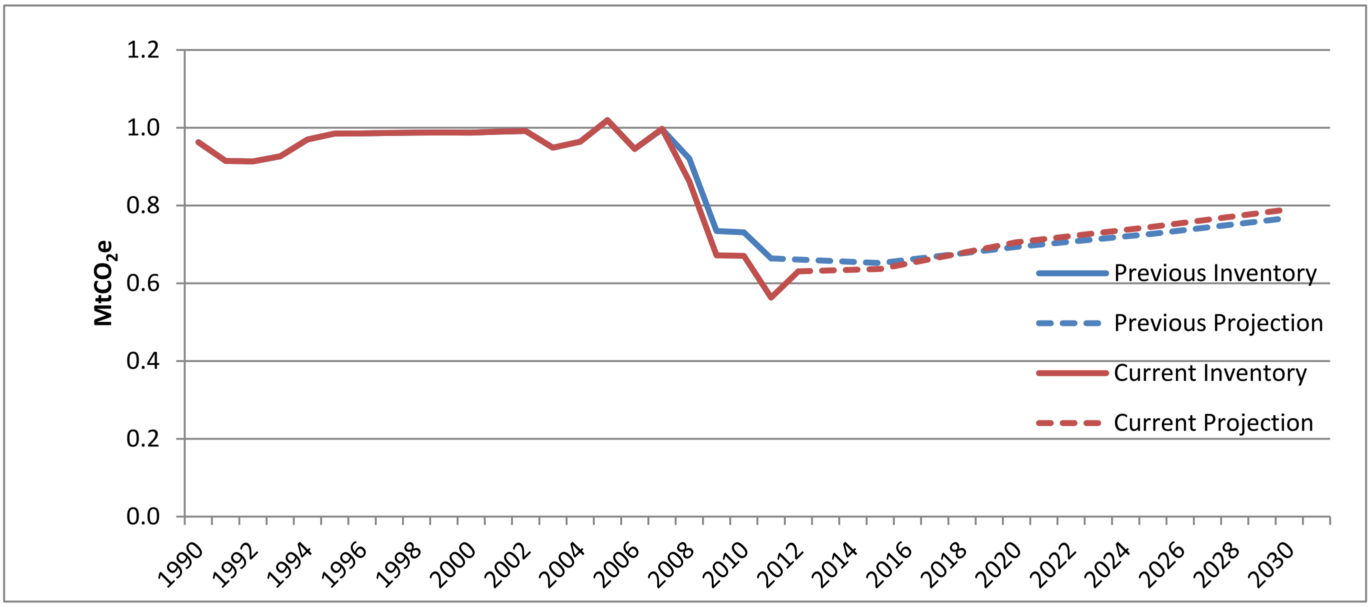


Emissions projections of industrial off-road mobile machinery are based on a set of four drivers to which the individual machinery types were mapped. Further details on this methodology are found in Annex A.

Changes in business sector N_2O emissions since the previous update

Since the Autumn 2013 update to the projections, industrial off-road mobile machinery projections have been updated to reflect a change in the GHGI. This is due to the fuel reconciliation process for gas oil consumption which has a knock on effect on the projections. Furthermore, projections have been updated to use updated projection drivers. Figure 5.9 highlights the difference this revision has made to the overall emissions of N_2O from the business sector. The result of this revision is that business sector N_2O emission are now 2% lower in 2015, and 3% higher in 2030 than in the Autumn 2013 publication.

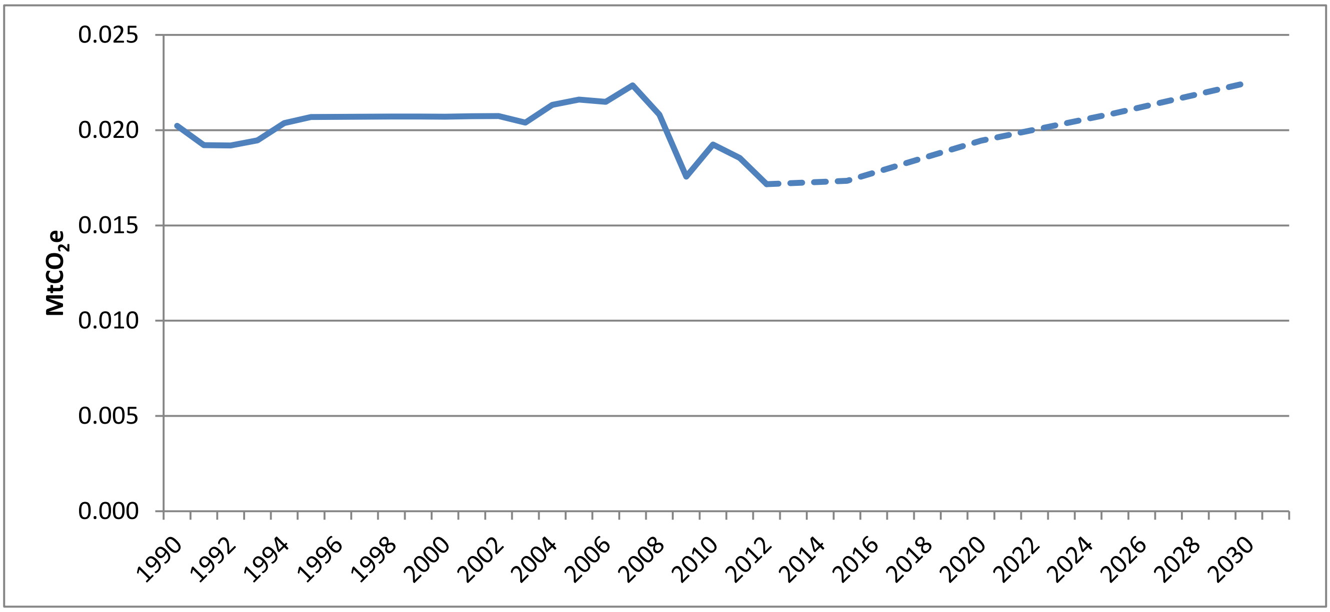
Figure 5.9 Comparison of Autumn 2013 and Summer 2014 business sector N2O projections



5.3 Business sector methane emissions

As with N_2O, CH_4 emissions from the Business sector are entirely as a result of industrial off-road mobile machinery. Methane emissions were estimated to be 17 $ktCO_2e$ in 2012 (Figure 5.10), representing less than 1% of non-CO_2 GHG emissions from the business sector. There has been no significant change in the emissions trend since 1990, except for a slight decrease in 2009. Emissions are projected to increase by approximately 5 $ktCO_2e$, or 31%, between 2012 and 2030. These percentage increases may be misleading though, as the absolute emissions values are very small. Emissions projections from this source are calculated analogously to the N_2O projections.

Figure 5.10 – CH4 emissions projections for the business sector

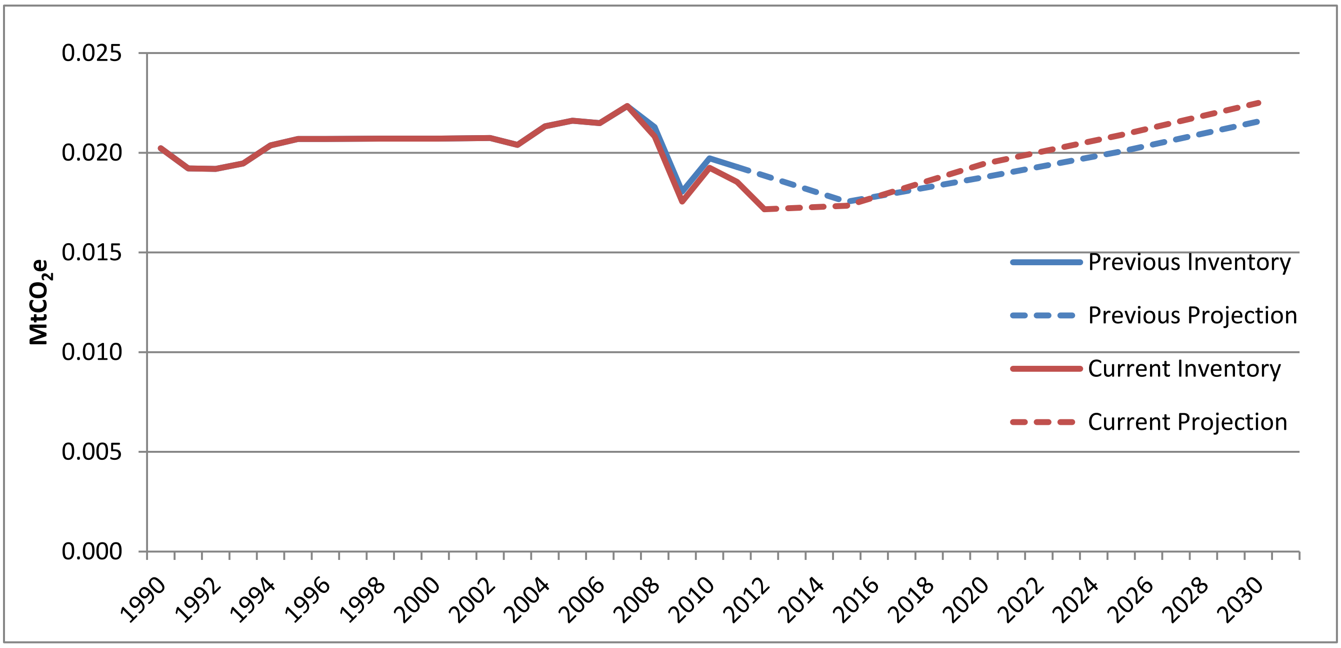


Changes in business sector CH_4 emissions since the previous update

As outlined in the N_2O section, there is a change in the GHGI for industrial off-road mobile machinery since the previous publication due to the fuel reconciliation process for gas oil consumption which has a knock on effect on the projections. The inclusion of updated projection drivers also has an effect on CH_4 projections.

Figure 5.11 highlights the difference these revisions have made to the overall emissions of CH_4 from the business sector. These revisions have had the effect of increasing CH_4 emissions from the business sector by approximately 1 ktCO_2e or 4% in 2030 when compared to the Autumn 2013 publication.

Figure 5.11 Comparison of Autumn 2013 and Summer 2014 business sector CH4 projections

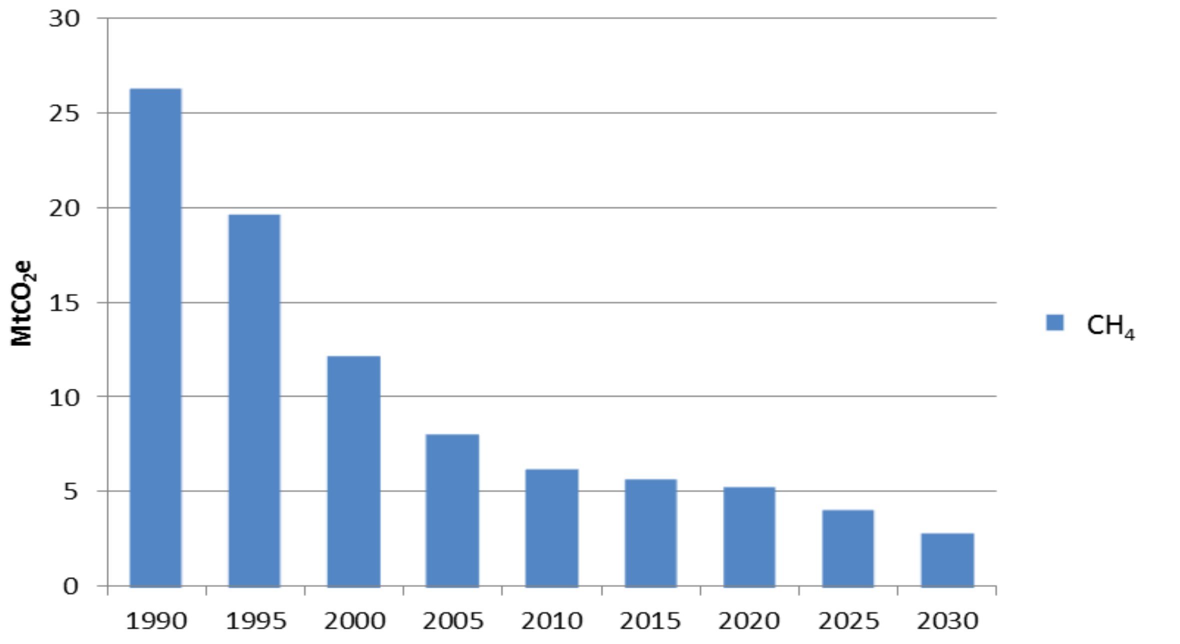


6. Energy Sector

In 2012 non-CO_2 greenhouse gas (GHG) emissions from the energy sector were 5.9 $MtCO_2e$, representing around 6% of the UK's total non-CO_2 emissions. Methane is the only non-CO_2 GHG contributing to emissions from this sector as defined by the coverage of this report. Historically, energy sector emissions have decreased by approximately 20 $MtCO_2e$ since 1990.

Since the Autumn 2013 update to the projections, projections from this sector have been updated to reflect the changes in the new GHGI. Overall emissions from the energy sector are projected to be 2.9 $MtCO_2e$ in 2030 which will correspond to a decrease in emissions of 51% since 2012 (Figure 6.1). This is predominantly due to reduced emissions from natural gas leakage and deep mined coal, with a smaller contribution from reductions in emissions from closed coal mines and coal storage & transport. Section 6.1 contains more detail on the current projections and the changes since the last update.

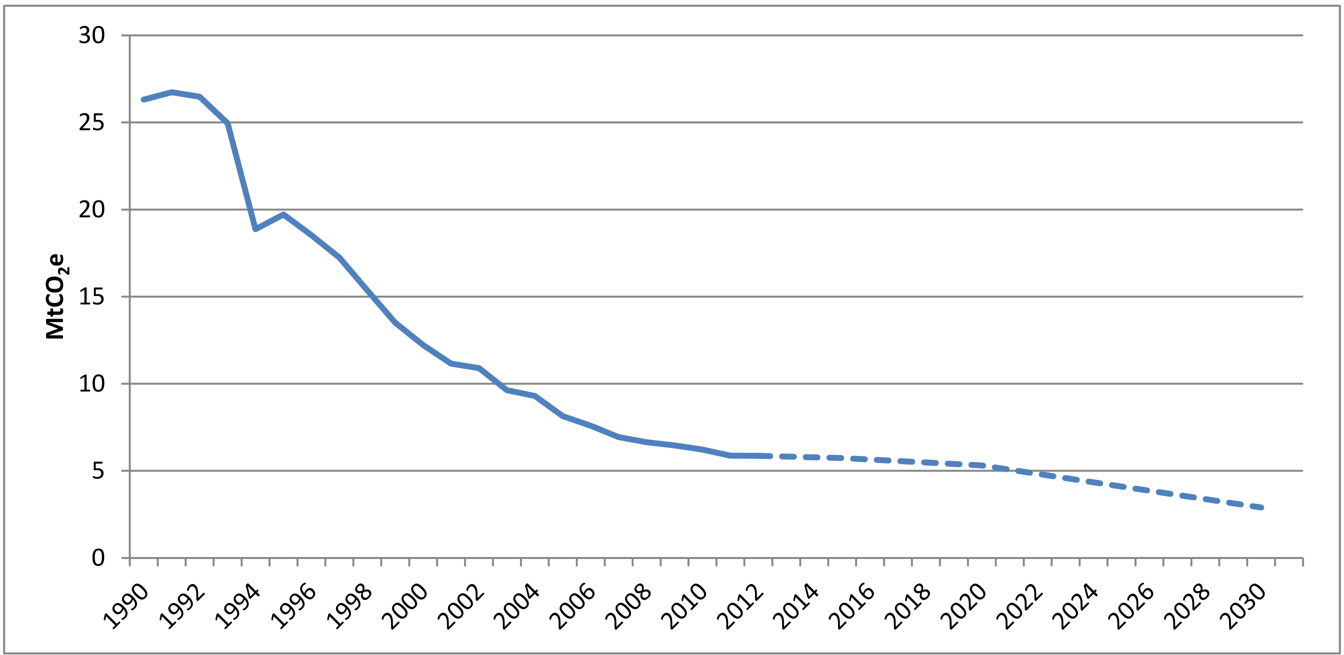
Figure 6.1 – Non-CO2 GHG emissions projections for the energy sector



6.1 Energy sector methane emissions

Methane emissions within the scope of this report in the energy sector result from natural gas leakage, operational and closed coal mines, and coke production. Remember that the majority of energy sector emissions are covered in the UEP (**DECC, 2013b**). Leakage from the gas distribution network is the largest CH_4 source in the GHGI outside of the Agriculture and Waste sectors, comprising approximately 8% of all CH_4 emissions in 2012. Methane emissions from deep mined coal also make a significant contribution. Both sources combined comprise around 94% of emissions from the Energy sector in 2012. Closed coal mine CH_4 emissions are the third most significant source in this sector. Historically, the decreasing trend in emissions is predominantly as a result of a reduction in emissions since 1990 from natural gas leakage of around 52% and deep mined coal of around 91%. Figure 6.2 shows the full time series of energy sector CH_4 emissions.

Figure 6.2 – Historical trend and projections of CH4 emissions for the energy sector



Emissions from gas leakage are projected to continue decline due to a 30 year programme (started in 2002) to reduce leakage from the gas distribution network by 70%. This involves the replacement of cast-iron pipes in the gas distribution system. Projected changes in CH_4 content of natural gas are not considered to have sufficiently meaningful fluctuations to take account of in the non-CO_2 GHG projections.

Emissions are projected to continue to decrease from deep mined coal to 2030, because of an expected decrease in the quantity of coal produced. Note that these projections are also influenced by limitations in the projected time-series for deep mined coal emissions, which only extends to 2025.

Closed coal mine emissions are estimated to have already been significantly reduced from this source and so are likely to remain approximately constant out to 2030.

Further details on these methodologies are found in Annex A. All other emissions from the Energy sector are reported in DECC's UEP publications; see Annex B for more details.

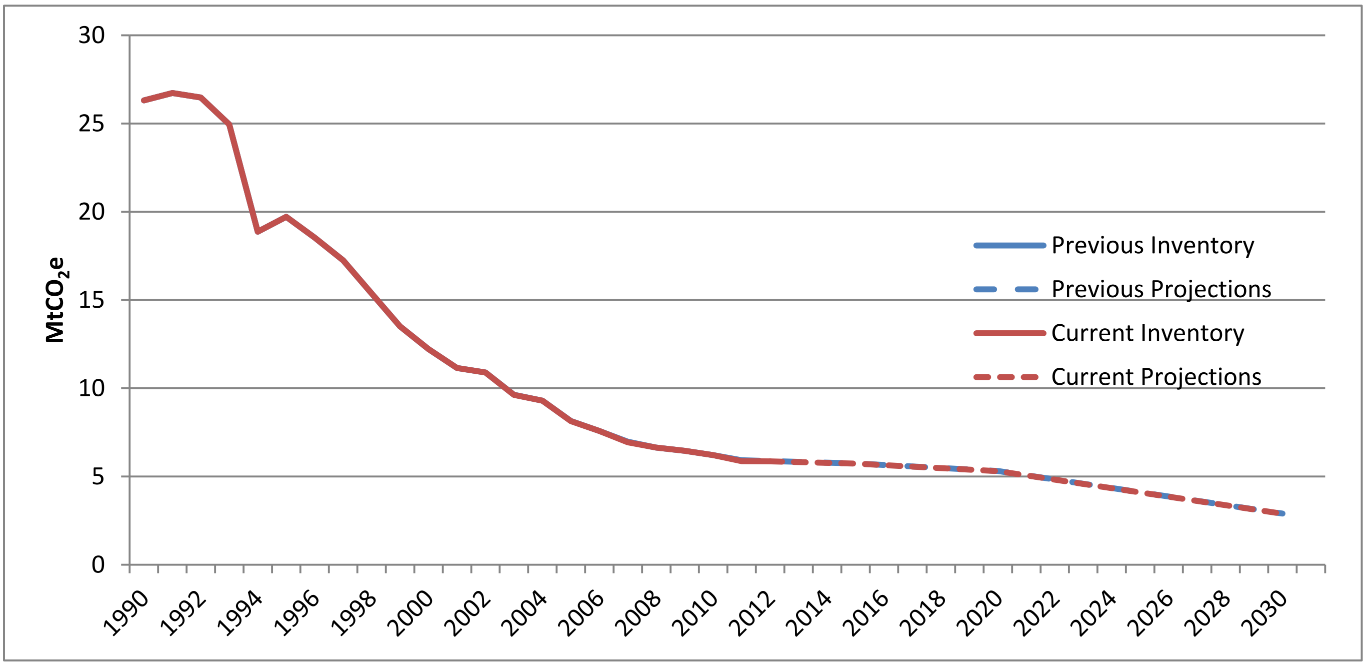
Changes in the energy sector's CH_4 emissions since the previous update

As outlined above the only source of change between the energy sector projections in the Autumn 2013 update and this set of projections has been the inclusion of the new GHGI. There are GHGI methodology changes in two categories which have a small effect on the complete time series:

- One of the UK gas network operators has revised the data provided in 2012 and new estimates of leakage from their distribution network have been provided from 2007 onwards. Furthermore, there is revised gas activity data in DUKES (DECC, 2013d). The net effect is a small decrease in CH_4 emissions from gas leakage in the historical time series which has a small effect on projections.
- Replacement of default emission factors for iron and steel causes a negligible increase in emissions.

Rebaselining to the latest GHGI in all categories causes a small decrease in energy sector CH_4 emissions, with the biggest changes being in closed coal mines, deep mined coal and coal storage & transport. These revisions have had the effect of reducing CH_4 emissions from the energy sector by approximately 0.3% in 2030 when compared to the Autumn 2013 publication. Figure 6.3 shows the small difference these revisions have made to the overall emissions of CH_4 from the energy sector.

Figure 6.3 – Comparison of Autumn 2013 and Summer 2014 energy sector CH4 projections

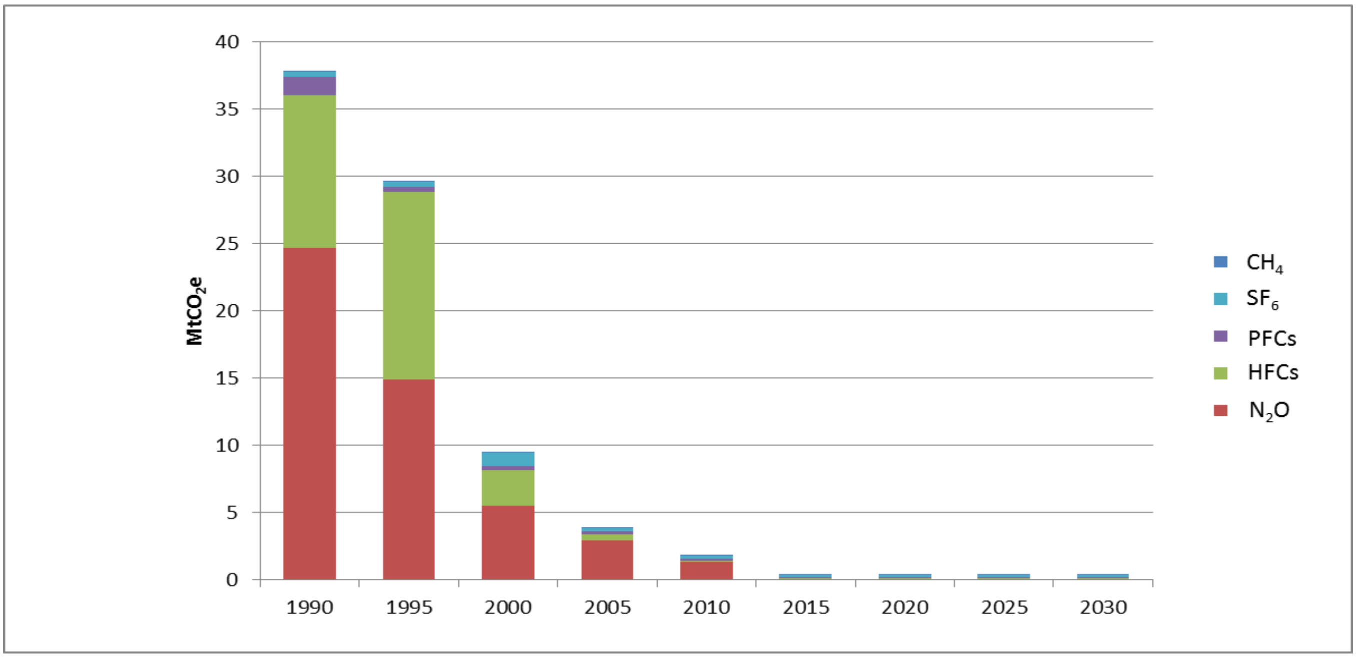


7. Industrial Processes Sector

The industrial processes sector has historically been a significant contributor to emissions, producing 21% of the UK's total non-CO_2 emissions in 1990. Nitric acid and adipic acid production contributed significantly to emissions from this sector, as well as F-gas emissions as a by-product from the production of halo-carbons and aluminium. However, by 2012 emissions from the industrial process sector have reduced to less than 1% of total non-CO_2 emissions resulting from changes in industrial activity and the adoption of improved abatement technology. Industrial processes do remain a source of N_2O, CH_4 and F-gas emissions, albeit on a much smaller scale than historically.

Since the Autumn 2013 update to the projections, projections from this sector have been updated to reflect the changes in the new GHGI. Overall emissions from the industrial processes sector are projected to be 0.4 $MtCO_2e$ in 2030, representing a reduction of 6% between 2012 and 2030 (see Figure 7.1). Sections 7.1 – 7.3 contain more detail on the current projections and the changes since the last update for each of the gases.

Figure 7.1 – Non-CO2 GHG emissions projections for the business sector industrial processes sector

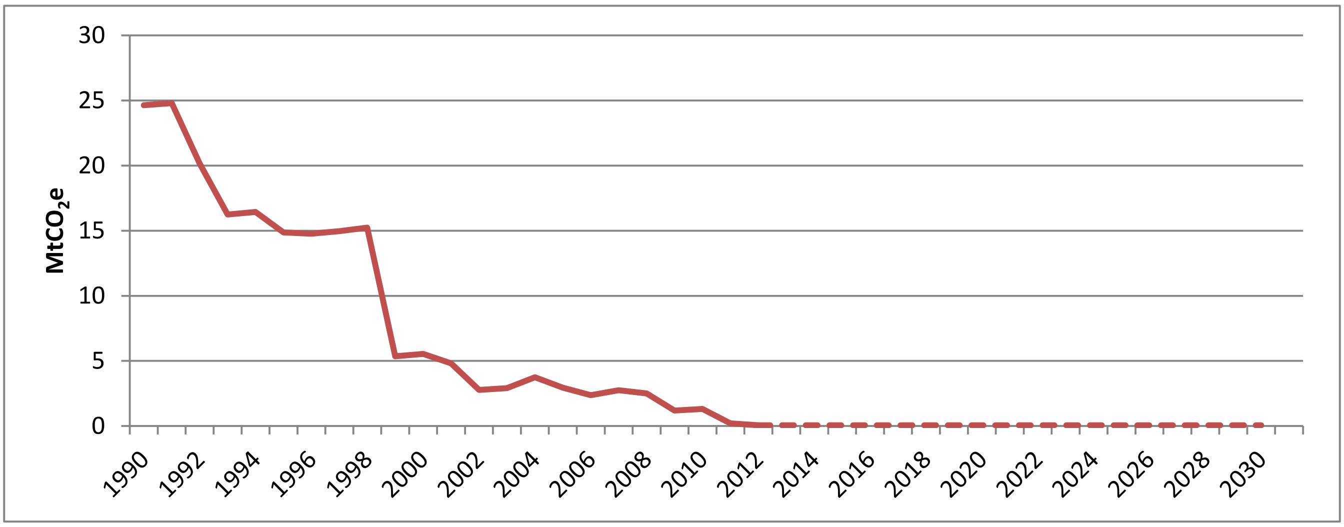


7.1 Industrial Processes sector nitrous oxide emissions

Historically, N_2O emissions from industrial processes have been significantly higher than they are today and are projected to be in the future. In 2030, these emissions are projected to be 0.06 $MtCO_2e$. Figure 7.2 shows the historical and projected trend for N_2O from this sector.

The drivers of N_2O emissions from this sector have historically been the production of adipic and nitric acids. The UK's only adipic acid production facility ceased operation in 2009 and so emissions from this source are now zero. Emissions from nitric acid production have significantly reduced for two reasons, the first of which is plant closures. The second is that a decision was taken for the UK to choose an early opt-in of emissions from nitric acid production into the EU Emissions Trading Scheme (EU ETS) (DECC, 2011b). As a result of this, best available technology (BAT) abatement technology was fitted at the remaining UK plants in 2010 and 2011. Post abatement emissions are projected to remain constant.

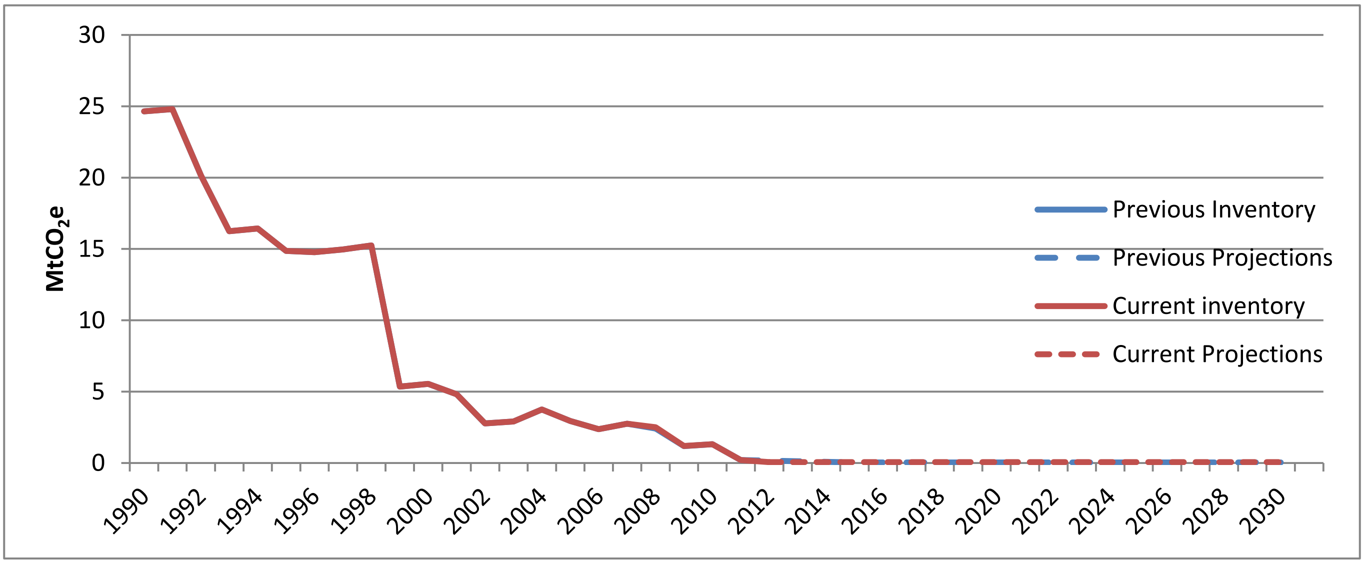
Figure 7.2 Historical trend and projections of N_2O emissions from the Industrial Processes sector



Changes in the industrial processes sector's N2O emissions since the previous update

As outlined above the only source of change between the industrial process sector projections in the Autumn 2013 update and this set of projections has been the inclusion of the new GHGI. Nitric acid production is the only source of N_2O emissions from this source. New abatement technology introduced in 2010 and 2011 caused a drop in emissions over that time. In the Autumn 2013 projections, an estimate had been made, based on the 2011 GHGI, of the level that emissions would drop to after abatement. The latest GHGI now provides the actual 2012 emissions which are used for the projection going forward. The 2012 GHGI value is greater than the estimate by 0.03 MtCO2e, and so the projections have increased slightly since the Autumn 2013 publication.

Figure 7.3 Comparison of Autumn 2013 and Summer 2014 industrial processes sector N2O projections



7.2 Industrial Processes sector F-Gas emissions

F-gas emissions from the industrial processes sector have, as with other gases, reduced markedly since 1990. F-gas emissions were 13 $MtCO_2e$ in 1990, are estimated at 0.35 $MtCO_2e$ in 2012, and are projected to be 0.32 $MtCO_2e$ by 2030. The historical emissions are predominantly as a result of HFC by-product emissions from halo-carbon production as well as PFC emissions from the primary production of aluminium. There are also HFC/SF_6 contributions also from their use as a cover gas in the manufacture of magnesium alloy by die-casting, as well as PFC fugitive emissions from halocarbon production. Presently all of these sources are of a similar magnitude, with the exception of HFCs from magnesium production which is significantly smaller. PFC emissions from this sector are the largest in the country and SF_6 emissions here make a significant contribution to the national total. However, HFC emissions are relatively minor in this sector.

Projections are based on work done in 2008 and 2010 (**AEA, 2008+2010**). The projected trend for each of the F-gases is expected to remain approximately flat from 2012 (Figures 7.4 to 7.6) as the majority of abatement measures expected in this sector are already in place. Abatement technology has been fitted to two of the three UK producers of halocarbons, significantly reducing by-product emissions. HFC replaced much of the SF_6 used as a magnesium cover gas due to its lower GWP and because much of it is destroyed in the process. This caused the significant reductions in SF_6 from the Industrial Processes sector and projected emissions from this source are based on a growth index for non-ferrous metals. The one significant change is in aluminium production where a plant closure in 2012 causes a significant drop in emissions. The effect of this partly shows up in the 2012 GHGI, with the remainder of the effect of closure expected in the 2013 GHGI. A projection for emissions from this source from 2013 onwards has been obtained based on the emissions from the plant which has closed.

Figure 7.4 Historical trend and projections of HFC emissions from the Industrial Processes sector

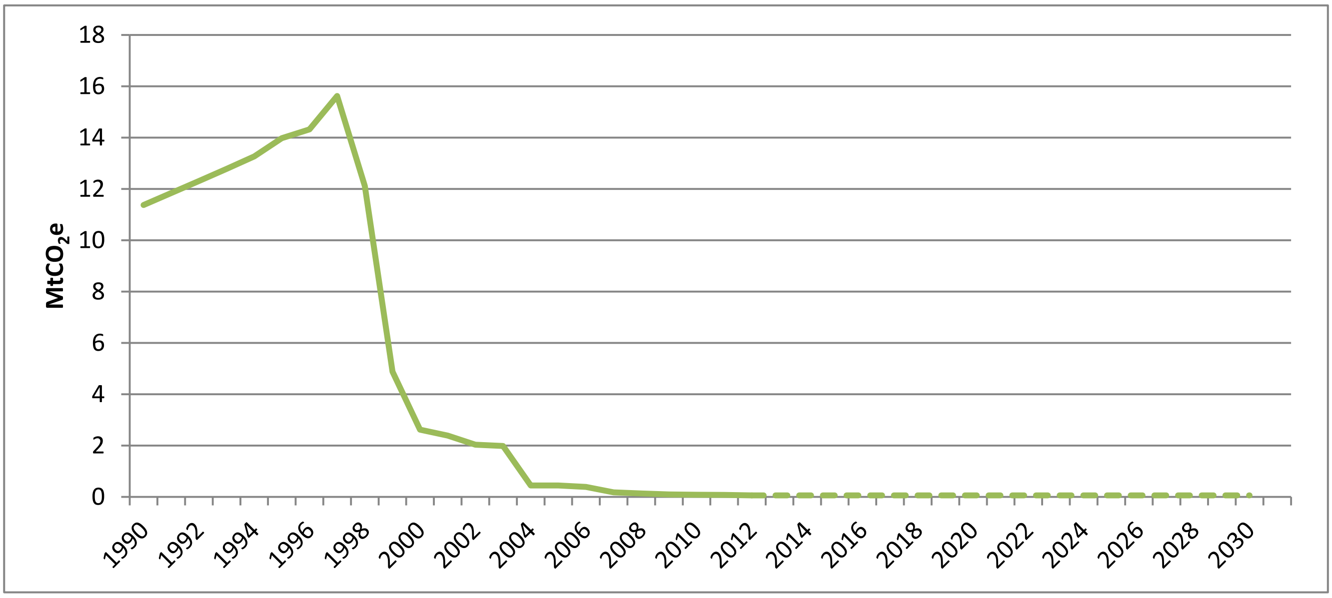


Figure 7.5 Historical trend and projections of PFC emissions from the Industrial Processes sector

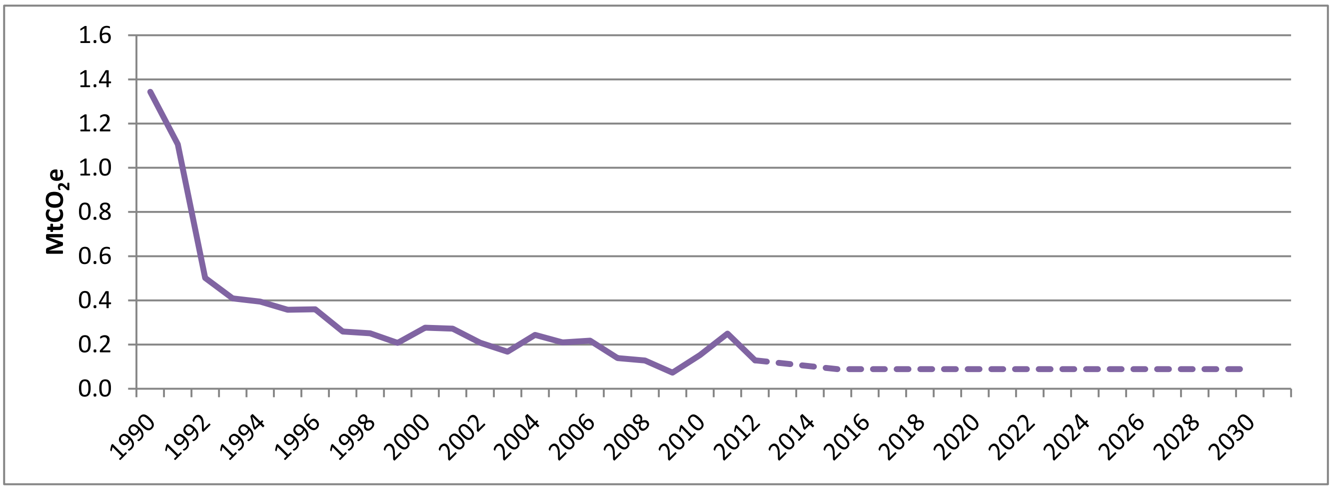
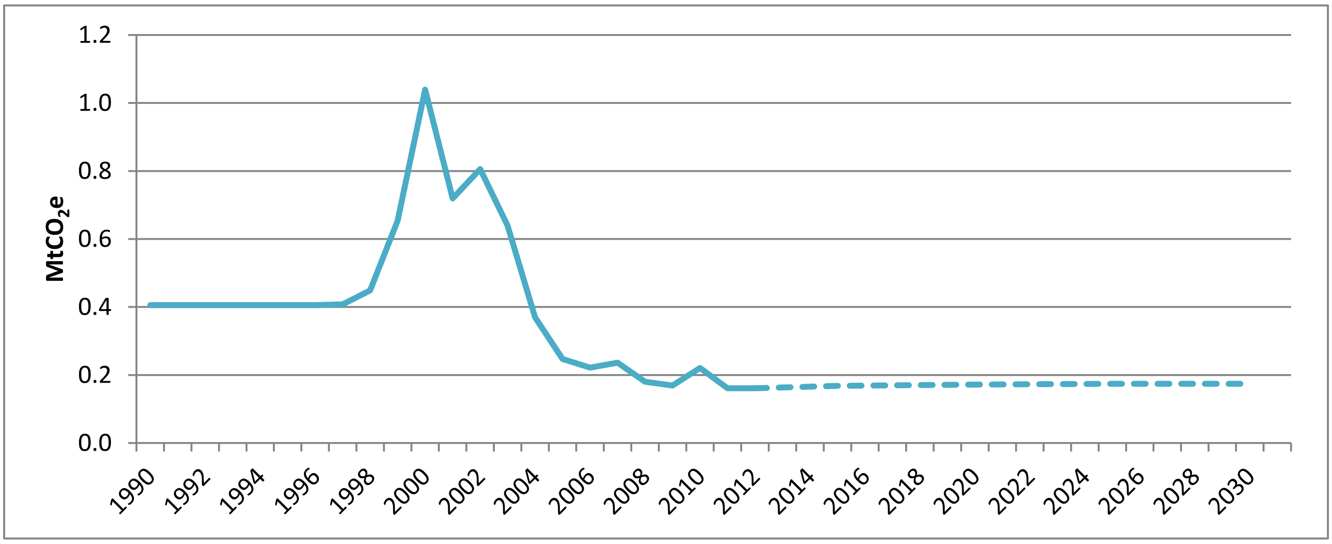


Figure 7.6 Historical trend and projections of SF_6 emissions from the Industrial Processes sector



Changes in the industrial processes sector's F-gas emissions since the previous update

As outlined above the only source of change between the industrial process sector projections in the Autumn 2013 update and this set of projections has been the inclusion of the new GHGI. There was a review carried out in 2013 of the data sources and methodology used to estimate emissions from F-gases used as cover gases in magnesium foundries. This caused a drop in historical HFC emissions and a variable change in historical SF_6 emissions. Rebaselining the projections against the data from the latest GHGI causes projections of emissions from magnesium foundries to reduce by approximately 20 ktCO_2e for HFCs and increase by approximately 90 ktCO_2e SF_6.

Rebaselining to the latest GHGI projections of HFC and PFC emissions resulting from halocarbon production processes causes a decrease in projections of both gases of around 15 ktCO_2e and 25 ktCO_2e respectively. Figures 7.7 – 7.9 visualise the effects these changes have had on the projections of the different F-gas families by comparing the Autumn 2013 projections with the new Summer 2014 update.

Figure 7.7 Comparison of Autumn 2013 and Summer 2014 industrial processes sector HFC projections

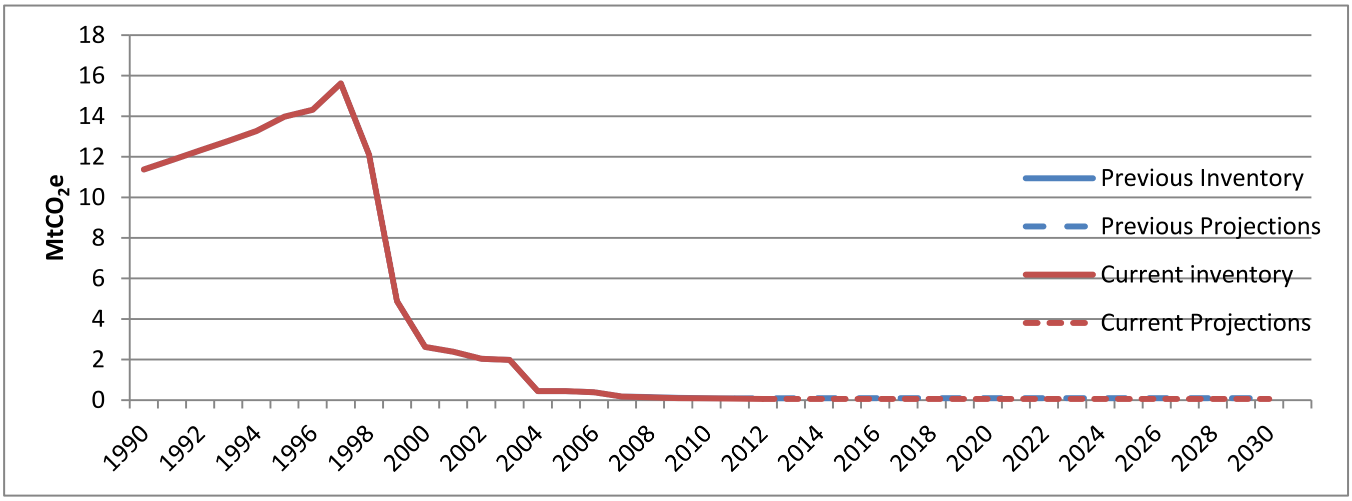


Figure 7.8 Comparison of Autumn 2013 and Summer 2014 industrial processes sector PFC projections

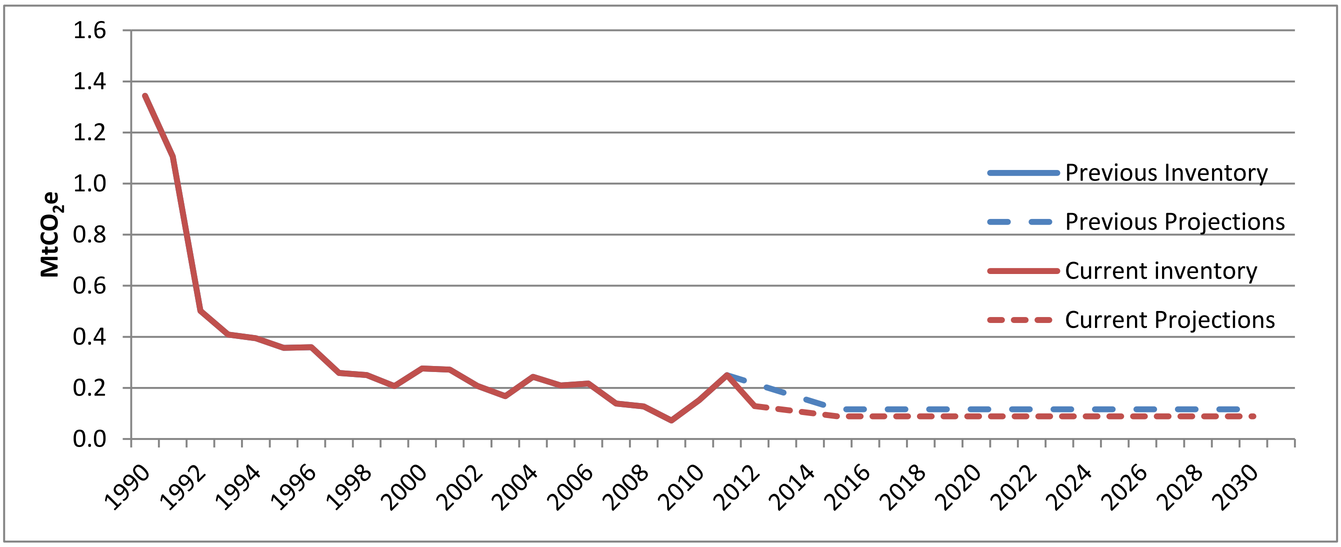
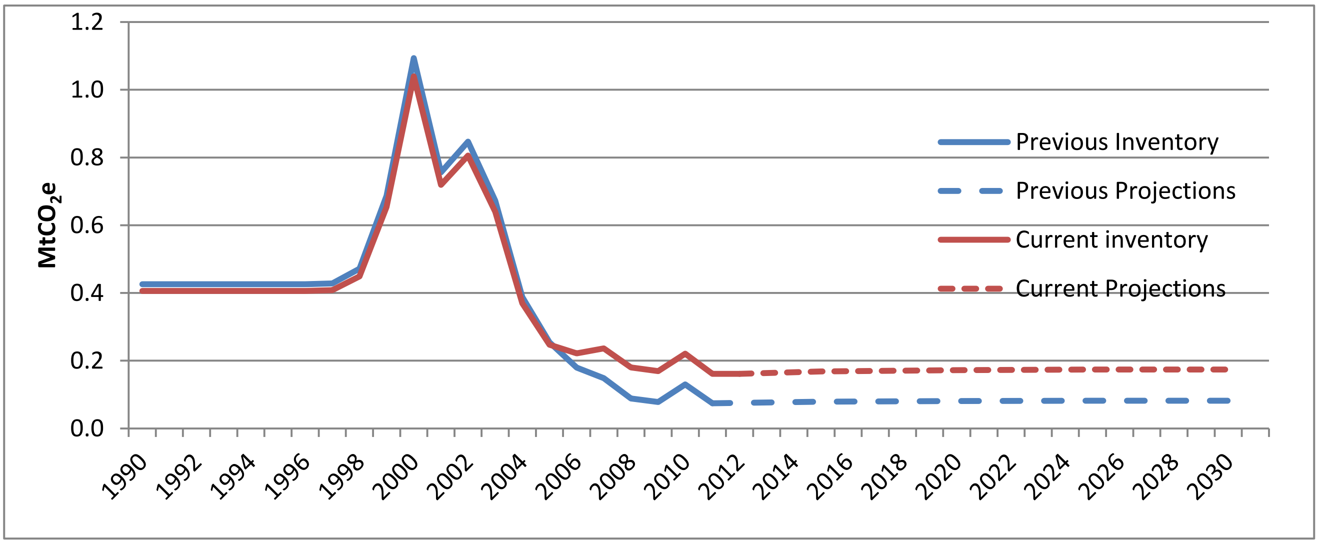


Figure 7.9 Comparison of Autumn 2013 and Summer 2014 industrial processes sector SF6 projections

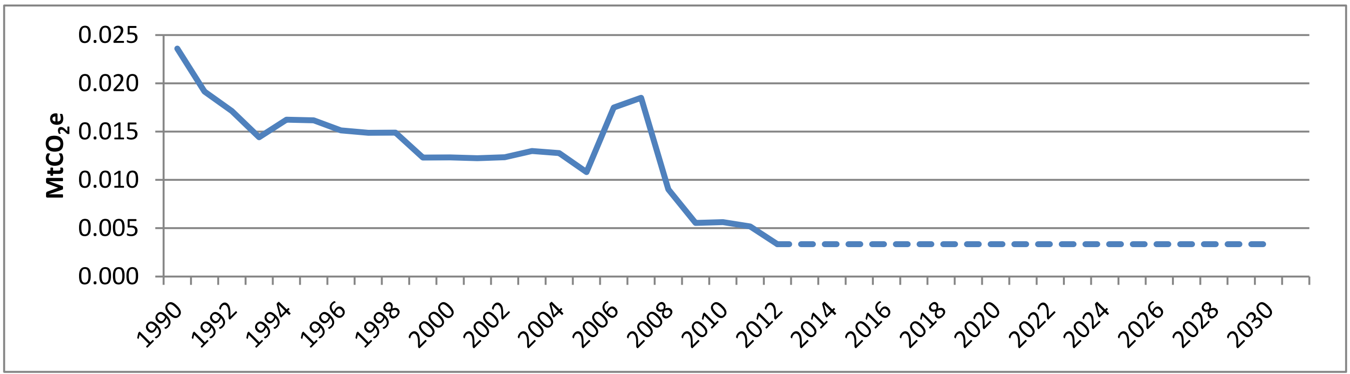


7.3 Industrial Processes sector methane emissions

Methane emissions from the industrial processes sector originate exclusively from Fletton brick manufacture. Methane has historically contributed a relatively small amount to overall emissions from the Industrial Processes sector. Figure 7.10 shows the historical and projected trend for CH_4 emissions from the Industrial Processes sector.

The emissions from Fletton brick manufacture have been relatively well correlated with the number of manufacturing plants in operation over the period. The closure of the last plant to burn coal in 2008 was the most notable event. Projections are currently projected to remain flat going forward as there are no expected plant closures. Furthermore, the relatively small emissions from the gas in this sector don't warrant detailed study.

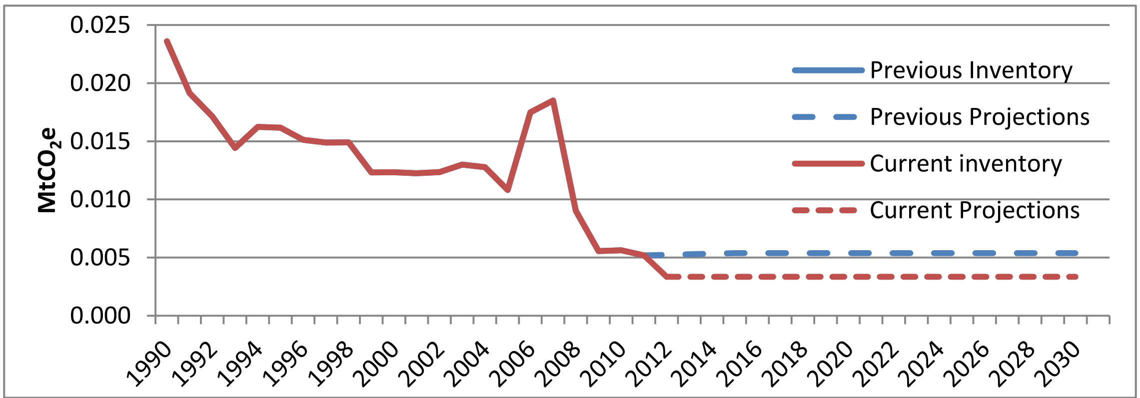
Figure 7.10 Historical trend and projections of CH_4 emissions from the Industrial Processes sector



Changes in the industrial processes sector's methane emissions since the previous update

As outlined above the only source of change between the industrial process sector projections in the Autumn 2013 update and this set of projections has been the inclusion of the new GHGI. As there have been no revisions to the historical emissions associated with fletton brick manufacture, the only change between the Autumn 2013 publication and this update is the re-baselining of the projections against the latest GHGI year. This has had the effect of reducing emissions of CH_4 from the industrial processes sector by approximately 2 $ktCO_2e$ for each projected year when compared to the previous set of projections. Figure 7.11 highlights the effect this change has made.

Figure 7.11 Comparison of Autumn 2013 and Summer 2014 industrial processes sector CH4 projections

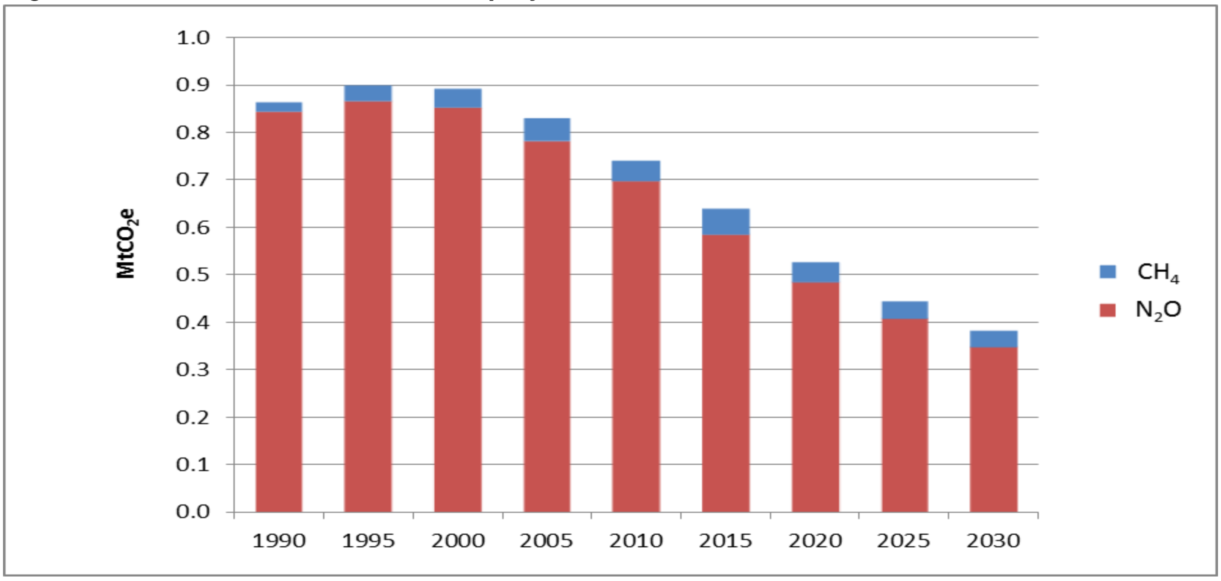


8. LULUCF Sector

The land use/land use change (LULUCF) sector is the second smallest sector in terms of contribution to overall non-CO_2 emissions considered in this report. LULUCF emissions in 2012 were 0.7 $MtCO_2e$, which represent 0.8% of total non-CO_2 emissions from all sectors. Of these emissions, 91% were from N_2O. Emissions have reduced by 15% between 1990 and 2012.

Since the Autumn 2013 update to the projections, new LULUCF projections have been produced by the Centre for Ecology Hydrology under contract to DECC (**CEH, 2014**) and are reproduced here. The updated projections reflect the changes in the new GHGI and some new projections assumptions. Overall emissions from LULUCF are projected to be 0.4 $MtCO_2e$ in 2030, representing a reduction of 47% on the 2012 level and 55% on the 1990 level (see Figure 8.1). The decline in emissions is predominantly due to reduced land disturbance from the conversion of land to crop-land. Sections 8.1 – 8.2 contain more detail on the current projections and the changes since the last update for both of the gases.

Figure 8.1 – Non-CO2 GHG emissions projections for the LULUCF sector

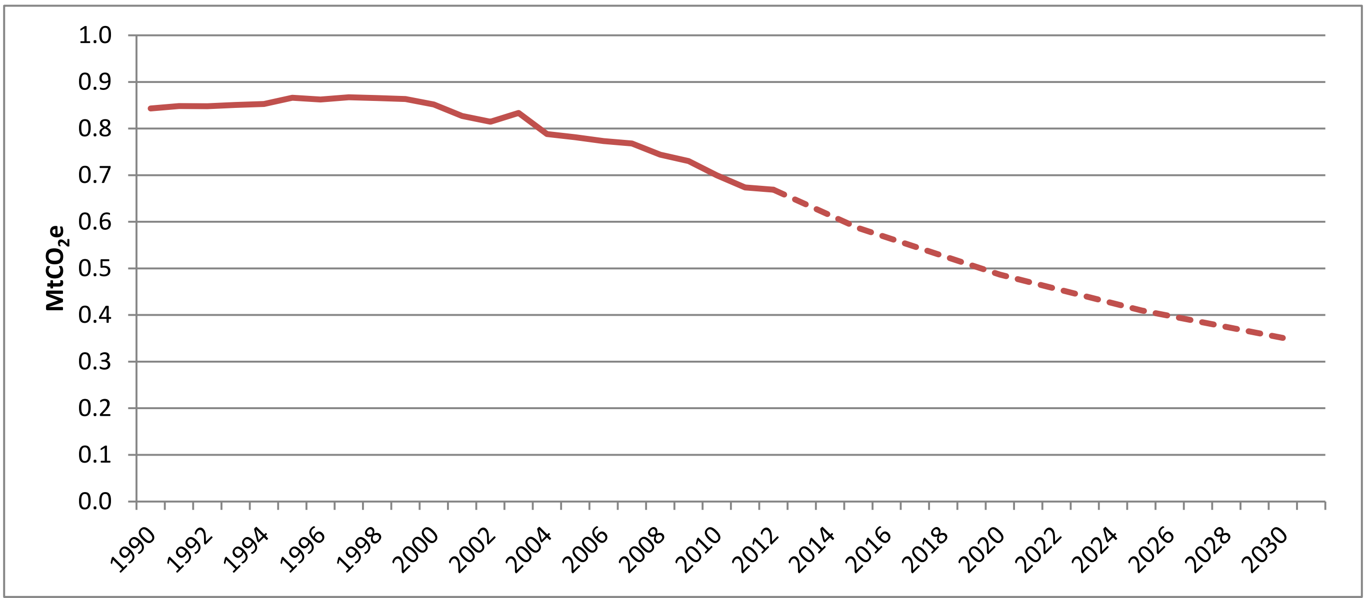


8.1 LULUCF sector nitrous oxide emissions

Emissions of N_2O account for 91% of non-CO_2 GHG emissions in the LULUCF sector. The major source of N_2O is the conversion of land to crop land and the associated disturbance of soil. Land is converted to crop land at a constant positive rate in Wales, but is now zero for England, Wales and Northern Ireland. This source alone results in 86% of N_2O emissions from LULUCF, with the remaining being the result of drainage of organic soils, biomass burning and the application of nitrogen based fertiliser to forested land.

Nitrous oxide emissions had remained broadly static from 1990 until 2000 before declining to 79% of the 1990 level by 2012. This trend is projected to continue at a roughly even pace to 2030, when N_2O emissions are projected to be 0.35 $MtCO_2e$ (see Figure 8.2). The slow reduction in projected emissions from this source is due to the exponential decay of the effect of pre-2013 conversion to cropland.

Figure 8.2 – Historical trend and projections of N_2O emissions for the LULUCF sector



Changes in LULUCF sector N_2O emissions since the previous update

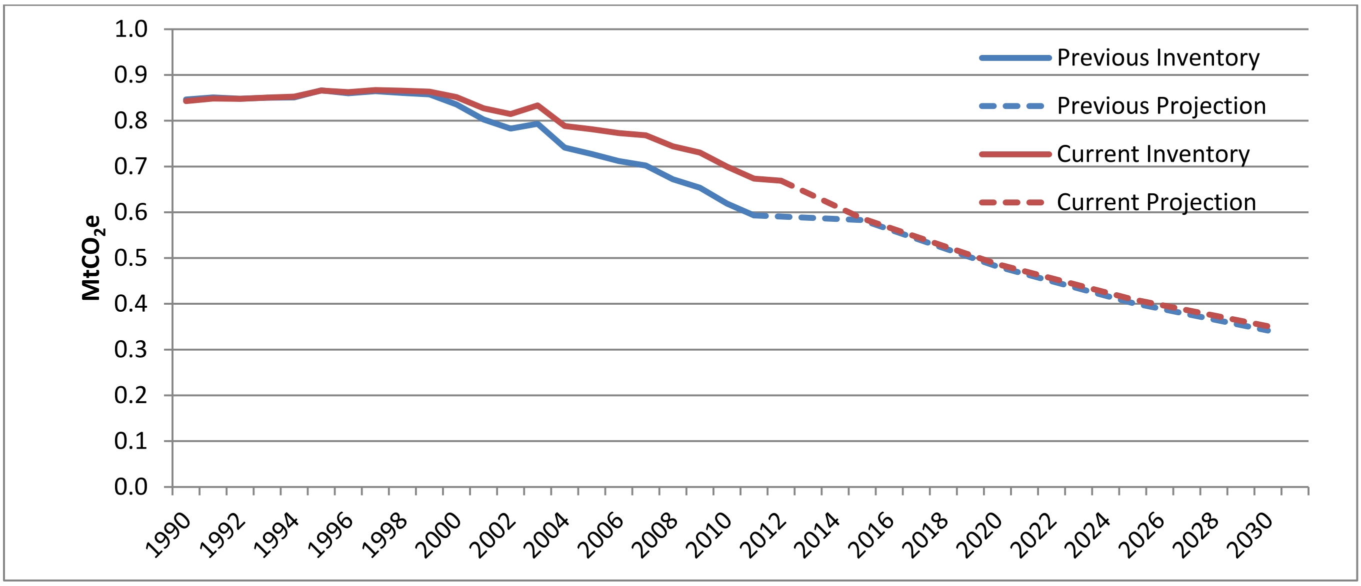
As outlined above there have been a new set of LULUCF projections (**CEH, 2014**) included in this update to the non-CO_2 projections. This set of non-CO_2 projections based on the new GHGI and use the mid-emissions scenario presented in the LULUCF publication, in line with the non-CO_2 projections methodology. In these updated projections the emissions from forest drainage and fertilisation are slightly affected by the updated planting scenario. Furthermore, the projected wildfires and wetland drainage areas have changed slightly.

The latest GHGI contained has also some improvements to the LULUCF sector. The difference in the 2000-2015 period is due to the fixing of an error. In the 1990-2011 GHGI these values were incorrect and for the 1990-2012 GHGI the error was fixed. However, this did not affect projections.

There are also some methodological differences in the GHGI which have a small effect on projections. The main methodological difference is the move to using the CARBINE carbon accounting model. This does affect N_2O emissions from soil draining, biomass burning and nitrogen based fertilisation. However, the effect is negligible. There is also an improved methodology for estimating grassland and other land areas for Jersey, the Isle of Man and the Falklands Islands, affecting conversions to and from these land uses from 2005 onwards.

The corrected error in the historical GHGI is most visible in the time series of N_2O in Figure 8.3. However the effects on the projections from the above changes are relatively minimal.

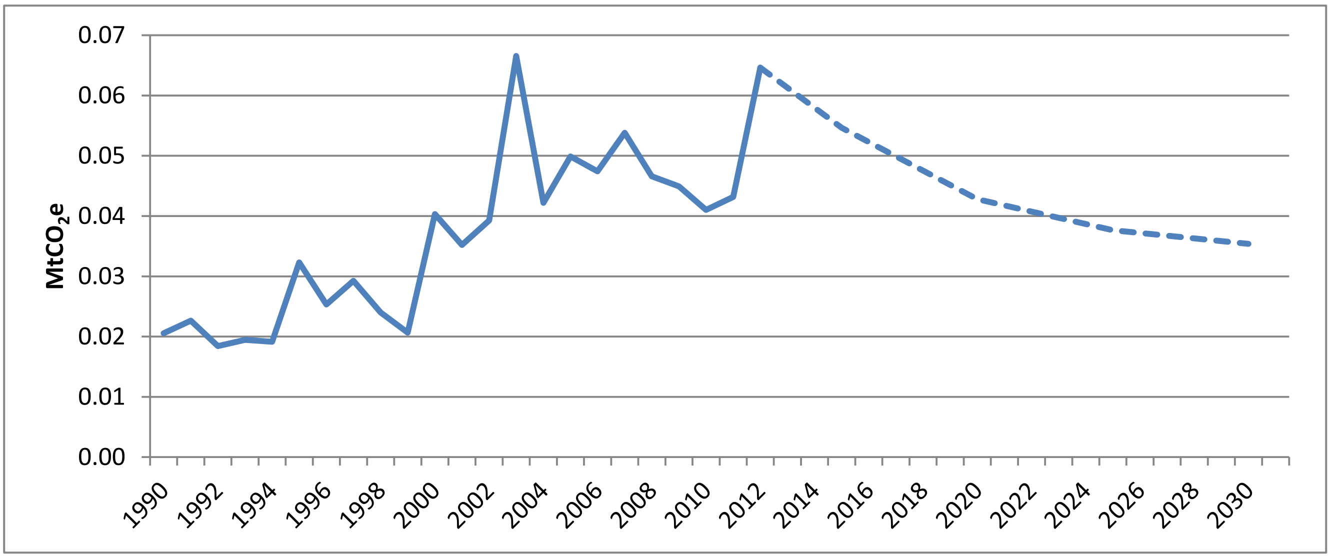
Figure 8.3 Comparison of Autumn 2013 and Summer 2014 LULUCF sector N2O projections



8.2 LULUCF sector methane emissions

Methane is a comparatively small contributor to overall emissions from LULUCF, representing 9% of emissions in 2012. Emissions of CH_4 from LULUCF are driven by biomass burning: wildfires and deforestation through controlled burning. Both of these have large inter-annual variability, which is shown in the historical GHGI data in Figure 8.4. In order to account for this in projecting wildfire emissions, an extrapolated trend and associated probability distribution function with lagged terms are fitted to 1990 Forestry Commission data, which is reported to the Food and Agriculture Organisation of the United Nations as part of the Global Forest Resource Assessment. It is difficult to predict wildfires and decadal averages are used.

Figure 8.4 – Historical trend and projections of CH_4 emissions for the LULUCF sector

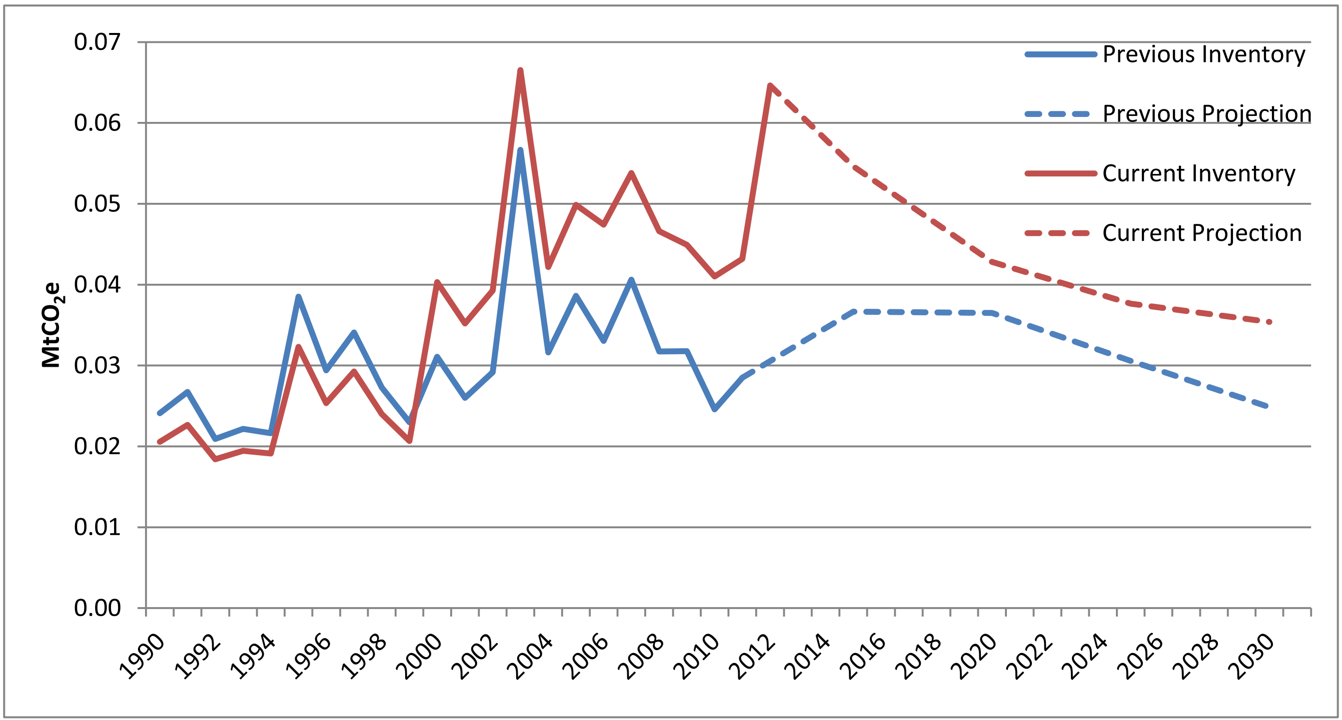


Changes in LULUCF sector CH_4 emissions since the previous update

As outlined in the LULUCF N_2O section above, a new set of LULUCF projections have been produced by CEH and included in this update to the non-CO_2 projections. This includes an updated and slightly different projected wildfires area. The main difference in the projection however is due to using 2012 GHGI data to base the projections on. There has been a slight increase in CH_4 emissions over the GHGI time series, due to revisions in activity data for wildfires and controlled burning following a change in biomass density with the forestry data underpinned by the CARBINE model, compared to the CFlow model used to underpin the forestry carbon data in the previous inventories. The GHGI time series has also changed due to an update to the deforestation to grassland areas (2000-2011 only) and an amendment of grassland / heathland split.

As a result of the changes to these sources, projected emissions of CH_4 from the LULUCF sector are now significantly different when compared to the Autumn 2013 publication (Figure 8.5). Current projections are for CH_4 emissions to decline until 2030.

Figure 8.5 Comparison of Autumn 2013 and Summer 2014 LULUCF sector CH4 projections

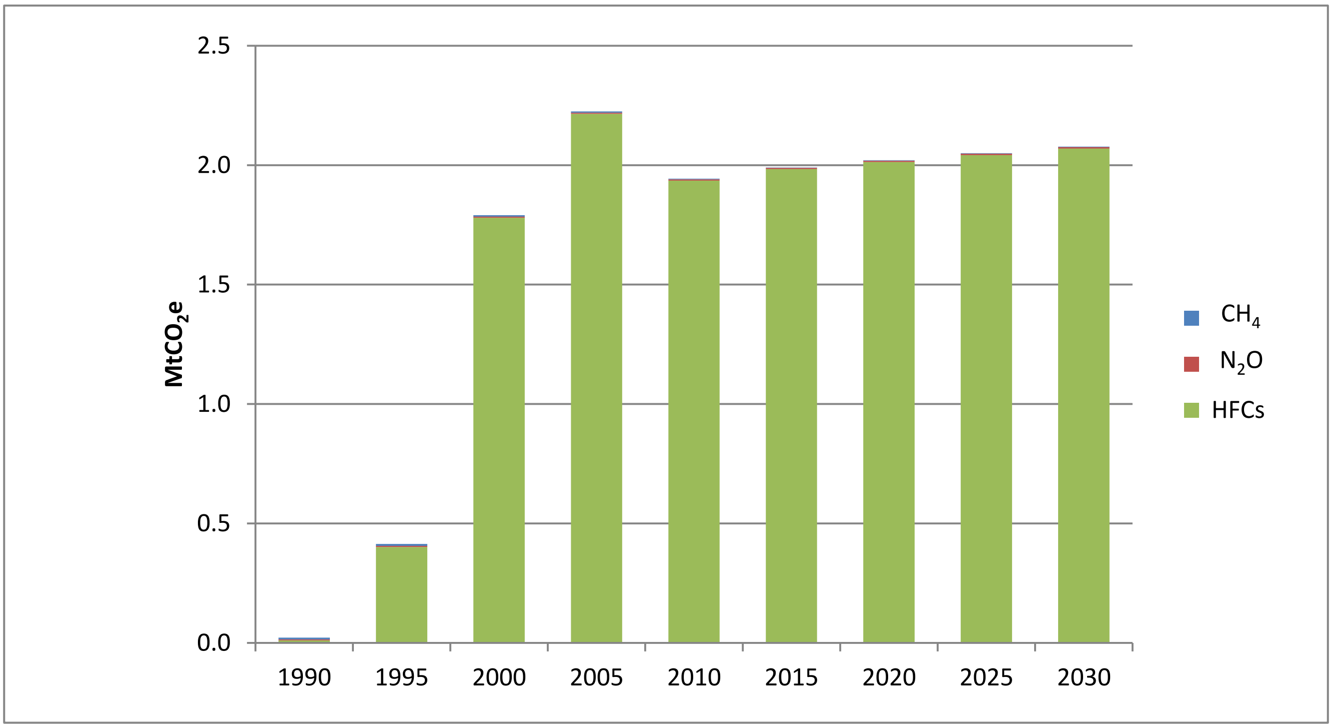


9. Residential Sector

In 2012 non-CO_2 greenhouse gas (GHG) emissions from the residential sector were approximately 2.0 MtCO_2e, representing around 2% of the UK's total non-CO_2 emissions. Nitrous oxide, methane and HFCs contribute to non-CO_2 GHG emissions from this sector. Historically, residential sector emissions have increased nearly 9000% since 1990. This resulted from a replacement of CFCs with HFCs as a result of the Montreal Protocol.

Since the Autumn 2013 update to the projections, projections from this sector have been updated to reflect the changes in the new GHGI. Furthermore, new projections of emissions from industrial off-road mobile machinery have been included. Overall emissions from the residential sector are projected to be 2.1 MtCO_2e in 2030 (see Figure 9.1). This is a projected 5% increase in emissions from 2012 to 2030, due to a projected increase in HFC emissions. Sections 9.1 – 9.3 contain more detail on the current projections and the changes since the last update for both of the gases.

Figure 9.1 – Non-CO2 GHG emissions projections for the residential sector

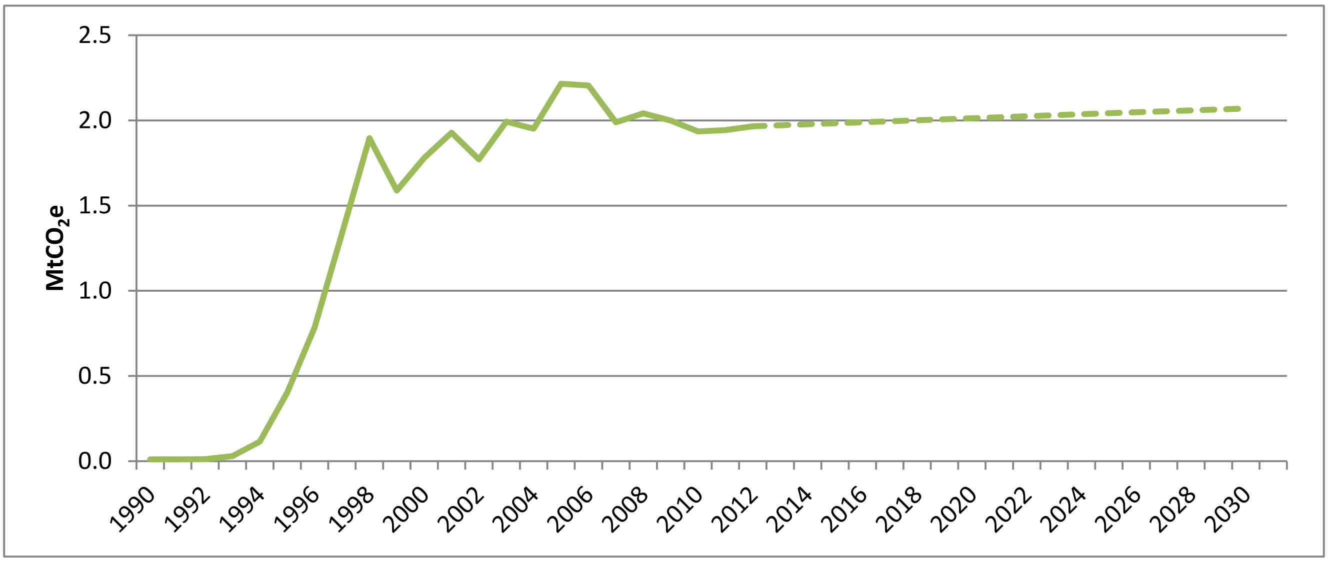


9.1 Residential sector Hydrofluorocarbon emissions

Non-CO_2 emissions from the residential sector are dominated by HFCs, which represent 99.6% of non-CO_2 GHG emissions from the sector. These emissions result from aerosols and metered dose inhalers (MDI). Emissions of HFCs have increased rapidly since 1990 due to the phasing out of CFCs due to the Montreal Protocol, resulting in the use of HFCs as replacement gases. Residential HFC emissions are projected to increase by 0.1 MtCO_2e, or 5%, between 2012 and 2030 (Figure 9.2), largely due to increased emissions from MDI as a result of increased UK population size (**AEA, 2008**). Emissions from aerosols are expected to remain constant because no clear trend in emissions is observed in the historical time-series (**AEA, 2010a**). The

EU's F-gas regulation is not expected to drive the replacement of HFCs with new lower GWP replacement gases in this specific sector, because no alternative compounds have been identified that meet the stringent criteria for delivering inhaled medication. Note that projections from these sources may be outdated and will undergo significant revision before next year's publication.

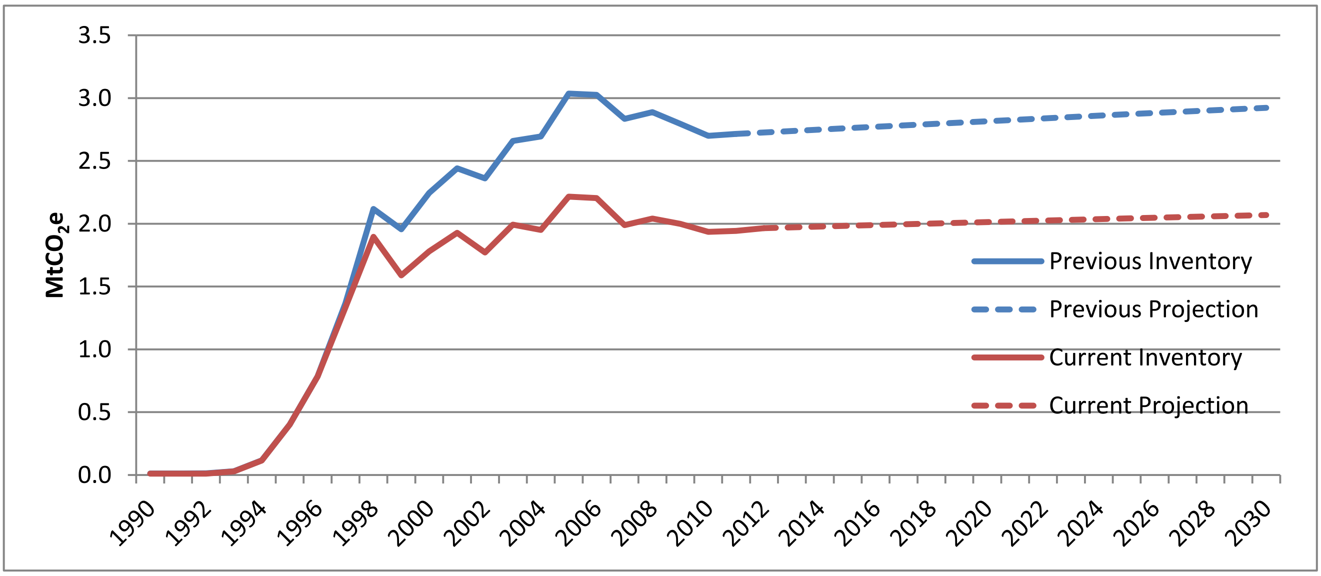
Figure 9.2 – Historical trend and projections of HFC projections for the Residential sector



Changes in Residential sector HFC emissions since the previous update

MDIs saw a change in the GHGI due to a revision to methodology used to calculate emissions from MDIs. The new approach is essentially a "UK consumption model" and the number of MDIs used each year in the UK is derived from the UK National Health Service (NHS) prescription data. The projections of MDI HFCs were rebaselined to this new GHGI year and this roughly halved the emissions from this source, which was by far the biggest change in the residential sector. The aerosols projection was only negligibly affected by rebaselining to the new aerosols GHGI. The net effect of these changes is to decrease HFC emissions projections across the time series, with a 0.85 $MtCO_2e$ decrease in 2030 compared to the previous set of projections. Figure 9.3 highlights this change.

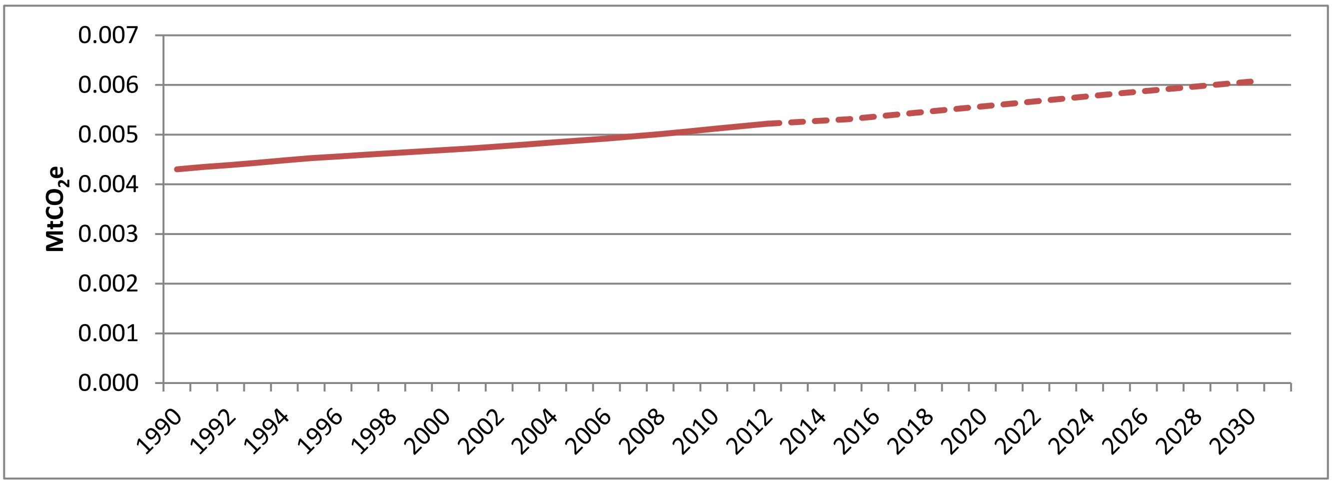
Figure 9.3 Comparison of Autumn 2013 and Summer 2014 residential sector HFC projections



9.2 Residential sector nitrous oxide emissions

Nitrous oxide emissions were estimated to be 5 ktCO_2e in 2012, representing 0.3% of non-CO_2 GHG emissions from the residential sector. These emissions result from the use of house and garden mobile machinery. Historically, N_2O emissions have increased 21% since 1990. Emissions are projected to increase by 1 ktCO_2e, or 16%, between 2012 and 2030 (see Figure 9.4). These percentage increases may be misleading though, as the absolute emissions values are very small. The driver on the projections is the number of households and further details on this methodology are found in Annex A.

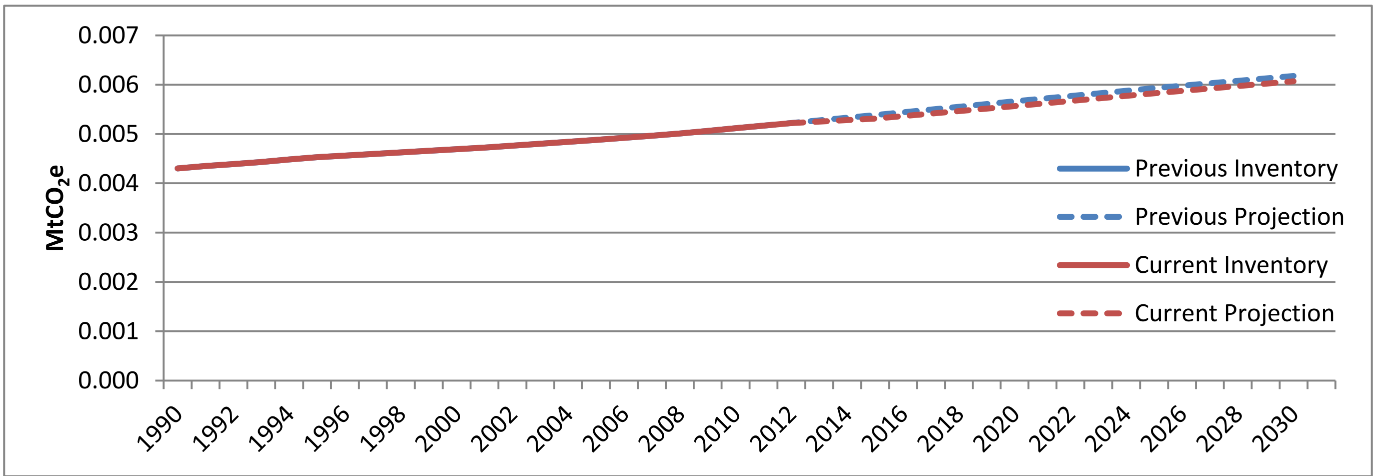
Figure 9.4 Historical trend and projections of N_2O emissions for the Residential sector



Changes in Residential sector N_2O emissions since the previous update

Since the Autumn 2013 projections a new set of off-road mobile machinery projections have been produced. These new projections have been included in the Summer 2014 update and include mobile house and garden machinery, which is part of the residential sector. Emissions from this source are projected using activity data projections of the number of households up to 2021 from the Department for Communities and Local Government (**DCLG, 2013**). This source did not provide household projections for the UK beyond 2021, so for those years an earlier set of household projections up to 2033 published by CLG in 2011 were used as drivers. The updated projections are shown in Figure 9.5.

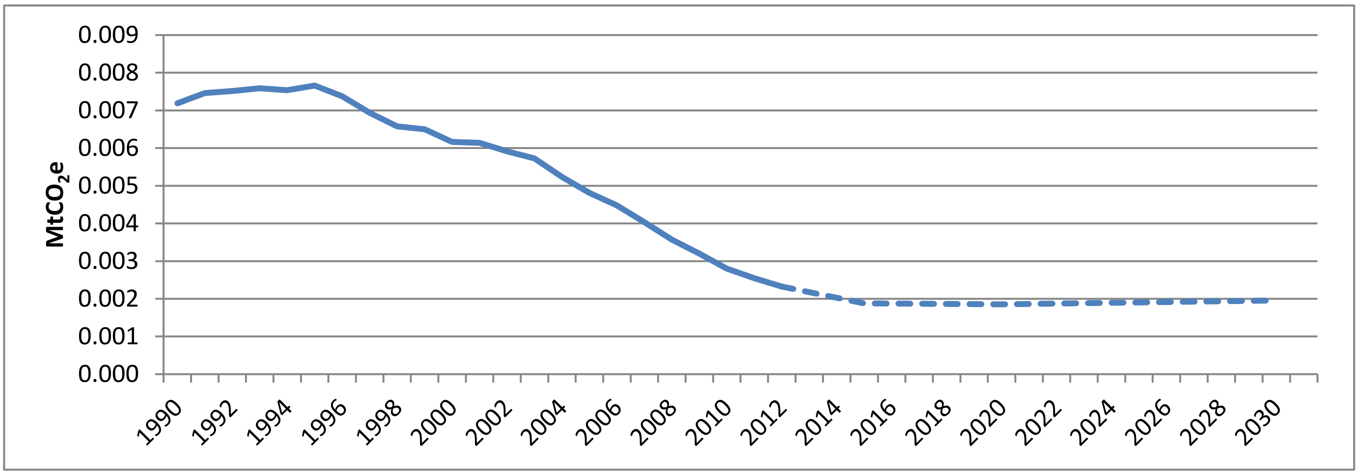
Figure 9.5 Comparison of Autumn 2013 and Summer 2014 Residential sector N2O projections



9.3 Residential sector methane emissions

Methane emissions were estimated to be 2 ktCO_2e in 2012, representing 0.1% of non-CO_2 GHG emissions from the residential sector. As with N_2O these emissions result from house and garden machinery and additionally accidental fires in vehicles. Historically, CH_4 emissions in this sector have decreased 68% since 1990. Emissions are projected to decrease by 0.4 $ktCO_2e$, or 16%, between 2012 and 2030. It is important to note that these percentage decreases relate to very small absolute emissions values. Figure 9.6 highlights the latest historical and projected trends for residential sector CH_4 emissions. The methodology is analogous to residential sector N_2O emissions and more details are found in Annex A.

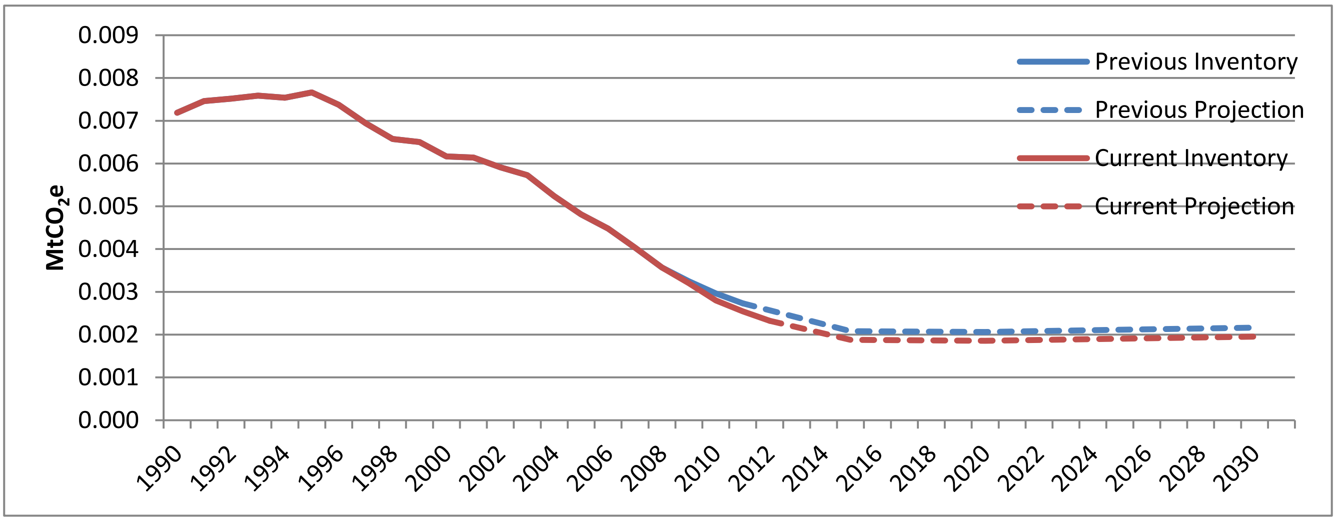
Figure 9.6 – Historical trend and projections of CH_4 emissions for the Residential sector



Changes in Residential sector CH_4 emissions since the previous update

As highlighted above, new residential house and garden mobile machinery projections have been produced and included in these CH_4 projections. This has caused only a negligible decrease in CH_4 emissions. There has also been a change to the GHGI for accidental vehicle fires. Updated fire statistics have now been received for 2009 – 2011, where previously these had been extrapolated. This caused a small decrease in emissions. The net effect is a very small decrease in projections (Figure 9.7).

Figure 9.7 Comparison of Autumn 2013 and Summer 2014 Residential sector CH4 projections

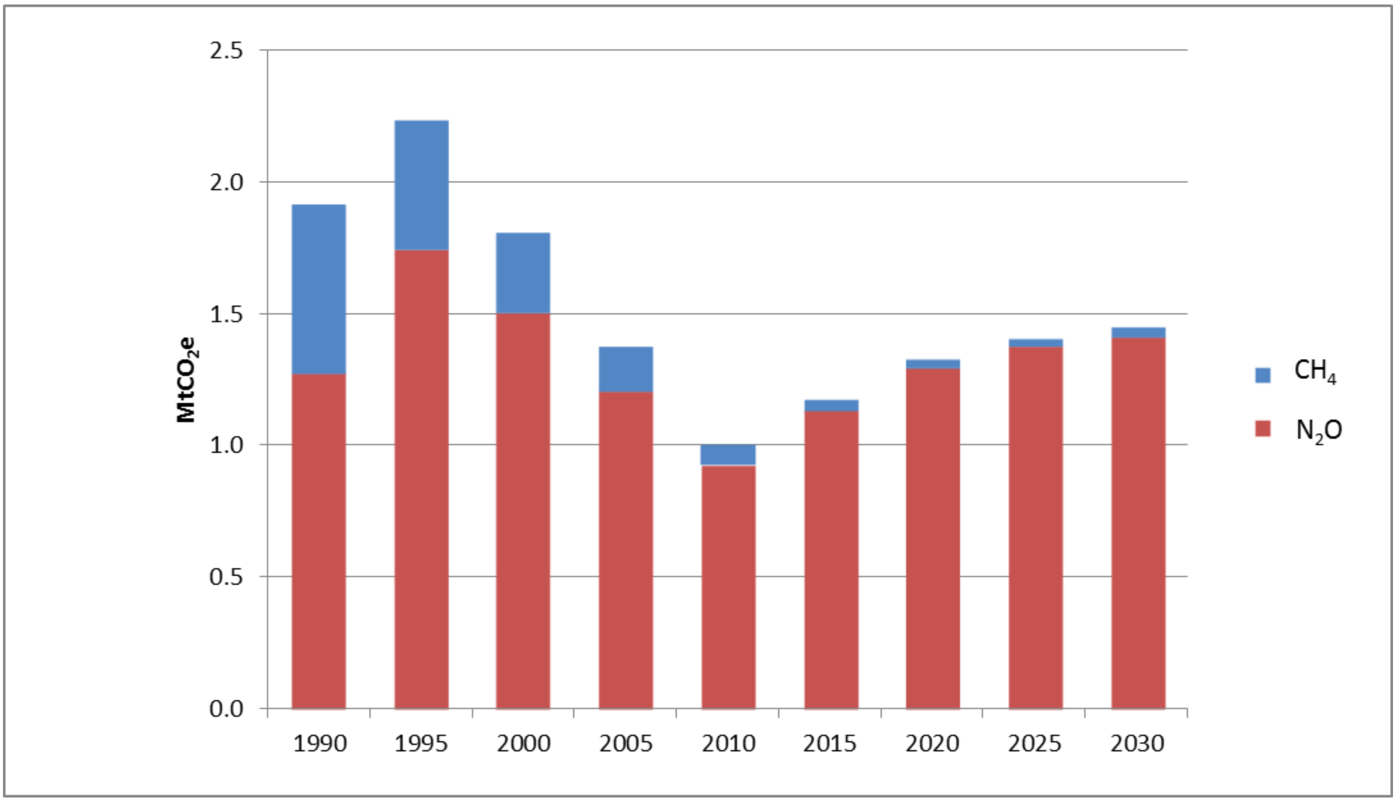


10. Transport Sector

The transport sector is the third smallest contributor to total non-CO_2 emissions. In 2012 it represented just over 1 $MtCO_2e$, equivalent to 1% of total non-CO_2 greenhouse gas emissions. Two gases represent the non-CO_2 contribution to emissions from this sector, N_2O and CH_4. Emissions from the transport sector have decreased by 45% from the 1990 level. The change in emissions from the sector is strongly affected by Euro standards on emissions from new road transport vehicles. The biggest effect is emissions constraints on nitrogen oxides (NO_x), using technologies which emit higher amounts of N_2O.

Since the Autumn 2013 update to the projections, projections from this sector have been updated to reflect the changes in the new GHGI. Furthermore, new projections of emissions from road transport and industrial off-road mobile machinery have been included. Overall emissions from the transport sector are projected to be approximately 1.5 $MtCO_2e$ in 2030, which corresponds to a projected increase in emissions of 37% on the 2012 level (See Figure 10.1). The projected increase in emissions is strongly driven by higher emitting diesel cars replacing petrol cars and increased activity by new HGVs. Sections 10.1 – 10.2 contain more detail on the current projections and the changes since the last update for both of the gases.

Figure 10.1 – Non-CO2 GHG emissions projections for the transport sector

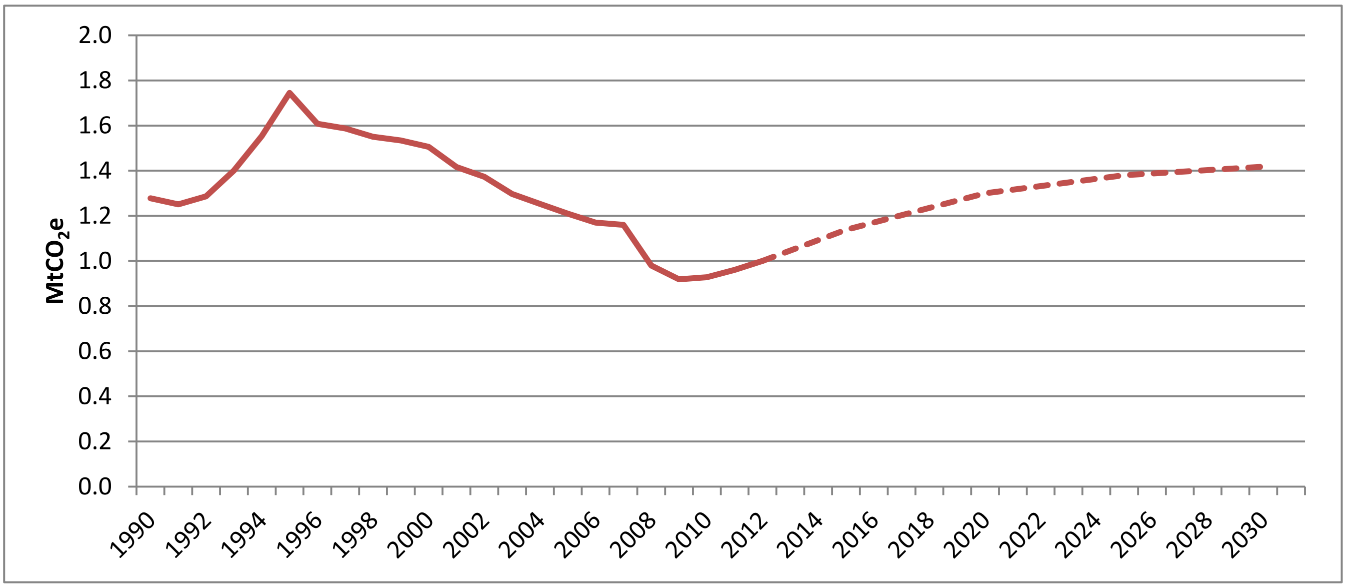


10.1 Transport sector nitrous oxide emissions

Nitrous oxide provides by far the most significant contribution to non-CO_2 emissions from the transport sector. In 2012 N_2O represents 95% of non-CO_2 emissions from transport, rising to 98% by 2030. Road transport, particularly cars, is the highest contributor to the transport sector's N_2O emissions across the projections time series, emitting 90% of the N_2O from transport in 2012. The other N_2O emissions result from aircraft support vehicles, domestic aircraft activity and transport used by the armed forces.

N_2O from the transport sector is projected to increase from 1.0 $MtCO_2e$ in 2012 to 1.4 $MtCO_2e$ in 2030 (see Figure 10.2).

Figure 10.2 Historical trend and projections of N_2O emissions from transport



Road transport emissions projections are produced with the road transport model by Ricardo-AEA under contract to DECC. The emission estimates follow a bottom up methodology in line with the current historical time-series of emissions. Emission factors (grams per kilometre) are vehicle-type specific. For the historical emissions, activity data is based on high level traffic statistics (vehicle kilometres travelled by vehicle type) and fleet data from DfT. For the projected emissions, activity data is based on DfT's latest traffic forecasts, turnover in the vehicle fleet and emission factors for future vehicle classes.

The driver for aircraft support vehicle projections is forecasts in the number of UK airport terminal passengers and the driver for domestic aircraft activity is DfT CO_2 emissions as a proxy for fuel use. Further details on all these methodologies are found in Annex A.

The trends in emissions from road transport cannot be explained by a single factor but are dictated by a combination of factors. These are mainly the rate of traffic growth for each vehicle type, the relative differences in emission factors for each vehicle type and across the Euro classes and the turnover in the vehicle fleet. There can be both combining and competing effects on the trends.

The trend in road transport **emissions factors** can be summarised as follows:

- N_2O emissions from road vehicles are affected by technologies introduced to control other air pollutant emissions which are regulated, especially NO_x.
- In particular, the Euro standards for petrol cars require the fitting of three-way catalyst systems. Initially, these led to higher N_2O emissions as a result of the unintended formation of N_2O as a by-product of the NO_x reduction process on the catalyst surface. Improved catalyst formulations are most likely to be the cause of the lower emissions factors for more recent Euro standards, however, other factors may be driving the trend. This is reflected in the fall in emissions in the 2000s and continued reduction in emission factors for new petrol vehicles penetrating the fleet.
- HGVs and buses emissions factors fall across the early Euro standards up to Euro III, but have been rising across successive Euro standards up to Euro V (introduced from 2008)

and are expected to continue to rise up to Euro VI (introduced from 2013). This implies factors have been increasing from new vehicles registered since around 2005. The reason for this is again likely to be due to measures aimed at controlling NOx and in particular the use of Selective Catalytic Reduction (SCR) which involves injecting urea (a nitrogen compound) into the exhaust stream. This can cause the unintended formation of N_2O in the NOx reduction process.

- Emission factors for diesel cars and LGVs remain unchanged since Euro 3 standards were introduced in 2000.

There is projected trend of dieselisation of the car fleet, i.e. diesel vehicles replacing petrol vehicles. There is also projected growth in diesel car, LGV and HGV distance travelled, as well a small decrease in predicted bus vehicle km. The increase in diesel vehicle emissions due to the projected overall increase in diesel vehicle activity is the major trend affecting overall road transport emissions. This increase is only partially offset by a decrease in the emissions from petrol cars in the initial years. The rise in N_2O emissions is initially steep with accelerated penetration of the diesel car fleet, as well as penetration of higher emitting new HGVs/buses in the fleet and the increase in vehicle kms. However, this levels off after 2020 as the diesel car penetration becomes complete and emission factors remain constant. The trend then becomes driven by the slower increase in overall vehicle activity.

Changes in transport sector nitrous oxide emissions since the previous update

As highlighted above, there has been a new set of road transport projections produced by Ricardo-AEA under contract to DECC and included in this update. The key changes to these projections which influence N_2O emissions from the transport sector are due to a methodology change in this year's GHGI. Previously, the emission time series was calculated on the basis of fuel consumed (kilometres travelled). This calculation was based on vehicle-type specific grammes per kilometre (g/km) emission factors, traffic statistics (vehicle kilometres travelled by vehicle type) and fleet data from DfT. In response to comments made by the UNFCCC Expert Review Team, the latest GHGI normalises the road transport emissions using data on fuel sales in DUKES (**DECC, 2013d**). The normalisation to align the sum of estimated fuel consumption for the different vehicle types to total petrol and diesel sales figures in DUKES (after correcting for consumption by off-road machinery) is also applied to the projections by using the average of the normalisation factors for the past 5 years in the GHGI time-series (2008-2012). The effect of this normalisation is to raise N_2O projections by 0.4 – 0.5%.

Other minor changes to road transport emissions projections were the use of the latest DFT traffic forecast (**DFT, 2013a**), as well as the following GHGI changes on emissions for current years:

- Update to data on London bus fleet composition and bus activity data in Northern Ireland
- Revisions to the composition of the LGV fleet used in the calculation of LPG emission factors
- Some revised data for the Falkands and Bermuda.

However, these make minimal difference to the N_2O projections.

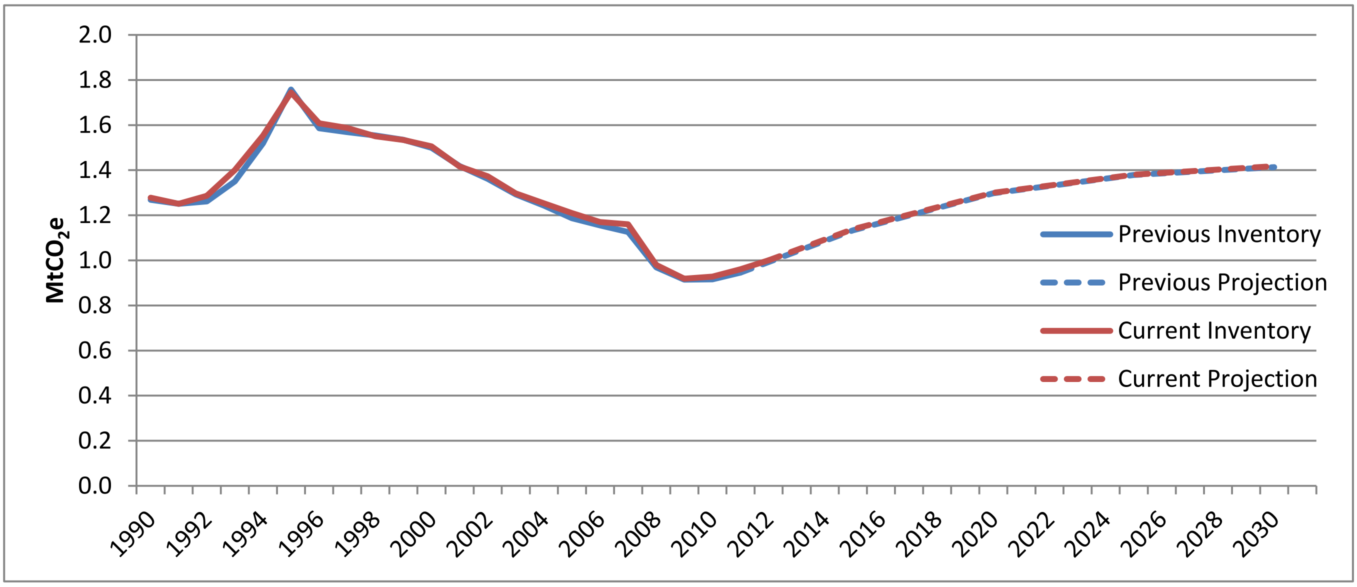
The emissions from aircraft machinery, which are projected using DFT projections of UK airport terminal passengers, have been updated using the latest DFT projections (**DFT, 2013b**). This causes a small increase in N_2O projections.

Regarding aircraft contribution to transport emissions, the latest GHGI has incorporated recent data from local London airport inventories (2008 onwards) so that aircraft engine mixes, times in mode and thrust settings are consistent. International flights with an intermediate stop at a domestic airport have been re-classified as having a domestic leg and an international leg, increasing the GHGI total for domestic flights and reducing the international component of aviation (which are not reported here). This caused a small net decrease in N_2O emissions through rebaselining.

Finally, projections of emissions from transport used by the armed forces have been rebaselined to the latest GHGI and seen a slight decrease.

The combined effect of these revisions to N_2O emissions from the transport sector have resulted in projected emissions being slightly higher when compared with the Autumn 2013 publication. Figure 10.3 below highlights the effects of this change.

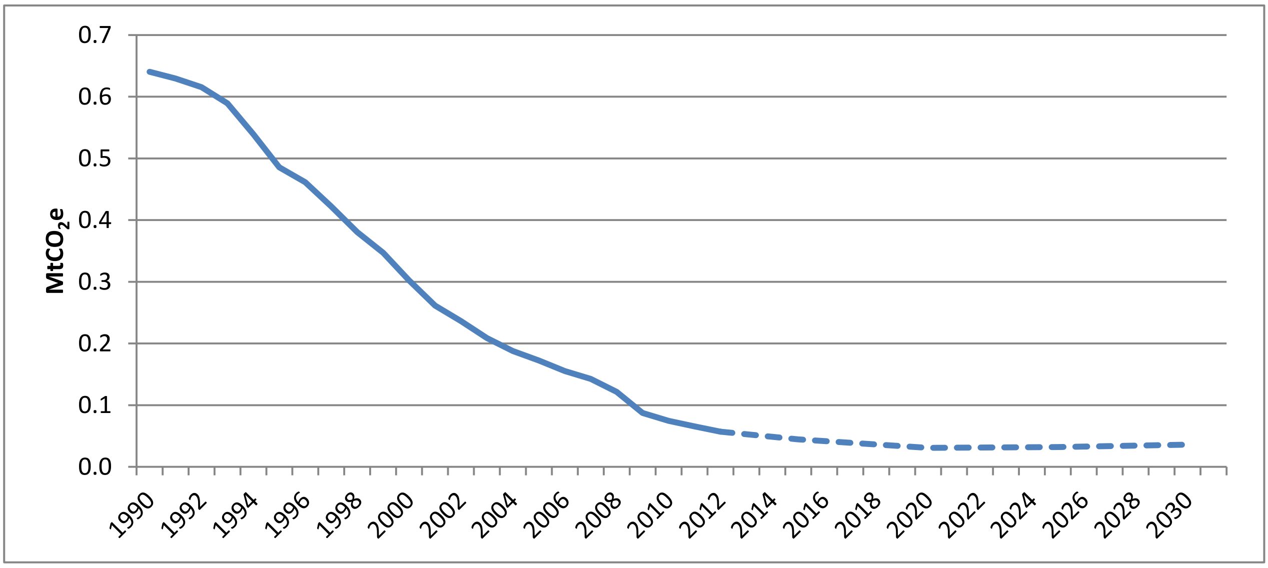
Figure 10.3 Comparison of Autumn 2013 and Summer 2014 transport sector N_2O projections



10.2 Transport sector methane emissions

Methane contributes a marginal proportion of the total non-CO_2 greenhouse gas emissions from the transport sector, representing 5% of emissions from this sector in 2012 and declining to 2% in 2030. As with N_2O from the transport sector, road transport is the most significant contributor to CH_4 emissions, representing 95% of CH_4 emissions from the transport sector in 2030. The remainder is from domestic aircraft activity and military vehicles. The methodologies for all these projections are analogous to N_2O emissions methodologies.

Figure 10.4 Historical trend and projections of CH_4 emissions from transport



Emissions of CH_4 from the transport sector have declined markedly since 1990, displaying a 91% reduction between 1990 and 2012. The projected trend is for CH_4 emissions to continue to reduce, albeit by a much slower rate, a further 3 percentage points lower on 1990 levels by 2030. Emissions are therefore projected to be 36 ktCO_2e in 2030.

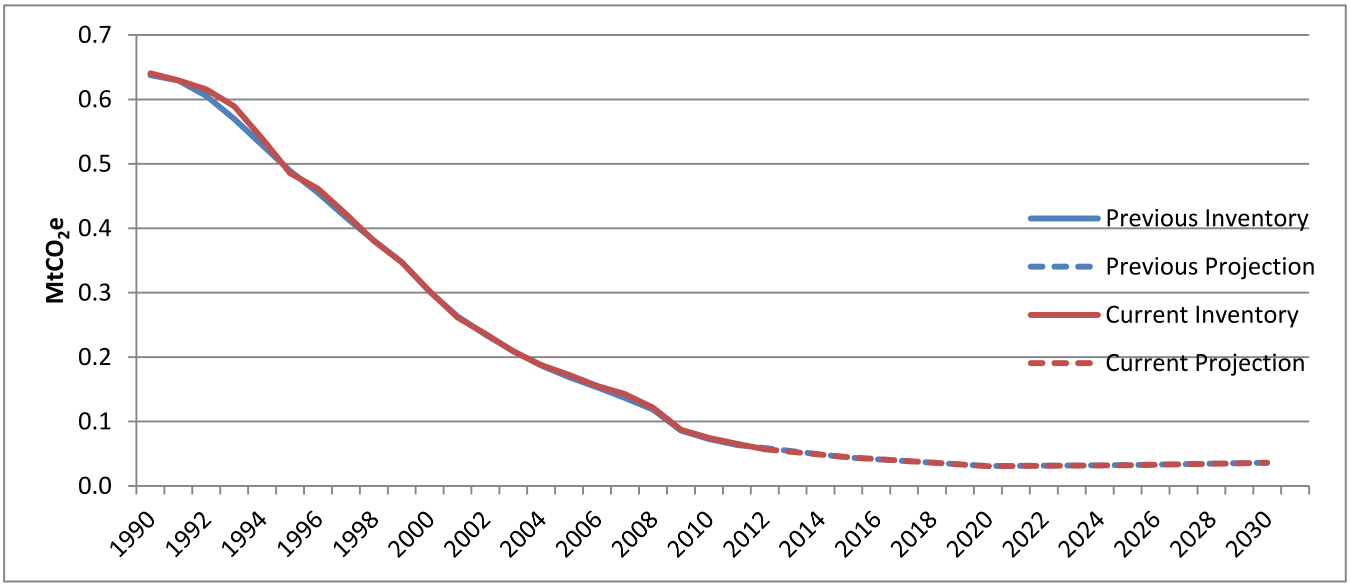
Methane emissions from road vehicles are not regulated by the Euro emission standards but are affected by technologies introduced to control other air pollutant emissions which are regulated, especially total hydrocarbons. These measures include three-way catalysts for petrol vehicles and oxidation catalysts for diesel vehicles, and general improvements in engine design and management. Thus, CH_4 emission factors broadly fall across the projected time series in line with the reductions in hydrocarbon emissions.

The trends in projected emissions from road transport cannot be explained by a single factor but are dictated by a combination of factors. These are mainly the rate of traffic growth for each vehicle type, the relative differences in emission factors for each vehicle type and across the Euro classes and the turnover in the vehicle fleet. There can be both combining and competing effects on the trends. The combination of these factors leads to the trend displayed in Figure 10.4 above, projecting only a slight further decrease in transport CH_4 emissions going forward.

Changes in transport sector methane emissions since the previous update

The revisions listed in the N_2O section above are all applicable with reference to CH_4. The only exception is that the update to data on London bus fleet composition and bus activity data in Northern Ireland does not affect CH_4. The effect of normalising road transport to data on fuel sold is to raise road transport projections by 2 – 3%. This is balanced by decreases in emissions from domestic aircraft activity and transport used by the armed forces. The effect is that projections of CH_4 are essentially unchanged since the Autumn 2013 projections, as seen in Figure 10.5.

Figure 10.5 Comparison of Autumn 2013 and Summer 2014 transport sector CH_4 projections

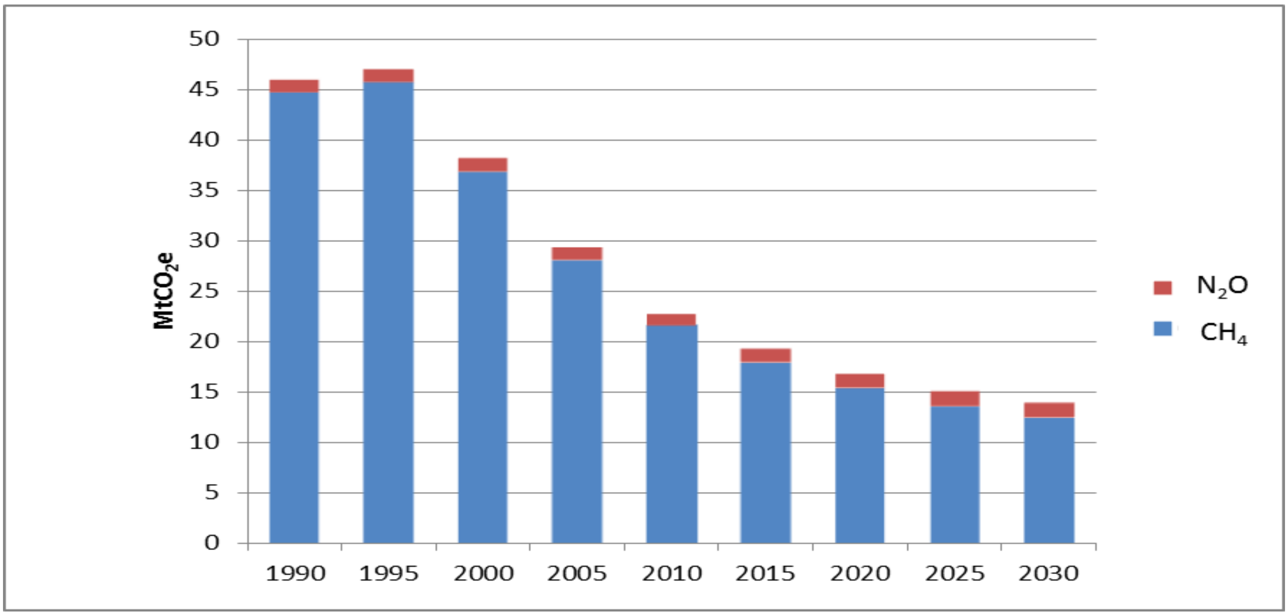


11. Waste Management Sector

In 2012 non-CO_2 GHG emissions from the waste management sector were 21.4 $MtCO_2e$, representing around 22% of the UK's total non-CO_2 emissions. Two gases represent the non-CO_2 contribution to emissions from this sector, N_2O and CH_4. Historically, waste management emissions have decreased by 25 $MtCO_2e$ since 1990, which equates to a reduction of 54%.

Since the Autumn 2013 update to the projections, projections from this sector have been updated to reflect the changes in the new GHGI. Overall emissions from the waste management sector are projected to be 14 $MtCO_2e$ in 2030, which corresponds to a decrease in emissions of 34% from 2012 (see Figure 11.1). Both historical and projected emissions reductions are dominated by significant reductions in landfill waste emissions. Sections 11.1 – 11.2 contain more detail on the current projections and the changes since the last update for both of the gases.

Figure 11.1 Non-CO2 GHG emissions projections for the waste management sector

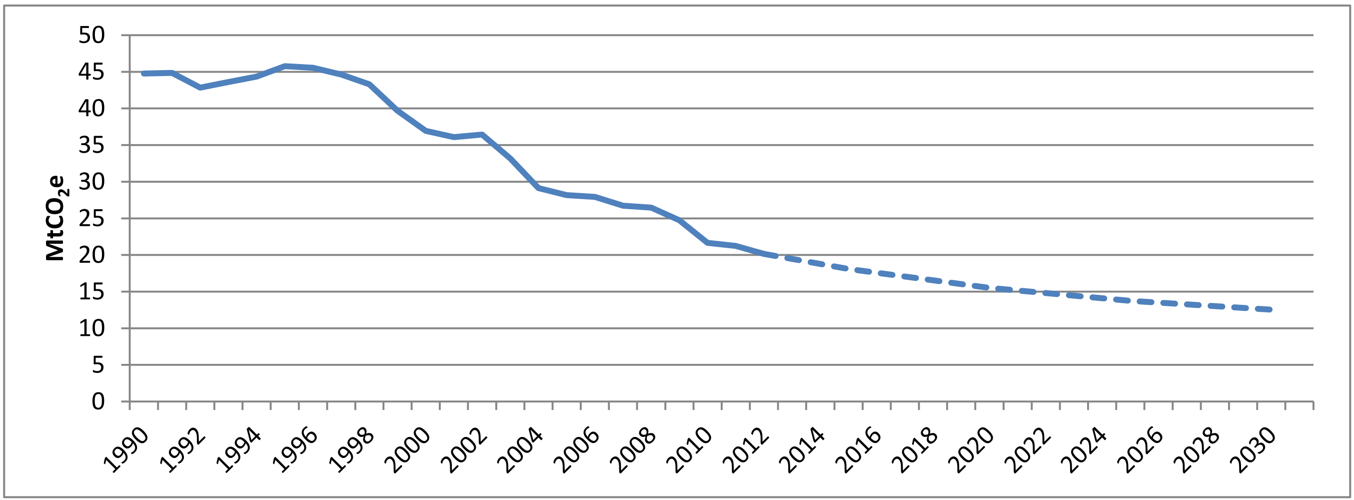


11.1 Waste management sector methane emissions

Emissions of CH_4 were estimated to be 20 $MtCO_2e$ in 2012, representing 94% of non-CO_2 GHG emissions from the waste management sector. Emissions from landfill waste represent 92% of waste management CH_4, with industrial waste water treatment, sewage sludge decomposition and waste incineration also contributing. There has been a significant reduction in the historical emissions trend since 1990 of around 55%. Emissions are projected to decrease by 8 $MtCO_2e$, or 38%, between 2012 and 2030 (see Figure 11.2). This is expected as a result of reductions in the amount of waste sent to landfill.

Projected CH_4 emissions from **landfill waste** are estimated using a model, MELMod (**Eunomia, 2010**), which is based on the first-order decay International Panel on Climate Change (IPCC) methodology, and is summarised in the NIR (**DECC, 2014b**).

Figure 11.2 Historical trend and projections of CH_4 emissions from waste management



The amount of CH_4 emitted from landfills depends primarily on the amount of carbon in biodegradable waste landfilled and how the sites are operated to reduce the escape of the CH_4 produced from such wastes. The most important legislative and regulatory measures which have reduced the emissions of CH_4 from UK landfills derive from the 1999 Landfill Directive. The provisions of the Landfill Directive require reduction of the amount of biodegradable waste landfilled to specific targets and improved landfill design, operation and management in order to reduce release of CH_4.

Emissions from landfill are dominated by emissions from waste already sent to landfill, i.e. historical waste. The trend in CH_4 production following deposition in a landfill site is typically an increase over the first few months/year or two, followed by a decrease in CH_4 production over 10 – 20 years. Emissions have decreased since 1995 due to reductions in waste sent to landfill and the introduction of CH_4 capture technology.

With respect to future waste sent to landfill it is projected that mass of waste sent to landfill will decrease, based on projections of waste arising from Local Authority Collected Waste (LACW) and Commercial & Industrial (C&I) waste. The projections currently used in the model do not make use of latest waste arising projections published last year. This is an area that we plan to improve for next year's non-CO_2 projections.

Projected CH_4 emissions from domestic & commercial waste water treatment and sewage disposal are based on a model used in the historical GHGI (**Hobson *et al*, 1996**), using assumptions from an Entec report (**Entec, 2006a+b**), also used in the Autumn 2013 and previous publications. Further details on all of these methodologies are found in Annex A.

Projected CH_4 emissions from industrial waste water treatment and waste incineration (not for power generation, and including the categories of incineration, incineration of clinical waste, and incineration of sewage sludge) are assumed to remain constant as the future levels of activities in these categories is unknown.

Changes in waste management sector methane emissions since the previous update

The only source of change between this update and the previous projections has been the inclusion of the latest GHGI.

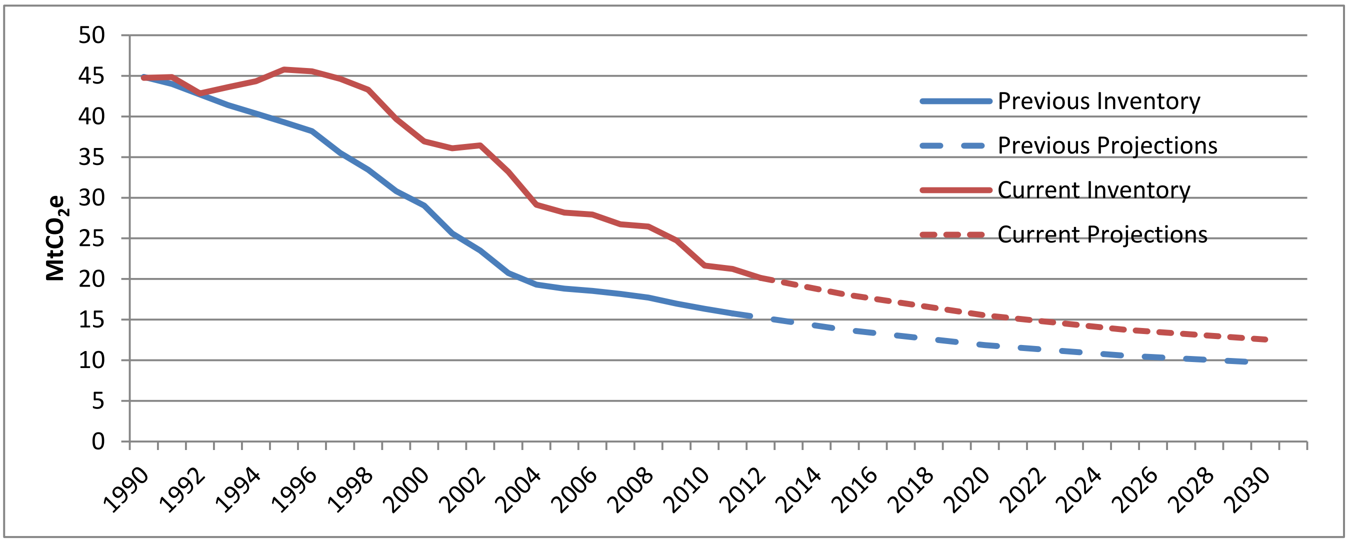
The main GHGI change is a significant methodology change affecting the whole time series of emissions from landfill waste. This is due to how flaring is treated. Previously, emissions were calculated by assuming that a specific proportion of CH_4 generated at UK landfill sites was captured. The balance was assumed to be emitted to the atmosphere, with a proportion (10%)

oxidised via the landfill surface. This approach has been improved, such that the quantity of CH_4 combusted in engines and flares in each year is subtracted from the quantity of CH_4 generated at UK landfill sites. Again, it is assumed that the balance is emitted to the atmosphere with a proportion (10%) oxidised via the landfill surface. This methodological change causes landfill emissions to significantly increase across the whole time series. This change has a large effect on the projections.

Rebaslining to the latest GHGI value for industrial waste water treatment, domestic & commercial waste water treatment / sewage disposal and waste incineration has only a very small further effect on the projections.

The effect of these changes to the GHGI has been to increase the trend in emissions across the time series. Compared to the Autumn 2013 projections publication, emissions are 32% higher in 2015 and 30% higher in 2030 (Figure 10.3).

Figure 11.3 Comparison of Autumn 2013 and Summer 2014 transport sector CH_4 projections

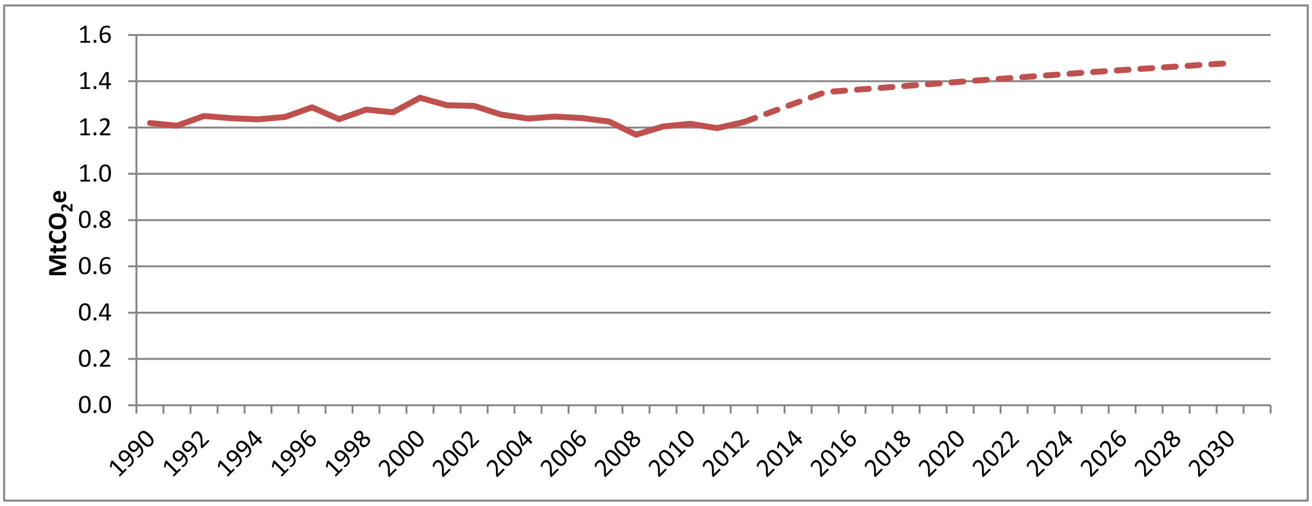


11.2 Waste management sector nitrous oxide emissions

Emissions of N_2O were estimated to be 1.2 $MtCO_2e$ in 2012, representing 6% of non-CO_2 GHG emissions from the waste management sector. These emissions result from domestic & commercial waste water treatment / sewage disposal and waste incineration. There has been no significant change in the emissions trend since 1990. Emissions are projected to increase by 0.26 $MtCO_2e$, or 21%, between 2012 and 2030 due to a projected increase in sewage sludge decomposition in line with population growth (see Figure 11.4).

Projections of N_2O from domestic & commercial waste water treatment / sewage disposal are based on some assumptions described in Annex A. Emissions from waste incineration are assumed constant.

Figure 11.4 Historical trend and projections of N_2O emissions from waste management



Changes in waste management sector nitrous oxide emissions since the previous update

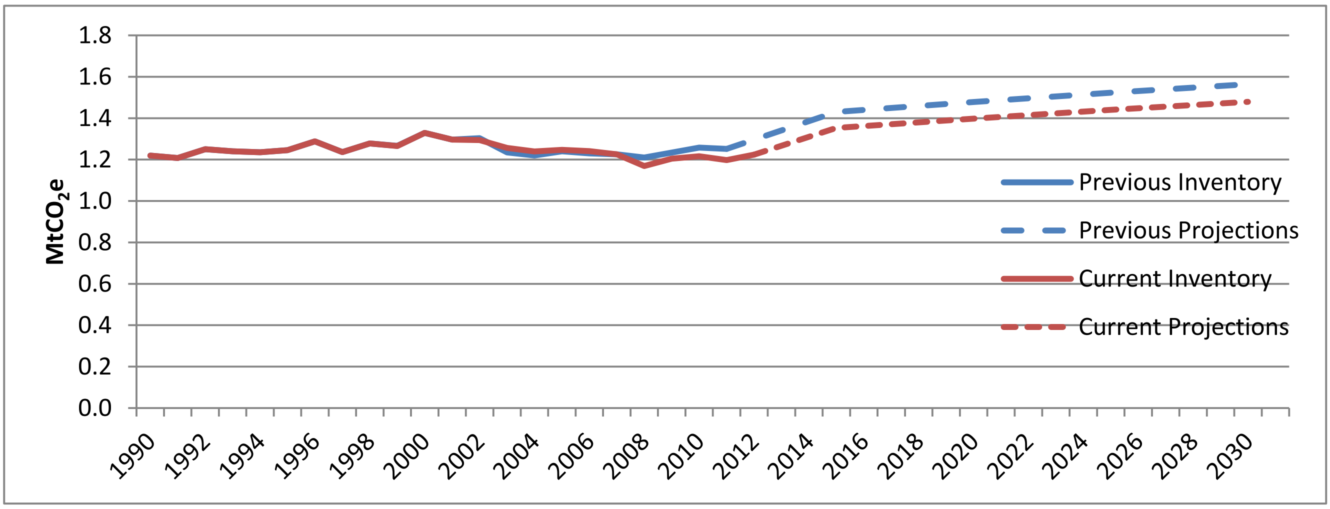
The only source of change between this update and the previous projections has been the inclusion of the latest GHGI. As explained in the methodology section of this report, the projections have been rebaselined against the latest GHGI.

The only methodology change affecting waste sector N_2O emissions is from domestic & commercial waste water treatment and sewage disposal. The GHGI agency has reviewed the activity data from water companies and corrected the emission estimates for 2011using actual protein consumption data for that year rather than to extrapolate protein data from 2010, as within the 2013 submission. There have also been some revisions to the estimates for N_2O emitted from sewage sludge disposal to agricultural soils and therefore this has a knock-on effect on the N_2O emission estimate in from this source.

Rebaslining to the latest GHGI value for waste incineration has only a very small further effect on the projections.

The effect of these changes to the GHGI has been to reduce the projected trend in emissions by approximately 5% across the time series when compared to the previous set of projections (Figure 10.4).

Figure 11.5 Comparison of Autumn 2013 and Summer 2014 waste sector N_2O projections



12. Uncertainties

12.1 Uncertainties methodology/approach

The DECC non-CO_2 projections model contains an uncertainties module which comprises a simplified Monte Carlo simulation. This is run at the National Communication sector level for each gas in order to quantify uncertainties in the emissions projections.

This module assumes that the latest GHGI year has no associated uncertainty, and so the uncertainties in future years relate only to how different the GHGI estimate is likely to be to the projected estimate in that year, ignoring the uncertainty associated with the GHGI method. This is because the magnitudes of the GHGI uncertainties are larger than projection uncertainties. Including the GHGI uncertainties for the non-CO_2 GHGs would result in these larger uncertainties dominating the Monte Carlo simulation and effectively hiding the much smaller uncertainties in the projected trend. See **AEA 2010b** for further detailed explanation of the methodology.

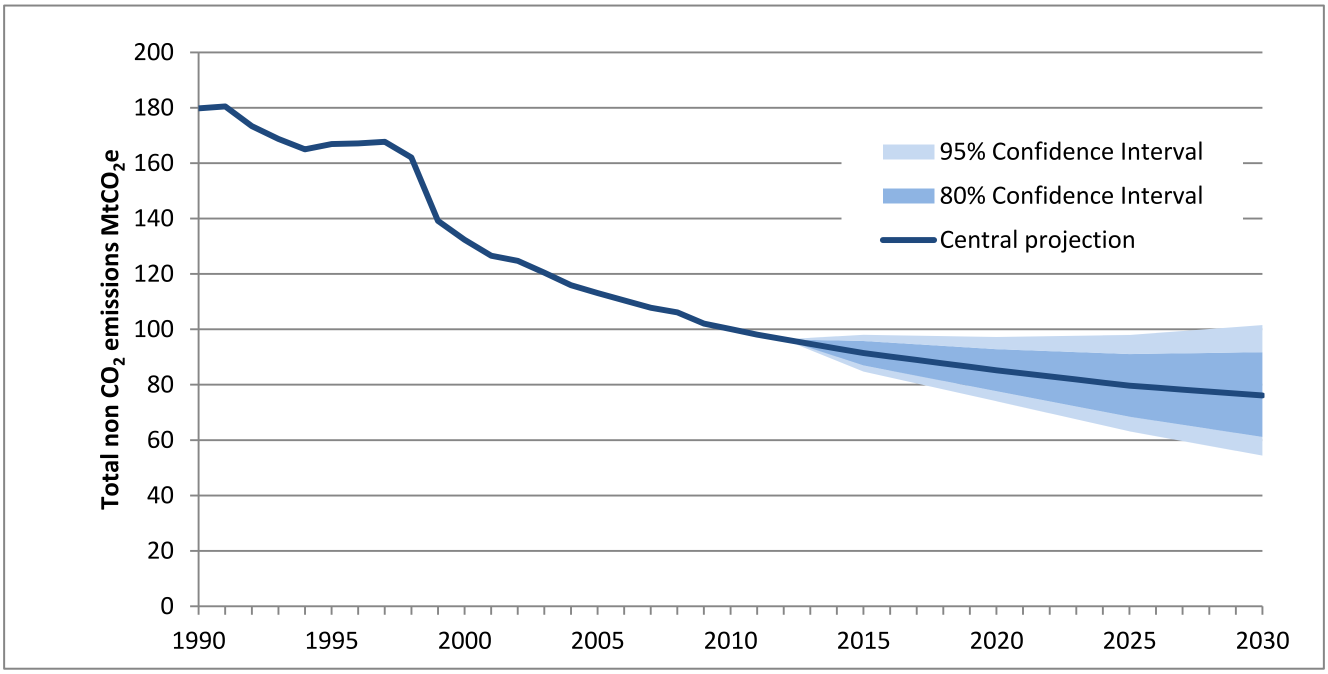
Since the Autumn 2011 update to the projections, the uncertainty on the growth (positive or negative) of the emissions is used as input for the Monte Carlo simulation rather than the uncertainty around each data point, as was used in prior updates. This conclusion logically follows our stated intention to model uncertainty in the trend without incorporating uncertainty in the historical data which is the basis of the trend.

Since the Spring 2013 projections update, the projection uncertainties are modelled using the @Risk analysis software. The principles of this model are the same as those used in the previous uncertainties model.

12.2 Uncertainty results

The uncertainty analysis indicated that the 95% confidence interval around the projections is +/-6% for 2015, increasing gradually to -11% / +12% in 2020, -18% / +19% in 2025 and -24% / +28% in 2030. This asymmetry is an artefact of analysing the uncertainty in the growth rates rather than absolute values, and reflects the effect of compounding a percentage increase compared with a percentage decrease: e.g. a 10% increase year on year for 5 years yields a 60% increase whereas a 10% decrease year on year for 5 years results in just a 40% decrease. Figure 12.1 below shows the confidence intervals around the central projection estimate, resulting from the uncertainty analysis.

Figure 12.1 Uncertainty analysis for projections used in the Summer 2014 update, as 80% and 95% confidence intervals



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Annex A: Summary of methods used to estimate emissions projections

Further information on the methodology for the derivation of projections for each emissions source is provided below. Where a sector has been updated, each individual sectoral update is explained more fully in the relevant sector chapters.

Agriculture

4A, 4B & 4D – Agricultural livestock and agricultural soils

Agriculture emissions projections used in this update (**DEFRA, 2014**) are based on Defra agriculture activity projections produced by the FAPRI model (**FAPRI, 2012**) of UK agriculture.

The FAPRI-UK modelling system was created, and is maintained, by Agri-Food Biosciences Institute (AFBI) at Queen's University Belfast. The model represents the UK agricultural sector via supply and demand equations and is broken down to the Devolved Administration level. Key variables modelled are production, consumption, net-trade and prices for the following commodities: Dairy, Beef, Sheep, Pigs, Poultry, Wheat, Barley, Oats, Rapeseed and Liquid Biofuels. Livestock numbers and crop areas are also modelled. The model is fully incorporated within the EU GOLD (Grain, Oilseeds, Livestock & Dairy) system which is run by FAPRI-Missouri. Consequently, the UK model gives projections to 2020 which are consistent with the equilibrium at EU level. The FAPRI-UK model has been used since 2011 and has greatly increased the accuracy of the activity drivers behind Defra's emissions projections.

GHG emissions factors, taken from the National Atmospheric Emissions Inventory (NAEI), are then applied to these activity projections to produce GHG emissions estimates.

4F1 & 4F5 – Field burning

In the absence of further data, these projections are projected to remain the same as the most up to date GHGI year.

Business

2F1 – Refrigeration and air conditioning

Refrigeration/air conditioning emissions are estimated using an updated model developed by ICF International (**ICF, 2011**), based on revised industry input and a more transparent, robust modelling approach consistent with IPCC guidance. The model has been reorganized from 9 to 13 end-uses, using detailed assumptions to utilise a fully bottom-up approach based on equipment stocks and average charge size from available market data. In the previous model, produced by AEA (**AEA 2010**) most end-uses were modelled using a top-down approach based on total refrigerant sales data. This updated model improves the accuracy of emissions allocated to end-uses and improves the understanding of the end-uses to better inform policy.

The updated model was reviewed and validated by comparing estimated refrigerant consumption (calculated as the amount of refrigerant used to manufacture new equipment produced in the UK plus the amount used to service leaking equipment) with annual refrigerant sales data from the British Refrigeration Association (BRA). A full description of the methodology, sources, input assumptions and uncertainties used to update emission estimates by end-use is contained in the above referenced ICF report.

2F2-2F9 – Production of Halocarbons and SF_6 foam blowing, fire fighting equipment, MDIs, solvents, semiconductors, electrical components, sporting goods and one component foams

Projections from these activities have been calculated using a bottom-up approach based on industry data and growth rates anticipated by industry experts. Full details on the methods and assumptions used to produce these forecasts can be obtained from a series of reports produced by AEA (**AEA, 2008 and 2010**) and from the most recent GHGI (**DECC, 2014b**).

1A2f - Industrial off-road mobile machinery

Emissions projections are calculated from a bottom-up approach by the Inventory Agency using machinery- or engine-specific emission factors in g/kWh based on the power of the engine and estimates of the UK population and annual hours of use of each type of machinery. The methodology follows the Tier 3 methodology described in the latest EMEP/CORINAIR emission inventory guidebook.

Projections are based on a set of four drivers. Each of the individual machinery types was mapped to one of these four drivers depending on the typical industry sector in which the machinery type is usually used. The four categories and drivers used are:

- ONS construction statistics Taken from the ONS Construction Statistics Annual (**ONS, 2013**). The value of all new work (i.e. excluding repair and maintenance work) is set at constant (2005) prices and seasonally adjusted. Projections are based on the growth driver "COI" taken from the DECC UEP48 energy projections (**DECC, 2013a**).
- Data on UK production of minerals, taken from UK Minerals Yearbook data, (**BGS, 2013**). Projections are based on the growth driver "OMMP" from the DECC UEP48 energy projections (**DECC, 2013a**).
- Growth driver based on the combination of the quarrying and construction drivers detailed above.
- General industry based on an average of growth indices for all industrial sectors, taken from the latest data supplied by DECC for use in energy and emissions projections (UEP48) (**DECC, 2013a**). The same approach is used for the historical GHGI as for the projections.

Energy

1B1a - Open coal mines (Open-cast, deep-mined and coal storage & transport)

Projected emissions from working coal mines have been estimated based on projected coal production data (open cast and deep mined) from DECC’s Energy Modelling Team. Emission factors from the GHGI have then been applied to these activity projections.

1B1a - Closed coal mines

Emissions from closed coal mines are calculated using a model by WSP Environmental (**WSP, 2011**), which updates an older model produced by White Young Green (WYG). The updates to the model incorporate refinements and additional data sources as well as upgrades to the assumptions made by WYG. The model uses a bottom-up approach incorporating physical properties of individual mines and mine areas, includes actual closure and re-commissioning dates up to 2010, and uses a single-value long-term emissions factor obtained from abandoned mine CH_4 reserves of eight UK mines, and flow rate of CH_4 from those mines. Further details of the model can be found in the referenced paper.

1B1b - Solid Smokeless Fuel (SSF), charcoal and coke production

All 1B1b categories which are covered in this report ('coke production' and 'solid smokeless fuel production') have been assumed constant in lieu of any appropriate projections data; emissions from these sources are extremely small, <0.01% of total non-CO_2 GHG emissions.

1B2b Gas leakage

Emissions from gas leakage are projected to continue decline due to a 30 yr programme (started 2002) to reduce leakage from the gas distribution network by 70%. This involves the replacement of cast-iron pipes in the gas distribution system. Projected changes in CH_4 content of natural gas are not considered sufficiently meaningful fluctuations to take account of in the non-CO_2 GHG projections.

Industrial

2A7 – Fletton brick manufacture

Emissions from fletton brick production are predicted to remain constant from the current GHGI year onwards, having decreased since 2008 due to the closure of one of the two manufacturing plants. Emissions from these sources only contribute a small amount to the emissions totals.

2B2 – Nitric acid production

Nitric acid production was previously a significant source of N_2O in the UK. Following a DECC consultation (**DECC 2011**) the UK chose an early opt-in of emissions from nitric acid production into the EU Emissions Trading Scheme (EU ETS). As a result of this, best available technology (BAT) abatement technology is now fitted at the two remaining UK plants, and which has significantly reduced N_2O emissions. Emissions are now projected to remain constant.

2B3 – Adipic acid production

In 2009 the last remaining Adipic Acid production plant in the UK closed; emissions from this source are projected to be zero in from 2010 onwards.

2C3 – Primary aluminium production

A plant closure in 2012 causes a significant drop in emissions from this source. A projection for emissions from this source from 2013 onwards has been obtained based on a record of emissions from the plant which has closed.

2C4 – Magnesium cover gas

Emissions estimates from this source are based on data and information obtained from plant operators and industry experts. There has been a reduction in the use of SF_6 as a cover due to its replacement with HFCs. Further information on the methodology employed can be found in a report produced by AEA (**AEA, 2010**) and the NIR (**DECC, 2014b**). Projected emissions from this source are based on a growth index for non-ferrous metals from UEP30.

2E– Production of Halocarbons

Projections from these activities have been calculated using a bottom-up approach based on industry data and growth rates anticipated by industry experts. Full details on the methods and assumptions used to produce these forecasts can be obtained from a series of reports produced by AEA (**AEA,2008 and 2010**) and from the most recent GHGI (**DECC, 2014b**).

Land Use, Land Use Change and Forestry

5A-5G– Biomass burning/wildfires, drainage of organic soils, N fertilisation of forest land and disturbance associated with land-use conversion to cropland

Estimates projections of N_2O and CH_4 from the LULUCF sector are supplied by the Centre for Ecology and Hydrology (**CEH, 2014**). Details of the activity data and emission factors methodology are given in 1990-2012 GHGI (**DECC, 2014b**). For the projections, four initial scenarios (Business-As-Usual (BAU), High emissions, Mid emissions and Low emissions) have been constructed. The non-BAU scenarios have also been modified to include continuing cropland-grassland rotations (churn). The scenarios were developed by a policy maker stakeholder group from trajectories in the 2050 DECC calculator report and take account of land use policies and aspirations. Consult the CEH projections for more information on the assumptions used (**CEH, 2014**).

Residential

2E–Metered Dose Inhalers and aerosols

Projections from these activities have been calculated using a bottom-up approach based on industry data and growth rates anticipated by industry experts. Full details on the methods and assumptions used to produce these forecasts can be obtained from a series of reports produced by AEA (**AEA,2008 and 2010**) and from the most recent GHGI, published in April 2014 (**DECC, 2014b**).

1A4b–House and garden machinery

For domestic house and garden machinery, projections in the number of households are used based on figures up to 2021 from the Department for Communities and Local Government (CLG) published in April 2013 (**DCLG, 2013**). This source did not provide household projections for the UK beyond 2021, so for those years an earlier set of household projections up to 2033 published by CLG in 2011 were used as drivers.

6C – Accidental vehicle fires

Estimated projected emissions from accidental vehicles fires are assumed to remain constant as the future levels of activities in these categories is unknown.

Transport

1A3a – Aircraft (domestic and UK to CDs)

Estimated emissions projections are based on DfT CO_2 emissions as a proxy for fuel use.

1A5b – Military aircraft and naval shipping

Estimated projected emissions from military aircrafts and naval shipping are assumed to remain constant as the future levels of activities in these categories is unknown.

1A3b – Road transport

Road transport emissions projections are produced with the road transport model by Ricardo-AEA under contract to DECC. The emission estimates follow a bottom up methodology in line with the current historical time-series of emissions. Emission factors (grams per kilometre) are vehicle-type specific. For the historical emissions, activity data is based on high level traffic statistics (vehicle kilometres travelled by vehicle type) and fleet data from DfT. This calculation methodology and many of the underlying assumptions are described in the NIR (**DECC, 2014b**).

For the projected emissions, the core activity data are the projections of vehicle km travelled by each main vehicle type on different regions and road types in the UK. These come from DFT and TFL traffic forecasts. However, the traffic projections only provide the total number of km travelled by each main vehicle type. This has to be further broken down by fuel type, vehicle size, Euro class of vehicle (related to age or year of first registration of the vehicle) and any specific types of technology that may influence emissions. The breakdown is provided by projections in the composition of the UK vehicle fleet using a fleet turnover model described in detail in the NIR (**DECC, 2014b**). For the projections, assumptions have been made about future sales of new vehicles, their survival rate and the Euro standards implemented and their effect on emissions.

1A33 – Aircraft support vehicles

For airport machinery, recent forecasts in the number of UK airport terminal passengers 2010-2050 (**DFT, 2013b**) published by DfT were used to form projections.

Waste

6A1 - Waste disposed to landfill

The current set of projections is based on data in the UK model used to estimate emissions from managed waste disposal on land, MELMod 2012 v1.1. The model is based on the first-order decay (FOD) methodology described in the IPCC Good Practice Guidance and IPCC Uncertainty Management in National Greenhouse Gas Inventories, and is summarised in the NIR (**DECC, 2014b**).

In the model physical-chemical properties are combined with data on historical and projected waste volumes to calculate the Decomposable Degradable Organic Carbon (DDOC) and the Degradable Organic Carbon (DOC). Then the CH_4 emissions are calculated based on rate constants of decay, CH_4 collection efficiency and CH_4 oxidation.

Projections of future waste sent to landfill are based on projections of waste arisings from Local Authority Collected Waste (LACW) and Commercial & Industrial (C&I) waste.

6B2 - Wastewater treatment

Projected CH_4 emissions from domestic & commercial waste water treatment and sewage disposal are based on a model used in the historical GHGI (**Hobson *et al*, 1996**). Projections to 2030 are based on implied emission factors for various disposal routes and projected changes to the amount disposed of to each route (e.g. due to the Landfill Directive), and population growth. The assumptions made on sewage sludge disposal routes in 2020 have been taken from an Entec report (**Entec, 2006a+b**), also used in the Autumn 2013 and previous publications.

Projections of N_2O emissions from domestic & commercial waste water treatment are based on a constant emission factor per head of population. The historical GHGI is based on protein consumption and population data. The projections assume that protein consumption will remain unchanged going forwards.

Projected CH_4 emissions from industrial waste water treatment are assumed to remain constant as the future levels of activities in these categories is unknown.

6C - Waste incineration

Estimated projected emissions from waste incineration (not for power generation, and including the categories of incineration, incineration of clinical waste, and incineration of sewage sludge) are assumed to remain constant as the future levels of activities in these categories is unknown.

Annex B: Categories now reported as part of DECC's Energy Projections

Prior to the Autumn 2011 projections update, all non-CO_2 GHG projections publications had reported emissions estimates as given in the most recently published GHGI for all CH_4, N_2O, HFC, PFC and SF_6 sources for all IPCC categories where they occur.

From the Autumn 2011 set of projections forward, new updates exclude a selection of IPCC categories whose projected trend is reliant on information within DECC's UEP publication. These projections will continue to be produced and presented in DECC's UEP publications. The UEP is published annually in the Autumn (**DECC, 2013a**).

A full list of categories which contain emissions of non-CO_2 gases but are not reported in the non-CO_2 GHG projections is presented below.

Categories will be continually reviewed and further additional categories may be added or removed.

Table B.1 Summary by Gas / IPCC category of non-CO2 GHG emissions to be produced and reported in DECC's UEP

Gas	NC Sector	IPCC Category	SourceName
CH4	Agriculture	1A4c	Agriculture - mobile machinery
			Agriculture - stationary combustion
			Miscellaneous industrial/commercial combustion
	Business	1A2a	Blast furnaces
			Iron and steel - combustion plant
		1A2b	Non-Ferrous Metal (combustion)
		1A2c	Ammonia production - combustion
			Chemicals (combustion)
		1A2d	Pulp, Paper and Print (combustion)
		1A2e	Food & drink, tobacco (combustion)
		1A2f	Autogeneration - exported to grid
			Autogenerators
			Cement production - combustion
			Lime production - non decarbonising
			Other industrial combustion
		1A4a	Miscellaneous industrial/commercial combustion
	Energy Supply	1A1a	Miscellaneous industrial/commercial combustion
			Power stations
			Public sector combustion
		1A1b	Refineries - combustion
		1A1c	Coke production
			Collieries - combustion
			Gas production
			Nuclear fuel production
			Solid smokeless fuel production
			Town gas manufacture
			Upstream Gas Production - fuel combustion
			Upstream oil and gas production - combustion at gas separation plant
			Upstream Oil Production - fuel combustion
		1B2a	Petroleum processes
			Upstream Oil Production - Offshore Oil Loading
			Upstream Oil Production - Offshore Well Testing
			Upstream Oil Production - Oil terminal storage
			Upstream Oil Production - Onshore Oil Loading
			Upstream Oil Production - process emissions
		1B2b	Upstream Gas Production - Gas terminal storage
			Upstream Gas Production - Offshore Well Testing
			Upstream Gas Production - process emissions
		1B2ci	Upstream Gas Production - venting
			Upstream Oil Production - venting
		1B2cii	Upstream Gas Production - flaring
			Upstream Oil Production - flaring
	Industrial Process	1A2a	Sinter production
		2B5	Chemical industry - ethylene
			Chemical industry - general
			Chemical industry - methanol
		2C1	Electric arc furnaces
			Iron and steel - flaring
	Public	1A4a	Public sector combustion
	Residential	1A4b	Domestic combustion
	Transport	1A3c	Rail - coal
			Railways - freight
			Railways - intercity
			Railways - regional
		1A3d	Inland goods-carrying vessels
			Motorboats / workboats (e.g. canal boats, dredgers, service boats, tourist boats, river boats)
			Personal watercraft e.g. jet ski
			Sailing boats with auxiliary engines
			Shipping - coastal
		1A4a	Railways - stationary combustion
		1A4c	Fishing vessels

Gas	NC Sector	IPCC Category	SourceName
N2O	Agriculture	1A4c	Agriculture - mobile machinery
			Agriculture - stationary combustion
			Miscellaneous industrial/commercial combustion
	Business	1A2a	Blast furnaces
			Iron and steel - combustion plant
		1A2b	Non-Ferrous Metal (combustion)
		1A2c	Ammonia production - combustion
			Chemicals (combustion)
		1A2d	Pulp, Paper and Print (combustion)
		1A2e	Food & drink, tobacco (combustion)
		1A2f	Autogeneration - exported to grid
			Autogenerators
			Cement production - combustion
			Lime production - non decarbonising
			Other industrial combustion
		1A4a	Miscellaneous industrial/commercial combustion
	Energy Supply	1A1a	Miscellaneous industrial/commercial combustion
			Power stations
			Public sector combustion
		1A1b	Refineries - combustion
		1A1c	Coke production
			Collieries - combustion
			Gas production
			Nuclear fuel production
			Solid smokeless fuel production
			Upstream Gas Production - fuel combustion
			Upstream oil and gas production - combustion at gas separation plant
			Upstream Oil Production - fuel combustion
		1B1b	Iron and steel - flaring
		1B2a	Upstream Oil Production - Offshore Well Testing
		1B2b	Upstream Gas Production - Offshore Well Testing
		1B2cii	Upstream Gas Production - flaring
			Upstream Oil Production - flaring
	Industrial Process	1A2a	Sinter production
		2C1	Electric arc furnaces
			Iron and steel - flaring
	Public	1A4a	Public sector combustion
	Residential	1A4b	Domestic combustion
	Transport	1A3c	Rail - coal
			Railways - freight
			Railways - intercity
			Railways - regional
		1A3d	Inland goods-carrying vessels
			Motorboats / workboats (e.g. canal boats, dredgers, service boats, tourist boats, river boats)
			Personal watercraft e.g. jet ski
			Sailing boats with auxiliary engines
			Shipping - coastal
		1A4a	Railways - stationary combustion
		1A4c	Fishing vessels

Annex C: Summary of Updated Projections

Tables C.1 and C.2 below contains a summary of the projections presented in this report. The projections have been split by gas and by sector. For a more detailed disaggregation of the projections, please see the spread sheet published alongside this report.

Table C.1 Summary of non-CO_2 GHG projections by gas ($ktCO_2e$)

		UK GHG Inventory		Projections			
Pollutant	NC Sector	1990	2012	2015	2020	2025	2030
CH_4	Agriculture	28,114	22,162	22,031	21,565	21,419	21,419
	Business	20	17	17	19	21	23
	Energy Supply	26,311	5,862	5,731	5,307	4,099	2,891
	Industrial Process	24	3	3	3	3	3
	Land Use Change	21	65	55	43	38	35
	Residential	7	2	2	2	2	2
	Transport	641	57	45	31	32	36
	Waste Management	44,759	20,141	18,098	15,522	13,751	12,550
CH_4 Total		99,896	48,310	45,981	42,493	39,365	36,959
N_2O	Agriculture	37,165	29,784	30,427	30,135	29,976	29,976
	Business	963	630	637	705	745	790
	Industrial Process	24,641	61	61	61	61	61
	Land Use Change	843	669	587	487	410	351
	Residential	4	5	5	6	6	6
	Transport	1,278	1,000	1,138	1,300	1,380	1,417
	Waste Management	1,219	1,224	1,353	1,398	1,441	1,479
N_2O Total		66,113	33,373	34,207	34,091	34,018	34,081
HFCs	Business	0	11,927	8,506	5,869	3,427	2,203
	Industrial Process	11,374	56	57	57	58	58
	Residential	10	1,965	1,983	2,013	2,042	2,069
HFCs Total		11,384	13,948	10,546	7,939	5,527	4,331
PFCs	Business	58	79	90	110	133	133
	Industrial Process	1,344	129	89	89	89	89
PFCs Total		1,402	208	179	199	222	222
SF_6	Business	582	381	333	332	341	341
	Industrial Process	406	161	168	172	174	174
SF_6 Total		987	542	502	504	515	515
Grand Total		**179,782**	**96,381**	**91,415**	**85,225**	**79,648**	**76,108**

Table C.2 Summary of non-CO_2 GHG projections by NC Sector ($ktCO_2e$)

		UK GHG Inventory		Projections			
NC Sector	Gas	1990	2012	2015	2020	2025	2030
Agriculture	CH_4	28,114	22,162	22,031	21,565	21,419	21,419
	N_2O	37,165	29,784	30,427	30,135	29,976	29,976
Agriculture Total		65,280	51,946	52,458	51,700	51,395	51,395
Business	CH_4	20	17	17	19	21	23
	HFCs	0	11,927	8,506	5,869	3,427	2,203
	N_2O	963	630	637	705	745	790
	PFCs	58	79	90	110	133	133
	SF_6	582	381	333	332	341	341
Business Total		1,622	13,034	9,583	7,035	4,668	3,491
Energy Supply	CH_4	26,311	5,862	5,731	5,307	4,099	2,891
Energy Supply Total		26,311	5,862	5,731	5,307	4,099	2,891
Industrial Process	CH_4	24	3	3	3	3	3
	HFCs	11,374	56	57	57	58	58
	N_2O	24,641	61	61	61	61	61
	PFCs	1,344	129	89	89	89	89
	SF_6	406	161	168	172	174	174
Industrial Process Total		37,788	410	378	383	385	385
Land Use Change	CH_4	21	65	55	43	38	35
	N_2O	843	669	587	487	410	351
Land Use Change Total		864	734	641	529	448	386
Residential	CH_4	7	2	2	2	2	2
	HFCs	10	1,965	1,983	2,013	2,042	2,069
	N_2O	4	5	5	6	6	6
Residential Total		22	1,973	1,991	2,020	2,050	2,077
Transport	CH_4	641	57	45	31	32	36
	N_2O	1,278	1,000	1,138	1,300	1,380	1,417
Transport Total		1,918	1,057	1,183	1,330	1,412	1,453
Waste Management	CH_4	44,759	20,141	18,098	15,522	13,751	12,550
	N_2O	1,219	1,224	1,353	1,398	1,441	1,479
Waste Management Total		45,978	21,365	19,451	16,919	15,191	14,029
Grand Total		**179,782**	**96,381**	**91,415**	**85,225**	**79,648**	**76,108**

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