Department
of Energy &
Climate Change

Projected emissions of methane, nitrous oxide and F-gases

A report to accompany the Autumn 2013 update to the UK's projections of non-CO2 Kyoto Protocol greenhouse gas emissions

12th September 2013

Executive summary

This report presents the Autumn 2013 update to DECC's projections of methane (CH_4), nitrous oxide (N_2O) and F-gases (non-CO_2 greenhouse gases (GHG's)), the methodologies used to derive them and the associated uncertainties.

The following have been updated since the previous non-CO_2 projections (**DECC, 2013a**), hereafter referred to as 'the Spring 2013 update', was published:

- Updated projections of emissions from Land use, land use change and forestry (LULUCF);
- Updated projections of emissions from road transport;
- Updated projections of emissions from off-road transport.

Non-CO_2 GHG's are now estimated to be 68 MtCO2e in 2030; representing a projected 22% decrease between 2011 and 2030. This would represent a 60% reduction on 1990 levels. The two greatest contributors to this projected reduction are methane emissions from waste management, where emissions reductions of 6.1 MtCO_2e are estimated at 2030 compared with 2011, and a reduction of approximately 9.6 MtCO_2e in business sector HFC emissions.

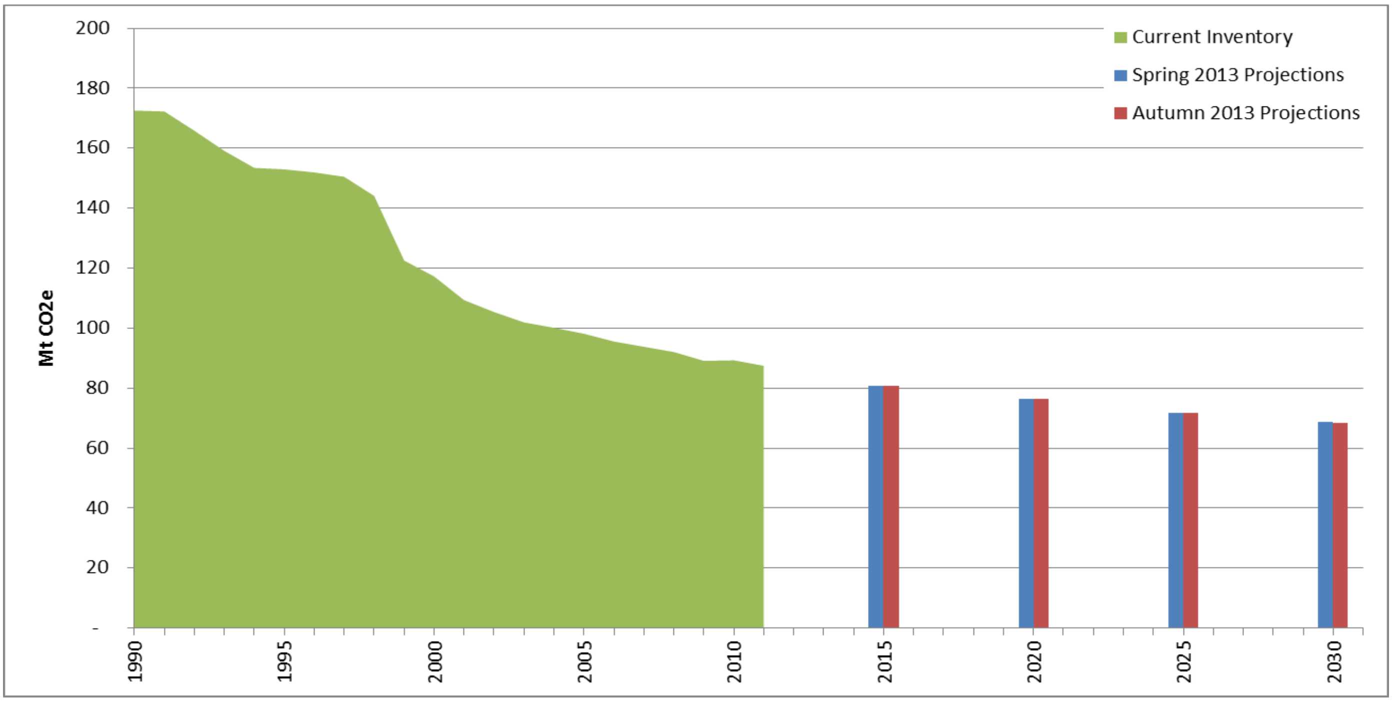
The Autumn 2013 non-CO_2 GHG projections predict that UK emissions will decrease at a marginally quicker rate between 2011 and 2030 than was projected in the Spring 2013 update. The magnitude of this change results in projected emissions in 2015 being approximately 0.04% lower, and in 2030 being approximately 0.2% lower than in the Spring 2013 update.

New projections for road and off-road transport as well as new LULUCF data have been included in this update to the projections. The new LULUCF projections have increased emissions from that sector by approximately 0.1 MtCO_2e across the time series. New projections for road transport activities in the transport sector and off-road transport activities in the residential and business sectors, have a combined effect of reducing emissions by between 0.2 and 0.25 MtCO_2e in each projected year. Therefore, the combination of these effects results in a net reduction in overall non-CO_2 emissions from all sectors of approximately 0.1 MtCO_2e in 2030.

Summary of projected non-CO_2 emissions in the Autumn 2013 update, MtCO_2e

	UK GHG Inventory		Projections			
	1990	**2011**	**2015**	**2020**	**2025**	**2030**
CH_4	94	40	37	35	32	30
N_2O	64	32	32	32	32	32
HFCs	11	15	11	9	6	5
PFCs	1	0	0	0	0	0
SF_6	1	1	1	1	1	1
Total	**173**	**87**	**81**	**76**	**72**	**69**

Figure 1: A comparison of total non-CO_2 GHG emissions in the Autumn 2013 projections with the Spring 2013 projections



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.

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1 Introduction

1.1 Overview

Projections of greenhouse gases

Emissions projections are used as a way of monitoring progress towards the UK's emission reduction targets. The UK government has set targets for reductions in greenhouse gas emissions out to 2050. 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 annually under the European Union Monitoring Mechanism Regulation, and periodically in the form of National Communications to the UNFCCC.

1.2 Gases considered

The projections which accompany this report are for the non-CO_2 component of the Kyoto Protocol's basket of greenhouse gases (GHG) and are collectively referred to as the non-CO_2 GHG's. 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 the majority of combustion activities are also reported in the UEP.

This report contains descriptions of the methodologies, data and assumptions used to estimate emissions of the above listed non-CO_2 GHG from UK 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).

Following the adoption of the IPCC's Fourth Assessment Report by the UK's Greenhouse Gas Inventory, changes to the GWPs and gases considered will also be reflected in the non-CO_2 projections.

1.3 Current UK GHG emissions

As part of the UK's commitments for reporting it's GHG emissions a national inventory is produced each year containing estimates for the UK's GHG emissions from all anthropogenic sources. The latest GHG Inventory was published in February 2013 and contains estimates for emissions from 1990-2011 (**DECC, 2013c**). Total UK emissions in 2011 were estimated at 549.2 $MtCO_2e$ (excluding EU ETS). Of this, non-CO_2 GHG's consistent with the coverage of this report represented 87.5 $MtCO_2e$. Based on the data in the most recent Inventory, the current situation with each of the non-CO_2 GHGs is as follows:

Methane (CH_4)

The Agriculture sector as a whole accounts for approximately 45% of all CH_4 emissions; the Waste Management sector accounts for approximately 40%. The remaining 15% of CH_4 emissions are largely attributed to the Energy Supply sector.

Nitrous oxide (N_2O)

The majority of N_2O emissions, approximately 89%, are attributed to the Agriculture sector. The remaining 11% are split relatively evenly between Business, Energy Supply, Industrial Processes, Transport, Waste, and LULUCF sectors. An additional minor (0.02%) fraction originates from the Residential sector

F-Gases (HFC's, SF_6 and PFC's)

HFC's comprise the majority of the combined F-gas emissions, accounting for 94% of emissions as total Carbon Dioxide equivalent (CO_2e).

Refrigeration and air conditioning account for 70% of HFC emissions; this includes mobile air conditioning HFC emissions which alone account for 34% of all HFC emissions. Other significant HFC emissions sources include aerosols and metered dose inhalers (MDIs, e.g. asthma inhalers), both of which comprise between 8 and 7% of total HFC emissions each.

SF_6 emissions accounted for approximately 4% of F-gas emissions, attributable largely to electrical insulation.

PFC's comprised the remaining 2% of all F-gas emissions (CO_2e); the major sources of PFC emissions are primary aluminium production and the electronics industry.

Further details on breakdown of each of these gases to specific activities can be found in the latest National Statistics release and the Nation Inventory Report (NIR) (**DECC 2013c**)

1.4 Updates to the calculation methods used for the GHG Inventory

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

There are therefore, two sources of change in the UK GhG Inventory; the first is the change in activity between consecutive years, for instance the number of vehicles on the road between 2010 and 2011, the second is the methodological changes which affect the whole time series, for instance a recalculated emissions factor for a specific activity.

The main methodological changes in the latest UK GhG Inventory (1990-2011) which have an impact on the non-CO2 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 UK Greenhouse Gas National Inventory Report which is available online[1].

1.5 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 uses a base year which is comprised of 1990 for CO_2, CH_4 and N_2O, and 1995 for F-gases. To meet its commitment under the Protocol, the UK has agreed a legally binding target to reduce its greenhouse gas emissions to 12.5 per cent below the base year level over the period 2008-2012.

In July 2007, on completion of the review of the UK Inventory, the UK's Kyoto base year figure was set at 779.9 million tonnes CO_2 equivalent, based on the 2006 UK Inventory 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 now the UK's *Assigned Amount*.

For more details of the UK's Kyoto commitment, see the UK Initial Report under the Kyoto Protocol (**Defra, 2006**)

UK Climate Change Act

This Act includes 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. It also establishes a system of binding five-year carbon budgets to set the trajectory towards these targets.

Like the Kyoto Protocol, the Act uses a base year which is comprised of 1990 for CO_2, CH_4 and N_2O, and 1995 for F-gases. 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 to the GhG Inventory made subsequent to the UK's Kyoto Protocol assigned amount having been fixed.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/207605/UK_GHG_Inventory_1990-2011-_Report.pdf

The Government has set the first four carbon budgets. The first of these budgets requires that total UK greenhouse gas emissions do not exceed 3,018 million tonnes CO_2 equivalent over the five-year period 2008-12, which is about 22 per cent below the base year level on average over the period. 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.

Future targets from 2013 onwards

Post-2012, the UK will have two new international and domestic targets for reducing greenhouse gas emissions. Details of these targets, as proposals currently stand, are summarised below:

Kyoto Protocol

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). The UK will be accepting a share of the EU ambition; however, the precise details of this share are yet to be agreed. The details are expected to be agreed over the coming 12 months.

Any Kyoto Protocol target would cover the UK, our Crown Dependencies, and those Overseas Territories which sign up to sharing this commitment.

European Union 2020 target

The European Union has committed to reducing overall greenhouse gas emissions across the EU27 member states by 20 per cent relative to 1990 levels by 2020. This differs from the Kyoto Protocol target in that it represents a 20 per cent reduction by the year 2020, rather than on average over the period 2013 to 2020. The two targets are consistent, but have differences in scope and base year.

EU member states have agreed to emissions reduction 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 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 a 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.

The EU has conditionally said that it wishes to move to a 30 per cent reduction target. This will be dependent on agreement amongst member states.

1.6 Spread sheet of tables of data accompanying this report

There are detailed tables of projections in a spread sheet that accompanies this report and is available on the DECC website; see spread sheet **Non-CO_2 GHG emission projections summary tables Autumn 2013.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 individual source category emissions are available in **ANNEX A** of this report.

2.1 Overview of method and database used

General approach to estimating emissions projections

Emissions in the historic 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). In order to maintain consistency with the historic inventory, projected emissions are calculated with reference to the most recent GHG Inventory data. This means that the base year for the projections is taken to be the latest year in the GHG inventory – this is important, since the historic estimates can be revised each year to account for any new information, recalculations or methodologies that become available.

As well as utilising the NAEI database, the DECC non-CO_2 GHG projections are also based on a number of independently produced emissions projections, available from various sources. The emissions projections from these sources will change in the future depending on variations in:

- Activity data (AD), for example projected changes to livestock numbers or changes in behaviour affecting the waste sector.
- Emission factors (EF), for example due to improvements to technology for the abatement of emissions.
- A combination of both factors.

Predicted changes in either the emissions factors or activity data for each sector will be reflected in the projections which form the basis of the DECC model.

These updates are rebaselined against the most recent GHG Inventory emissions estimate for that year. The ‘rebaselining factor’ is then applied to all future emissions estimates in that time series. **Table 2.1** Illustrates this process with a simple example.

Table 2.1 Simple rebaselining example

Rebaselining process	2011	2015	2020	2025	2030
GHG Inventory estimate (baseline)	**675**				
Previous projections		624	495	395	320
New projections (before rebaselining)	*645*	*600*	*475*	*320*	*250*
Rebaselining factor (previous interpolated 2011/ ‘new’ 2011)	**1.05**				
New time series rebaselined to the 2013 GHG Inventory (rebaselining factor x ‘new’ time series)	675	628	497	335	262

Projections scenarios and nomenclature

The central projection estimate

The UNFCCC Guidelines for the preparation of National Communications[2] 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 based on all currently implemented and adopted policies and measures in accordance with the UNFCCC reporting guidelines. They are distinct from ‘with additional measures’ projections that encompass planned policies and measures, and distinct from ‘without measures’ projections that excludes all policies and measures implemented, adopted or planned after the base year.

2.2 QA/QC procedures

A wide range of data are used in the projections and each source is quality assured. New data sources are required to be publicly available for scrutiny for a minimum period of two weeks prior to being included in the projections, and where possible data are subject to peer review.

Data (activity data, emission factors and calculated emissions) that are part of the core GHG inventory are subject to rigorous QA/QC processes within the annual inventory compilation cycle by the Inventory Agency, a consortium led by 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 National Inventory Report (NIR).

The changes incorporated into this Autumn 2013 update have been quality checked, and overseen by the non-CO_2 GHG emissions projections Steering Group.

2.3 Coverage of emissions in the non-CO_2 GHG projections

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.

[2] FCCC/CP/1999/7

A complete mapping of IPCC sectors to National Communication sectors is available on the DECC website (**DECC, 2012**).

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

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) 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 2013 GHG inventory which for methodological were deemed to be better suited to production of the UEP, have also been transferred. These categories are also included in the table in **ANNEX B.**

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.

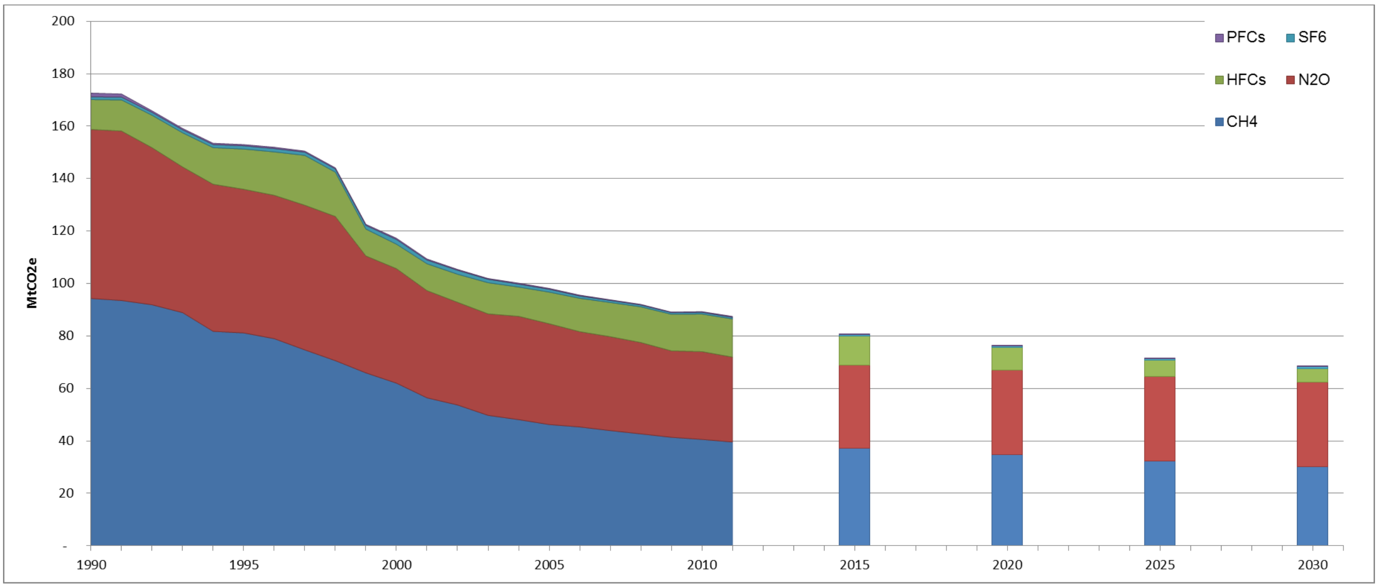
2.4 Geographical coverage and UK projections

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): Bermuda, Cayman Islands, Falkland Islands, Montserrat and Gibraltar. This coverage is consistent with the geographical coverage of the UK energy projections.

3 Summary of Autumn 2013 non-CO_2 GHG projections

The historic trend in non-CO_2 GHG emissions shows a significant reduction from 1990 to 2011 levels, decreasing by approximately 49% in this period. The Autumn 2013 update projects non-CO_2 GHG's to be approximately 68 MtCO_2e in 2030; representing a projected 22% decrease between 2011 and 2030. This projected trend would represent a 60% reduction on 1990 levels. The historic reduction comes from decreases in nitrous oxide (N_2O) and methane (CH_4) emissions, whereas the majority of the projected reduction is predicted to come from decreases in CH_4 emissions, and also some decreases in HFC emissions, as shown in **Figure 3.1**.

Figure 3.1 Summary of projected non-CO_2 GHG emissions by gas (MtCO_2e)



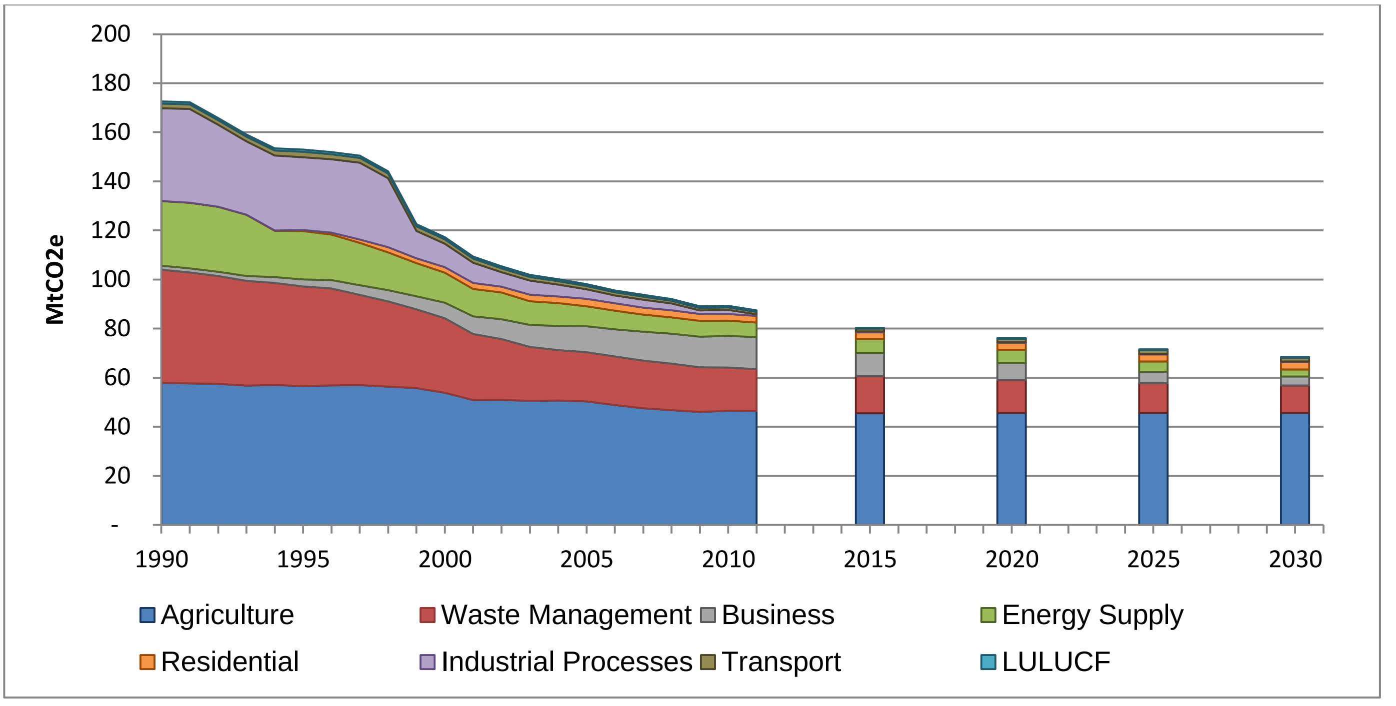
The historic reduction is attributable to emissions from a number of sectors (**Figure 3.2**) – Waste Management, Industrial Processes and Energy Supply have all seen large decreases in emissions from 1990-2011**.**

Projected reductions from 2011 to 2030 are anticipated to come from:

- Waste Management (a result of a decrease in the volume of waste sent to 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).

In addition to these anticipated reductions but of smaller magnitude (~1Mt CO_2e reduction) a series of significant savings in absolute terms are expected in the agriculture sector primarily due to its contraction.

Figure 3.2 Summary of projected non-CO_2 GHG emissions by National Communication sector ($MtCO_2e$)



The Autumn 2013 non-CO_2 GHG projections predict that UK emissions will decrease at a marginally faster rate between 2011 and 2030 than was projected in the Spring 2013 update. The magnitude of this change results in projected emissions in 2030 being approximately 0.2% lower (~0.1 Mt CO_2e) than in the Spring 2013 update (see **Figure 3.3**).

The most significant changes since the Spring 2013 update are due to:

- Updated projections of emissions from Land use, land use change and forestry (LULUCF);
- Updated projections of emissions from road transport in the transport sector;
- Updated projections of emissions from off-road transport in the business and residential sectors.

Figure 3.4 below highlights the magnitude of each of these updates in each of the projected years, as well as the net effect on the projections. From **Figure 3.4** it can been seen that the updates to N_2O projections from the business sector and the LULUCF sector have had the largest effect on net emissions when comparing the Spring 2013 and Autumn 2013 projections.

Details of the each of these updates are laid out in the relevant sector specific chapters below.

Figure 3.3 A comparison of total non-CO_2 GHG emissions in the Autumn 2013 projections with the Spring 2013 projections

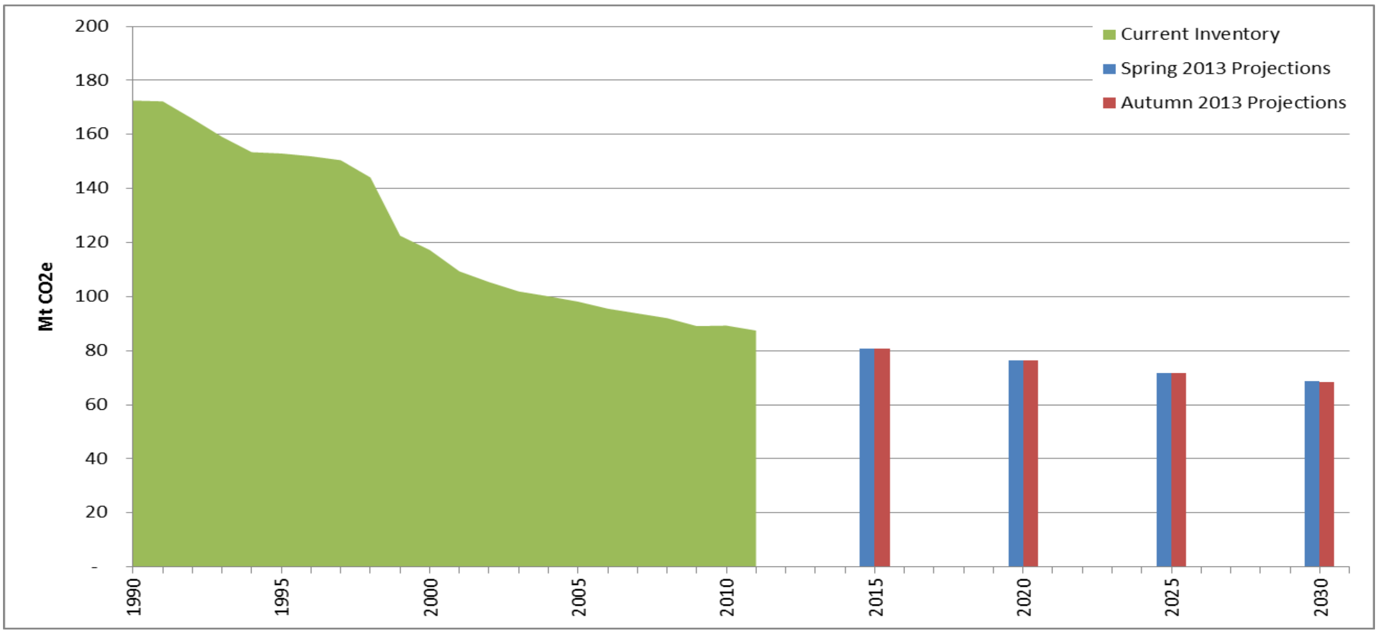
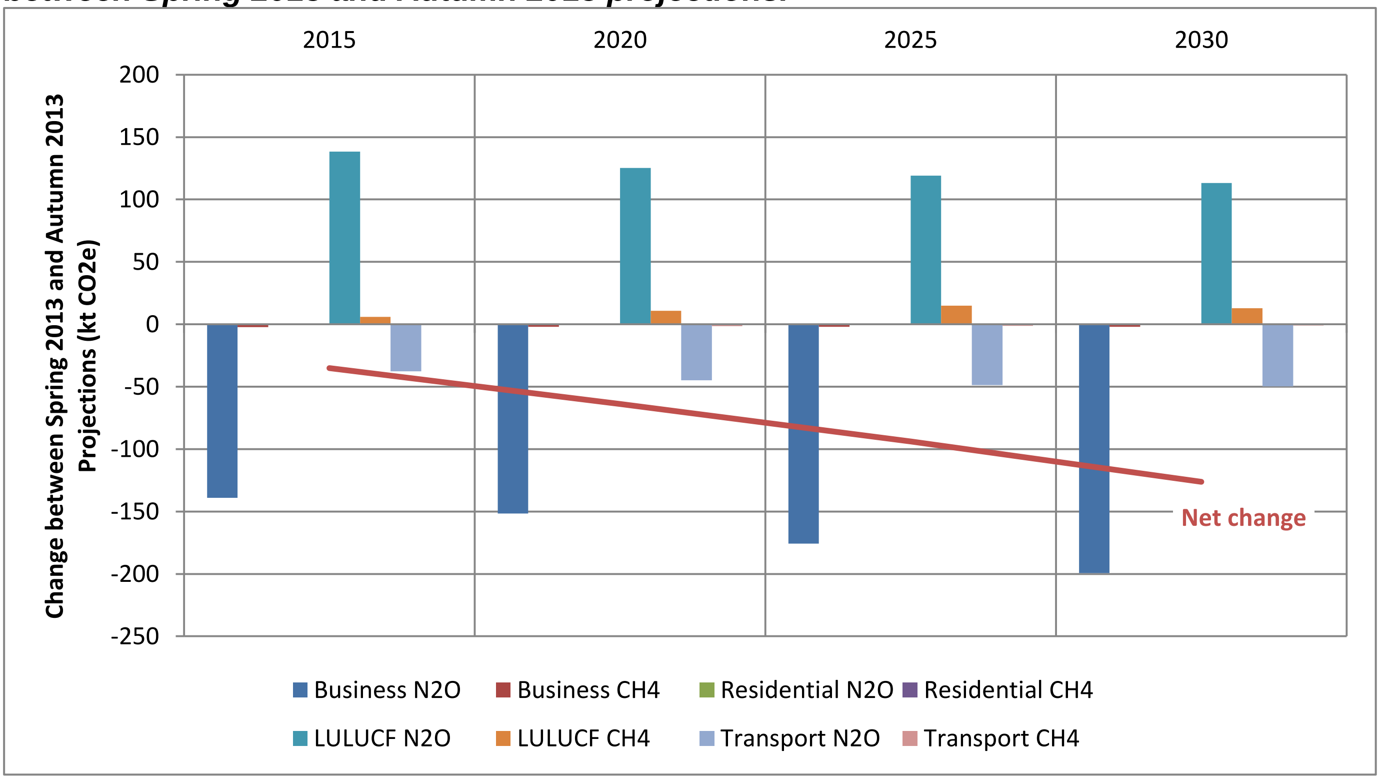


Figure 3.4 Magnitude of updates made to each gas and sector and overall change between Spring 2013 and Autumn 2013 projections.



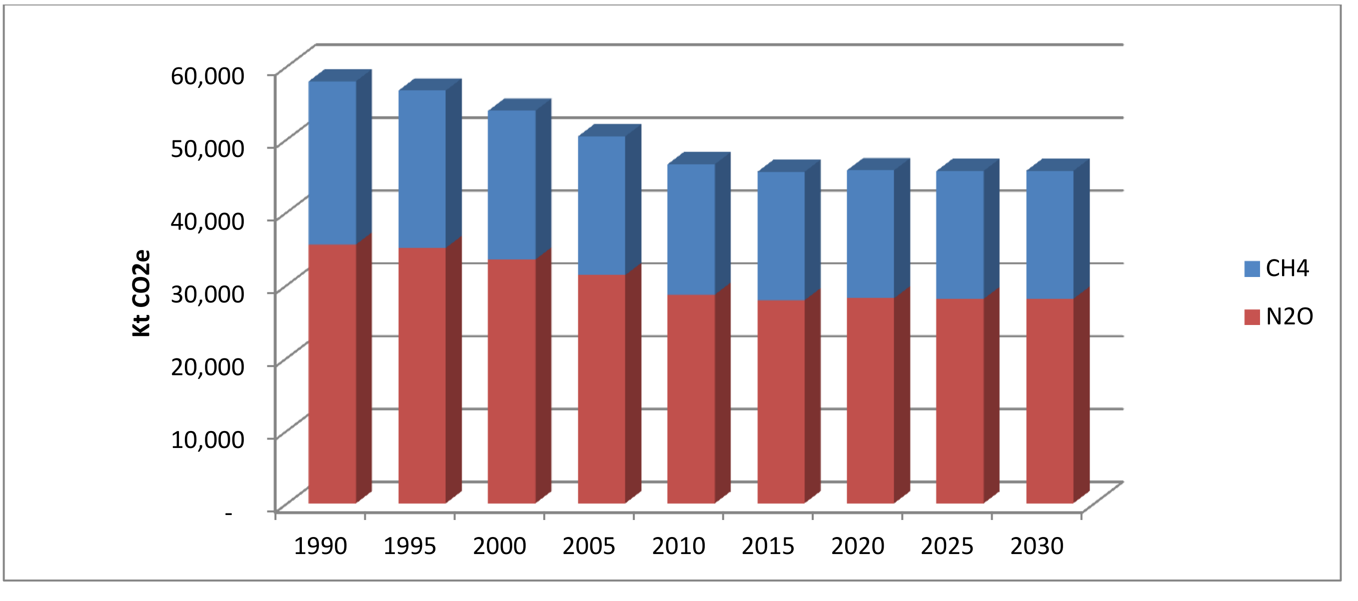
Projections of non-CO_2 GHG by National Communication Sector

4 Agriculture Sector

The Agriculture sector is the single largest contributor to overall non-CO_2 greenhouse gas emissions presented in this report. In 2011 non-CO_2 emissions from agriculture were approximately 46.5 MtCO_2e which represented approximately 53% of the UK's total non-CO_2 emissions. Two gases represent the non-CO_2 contribution to emissions from this sector, nitrous oxide (N_2O) and methane (CH_4).

There have been no changes to the projected emissions from the agriculture sector in this update to the projections.

Figure 4.1 – Overall Agriculture sector emissions projections



Overall emissions from the agricultural sector are projected to be approximately 45.6 MtCO_2e in 2030 which corresponds to reduction in emissions of approximately 3% on the 2011 level.

Emissions are predicted to decline until 2015 at which point they remain at a fairly 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 2020 (**Defra 2013**).

The key driver for the reduction in emissions during the projected time series is the anticipated contraction in the UK's agriculture sector, leading to a reduction in land area used for arable farming and, therefore, associated fertilizer application, as well as reductions in the nation's beef, dairy and pig herds.

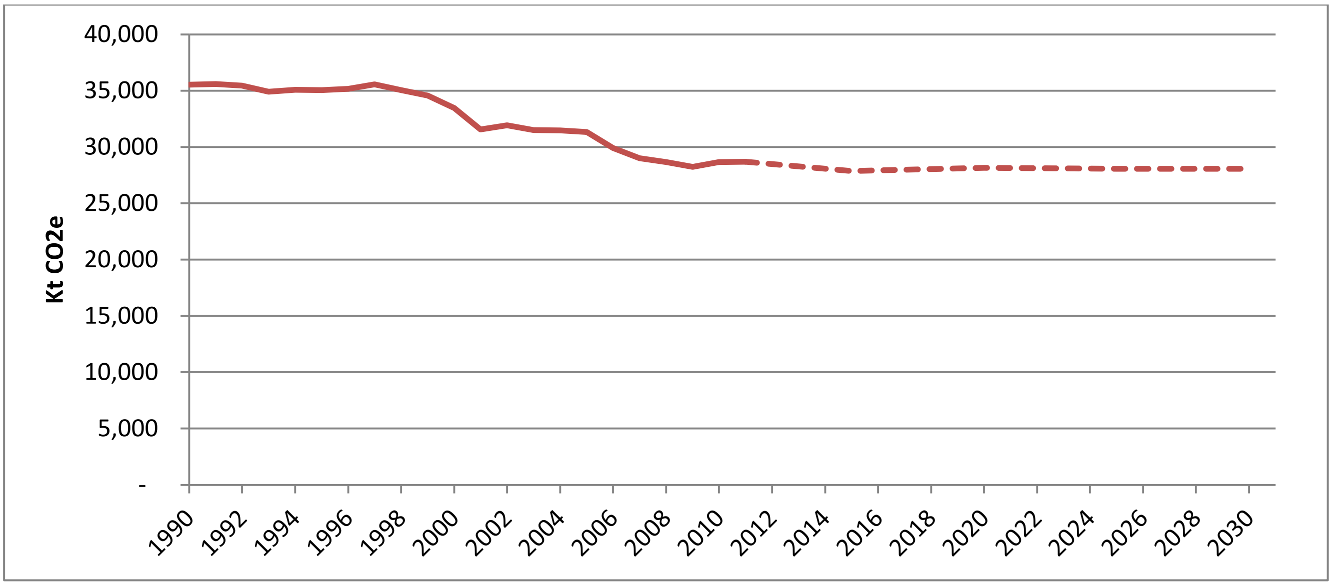
These reductions are the result of macroeconomic assumptions that impact on the UK agriculture sector. A key driver for the changes is the pound sterling to Euro exchange rate with the pound projected to strengthen against the Euro over the period. This will affect UK agriculture in a number of ways: 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.

4.1 Agriculture sector nitrous oxide emissions

Agricultural N_2O represents the most significant contributor to overall UK N_2O emissions, and represents approximately 87% of the total N_2O emissions in the non-CO_2 GHG projections. Emissions of N_2O in the agriculture sector come from a variety of sources such as agricultural soils, manure management systems and field burning. The most significant contributor of these is agricultural soils which represents approximately 94% of agricultural N2O emissions in 2011 and 82% of total N_2O from all sectors covered by this report.

Figure 4.2 Historical trend and projections of N_2O emissions from agriculture



N_2O from the agriculture sector is projected to decline from approximately 29 $MtCO_2e$ in 2011 to approximately 28 $MtCO_2e$ in 2020; the trend then flat-lines to 2030 due to the limitations of the Defra FAPRI-UK model, see **Figure 4.2**.

Defra's agriculture projections estimate approximately 10% reduction in total UK fertiliser application by 2020. This is driven by a small reduction (2%) 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 out to 2020 also impact the level of N_2O emissions by leading to fewer N_2O emissions from manure management.

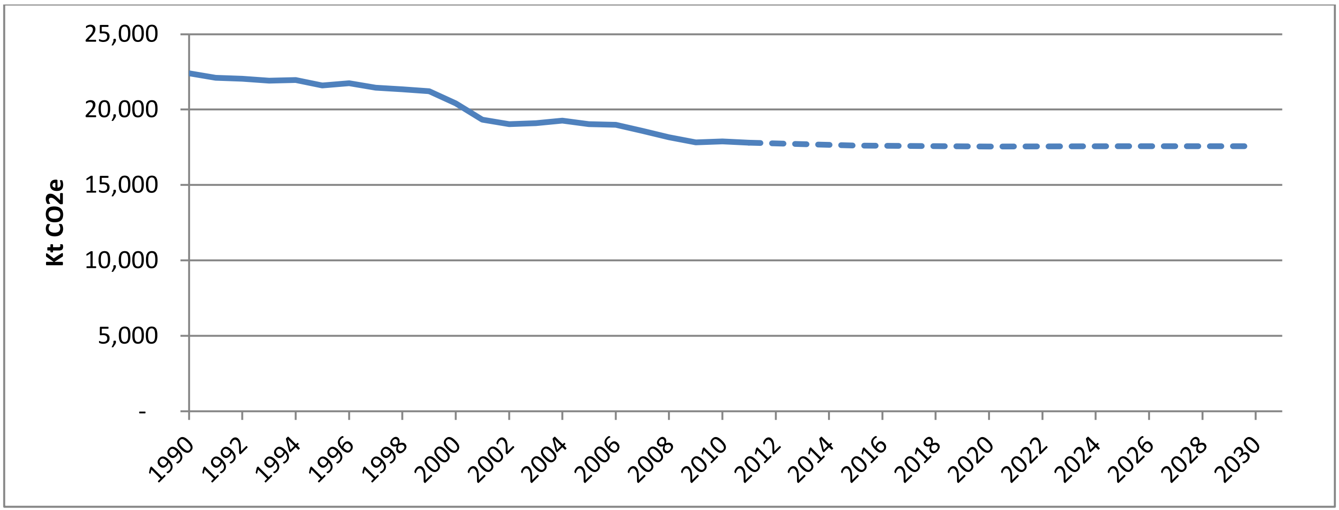
Since 2011 Defra have used an updated methodology for their projections for agricultural emissions in order to make use of the AFBI FAPRI model of UK agriculture (**FAPRI, 2012**). The

FAPRI-UK model has greatly increased the accuracy of the activity drivers behind Defra's emissions 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 approximately 45% of total CH_4 emissions from the sectors considered in this report in 2011. Major sources of CH_4 in the agriculture sector are enteric fermentation by livestock, particularly cattle, which accounts for approximately 65% of total CH_4 emissions from this sector, and livestock wastes which account for a further 15%.

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



Methane emissions from the agriculture sector have declined in an almost linear fashion since 1990, with emissions in 2011 being approximately 20% lower than the base year (see **Figure 4.4**).

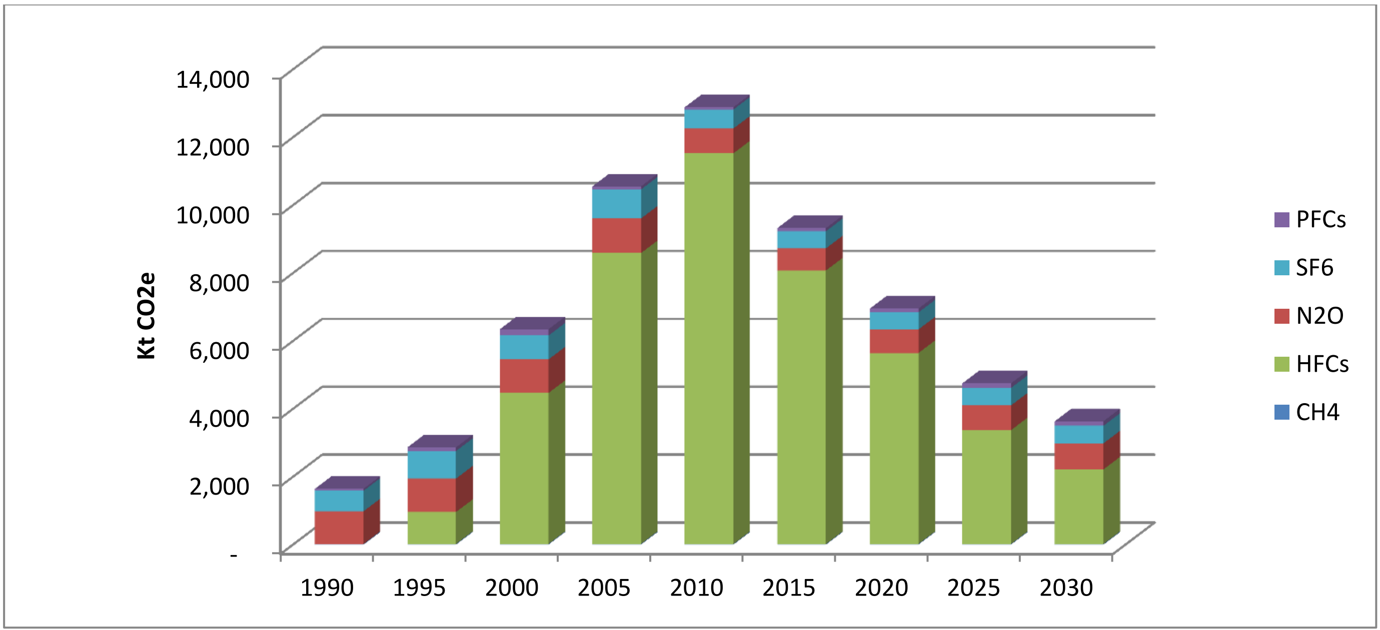
Methane from the agriculture sector is projected to decline from approximately 18 $MtCO_2e$ in 2011 to approximately 17 $MtCO_2e$ in 2020, a reduction of just over 2%. This is due to an overall reduction in activity in the sector as explained above. The decrease in the projected trend is specifically due to an anticipated reduction in the size of livestock herds and therefore their associated enteric fermentation and waste emissions. As is the case with the agricultural N_2O emissions, the trend then flat lines to 2030 due to limitations in the Defra FAPRI-UK model.

5 Business Sector

In 2011 non-CO_2 greenhouse gas (GHG) emissions from the business sector were approximately 13.1 MtCO_2e, representing around 15% of the UK's total non-CO_2 emissions. All non-CO_2 GHG's contribute to emissions from this sector: Nitrous oxide (N_2O), methane (CH_4) and the F-gases (HFC, PFC & SF6). **Figure 5.1** highlights how each of the gases considered account for non-CO_2 emissions from this sector.

New projections of emissions from industrial of-road mobile machinery have been included in this update to the projections. Section 5.2 and 5.3 contain more detail on the effects of this updated data.

Figure 5.1 – Non-CO_2 GHG emissions projections for the business sector



Overall emissions from the business sector are projected to be approximately 4 MtCO_2e in 2030 which will correspond to a decrease in emissions of approximately 72% from 2011. Historically, business sector emissions have increased by 11 MtCO_2e since 1990, reaching their highest point in 2011.

5.1 Business sector F-Gas emissions

F-gas emissions were estimated to be approximately 12 MtCO_2e in 2011, representing 95% of non-CO_2 GHG emissions from the business sector. These emissions result mainly from refrigeration and air conditioning, with contributions also from foams, fire fighting, solvents, electronics, electrical insulation and sporting goods. Emissions of f-gases have increased rapidly since 1990 due to the phasing out of CFC's as a result of the Montreal Protocol, and the use of HFC's as replacement gases in a growing refrigeration and air conditioning sector. F-gas emissions are projected to decline by approximately 9.5 MtCO_2e, or 77%, between 2011 and 2030. We project this reduction to be largely driven by the impact of the EU F-gas regulation driving the replacement of HFC's with new lower GWP refrigerants, and because leakage rates from refrigeration equipment are now much better controlled than in the 1990s, thus reducing fugitive emissions.

Emissions of **HFC's** were approximately 11.7 $MtCO_2e$ in 2011, representing 90% of non-CO_2 GHG emissions from the business sector. The majority of these emissions were from refrigeration and air conditioning (RAC). 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.

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).

The historic trend for HFC emissions is beginning to show a levelling off in trajectory, consistent with its expected future trend. HFC emissions are visualised in **Figure 5.2** below.

Emissions of **SF6** (**Figure 5.3**), all of which are attributable to semiconductor manufacture, electrical and sporting goods, were 0.5 $MtCO_2e$ in 2011. They are projected to decrease by approximately 3% between 2011 and 2030.

Emissions of **PFCs** (**Figure 5.4**), which are also wholly attributable to semiconductors, electrical and sporting goods, were 76 $ktCO_2e$ in 2011. They are projected to increase by approximately 77% between 2011 and 2030 based on assumptions about market growth.

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

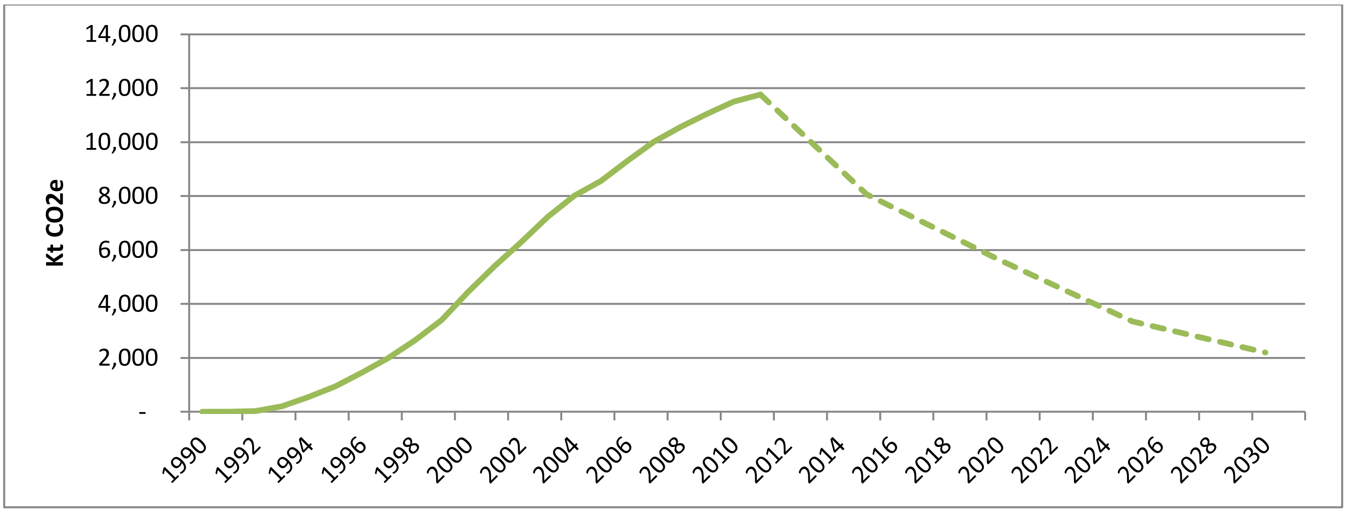


Figure 5.3 – Historical trend and projections of SF6 emissions for the business sector

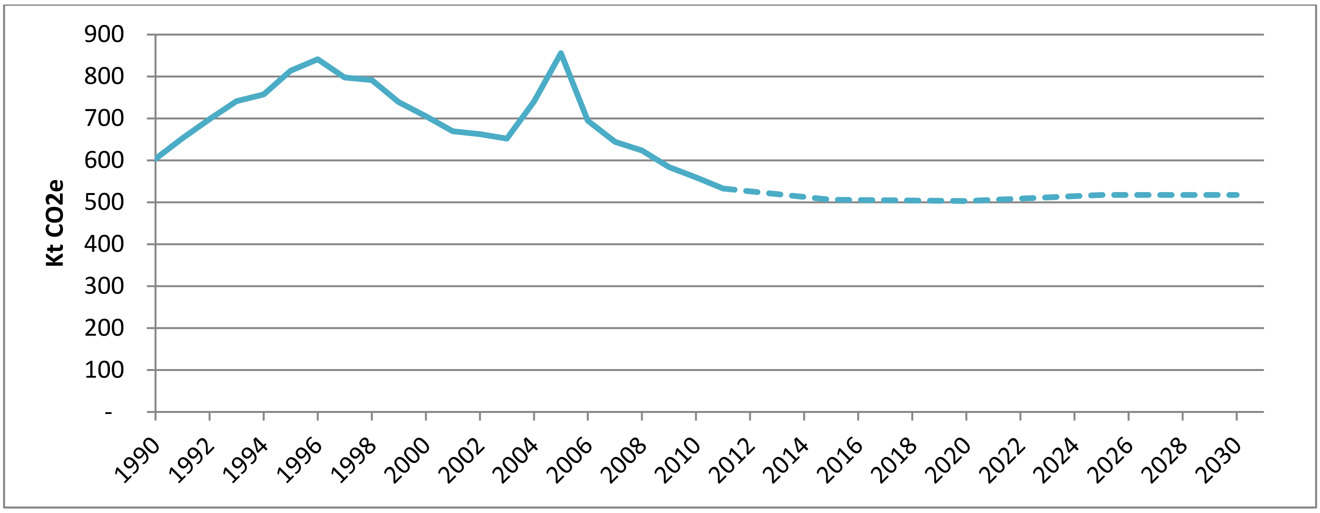
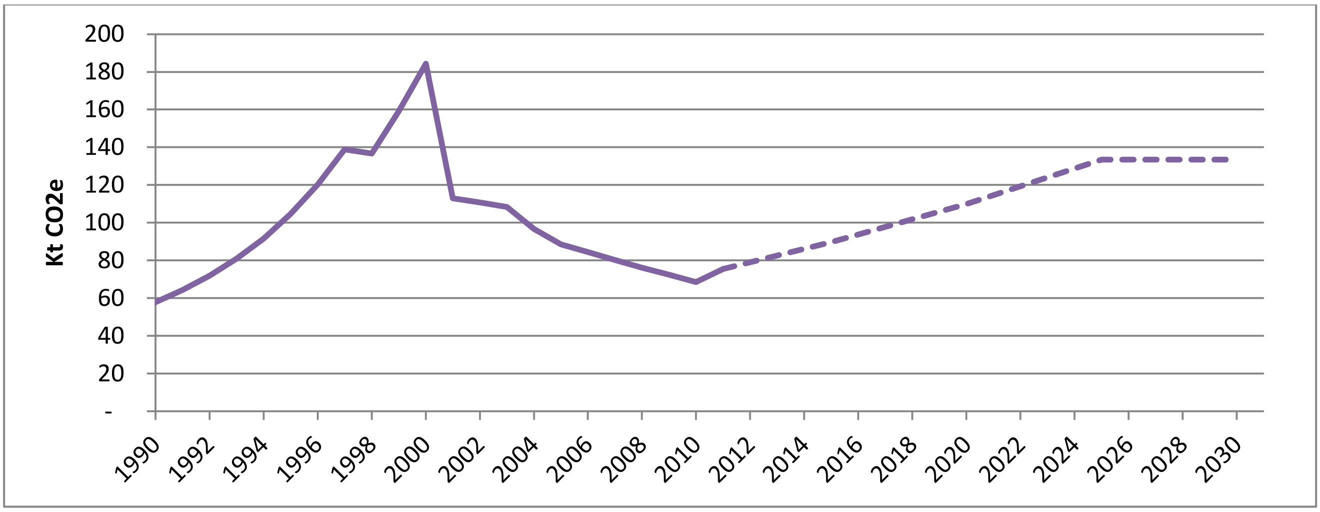


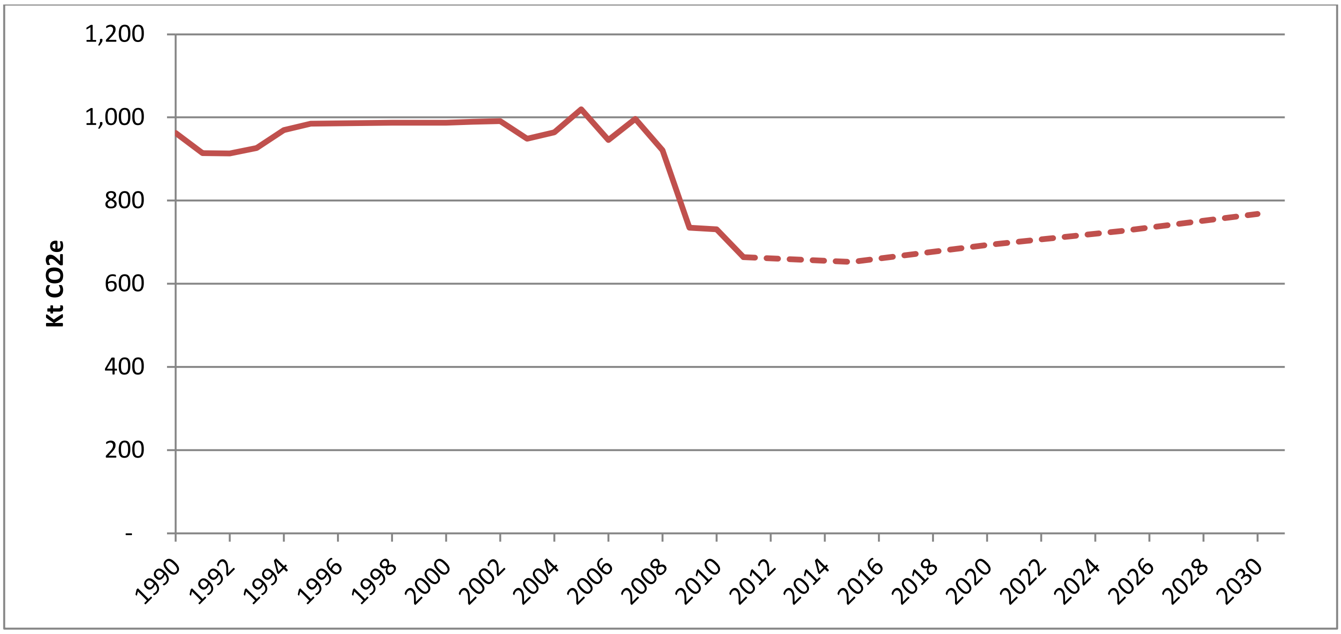
Figure 5.4 –Historical trend and projections of PFC emissions for the business sector



5.2 Business nitrous oxide emissions

Nitrous oxide emissions were estimated to be 0.7 $MtCO_2e$ in 2011 (**Figure 5.5**), representing approximately 5% of non-CO_2 GHG emissions from the business sector. 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. Emissions have generally been flat since 1990 with a sharp downturn from 2008. 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 approximately 0.1 $MtCO_2e$, or 16%, between 2011 and 2030.

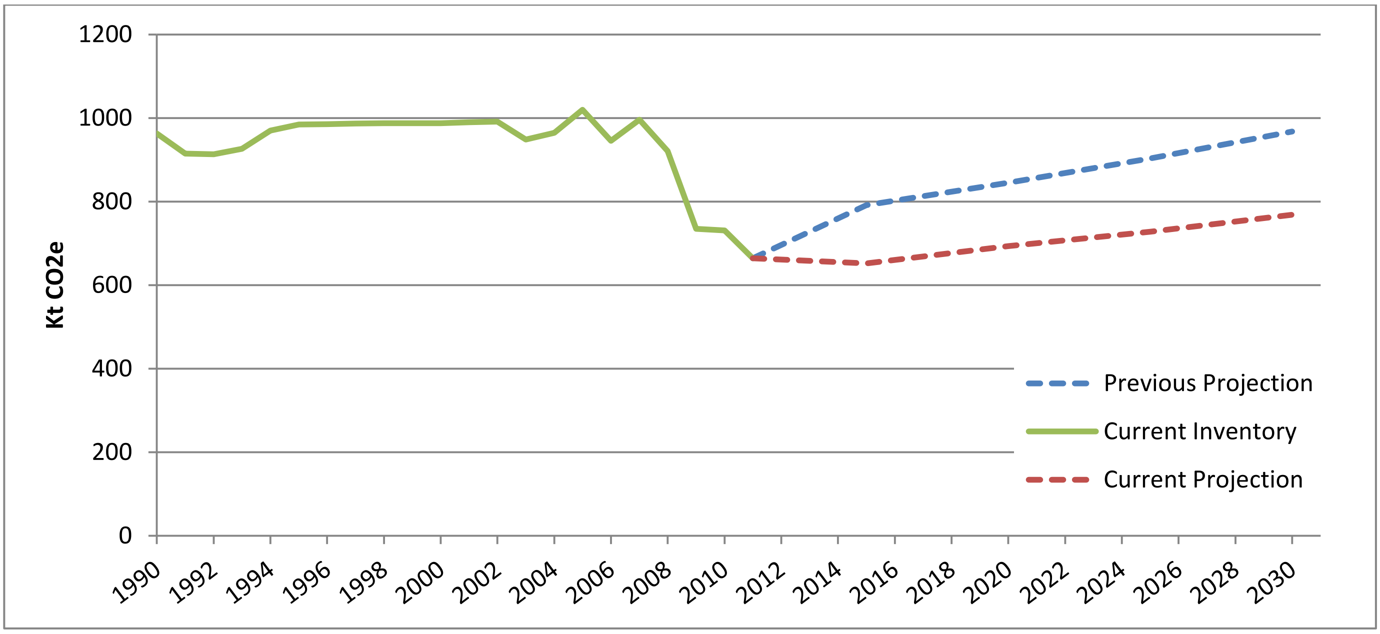
Figure 5.5 – Historical trend and projections of N_2O emissions for the business sector



Changes in business sector N_2O emissions since the previous update

There has been one change to the source data between the business sector projections in the Spring 2013 update and this set of projections. This is the inclusion of new projections for emissions from industrial off-road mobile machinery. **Figure 5.6** highlights the difference this revision has made to the overall emissions of N_2O from the business sector. The results of this revision is that business sector N_2O emission are now approximately 140 kt CO_2e lower in 2015 and 200 kt CO_2e lower in 2030 than in the Spring 2013 publication. This is as a result of new sector growth assumptions presented in UEP45.

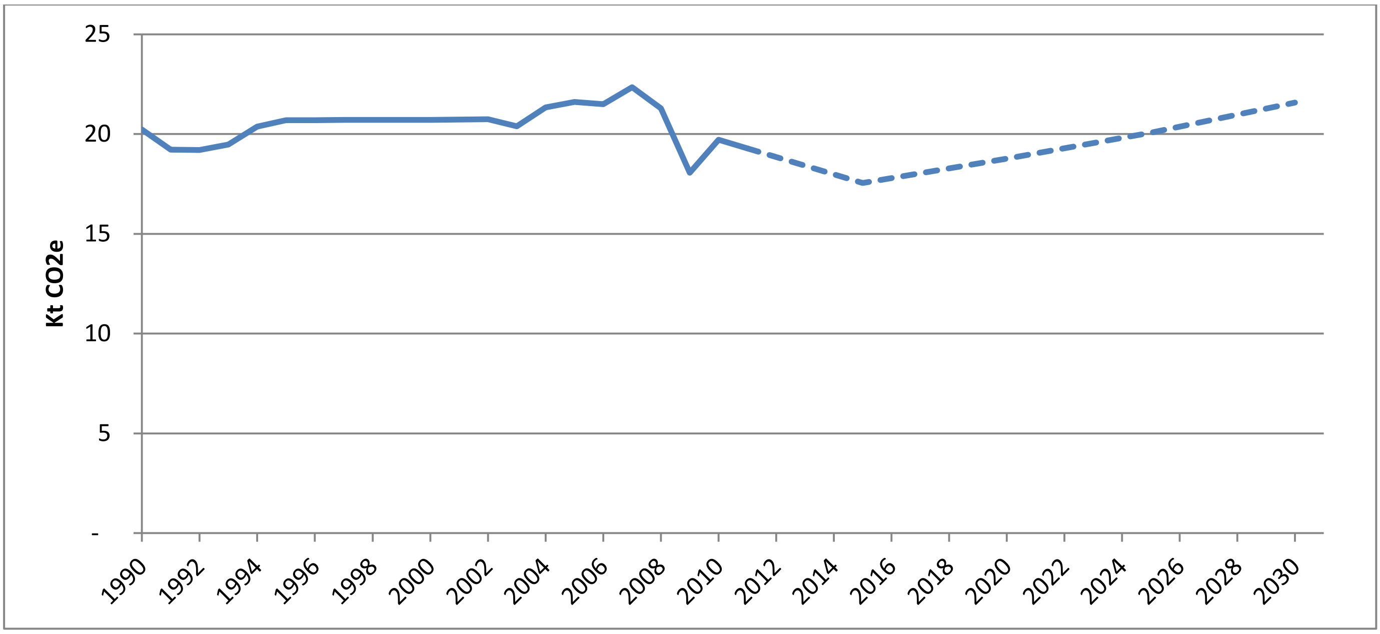
Figure 5.6 Comparison of Spring 2013 and Autumn 2013 business sector N_2O projections



5.3 Business methane emissions

Methane emissions were estimated to be 19 ktCO_2e in 2011 (**Figure 5.7**), representing less than 1% of non-CO_2 GHG emissions from the business sector. These emissions result from iron and steel combustion, and other industrial and commercial combustion. 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 2 ktCO_2e, or 12%, between 2011 and 2030. These percentage increases may be misleading though, as the absolute emissions values are very small.

Figure 5.7 – CH_4 emissions projections for the business sector



Changes in business sector CH_4 emissions since the previous update

As outlined above the only source of change between the business sector projections in the Spring 2013 update and this set of projections has been the inclusion of the new industrial off-road mobile machinery projections. As with N_2O, all emissions of CH_4 in the business sector come from this source. Changes to these projections are due to updated sectoral growth forecasts in UEP45, i.e. a delay in improved growth until 2015.

Figure 5.8 highlights the difference this revision has made to the overall emissions of CH_4 from the business sector. These revisions have had the effect of reducing CH_4 emissions from the business sector by approximately 2 kt CO_2e or 8% in 2030 when compared to the Autumn 2012 publication.

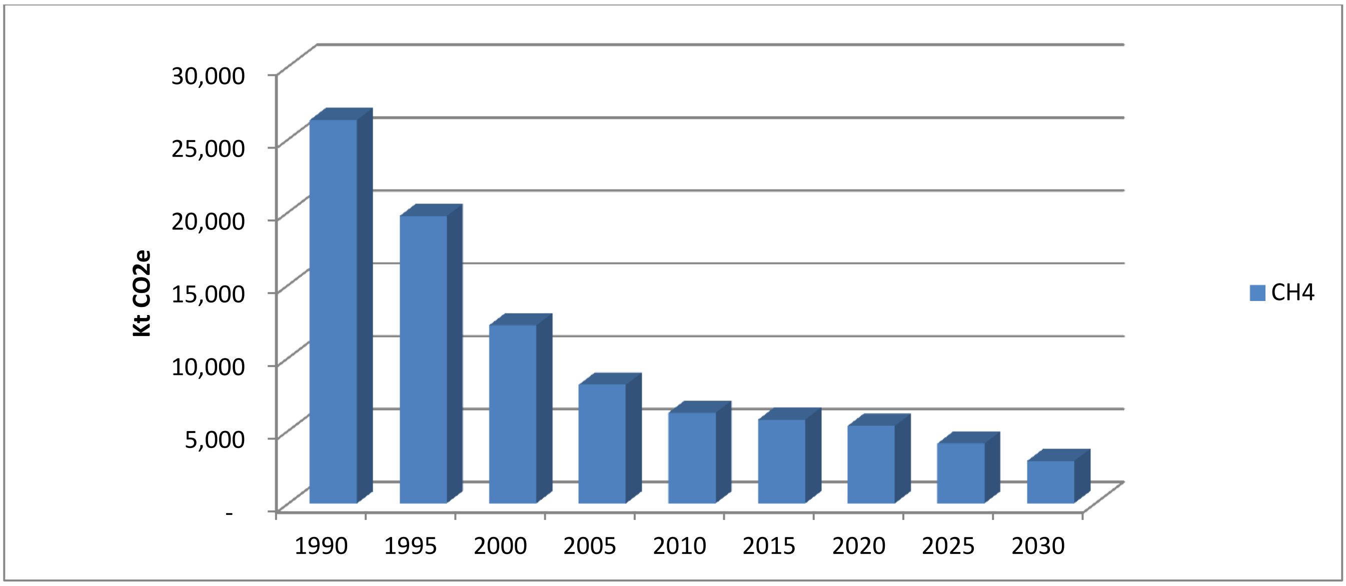
Figure 5.8 Comparison of Spring 2013 and Autumn 2013 business sector CH_4 projections

6 Energy Sector

In 2011 non-CO_2 greenhouse gas (GHG) emissions from the energy sector were approximately 6 $MtCO_2e$, representing around 7% of the UK's total non-CO_2 emissions. Methane (CH_4) is the only non-CO_2 GHG contributing to emissions from this sector as defined by the coverage of this report.

There have been no changes to the projections of emissions in this sector since the Spring 2013 update.

Figure 6.1 – Non-CO_2 GHG emissions projections for the energy sector

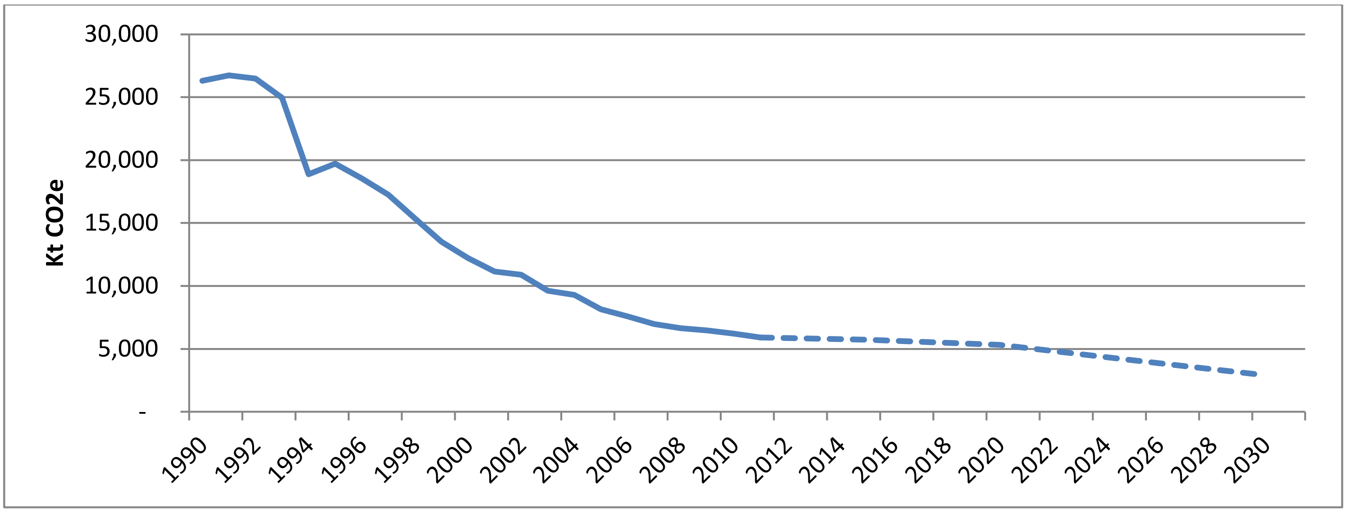


Overall emissions from the energy sector are projected to be approximately 3 $MtCO_2e$ in 2030 which will correspond to a decrease in emissions of approximately 51% since 2011 (**Figure 6.1**). This is predominantly due to reduced emissions from natural gas leakage and from deep mined coal. Historically, energy sector emissions have decreased by approximately 20 $MtCO_2e$ since 1990.

6.1 Energy methane emissions

Methane emissions in the energy sector result from natural gas leakage, operational and closed coal mines, and coke production. Historically, the decreasing trend in emissions is as a result of a reduction in emissions from natural gas leakage of around 48% and deep mined coal of around 92%; both of which are the dominant contributors to emissions in this sector (still comprising around 89% of emissions in 2011). Emissions are projected to continue to decrease from natural gas leakage and deep mined coal to 2030 (see **Figure 6.2**), because of an expected decrease in the quantity of coal produced, and the replacement of cast-iron pipes in the gas distribution system. Note that these projections are also influenced by limitations in the projected time-series for deep mined coal emissions, which only extends to 2025.

Figure 6.2 – Historical trend and projections of CH_4 emissions for the energy sector



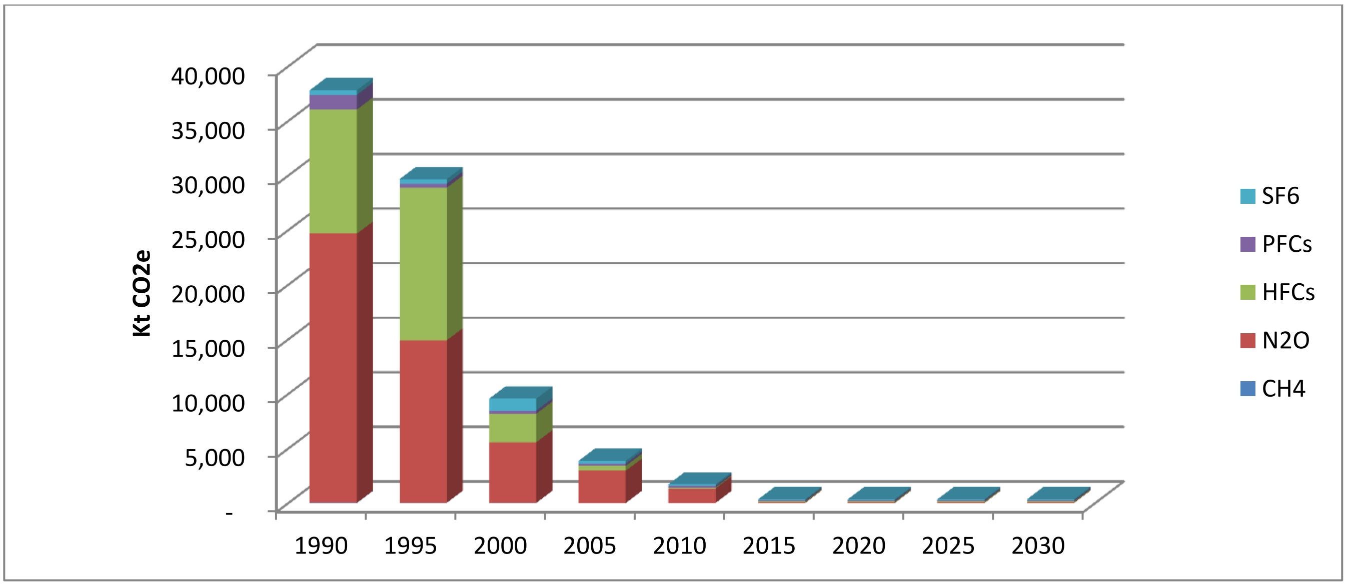
Closed coal mine CH_4 emissions are the third most significant source in this sector. Projections of these emissions were recently updated (**WSP ENVIRONMENTAL, 2011**). The model uses a bottom-up approach incorporating physical properties of individual mines and mine areas, includes actual closure and 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. Emissions are estimated to have already been significantly reduced and likely to remain approximately constant out to 2030.

7 Industrial Processes Sector

The industrial processes sector has historically been a significant contributor to emissions, producing the equivalent of approximately 22% of the UK's total non-CO_2 emissions in 1990. However, by 2011 emissions from the industrial process sector have reduced to less than 1% of total non-CO_2 emissions. Industrial processes do remain a source of nitrous oxide (N_2O), methane (CH_4) and F-gas emissions, albeit on a much smaller scale than historically.

There have been no changes to the projections of emissions in this sector since the Spring 2013 update.

Figure 7.1 – Overall Industrial Processes sector emissions projections



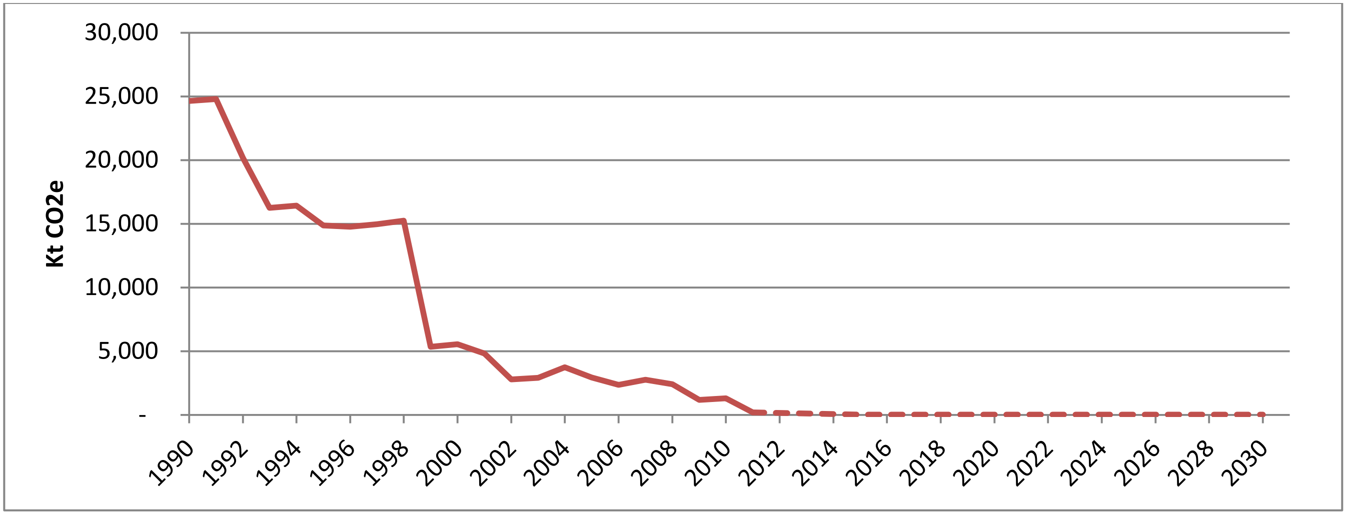
Overall emissions from the industrial processes sector are projected to be 0.3 MtCO2e in 2030, representing a reduction of approximately 47% between 2011 and 2030 (see Figure 7.1). Historically, N_2O emissions from nitric acid and adipic acid production have contributed significantly to overall emissions from this sector, as well as by-product emissions from the production of HFCs. Changes in industrial activity and the adoption of improved abatement technology has led to the significant reductions seen in this sector. Historically emissions have decreased 98% from 1990 to 2011.

7.1 Industrial Processes 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 0.1 $MtCO_2e$. **Figure 7.2** shows the historical and projected trend for N_2O from this sector.

The key driver of N_2O emissions from this sector has historically been the production of adipic and nitric acids. The UK's only adipic acid production facility ceased operation in 2009 and plant closures coupled with early adoption of emissions abatement technology in the production of nitric acid has resulted in significant reductions from these sources.

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



7.2 Industrial Processes F-Gas emissions

F-gas emissions from the industrial processes sector have, as with other gases, reduced markedly since 1990. F-gas emissions were approximately 13 $MtCO_2e$ in 1990, estimated at 0.4 $MtCO_2e$ in 2011, and are projected to be 0.3 $MtCO_2e$ by 2030. These 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.

The projected trend for each of the F-gases is expected to remain approximately flat from 2011 (**Figures 7.3 to 7.5**) 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 HCFCs, significantly reducing by-product emissions.

Emissions of PFCs in this sector are driven by the primary production of aluminium, with a smaller contribution from fugitive emissions from halocarbon production. SF_6 emissions are as a result of its use as a cover gas in the manufacture of magnesium alloy by die-casting.

Figure 7.3 Historical trend and projections of HFC emissions from the Industrial Processes sector

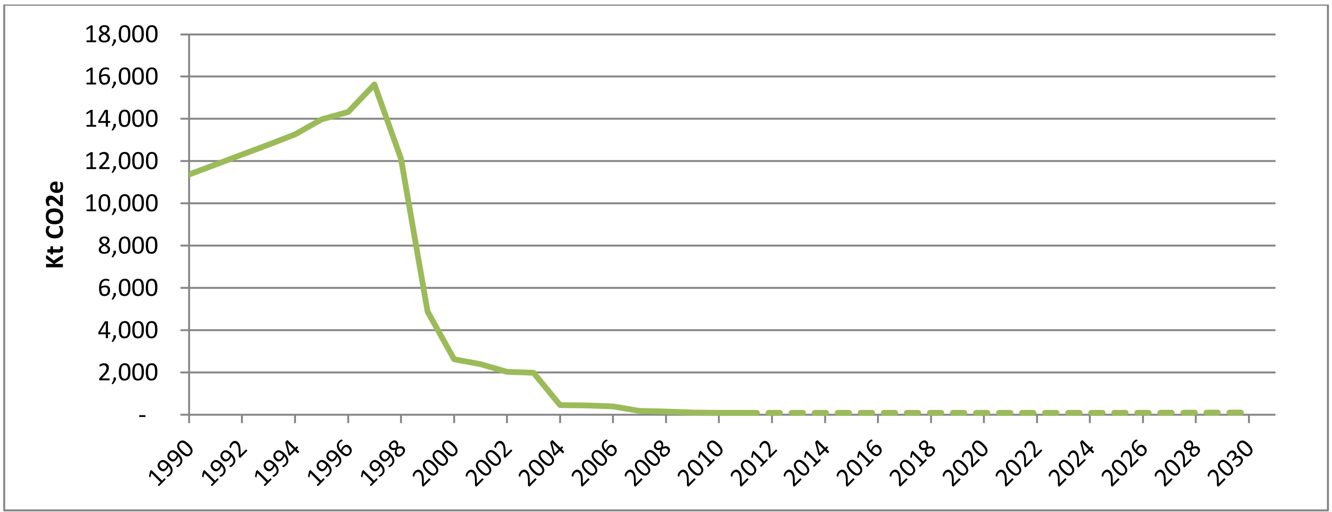


Figure 7.4 Historical trend and projections of PFC emissions from the Industrial Processes sector

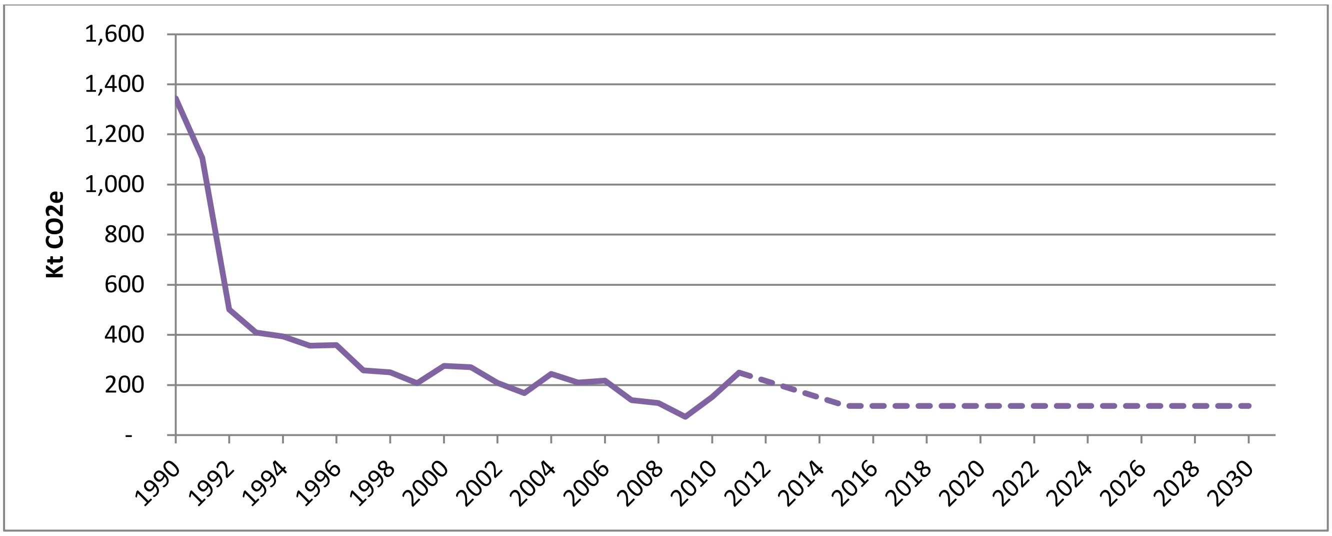
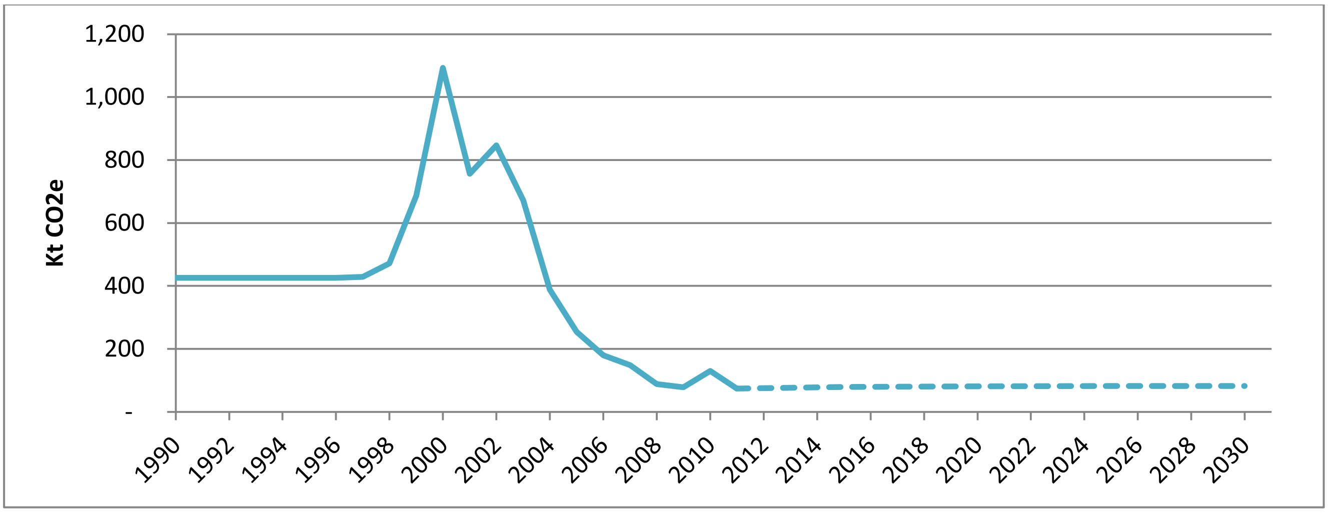


Figure 7.5 Historical trend and projections of SF6 emissions from the Industrial Processes sector

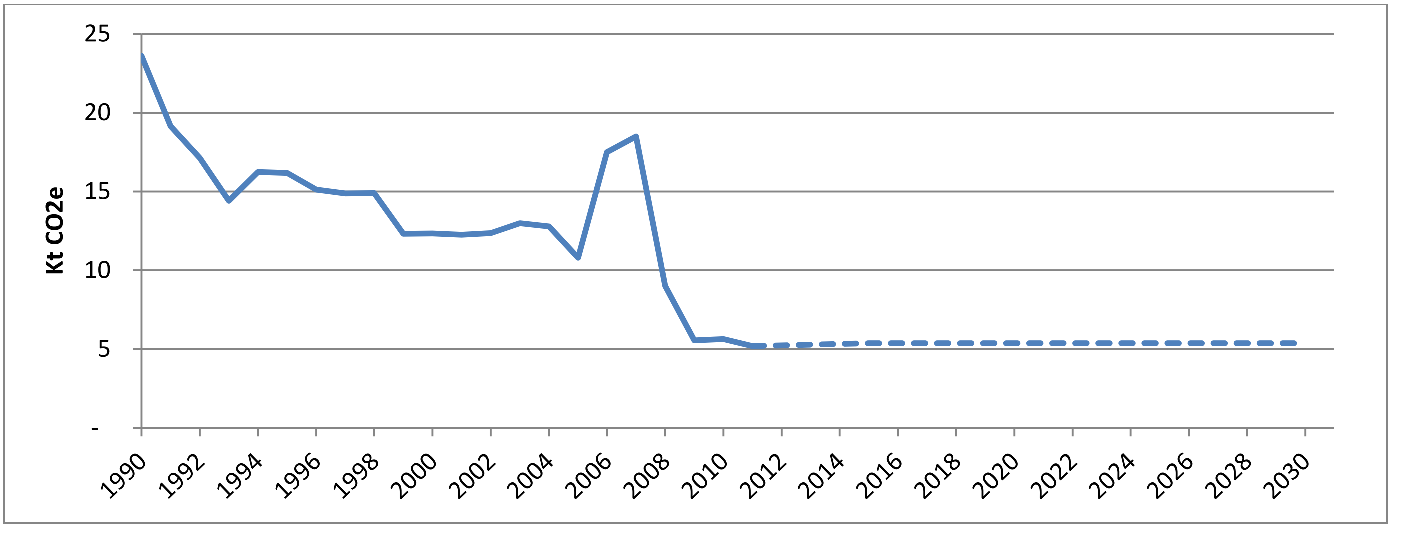


7.3 Industrial Processes sector methane emissions

Methane emissions from the industrial processes sector originates exclusively from fletton brick manufacture. Methane has historically contributed a relatively small amount to overall emissions from the Industrial Processes sector. Figure 7.6 shows the historical and projected trend for CH_4 emissions from the Industrial Processes sector.

Similar to the business sector, reductions in emissions in the 2007 to 2009 time frame could be associated with a slowdown in overall economic activity due to the recession. However, fluctuations of this small magnitude are difficult to attribute to a single cause. Projections are expected to remain flat going forward due to the relatively small emissions from this gas in this sector and relatively high inter-annual variability.

Figure 7.6 Historical trend and projections of CH_4 emissions from the Industrial Processes sector

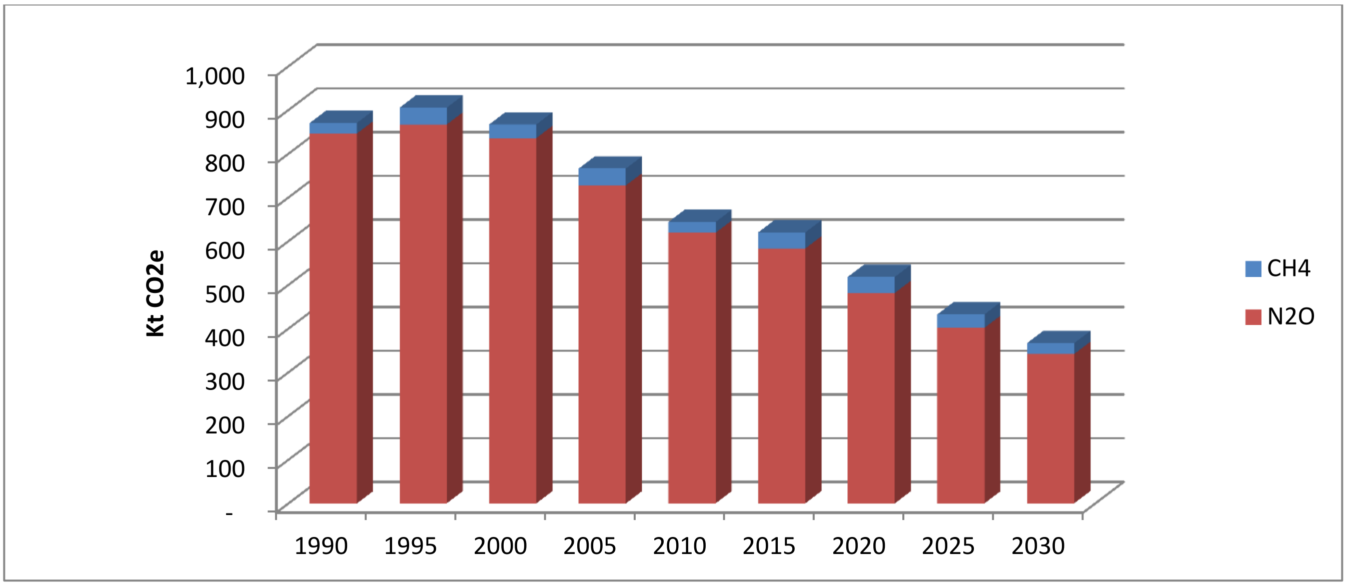


8 LULUCF Sector

The land use/land use change (LULUCF) sector is the smallest sector in terms of contribution to overall non-CO_2 emissions considered in this report. Emissions in 2011 were approximately 0.6 $MtCO_2e$, of which approximately 95% were from nitrous oxide (N_2O), which equates to approximately 0.7% of total non-CO_2 emissions from all sectors. Remaining emissions are from methane (CH_4).

Since the Spring 2013 update to the projections, new LULUCF data have been produced which are methodologically consistent with the broad changes made to the latest GHG inventory. Further details of this update are present in the sections below.

Figure 8.1 – Overall LULUCF sector emissions projections



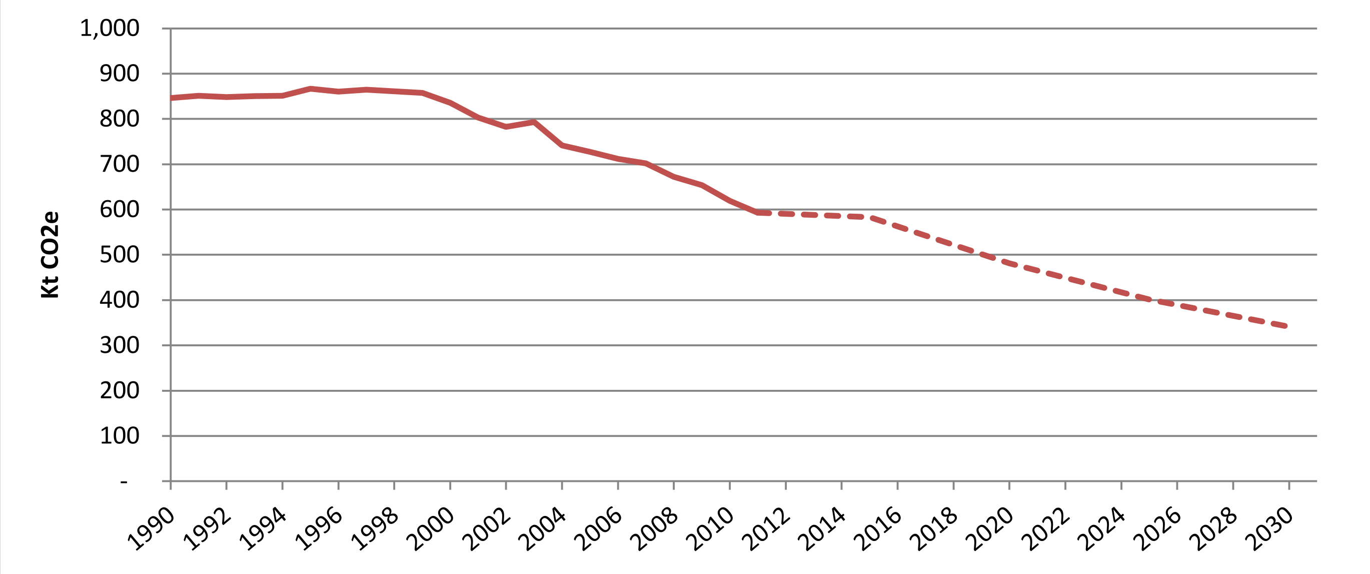
Overall emissions from LULUCF are projected to be approximately 0.4 $MtCO_2e$ in 2030, representing a reduction of approximately 41% on the 2011 level and 58% on the 1990 level (see Figure 8.1). The decline in emissions is predominantly due to reduced land disturbance from the conversion of land to crop-land.

8.1 LULUCF Sector nitrous oxide emissions

Emissions of N_2O accounts for approximately 95% 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. This source alone results in approximately 83% 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 approximately 70% of the 1990 level by 2011. This trend is projected to continue at a roughly even pace to 2030, when N_2O emissions are projected to be 0.3 $MtCO_2e$ (see Figure 8.2). The slow reduction in projected emissions from this source is due to an estimated slow decline in the rate at which land is converted to crop land, specifically in Wales. The total area of crop land in Scotland, England and Northern Ireland is expected to remain unchanged beyond 2011.

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 produced by the Centre for Ecology Hydrology under contract to DECC (**CEH, 2012**) and included in this update to the non-CO_2 projections. These new projections take into account changes in the LULUCF classifications presented in the 1990-2011 Greenhouse Gas Inventory.

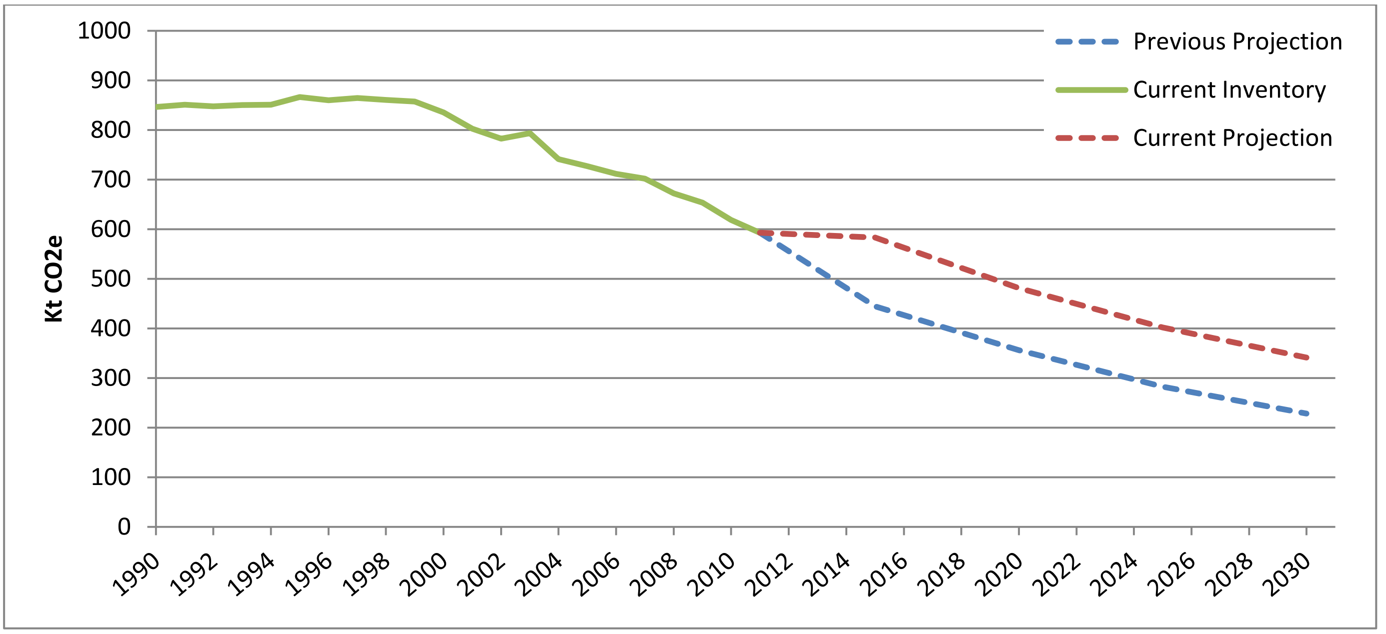
This set of non-CO_2 projections use the mid-emissions scenario presented in the LULUCF publication, in line with the non-CO_2 projections methodology. The mid-emissions scenario, representing the central projection, as described in chapter 2 of this report, uses land use change, afforestation and deforestation rates midway between the High and Low scenario rates.

There are several key assumptions used to calculate the new LULUCF projections. The land areas for each country of the UK are assumed to remain constant for the duration of the projections. They are taken from the Standard Area Measurement, which is the national baseline and assume that land loss due to sea level rise is assumed not to have an impact before 2050. For afforestation rates, the current (2011) ratio between conifer and broadleaf planting rates are assumed to remain constant throughout the projections period. These ratios are currently 1:99 in England and Northern Ireland, 30:70 in Scotland and 3:97 in Wales (conifer:broadleaf). The afforestation rate on settlement land is assumed to continue at the same rate as currently, with all other afforestation coming from conversion of grassland. Settlements are assumed to increase in area by 17 kha a year across the UK, this assumption is based on the DECC 2050 calculator report.

The latest GhGI contained a series of improvements to the LULUCF sector. For the first time N_2O emissions from drainage of forest land as well as emissions from non-forest wildfires were included in the historic time series. Projections for these categories were assumed to remain constant in the Spring 2013 update to the projections due to a lack of any further data. In the new set of LULUCF projections however, emissions from these sources have been calculated using consistent activity drivers with the GhGI and are included in this set of projections.

The combined effects of these changes to the LULUCF projections have raised the N_2O emissions from this sector across the projected time series; emissions in 2030 are now approximately 50% higher than in the Spring 2013 projections. The primary source of this increase is the inclusion of projections for the new GhGI category for drainage of forest land and new, higher emissions projections for the disturbance of land associated with land converted to cropland category. Figure 8.3 highlights the effect of this update on the time series.

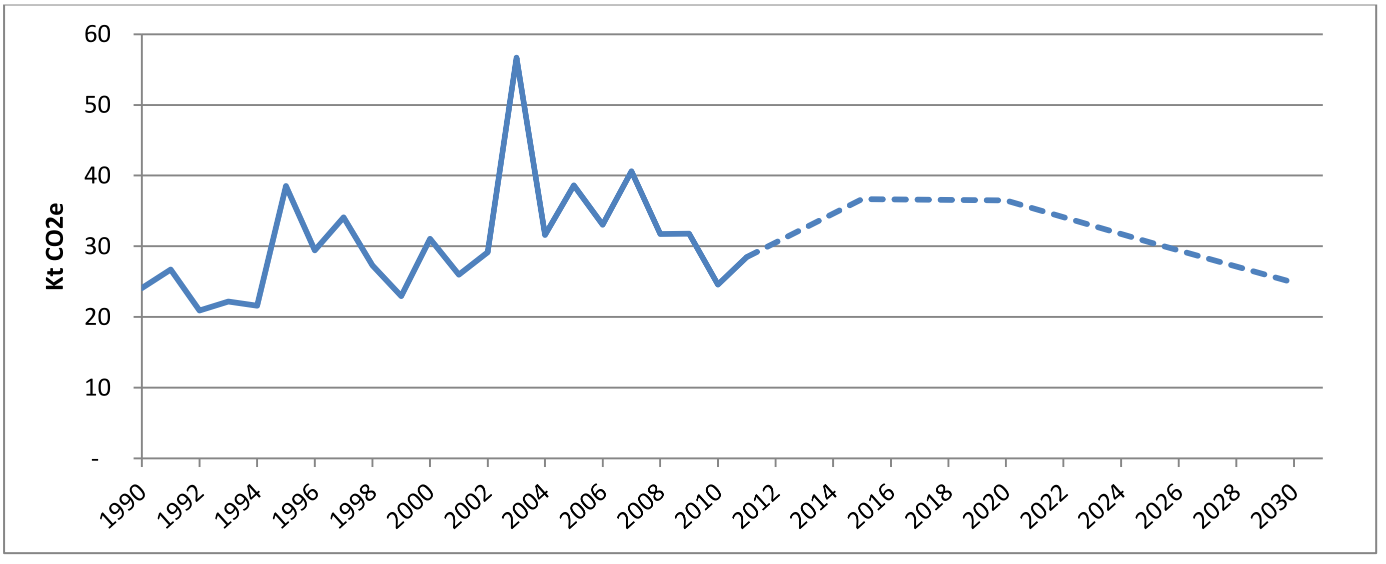
Figure 8.3 Comparison of Spring 2013 and Autumn 2013 LULUCF sector N_2O projections



8.2 LULUCF Sector methane emissions

Methane is comparatively a small contributor to overall emissions from LULUCF, representing approximately 5% of emissions in 2011. Emissions of CH_4 from LULUCF are largely driven by biomass burning (wildfires) and deforestation, both of which have large inter-annual variability. Figure 8.4 highlights this high level of inter-annual variability in the historic inventory data. 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.

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

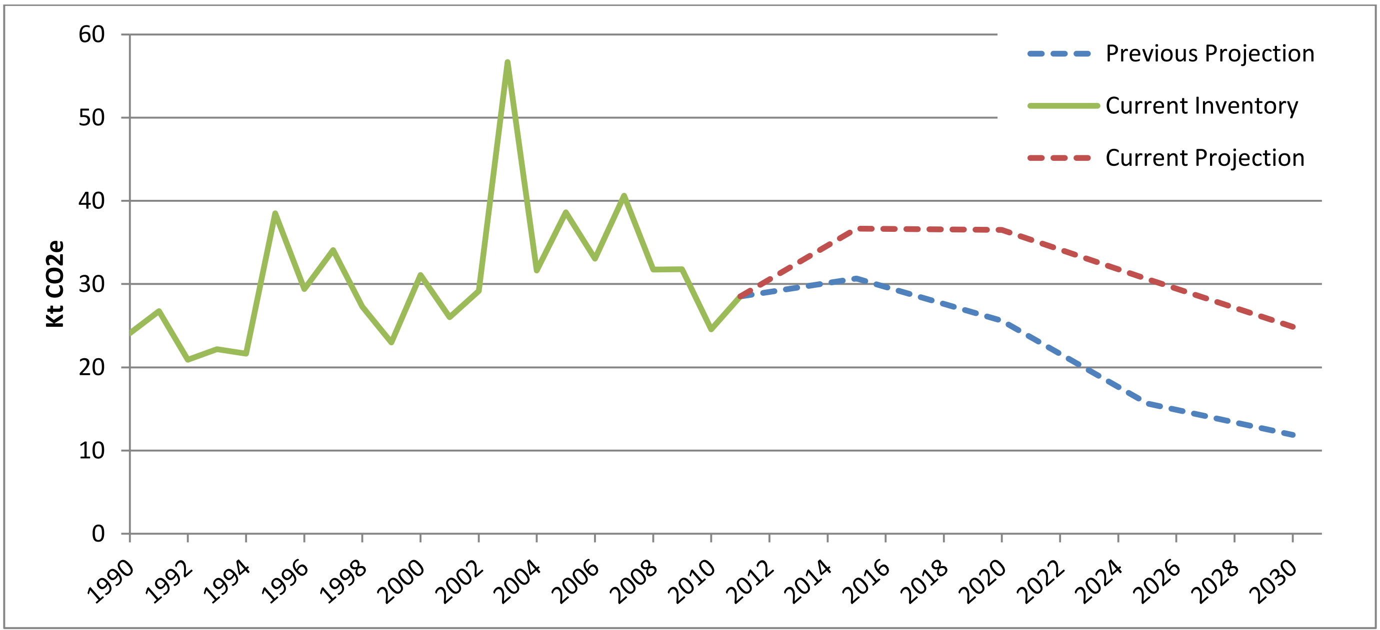


Changes in LULUCF sector CH_4 emissions since the previous update

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. As with N_2O, changes to emissions calculations for biomass burning and wildfires have had the largest effect on the projected emissions. These are new sources of projected emissions and therefore emissions are expected to be higher than in previous publications.

As a result of the changes to these sources, projected emissions of CH_4 from the LULUCF sector are now expected to be approximately 6 KtCO_2e higher in 2015 and 13 ktCO_2e higher in 2030 in the Autumn 2013 update when compared to the Spring 2012 publication. **Figure 8.5** highlights the effects of these changes.

Figure 8.5 Comparison of Spring 2013 and Autumn 2012 LULUCF sector CH_4 projections

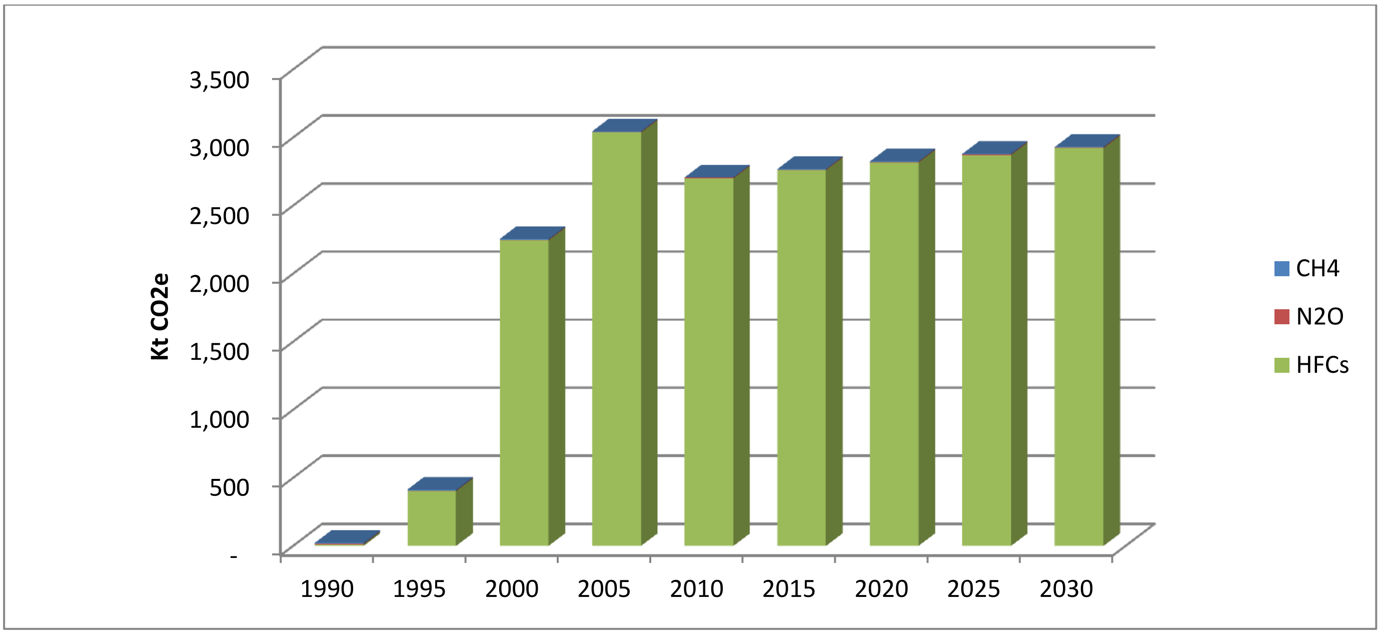


9 Residential Sector

In 2011 non-CO_2 greenhouse gas (GHG) emissions from the residential sector were approximately 2.7 $MtCO_2e$, representing around 3% of the UK's total non-CO_2 emissions. Nitrous oxide (N_2O), methane (CH_4) and HFC's contribute to non-CO_2 GHG emissions from this sector.

Since the Spring 2013 update to the projections, new projections of residential off-road machinery have been produced and are included in this update. Further details of this update are present in the sections below.

Figure 9.1 – Overall Residential sector emissions projections



Overall emissions from the residential sector are projected to be approximately 2.9 $MtCO_2e$ in 2030. From 2011, they are projected to increase approximately by 7% until 2030, due to a projected increase in HFC emissions. Historically, residential sector emissions have increased approximately 2.7 $MtCO_2e$ since 1990.

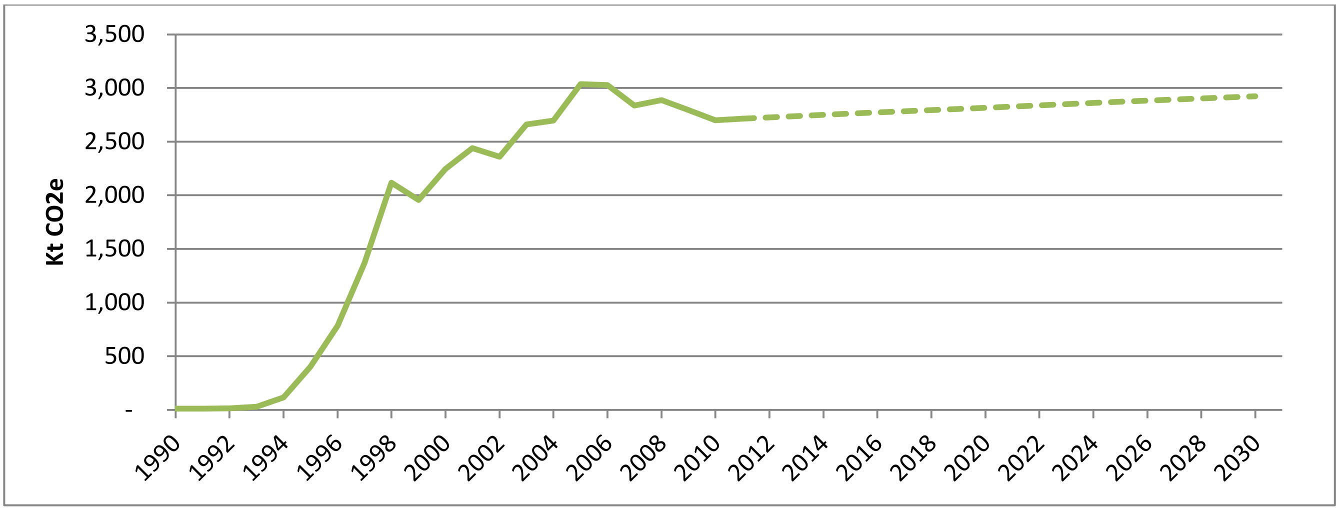
9.1 Residential Sector Hydrofluorocarbon emissions

Non-CO_2 emissions from the residential sector are dominated by HFCs. Emissions of HFCs in the residential sector were estimated to be 2.7 $MtCO_2e$ in 2011, representing approximately 99.7% of non-CO_2 GHG emissions from the residential sector, (**Figure 9.2**).

These emissions result from aerosols and metered dose inhalers (MDI). Emissions of HFC's have increased rapidly since 1990 due to the phasing out of CFC's due to the Montreal Protocol, resulting in the use of HFC's as replacement gases. Residential HFC emissions are projected to increase by approximately 0.2 $MtCO_2e$, or 8%, between 2010 and 2030, due to increased emissions from MDI as a result of increased UK population size (**AEA, 2008**).

The EU's F-gas regulation is not expected to drive the replacement of HFC's 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. Emissions from aerosols are expected to remain constant because no clear trend in emissions is observed in the historic time-series (**AEA, 2010**).

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

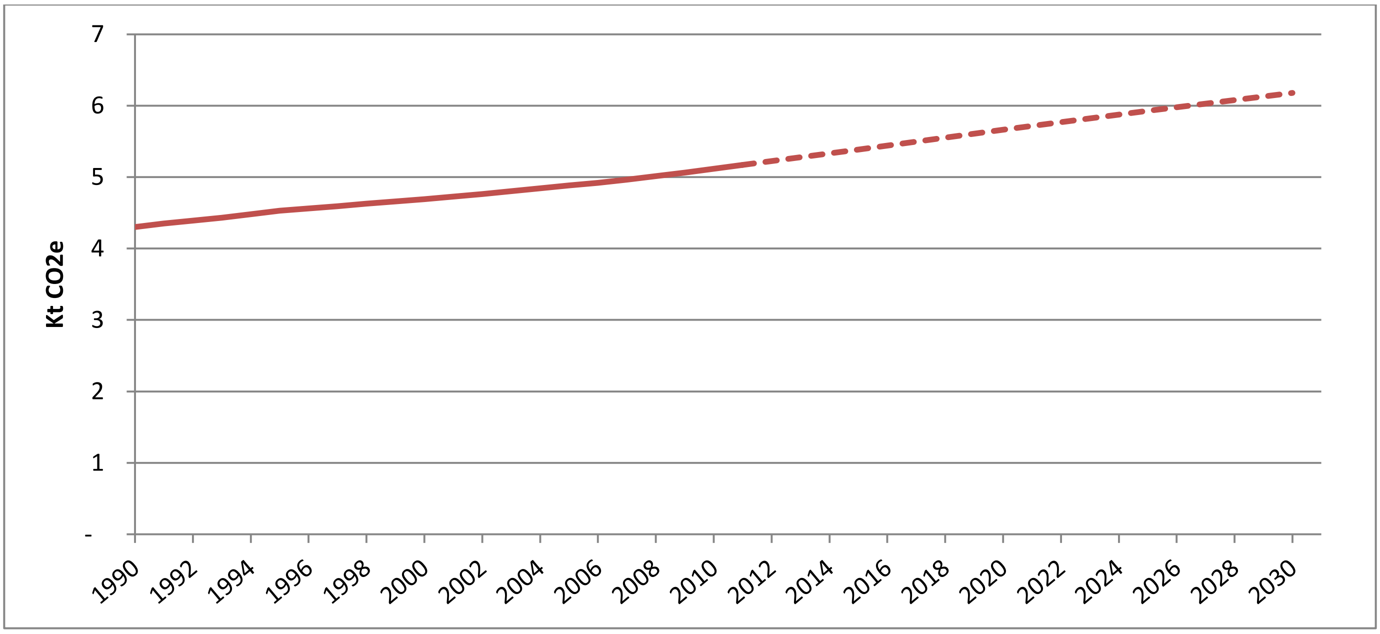


9.2 Residential Sector nitrous oxide emissions

Nitrous oxide emissions were estimated to be 5.1 ktCO_2e in 2011, representing approximately 0.2% 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 approximately 19% since 1990. Emissions are projected to increase by approximately 1 ktCO_2e, or 20%, between 2011 and 2030 (see **Figure 9.4**). These percentage increases may be misleading though, as the absolute emissions values are very small.

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

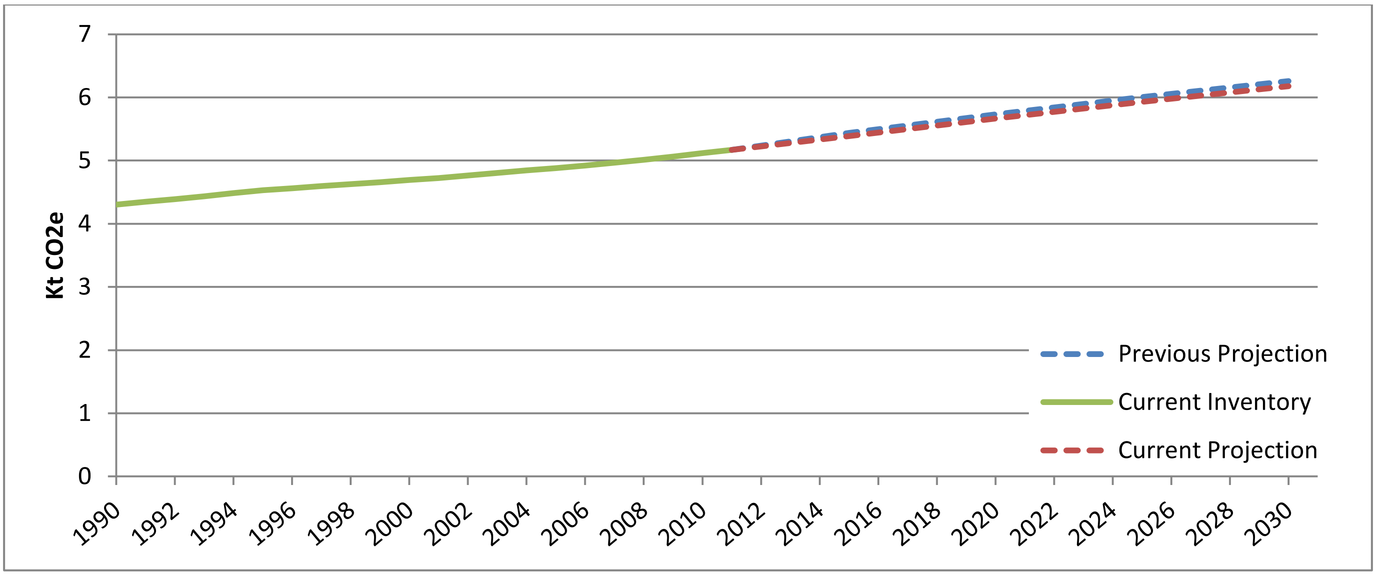


Changes in Residential sector N_2O emissions since the previous update

Since the Spring 2013 projections a new set of off-road mobile machinery projections have been produced. These new projections have been included in the Autumn 2013 update and include mobile house and garden machinery, which is part of the residential sector. A change in the assumptions on the allocation of DERV and gas oil to UK inventory sectors has resulted in the small reduction in CH_4 emissions from the residential sector across the time series. **Figure 9.5** highlights this very small change.

Emissions from this source are now between 0.05 and 0.08 $ktCO_2e$ lower between 2015 and 2030 when compared with the Spring 2013 projections.

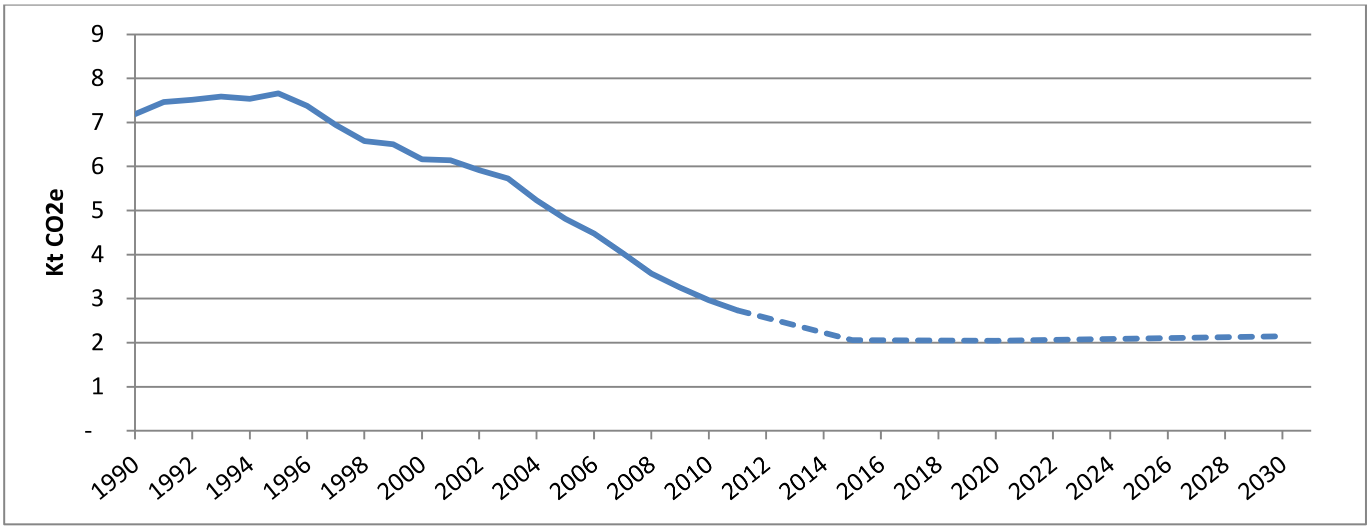
Figure 9.5 Comparison of Spring 2013 and Autumn 2012 Residential sector N_2O projections



9.3 Residential Sector methane emissions

Methane emissions were estimated to be 3 $ktCO_2e$ in 2011, representing approximately 0.1% of non-CO_2 GHG emissions from the residential sector. As with N_2O these emissions result from house and garden machinery, as well as accidental fires in vehicles. Historically, CH_4 emissions in this sector have decreased approximately 59% since 1990. Emissions are projected to decrease by approximately 0.6 $ktCO_2e$, or 26%, between 2011 and 2030. It is important to note that these percentage decreases relate to very small absolute emissions values. **Figure 9.6** highlights the latest historic and projected trends for residential sector CH_4 emissions.

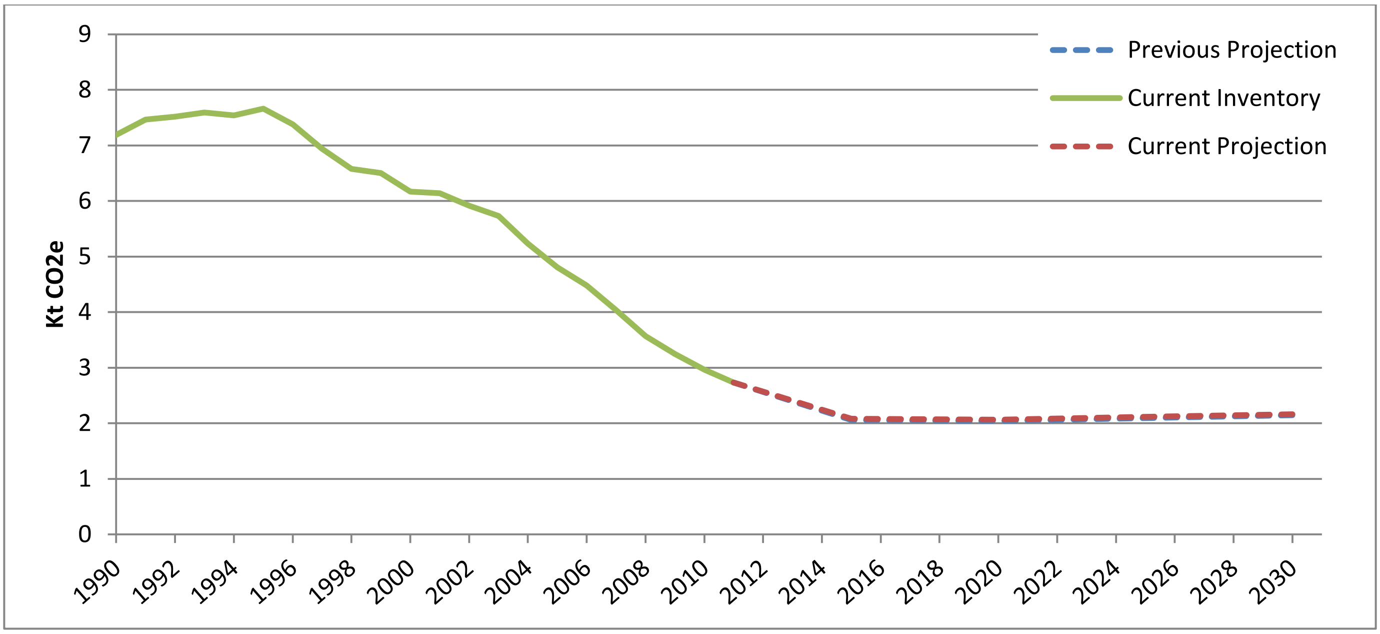
Figure 9.6 – Historical trend and projections of CH_4 emissions for the Residential sector



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 the Autumn update. The incorporation of this new data has led to an almost negligible increase in projections of approximately 0.02 kt CO_2e by 2030. This is due to the reallocation of DERV and gas oil in the GhGI. **Figure 9.7** highlights this very small change.

Figure 9.7 Comparison of Spring 2013 and Autumn 2012 Residential sector N_2O projections

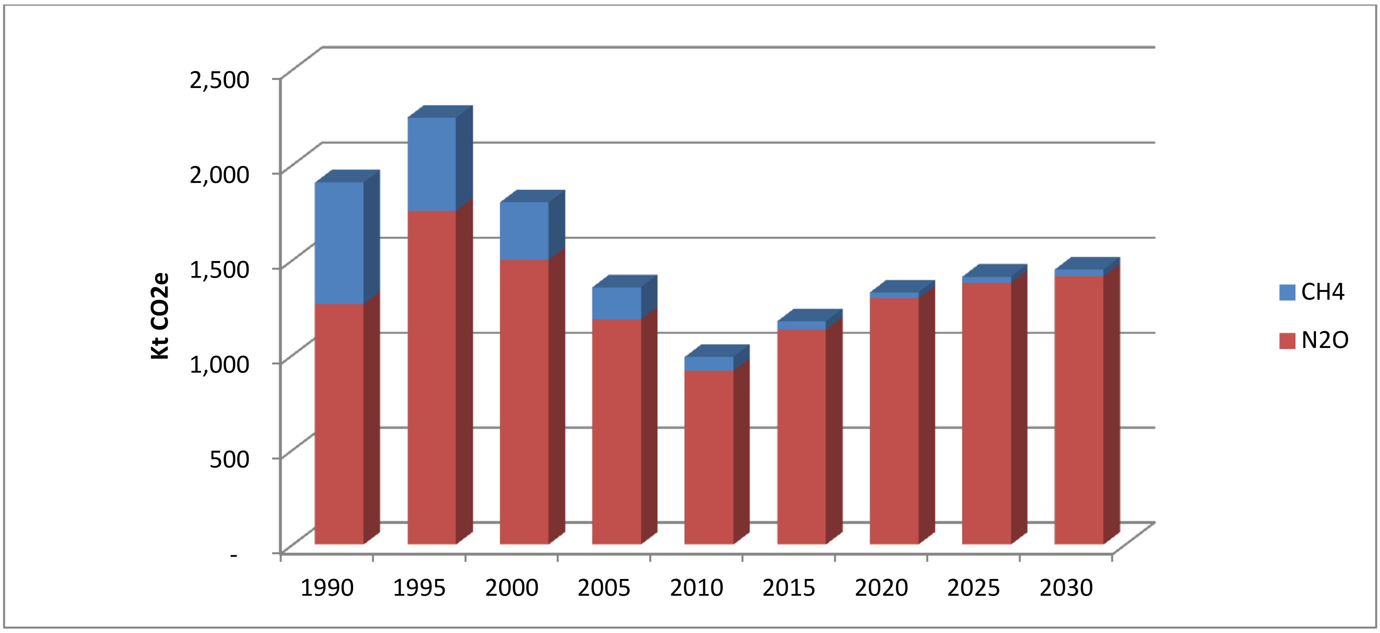


10 Transport Sector

The transport sector is the second smallest contributor of total non-CO_2 emissions. In 2011 it represented approximately 1 $MtCO_2e$, equivalent to approximately 1% of total non-CO_2 greenhouse gas emissions. Two gases represent the non-CO_2 contribution to emissions from this sector, nitrous oxide (N_2O) and methane (CH_4).

Since the Spring 2013 update to the projections, new road transport projections have been produced and are included in this update. Further details of this update are present in the sections below.

Figure 10.1 – Overall Transport sector emissions projections



Overall emissions from the transport sector are projected to be approximately 1.4 $MtCO_2e$ in 2030, which corresponds to a projected increase in emissions of approximately 44% on the 2011 level (See Figure 10.1). However, overall emissions from the transport sector have decreased by 47% from 1990 level, resulting in projected emissions in 2030 being approximately 24% lower than in 1990.

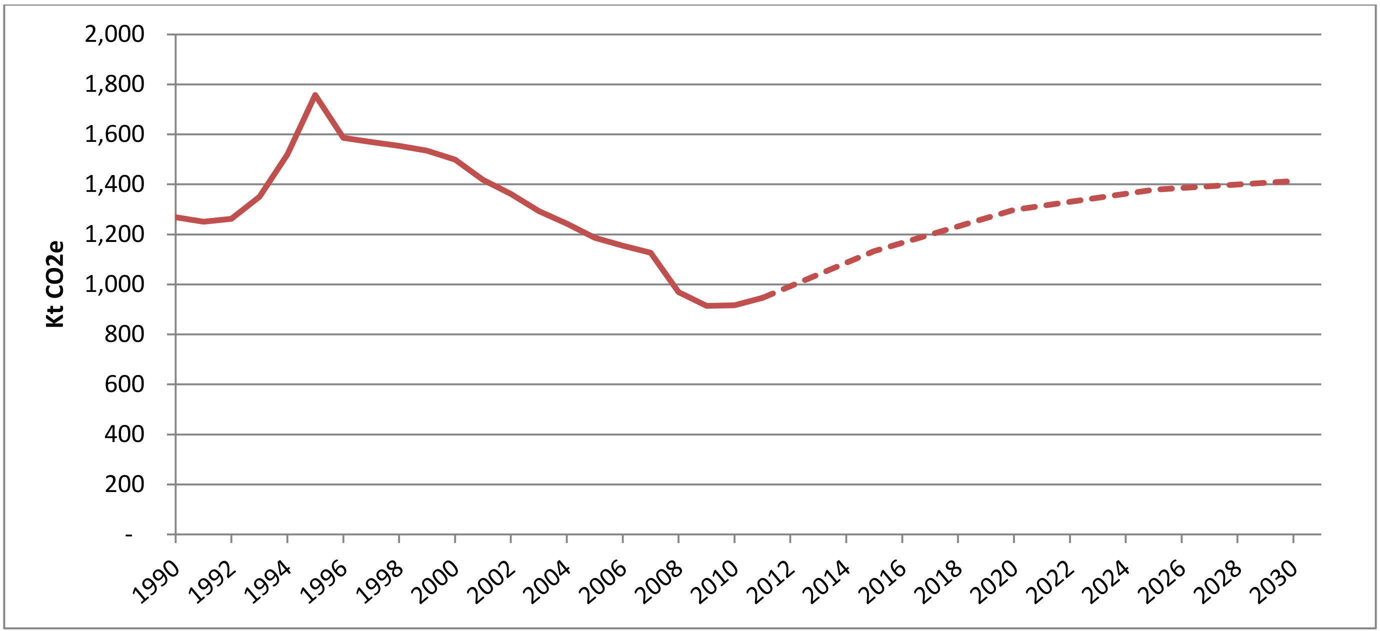
The increase in projected overall emissions from the transport sector is being driven by N_2O emissions from new road transport vehicles with emissions constraints on nitrogen oxides (NO_x), which emit higher amounts of N_2O. Further explanation of this is contained in **Section 10.1**.

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 2011 N_2O represents approximately 94% of non-CO_2 emissions from transport, rising to approximately 98% by 2030.

Road transport, particularly cars, are the highest contributor to the transport sector's N_2O emissions across the projections time series, emitting approximately 80% of the N_2O from transport in 2011,this proportion remains relatively static out to 2030 as a decline in petrol car and LGV emissions is compensated by a rise in those from diesel equivalents.

Figure 10.2 Historical trend and projections of N_2O emissions from transport



N_2O from the transport sector is projected to increase from approximately 1 $MtCO_2e$ in 2011 to approximately 1.4 $MtCO_2e$ in 2030 (see **Figure 10.2**). This projected rise is predominantly being driven by changes in the road transport categories.

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.

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 factors for more recent Euro standards, however, other factors may be driving the trend. This is reflected in the fall in emissions in the 2000's.

With respect to HGVs and buses, emissions factors have been increasing since the introduction of new vehicles registered since around 2005. The reason for this is again likely to be due to measures aimed at controlling NO_x 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 NO_x reduction process.

The steeper rise in projections from 2011 is mainly due to the increased proportion of diesel powered cars in the car fleet and penetration of higher emitting new HGVs in the fleet and increase HGV vehicle km's which eventually levels off causing the rate of increase to slow down.

Changes in transport sector nitrous oxide emissions since the previous update

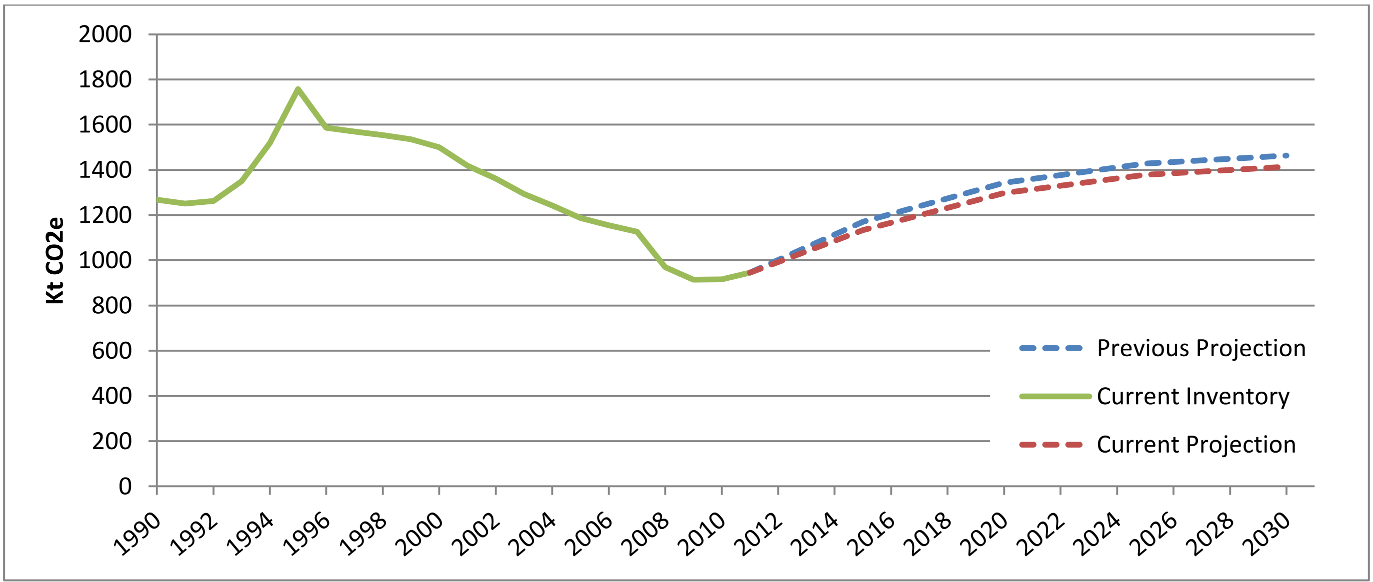
As highlighted above, there has been a new set of road transport projections produced by Ricardo-AEA under contract to DECC and included in this update. The key changes to these projections which influence N_2O emissions from the transport sector are as follows:

- New traffic forecasts produced by DfT in January 2013 covering the UK with the exception of London, where data are provided by TfL.
- New fleet composition projections which are re-forecast based on actual sales in 2011,
- The effect of the London Low Emissions Zone on the LGV and HGV fleet operating in the capital.
- Revised uptake of electric cars.
- Updated diesel car penetration rates in the new car fleet.
- New Automatic Number Plate Recognition (ANPR) data, refining the diesel/petrol split and age of current vehicle fleet.

The combined effect of these revisions to N_2O emissions from the transport sector have resulted in projected emissions being lower when compared with the Spring 2013 publication. **Figure 10.3** below highlights the effects of this change. Emissions are now projected to be approximately 3% lower across the time series when compared to the Spring 2013 publication.

There has also been an alteration to the way road transport projections are presented in this update. In previous publications, road transport projections were disaggregated to highly detailed engine size and road type categories, by applying the proportional split in the latest inventory to the projections This process increased uncertainty in the projections and has now been removed. Road transport projections are now displayed by vehicle type only and with a consistent time series from the GhGI.

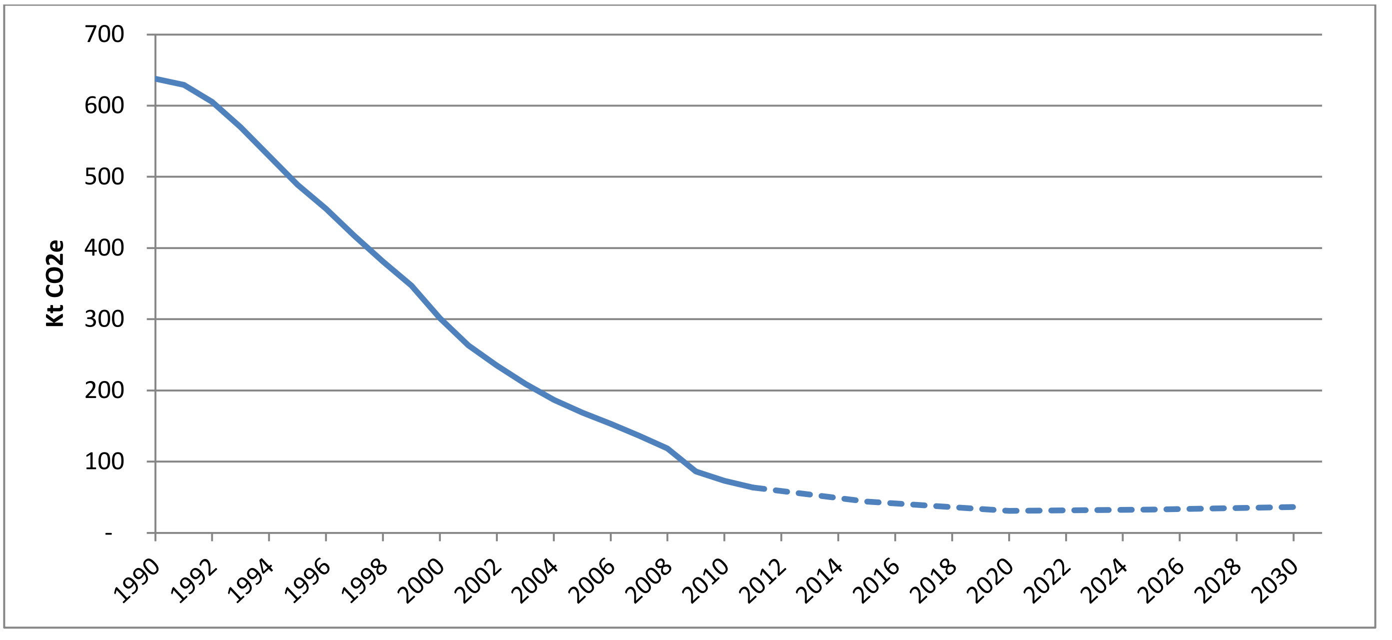
Figure 10.3 Spring 2013 and Autumn 2013 transport sector N_2O projections



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 approximately 6% of emissions from this sector in 2011 and declining to approximately 2.3% in 2030. As with N_2O from the transport sector, road transport is the most significant contributor to CH_4 emissions, representing approximately 90% of CH_4 emissions from the transport sector in 2030. Air transport, including military, by comparison account for approximately 10%.

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 90% reduction between 1990 and 2011. The projected trend is for CH_4 emissions to continue to reduce, albeit by a much slower rate, a further 4% lower on 1990 levels by 2030. Emissions are therefore projected to be approximately 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.

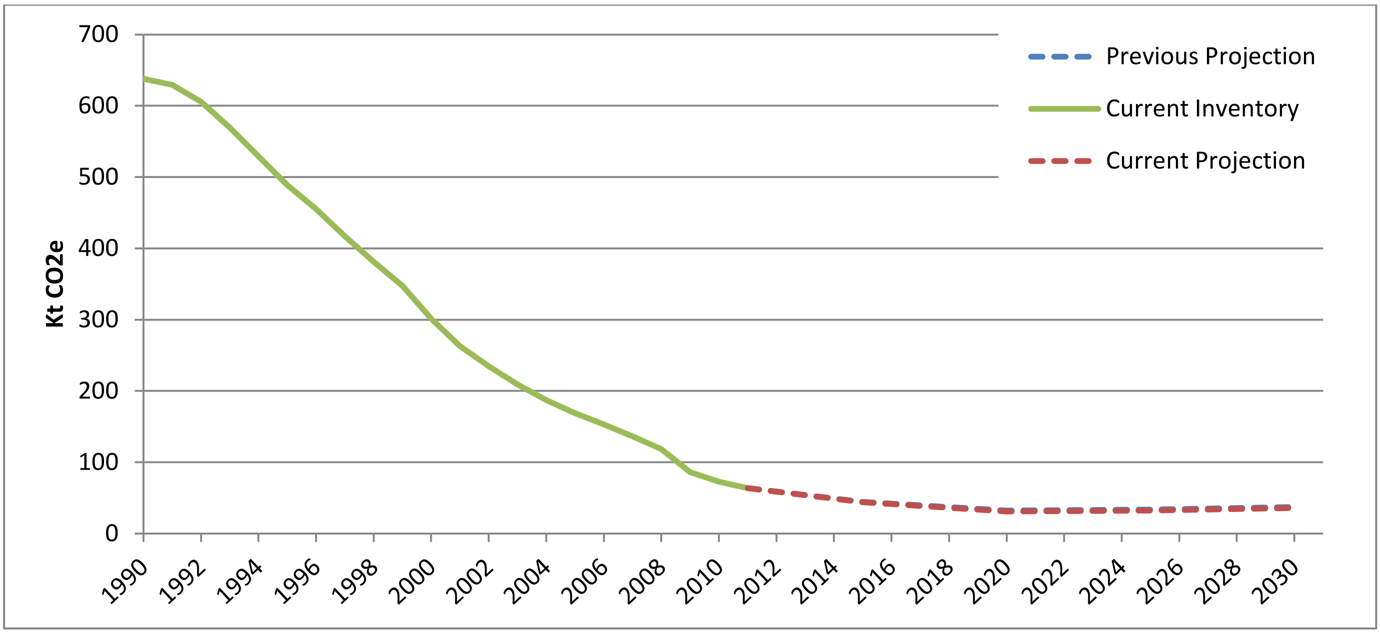
The trends in projected emissions from road transport cannot be explained by a single factor but are dictated by a combination of factors. These are mainly the rate of traffic growth for each vehicle type, the relative differences in emission factors for each vehicle type and across the Euro classes 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

As detailed in the section on transport emissions of N_2O above, a new set of road transport projections have been produced and incorporated in this update. The revisions listed in the N_2O section above are applicable with reference to CH_4. A general reduction in activity of motorcycles and mopeds, combined with the penetration into the fleet of newer mopeds and motorcycles, conforming to new hydrocarbon emissions limits, are an additional revision affecting CH_4 emissions.

The effects of these revisions are to marginally decrease the projected emissions of CH_4 from the transport sector, when compared with the Spring 2013 projections. **Figure 10.5** below highlights the difference these changes have made. Projections are now expected to be approximately 3% or 1 ktCO_2e lower in 2030 when compared with the previous estimates.

Figure 10.5 Spring 2013 and Autumn 2013 transport sector CH_4 projections

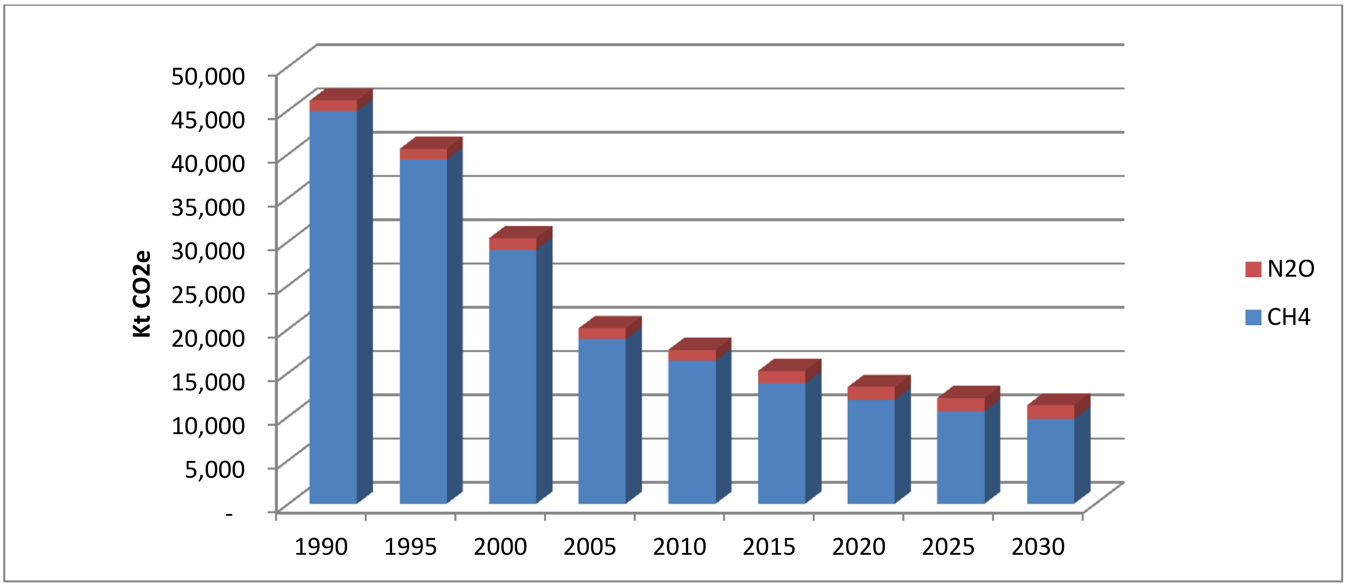


11 Waste Management Sector

In 2011 non-CO_2 greenhouse gas (GhG) emissions from the waste management sector were approximately 17 $MtCO_2e$, representing around 19% of the UK's total non-CO_2 emissions. Two gases represent the non-CO_2 contribution to emissions from this sector, nitrous oxide (N_2O) and methane (CH_4). **Figure 11.1** below highlights the breakdown in emissions by gases for the waste management sector.

There have been no updates to the waste management sector projections in this update.

Figure 11.1 Non-CO_2 GHG emissions projections for the waste management sector

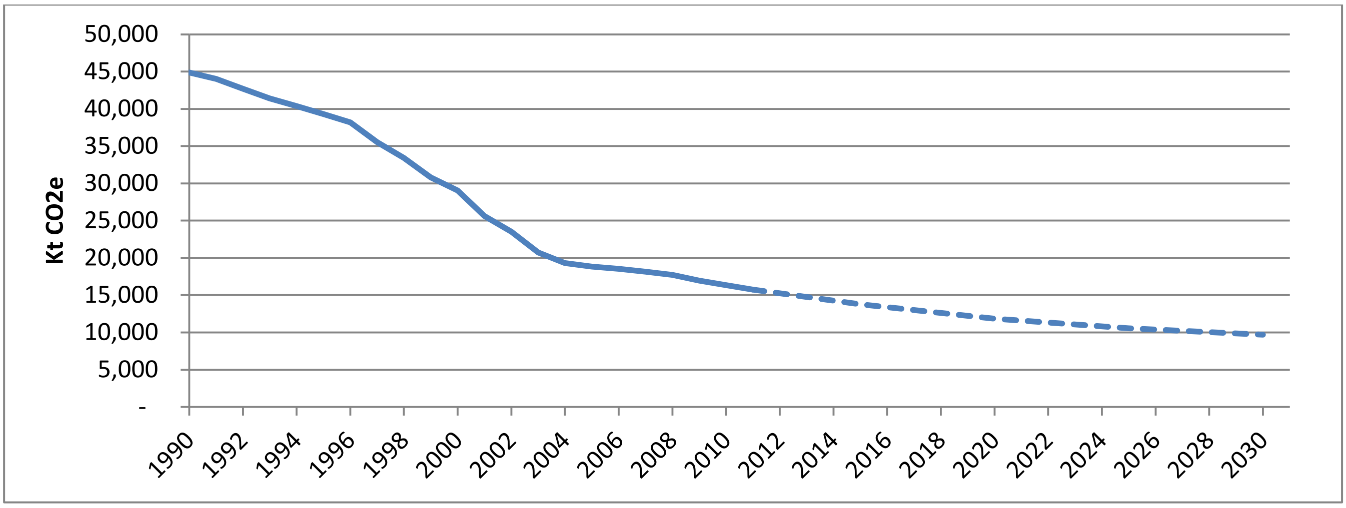


Overall emissions from the waste management sector are projected to be approximately 11 $MtCO_2e$ in 2030, which corresponds to a decrease in emissions of approximately 34% from 2011. Historically, waste management emissions have decreased by 29 $MtCO_2e$ since 1990, which equates to a reduction of approximately 63%. Both historic and projected emissions reductions are dominated by significant reductions in landfill waste emissions.

11.1 Waste management methane emissions

Emissions of CH_4 were estimated to be approximately 16 $MtCO_2e$ in 2011, representing approximately 93% of non-CO_2 GHG emissions from the waste management sector. Emissions from landfill waste represent approximately 90% of waste management CH_4, with industrial waste water treatment and sewage sludge decomposition also contributing. There has been a significant reduction in the historic emissions trend since 1990 of around 65%. Emissions are projected to decrease by approximately 6 $MtCO_2e$, or 39%, between 2011 and 2030 (see **Figure 11.2**). This is expected as a result of reductions in the amount of waste sent to landfill.

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



Projected CH_4 emissions from **landfill waste** are estimated using a model, MELMod, which is based on the first-order decay International Panel on Climate Change (IPCC) methodology, and is summarised in the UK's National Inventory Report (NIR).

Emissions from landfill are dominated by emissions from waste already sent to landfill, i.e. historical waste. The decay of this waste drives the observed reduction of approximately 45% in CH_4 emissions from this source. Methane emitted from waste already in landfill will reduce over time, particularly from waste in older landfill sites with little or no CH_4 capture technology.

With respect to future waste sent to landfill it is projected that mass of waste sent to landfill will decrease by approximately 15% from 2011 to 2030, based on projections of waste arisings from Local Authority Collected Waste (LACW) to 2019, and Commercial & Industrial (C&I) waste to 2014. As no additional information is available on projected emissions from this category beyond 2019 and 2014, volumes of landfill waste are assumed to remain constant after these respective years.

Projected CH_4 emissions from waste water treatment are based on a model used in the historic inventory (Hobson, 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 2012 and previous publications.

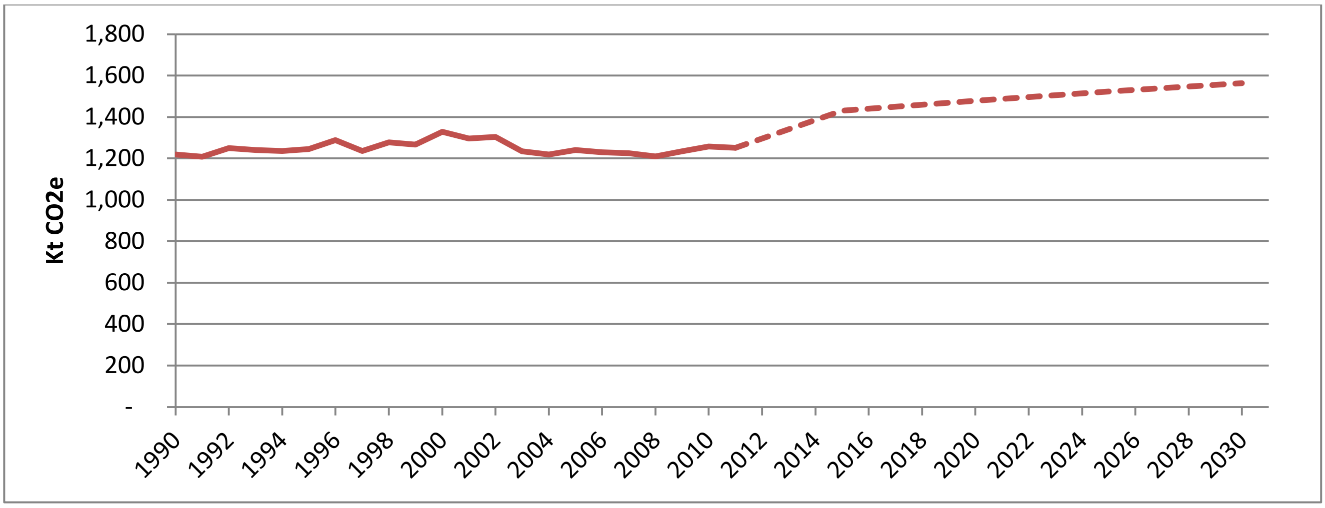
Projected CH_4 emissions from **waste incineration** (not for power generation, and including the categories of accidental vehicles fires, incineration, incineration of clinical waste, and incineration of sewage sludge) are assumed to remain constant as the future levels of activities in these categories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

11.2 Waste management nitrous oxide emissions

Emissions of N_2O were estimated to be approximately 1.3 $MtCO_2e$ in 2011, representing approximately 7% of non-CO_2 GHG emissions from the waste management sector. These emissions result mainly from sewage sludge decomposition, incineration of sewage sludge, and other incineration. There has been no significant change in the emissions trend since 1990. Emissions are projected to increase by approximately 300 $ktCO_2e$, or 25%, between 2011 and

2030 due to a projected increase in sewage sludge decomposition in line with population growth (see **Figure 11.3**).

Figure 11.3 Historical trend and projections of nitrous oxide emissions from waste management



Projections of N_2O emissions from **waste water treatment** are based on a constant emission factor per head of population (**GAD, 2008**). The historic inventory is based on protein consumption and population data. The projections assume that protein consumption will remain unchanged going forwards.

Projected emissions from **waste incineration** (not for power generation, and including the categories of accidental vehicles fires, 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.

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 run at the National Communication level in order to quantify uncertainties in the emissions projections.

This module assumes that the latest inventory year has no associated uncertainty, and the uncertainties in future years relate only to how different the inventory estimate is likely to be to the projected estimate in that year, ignoring the uncertainty associated with the inventory method; see **AEA 2010b** for further detailed explanation of the methodology.

The GHG Inventory uncertainty values are disregarded in this analysis due to the magnitude of the Inventory uncertainties. Including the GHG Inventory uncertainties (specifically N_2O uncertainty: -74% / +263%, see **DECC 2013c**) for the non-CO_2 GHGs would result in these larger uncertainties dominating the Monte Carlo simulation and effectively hiding the much smaller (typically +/- 10 to 30% for most sectors at 2020, up to +/- 50% at 2030) uncertainties in the projected trend.

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 historic data which is the basis of the trend.

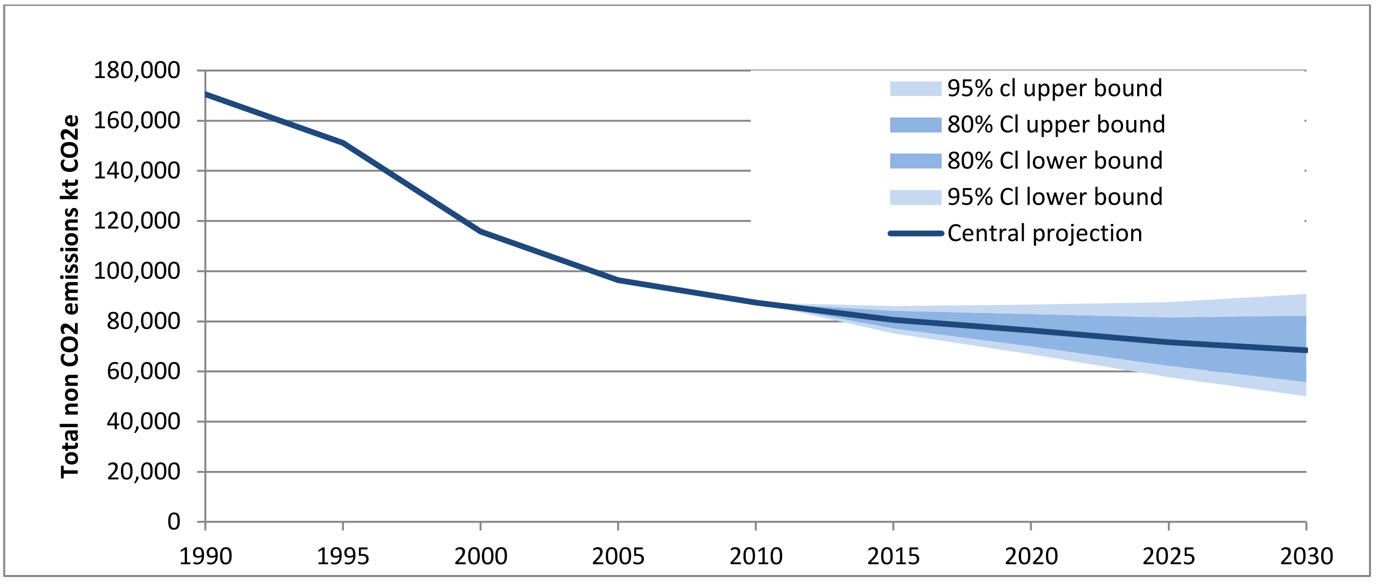
Since the Spring 2013 projections update a new projections model has been built in the @Risk analysis software. The principles of this model are the same as those used in the previous uncertainties model.

12.2 Uncertainty results

The uncertainty analysis indicated approximately +/- 5% total uncertainty in the emissions for 2011, increasing gradually to around +/- 13% uncertainty at 2020. Beyond 2020 the uncertainty region becomes noticeably asymmetric so at 2030 the lower bound is 27% below the central estimate and the upper bound is approximately 32% above.

This asymmetry is an artefact of analysing the uncertainty in the growth rates rather than on 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 highlights the uncertainty analysis results around the central projection estimate.

Figure 12.1 Uncertainty analysis for projections used in the Autumn 2013 update, as 80% and 95% confidence intervals



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Annex A: Summary of methods used to estimate emissions projections

Methodology for the derivation of projections for each sector are provided below. Where a sector has been updated, each individual sectoral update is explained more fully in the relevant sector chapters.

IPCC Source Categories 4A, 4B, 4D & 4F

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

Agriculture projections used in this update are based on updated DEFRA projections (**DEFRA 2013**), which are in turn based on agricultural 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.

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

DEFRA have used the FAPRI projections to 2020 as the basis of their projections to 2030. Methane and N_2O emissions are projected to decline slowly from 2010 to 2019 and then remain constant from 2020 to 2030 under DEFRA's assumptions.

4F1 & 4F5 – Field burning

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

IPCC Source Category 1A2f

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. For Industrial machinery, ONS construction statistics and DECC Construction, Industry and Energy growth indexes are used as projections drivers. The methodology follows the Tier 3 methodology described in the latest EMEP/CORINAIR emission inventory guidebook.

IPCC Source Categories 2E and 2F

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.

2E & 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 Greenhouse Gas Inventory, to be published in April 2013.

Source category 1B1 – Solid fuels

1B1a - Open coal mines

Projected emissions from working coal mines utilise the DECC model and have been estimated based on projected coal production data (open cast and deep mined). Up to date emission factors from the GHG inventory have been applied to these activity projections for mining, and coal storage and transport.

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. Further details of the model can be found in the referenced paper.

1B1b - Solid Smokeless Fuel (SSF) 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.

Source category 1B2 – Oil and natural gas

1B2b Gas production

Emissions of methane from leakage from the gas distribution network is the largest methane source in the UK inventory outside of the Agriculture and Waste sectors, comprising approximately 10% of all methane emissions in 2011.

Emissions in this category are projected to decline due to a 30 yr programme (started 2002) to reduce leakage from the gas distribution network by 70%. Projected changes in methane content of natural gas are not considered sufficiently meaningful fluctuations to take account of in the non-CO_2 GHG projections.

Ofgem is currently conducting a consultation on the next round of licensing for the gas distribution network. It is likely that the granting of these licenses will contain commitments on the further reduction of fugitive emissions going forward.

All other emissions in these categories are reported in DECC's UEP publications; see **Annex B** for more details.

Source category 2A7 – Other

Emissions from fletton brick production are predicted to remain constant from the current inventory 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.

Source category 2B – Chemical industries

2B2 – Nitric acid production

Nitric acid production has been a significant source of N_2O in the UK. Previous consultation with Industry representatives from all operating plants in the UK concluded that nitric acid production is expected to remain constant. Following a

DECC consultation (for published documents see **DECC 2011e**) the 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). As a result of this, best available technology (BAT) abatement technology is now fitted at the two remaining UK plants, and this is projected to significantly reduce N_2O from the end of 2012, as stated in the Impact Assessment which accompanies the Consultation document.

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.

Source category 2C – Metal production

2C4 – Magnesium cover gas

Emissions estimates from this source are based on data and information obtained from plant operators and industry experts. Reduction in the use of SF_6 as a cover gas is expected to continue with the replacement of it's use with that of HFCs. Further information on the methodology employed can be found in a report produced by AEA (**AEA, 2010**) and the National Inventory Report, expected to be published in April 2013.

Sector 5 – Land Use, Land Use Change and Forestry

Estimates of N_2O emissions due to disturbance associated with land use conversion to cropland, N_2O emissions from drained wetlands used for peat extraction and non-CO_2 GHG emissions from biomass burning are calculated using IPCC Tier 1 methodologies. Details of activity data and emission factors are given in Annex 3.7 of the 1990-2011 UK greenhouse gas inventory. Emissions of methane and N_2O from the LULUCF sector are supplied by the Centre for Ecology and Hydrology (**CEH, 2013**).

Sector 6 – Waste

6A1 - Waste disposed to landfill

The current set of projections are based on a recent update to the 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 UK's 2009 National Inventory Report (NIR).

6B2 - Wastewater treatment

Emissions of methane from waste water treatment to 2010 have been taken from the Hobson model report (**Hobson, 1996**). This is the same data source used for the historic inventory. 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, also used in the Spring 2012 and previous publications.

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

6C - Waste incineration

Estimated projected emissions from waste incineration (not for power generation, and including the categories of accidental vehicles fires, 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 GHG Inventory 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.

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-CO_2 GHG emissions to be produced and reported in DECC's UEP

Gas	NC Sector	IPCC Category	SourceName	Gas	NC Sector	IPCC Category	SourceName
CH4	Agriculture	1A4c	Agriculture - mobile machinery	N2O	Agriculture	1A4c	Agriculture - mobile machinery
			Agriculture - stationary combustion				Agriculture - stationary combustion
			Miscellaneous industrial/commercial combustion				Miscellaneous industrial/commercial combustion
	Business	1A2a	Blast furnaces		Business	1A2a	Blast furnaces
			Iron and steel - combustion plant				Iron and steel - combustion plant
		1A2b	Non-Ferrous Metal (combustion)			1A2b	Non-Ferrous Metal (combustion)
		1A2c	Ammonia production - combustion			1A2c	Ammonia production - combustion
			Chemicals (combustion)				Chemicals (combustion)
		1A2d	Pulp, Paper and Print (combustion)			1A2d	Pulp, Paper and Print (combustion)
		1A2e	Food & drink, tobacco (combustion)			1A2e	Food & drink, tobacco (combustion)
		1A2f	Autogeneration - exported to grid			1A2f	Autogeneration - exported to grid
			Autogenerators				Autogenerators
			Cement production - combustion				Cement production - combustion
			Lime production - non decarbonising				Lime production - non decarbonising
			Other industrial combustion				Other industrial combustion
		1A4a	Miscellaneous industrial/commercial combustion			1A4a	Miscellaneous industrial/commercial combustion
	Energy Supply	1A1a	Miscellaneous industrial/commercial combustion		Energy Supply	1A1a	Miscellaneous industrial/commercial combustion
			Power stations				Power stations
			Public sector combustion				Public sector combustion
		1A1b	Refineries - combustion			1A1b	Refineries - combustion
		1A1c	Coke production			1A1c	Coke production
			Collieries - combustion				Collieries - combustion
			Gas production				Gas production
			Nuclear fuel production				Nuclear fuel production
			Solid smokeless fuel production				Solid smokeless fuel production
			Town gas manufacture				Upstream Gas Production - fuel combustion
			Upstream Gas Production - fuel combustion				Upstream oil and gas production - combustion at gas separation plant
			Upstream oil and gas production - combustion at gas separation plant				Upstream Oil Production - fuel combustion
			Upstream Oil Production - fuel combustion			1B1b	Iron and steel - flaring
		1B2a	Petroleum processes			1B2a	Upstream Oil Production - Offshore Well Testing
			Upstream Oil Production - Offshore Oil Loading			1B2b	Upstream Gas Production - Offshore Well Testing
			Upstream Oil Production - Offshore Well Testing			1B2cii	Upstream Gas Production - flaring
			Upstream Oil Production - Oil terminal storage				Upstream Oil Production - flaring
			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		Industrial Process	1A2a	Sinter production
		2B5	Chemical industry - ethylene			2C1	Electric arc furnaces
			Chemical industry - general				Iron and steel - flaring
			Chemical industry - methanol				
		2C1	Electric arc furnaces				
			Iron and steel - flaring				
	Public	1A4a	Public sector combustion		Public	1A4a	Public sector combustion
	Residential	1A4b	Domestic combustion		Residential	1A4b	Domestic combustion
	Transport	1A3c	Rail - coal		Transport	1A3c	Rail - coal
			Railways - freight				Railways - freight
			Railways - intercity				Railways - intercity
			Railways - regional				Railways - regional
		1A3d	Inland goods-carrying vessels			1A3d	Inland goods-carrying vessels
			Motorboats / workboats (e.g. canal boats, dredgers, service boats, tourist boats, river boats)				Motorboats / workboats (e.g. canal boats, dredgers, service boats, tourist boats, river boats)
			Personal watercraft e.g. jet ski				Personal watercraft e.g. jet ski
			Sailing boats with auxiliary engines				Sailing boats with auxiliary engines
			Shipping - coastal				Shipping - coastal
		1A4a	Railways - stationary combustion			1A4a	Railways - stationary combustion
		1A4c	Fishing vessels			1A4c	Fishing vessels

14 Annex C: Summary of Updated Projections

Tables C.1 and C.2 below contains a summary of the updated Autumn 2013 projections. 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 and available from the following link https://www.gov.uk/government/publications/non-co2-greenhouse-gas-emissions-projections-report-autumn-2013

Table C.1 Summary of non-CO_2 GHG projections by gas (kt CO_2e)

		UK GHG Inventory		Projections			
Pollutant	NC Sector	1990	2011	2015	2020	2025	2030
CH4	Agriculture	22 406	17 808	17 626	17 555	17 564	17 564
	Business	20	19	18	19	20	22
	Energy Supply	26 311	5 920	5 743	5 319	4 109	2 899
	Industrial Process	24	5	5	5	5	5
	Land Use Change	24	28	37	37	31	25
	Residential	7	3	2	2	2	2
	Transport	638	64	44	31	32	36
	Waste Management	44 869	15 761	13 759	11 868	10 569	9 688
CH4 Total		94 299	39 608	37 234	34 836	32 331	30 240
N2O	Agriculture	35 519	28 688	27 864	28 150	28 064	28 064
	Business	963	664	652	693	727	768
	Industrial Process	24 641	207	31	31	31	31
	Land Use Change	846	593	583	481	402	342
	Residential	4	5	5	6	6	6
	Transport	1 268	946	1 133	1 298	1 379	1 413
	Waste Management	1 219	1 252	1 430	1 478	1 523	1 564
N2O Total		64 461	32 355	31 698	32 137	32 132	32 188
HFCs	Business	0	11 766	8 056	5 625	3 350	2 194
	Industrial Process	11 374	86	92	93	95	96
	Residential	12	2 715	2 760	2 816	2 872	2 923
HFCs Total		11 386	14 566	10 909	8 535	6 317	5 214
PFCs	Business	58	76	90	110	133	133
	Industrial Process	1 344	250	116	116	116	116
PFCs Total		1 402	325	206	226	250	250
SF6	Business	604	533	506	503	517	517
	Industrial Process	426	74	79	81	82	82
SF6 Total		1 030	607	585	584	599	599
Grand Total		**172 577**	**87 462**	**80 632**	**76 317**	**71 628**	**68 490**

Table C.2 Summary of non-CO_2 GHG projections by NC Sector (kt CO_2e)

		UK GHG Inventory		Projections			
NC Sector	Gas	1990	2011	2015	2020	2025	2030
Agriculture	CH4	22 406	17 808	17 626	17 555	17 564	17 564
	N2O	35 519	28 688	27 864	28 150	28 064	28 064
Agriculture Total		57 925	46 496	45 490	45 705	45 628	45 628
Business	CH4	20	19	18	19	20	22
	HFCs	0	11 766	652	693	727	768
	N2O	963	664	8 056	5 625	3 350	2 194
	PFCs	58	76	90	110	133	133
	SF6	604	533	506	503	517	517
Business Total		1 645	13 058	9 321	6 950	4 748	3 635
Energy Supply	CH4	26 311	5 920	5 743	5 319	4 109	2 899
Energy Supply Total		26 311	5 920	5 743	5 319	4 109	2 899
Industrial Process	CH4	24	5	5	5	5	5
	HFCs	11 374	86	31	31	31	31
	N2O	24 641	207	92	93	95	96
	PFCs	1 344	250	116	116	116	116
	SF6	426	74	79	81	82	82
Industrial Process Total		37 808	622	324	327	329	331
Land Use Change	CH4	24	28	37	37	31	25
	N2O	846	593	583	481	402	342
Land Use Change Total		870	622	620	518	432	366
Residential	CH4	7	3	2	2	2	2
	HFCs	12	2 715	5	6	6	6
	N2O	4	5	2 760	2 816	2 872	2 923
Residential Total		23	2 722	2 768	2 824	2 880	2 931
Transport	CH4	638	64	44	31	32	36
	N2O	1 268	946	1 133	1 298	1 379	1 413
Transport Total		1 906	1 009	1 177	1 329	1 411	1 450
Waste Management	CH4	44 869	15 761	13 759	11 868	10 569	9 688
	N2O	1 219	1 252	1 430	1 478	1 523	1 564
Waste Management Total		46 088	17 012	15 189	13 346	12 092	11 251
Grand Total		**172 577**	**87 462**	**80 632**	**76 317**	**71 628**	**68 490**

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URN: 13D/249