Department of Energy & Climate Change

UPDATED ENERGY AND EMISSIONS PROJECTIONS 2013

September 2013

Department
of Energy &
Climate Change

Index

UPDATED ENERGY AND EMISSIONS PROJECTIONS 2013 1
Index 4
Executive Summary 6
Chapter 1: Introduction 10
Chapter 2: Assumptions 12
Fossil fuel price assumptions and exchange rates 12
Economic growth 14
Carbon price 15
Chapter 3: UK emissions projections 16
Progress towards the carbon budgets 16
Traded and non-traded sectors 17
Sector Emissions 20
Changes to emissions projections since October 2012 22
Chapter 4: Policies included in the projections 26
Chapter 5: Uncertainty in the projections 29
Uncertainty ranges 29
Sensitivity to GDP growth assumptions 31
Uncertainty in projections of EUA purchases and sales 33
Chapter 6: Electricity generation 34
Background 34
Assumptions 34
Modelling approach 36
Major Power Producers (MPP) 36
Combined heat and power capacity 40
All electricity supply 41
Chapter 7: Demand for energy 42

Final energy demand 42

Primary energy demand 46

Chapter 8: List of supporting tables 47

Appendix: Model development 48

Introduction 48

Revisions to demand equations 48

Fuel share equations for industrial sub-sectors 48

Public sector total energy demand 48

Domestic sector electricity demand 49

Energy intensity equations 49

Iron and steel emissions 50

Revised modelling of transport 50

Executive Summary

The Department of Energy and Climate Change (DECC) regularly updates projections of energy demand, supply and greenhouse gas (GHG) emissions. The last full set of projections was published in October 2012[1]. This report updates those projections.

The projections take account of policies that affect energy use and GHG emissions where funding has been agreed and decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made. The government has in place a clearly defined suite of policies to reduce emissions to meet the first three carbon budgets. Therefore, the projections for 2012 to 2022 indicate how we expect to perform against the first three carbon budgets based on a set of analytical assumptions (table 1 and figure 1).

The projections for the period 2023 onwards represent our expectations in the absence of any additional policy effort, i.e. no new policies or extensions to existing policies. They show that our suite of existing policies will continue to reduce emissions over the fourth carbon budget period, but not by enough to meet the fourth carbon budget level. The difference between the projections for 2023 - 2027 and the fourth carbon budget level therefore indicates the amount of additional policy effort that would be required to meet the budget.

The projections have been updated to take account of new data including revisions to policy savings estimates, fossil fuel prices[2], and carbon price projections[3], Office for Budget Responsibility (OBR) growth projections[4] and cost estimates for the power sector[5]. There are also improvements to the underlying energy and emissions projection model[6].

Emissions projections are reported on both a net UK carbon account basis and territorial basis. Territorial emissions comprise both emissions covered by the EU Emissions Trading Scheme (EU ETS), referred to as “traded” emissions and emissions outside the EU ETS, referred to as “non-traded” emissions. UK participants in the EU ETS receive allocations of EU emissions allowances which in total are equal to the UK’s share of the EU ETS cap, referred to as the “traded sector cap”. These participants may either reduce carbon emissions or purchase allowances to comply with the EU ETS. The net UK carbon account is equal to the sum of the

[1] 2012 energy and emissions projections
https://www.gov.uk/government/publications/2012-energy-and-emissions-projections

[2] Fossil fuel price projections: 2013
https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013

[3] Carbon valuation
https://www.gov.uk/carbon-valuation

[4] Economic & Fiscal Outlook, Office for Budget Responsibility, March 2013,
http://budgetresponsibility.independent.gov.uk/pubs/March-2013-EFO-44734674673453.pdf

Fiscal Sustainability Report, Office for Budget Responsibility, July 2013
http://budgetresponsibility.independent.gov.uk/pubs/2013-FSR_OBR_web.pdf

[5] DECC Electricity Generation Costs 2013
https://www.gov.uk/government/publications/decc-electricity-generation-costs-2013

[6] The DECC Updated Energy and Emissions Model was reviewed in 2011 by Cambridge Econometrics
http://hmccc.s3.amazonaws.com/Progress%202011/CCC%20Progress%20Report_Interactive_2.pdf

traded sector cap and the actual level of non-traded emissions. The UK carbon budgets are set on this basis.

The level of the 4th carbon budget (2023 – 2027), which was set at 1,950 million tonnes carbon dioxide equivalent ($MtCO_2e$) of average annual emissions, is subject to review in 2014. If, at that point, our domestic commitments place us on a different emissions trajectory to that of the EU Emissions Trading System the Government will, as appropriate, revise the budget to align it with the actual EU trajectory. For the purposes of projecting progress against the 4th carbon budget an illustrative EU ETS cap of 690 $MtCO_2e$ is used, which is consistent with the assumption made by the Committee on Climate Change (CCC) in their recommendation for the fourth carbon budget level[7].

The updated projections suggest that the UK will meet its first three legislated carbon budget targets by smaller margins than those published last year. There are several factors contributing to the change in projected emissions, including changes to policy savings estimates, updates to data, assumptions and improvements to our models.

These projections are subject to several sources of uncertainty including forecast error in demand equations, uncertainty in future policy impacts and uncertainty in projections for economic drivers of demand. Analysis of the sensitivity of our projections to uncertainty in assumptions, suggests the true future values could be about 6% higher or lower than the projected values in the long run. However, despite this uncertainty, the analysis suggests that the risk of the UK failing to meet its first three carbon budgets is low. Details of the impact of uncertainty are given in Chapter 5.

[7] Meeting Carbon Budgets – ensuring a low-carbon recovery (2nd progress report)
http://archive.theccc.org.uk/aws2/0610/CCC-Progress-Report-web-version_3.pdf

The Fourth Carbon Budget – reducing emissions through the 2020s
http://archive.theccc.org.uk/aws2/4th%20Budget/CCC_4th-Budget_interactive.pdf

Table 1 Emissions projections by carbon budget period ($MtCO_2e$)

$MtCO_2e$	UEP October 2012				UEP September 2013			
	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Traded sector[8]	1,201	984	678	624	1,195	983	706	618
Non-traded	1,695	1,572	1,488	1,465	1,731	1,625	1,517	1,475
of which: non-CO_2	455	415	374	350	467	430	393	368
Total Territorial emissions	**2,897**	**2,556**	**2,166**	**2,089**	**2,925**	**2,607**	**2,223**	**2,093**
Change in territorial emissions from Oct. 2012					*29*	*51*	*57*	*4*
Traded sector cap[9]	1,233	1,078	985	690	1,233	1,078	985	690
EUAs purchased (negative implies sold)[10]	-32	-94	-307	-66	-38	-96	-279	-72
Change in traded EUAs[11] from Oct. 2012					*-7*	*-2*	*28*	*-6*
Net carbon account	**2,928**	**2,650**	**2,473**	**2,155**	**2,964**	**2,703**	**2,502**	**2,165**
Carbon budget	**3,018**	**2,782**	**2,544**	**1,950**	**3,018**	**2,782**	**2,544**	**1,950**
Shortfall (negative implies emissions under budget)	**-90**	**-132**	**-71**	**205**	**-54**	**-79**	**-42**	**215**
Change in non-traded / net carbon account from Oct. 2012					*35*	*53*	*29*	*10*

* Note that figures in this and subsequent tables have been rounded. Totals are calculated from the un-rounded data and therefore may not appear to be the sum of the component parts.

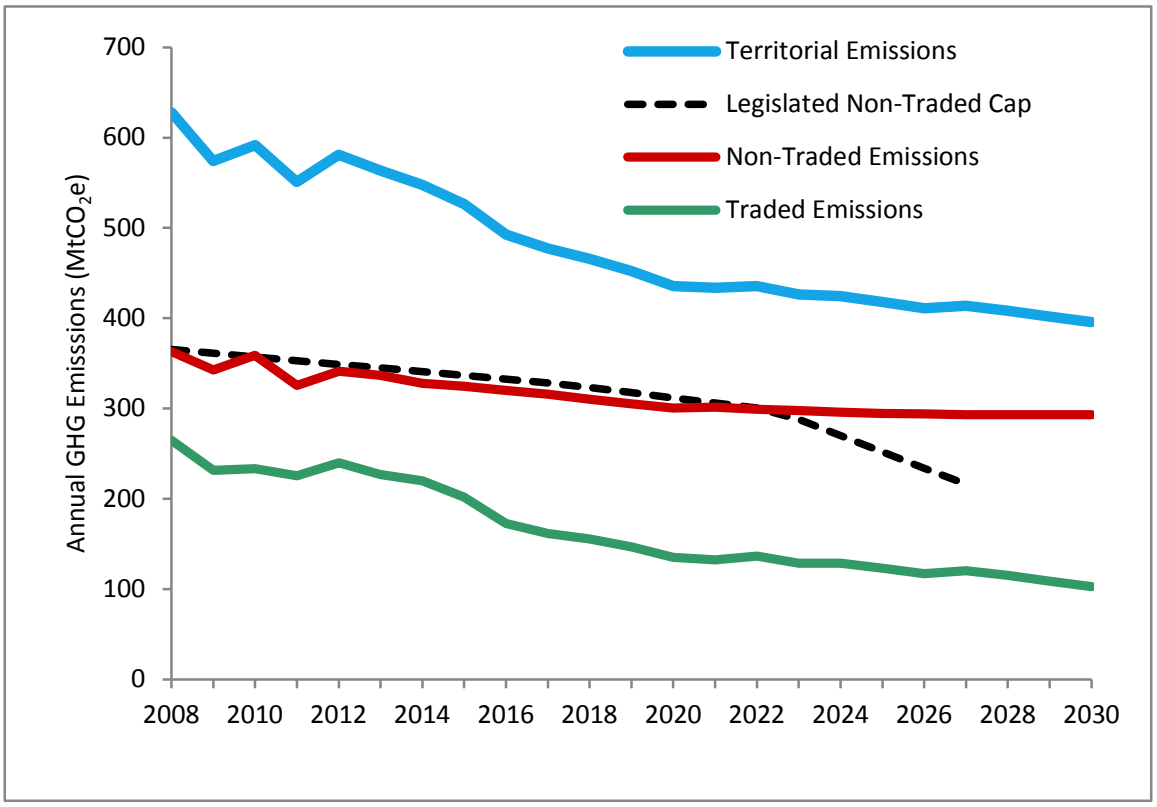
[8] Actual emissions from the traded sector unadjusted for any purchase or sale of EUAs.

[9] The traded sector cap shown here is the estimated UK share of the EU ETS cap recorded in the UK carbon budgets legislation for carbon budgets 1, 2 and 3. For carbon budget 4 an illustrative cap of 690 $MtCO_2e$ is used in line with the level assumed by the CCC in their recommendations for the 4th carbon budget.

[10] The projected EUA purchases shown here are estimated by subtracting the UK traded cap recorded in the carbon budgets legislation from the projected level of traded emissions. This legislated cap was based on estimates of the UK allocation of EU ETS allowances in each of the first three carbon budget periods. DECC now has more accurate estimates of the actual allocation, see Chapter 5 for details.

[11] EU ETS allowances

Figure 1 Projected UK emissions of greenhouse gases against targets ($MtCO_2e$)



Note: The non-traded budget level for carbon budget 4 has been set at the level recommended by the CCC (1,260 $MtCO_2e$) which assumes an EU ETS traded sector cap of 690 $MtCO_2e$[12].

[12] The Fourth Carbon Budget – reducing emissions through the 2020s, Chapter 3, Page 136, Committee on Climate Change, December 2010, http://archive.theccc.org.uk/aws2/4th%20Budget/CCC-4th-Budget-Book_with-hypers.pdf

Chapter 1: Introduction

The Climate Change Act 2008 introduced a legally binding target to reduce the UK's greenhouse gas (GHG) emissions to at least 80 per cent below 1990 levels by 2050. To ensure progress towards this target the Act introduced five-year "carbon budgets". They will define the emissions pathway to the 2050 target by limiting the total GHG emissions allowed in each five year period, beginning in 2008. The first four carbon budgets (for 2008-2012, 2013-2017, 2018-2022, and 2023-2027) have now been set through secondary legislation[13].

Projections of UK energy demand, supply and carbon dioxide emissions (CO_2) have been published by the UK government on a regular basis, to inform Government energy and environmental analysis, since 2000[14].

CO_2 emissions apart from those arising from Land Use, Land-Use Change and Forestry (LULUCF) are projected using the DECC Energy and Emissions Model. Within this model, demand for energy is projected using a series of equations that relate energy demand to its key drivers such as GDP growth. Demand is adjusted to take account of the impacts of policies that affect energy use and emissions from energy. Adjustments for policy savings are only made where funding has been agreed and decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made.

Electricity supply is projected using a market-based model of producer behaviour, including how they meet demand, invest in new capacity and retire of old capacity. There is also a sub-model that projects Combined Heat and Power (CHP) capacity and the electricity produced from it.

Projections for non-energy related non-CO_2 emissions and LULUCF emissions are projected using separate models. Updated non-energy related non-CO_2 projections were published in March 2013[15] and they have been incorporated into the projections reported here. The methodology and changes in non-CO_2 projections since the last projection are described in Chapter 2 of the March publication.

The Centre for Ecology and Hydrology estimated the net CO_2 emissions from LULUCF under a contract with DECC, using a methodology that is consistent with the UK Greenhouse Gas Inventory. The LULUCF projections were updated in April 2013[16]. The non- CO_2 component of these is therefore more recent than that used in the March non-energy related non- CO_2 projections.

---

[13] Reducing the UK's greenhouse gas emissions by 80% by 2050 https://www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/carbon-budgets

[14] Energy and emissions projections – in the national archive http://webarchive.nationalarchives.gov.uk/20130106105028/http:/www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx#previous-projections

[15] Non-CO_2 greenhouse gas emissions projections report: Spring 2013 https://www.gov.uk/government/publications/non-co2-greenhouse-gas-emissions-projections-report-spring-2013

[16] LULUCF Projections – Centre for Ecology and Hydrology, April 2013 : http://uk-air.defra.gov.uk/reports/cat07/1304300925_Projections_of_emissions_and_removals_from_the_LULUCF_sector_to_2050_2011i_UK-FINAL-VERSION.pdf

These projections are used to model future levels of the net UK carbon account, and so help government to monitor progress in meeting the carbon budgets. For the 4th carbon budget period the difference between these projections and the carbon budget level show the level of additional policy effort that would be required to meet the budget. The projections take into account the impact of all policies where funding has been agreed and decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made. The policies that will be put in place to deliver the 4th carbon budget are still under development; more details of these policies will be included as they are developed. Therefore the projection for the 4th carbon budget period represents a scenario in which there is no extension of existing policies or introduction of new policies after 2022. It will provide the baseline against which the Government will consider further opportunities to reduce emissions over the 2020s.

The first three carbon budgets set a limit on the level of the net UK carbon account. This is calculated by adjusting UK GHG emissions to account for any carbon units which have been bought from overseas by the Government and others to offset UK emission ('credits') and UK carbon units which have been sold outside the UK ('debits'). Under net carbon accounting procedures non-traded emissions are added to the traded sector cap to give net emissions. The actual level of traded sector emissions therefore has no impact on performance in the first three carbon budgets. It only affects the level of EU ETS allowances purchased or sold.

There remains uncertainty over what the level of the EU ETS traded sector cap will be during the 4th carbon budget period. For the purposes of these projections, a 4th carbon budget traded sector cap of 690 $MtCO_2e$ has been assumed for consistency with assumptions in the CCC recommendations for the 4th carbon budget level. The level of the 4th carbon budget is subject to review in 2014. If at that point UK commitments place us on a different emissions trajectory to that of the EU ETS the level of the budget will be revised to align it with the actual EU trajectory.

The projections have been updated to take account of revised estimates of the impacts of policies, revised fossil fuel and carbon price projections, revised OBR growth projections and revised generation cost estimates for the power sector. Changes were also made to the demand equations to correct small errors in a number of equations following a quality assurance exercise.

The rest of this document is structured as follows. The key assumptions are set out in Chapter 2. The projections are set out in chapter 3 and compared with the October 2012 projections. A detailed list of policies included in these projections is provided in chapter 4. Uncertainty in the projections is considered in chapter 5. Chapter 6 provides detail on electricity generation. Final and primary demand for energy is presented in chapter 7. The appendix provides details of the methodology changes. A number of downloadable tables provided in Microsoft Excel format (the Annexes) are listed in chapter 8.

Chapter 2: Assumptions

The DECC Energy and Emissions Projections Model provides the basis for the carbon dioxide emissions and energy related non-CO_2 GHG projections in this report, and requires a set of key assumptions including the level of economic growth, international fossil fuel prices and the number of households in the UK. The assumptions are based on official published UK government projections where they are available.

Projections of non-energy related non-CO_2 GHG emissions and GHG emissions from the LULUCF sector are provided by other models[17,18], based on consistent assumptions. They are added to the CO_2 and energy related non-CO_2 GHG projections to provide projections of total UK GHG emissions.

Fossil fuel price assumptions and exchange rates

Projections of the level of wholesale fossil fuel prices are produced by DECC based on analysis of the international market and informed by other forecasts published by international organisations. The latest fossil fuel price assumptions were published in July 2013[19].

Fossil fuel projections are presented in three different scenarios of future global fuel markets.

The three fossil fuel scenarios reflect:

- low global energy demand (low)
- timely investment and moderate demand (reference)
- high demand and producers' market power (high)

The reference energy and emissions projections presented here are based on the reference price scenario.

The full range of price assumptions for all fossil fuels is contained in Annex F. Table 2.1 shows the reference scenario prices. Table 2.2 shows the crude oil price assumptions for all scenarios to illustrate the range of prices encompassed by these scenarios.

[17] Non-energy related non-CO_2 GHG Projections - Department of Energy and Climate Change, March 2013 : https://www.gov.uk/government/publications/non-co2-greenhouse-gas-emissions-projections-report-spring-2013

[18] LULUCF Projections – Centre for Ecology and Hydrology, April 2013 : http://uk-air.defra.gov.uk/reports/cat07/1304300925_Projections_of_emissions_and_removals_from_the_LULUCF_sector_to_2050_2011i_UK-FINAL-VERSION.pdf

[19] Fossil fuel prices projections - Department of Energy and Climate Change, July 2013: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/212521/130718_decc-fossil-fuel-price-projections.pdf

Table 2.1 Fossil fuel price assumptions for reference scenario[19,20,21]

2013 prices (annual average)	Crude Oil (Brent) $/bbl	Natural gas (NBP) p/therm	Coal (ARA) $/tonne
2012	114.0	60.9	94.4
2013	110.0	63.6	91.4
2015	112.7	69.7	103.9
2020	119.7	73.8	122.9
2025	127.1	73.8	122.9
2030	135.0	73.8	122.9

National Balancing Point (NBP) and Amsterdam-Rotterdam-Antwerp (ARA) are liquid European trading markets for natural gas and electricity steam coal respectively.

Table 2.2 Crude oil price assumptions for all scenarios[19]

$/bbl in 2013 prices (annual average)	Low prices	Reference prices	High prices
2013	95.0	110.0	125.0
2015	92.4	112.7	131.7
2020	86.2	119.7	150.1
2025	80.4	127.1	171.1
2030	75.0	135.0	195.0

The exchange rates used from 2013 to 2035 are summarised in Table 2.3. They are the average of the previous calendar year's market rates, and are assumed to remain constant over the projection period. Details of the methodology are given in DECC's Interdepartmental Analysts' Group (IAG) Guidance for Policy Appraisal[21].

Table 2.3 Exchange rate assumptions

Currency	Exchange rate
$/£	1.5873
€/£	1.1749

[20] Prices for 2012 from the BP Statistical Review of World Energy 2013. http://www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf

[21] Using evidence and analysis to inform energy and climate change policies https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/policy-appraisal

Economic growth

Economic and population growth assumptions are shown in Table 2.4. The growth assumptions for UK real GDP, employment and population have been updated since 2012, reflecting new projections, both short and long-term, from the OBR.
The short-term growth assumptions are from the OBR's Economic & Fiscal Outlook[22] published with the Budget in March 2013.

The long-term projections for GDP and employment growth are from the assumptions in the OBR's Fiscal Sustainability Report[23] from July 2013.

Table 2.4 Exogenous socio-economic growth projections

UK growth rates (% per annum)	2012	2013	2014	2015	2016	2017	2020	2025	2030
Real GDP	0.2	0.6	1.8	2.3	2.7	2.8	2.8	2.5	2.5
Population	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.4
Employment	1.0	1.0	0.3	0.7	0.7	0.7	0.4	0.3	0.3

The OBR's growth assumptions use the Office for National Statistics' (ONS) 2010-based lower migration variant for population growth. We have adjusted the Department for Communities and Local Government's (DCLG) 2010 projection of household numbers, which is based on the ONS's 2008-based principal projection, in line with these updated population growth projections. These are shown in table 2.5.

Table 2.5 DECC derived growth assumptions

UK growth rates (% per annum)	2012	2013	2014	2015	2016	2017	2020	2025	2030
Households	1.1	1.1	1.1	1.1	1.0	1.0	0.9	0.8	0.8

[22] Economic & Fiscal Outlook, Office for Budget Responsibility, March 2013, http://budgetresponsibility.independent.gov.uk/pubs/March-2013-EFO-44734674673453.pdf

[23] Fiscal Sustainability Report, Office for Budget Responsibility, July 2013 http://budgetresponsibility.independent.gov.uk/pubs/2013-FSR_OBR_web.pdf

Carbon price

Participants within the EU ETS, including the power generation sector, may either reduce carbon emissions or purchase allowances to comply with the EU ETS. Table 2.6 shows the price of allowances (the carbon price) projected by DECC. These projections have been developed for modelling purposes within DECC and should not be considered as DECC "forecasts" of future carbon values. The assumptions underlying these values are explained in the explanatory note published on the same day as these emissions projections[24].

Table 2.6 also shows the effective carbon price assumed for modelling electricity supply which includes carbon price floor (CPF) mechanism. These prices are consistent with those used in the Draft EMR Delivery Plan[25].

Table 2.6 Carbon prices assumed (£/tonne CO_2)

Carbon Prices £/tCO_2, 2013 Prices	2012	2013	2014	2015	2016	2017	2020	2025	2030
Industry & Services (EU ETS price - no carbon price floor)	6.1	3.5	3.6	3.7	3.8	3.9	4.9	5.5	6.2
Electricity Supply Sector (with carbon price floor support)	6.1	7.2	11.8	19.0	23.8	26.0	32.7	54.5	76.2

[24] Updated short-term traded carbon values used for modelling purposes, DECC, September 2013

[25] Draft EMR Delivery Plan
https://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery

Chapter 3: UK emissions projections

This chapter summarises and discusses the GHG emissions projections. Results are presented on two bases, which define the sectors that are used to disaggregate emissions. Regardless of the basis used, the projected value of the net UK carbon account and territorial emissions in a particular year is the same – the basis only affects how this total is split into its components.

The National Communication (NC) basis is defined by the United Nations Framework Convention on Climate Change (UNFCC) and used for reporting under this convention. The Updated Emissions Projections (UEP) basis is that used in previous DECC emissions projections and is consistent with the Digest of United Kingdom Energy Statistics (DUKES), an important source of input data for the DECC Energy and Emissions Projections Model. The NC break down categorises emissions according to the type of process that generates them whereas the UEP/DUKES basis attributes emissions to the sector that emits them.

This chapter presents DECC's reference emissions projections. Chapter 5 looks at uncertainty in these reference projections and sensitivity to economic growth assumptions.

Progress towards the carbon budgets

The statutory, independent CCC was established by the Climate Change Act 2008 with the principal aim of advising the Government on setting levels, for the five-year carbon budgets, which set a trajectory for UK GHG[26] emission reductions towards the long-term target of at least an 80% reduction in emissions by 2050.

The levels of the first three carbon budgets were set in fiscal budget 2009[27,28] at the "interim" level recommended by the CCC prior to global agreement on emissions reductions. The carbon budgets require a reduction in greenhouse gas emissions of 34%, against 1990 levels, by 2020. The fourth carbon budget level was set in June 2011[29].

The UK emissions projections, including the projection of the CO_2 equivalent of the Kyoto basket of non-CO_2 GHGs, provide the basis for assessing progress against meeting the UK carbon budgets. In this section, the emissions are presented on the net UK carbon account basis for the all carbon budget periods. Uncertainty remains about what the level of the EU ETS cap will be in the fourth carbon budget period. For illustrative purposes a traded sector cap of 690 $MtCO_2e$ has been assumed for the fourth carbon budget period which is consistent with CCC assumptions in their recommendations for the fourth carbon budget level[30]. The

[26] In the context of the CCC and the carbon budgets, GHG refers to the Kyoto basket of gases.

[27] Reducing the UK's greenhouse gas emissions by 80% by 2050. https://www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/carbon-budgets

[28] The Carbon Budget Order 2009, May 2009. See http://www.legislation.gov.uk/uksi/2009/1259/contents/made

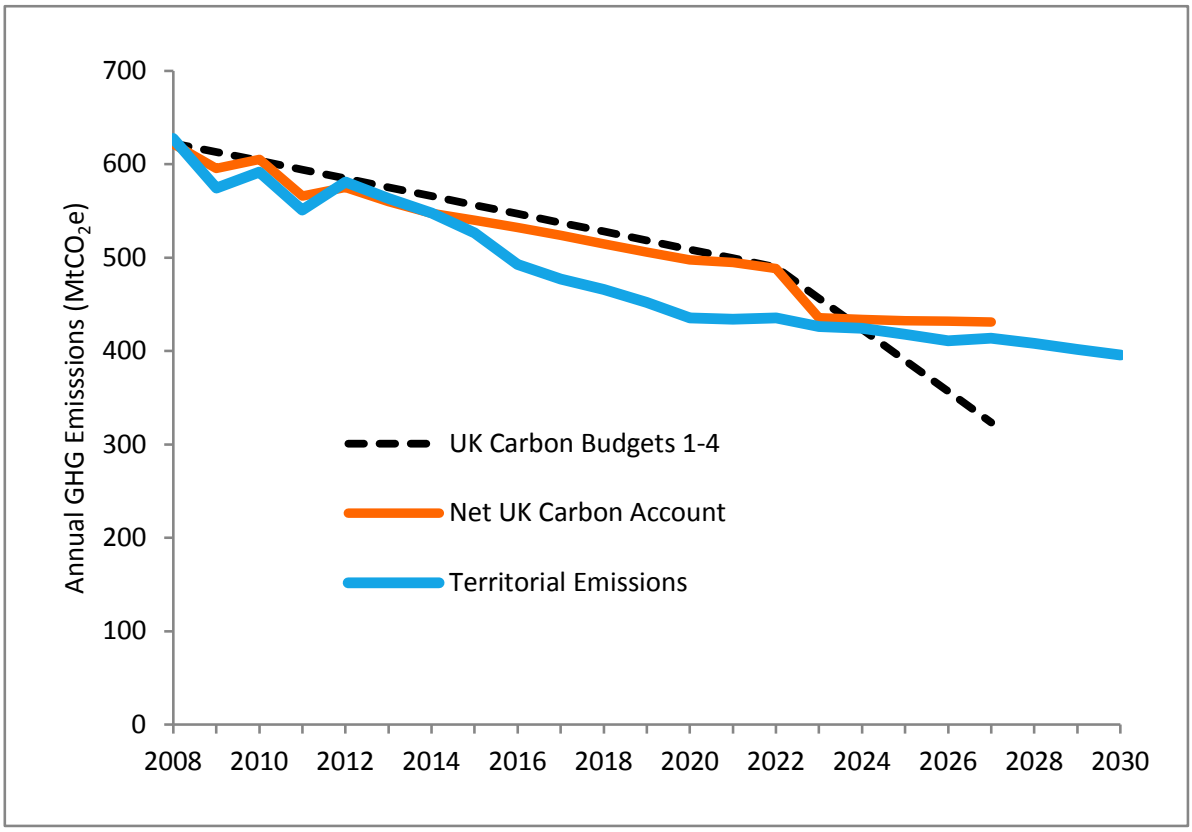
[29] The Carbon Budget Order 2011, June 2011. See http://www.legislation.gov.uk/uksi/2011/1603/made

[30] The Fourth Carbon Budget – reducing emissions through the 2020s, Chapter 3, Page 136, Committee on Climate Change, December 2010, http://archive.theccc.org.uk/aws2/4th%20Budget/CCC-4th-Budget-Book_with-hypers.pdf

projections for 2023 onwards represent a no additional policy baseline i.e. what we would expect to happen if the government took no further action beyond existing policies.

Figure 3.1 shows the latest projections of traded and non-traded emissions against carbon budgets[31].

Figure 3.1 Net UK carbon account and territorial emissions projection: 2008-2030 ($MtCO_2e$)



Traded and non-traded sectors

The total UK emissions projections are split into the traded and non-traded sectors. Emissions from installations within the EU ETS are referred to as "traded sector" emissions. Emissions from sectors and installations not participating in the EU ETS are referred to as "non-traded" sector emissions. Under the carbon accounting regulations for UK carbon budgets, the net contribution to the net UK carbon account from the traded sector is equal to the UK share of the EU ETS cap.

The traded sector comprises: energy industries including power stations, refineries, offshore oil and gas, some combined heat and power (CHP) installations, energy intensive industries and a small number of service sector participants. In Phase III of the EU ETS (2013-2020), some non-CO_2 emissions (from nitric acid plants and perfluorocarbons (PFC) emissions from primary aluminium manufacture) will also be treated as traded. Although international aviation will start to be included in the EU ETS from 2013, it is not included in the current scope of UK carbon

[31] Note: A carbon budgets traded cap of 690 $MtCO_2e$ has been assumed for the 4th carbon budget. This is in line with CCC's suggestions.

budget legislation and its inclusion is currently suspended pending discussions to set an international framework.

The non-traded sector comprises: the residential sector, non-electric traction in the transport sectors, part of the industry sector, the majority of non-electric use in the commercial and public sectors, LULUCF and non-CO_2 emissions – excluding those gases which are categorised as traded in Phase III.

Table 3.1 summarises the updated projections and compares them to the previous projections published in October 2012. They indicate that the UK is likely to meet its first three carbon budgets. Projected territorial emissions are higher in the first, second and third carbon budget periods than in the October 2012 projections. Traded emissions are lower in the first, second and fourth, but higher in the third. Projected non-traded emissions, and hence Carbon Budget Account emissions are higher in carbon budgets 1, 2 and 3 and, to a lesser extent in the 4th budget. Therefore, the margin by which the UK is projected to overachieve against the first three carbon budgets is smaller.

Table 3.1 Carbon budget, October 2012 and September 2013 projections; headline results

$MtCO_2e$	UEP October 2012				UEP September 2013			
	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Traded sector[32]	1,201	984	678	624	1,195	983	706	618
Non-traded	1,695	1,572	1,488	1,465	1,731	1,625	1,517	1,475
of which: non-CO_2	455	415	374	350	467	430	393	368
Total territorial emissions	**2,897**	**2,556**	**2,166**	**2,089**	**2,925**	**2,607**	**2,223**	**2,093**
Change in territorial emissions from Oct. 2012					*29*	*51*	*57*	*4*
Traded sector cap[33]	1,233	1,078	985	690	1,233	1,078	985	690
EUAs purchased (negative implies sold)[34]	-32	-94	-307	-66	-38	-96	-279	-72
Change in traded EUAs[35] from Oct. 2012					*-7*	*-2*	*28*	*-6*
Net carbon account	**2,928**	**2,650**	**2,473**	**2,155**	**2,964**	**2,703**	**2,502**	**2,165**
Carbon budget	**3,018**	**2,782**	**2,544**	**1,950**	**3,018**	**2,782**	**2,544**	**1,950**
Shortfall (negative implies emissions under budget)	**-90**	**-132**	**-71**	**205**	**-54**	**-79**	**-42**	**215**
Change in non-traded / net carbon account from Oct. 2012					*35*	*53*	*29*	*10*

[32] Actual emissions from the traded sector unadjusted for any purchase or sale of EUAs.

[33] The traded sector cap shown here is the estimated UK share of the EU ETS cap recorded in the UK carbon budgets legislation for carbon budgets 1, 2 and 3. For carbon budget 4 an illustrative cap of 690 $MtCO_2e$ is used in line with the level assumed by the CCC in their recommendations for the 4th carbon budget.

[34] The projected EUA purchases shown here are estimated by subtracting the UK traded cap recorded in the carbon budgets legislation from the projected level of traded emissions. This legislated cap was based on estimates of the UK allocation of EU ETS allowances in each of the first three carbon budget periods. DECC now has more accurate estimates of the actual allocation, see Chapter 5 for details.

[35] EU ETS allowances

Sector Emissions

Table 3.2 shows projected emissions by NC sector and total territorial emissions compared to 1990, the principle base year for the Kyoto protocol targets.

Table 3.2 Projected and emissions by NC sectors[36]

$MtCO_2e$ (Annual)	UK GHG emissions*					
	1990[37]	2010	2015	2020	2025	2030
Total UK territorial emissions	**773**	**592**	**526**	**436**	**418**	**396**
Change since 1990 (Territorial)		*-23%*	*-32%*	*-44%*	*-46%*	*-49%*
Sectors (NC basis):						
Energy Supply	272	204	171	105	92	71
Business	115	92	79	70	66	64
Industrial Processes	55	12	10	10	9	9
Transport	121	120	113	107	106	103
Residential	81	90	80	78	80	84
Public	13	8	9	8	7	7
Agriculture	64	51	49	45	45	45
Land Use Change	4	-4	-1	0	1	2
Waste Management	47	18	15	14	12	12
Total	**773**	**592**	**526**	**436**	**418**	**396**

* Note that figures in this and subsequent tables have been rounded. Totals are calculated from the un-rounded data and therefore may not appear to be the sum of the component parts.

Emissions from energy supply industries are projected to fall by 133 $MtCO_2$ between 2010 and 2030 due primarily to decarbonisation of the grid in line with the draft EMR delivery plan[38] with total electricity consumption rising slightly over the period. Without additional policy effort, between 2010 and 2030 business emissions are each projected to fall by around 28 $MtCO_2$, transport by 17 $MtCO_2$ and residential emissions by around 6 $MtCO_2$. The majority of this

[36] In Table 3.2 the United Nations Framework Convention on Climate Change (UNFCCC) National Communication definition of the transport sector is used. This is the sum of road transport and other categories including domestic aviation (from 2008), rail, national navigation and military aviation and shipping.

[37] The 1990 and 2010 GHG estimates are for emissions from the UK, including LULUCF, based on the scope in the UK National Inventory (NAEI). See: https://www.gov.uk/government/publications/final-uk-emissions-estimates. This is the same basis as used in these UEP projections but differs slightly from the definition used for EU reporting, which includes Gibraltar; and reporting against the Kyoto protocol, which includes Crown Dominions and Overseas Territories.

[38] https://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery

reduction is due to policy impacts with almost all of the reduction occurring in the first three carbon budget periods. Without additional policy effort there is projected to be a small fall in transport and business emissions between 2020 and 2030 and a rise in residential sector emissions.

Table 3.3 shows the emissions projections from each of the traded and non-traded sectors by budget period.

Table 3.3 GHG emissions by sector (DUKES sectors)

$MtCO_2e$		September 2013 Projections			
		Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Traded sector emissions					
CO_2	Power stations	789	610	342	260
	Refineries	84	86	87	93
	Services	10	9	8	7
	Industry	310	269	258	247
	Aviation[39]	2	9	10	10
Non-CO_2	Traded Emissions[40]	0	0	0	0
All traded sector emissions		**1,195**	**983**	**706**	**618**
Traded sector cap under EU ETS		**1,233**	**1,078**	**985**	**690**
EUAs purchased (negative implies sold)		**-38**	**-96**	**-279**	**-72**
Non-traded sector emissions					
CO_2	Residential	381	384	372	382
	Services	86	84	67	61
	Industry	168	147	133	125
	Transport	649	591	557	537
	LULUCF[41]	-20	-11	-5	2
Non-CO_2	Non-traded emissions	467	430	393	368
All non-traded sector emissions		**1,731**	**1,625**	**1,517**	**1,475**
Net UK Carbon Account		**2,964**	**2,703**	**2,502**	**2,165**
CARBON BUDGET		**3,018**	**2,782**	**2,544**	**1,950**
Shortfall (negative implies emissions are under budget)		**-54**	**-79**	**-42**	**215**

[39] Domestic aviation is included in the EU ETS from 2012. Emissions from domestic aviation are included in non-traded transport emissions prior to this.

[40] N_2O emissions from nitric acid plants and PFC emissions from primary aluminium manufacture are included in the EU ETS for 2013. UK nitric acid plants were opted-in in 2012.

[41] Land use, land use change and forestry differ from other sectors in that it contains both sources and sinks of GHGs. Sinks remove GHGs from the atmosphere and can therefore give rise to negative figures.

Changes to emissions projections since October 2012

The projected level of total GHG emissions is higher than that reported in October 2012. Table 3.4 shows the breakdown of the changes between the 2012 and 2013 projections by sector.

Power station emissions are little changed in carbon budgets 1, 2 and 4 but higher in carbon budget 3. Higher projected emissions in carbon budget 3 are due to a combination of lower projected gas CHP generation and inclusion of the Levy Control Framework (LCF) as a constraint on expenditure.

Lower generation from gas CHP leads to higher generation by major power producers (MPPs) as the latter need to increase supply to meet a higher proportion of total electricity demand. The majority of projected gas CHP capacity lies in the industrial sector. Therefore, lower gas CHP projections lead to higher projections for emissions from power stations and lower projections for emissions from industry. Projections for gas CHP capacity have been revised downwards as a result of updates to electricity and gas prices.

For the purposes of modelling, a carbon intensity of generation of 100g/kWh by 2030 is assumed. This is in line with the scenario as set out in the EMR Draft Delivery Plan Impact Assessment[42]. Inclusion of the LCF in the modelling constrains the extent to which low carbon generation is projected to expand during the 3rd carbon budget period. Levy controls for the 4th carbon budget period have not yet been set. Therefore, the projections for this period do not include a levy control constraint on EMR policies. As a result, low carbon generation expands in the 4th carbon budget period bringing projected power sector emissions back down to levels similar to those projected in 2012

Emissions from refineries are higher than projected in October 2012 as a result of revisions to the GHG Inventory methodology. The change is due to the inclusion of a number of fuel uses in refineries that had not previously been included in the GHG Inventory. DECC's energy demand projections have been adjusted for consistency with the revised GHG Inventory methodology leading to higher projected emissions from refineries.

Industrial sector emissions are lower due to the closure of the Lynemouth aluminium smelter, energy demand policies, improvements to the emissions projections model and lower projected gas CHP generation.

Residential emissions projections are higher, primarily due to a re-evaluation of older supplier obligation schemes in line with current Green Deal / Energy Company Obligation (ECO) assessments.

The main changes in the services and agriculture sector arise from improvement to the equations used to project public sector demand in the emissions projections model – see appendix 'Model development' for more information.

The summary Table 3.5 summarises the impact of the changes on total territorial emissions.

[42] The IA also includes analysis based on average emissions levels of both 50gCO_2/kWh and 200gCO_2/kWh in 2030 see:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225981/emr_delivery_plan_ia.pdf

Table 3.4 Indicative contribution of changes between October 2012 projections and September 2013 projections in $MtCO_2e$

$MtCO_2e$	Change between October 2012 and September 2013			
	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Power stations (CO_2 only):	**-1**	**7**	**36**	**2**
Gas CHP (Reduced electricity production, replaced in power stations)	-6	1	34	39
Economic growth assumptions	0	-6	-8	-5
Updated energy demand/emission reduction policies	5	13	8	2
Updated fossil fuel price projections and retail price uplifts	-0	-0	-2	-3
DUKES 2013 (new 2008-12 data)	-10	-3	-3	-3
Revised domestic electricity demand equation	2	10	11	10
Updated industry fuel share model	-0	-2	-4	-4
Other power sector modelling (e.g. redefinition of EMR decarbonisation assumption to include non-MPP generation) [43]	8	-5	-1	-35
Refineries (CO_2 only):	**7**	**19**	**18**	**17**
National Inventory 2013 (1990-2011 data)	3	16	16	17
DUKES 2013 (new 2008-12 data)	3	0	0	1
Other updates	0	2	2	0
Industry (CO_2 only):	**10**	**-23**	**-43**	**-49**
National Inventory 2013 (1990-2011 data)	3	11	13	15
Economic growth assumptions	6	-10	-9	-6
Updated energy demand/emission reduction policies	0	-5	-6	-7
DUKES 2013 (new 2008-12 data)	9	-7	-10	-12
Updated industry fuel share model	8	3	4	7
Revised industry energy intensity equations	-1	-8	-11	-13
Updated fossil fuel price projections and retail price model	-14	9	6	4
CHP (Reduced electricity production, replaced in Power Stations)	1	-14	-30	-37
Closure of Lynemouth aluminium smelter (Mar-2012)	-3	-15	-15	-15
Other updates	-3	-2	-1	-0
Residential (CO_2 only):	**0**	**40**	**43**	**38**
Policy updates	1	31	37	33
Updated fossil fuel price projections and retail price uplifts	-1	7	3	3
Other updates	-0	3	2	2

[43] These projections assume that EMR policies are designed to achieve a carbon intensity of generation of 100g/KWh by 2030 in line with the scenario as set out in the EMR Draft Delivery Plan IA. The same assumption was used in the October 2012 projections. However the definition has been revised to include electricity generation from all sources. Previously only generation from major power producers was included. This means that gas CHP generation is now included in the emissions intensity definition and therefore a higher level of low carbon generation is required to achieve 100g/KWh in 2030.

$MtCO_2e$	Change between October 2012 and September 2013			
	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Services and Agriculture (CO_2 only):	**1**	**-9**	**-11**	**-14**
Revision to public sector demand equations[44]	-2	-25	-36	-41
DUKES 2013 (new 2008-12 data)	2	13	12	11
Updated energy demand/emission reduction policies	0	4	14	16
Other updates	0	-0	-0	0
Transport (CO_2 only):	**0**	**-2**	**-8**	**-13**
Modelling changes, including alignment with DfT models	1	10	8	7
Updated fossil fuel price projections and retail price uplifts	3	7	4	0
Reduced demand for off-road (from industry/services model changes)	-4	-8	-11	-14
Economic growth assumptions	-1	-6	-3	-1
Other updates	1	-4	-6	-6
LULUCF (CO_2 only):	**1**	**4**	**5**	**5**
Total (CO_2 only):	**19**	**37**	**39**	**-13**
Non-CO_2 GHGs:	**10**	**15**	**18**	**17**
Total change in territorial emissions since Oct 2012 projection	**29**	**51**	**57**	**4**

[44] The equations have been modified to reflect more accurately the relationship employment and demand.

Table 3.5 Indicative contribution of changes to projections in $MtCO_2e$ – summary

$MtCO_2e$	September 2013 Projections			
	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Gas CHP (Reduced electricity production, replaced in power stations)	-5	-13	4	2
DUKES 2013 (new 2008-12 data)	5	3	-1	-4
Economic growth assumptions	6	-22	-20	-12
Modelling changes, including alignment with DfT models	1	10	8	7
National Inventory 2013 (1990-2011 data)	6	27	30	32
New public sector demand equations (see appendix for details)	-2	-25	-36	-41
Policy updates	1	31	37	33
Reduced demand for off-road (from industry/services model changes)	-4	-8	-11	-14
Revised domestic electricity demand equation	2	10	11	10
Revised industry energy intensity equations	-1	-8	-11	-13
Updated industry fuel share model	8	1	0	4
Updated energy demand/emission reduction policies	5	12	16	11
Updated fossil fuel price projections and retail price uplifts	-12	22	11	4
Other updates	7	-6	-4	-39
LULUCF (CO_2 only)	1	4	5	5
Non-CO_2 GHGs	10	15	18	17
Total change in territorial emissions since Oct 2012 projection	**29**	**51**	**57**	**4**

Chapter 4: Policies included in the projections

These emissions projections include all policies that directly affect GHG emissions and to which the Government is committed. The assessment of these policies is undertaken according to DECC-HM Treasury policy appraisal guidelines[45] consistent with the most recent projection baseline. Under these guidelines the impact of each policy is assessed against a "business as usual" i.e. a projection of what we would expect to happen in the absence of the policy in question.

The majority of policies that impact directly on energy demand are modelled as reductions or increases in demand for different types of energy (gas, electricity, renewables, etc). The demand equations in the DECC Energy and Emissions Model projects what demand would be in the absence of these policy impacts. The projected impacts are then subtracted or added to demand as appropriate. Other policies are incorporated into the modelling directly e.g. through price impacts. The EU ETS and all EMR policies are modelled in this way. However these mainly affect traded sector emissions and therefore are not included in Table 4.1. Policies are included where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made.

Table 4.1 shows non-traded savings from policy measures included in projections. The figures given in the table may differ from those reported in the latest published impact assessment for the individual policies. There are three main reasons for these differences.

Firstly, policy savings are re-evaluated periodically on the basis of new evidence, improved methodologies or announced changes to the policy. For instance, revisions to UEP baseline projections affect the absolute level of savings expected from certain policies.

Secondly, the treatment of policy overlaps used in the UEP projections differs to that used for policy appraisal purposes. In the UEP projections, a number of criteria are used to determine the order in which savings are attributed. These include the extent to which the policy is binding (e.g. regulations), when it was announced and how cost-effective the measure is expected to be. This is different to the approach followed for appraisal purposes where the marginal impact of each new policy is assessed after taking account of any policies that have already been announced.

Thirdly, a revised assessment for each policy has been made of the extent to which a policy may impact in the traded sector and non-traded sector.

Future policies to meet the 4th carbon budget have not been taken into account in these projections[46]. New policies will be incorporated once the details have been agreed. Different options for meeting the 4th carbon budget were published last year in the Carbon Plan[47]

---

[45] The IAG guidance https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/policy-appraisal supplements the HMT Green Book (http://www.hm-treasury.gov.uk/data_greenbook_index.htm) that provides general guidance on how to conduct appraisal and evaluation of energy use and greenhouse gas emissions.

[46] However, the UEP reference scenario modelled here is consistent with the latest EMR analysis for the draft Delivery Plan, which is based on targeting an average emissions intensity of 100gCO_2/kWh for the power sector in 2030. https://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery

Table 4.1 Non-traded savings from policy measures included in projections

$MtCO_2e$	September 2013 Projections			
	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Residential:	**26.4**	**48.8**	**70.3**	**75.7**
of which – baseline measures ‡	***25.4***	***37.9***	***44.8***	***39.5***
Building Regulation Part L (2002 & 2005/6)	19.0	30.8	36.4	29.5
Warm Front & Fuel Poverty Measures	-3.1	-3.7	-1.3	1.3
Supplier Obligation (EEC1, EEC2, original CERT)	9.5	10.8	9.7	8.8
of which – measures in the LCTP or later ‡	***1.0***	***10.9***	***25.5***	***36.1***
Real time displays/Smart meters	0.0	1.6	4.9	5.4
EU Products policy (Tranche 1, Legislated)	-1.4	-7.1	-9.9	-9.0
Community Energy Saving Programme	0.1	0.3	0.3	0.2
Supplier Obligation (CERT +20% and CERT Extension)	1.9	6.5	6.5	6.1
Building Regulations 2010 Part L	0.4	7.6	15.0	20.0
Zero Carbon Homes	0.0	0.1	2.0	4.7
ECO & Domestic Green Deal	0.0	1.5	3.5	4.9
EU Products policy (Tranche 2, Agreed)	-0.0	-0.2	-0.1	-0.1
Renewable Heat Incentive	0.0	0.6	3.3	3.9
Commercial and Public Services:	**11.4**	**17.4**	**28.9**	**28.7**
of which – baseline measures ‡	***11.1***	***10.5***	***9.2***	***7.3***
Carbon Trust Measures	4.9	2.4	0.7	0.1
Small Business Energy Efficiency Interest-free Loans	0.1	0.1	0.0	0.0
Salix, Public Sector Loans	0.1	0.1	0.1	0.1
Energy Performance of Buildings Directive	1.4	1.4	1.4	1.4
Building Regulations Part L (2002 & 2005/6)	4.7	6.5	7.0	5.7
of which – measures in the LCTP or later	**0.3**	**6.9**	**19.6**	**21.4**
EU Products policy (Tranche 1, Legislated)*	-0.1	-0.4	-0.7	-0.6
EU Products policy (Tranche 2, Agreed)	-0.0	0.0	0.7	1.0
Business Smart Metering	0.0	1.3	3.6	3.4
Building Regulations 2010 Part L	0.1	1.7	3.3	4.4
Non-Domestic Green Deal	0.0	1.2	4.4	2.2
Carbon Reduction Commitment Energy Efficiency Scheme	0.3	2.1	5.1	7.2
Renewable Heat Incentive	0.0	1.1	3.2	3.7
Industry:	**2.8**	**3.9**	**8.1**	**8.8**
of which – baseline measures ‡	***2.8***	***2.0***	***1.4***	***0.9***
Carbon Trust Measures	2.0	1.0	0.3	0.0
Small Business Energy Efficiency Interest-free Loans	0.1	0.1	0.1	0.0
Building Regulations Part L (2002 & 2005/6)	0.7	0.9	1.0	0.8

[47] The Carbon Plan - reducing greenhouse gas emissions
http://www.decc.gov.uk/en/content/cms/tackling/carbon_plan/carbon_plan.aspx

$MtCO_2e$	September 2013 Projections			
	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Industry (continued): ***of which – measures in the LCTP or later***	***0.0***	***1.9***	***6.8***	***7.9***
EU Products policy (Tranche 1, Legislated)*	-0.0	-0.0	-0.0	-0.0
EU Products policy (Tranche 2, Agreed)	-0.0	-0.0	0.0	0.0
Climate Change Agreements (2011-18)	0.0	0.0	0.0	0.0
Building Regulations 2010 Part L	0.0	0.2	0.4	0.5
Non-Domestic Green Deal	0.0	0.0	0.0	0.0
CRC Energy Efficiency Scheme	0.0	0.2	0.4	0.6
Renewable Heat Incentive	0.0	1.6	6.0	6.9
Transport - measures in the LCTP (2009) or later:	**1.4**	**25.4**	**67.0**	**99.2**
Car policies: EU new car mid-term target (130g CO_2/km in 2015); the EU new car long-term target (95g CO_2/km in 2020); and complementary measures for cars.	0.3	11.2	38.2	71.2
LGV policies: the EU new LGV target (147g CO_2/km in 2020).	0.1	1.5	5.7	12.4
HGV policies: Low rolling resistance types; and industry-led action to improve efficiencies.	0.2	3.1	6.6	10.0
PSV policies: Assumes uptake in low carbon emissions buses	0.0	0.1	1.5	3.2
Transport biofuels (8% by energy in 2020[48,49])	0.0	5.6	10.7	0.0
Local Sustainable Transport Fund	0.8	3.7	2.2	0.3
Rail electrification	0.0	0.1	2.2	2.2
Agriculture & Waste: (non-CO_2) - LCTP or later measures[50]	**-**	**2.1**	**14.9**	**17.0**
Agriculture Action Plan	-	2.1	14.9	17.0
Total	**42.1**	**97.5**	**189.2**	**229.3**
Total – of which baseline measures ‡	***39.3***	***50.4***	***55.4***	***47.7***
Total - measures in the LCTP or later	***2.8***	***47.1***	***133.8***	***181.7***

‡ Baseline measure: a policy introduced or announced in or before the Low Carbon Transition Plan (LCTP), 15 July 2009. Baseline policy measures in Transport and in Agriculture and Waste have not been separately estimated but are included in the baseline projections. Following consultation with the CCC we have reclassified Carbon Trust administered Small Business Interest Free Loans and Salix Public Sector loans, which had been combined with later measures for which we are no longer claiming savings, as Baseline measures.

* EU Products Policy (Tranche 1) relates primarily to energy efficiency improvements in electrical appliances. These lead to reductions in traded sector emissions projections due to reduced demand for electricity. However, because more efficient electrical appliances produce less waste heat, this policy is projected to lead to small increases in non-traded emissions from space heating.

[48]This includes 31TWh renewables contribution to transport energy demand which is consistent with the 10% transport sub-target as set out in the Renewable Energy Directive, including the principle that certain biofuels products count as double towards this target.

[49] Savings from the Renewable Fuels Transport Obligation (RFTO) (5% biofuels by volume by April 2013) and the EU Voluntary Agreements on new car CO_2 to 2009 are taken into account in these projections since savings from older measures are included in the baseline for newer measures. However the methodology used to derive the impact of transport measures does not allow policy savings for these older measures to be estimated.

[50] Projections for waste emissions do not include an explicit estimate for the impact of Landfill Tax or Waste policy: these have been absorbed into a single baseline projection.

Chapter 5: Uncertainty in the projections

The projections are sensitive to data inputs (e.g. real GDP growth, power generation costs, policy impacts) and modelling assumptions. Accuracy of the projections is also affected by the extent to which the equations used to forecast future demand accurately predict responses to changes in future prices, growth or other drivers of demand. This chapter contains three sections. The first provides estimates for the overall level of uncertainty in the projections taking account of the combined impact of different sources of uncertainty in model inputs. The second section focuses on sensitivity to economic growth assumptions. The third considers uncertainty in the projections of EU ETS allowances purchased or sold.

Uncertainty ranges

Projecting emission levels into the 2020s is subject to uncertainty. It depends upon correctly modelling the links between economic activity and GHG emissions and anticipating future drivers, such as temperatures, primary energy prices, power station capital costs, economic growth and population; and accurately forecasting the impact of climate change policy.

In order to take account of some of the sources of this uncertainty in the emissions projections, ranges for emissions levels have been produced based on statistical techniques to capture the likely variations in some of the key inputs to the projections, in particular, primary energy prices, various macroeconomic variables, temperature parameters and policy impacts.

Results presented in this section show the impact of capturing this uncertainty. The methodology uses a “Monte Carlo” method to simulate demand for fuel, and hence emissions under a large range of possible values of the drivers, allowing a picture of the uncertainty surrounding emissions projections to emerge. For instance a range within which we would expect the true level of total future policy savings to lie is derived taking account of uncertainties in individual policy savings estimates. During a simulation a savings impact estimate is selected at random many times from the range of possible values. Simulated values for the other drivers are generated in a similar way. These values are fed through to the demand model to provide a plausible range for emissions projections.

The 95% Confidence Intervals (CI) in tables 5.1 and 5.2 represent the value of emissions obtained from the lower 2.5% and upper 97.5% percentiles of the simulations respectively. Figure 5.1 shows how the range of uncertainty increases over time. This analysis suggests that the UK is likely to meet the first three carbon budget periods.

Table 5.1 Uncertainty in net UK Carbon Account and shortfall against budget

$MtCO_2e$		Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Net UK Carbon Account	Lower 95% CI*	2,964	2,668	2,441	2,085
	Reference scenario value	**2,964**	**2,703**	**2,502**	**2,165**
	Upper 95% CI	2,964	2,733	2,568	2,265
Carbon Budget		**3,018**	**2782**	**2544**	**1950**
Shortfall (negative implies under budget)	Lower 95% CI	-54	-114	-103	135
	Reference scenario value	**-54**	**-79**	**-42**	**215**
	Upper 95% CI	-54	-49	24	315

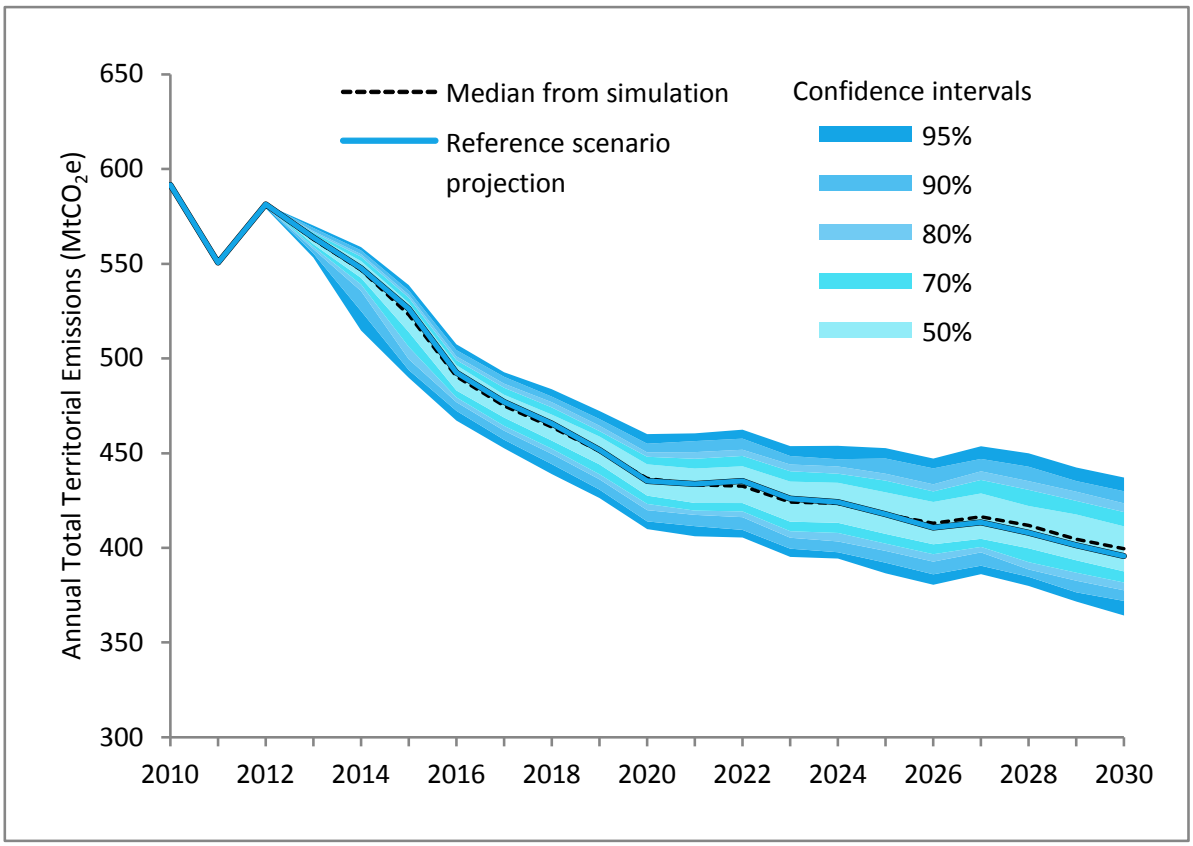
*Confidence Interval

Table 5.2 Uncertainty in Territorial Emissions

$MtCO_2e$		Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Traded	Lower 95% CI*	1,195	883	622	549
	Reference scenario value	**1,195**	**983**	**706**	**618**
	Upper 95% CI	1,195	1,009	769	697
Non-traded	Lower 95% CI	1,730	1,589	1,456	1,395
	Reference scenario value	**1,731**	**1,625**	**1,517**	**1,475**
	Upper 95% CI	1,730	1,654	1,583	1,575
Total	Lower 95% CI	2,925	2,494	2,098	1,952
	Reference scenario value	**2,925**	**2,607**	**2,223**	**2,093**
	Upper 95% CI	2,925	2,661	2,348	2,273

*Confidence Interval

Figure 5.1 Uncertainty in territorial emissions projections



Sensitivity to GDP growth assumptions

One of the main drivers of emissions is the overall rate of economic growth. The uncertainty analysis in the preceding section takes account of uncertainty in economic growth alongside other factors. This section examines the sensitivity of projections to GDP growth assumptions if all other assumptions remain unchanged. Tables 5.3 and 5.4 show how the projections would change if GDP growth were one quarter of a percentage point higher or lower than the reference projection in each year. They show that although the projections are sensitive to real GDP growth, we would still be projected to meet carbon budgets 1, 2 and 3 under this higher growth scenario.

The projections are also sensitive to sub-sector growth projections as industrial sub-sectors tend to be more energy intensive than the commercial and public sectors. Uncertainty in relative growth rates is not taken into account in Tables 5.3 and 5.4.

Table 5.3 Economic growth sensitivity in net UK carbon account and shortfall against budget

$MtCO_2e$		Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Net UK Carbon Account	Scenario: Reference	2,964	2,703	2,502	2,165
	Low growth	2,964	2,700	2,493	2,151
	High growth	2,964	2,706	2,511	2,180
Carbon Budget		**3,018**	**2,782**	**2,544**	**1,950**
Shortfall (negative implies under budget)	Scenario: Reference	-54	-79	-42	215
	Low growth	-54	-82	-51	201
	High growth	-54	-76	-33	230

Table 5.4 Economic growth sensitivity in territorial emissions

$MtCO_2e$		Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Traded	Scenario: Reference	1,195	983	706	618
	Low growth	1,195	978	692	602
	High growth	1,195	988	721	642
Non-traded	Scenario: Reference	1,731	1,625	1,517	1,475
	Low growth	1,731	1,621	1,508	1,461
	High growth	1,731	1,628	1,526	1,490
Total	Scenario: Reference	2,925	2,607	2,223	2,093
	Low growth	2,925	2,599	2,200	2,063
	High growth	2,925	2,616	2,246	2,132

Uncertainty in projections of EUA purchases and sales

The actual level of EU ETS allowances that will be allocated to UK installations in future carbon budget periods is uncertain. This uncertainty has an impact on projections of the net UK carbon account and of purchases and sales of EU ETS allowances. The value of the "traded sector cap" is set equal to the forecast allocation of UK EU ETS allowances that were anticipated in the UK carbon budgets legislation. This "traded sector cap" is used for the purpose of projecting purchase and sale of UK EU ETS allowances and the UK net carbon account elsewhere in this report.

These values, reported in the legislation, are used because the true values are uncertain and will not be known until after the end of the budget period to which they relate. However DECC does have internal projections of the actual level of allowances that it expects to be allocated to the UK. These are used for the purpose of internal monitoring. Projections of UK purchases and sales of EU ETS allowances based on these internal projections are shown in Table 5.5 and compared with the estimates reported elsewhere in this report. This provides an indication of the sensitivity of projections to uncertainty in the level of EU ETS allowances that will be allocated to the UK.

Table 5.5 EUA purchases and sales

$MtCO_2e$	Carbon budget 1 (2008-12)	Carbon budget 2 (2013-17)	Carbon budget 3 (2018-22)	Carbon budget 4 (2023-27)
Projected traded sector emissions	1,195	983	706	618
Traded sector carbon budget (UK legislation)	1,233	1,078	985	690
Projected purchase of EU ETS allowances using traded sector carbon budget	-38	-95	-279	-72
Latest DECC projections of EU ETS allowances the UK will receive[51]	1,233	987	893	799
Projected purchase of EU ETS allowances using latest projection of UK allocation	-38	-4	-187	-181

[51] These are indicative and based on estimates of the UK's share of the EU ETS cap that were calculated before the European Commission's Decision on National Implementation Measures for Phase III of the EU ETS was published. As a result these estimates may change in future.

Chapter 6: Electricity generation

The projections and discussion in this section relates to MPPs, including all renewables plants[52]. The discussion also concerns the reference case scenario, although the generation mix is sensitive to fossil fuel price assumptions. Full results including those from other fossil fuel price scenarios can be found in annexes D, E, I, J, K, and L.

Background

Final electricity demand fell slightly in 2012 and remains well below pre-recession levels. The sector data shows that industrial demand fell by over 4% in 2012, but demand rose in the other main consuming sectors – by around 2% in aggregate. Demand in 2012 is estimated to have been 7% lower than in 2007, the last full year before the recession started to take effect. Electricity demand in 2012 was also lower than in any year since 1998.

In comparison with the levels of final demand in 1998, demand in 2012 was 9% lower, 5% higher, 12% lower and 20% higher in the industrial, domestic, public administration and commercial sectors respectively.

On the generation side, supply from nuclear plants rose again in 2012 following the sharp falls in 2007 and 2008 and trend recovery in 2009 to 2011. Generation was higher in 2012 than in any year since 2006. The average load factor on nuclear stations, at around 71%, was higher than in any year since 2005. The load factor remains below the levels seen around the turn of the decade.

The overall available market for fossil fuel sourced generation in 2012 fell again, due to lower demand, higher nuclear output and a further significant increase in renewables generation. Within the fossil fuel sector, electricity supply from coal stations was significantly higher in 2012, registering around 133 TWh compared with 100 TWh in 2011. Supply from gas fired stations again fell sharply, from 131TWh to 85 TWh, which represents the lowest contribution by gas since 1996. Supply from oil stations remained at very low levels. The fall in gas sourced electricity supply resulted from a combination of the reduced need for fossil sourced supply and a deterioration in the competitiveness of gas against coal. Electricity supply from gas continued to drift a little lower in the early part of 2013, while supply from coal was broadly unchanged from 2012 levels. Supply from nuclear plants fell slightly from 2012 levels.

The overall result of these developments was a significant increase in power station CO_2 emissions in 2012, though emissions were still well below pre – recession levels.

Assumptions

The power station projections are dependent on a number of specific assumptions. Using different assumptions will lead to different results. The particular results shown here reflect a set of assumptions on fossil fuel and carbon prices and generation costs. They do not reflect a desired or preferred outcome for Government.

The key assumptions, including those for potential new build, together with a description of the power sector modelling approach used in this work are based on published information on the

[52] MPPs are as defined in the Digest of UK Energy Statistics, 2013, section 5.66 et seq.

DECC website[53]. The fossil fuel price and carbon price assumptions are also set out in Chapter 2 of this document.

The power station projections embody a number of other assumptions. A brief description of these follows.

Carbon Capture and Storage (CCS): It is assumed that two early stage CCS plants proceed, with both plants assumed to start operation in 2018. Commercial CCS technology is assumed to be available by 2025.

Industrial Emissions Directive (IED): It is unclear how plant operators will decide to operate their plants under the IED. Industrial Emissions Directive (IED) decisions are based on Redpoint analysis and stakeholder engagement

Electricity Market Reform (EMR): These projections make assumptions about measures forthcoming as a result of the EMR. In particular, while a formal decarbonisation target has not been set for the power sector, it is assumed that EMR measures achieve a carbon intensity of generation in 2030 of 100 gCO_2/kWh[54]. It is assumed that EMR measures are generally deployed to achieve a least cost decarbonisation pathway. However in order to take account of uncertainty in the future costs of alternative technologies, for the purposes of modelling it has been assumed that EMR supports initially a broader diversity of technologies than would be the case based purely on current reference projections for generation costs, demand and fossil fuel prices. Strike prices under the Contracts for Difference (CfD) arrangements are assumed to be those set out in Annex B of the draft EMR Delivery Plan[55].

Policies that impact on electricity demand: These projections only take account of policies where funding has been agreed and their design is sufficiently well developed to allow robust estimates of impacts to be provided. On the demand side, this means only policies that are already in operation are included. A number of policies that are likely to affect electricity demand are under development or consideration. For instance, the Energy Savings Opportunity Scheme (ESOS) scheme, which is currently out for consultation, is not taken into account. Potential extensions to existing policies are also not included. Therefore the impact of EU Products Policy is projected to decline sharply from around 2020. New policies and policy extensions will be included when funding has been agreed and estimated impacts are available.

Renewables: The Renewable Energy Strategy, including the impact of the Renewables Obligation and measures relating to small scale renewables, is modelled to deliver a contribution of at least 30% of total electricity supply from renewable sources by 2020. For the period beyond 2020 it is the assumed overall decarbonisation target for EMR policies which drives greater renewables generation.

Carbon price floor: The carbon price faced by electricity providers incorporates the impact of the carbon price floor at levels announced as part of the March 2013 Budget.

---

[53] See https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/modelling-and-analytical-projections

[54] It is assumed that the target relates to all sources of generation, excluding net imports.

[55] draft EMR Delivery Plan https://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery

Investor plans: the projections do not take account of any announcements made by energy companies about planned investment in new plants. However the projections do make allowance for plants whose construction has already begun.

Modelling approach

Continuing the practice adopted in the October 2012 projections, the power station projections in this work have been produced from the Dynamic Dispatch Model (DDM). The DDM dispatches plant in a traditional cost-minimisation way, but unlike the previous model, projected new builds are dependent on whether plant types are able to achieve pre-determined rates of return. In general the generation mix in the DDM is more responsive in the short run to the difference between coal and gas prices than in the model used prior to 2012. The DDM is also able to model plant closure economics. This feature is an important modelling development and allows simulation of closures across a wide range of economic and other scenarios. Further information about the DDM can be found on the DECC website[56].

Major Power Producers (MPP)

Total electricity demand is projected to decline further until 2019, mainly under the influence of existing or planned energy saving programmes. Demand then increases steadily from 2020 onwards. The renewed growth in demand post – 2019 is due mainly to the declining impact of policy – in particular, no new policies designed to further abate emissions are included in the projections. Chapter 4 of this document sets out the assumed policy background.
In the long term, final electricity demand in these projections is significantly lower than in the October 2012 projections, mainly as a result of revisions to assumptions about economic activity. Some changes to the modelling of demand by consumer sectors and revisions to policy assumptions have also been made. The projected final consumption of electricity in 2030 is around 16 TWh lower in this work than in the 2012 projections, representing a decline of around 4%.

The generating requirement of the MPPs is determined by the level of overall electricity demand in comparison with the level of generation from the non-MPP sector. In contrast to the October 2012 projections, the level of generation from the non-MPP sector is now projected to be broadly unchanged over the rest of this decade before declining slowly from 2020 to 2030. Further information on the factors involved in the CHP projection can be found at the end of this chapter. In net terms the generating requirement of the MPPs sector in 2030 is a little higher than in the 2012 projections, by around 2%.

The size of the available market for fossil fuels to 2020 is broadly unchanged, as the changes to demand and to renewables generation over this period broadly offset each other. The reference scenario fossil fuel price assumptions imply a strong initial competitive environment for coal against gas. The projected annual amount of coal generation in 2013 and 2014 exceeds that achieved in any period since 2007, notwithstanding the closure of some coal capacity in the intervening years. Thereafter coal's competitive situation becomes less advantageous, due to the impact of the carbon price support mechanism, falling gas prices relative to coal prices and the impact of the Industrial Emissions Directive. This leads to a fall in projected coal generation. Generation from gas-fired plant is projected to remain at historically

[56] Dynamic Dispatch Model (DDM) - May 2012
https://www.gov.uk/government/publications/dynamic-dispatch-model-ddm

low levels over the next two to three years, before increasing somewhat by 2020 due to the decline in coal generation. Generation from the early stage CCS plant commences in 2018 and maintains steady output at around 4.7 TWh per year initially. Further growth in capacity from the mid - 2020s produces a generation of 33 TWh in 2030.

The Renewable Energy Strategy, including the impact of the Renewables Obligation and measures relating to small scale renewables, delivers a contribution of more than 30% of total electricity supply from renewable sources by 2020. For the period beyond 2020 it is EMR policies which drive greater renewables generation. With respect to the October 2012 projection, renewables generation is lower in 2020, reflecting agreed spending limits arising from the recent spending review.

The projected build of new nuclear plants has a similar impact in the period to 2030, but the assumed need to decarbonise the generation system to 100 g/kWh is ultimately the key factor. The first new nuclear plant is expected to commence generation in 2020 and further new capacity is added to 2030 leading to an overall new build over the period of around 10 GW. The exact timescale for the deployment of new nuclear capacity in the UK will be the result of commercial decisions made by private investors and will be affected by the final structure of the reforms of the electricity market.

Figure 6.1 shows projected cumulative new build by plant type. While there is a contribution from a number of generation technologies, the major expansion in generating capacity over the projection period is from renewable technologies and natural gas plants.

Figure 6.1 Projected cumulative new build by plant type for MPPs, 2013 to 2030

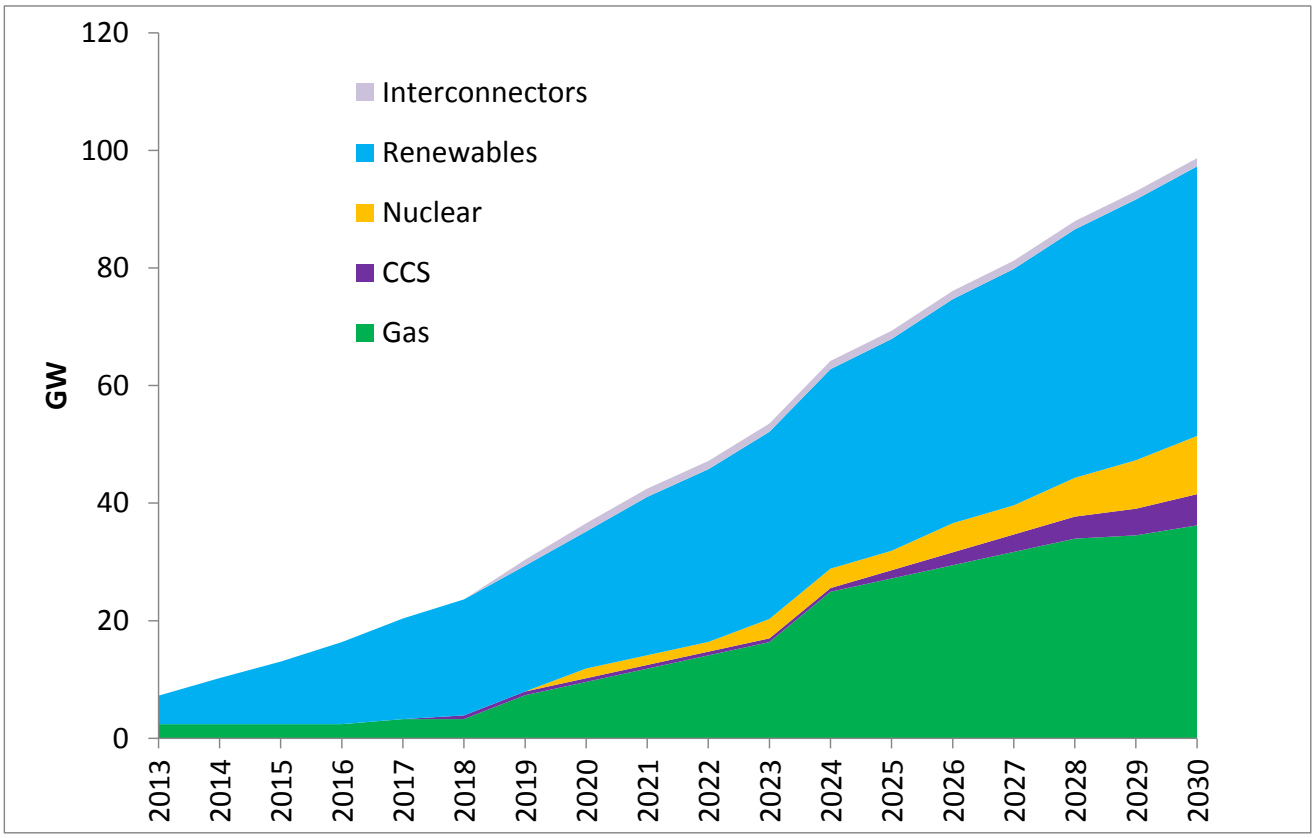
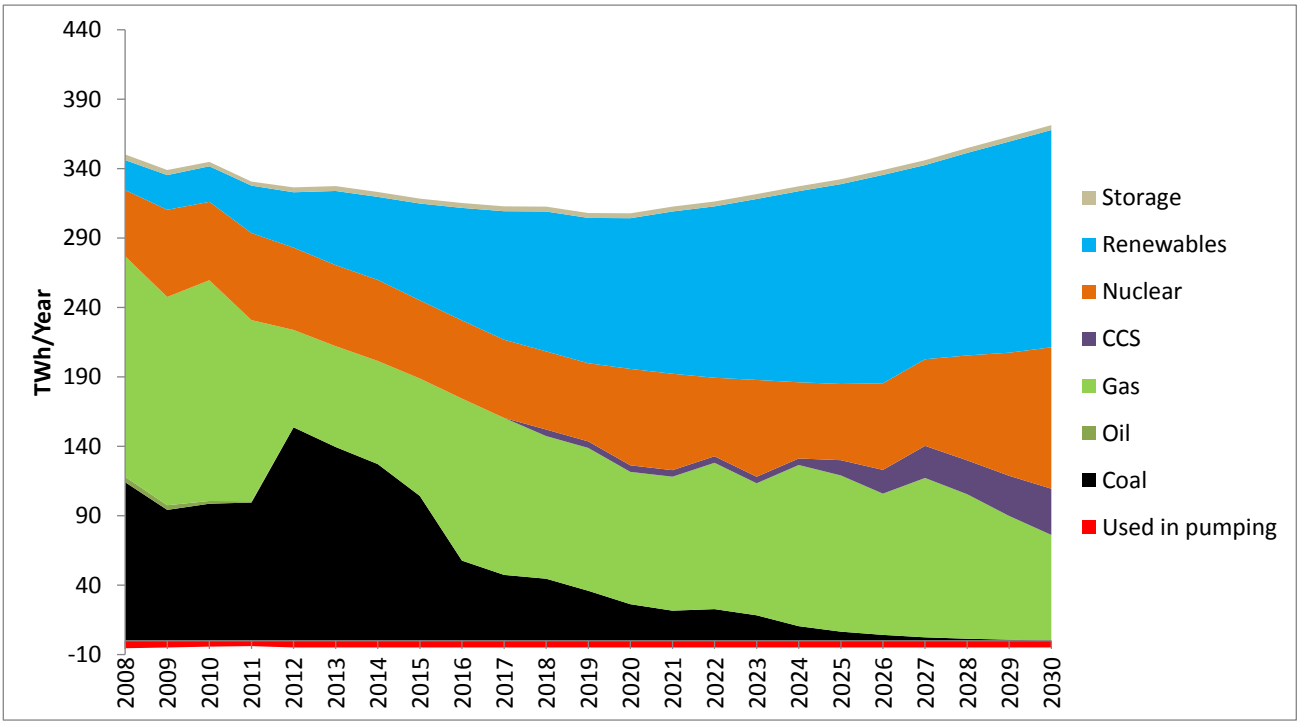


Figure 6.2 shows actual and projected levels of electricity supply by fuel. In summary, the major features of the projection are a large expansion in supply from renewables and a significant diminution in supply from coal-fired plants, especially between 2014 and 2020, but continuing into the longer term. Nuclear generation expands in the longer term as a result of the increase in nuclear capacity.

Figure 6.2 Electricity supplied[57] by fuel for the MPPs, 2008 to 2030



[57] Electricity supply is defined as gross generation less the amount of electricity used on station sites (own use) and after deducting electricity used in pumping. It therefore corresponds to the term 'Supplied (net)' used in DUKES Table 5.6.

Combined heat and power capacity

Good quality combined heat and power (CHP) systems offer highly efficient fuel use with low associated emissions per unit of energy output. Whilst providing considerable scope for emissions reduction over the conventional, separate means of generating electricity and heat (i.e. via power station and boiler), development has been restricted over recent years primarily as a result of unfavourable market price differentials between gas and electricity, uncertainty in heat markets and difficulty in acquiring capital finance .

DECC's CHP modelling consists of a bottom-up technical and basic economic model, operated on behalf of DECC by Ricardo-AEA and an in-house model that projects future CHP capacity by type of CHP (renewable and gas) . Whilst the former considers the economic case for individual sites based on their heat and power requirements, the latter model has been designed to capture the majority of the costs of CHP, policies that affect development and behavioural aspects of the industrial decision making process. These policies include Enhanced Capital Allowances, the Renewables Obligation, the Renewable Heat Incentive, the EUETS and the Carbon Price Floor. Work on both the bottom up model and the Monte Carlo model continues in order that the contribution that CHP can make to meeting carbon targets can be fully understood.

Revised projections of installed capacity are shown in Table 6.1 and their comparisons with previous projections.

Table 6.1: Updated projection of installed capacity of renewables and gas CHP

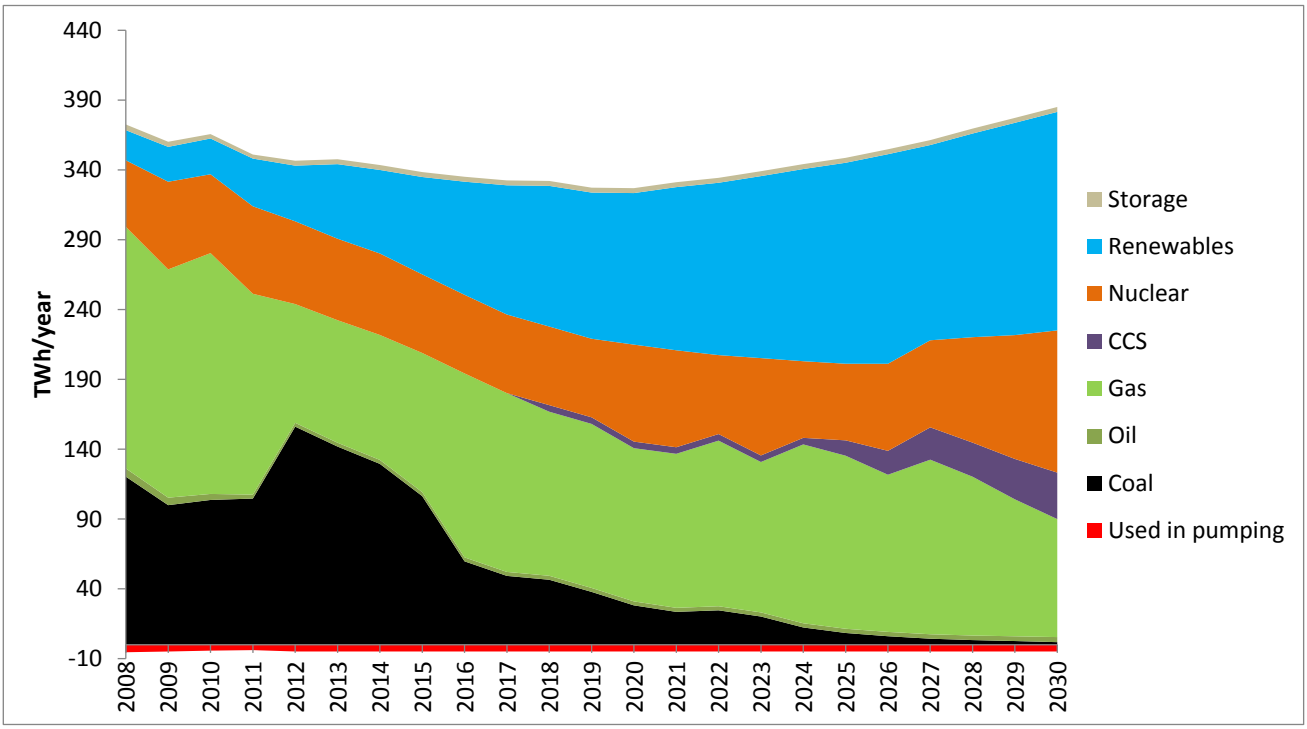
Capacity, GW	2010	2015	2020	2025	2030
October 2012 projection	6.1	8.1	8.6	-	-
September 2013 projection	6.0	7.7	8.4	9.2	8.8

Over the last few years, CHP development has been slow and the latest results suggest that this trend is likely to continue. Of particular note is the decrease in projected potential between 2025 and 2030. The main cause of this is electricity prices which make it more economic for some sites to import electricity from the grid than to invest in CHP. The effect of this is felt most in fossil fuelled sites in the EU ETS, whilst sites that are fuelled by bio-energy remain quite resilient.

All electricity supply

Figure 6.3 below shows electricity supply by fuel for all generators, including MPP, CHP and auto-generators.

Figure 6.3 Electricity supply[58] by primary energy for all generators, 2010 to 2030



The overall trends for all generators is similar to that for MPPs alone, as the non-MPP sector shows relatively little change in generation over much of the period.

[58] Electricity supply is defined as gross generation less the amount of electricity used on station sites (own use) and after deducting electricity used in pumping. It therefore corresponds to the term 'Supplied (net)' used in DUKES Table 5.6.

Chapter 7: Demand for energy

Demand for energy can be considered on a final energy demand or a primary demand basis. Final energy demand is energy used by final consumers - households, businesses etc. Primary energy demand is derived from final energy demand and refers to the energy that is used to before it has been converted into a useful energy carrier, for example such as transport fuels and electricity. Examples of primary energy are the natural gas or wind used to produce electricity. Primary and final energy differ because of the energy used and lost in the conversion of primary energy into useful energy carriers.

In this chapter projections of final energy demand are presented first. They can be used, together with the results on electricity generation contained in Chapter 6, to calculate projections of primary energy demand.

Final energy demand

The results are arranged on the basis of final energy demand by final user and across all sectors and include the estimated impact of the policy measures. Table 7.1 is based on reference price assumptions and provides disaggregated demand for each energy source and major sector. Figures, in million tonnes of oil equivalent (Mtoe), are presented on a consistent basis with the Digest of UK Energy Statistics (DUKES) and include all energy carriers sold within the UK or supplied to the Crown Dependencies of Guernsey, Jersey and the Isle of Man.

Table 7.1 Energy demand by final user (UEP sectors)[59]

Mtoe	2010	2015	2020	2025	2030
Industry:	**28**	**24**	**24**	**24**	**24**
Electricity	9	8	8	8	9
Gas	11	9	9	9	8
Petroleum	5	4	3	3	3
Solid / manufactured fuels	2	2	1	1	1
Renewables	0	1	2	2	2
Domestic:	**48**	**43**	**41**	**43**	**46**
Electricity	10	9	8	9	10
Gas	33	30	29	31	33
Petroleum	3	3	2	2	2
Solid / manufactured fuels	1	1	1	1	1
Renewables	1	0	1	1	1
Transport:	**43**	**40**	**39**	**37**	**36**
Electricity	0	0	1	1	1
Aviation fuel	0	0	0	0	0
Petroleum (rail)	1	1	1	1	1
Petroleum (shipping)	0	0	0	0	0
Petroleum (road transport)	39	37	34	34	33
Bio-fuel	1	2	3	1	1
Services and agriculture:	**19**	**18**	**16**	**16**	**17**
Electricity	9	9	9	9	11
Gas	9	8	6	6	6
Petroleum	1	1	1	0	0
Solid / manufactured fuels	0	0	0	0	0
Renewables	0	0	1	1	1
Total: (excluding international aviation)	**137**	**125**	**120**	**120**	**124**
Electricity	28	26	26	28	30
Gas	53	47	44	45	47
Petroleum	51	46	42	41	39
Solid / manufactured fuels	3	3	2	2	2
Renewables	3	4	6	5	5

[59] On an energy supplied basis, excluding non-energy uses, and including fuels used to generate heat sold under contract to third parties.

Figure 7.1 shows final energy demand is projected to fall until 2022. The projections then increase over the period of the fourth carbon budget as existing policies run out and new policies are not yet shown. However, the projected level of final energy demand in 2030 still remains below that for 2010. There is a projected increase in final demand for renewable fuels and electricity. This is accompanied by a reduction in the final demand for petroleum and gas.

Figure 7.1 Final energy demand by type of energy (Mtoe)

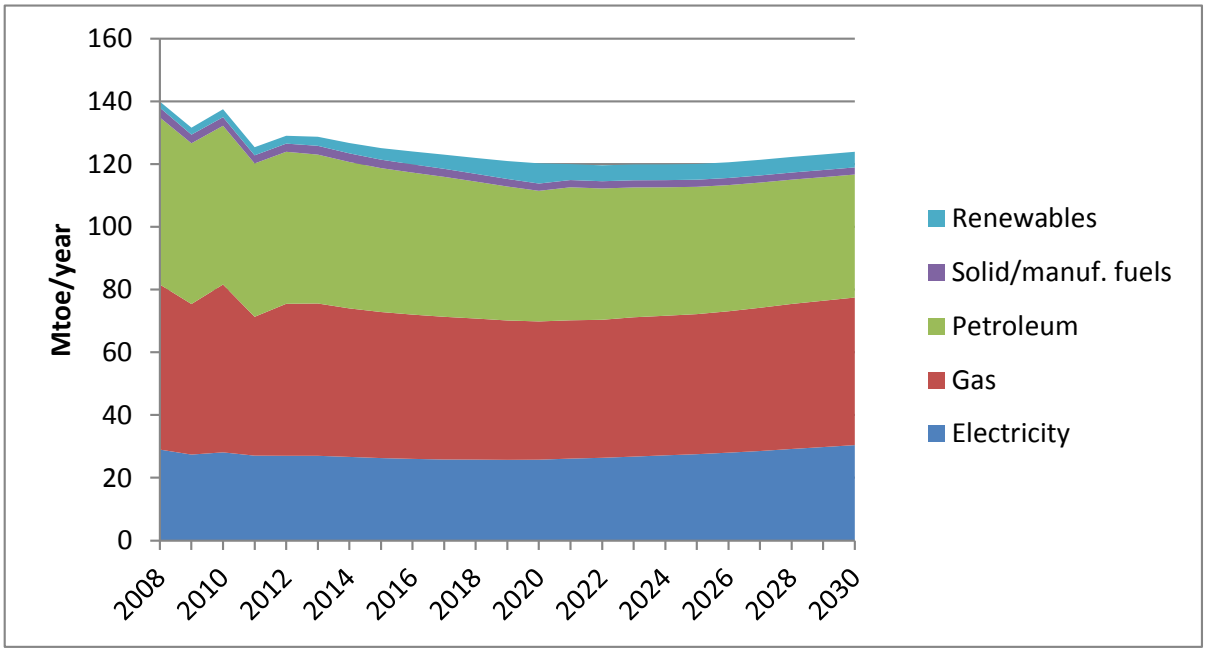
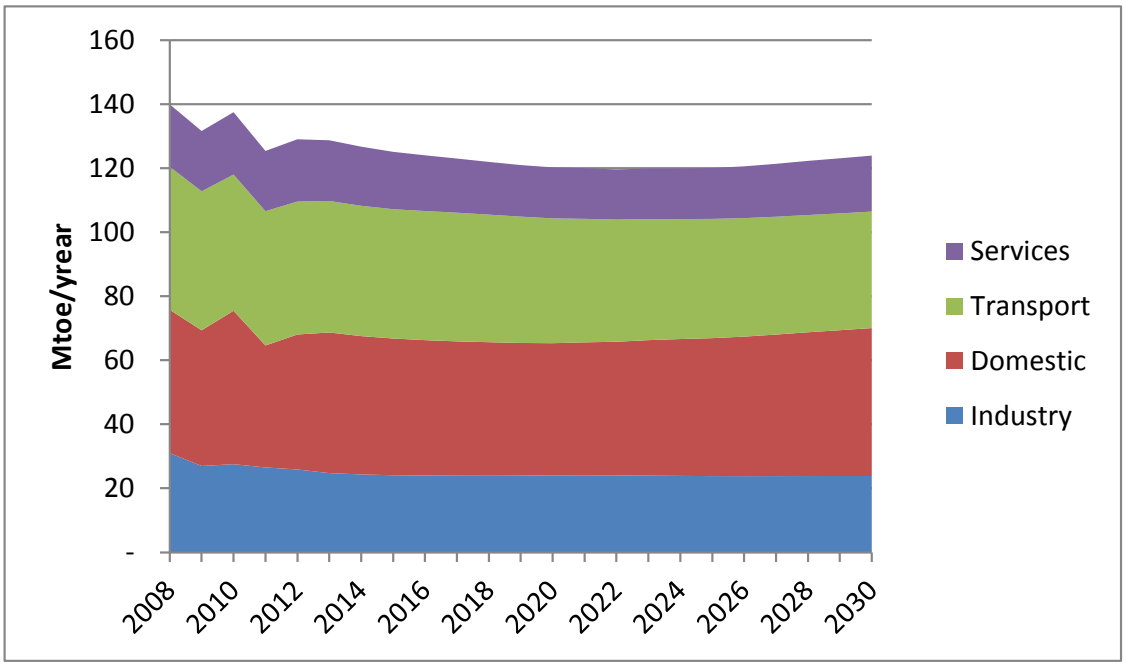


Figure 7.2 shows final energy demand is projected to decrease in all sectors. Further details are available in Annex C.

Figure 7.2 Final energy demand by sector[60] (Mtoe)

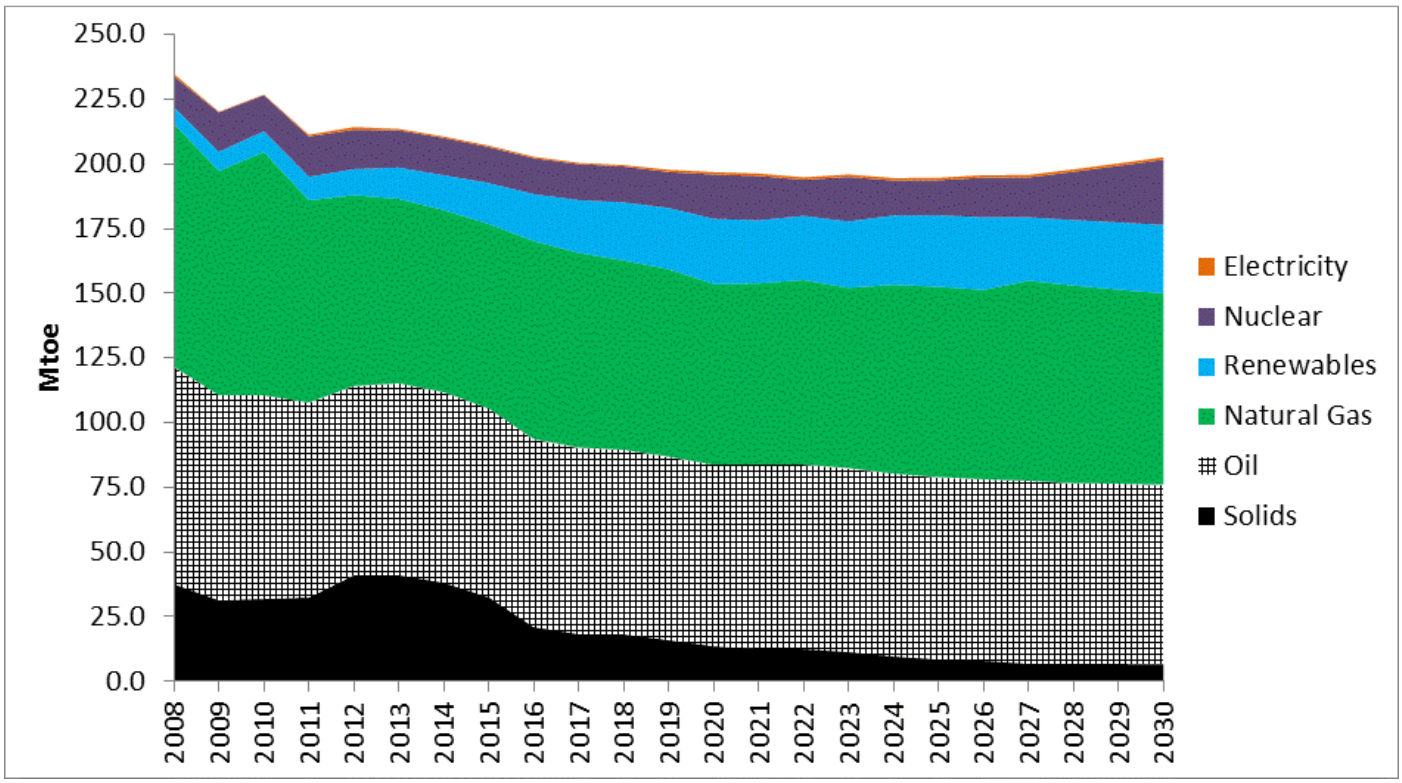


[60] Sectors used here are on the same basis as the Digest of UK Energy Statistics and are not comparable with sectors described for emissions in earlier sections.

Primary energy demand

Figure 7.3 shows that primary energy demand falls through the period to the mid - 2020s and then increases to 2030. The absence by assumption of new energy saving programmes is the key reason for the increase. There is a large projected decline in solid fuel use while natural gas use remains relatively constant through the whole projections period. In contrast, the use of renewable and nuclear fuels increases strongly though nuclear fuel inputs only reach recently recorded levels in the late 2020s. Annex H contains the data supporting Figure 7.3.

Figure 7.3 Projections of primary energy demand[61] [62]



[61] In this figure, all renewable energy is included in the category 'renewables', whereas in DUKES, some renewables are included in other categories, for example, hydro and wind are included with 'primary electricity' in the overall energy balances. The renewables category in this section includes a small amount of waste fuel use.

[62] Electricity is net import of electricity from abroad.

Chapter 8: List of supporting tables

The following data tables can be downloaded providing individual year projections for a range of scenarios.

Annex A: Greenhouse gas emissions by source

Annex B: Carbon dioxide emissions by source

Annex C: Final energy demand

Annex D: Major power producers' generation by source

Annex E: Total electricity generation by source

Annex F: Price and growth assumptions

Annex G: Policy savings included in the projections

Annex H: Primary energy demand

Annex I: Total cumulative new electricity generation capacity

Annex J: Total electricity generation capacity

Annex K: Major power producers cumulative new capacity

Annex L: Major power producers capacity

Appendix: Model development

Introduction

The following improvements were incorporated into the Energy and Emissions Projections model used by DECC to produce these projections:

- improved modelling of the electricity sector
- improved alignment with DfT's transport models (road, rail and air)
- new fuel share equations for industrial sub-sectors
- revised public sector total energy demand
- re-estimation of some of the industrial energy intensity equations
- improved modelling of iron and steel energy use
- updated gas CHP modelling and data

The equations revised this year were identified in 2011 during a review of the energy demand model.

Revisions to demand equations

Last year, we identified a number of equations requiring development. They have been addressed following back-casting tests and comparison of recent actual and projected trends.

Fuel share equations for industrial sub-sectors

Previously, fuel shares in industrial sub-sectors in the model were projected independently using a log-log model in fuel shares. They were then normalised to sum to 100%.
A revised model was proposed and tested. The new model is a Logit share model, which always converts to a share between 0 and 100% unlike the log share.

As well as passing statistical tests, a sample of the models was also validated by back casting (dynamically projecting forward over recent years) where improved performance compared to the previous models was confirmed.

Subsequent to the analysis, DUKES 2013 has resulted in significant re-allocations of fuels between sub-sectors with revisions taken back over 2008-12. We have added dummy variables from 2008 onwards to correct for the effect of this on modelled fuels shares. We intend to re-estimate fully next year.

Public sector total energy demand

Demand for energy in all forms has been falling in the public sector both absolutely and relative to sector employment since the mid-1990s. The existing model for energy demand in the sector was a co-integration model that asserted a long-term fixed energy intensity ratio between energy demand and employment in the sector. It was developed using data from before the mid-90s when energy intensity had been increasing and also excluded recent data.
We have replaced the co-integration model (for which there is no longer any statistical justification) with an energy intensity difference equation. This takes into account the newer data and revisions to the past data series. We have also separated the demand equations for electricity from the other fuels that are predominantly used for heating and cooking and where we continue to use an energy shares model.

We are now projecting a gradual decline in demand. Previously, we were projecting an increase in demand in the sector, despite falling sector employment and increasing policy savings.

Figure A.1 October 2012 Projection of Public Services Sector energy demand

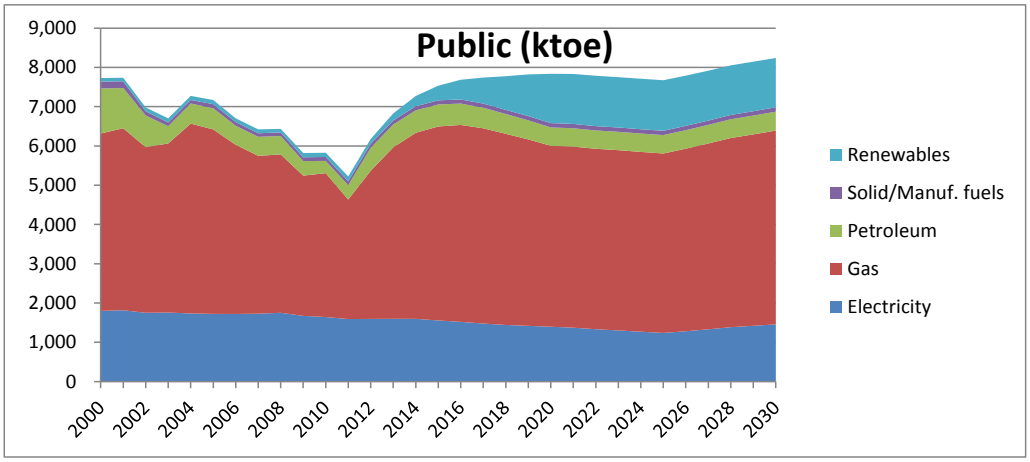
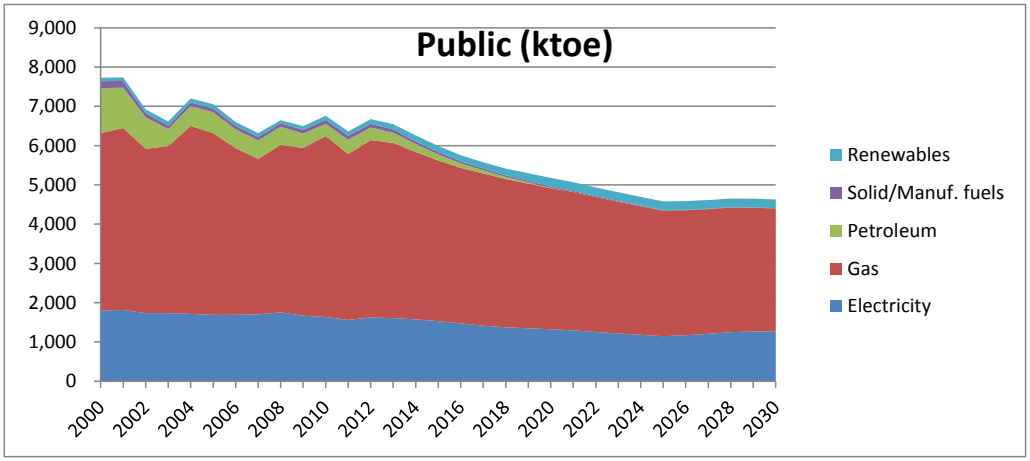


Figure A.2 September 2013 Projection of Public Services Sector energy demand



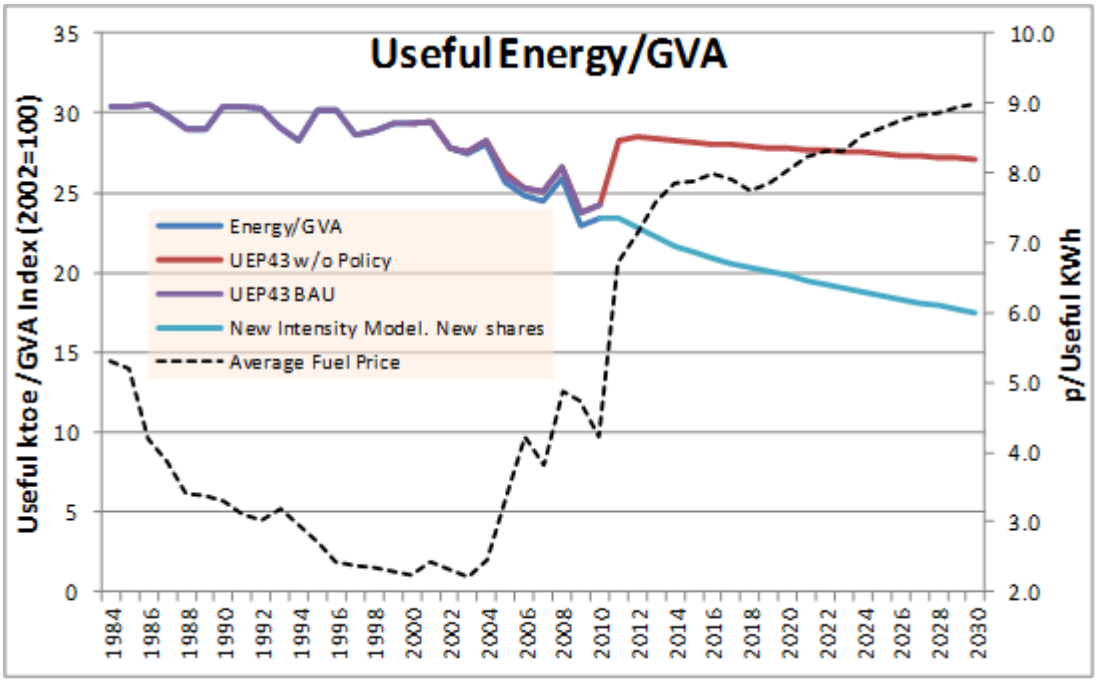
Domestic sector electricity demand

Domestic demand for electricity and other fuels were re-estimated last year. During quality assurance we identified further issues with the projection for electricity, particularly in the way in which recent policy savings were being allowed for. Electricity demand has been re-estimated and our new projections are higher.

Energy intensity equations

Prior to estimating industry sub-sector fuel shares, we relate total useful energy used in the sub-sector to a measure of output (GVA) through an energy intensity equation. Energy intensity equations were last estimated for DECC in 2008, by Oxford Economics. We have re-estimated the equations where the model fit to reality was poor. Sub-sectors affected were food, drink and tobacco; textile, leather and clothing; and non-metallic minerals. Figure A.3 shows an example of the original and the re-estimated projections.

Figure A.3 Comparison between old and new projection of energy intensity the food, drink & tobacco subsector.



Iron and steel emissions

Generally there is a simple relationship between coal consumed and tonnages of steel produced. However this has been confounded in the past data because of imbalances between coke production from coal and its use in blast furnace. Recently, coke has been stocked and exported: this means there is a less tight link between coal consumed and CO_2 emissions in any given year.

Our modelling has been update to account for this and for the 'leakages' of carbon to other industries and products identified in DUKES. We are currently projecting on the assumption that there will be no net stocking or exports in future years. Next year we intended to improve our projections further to take more dynamic account of these imbalances between coke production and its domestic use.

Revised modelling of transport

We have aligned the transport equations for air, road and rail with the DfT's transport models.

Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2AW
www.gov.uk/decc

URN: 13D/231