

# **UPDATED ENERGY AND CARBON EMISSIONS PROJECTIONS**

**NOVEMBER 2008**

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## UPDATED EMISSIONS PROJECTIONS: NOVEMBER 2008

### EXECUTIVE SUMMARY

The Energy Group within BERR (now DECC) has for many years been responsible for providing comprehensive energy and carbon dioxide emissions projections out to 2020. These are based on the BERR Energy Model, a partial –equilibrium model of the whole UK energy market. Previous emissions projections have informed the Climate Change Programme 2000, the Climate Change Review 2006, the Energy White Papers 2003 and 2007 and formed the basis for the National Allocation Plans of both Phase 1 and 2 of the EU emissions trading system (EUETS). The carbon dioxide emissions projections, combined with projections of other non- carbon dioxide gases of the basket of greenhouse gases designated under the Kyoto Protocol, inform the National Communications on the UK's progress towards its greenhouse gas contribution to the European target.

The projections are regarded as robust and of a high standard. The assumptions underlying the projections are used by all government departments in assessing or developing energy and environmental policy. The projections updated annually, include only government policy that is deemed firm and funded at the time the projections are produced. In this way the projections provide a valuable platform for further policy consideration and do not anticipate UK government policy decisions. The projections take into account the impact of the policies announced in the 2007 Energy White Paper and the estimated net impact of the European Commission's recent proposals on the EU emissions trading system. They do not include policy under consideration, such as, the Climate Change Bill, the Renewable Energy Consultation related to the proposed EU Renewable Target or the proposed EU Industrial Emissions Directive.

Implications of the Climate Change Bill currently under consideration by Parliament and the development of a Renewable Energy Strategy for example, will be incorporated in updated future versions of the projections in 2009.

This paper presents the latest full UK carbon dioxide emissions projections replacing those previously published alongside the Energy White Paper in May 2007. These updated projections informed the Annual Report to Parliament on the UK Climate Change Programme (REF: <http://www.defra.gov.uk/environment/climatechange/uk/ukccp/index.htm>) and the 5th Annual Report on the 2003 Energy White Paper (REF: <http://www.berr.gov.uk/files/file46645.pdf>) published by Defra and BERR respectively earlier this year. The projections published in July differ slightly from the current updated projections due to more recent published data becoming available and some slight modelling revisions since July 2008.

The updated projections confirm that by 2020, taking into account the impact of the policies announced in the 2007 Energy White Paper and the estimated net impact of the European Commission's recent proposals on the EU emissions trading system, the UK's carbon dioxide emissions are projected to fall to about 26 per cent below 1990 levels. This represents an improvement in projected underlying baseline UK emissions (excluding the impact of the EUETS) of some 1 million tonnes of carbon dioxide (MtCO<sub>2</sub>) from the previous projections by 2020. Including the impact of the EUETS the updated projections in 2020 are some 4MtCO<sub>2</sub> lower than the previous projections.

The projections confirm that we remain on track to exceed by a large margin our commitment under the Kyoto Protocol to reduce by 12.5% our emissions from a base year of 1990 of a basket of greenhouse gases by 2008-2012.

The projections indicate that, taking into account the net impact of allowances and credits surrendered through the EU emissions trading scheme, emissions of the basket of six gases controlled under the Kyoto Protocol might be about 23 per cent below base year levels in 2010.

By 2020, greenhouse gas emissions are projected to fall to about 32 per cent below base year levels.

The updated projections represent significant development in modelling and data revision, including the facility to project out to 2025 and covering the proposed Carbon Budget period on a year by year basis. The BERR Energy Model has independently and separately been used to inform analysis by the Climate Change Committee.

The updated projections also reflect new data and revised key assumptions of future economic growth, population, fossil fuel prices and a number of other variables. The key assumptions relate to the economic situation at the time of the March 2008 Budget and prior to the very recent development of the global credit crisis and the volatile higher oil prices of the summer of this year.

The updated projections assume a range of fossil fuel prices from a low oil price of \$45/bbl to a high-high price of \$150/bbl by 2020 with a central oil price \$70/bbl in 2020. The previously assumed oil price range was from a low oil price of \$26/bbl to a high price of \$83/bbl. with a central oil price of \$55/bbl. The projections are based on a carbon price of 25€/tonne of carbon dioxide and include allowances estimated to be purchased under the EUETS. The carbon price of 25€ per tonne of carbon dioxide is consistent with the Energy White Paper Projections<sup>1</sup>.

Other changes since the Energy White Paper projections include the European Commission's proposals to revise the EU emissions trading system. The projections include the net impact of allowances and credits surrendered through the EU emissions trading scheme based on our estimate of the implications for the UK of the proposed EU-wide cap. An Annex provides projections excluding allowances purchased through the scheme.

The updated headline emissions of carbon dioxide, based on central fossil fuel prices and full impact of the proposed Energy White Paper measures at their central estimates are shown in Table 1 below and compared with the previous central projections.

**Table 1 – Headline UK carbon dioxide emissions projections including purchase of allowances under the EUETS and an assumed carbon price of 25€/tonne of carbon dioxide, based on central assumptions of growth, prices and delivery of measures proposed in the Energy White Paper, May 2007. The figures in brackets represent change on 1990.**

MtCO <sub>2</sub>	1990	2010	2015	2020
<b>Updated central projection</b>	592	504 (-15%)	473 (-20%)	440 (-26%)
<b>Energy White Paper May 2007 central projection</b>	592	498 (-16%)	485 (-18%)	464 (-22%)

The updated projections suggest that under central assumptions emissions are slightly higher in the near term and lower in the longer term. This is due to a number of effects. Higher fuel price assumptions in the longer term suggest lower projected energy demand, including electricity from the major power producers (5% reduction in 2020) while emissions from electricity generation have increased mainly due the higher levels of coal use and lower levels of gas use in generation (Table 2). Higher coal use is an outcome of the modelling approach which is based on selecting the most economic generation mix to meet a given electricity demand and does not reflect government policy.

<sup>1</sup> EWP assumed 20€/tCO<sub>2</sub> to 2010 and 25€/tonne from 2015 to 2020

However, the European Commission's proposals and specifically our estimate of the implications for the UK of the proposed EU-wide cap suggest changes in the level of allowances purchased through the scheme resulting in an overall reduction in UK emissions in 2020 compared with the Energy White Paper projection.

Table 2 illustrates the changes in the composition of electricity generation by fuel of the major electricity producers.

**Table 2 - Changes in the composition of electricity generation by fuel (TWh)**

TWh	Updated central projection			Energy White Paper projection May 2007			Changes		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
<b>Coal</b>	120	112	87	113	75	71	7	37	17
<b>Oil</b>	1	1	1	2	1	1	-1	0	0
<b>Gas</b>	132	142	153	129	186	195	3	-45	-41
<b>Nuclear</b>	63	45	32	68	31	25	-5	14	7
<b>Renewables</b>	33	50	56	33	53	57	0	-3	-1
<b>Imports</b>	14	17	17	11	16	16	3	0	0
<b>Storage</b>	2	2	2	3	3	3	0	-1	-1
<b>Total</b>	<b>366</b>	<b>369</b>	<b>348</b>	<b>359</b>	<b>365</b>	<b>367</b>	<b>7</b>	<b>4</b>	<b>-19</b>
<b>% change</b>							1.9%	1.0%	-5.2%

Renewables generation is a little lower in 2015 as a result of a minor adjustment to the build profiles for renewable plants while in 2020, the minor downward adjustment reflects both adjustments to the build profiles and lower electricity demand. It should be noted that, on the definition above, the percentage share of renewables generation is a little higher in 2020 than it was in the 2007 EWP projections. The projections do not include policy implications resulting from the Renewable Energy Consultation.

The projections shown in Figures 1 and 2 are based on a central fossil fuel price scenario; the range reflects uncertainties about the carbon savings that policies in the Energy White Paper will deliver and based on the range of projected fuel prices assumed. The full range of results for the fossil fuel price scenarios are shown in the main report.

**Figure 1: Historic and projected UK greenhouse gas emissions, including the impact of EUETS.**

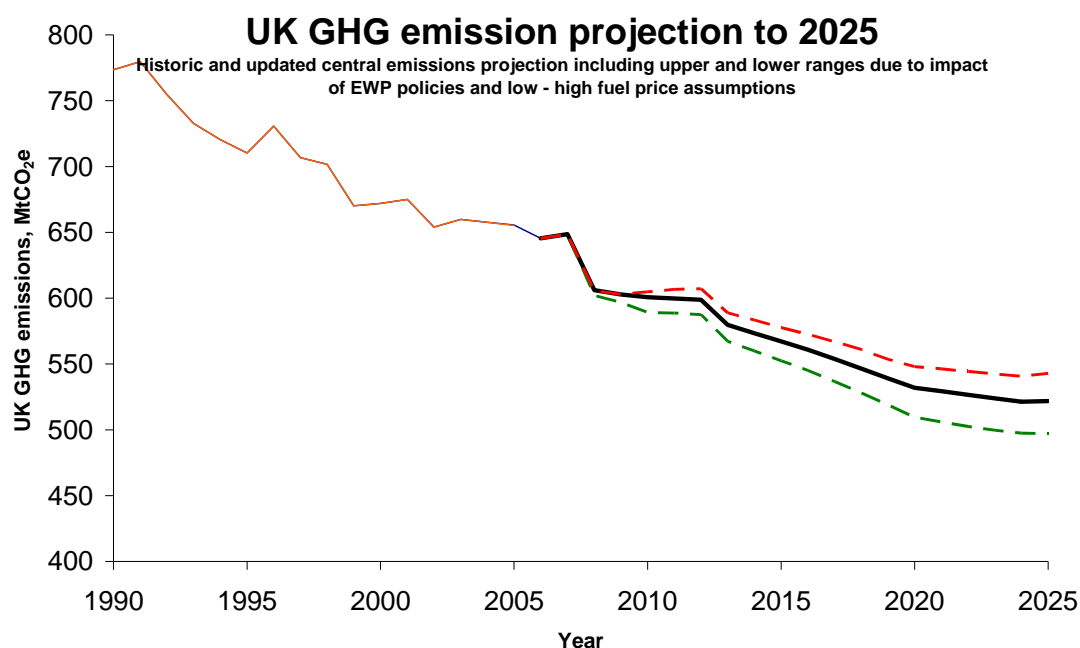
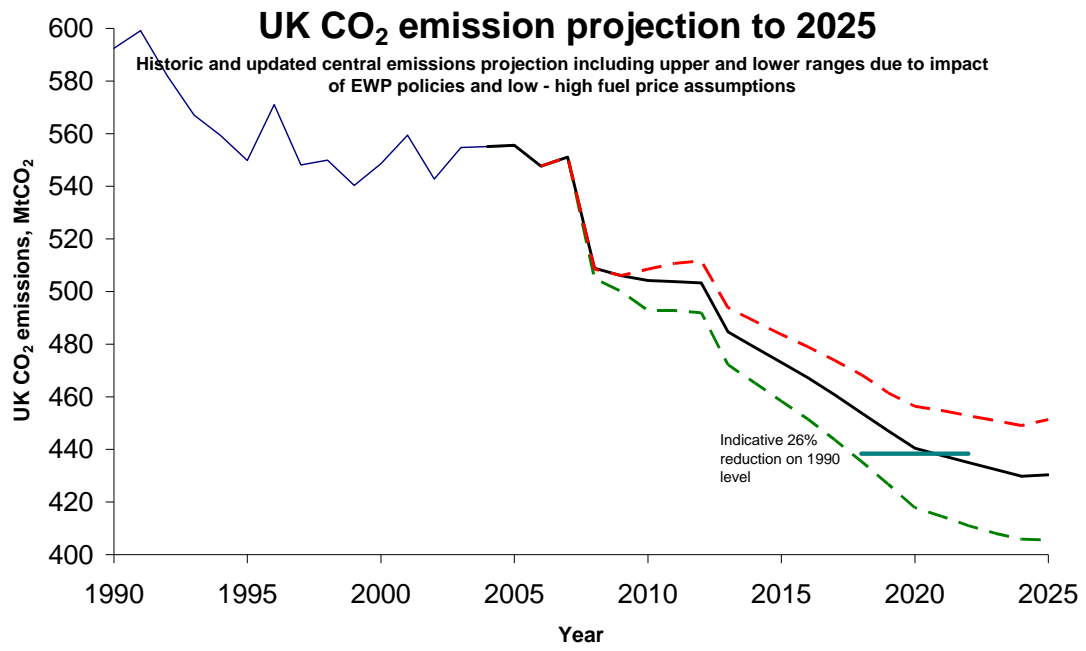


Figure 2: Historic and projected UK CO<sub>2</sub> emissions, including the impact of EUETS



## SECTION 1 - INTRODUCTION AND UPDATED HEADLINE EMISSIONS PROJECTIONS

### INTRODUCTION

The carbon dioxide emissions published alongside the Energy White Paper May 2007 have been updated to reflect changes in key assumptions of fossil fuel prices, economic growth, population and new energy data. The economic growth assumption reflects the UK economic position in March 2008 and is consistent with HM Treasury Budget forecasts. Fossil fuel prices were published in May 2008 by the Energy Group Market Analysts based on prevailing market opinion and following a short public consultation. UK population figures and household numbers were revised following the ONS revision to population projections in October 2007. The assumptions are shown in summary in Tables 1.1 -1.3 and provided in detail in Annex A and B.

These projections include only current and previous policy deemed “firm and funded” and included with in the Energy White Paper 2007 and therefore exclude any policy arising from consideration of the forthcoming Climate Change Bill, the proposed EU Renewable Energy Target and the Renewable Energy Consultation and the proposed EU Industrial Emissions Directive. Inclusion of future policy will be considered in subsequent projections. Policy included in these projections is listed in Annex C.

The updated projections take account the European Commission’s proposals to revise the EU emissions trading system and specifically our estimate of the implications for the UK of the proposed EU-wide and are based on an assumed carbon price of 25€/tonne of carbon dioxide.

The paper is arranged as follows:

Section 1 presents the key assumptions and headline emissions projections. Section 2 provides a breakdown of the main changes between the central updated projection and the central Energy White Paper 2007 projection. Section 3 presents the headline projections for a range of fuel prices and policy saving scenarios. Section 4 provides detailed sector emissions by scenario. Final Energy Demand by sector and fuel is provided in Section 5 and Section 6 provides details of the projections for the energy industry sector including electricity generation by fuel and capacity and information on CHP and refinery assumptions. Section 7 illustrates the uncertainty associated with the projections. Annex F provides parallel results to those shown in Sections 1 to 3 excluding the impact of EUETS. Annex D provides headline projections under assumptions of high growth and worst case scenarios.

### KEY ASSUMPTIONS

**Table 1.1 Range of oil price assumptions (low, central, high and high-high fossil fuel price assumptions)**

\$/bbl (2007 prices)	Low	Central	High	High-high
<b>2020</b>	45	70	95	150

**Table 1.2 Growth assumptions**

Percent per annum growth	2007	2008	2009-13	2014-2016	2017-2025
<b>GDP</b>	3.16	3.00	2.75	2.30	2.20
<b>Manufacturing</b>	0.60	1.00	2.00	1.75	1.60

**Table 1.3 Household growth assumptions**

Millions	2005	2010	2015	2020	2025
<b>Households</b>	25.5	26.9	28.5	30.0	31.5

The projections are based on a range of fossil fuel prices to reflect the uncertainty associated with projecting fossil fuel prices into the future. The projections are low, central, high and high-high prices providing the range \$45/bbl to \$150/bbl (in 2007 prices) This is a similar approach to that used in the EWP projections of low, central and high providing the range (\$26/bbl to \$83/bbl, in 2007 prices). The fossil fuel assumptions are also combined with assumptions reflecting the uncertainty in the delivery of Energy White Paper measures which is the same approach as in the EWP projections as low, central and high levels of EWP policy savings. This approach provides a wide range of results which reflect the uncertainty associated with these assumptions. Overall emissions uncertainty is illustrated in Section 7.

The updated headline emissions of carbon dioxide, based on central fossil fuel prices taking account of the net impact of allowances and credits surrendered through the EU emissions trading scheme and full impact of the proposed Energy White Paper measures at their central estimates are shown in Table 1.4 below and compared with the previous EWP central projections.

**Table 1.4 Headline UK Emissions carbon dioxide projections including purchase of allowances under the EUETS, based on central assumptions of growth, prices and delivery of measures proposed in the Energy White Paper May 2007.** The figures in brackets represent change on 1990.

MtCO <sub>2</sub>	1990	2010	2015	2020
<b>Updated central projection</b>	592	504 (-15%)	473 (-20%)	440 (-26%)
<b>Energy White Paper May 2007 central projection</b>	592	498 (-16%)	485 (-18%)	464 (-22%)

The updated projections suggest that under central assumptions emissions are slightly higher in the near term and lower in the longer term. This is due to a number of effects. Higher fuel price assumptions in the longer term suggest lower projected energy demand, including electricity from the major power producers (5% reduction in 2020) while emissions from electricity generation have increased due the higher projected levels of coal use in generation (Table 2.2). Higher coal use is an outcome of the modelling approach which is based on selecting the most economic generation mix to meet a given electricity demand and does not reflect any particular government policy. However, the European Commission's proposals and specifically our estimate of the implications for the UK of the proposed EU-wide cap suggest changes in the level of allowances purchased through the scheme resulting in an overall reduction in UK emissions in 2020 compared with the Energy White Paper projection.

## SECTION 2 – BREAKDOWN OF CHANGES IN 2020 EMISSIONS

In this section the broad changes between the central baseline projections of the updated projection and the Energy White Paper projection are shown. These are shown by broad category in Table 2.1. Further breakdowns are shown in Table 2.2 for generating fuels and Table 2.3 for emissions by sector.

**Table 2.1 Breakdown of main changes by broad category**

MtCO <sub>2</sub>	2010	2015	2020
Updated emissions projections (central)	504	473	440
Energy White Paper May 2007	498	485	464
<b>Difference</b>	<b>7</b>	<b>-11</b>	<b>-23</b>
<i>Of which due :</i>			
Increased power station emissions (see Table 2.3)	11	22	11
Adjustment to refinery emissions	-5	-6	-6
Impact of higher prices and other modelling effects between the projections (See Table 2.3)	-7	-8	-9
Land Use Change adjustment	0	1	1
<b>Sub-total of changes (a)</b>	<b>-1</b>	<b>9</b>	<b>-3</b>
Increased emissions from the traded sector	4	14	3
Tightening of the EUETS cap above assumed level in EWP		-2	-11
<b>Additional allowances required to purchase with in EUETS (b)</b>	<b>-8</b>	<b>21</b>	<b>20</b>
<b>Total change ( a ) –(b)</b>	<b>7</b>	<b>-11</b>	<b>-23</b>

Table 2.2 illustrates the changes in the composition of electricity generation by fuel of the major electricity producers.

**Table 2.2 Changes in the composition of the generation fuels for electricity demand<sup>2</sup> (TWh)**

TWh	Updated central projection			Energy White Paper projection May 2007			Changes		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
<b>Coal</b>	120	112	87	113	75	71	7	37	17
<b>Oil</b>	1	1	1	2	1	1	-1	0	0
<b>Gas</b>	132	142	153	129	186	195	3	-45	-41
<b>Nuclear</b>	63	45	32	68	31	25	-5	14	7
<b>Renewables</b>	33	50	56	33	53	57	0	-3	-1
<b>Imports</b>	14	17	17	11	16	16	3	0	0
<b>Storage</b>	2	2	2	3	3	3	0	-1	-1
<b>Total</b>	<b>366</b>	<b>369</b>	<b>348</b>	<b>359</b>	<b>365</b>	<b>367</b>	<b>7</b>	<b>4</b>	<b>-19</b>
<b>% change</b>							1.9%	1.0%	-5.2%

Renewables generation is a little lower in 2015 as a result of a minor adjustment to the build profiles for renewable plants while in 2020, the minor downward adjustment reflects both adjustments to the build profiles and lower electricity demand. It should be noted that the percentage share of renewables generation is a little higher in 2020 than it was in the 2007 EWP projections. The projections do not include policy implications resulting from the Renewable Energy Consultation.

The increase in generation of electricity by coal fired plants compared with the Energy White Paper is largely due the changes in the relative price of gas and coal which has tended to favour coal burn. This is an outcome of the modelling approach which is based on selecting the most economic generation mix to meet a given electricity demand and does not reflect any particular government policy.

Carbon dioxide emissions by sector including purchases of EUETS allowances is shown in Table 2.3 below and compared with the EWP projections assuming central assumptions of fossil fuel prices and EWP policy delivery.

<sup>2</sup> The coverage of this sector is major power producers – as defined in the Digest of UK Energy Statistics - plus all other renewable generators. The activities of other generators of electricity are included within the industrial or commercial sectors. Electricity supply is measured as electricity supplied (gross) as in Table 5.6 of DUKES 2008.

**Table 2.3 Updated sector emissions compared with Energy White Paper emissions**

MtCO <sub>2</sub>	Updated central projection			Energy White Paper projection May 2007			Changes		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
Power stations	170	166	144	159	144	133	11	22	11
Refineries	16	16	17	21	22	22	-5	-6	-6
Residential	74	66	53	72	65	55	2	1	-2
Services	23	23	22	22	21	21	-	2	1
Industry	108	107	105	113	112	109	-5	-5	-4
Road Transport	115	115	115	119	120	118	-4	-5	-3
Off-road	11	10	10	12	12	12	-1	-2	-2
Other Transport	13	13	14	12	12	12	-	1	1
Land use Change	-1	1	3	-2	0	2	-	1	1
<b>Total in UK</b>	<b>528</b>	<b>516</b>	<b>482</b>	<b>529</b>	<b>507</b>	<b>485</b>	<b>-1</b>	<b>9</b>	<b>-3</b>
EUETS Allowances purchased	24	43	41	32	23	21	-8	21	20
<b>Total</b>	<b>504</b>	<b>473</b>	<b>440</b>	<b>498</b>	<b>485</b>	<b>464</b>	<b>7</b>	<b>-11</b>	<b>-23</b>

### SECTION 3 – HEADLINE EMISSIONS PROJECTIONS OF CARBON DIOXIDE AND GREENHOUSE GASES FOR ALTERNATIVE SCENARIOS

The updated headline projections are presented for alternative assumptions of Energy White Paper policy saving and fossil fuel prices which illustrate the range of uncertainty. These are shown in Tables 3.1 – 3.3.

**Table 3.1: Updated Headline carbon dioxide projections MtCO<sub>2</sub>**

MtCO <sub>2</sub>	1990	2010	2015	2020	2025
Including full impact of EU ETS and assuming low impact of 2007 Energy White Paper measures	592	504	474	443	433
Including full impact of EU ETS and assuming central impact of 2007 Energy White Paper measures	592	504	473	440	430
Including full impact of EU ETS and assuming high impact of 2007 Energy White Paper measures	592	499	466	432	422

**Table 3.2 Headline carbon dioxide emissions projections, including the impact of the EUETS and reductions on a 1990 level, of 592 MtCO<sub>2</sub> are shown for a range of assumptions**

Projection	Emissions, including EU ETS (MtCO <sub>2</sub> )				% reduction on base year level of 592 MtCO <sub>2</sub>			
	2010	2015	2020	2025	2010	2015	2020	2025
Central prices, central EWP delivery	504	473	440	430	15	20	26	27
Central prices, high EWP delivery	499	466	432	422	16	21	27	29
Central prices, low EWP delivery	504	474	443	433	15	20	25	27
High prices, central EWP delivery	502	469	436	425	15	21	26	28
Low prices, central EWP delivery	508	478	446	436	14	19	25	26
High prices, high EWP delivery	499	462	428	418	16	22	28	29

**Table 3.3 Headline greenhouse gas emissions projections, including the impact of the EUETS, and reductions on base-year emissions level of 777 MtCO<sub>2</sub>e are shown for a range of assumptions.**

Projection	Emissions, including EUETS (MtCO <sub>2</sub> e)				% reduction on base year level 777 MtCO <sub>2</sub> e			
	2010	2015	2020	2025	2010	2015	2020	2025
<b>Central prices, central EWP delivery</b>	601	567	532	522	23	27	32	33
<b>Central prices, high EWP delivery</b>	596	561	523	513	23	28	33	34
<b>Central prices, low EWP delivery</b>	601	568	534	524	23	27	31	33
<b>High prices, central EWP delivery</b>	598	563	527	517	23	28	32	33
<b>Low prices, central EWP delivery</b>	605	572	537	527	22	26	31	32
<b>High prices, high EWP delivery</b>	596	556	519	509	23	28	33	34

## **SECTION 4 SECTOR EMISSIONS, TRADED AND NON-TRADED SPLIT BY SCENARIO & PROGRESS TOWARDS KYOTO GOAL**

In this section the impact of the EUETS including the purchase of allowances under the scheme is illustrated with reference to a range of price and policy scenario projections. The updated projections take into account the European Commission's proposals to revise the EU emissions trading system, and specifically our estimate of the implications for the UK of the proposed EU-wide cap are presented. Projections by scenario split by traded and non-traded emissions are illustrated. Progress towards the UK goal under the Kyoto Protocol for a 12.5% reduction from base year levels of a basket of greenhouse gases is also shown.

The Energy White Paper projections included an illustrative level of effort associated with the EUETS beyond Phase 1 which provided estimates of purchases of allowances within the scheme which were included in the overall UK emissions projections. The EWP projections made no assumptions regarding expansion of traded sectors within the EUETS beyond Phase 1.

In this Section we illustrate the impact of the revised EUETS on the updated projections including assumptions of an expanded traded sector in Phase 2, together with our estimate of the implications for the UK of the proposed revision to the EU-wide cap. The implication of the revision to the cap in terms of overall projection uncertainty is shown in Section 7.

Presenting the emissions projections on a range of fossil fuel prices and Energy White Paper policy delivery represents uncertainty associated with projecting future prices. Inclusion of the range of savings associated with the proposed policy measures included in the Energy White Paper provides a useful range of scenarios. These scenarios are then set within the EUETS and overall projections are compared with the Energy white Paper scenarios.

The four price projection assumptions when combined with the three assumptions made in the Energy White Paper of the policy delivery and a central growth assumption provide a basis for the six price and policy variants reported in this section. These are

Central fossil fuel prices and policy variants:

- Central prices, low carbon saving (i.e. low EWP policy delivery) and central growth
- Central prices, central carbon saving (i.e. central EWP policy delivery) and central growth
- Central prices, high carbon saving (i.e. high EWP policy delivery) and central growth

Price variants and central policy

- Low prices, central policy and central growth
- Central prices, central policy and central growth ( as in grouping above)
- High prices, central policy and central growth
- High-high prices, central policy and central growth

Additional variants are possible such as on growth and pessimistic assumptions on all policy but these do not form part of the main projections and are reported only in Annex D.

The other variants are

- High growth: central prices, central policy and high economic and demographic growth.
- Worst case: low prices, low policy (including existing policy) and high growth

The headline results for the policy variants, including the impact of purchased allowances under the revised EUETS are shown in Table 4.1. Due to revisions to the assumed participation in Phase 2 of the EUETS, the proportion of the industrial sector emissions included within the EUETS beyond 2008 is approximately 76% compared with 45% assumed in the Energy White Paper projections.

**Table 4.1 Headline updated projections including the impact of the revised EU ETS cap and expanded traded sector post Phase 1 (central fuel prices)**

MtCO <sub>2</sub>	1990	2010	2015	2020	2025
<b>Emissions projection and assuming low impact of policy measures</b>	592	504	474	443	433
<b>Emissions projection and assuming central impact of policy measures</b>	592	504	473	440	430
<b>Emissions projection and assuming high impact of policy measures</b>	592	499	466	432	422

Table 4.1 shows that in the central price scenario carbon dioxide emissions in 2020 are projected to be between 404 and 416 MtCO<sub>2</sub> (30 to 32 per cent below 1990 levels). These projections assume a carbon price of 25€/tonne of CO<sub>2</sub> and a banded Renewable Obligation, consistent with the Energy White Paper projections.

Assuming central fuel prices and variants on carbon saving from the Energy White Paper policies the sector emissions, by source, are shown in Table 4.2.

**Table 4.2 Sector emissions under the central high and low policy scenarios**

MtCO <sub>2</sub>		CENTRAL FOSSIL FUEL PRICES								
		Assuming low carbon saving			Assuming central carbon saving			Assuming high carbon saving		
	2005	2010	2020	2025	2010	2020	2025	2010	2020	2025
<b>Power Stations</b>	175	171	149	146	170	144	141	170	136	132
<b>Refineries</b>	19	16	17	19	16	17	19	16	17	19
<b>Residential</b>	85	74	56	56	74	53	54	74	51	52
<b>Services</b>	23	23	22	22	23	22	22	23	20	21
<b>Industry</b>	112	108	105	106	108	105	106	108	104	106
<b>Road transport</b>	120	115	115	116	115	115	116	110	110	111
<b>Off-road</b>	13	11	10	10	11	10	10	11	10	10
<b>Other transport</b>	11	13	14	14	13	14	14	13	14	14
<b>Land Use Change<sup>3</sup></b>	-2	-1	3	3	-1	3	3	-1	3	3
<b>Total</b>	<b>555</b>	<b>529</b>	<b>489</b>	<b>493</b>	<b>528</b>	<b>482</b>	<b>485</b>	<b>523</b>	<b>465</b>	<b>468</b>
<b>EU ETS allowances purchased from abroad</b>		25	46	60	24	41	55	23	33	46
<b>Total including impact of EU ETS</b>	<b>555</b>	<b>504</b>	<b>443</b>	<b>433</b>	<b>504</b>	<b>440</b>	<b>430</b>	<b>499</b>	<b>432</b>	<b>422</b>
<b>% change from 1990 baseline</b>	<b>-6%</b>	<b>-15%</b>	<b>-25%</b>	<b>-27%</b>	<b>-15%</b>	<b>-26%</b>	<b>-27%</b>	<b>-16%</b>	<b>-27%</b>	<b>-29%</b>

<sup>3</sup> Thomson, A.M. (ed.) (2008). Inventory and projections of UK emissions by sources and removals by sinks due to land use, land use change and forestry. Annual Report, July 2008, DEFRA Contract GA01088, CEH no.C03116.

And it's available on the project website at <http://www.edinburgh.ceh.ac.uk/ukcarbon/reports.htm>

Assuming central carbon saving and variants on fuel prices the sector emissions, by source, are shown in Table 4.3.

**Table 4.3 Sector emissions under the low, high and high-high price scenarios**

		<b>CENTRAL CARBON SAVING</b>								
MtCO <sub>2</sub>		Assuming low fossil fuel prices			Assuming high fossil fuel prices			Assuming high-high fossil fuel prices		
	2005	2010	2020	2025	2010	2020	2025	2010	2020	2025
<b>Power Stations</b>	175	170	147	148	167	143	139	166	139	134
<b>Refineries</b>	19	16	17	19	16	17	19	16	17	19
<b>Residential</b>	85	77	55	56	73	52	52	71	48	49
<b>Services</b>	23	23	22	22	23	22	22	23	22	22
<b>Industry</b>	112	108	105	107	108	104	105	108	103	104
<b>Road transport</b>	120	116	117	119	114	113	114	113	109	110
<b>Off-road</b>	13	11	10	10	11	10	10	11	10	10
<b>Other transport</b>	11	13	14	14	13	13	14	13	13	14
<b>Land Use Change</b>	-2	-1	3	3	-1	3	3	-1	3	3
<b>Total</b>	<b>555</b>	<b>532</b>	<b>490</b>	<b>498</b>	<b>522</b>	<b>476</b>	<b>478</b>	<b>518</b>	<b>464</b>	<b>466</b>
<b>EU ETS allowances purchased from abroad</b>		23	45	62	21	40	52	19	36	48
<b>Total including impact of EU ETS</b>	<b>555</b>	<b>508</b>	<b>446</b>	<b>436</b>	<b>502</b>	<b>436</b>	<b>425</b>	<b>499</b>	<b>428</b>	<b>418</b>
<b>% change from 1990 baseline</b>	<b>-6%</b>	<b>-14%</b>	<b>-25%</b>	<b>-26%</b>	<b>-15%</b>	<b>-26%</b>	<b>-28%</b>	<b>-16%</b>	<b>-28%</b>	<b>-29%</b>

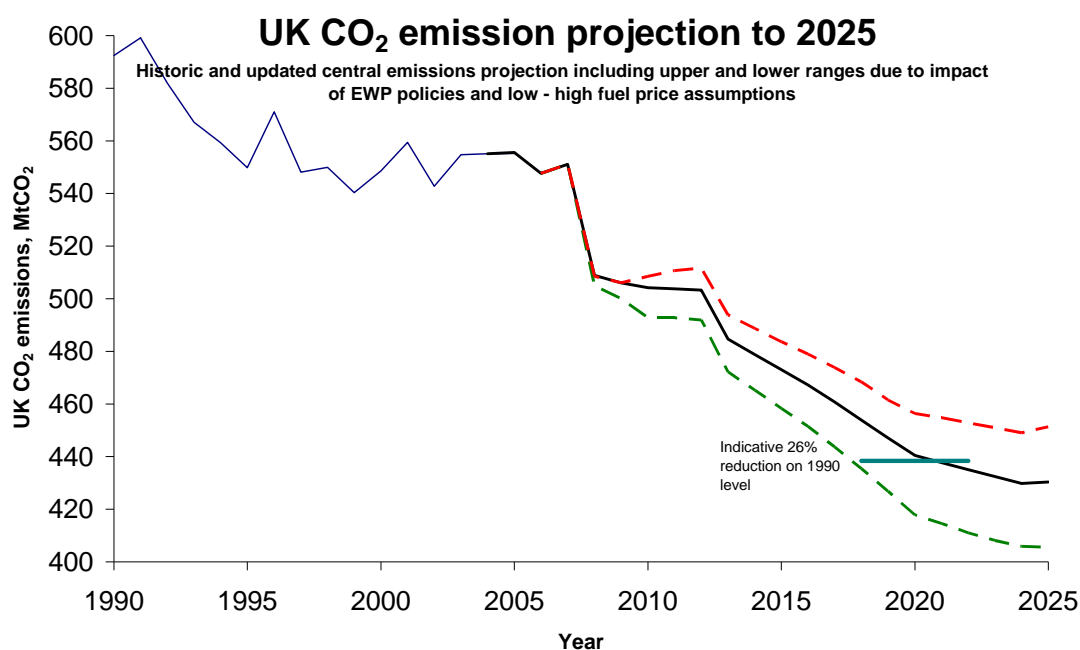
## TRADED AND NON-TRADED SECTOR PROJECTIONS BY SCENARIO

Table 4.4 illustrates the projected carbon dioxide emissions by scenario and split by traded and non-traded sectors. Emissions from the traded sector reflect the emissions projected under the scenario assumptions before purchase of any EU allowances.

**Table 4.4: Carbon dioxide emissions from EU ETS traded sector** Figures in brackets represent the allowances that would have to be purchased for each scenario.

MtCO <sub>2</sub>	Emissions from Traded Sector				Emissions from Non-traded Sector			
	2010	2015	2020	2025	2010	2015	2020	2025
Projection								
<b>Central prices, central EWP delivery</b>	264 (24)	256 (43)	232 (41)	229 (55)	264	260	250	256
<b>Central prices, high EWP delivery</b>	263 (23)	254 (41)	224 (33)	220 (46)	259	254	241	248
<b>Central prices, low EWP delivery</b>	265 (25)	258 (45)	237 (46)	234 (60)	264	261	252	259
<b>High prices, central EWP delivery</b>	261 (21)	254 (42)	230 (40)	226 (52)	262	256	245	252
<b>Low prices, central EWP delivery</b>	263 (23)	259 (46)	235 (45)	236 (62)	268	265	255	262
<b>High prices, high EWP delivery</b>	259 (19)	251 (38)	226 (36)	222 (48)	259	249	237	244

**Figure 4.1** Headline central updated projections of carbon dioxide including and excluding the purchase of EU ETS allowances (based on central fuel prices and EWP policy savings)

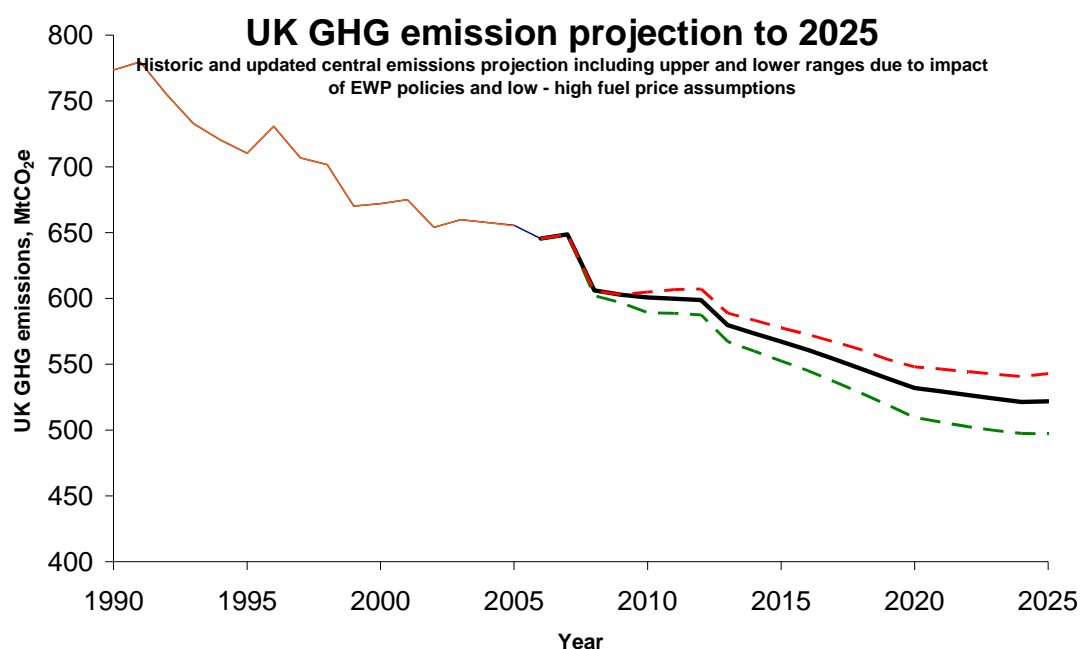


## PROGRESS TOWARDS KYOTO PROTOCOL

Under the Kyoto Protocol, the UK has a goal to reduce greenhouse gas emissions (GHGs) by 12.5% below 1990 levels by 2008-2012. The Kyoto goal is based on a basket of greenhouse gases (GHG) of which carbon emissions represent the largest share. The updated projections show that the UK remains on track to exceed its Kyoto commitment.

Based on the carbon price we have assumed for the EU ETS sectors and assuming that the UK will achieve between a high and low range of carbon savings for the White Paper proposals, the carbon emissions projections together with an estimated non-CO<sub>2</sub> GHG emissions projections<sup>4</sup> suggest that total UK GHG emissions will be between 523-534 million tonnes of carbon dioxide equivalent (MtCO<sub>2</sub>e) in 2020, i.e. 31-33% lower than 1990 levels. This projection of UK GHG emissions is inclusive of savings of carbon achieved domestically through a carbon price of €25/t CO<sub>2</sub> in 2020;<sup>5</sup> and is based on the central current non-carbon greenhouse gases projection and under central fossil fuel prices.

**Figure 4.2 Headline updated projections of Greenhouse gases, including purchase of EU ETS allowances (central carbon savings)**



## PROPOSED CARBON BUDGETS

The Climate Change Bill creates a new legal framework for the UK to reduce, through domestic and international action, its greenhouse gas emissions by at least 80% below 1990 levels by 2050. The Government will be required to set five-year carbon budgets, which place binding limits on emissions and set the trajectory towards the target. Decisions on the carbon budgets for the first three five-year periods (2008-2012, 2013-2017, 2018-2022) will need to be agreed by Parliament before June 2009.

<sup>4</sup> Provisional estimates of non-CO<sub>2</sub> greenhouse gas emissions provided by Defra to the EU in March 2007 have since been updated to take account of the CO<sub>2</sub> projections provided in the Energy White Paper, and other information available since the 2006 Climate Change Programme was published. These updated estimates are included in the GHG projection

<sup>5</sup> These GHG projections do not take into account the estimated additional allowances purchased by EU ETS sectors from other Member States

## SECTION 5 – FINAL ENERGY DEMAND RESULTS

### 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 Energy White Paper policy measures. Table 5.1 and 5.2 are based on central fuel price assumptions and central policy estimates. Table 5.3 presents energy demand by sector for all six price and policy scenarios and Table 5.4 provides final energy demand by fuel aggregated across sectors.

Table 5.1 includes all energy in the UK used for final consumption. Transport is presented on a consistent basis with the Digest of United Kingdom Energy Statistics<sup>6</sup>

**Table 5.1 Energy demanded by final user<sup>7</sup>, updated projection with central fossil fuel prices and central policy, (Mtoe)**

	Residential	Transport	Industry	Services	Total
<b>1990</b>	40.8	48.6	38.7	19.2	<b>147.3</b>
<b>1995</b>	42.7	50.2	36.3	21.2	<b>150.4</b>
<b>2000</b>	46.8	55.6	35.2	21.5	<b>159.1</b>
<b>2005</b>	47.0	59.2	33.1	20.2	<b>159.5</b>
<b>2010</b>	42.2	59.5	32.2	19.0	<b>153.0</b>
<b>2015</b>	38.9	62.0	32.7	18.6	<b>152.2</b>
<b>2020</b>	32.6	64.0	33.1	17.4	<b>147.2</b>
<b>2025</b>	33.9	66.6	34.0	17.7	<b>152.2</b>

Table 5.2 excludes fuel purchased which is used for international aviation. This is separated out in the modelling since international aviation is not included in the UK National Atmospheric Emissions Inventory.

**Table 5.2 Energy demanded by final user<sup>7</sup>, updated projection with central fossil fuel prices and central policy (excludes fuel used for international), (Mtoe)**

	Residential	Transport	Industry	Services	Total
<b>1990</b>	40.8	41.7	38.7	19.2	<b>140.4</b>
<b>1995</b>	42.7	42.3	36.3	21.2	<b>142.5</b>
<b>2000</b>	46.8	44.3	35.2	21.5	<b>147.8</b>
<b>2005</b>	47.0	46.2	33.1	20.2	<b>146.5</b>
<b>2010</b>	42.2	46.0	32.2	19.0	<b>139.5</b>
<b>2015</b>	38.9	46.3	32.7	18.6	<b>136.5</b>
<b>2020</b>	32.6	46.3	33.1	17.4	<b>129.5</b>
<b>2025</b>	33.9	46.9	34.0	17.7	<b>132.6</b>

<sup>6</sup> <http://www.berr.gov.uk/whatwedo/energy/statistics/publications/dukes/page45537.html>

<sup>7</sup> On energy supplied basis, excludes non-energy uses, excludes fuel used for transformation in Iron & Steel sector

**Table 5.3 Final energy demand by sector for all policy estimates and fuel price scenarios (Mtoe)**

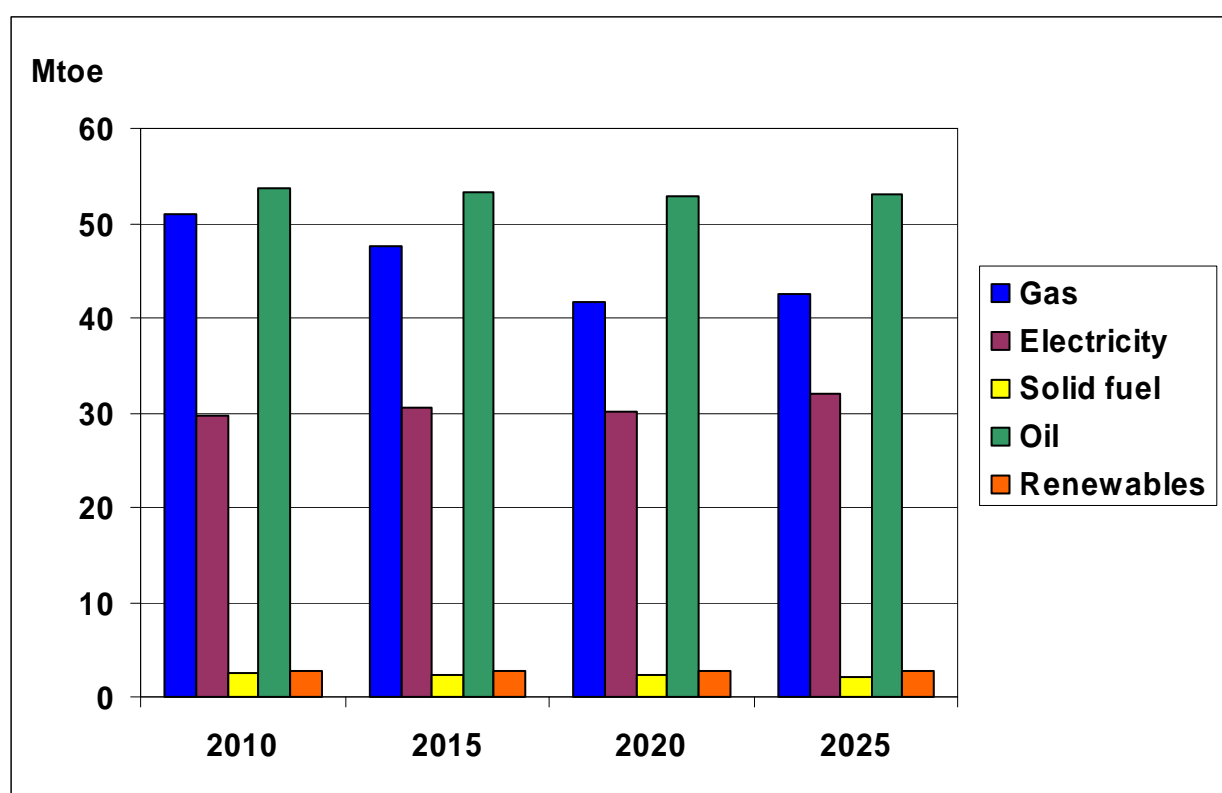
	Mtoe	2010	2015	2020	2025
<b>Industry</b>	<b>Central prices central policy impact</b>	32.2	32.7	33.1	34.0
	<b>Central prices high policy impact</b>	32.2	32.6	32.9	33.9
	<b>Central prices low policy impact</b>	32.2	32.8	33.3	34.2
	<b>High prices central policy impact</b>	32.1	32.5	32.9	33.8
	<b>Low prices central policy impact</b>	32.4	33.0	33.4	34.3
	<b>High-high prices central policy impact</b>	32.0	32.1	32.5	33.4
<b>Residential</b>	<b>Central prices central policy impact</b>	42.2	38.9	32.6	33.9
	<b>Central prices high policy impact</b>	42.1	38.2	31.0	32.3
	<b>Central prices low policy impact</b>	42.3	39.6	34.2	35.5
	<b>High prices central policy impact</b>	41.4	37.9	31.6	32.7
	<b>Low prices central policy impact</b>	43.7	40.1	33.7	35.1
	<b>High-high prices central policy impact</b>	40.6	36.0	29.7	31.0
<b>Services</b>	<b>Central prices central policy impact</b>	19.0	18.6	17.4	17.7
	<b>Central prices high policy impact</b>	19.0	18.1	16.3	16.6
	<b>Central prices low policy impact</b>	19.1	18.8	17.8	18.0
	<b>High prices central policy impact</b>	19.0	18.6	17.4	17.7
	<b>Low prices central policy impact</b>	19.0	18.6	17.4	17.7
	<b>High-high prices central policy impact</b>	19.0	18.6	17.4	17.7
<b>Transport (domestic)</b>	<b>Central prices central policy impact</b>	46.0	46.3	46.3	46.9
	<b>Central prices high policy impact</b>	46.0	46.3	46.3	46.9
	<b>Central prices low policy impact</b>	46.0	46.3	46.3	46.9
	<b>High prices central policy impact</b>	45.7	45.6	45.5	46.0
	<b>Low prices central policy impact</b>	46.2	47.0	47.1	47.7
	<b>High-high prices central policy impact</b>	45.7	45.6	45.5	45.9
<b>TOTAL</b>	<b>Central prices central policy impact</b>	139.5	136.5	129.5	132.6
	<b>Central prices high policy impact</b>	139.4	135.3	126.5	129.6
	<b>Central prices low policy impact</b>	139.7	137.5	131.6	134.6
	<b>High prices central policy impact</b>	138.2	134.6	127.4	130.2
	<b>Low prices central policy impact</b>	141.3	138.6	131.6	134.9
	<b>High-high prices central policy impact</b>	137.3	132.3	125.1	128.1

Table 5.4 and Figure 5.1 illustrate demand by fuel for the updated projection in the case with central policy impact and central fossil fuel prices. Fuel used for international aviation is excluded.

**Table 5.4 Final energy demand by fuel in the updated projection for central fossil fuel prices and central policy**

Mtoe	Gas	Electricity	Solid fuel	Oil	Renewables	Total
2010	51.0	29.6	2.5	53.6	2.8	139.5
2015	47.5	30.6	2.4	53.3	2.8	136.5
2020	41.6	30.0	2.2	52.8	2.8	129.5
2025	42.6	31.9	2.1	53.1	2.8	132.6

**Figure 5.1 Projected Total Final Energy Demand**



## SECTION 6 – ENERGY INDUSTRIES

This section provides projections for power stations, offshore, combined heat and power plants (CHP) and refineries. It also sets out the recent context for the electricity generation sector<sup>8</sup>, information on changes to the modelling procedure and a summary of the projections. Further detail on the generating sector is set out in Annex E.

Recently overall electricity use has continued to fall since 2003 and in the first seven months of 2008 was down by just over 1% compared with the same period in 2007. Generation from coal – fired stations reached about 138TWh in 2006, its highest level since 1995. At the same time, generation from gas – fired stations fell to its lowest level since 1998. Coal – fired generation was boosted by the significant gap between the input costs of coal and gas, even after allowing for the impact of emissions trading, particularly during the first six months of 2006. The boost was much less marked in the last half of 2006, as the differential between coal and gas costs narrowed.

Since 2006, coal generation has diminished somewhat, reaching about 126TWh in 2007 and this trend continued into the first half of 2008. Whilst gas prices have remained relatively high compared with coal costs, coal generation has been affected somewhat by the retrofitting of FGD equipment at a number of stations, the effect of which has been to restrain generation at these plants. It remains to be seen whether the generation at non – FGD plants and some FGD plants, which appears to have picked up in order to offset the lower generation from stations undergoing retrofitting of FGD, will continue at relatively high levels. Another factor which is likely to have reduced coal – sourced generation in 2008 will have been the impact of the Large Combustion Plant Directive.

Output from nuclear plants fell to 57TWh in 2007, compared with output of around 80TWh between 2000 and 2003. There has been a further significant decline during the first half of 2008. Aggregate nuclear generation is expected to increase somewhat in the last part of 2008 as the stations which have been off – line begin to supply electricity again, following sustained outages. The effect of lower nuclear output in the last few years, together with relatively low imports of electricity, has been a significantly greater reliance on coal and gas plants in the overall mix, despite a steady increase in the contribution of renewable plants.

### Changes to Modelling Approach

A number of changes have been made to the modelling approach since the Energy White Paper projections of May 2007. The most significant of these has been the formal introduction of seasonal modelling, building on off – model developments in the previous two years. The development of seasonal modelling has allowed improved modelling of the seasonal aspect of gas prices and also an improved simulation capability of wholesale electricity prices. A capability to introduce ‘bidding’ into the basic cost minimisation approach has been introduced.

Renewables modelling has also been updated and in particular, allows for the incorporation of ROC prices and maximum build rates for particular renewable types.

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<sup>8</sup> The coverage of this sector is major power producers – as defined in the Digest of UK Energy Statistics - plus all other renewable generators. The activities of other generators of electricity are included within the industrial or commercial sectors.

## Key Power Station Assumptions

There are a number of assumptions underlying the power station projections. The key ones are as follows:

- The central case assumes a flat CO<sub>2</sub> price of €25/t CO<sub>2</sub><sup>9</sup>.
- The current Large Combustion Plant Directive applies – the proposed Industrial Emissions Directive is not incorporated<sup>10</sup>.
- Energy White Paper measures of a banded Renewables Obligation are included but projections do not include any assumptions about targets under the renewables directive as the strategy is still being consulted on.
- Some non opted – out coal – fired capacity closures are assumed.

The prospects for individual fuels or plants suggested by the central projection are as follows:

A projected small increase in electricity demand suggests an increased call on grid plants through to around 2013, but the call on the grid reduces thereafter as a result of demand measures and growth in CHP capacity. The projected call on grid plants is around 4% lower in 2020 than the level in 2007.

In the years to 2011, coal generation in the central projection remains close to the levels thus far seen in 2008. The precise impact of the LCPD will become clearer through time. Coal-fired generation falls away as generating units or stations close due either to having generated 20,000 hours or through reaching the end of their economic lifetimes. The exact timing of the former effect is uncertain, however, it is inevitable that there will be a steady and significant decline in coal-fired capacity between around 2011 and the end of 2015. A small build of new coal stations is projected, with the initial units commencing operations in 2013/14. The extent of new coal capacity coming on stream is difficult to assess, particularly as there are a large number of significant influences. The central projections include new coal capacity of around 3GW in 2020, rising to around 4GW in 2023. Of these totals, around 0.5GW is assumed to have CCS in operation. Coal generation in the long term is projected to be around 90TWh/year compared with around 71TWh in the EWP projections.

Gas-fired generation in the central projection indicates little change from 2008 levels through to around 2014 despite more gas-fired capacity coming on stream. The central projection suggests further new gas build by 2016 temporarily increasing gas-fired generation before falling away somewhat as a result of other base load generation such as nuclear and, when available, renewables coming on stream.

Although the exact profile of nuclear generation in the very short term is unclear, it is projected to recover from recent low levels to around 63TWh in 2010, before falling through time reflecting the expected profile of plant closures. The cost of new nuclear build continues to be competitive with other forms of new capacity and it is assumed (a modelling assumption also made in the Energy White Paper high policy case) that by 2020 the equivalent of one new station will be available with further new capacity following thereafter. By 2023 around 5GW of new nuclear capacity is projected and by 2025 close to 8GW. At the end of 2025, total nuclear capacity is projected to be 10GW just a little lower than the current level of

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<sup>9</sup> The assumed CO<sub>2</sub> price varies between €20 per tonne of CO<sub>2</sub> in the low energy price case to €50 per tonne of CO<sub>2</sub> in the high-high energy price scenario. CO<sub>2</sub> prices are held flat through out the projections period. Simulation work has been carried out to examine the impact of a rising CO<sub>2</sub> price through time and further work is planned to refine this analysis.

<sup>10</sup> The proposed EU Directive on Industrial Emissions (IED) could have very significant impacts on power stations. In summary, the IED would supersede many of the provisions of the Large Combustion Plant Directive (LCPD) which was agreed just a few years ago and which has only begun to operate from January 1st this year. Amongst the more onerous proposals are the removal of the 'NERP' flexibility - expressly negotiated by the UK as essentially a cap and trade system for controlling emissions of SO<sub>2</sub> and NO<sub>x</sub> - and the imposition of tighter emission limits on a wide range of plants, including gas - fired stations, from 2016 onwards. If adopted in full, the IED would imply higher generation costs, substantially reduced flexibility for coal plants to meet emission limits, possible significant plant modification costs for existing CCGTs and ultimately, earlier plant closure than might otherwise have been the case.

11GW although it is of course possible that the actual amount of new capacity will exceed this level.

Prospects for renewables in the short term are very much dependent on the rate at which capacity can physically be added to the system<sup>11</sup>. It remains to be seen how quickly some of the larger projects in particular actually come on stream in the short to medium term. In the longer term generation from renewables is expected to reach around 56TWh/year in 2020 with further small increases following in later years. This projection is broadly unchanged from the 2007 EWP projection.

Imports of electricity have remained below the peak levels seen in 1999 and 2000 but remain significant. The average level of electricity imports since 1998 has been close to 11TWh/year. The short term projection is for imports of 8.5TWh/year followed by increased imports from 2010 onwards (close to the historic average) as a result of new interconnection capacity. Beyond 2014 it is assumed that further interconnection capacity will be added which increases imports to around 17TWh/year.

The projected generation and capacity figures for the central case are shown in Tables 6.1 and 6.2. Chart 6.1 shows a comparison of electricity generation by fuel for the updated central case results and the central case projections from 2007.

**Table 6.1: Updated Projections of Electricity Supply, TWh<sup>12</sup>**

TWh	2010	2015	2020	2025
<b>Coal</b>	120	112	87	93
<b>Oil</b>	1	1	1	2
<b>Gas</b>	132	142	153	134
<b>Nuclear</b>	63	45	32	62
<b>Renewables</b>	33	50	56	59
<b>Imports</b>	14	17	17	17
<b>Storage</b>	2	2	2	2
<b>Total</b>	<b>366</b>	<b>369</b>	<b>348</b>	<b>368</b>

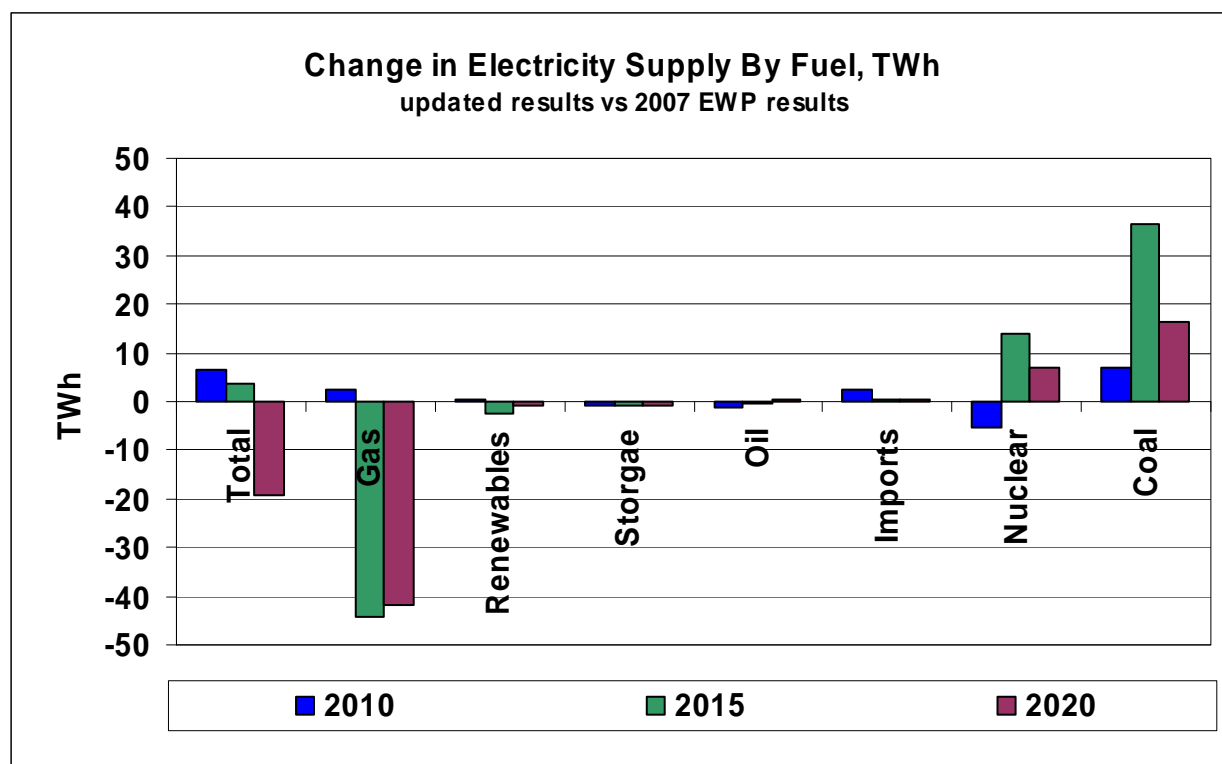
<sup>11</sup> It should be remembered that the coverage of the power station model includes all renewable generating plants, be they owned by major power producers or by others.

<sup>12</sup> The coverage of this sector is major power producers – as defined in the Digest of UK Energy Statistics - plus all other renewable generators. The activities of other generators of electricity are included within the industrial or commercial sectors. Electricity supply is measured as electricity supplied (gross) as in Table 5.6 of DUKES 2008. <http://www.berr.gov.uk/whatwedo/energy/statistics/publications/dukes/page45537.html>

**Table 6.2: Updated Projections of Electricity Capacity, GW**

GW	2010	2015	2020	2025
<b>Coal</b>	28	22	16	17
<b>Oil</b>	4	2	1	1
<b>Gas</b>	30	37	42	43
<b>Nuclear</b>	11	7	5	10
<b>Renewables</b>	10	16	18	19
<b>Imports</b>	3	5	5	5
<b>Storage</b>	3	3	3	3
<b>Total</b>	<b>89</b>	<b>91</b>	<b>90</b>	<b>97</b>

**Chart 6.1**



The increase in generation of electricity by coal fired plants compared with the Energy White Paper is largely due the changes in the relative price of gas and coal which has tended to favour coal burn. This is an outcome of the modelling approach which is based on selecting the most economic generation mix to meet a given electricity demand and does not reflect any particular government policy.

Compared with the 2007 Energy White Paper central case projection, call on the grid is little changed in 2010 and 2015, but rather lower in 2020; gas generation is lower in 2015 and 2020, coal, conversely, is higher in those years. Nuclear generation is a little higher in later years.

Much of the change from the 2007 EWP projections for gas and coal generation in the later years can be attributed to changes in relative fuel price assumptions which act to increase coal generation and reduce gas generation.

### Other Scenarios

In broad terms, the key results for other scenarios compared with the central case may be summarised as follows (Detailed figures are shown in Annex E) :

Lower energy prices suggest higher gas capacity and generation. Higher energy prices suggest slightly less gas generation and slightly higher renewables generation. Very high energy prices suggest higher coal generation, lower gas generation and higher renewables generation.

### Uncertainties In The Power Sector Projections

As well as uncertainties over future fossil fuel prices there are a number other uncertainties related specifically to the power sector which include

- The longevity of existing coal – fired capacity, including 'opted-in' plant.
- The future CO<sub>2</sub> price.
- The evolution of renewables capacity.

Examination of these uncertainties is ongoing.

### OFFSHORE

The use of natural gas offshore has declined significantly since its peak in 2002. The estimated amount used offshore in 2007 was around 18% lower than in 2002. Production of both natural gas and crude oil have fallen by 30% and 35% respectively. The energy intensity of offshore production activity has therefore continued to increase.

Table 6.3 provides the updated projection of offshore emissions compared with the EWP projections. The updated projection is somewhat lower than the 2007 projection. The future trend in offshore energy intensity is however, uncertain.

**Table 6.3: Updated Offshore Emissions from Gas Combustion, and gas separation compared with the EWP projection (MtCO<sub>2</sub>)**

	2005	2010	2015	2020	2025
<b>EWP projection</b>	15.6	16.4	12.3	8.2	..
<b>Updated projection</b>	15.6	12.5	9.4	6.9	5.3

Updated projection of emissions from offshore flaring is shown in Table 6.4 and compared with the EWP projection.

**Table 6.4: Offshore Emissions from Flaring (MtCO<sub>2</sub>)**

	2005	2010	2015	2020	2025
<b>EWP projection</b>	4.6	4.6	3.9	3.2	-
<b>Updated projection</b>	4.6	3.4	3.1	2.8	2.6

Emissions from flaring have been revised down from the EWP projections. As oil production falls over time, some reduction in flaring might be expected, but the extent is uncertain, particularly as there is little evidence of a significant fall in the last few years. This projection will be reviewed during 2009.

### **COMBINED HEAT AND POWER (CHP)**

CHP systems offer highly efficient fossil fuel use with low associated emissions per unit of useful energy output. In recognition of this in 1999 the government set a target of 10 GW installed capacity by 2010 and developed a strategy and incentives in order to achieve this. Since then CHP development has been well below the necessary level to meet this target primarily as a result of unfavourable price differentials for gas and electricity and uncertainty in heat markets. The current projections are based on improved modelling and data that incorporates behavioural aspects of the decision making process, estimates of economic viability and a probabilistic view of industry attitudes towards risk. Revised projections of installed capacity are shown in Table 6.5 and compared with the previous projections.

**Table 6.5: Updated projection of Installed capacity of CHP**

Capacity, GW	2010	2015	2020	2025
<b>Updated projection</b>	7.1	9.1	12.1	13.7
<b>EWP projection</b>	7.3	8.6	8.6	..

The differences reflect revised assumptions and increased sophistication of the modelling rather than more optimism, however both projections suggest that under prevailing conditions CHP take-up will be slow. In the near-term much of the expansion is due to the use of CHP heat to re-gassify liquefied natural gas which has been imported from abroad. In the longer-term, as this market becomes saturated, other sectors will respond to price signals and expand take-up. In October 2007 the Government published an analysis of the UK potential for combined heat and power<sup>13</sup> and this suggests that values presented here fall well short of the full economic potential. Options for reducing uncertainty, in the heat market will be considered in the forthcoming DECC Consultation Document-Heat and Energy Saving.

<sup>13</sup> <http://www.defra.gov.uk/environment/climatechange/uk/energy/chp/pdf/potential-report.pdf>

## OIL REFINERIES

Recent trends in oil refinery emissions have been strongly influenced by the need for reduction in sulphur content of gasoline and diesel. These trends look set to continue over the next 18 months with further effects in the longer term resulting from new International Maritime Organisation (IMO) regulations<sup>14</sup>. A second influence is increasing demand for diesel which, combined with the potential increase in gas oil demand arising from the IMO regulations, will put further strain on refineries. Energy use at refineries is expected to rise over the next few years followed by a period of consolidation in the next decade with relatively stable energy use and increasing throughput. By 2025, the new limits for marine fuel oil are expected to have forced up refinery energy use.

Assumptions have been updated in the light of the latest information. The key assumptions affecting emissions are:

- Constant throughput to 2010, followed by 0.5% p.a. increase
- Average energy consumption of 0.825GWh/kt of throughput (2010-2020)
- Fuels consisting of refinery gases, fuel oil, natural gas, petroleum coke<sup>15</sup> and gas oil

Under these revised assumptions the updated projected emissions from oil refineries, compared with the EWP projection are shown in Table 6.6

**Table 6.6 Emissions from Refineries**

MtCO <sub>2</sub>	2010	2015	2020	2025
<b>Updated projection</b>	16.1	16.5	17.0	19.1
<b>EWP projection</b>	21.3	22.0	22.4	..

The current projections are lower than those published previously. This is due primarily to the updated assumptions and to definitional changes in the treatment of combined heat and power units (CHP). In line with the Digest of UK Energy Statistics, these values exclude both the fuels used in those refinery CHPs which are Major Power Producers and that proportion of the fuel input to embedded CHP units that is considered to be used for electricity generation.

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<sup>14</sup> Marine fuel oil is a major source of acid emissions at sea. New regulations, confirmed in October 2008, seek to reduce the sulphur content by around 90% by 2020, or 2025 at the latest.

<sup>15</sup> The term petroleum coke is used here to describe the coke deposits that are burnt off catalytic cracking units.

## SECTION 7 – OVERALL EMISSIONS UNCERTAINTY

The updated emissions projections are subject to uncertainty in the same way as any projections into the future will be. We try to capture some of the uncertainty by assuming a range on fossil fuel prices for example, and examine the impact on emissions. This provides some understanding of the changes in level of emissions due to the uncertainty in projecting international fuel prices. Assuming a range of policy delivery of the Energy White Paper proposals also captures the uncertainty associated with estimating the impact of these policies. However, there are other sources of uncertainty which include uncertainty of future economic growth, the delivery of existing policy measures and parameter or modelling uncertainty which derives from the assumption that we can project future energy market behaviour based on historic trends. There is also the uncertainty associated with projecting a carbon price and the estimation of the future purchase of EU allowances based on European Commission's proposals and specifically our estimate of the implications for the UK of the proposed EU-wide cap and the level of allowances purchased through the scheme.

Uncertainty in Land use change emissions estimates and (where projections include other greenhouse gases<sup>16</sup> projections) the uncertainty associated with these non-carbon dioxide projections is also considered.

It is estimated that the uncertainty associated with the updated central projection of all GHG is approximately plus or minus 43MtCO<sub>2</sub>e by 2020 and 47MtCO<sub>2</sub>e by 2025. This is marginally lower than the uncertainty margin of 51MtCO<sub>2</sub>e estimated for the central Energy White Paper projection. The reduction is due in part to a lower estimated level of uncertainty associated with the estimation of the EUETS cap (the Energy White Paper cap was more illustrative at a constant level of effort than the current EC proposals).

The largest component of uncertainty is modelling uncertainty at around 50%, followed by policy uncertainty around 30% and fuel price 9-12%. It is estimated that a higher level of economic growth would contribute around 2-5% uncertainty by 2025 and Land use change around 4%. EUETS contributes around 2-3%.

Uncertainty associated with the carbon dioxide central projection is approximately plus or minus 46 MtCO<sub>2</sub> by 2025 respectively. By 2020 this is 42MtCO<sub>2</sub> and 7MtCO<sub>2</sub> lower than associated with the Energy White Paper central projection.

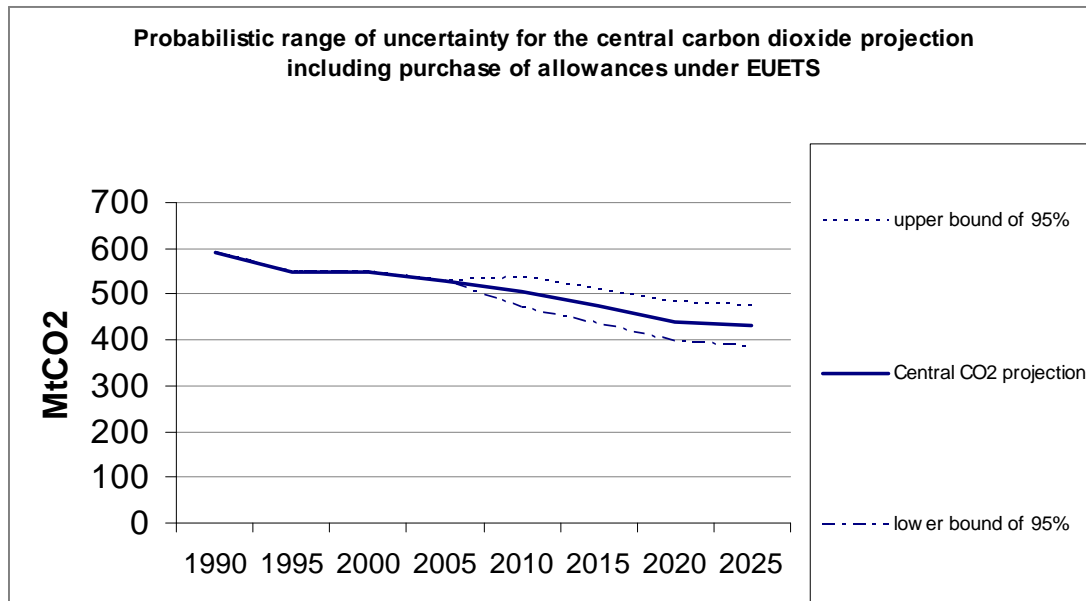
Figure 7.1 and Figure 7.2 illustrate the probabilistic uncertainty bounds for the carbon dioxide projection and the associated GHG central projections respectively. Illustrated also are the Kyoto, domestic and EU targets and illustrative Carbon Budget range.

An updated central projection of carbon dioxide emissions including the impact of the Energy White Paper proposals central estimates and the estimated allowances purchased under the EU ETS is illustrated in Figure 7.1 showing a probabilistic range around the central carbon emission projection of plus or minus 46 MtCO<sub>2</sub> in 2020 (42 MtCO<sub>2</sub> in 2025).

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<sup>16</sup> The five non- CO<sub>2</sub> greenhouse gases covered by the Kyoto Protocol are methane, nitrous oxide, HFCs, PFCs and SF<sub>6</sub>.

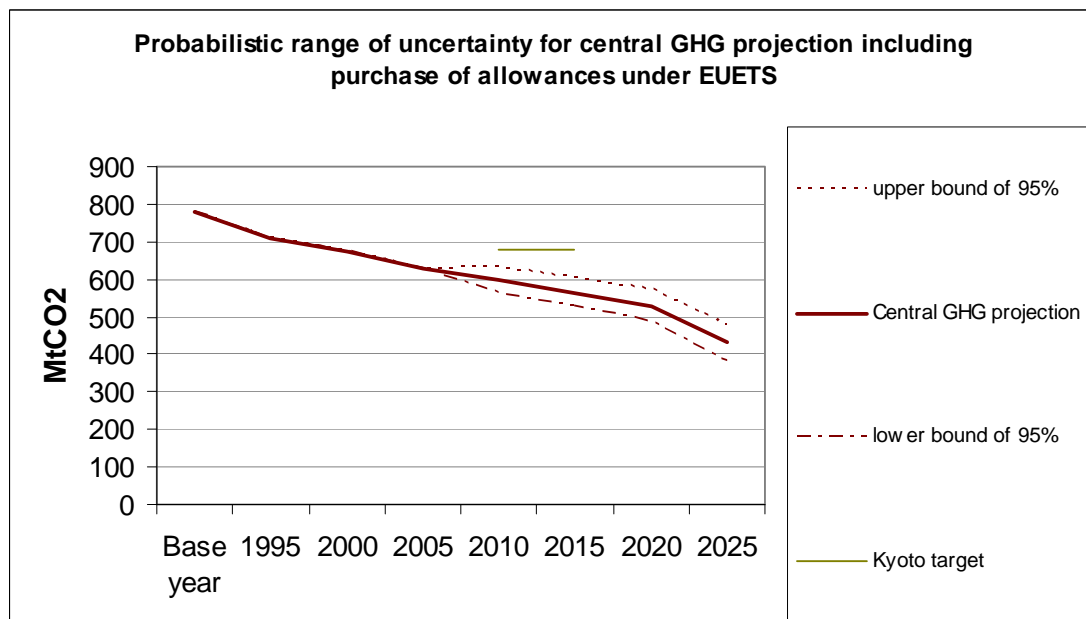
**Figure 7.1 Probabilistic range of uncertainty for the central carbon dioxide projection including purchase of allowances under EU ETS**



An updated central projection of carbon dioxide and other GHG emissions including the impact of the Energy White Paper proposals central estimates and the estimated allowances purchased under the EU ETS is illustrated in Figure 7.2 showing a probabilistic range around the central carbon emission projection of plus or minus 47 MtCO<sub>2</sub> in 2020 (43 MtCO<sub>2</sub> in 2025).

This suggests that in 2010 UK emissions of greenhouse gases will be between 18% and 27% below base year levels, with the central scenario about 21% below. This range takes into account macroeconomic, policy and modelling uncertainties and therefore our Kyoto goal is very likely to be met on the basis of current policy.

**Figure 7.2 Probabilistic range of uncertainty for the central GHG projection including purchase of allowances under EU ETS**



## Annex A- Fuel price assumptions

### Fossil fuel price assumptions

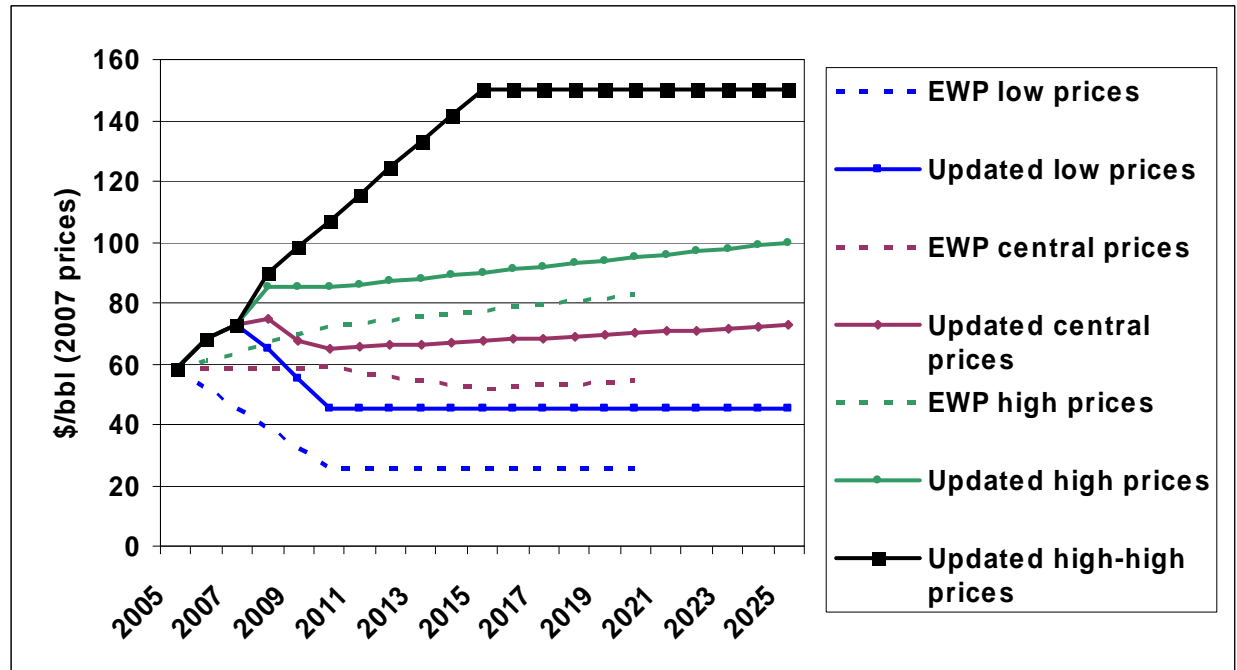
**Table A1 Central fossil fuel price assumptions, Updated and Energy White Paper (EWP) 2007**

2007 prices	Crude oil \$/bbl		Natural gas NBP p/therm		ARA coal £/tonne	
	EWP (May 2007)	Updated	EWP (May 2007)	Updated	EWP (May 2007)	Updated
<b>2010</b>	59	65	43	43	31	36
<b>2015</b>	52	68	39	44	32	31
<b>2020</b>	55	70	41	46	33	32
<b>2025</b>	..	73	..	47	..	33

The updated oil price assumptions are higher than those used in the Energy White Paper analysis. The most recent fossil fuel price assumptions were published by the Department in May 2008. The upward revisions in the central scenario are consistent with changes made by the International Energy Agency (IEA) and the US Energy Information Administration (EIA), and reflect the continuing market tightness and higher costs of production. For this scenario it is assumed that new production capacity comes on-stream and demand growth moderates until 2010. Beyond 2010, it is assumed that the oil market gets tighter again as demand from Newly Industrialised Countries (NICs) such as China, India and the Middle East continues to grow. It is further assumed that not all the investment required to increase oil production takes place or is timely. Therefore, as oil is increasingly produced from more expensive sources and spare capacity remains relatively tight, prices rise after 2010 and are assumed to remain higher than the historic average. Oil is now assumed to be 65 \$/bbl in 2010 and 73 \$/bbl in 2025 (2007 prices).

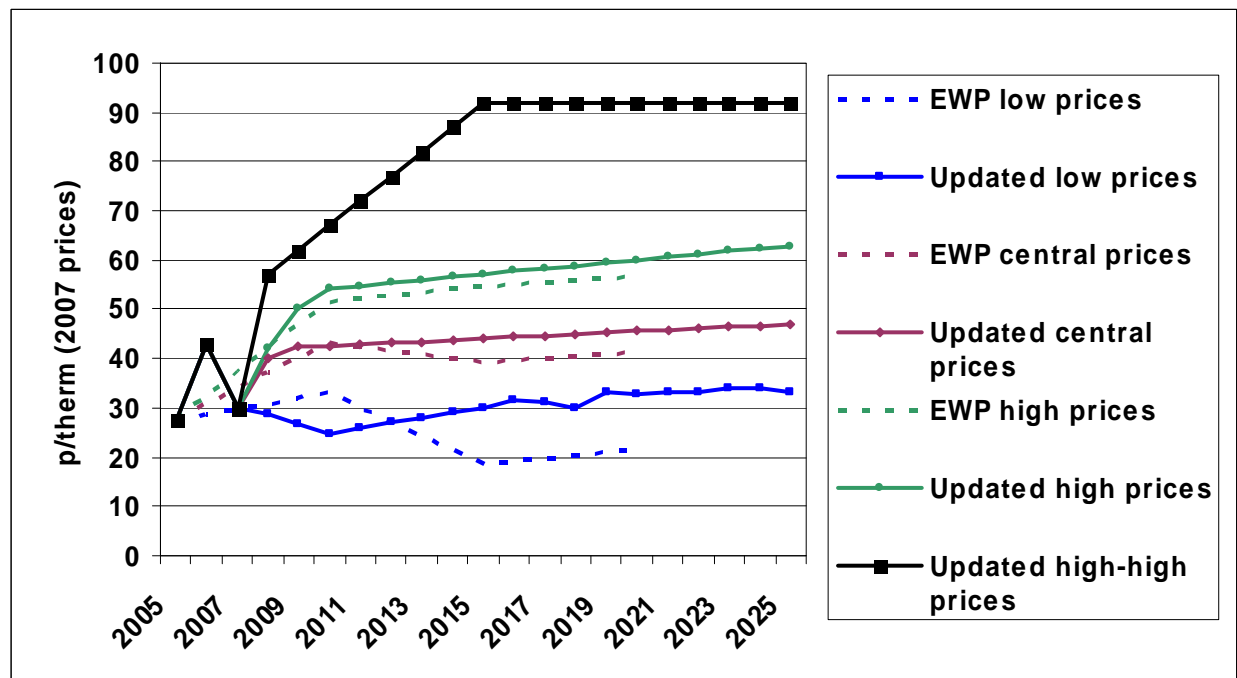
A range of scenarios for fuel prices are presented and used in the Energy model to reflect the uncertainty surrounding fuel prices. An additional scenario for high-high prices is included to reflect strong oil demand, a lack of investment and a fast decline in spare capacity. This is assumed to drive prices upwards until the time when alternative energy sources become competitive and oil consumption declines. The oil price is then assumed to remain around this point in the long-term.

Figure A1 illustrates changes in the oil price projections in the low, central and high case scenarios (\$/bbl)



The gas price in Europe and the US is assumed to remain oil linked. UK gas prices are assumed to be similar to continental prices, plus a transport cost add-on, as the continent will remain the marginal source of gas in winter. Gas is assumed to be 43 p/therm in 2010, and 47p/therm in 2025.

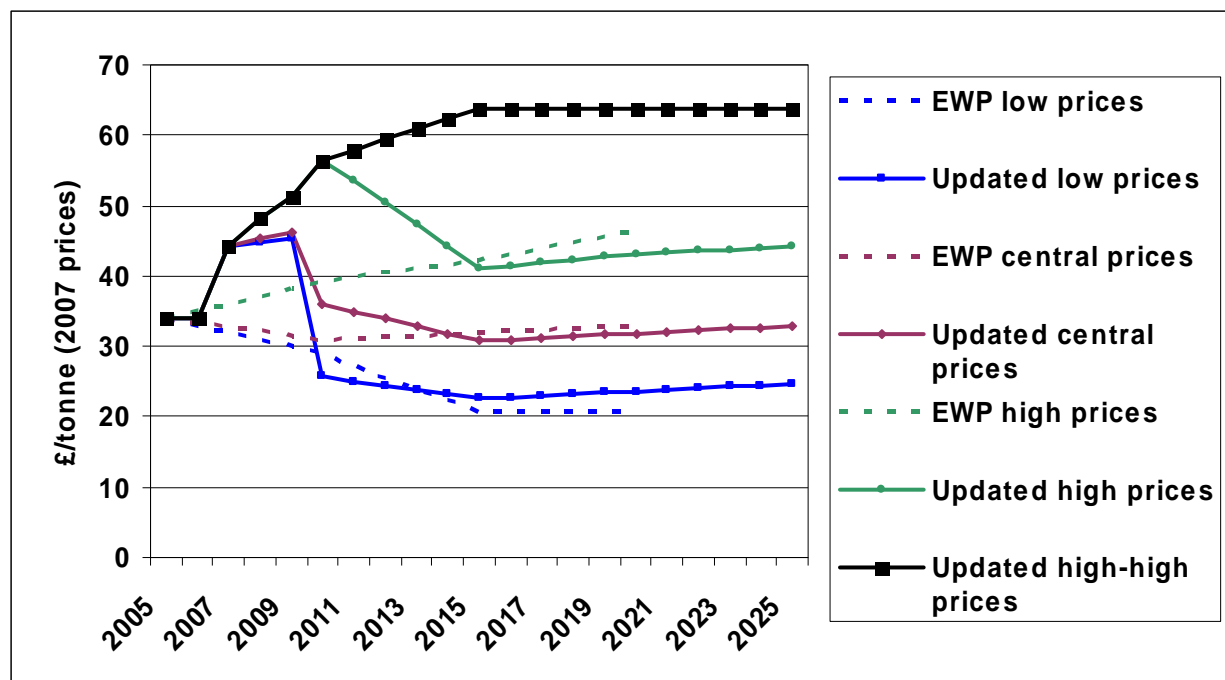
Figure A2 illustrates changes in the gas price projections in the low, central and high case scenario (p/therm)



In the near term coal prices continue to be high compared to historic averages due to congestion at Australian ports, high coal demand from China/India as well as high freight rates. New vessels are predicted to come "online" by 2009 which should lower freight rates

around late 2009. The supply/demand balance is expected to improve by 2010, due to increased availability of South African and Chinese coal, and increased Indonesian exports. In the longer term, coal prices are assumed to grow in line with oil and gas prices due to the opportunities for substituting between the different fossil fuels. Coal is assumed to be £36/tonne in 2010 and £33/tonne in 2025.

**Figure A3 illustrates the change in coal price projections in the low, central and high case scenarios (£/tonne)**



The high, central and low prices assumptions are illustrative scenarios developed by former BERR analysts and are used to reflect uncertainty over the outcome of future prices in the modeling. They are not detailed forecasts or predictions of future prices.

**In the high price scenario** the oil price is assumed to be \$85/bbl in 2010 increasing to \$100/bbl by 2025, a gas price of 54p/therm to 63p/therm respectively and a coal price is projected to increase to £57/tonne in 2010 and then fall to £44/tonne by 2025.

**In the high-high price scenario** the oil price is assumed to be \$107/bbl in 2010 increasing to \$150/bbl by 2025, a gas price of 67p/therm to 92p/therm and a coal price of £56/tonne to £64/tonne respectively.

**In the low price scenario** the oil price is assumed to be stable at \$45/bbl in 2010 and 2025. The gas price is assumed to be 25 p/therm by 2010 and 33p/therm by 2020. A coal price of 26 £/tonne in 2010 and 25£/tonne in 2025 is projected.

Tables A2 to A4 give a more detailed account of changes in fossil fuel price projections from Energy White Paper assumptions.

**Table A2- Changes in oil price projections**

<b>Crude Oil (\$/bbl) (2007 prices)</b>	<b>EWP low prices</b>	<b>Updated low prices</b>	<b>EWP central prices</b>	<b>Updated central prices</b>	<b>EWP high prices</b>	<b>Updated high prices</b>	<b>Updated high-high prices</b>
<b>2005</b>	58	58	58	58	58	58	58
<b>2010</b>	26	45	59	65	72	85	107
<b>2015</b>	26	45	52	68	77	90	150
<b>2020</b>	26	45	55	70	83	95	150
<b>2025</b>	..	45	..	73	..	100	150

**Table A3- Changes in gas price projections**

<b>Natural gas p/therm (2007 prices)</b>	<b>EWP low prices</b>	<b>Updated low prices</b>	<b>EWP central prices</b>	<b>Updated central prices</b>	<b>EWP high prices</b>	<b>Updated high prices</b>	<b>Updated high-high prices</b>
<b>2005</b>	28	28	28	28	28	28	28
<b>2010</b>	33	25	43	43	52	54	67
<b>2015</b>	19	30	39	44	55	57	92
<b>2020</b>	22	33	41	46	57	60	92
<b>2025</b>	..	33	..	47	..	63	92

**Table A4- Changes in coal price projections**

<b>ARA coal £/tonne (2007 prices)</b>	<b>EWP low prices</b>	<b>Updated low prices</b>	<b>EWP central prices</b>	<b>Updated central prices</b>	<b>EWP high prices</b>	<b>Updated high prices</b>	<b>Updated high-high prices</b>
<b>2005</b>	34	34	34	34	34	34	34
<b>2010</b>	29	26	31	36	39	57	56
<b>2015</b>	21	23	32	31	42	41	64
<b>2020</b>	21	24	33	32	46	43	64
<b>2025</b>	..	25	..	33	..	44	64

**Table A5- Retail fuel price assumptions: Central fossil fuel prices, central policy impact**

p/kWh (2007 prices)	Electricity			Gas		
	Industry	Residential	Services	Industry	Residential	Services
2005	4.5	9.1	4.9	1.5	2.4	1.6
2010	8.2	12.9	9.6	2.0	3.0	2.6
2015	8.1	12.3	9.6	2.0	3.0	2.7
2020	8.4	12.5	9.8	2.1	3.1	2.7
2025	8.5	12.7	10.0	2.1	3.2	2.8

**Table A6- Retail fuel price assumptions: High fossil fuel prices, central policy impact**

p/kWh (2007 prices)	Electricity			Gas		
	Industry	Residential	Services	Industry	Residential	Services
2005	4.5	9.1	4.9	1.5	2.4	1.6
2010	9.7	14.5	11.1	2.4	3.4	3.0
2015	9.7	13.9	11.2	2.5	3.5	3.1
2020	10.1	14.3	11.6	2.6	3.6	3.2
2025	10.4	14.7	11.9	2.7	3.7	3.3

**Table A7- Retail fuel price assumptions: High-high fossil fuel prices, central policy impact**

p/kWh (2007 prices)	Electricity			Gas		
	Industry	Residential	Services	Industry	Residential	Services
2005	4.5	9.1	4.9	1.5	2.4	1.6
2010	11.4	16.3	12.8	2.8	3.9	3.5
2015	13.5	17.9	14.9	3.7	4.8	4.3
2020	13.6	18.0	15.1	3.7	4.8	4.3
2025	13.6	18.0	15.1	3.7	4.8	4.3

**Table A8- Retail fuel price assumptions: Low fossil fuel prices, central policy impact**

p/kWh (2007 prices)	Electricity			Gas		
	Industry	Residential	Services	Industry	Residential	Services
2005	4.5	9.1	4.9	1.5	2.4	1.6
2010	6.4	11.0	7.8	1.4	2.4	2.0
2015	6.6	10.7	8.1	1.5	2.5	2.2
2020	7.0	11.1	8.5	1.6	2.7	2.3
2025	7.1	11.2	8.5	1.6	2.7	2.3

**Table A9- Weighted average<sup>17</sup> road transport fuel price assumptions**

<b>p/litre (2007 prices)</b>	<b>Low oil price</b>	<b>Central oil price</b>	<b>High oil price</b>	<b>High-high oil price</b>
<b>2005</b>	86	86	86	86
<b>2010</b>	87	95	103	111
<b>2015</b>	88	96	105	128
<b>2020</b>	88	98	107	129
<b>2025</b>	88	99	109	129

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<sup>17</sup> Weighted average calculated based on fuel demand for Premium Unleaded, Super Unleaded and Diesel demand from private vehicles.

## Annex B – Growth Assumptions

Near and medium-term economic growth assumptions are consistent with HM Treasury announcements in the most recent Budgets or Pre Budget Reports. Longer term GDP growth assumptions are based upon (but not exclusively) the on the HM Treasury neutral growth assumptions and longer term manufacturing growth is a modelling assumption.

The projection of household numbers is based on the most recent population projections made by the Office for National Statistics.

**Table B1 Economic growth assumptions: GDP and manufacturing (percent per annum).**

Percent per annum growth	2007	2008	2009	2010	2011	2012	2013	2014-2016	2017-2025
<b>GDP White Paper projection</b>	3.00	2.75	2.75	2.50	2.50	2.00	2.00	2.00	2.00
<b>GDP Updated projection</b>	3.20	2.00	2.75	2.75	2.75	2.75	2.75	2.30	2.20
<b>Manufacturing White Paper projection</b>	1.88	2.00	2.00	1.13	1.13	1.13	1.13	1.13	1.13
<b>Manufacturing Updated projection</b>	0.60	1.00	2.00	2.00	2.00	2.00	2.00	1.75	1.60

**Table B2- illustrates projected industrial growth indices by sector**

2005=100	Food, drink & tobacco	Textiles, leather & clothing	Pulp, paper printing & publishing	Chemicals & chemical products	Non-metallic minerals
<b>2005</b>	100	100	100	100	100
<b>2010</b>	103	92	101	111	111
<b>2015</b>	112	79	108	134	123
<b>2020</b>	121	68	113	160	134
<b>2025</b>	130	58	118	189	145

2005=100	Non-ferrous metals	Engineering & vehicles	Construction and other industry	Iron and Steel <sup>1</sup>
<b>2005</b>	100	100	100	100
<b>2010</b>	106	111	109	110
<b>2015</b>	112	124	121	116
<b>2020</b>	117	135	129	120
<b>2025</b>	122	147	136	125

**Table B3 Household growth assumptions (million households)**

	<b>White Paper projection</b>	<b>Updated projection</b>
<b>2005</b>	25.5	25.5
<b>2010</b>	26.7	26.9
<b>2015</b>	27.7	28.5
<b>2020</b>	28.5	30.0
<b>2025</b>	..	31.5

**Annex C – Climate Change and proposed Energy White Paper policies included in the projections**

**Table C1 provides the sector breakdown of carbon savings from Climate Change Programme policies that are included in the projection (MtCO<sub>2</sub>)**

		<b>2010</b>	<b>2015</b>	<b>2020</b>
<b>Business</b>	CT support for Energy efficiency in SME	0.4	0.4	0.4
	Energy saving opportunities in SMEs	0.4	0.4	0.4
	UK ETS	1.1	1.1	1.1
	Building regulations (re-evaluated)	1.8	4.0	5.9
	Carbon Trust	4.0	4.0	4.0
	Climate Change Agreement	10.6	10.6	10.6
	Subsidy to biomass	0.4	0.4	0.4
	<b>Total business</b>	<b>18.7</b>	<b>20.9</b>	<b>22.8</b>
<b>Transport</b>	RTFO (re-evaluated)	4.4	5.5	5.9
	Voluntary Agreements on new car CO <sub>2</sub> emissions plus supporting fiscal measures	8.4	11.4	13.2
	Wider Transport Measures	2.9	2.9	2.9
	Sustainable Development (Scotland )	0.4	0.4	0.4
	Local Authorities policies	0.7	0.7	0.7
	<b>Total transport</b>	<b>16.8</b>	<b>20.9</b>	<b>23.1</b>
<b>Residential</b>	Energy Performance of Buildings Directive	0.7	0.7	0.7
	Package of measures (e.g. energy efficiency in buildings)	0.4	0.4	0.4
	EEC1 (2002-2005) (re-evaluated)	1.1	1.1	1.1
	EEC2 (2005-2008) (re-evaluated)	1.8	1.8	1.8
	CERT (2008-2011) (re-evaluated)	4.0	4.0	4.0
	Building Regulations (re-evaluated)	5.5	8.4	12.1
	Warm front and fuel poverty programmes	1.5	1.5	1.5
	Energy efficient products	1.5	1.5	1.5
	<b>Total residential</b>	<b>16.5</b>	<b>19.4</b>	<b>23.1</b>
<b>Agriculture</b>	Food crop strategy	0.4	0.4	0.4
	Woodland grant scheme (England)	0.7	0.7	0.7
	Woodlands planting since 1990 (Scotland)	1.8	1.8	1.8
	<b>Total agriculture sector</b>	<b>2.9</b>	<b>2.9</b>	<b>2.9</b>
<b>Public sector</b>	Revolving loan	0.4	0.4	0.4
	Devolved Administration	1.1	1.1	1.1
	Activities including CT	0.7	0.7	0.7
	<b>Total public sector</b>	<b>2.2</b>	<b>2.2</b>	<b>2.2</b>
<b>TOTAL EXCLUDING EU ETS</b>		<b>57.1</b>	<b>66.3</b>	<b>74.1</b>

Other measures included are the Climate Change Levy with projected savings of 4 MtCO<sub>2</sub> by 2020, the Fuel Duty Escalator (an estimated 7MtCO<sub>2</sub> by 2020) and the Renewables

Obligation with estimated savings of 14MtCO<sub>2</sub> by 2020. Thus, excluding the impact of EU ETS the estimated total saving of existing measures is some 100MtCO<sub>2</sub><sup>18</sup>

The Energy White Paper 2007 proposed a number of additional policies and suggested three levels of possible impact termed central, low and high. The policies at the central carbon saving impact are listed by sector in Table C2 and at the variant either high or low in Table C3<sup>19</sup>

Table C2 provides the sector breakdown of carbon savings from White Paper policies (MtCO<sub>2</sub>) in the central case

		2010	2015	2020
<b>Energy supply</b>	CCS demonstration project	0.0	0.8	0.8
	Changes to Renewables Obligation	0.7	2.6	2.9
	<b>Total Energy Supply</b>	<b>0.7</b>	<b>3.4</b>	<b>3.7</b>
<b>Business</b>	Carbon reduction Commitment	0.0	1.5	2.9
	Products policy	0.7	1.8	3.3
	Energy Performance of Buildings Directive	0.0	0.7	1.1
	Business Smart Metering	0.4	0.7	0.7
	<b>Total business</b>	<b>1.1</b>	<b>4.7</b>	<b>8.0</b>
<b>Transport</b>	Further improvements in vehicle efficiency	0.4	2.6	6.2
	Domestic aviation included in EU ETS	0.0	1.1	1.1
	<b>Total transport</b>	<b>0.4</b>	<b>3.7</b>	<b>7.3</b>
<b>Residential</b>	Better billing	0.0	0.4	0.4
	Real time displays and Smart metering	0.4	0.7	0.4
	Product policy	0.7	1.8	3.3
	Supplier obligation	0.0	6.6	12.8
	DCLG- Zero carbon homes	0.0	0.0	4.4
	Energy Performance of Buildings Directive	0.0	0.7	1.5
	<b>Total residential</b>	<b>1.1</b>	<b>10.2</b>	<b>22.8</b>
<b>Public sector</b>	Carbon Reduction Commitment	0.0	0.4	0.7
	Carbon neutral government	0.0	0.4	0.7
	Products policy	0.0	0.4	0.7
	EPBD- Energy Performance Buildings Directive	0.0	0.7	1.1
	<b>Total public sector</b>	<b>0.0</b>	<b>1.8</b>	<b>3.3</b>
<b>TOTAL EXCLUDING EU ETS</b>		<b>3.3</b>	<b>23.8</b>	<b>45.1</b>

<sup>18</sup> Savings represented in this table are based on estimates against counterfactual future projections that differ from those implied by emissions baseline which represent a continuation of historic trends. Therefore the addition of total savings as shown in the table to the emissions projection may overstate the overall level of emissions had the policies not been in place. The overall carbon saving from existing policies which may be added to the White Paper emissions projection is some 92MtCO<sub>2</sub>.

<sup>19</sup> These measures correspond to those listed in Chapter 10, Table 10.1 of the White Paper

Table C3 provides the sector breakdown of carbon savings from White Paper policies (MtCO<sub>2</sub>) in the low and high case for 2020.

		Low policy impact	High policy impact
		2020	2020
<b>Energy supply</b>	CCS demonstration project	0.8	0.8
	Changes to Renewables Obligation	1.5	4.0
	<b>Total Energy Supply</b>	<b>2.3</b>	<b>4.8</b>
<b>Business</b>	Carbon Reduction Commitment	2.9	2.9
	Products policy	1.8	5.1
	Energy Performance of Buildings Directive	0.7	1.8
	Business Smart Metering	0.4	0.7
	<b>Total business</b>	<b>5.8</b>	<b>10.5</b>
<b>Transport</b>	Further improvements in vehicle efficiency	0.3	12.0
	Domestic aviation included in EU ETS	0.7	1.5
	<b>Total transport</b>	<b>1.0</b>	<b>13.5</b>
<b>Residential</b>	Better billing	0.0	0.4
	Real time displays and Smart metering	0.0	1.8
	Product policy	1.5	4.8
	Supplier obligation	11.0	14.7
	DCLG- Zero carbon homes	4.0	4.4
	Energy Performance of Buildings Directive	0.7	2.2
	<b>Total residential</b>	<b>17.2</b>	<b>28.3</b>
<b>Public sector</b>	Carbon Reduction Commitment	0.7	0.7
	Carbon neutral government	0.7	0.7
	Products policy	0.4	1.1
	EPBD- Energy performance Buildings Directive	0.7	1.8
	<b>Total public sector</b>	<b>2.5</b>	<b>4.3</b>
<b>TOTAL EXCLUDING EU ETS</b>		<b>28.8</b>	<b>61.4</b>

## ANNEX D – Headline emissions with high growth assumption

This Annex presents headline results of two additional scenarios not covered previously in this report.

It includes higher growth assumptions for the economy and demographics. Tables D1 and D2 compare these assumptions with the central growth case.

**Table D1 Economic growth assumptions: GDP and manufacturing (percent per annum)**

Percent per annum growth	2007	2008	2009	2010	2011	2012	2013	2014-2016	2017-2025
<b>GDP High projection</b>	3.20	2.30	3.20	3.30	3.30	3.30	3.20	2.60	2.40
<b>GDP Central projection</b>	3.20	2.00	2.75	2.75	2.75	2.75	2.75	2.30	2.20
<b>Manufacturing High projection</b>	0.60	1.50	2.25	2.25	2.25	2.25	2.25	1.75	1.75
<b>Manufacturing Central projection</b>	0.60	1.00	2.00	2.00	2.00	2.00	2.00	1.75	1.60

**Table D2 Household growth assumptions (million households)**

	Central projection	High projection
<b>2005</b>	25.5	25.5
<b>2010</b>	26.9	27.1
<b>2015</b>	28.5	28.9
<b>2020</b>	30.0	30.6
<b>2025</b>	31.5	32.4

Table D3 compares the projections of carbon dioxide emissions excluding the impact of EU ETS from the central case to:

- The high growth scenario
- The combination of assumptions resulting in the highest emissions with low prices, low policy impact and high growth.

Table D3 Comparison to higher growth assumptions

MtCO <sub>2</sub>	Assuming central price, central policy, central growth.				Assuming central price, central policy, high growth.			Assuming low price, low policy, high growth.		
	2005	2010	2020	2025	2010	2020	2025	2010	2020	2025
<b>Power Stations</b>	175	170	144	141	171	147	146	171	154	157
<b>Refineries</b>	19	16	17	19	16	17	19	16	17	19
<b>Residential</b>	85	74	53	54	74	54	55	77	58	60
<b>Services</b>	23	23	22	22	23	22	23	23	22	23
<b>Industry</b>	112	108	105	106	108	105	107	109	106	108
<b>Road transport</b>	120	115	115	116	115	116	118	116	118	120
<b>Off-road</b>	13	11	10	10	11	10	10	11	10	10
<b>Other transport</b>	11	13	14	14	13	14	14	13	14	14
<b>LUC</b>	-2	-1	3	3	-1	3	3	-1	3	3
<b>Total</b>	<b>555</b>	<b>528</b>	<b>482</b>	<b>485</b>	<b>530</b>	<b>488</b>	<b>494</b>	<b>534</b>	<b>503</b>	<b>514</b>
<b>EU ETS allowances purchased from abroad</b>		24	41	55	25	45	60	25	52	71
<b>Total including impact of EU ETS</b>		<b>504</b>	<b>440</b>	<b>430</b>	<b>505</b>	<b>443</b>	<b>434</b>	<b>509</b>	<b>451</b>	<b>443</b>
<b>% change from 1990 baseline</b>	<b>-6%</b>	<b>-15%</b>	<b>-26%</b>	<b>-27%</b>	<b>-15%</b>	<b>-25%</b>	<b>-27%</b>	<b>-14%</b>	<b>-24%</b>	<b>-25%</b>

The impact of higher growth is to increase CO<sub>2</sub> emissions by 3 MtCO<sub>2</sub> in 2020 with a further 8 MtCO<sub>2</sub> increase when combined with low price and low policy impacts. These figures include the additional purchase of EU ETS allowances.

**ANNEX E Electricity Supply: Supplementary Tables of Supply and Capacity<sup>20</sup>**

**CENTRAL ECONOMIC GROWTH, CENTRAL ENERGY PRICES, CENTRAL POLICY**

**Table E1: Updated Projections of Electricity Supply, TWh**

TWh	2006	2007	2010	2015	2020	2025
<b>Coal</b>	139	126	120	112	87	93
<b>Oil</b>	2	2	1	1	1	2
<b>Gas</b>	124	146	132	142	153	134
<b>Nuclear</b>	69	57	63	45	32	62
<b>Renewables</b>	18	20	33	50	56	59
<b>Imports</b>	10	9	14	17	17	17
<b>Storage</b>	4	3	2	2	2	2
<b>Total</b>	<b>367</b>	<b>362</b>	<b>366</b>	<b>369</b>	<b>348</b>	<b>368</b>

**Table E2: Updated Projections of Electricity Capacity, GW**

GW	2006	2007	2010	2015	2020	2025
<b>Coal</b>	28	28	28	22	16	17
<b>Oil</b>	4	4	4	2	1	1
<b>Gas</b>	28	28	30	37	42	43
<b>Nuclear</b>	11	11	11	7	5	10
<b>Renewables</b>	5	6	10	16	18	19
<b>Imports</b>	3	3	3	5	5	5
<b>Storage</b>	3	3	3	3	3	3
<b>Total</b>	<b>80</b>	<b>81</b>	<b>89</b>	<b>91</b>	<b>90</b>	<b>97</b>

<sup>20</sup> The coverage of this sector is major power producers – as defined in the Digest of UK Energy Statistics - plus all other renewable generators. The activities of other generators of electricity are included within the industrial or commercial sectors. Electricity supply is measured as electricity supplied (gross) as in Table 5.6 of DUKES 2008.

**CENTRAL ECONOMIC GROWTH, LOW ENERGY PRICES, CENTRAL POLICY**

**Table E3: Updated Projections of Electricity Supply, TWh**

TWh	2006	2007	2010	2015	2020	2025
<b>Coal</b>	139	126	117	112	84	81
<b>Oil</b>	2	2	1	1	1	1
<b>Gas</b>	124	146	137	148	170	178
<b>Nuclear</b>	69	57	63	45	28	37
<b>Renewables</b>	18	20	32	45	49	54
<b>Imports</b>	10	9	14	17	17	17
<b>Storage</b>	4	3	2	3	2	2
<b>Total</b>	<b>367</b>	<b>362</b>	<b>368</b>	<b>371</b>	<b>351</b>	<b>370</b>

**Table E4: Updated Projections of Electricity Capacity, GW**

GW	2006	2007	2010	2015	2020	2025
<b>Coal</b>	28	28	28	22	15	15
<b>Oil</b>	4	4	4	2	1	1
<b>Gas</b>	28	28	31	38	46	68
<b>Nuclear</b>	11	11	11	7	4	6
<b>Renewables</b>	5	6	10	14	15	16
<b>Imports</b>	3	3	3	5	5	5
<b>Storage</b>	3	3	3	3	3	3
<b>Total</b>	<b>80</b>	<b>81</b>	<b>88</b>	<b>91</b>	<b>89</b>	<b>113</b>

**CENTRAL ECONOMIC GROWTH, HIGH ENERGY PRICES, CENTRAL POLICY**

**Table E5: Updated Projections of Electricity Supply, TWh**

TWh	2006	2007	2010	2015	2020	2025
<b>Coal</b>	139	126	116	113	89	94
<b>Oil</b>	2	2	1	1	1	1
<b>Gas</b>	124	146	135	137	147	126
<b>Nuclear</b>	69	57	63	45	32	62
<b>Renewables</b>	18	20	33	52	58	62
<b>Imports</b>	10	9	14	17	17	17
<b>Storage</b>	4	3	2	2	2	2
<b>Total</b>	<b>367</b>	<b>362</b>	<b>364</b>	<b>366</b>	<b>345</b>	<b>364</b>

**Table E6: Updated Projections of Electricity Capacity, GW**

GW	2006	2007	2010	2015	2020	2025
<b>Coal</b>	28	28	28	22	16	17
<b>Oil</b>	4	4	4	2	1	1
<b>Gas</b>	28	28	31	36	41	41
<b>Nuclear</b>	11	11	11	7	5	10
<b>Renewables</b>	5	6	10	16	18	19
<b>Imports</b>	3	3	3	5	5	5
<b>Storage</b>	3	3	3	3	3	3
<b>Total</b>	<b>80</b>	<b>81</b>	<b>89</b>	<b>91</b>	<b>89</b>	<b>96</b>

**CENTRAL ECONOMIC GROWTH, HIGH-HIGH ENERGY PRICES, CENTRAL POLICY**

**Table E7: Updated Projections of Electricity Supply, TWh**

TWh	2006	2007	2010	2015	2020	2025
<b>Coal</b>	139	126	116	115	96	102
<b>Oil</b>	2	2	1	1	1	1
<b>Gas</b>	124	146	131	122	122	98
<b>Nuclear</b>	69	57	63	45	37	66
<b>Renewables</b>	18	20	34	58	66	72
<b>Imports</b>	10	9	14	17	17	17
<b>Storage</b>	4	3	2	2	2	2
<b>Total</b>	<b>367</b>	<b>362</b>	<b>362</b>	<b>361</b>	<b>340</b>	<b>359</b>

**Table E8: Updated Projections of Electricity Capacity, GW**

GW	2006	2007	2010	2015	2020	2025
<b>Coal</b>	28	28	28	23	17	18
<b>Oil</b>	4	4	4	2	1	1
<b>Gas</b>	28	28	31	34	37	37
<b>Nuclear</b>	11	11	11	7	6	11
<b>Renewables</b>	5	6	10	17	20	21
<b>Imports</b>	3	3	3	5	5	5
<b>Storage</b>	3	3	3	3	3	3
<b>Total</b>	<b>80</b>	<b>81</b>	<b>89</b>	<b>91</b>	<b>88</b>	<b>95</b>

**HIGH ECONOMIC GROWTH, CENTRAL ENERGY PRICES, CENTRAL POLICY**

**Table E9: Updated Projections of Electricity Supply, TWh**

TWh	2006	2007	2010	2015	2020	2025
<b>Coal</b>	139	126	120	112	88	94
<b>Oil</b>	2	2	1	1	1	1
<b>Gas</b>	124	146	134	146	162	144
<b>Nuclear</b>	69	57	63	45	32	62
<b>Renewables</b>	18	20	33	51	56	62
<b>Imports</b>	10	9	14	17	17	17
<b>Storage</b>	4	3	2	2	2	2
<b>Total</b>	<b>367</b>	<b>362</b>	<b>368</b>	<b>375</b>	<b>358</b>	<b>381</b>

**Table E10: Updated Projections of Electricity Capacity, GW**

GW	2006	2007	2010	2015	2020	2025
<b>Coal</b>	28	28	28	22	16	17
<b>Oil</b>	4	4	4	2	1	1
<b>Gas</b>	28	28	31	38	44	45
<b>Nuclear</b>	11	11	11	7	5	10
<b>Renewables</b>	5	6	10	16	18	19
<b>Imports</b>	3	3	3	5	5	5
<b>Storage</b>	3	3	3	3	3	3
<b>Total</b>	<b>80</b>	<b>81</b>	<b>89</b>	<b>92</b>	<b>92</b>	<b>100</b>

CENTRAL ECONOMIC GROWTH, CENTRAL ENERGY PRICES, HIGH POLICY

Table E11: Updated Projections of Electricity Supply, TWh

TWh	2006	2007	2010	2015	2020	2025
<b>Coal</b>	139	126	120	112	87	93
<b>Oil</b>	2	2	1	1	1	1
<b>Gas</b>	124	146	132	136	132	113
<b>Nuclear</b>	69	57	63	45	32	62
<b>Renewables</b>	18	20	33	50	61	64
<b>Imports</b>	10	9	14	17	17	17
<b>Storage</b>	4	3	2	2	2	2
<b>Total</b>	<b>367</b>	<b>362</b>	<b>365</b>	<b>363</b>	<b>332</b>	<b>351</b>

Table E12: Updated Projections of Electricity Capacity, GW

GW	2006	2007	2010	2015	2020	2025
<b>Coal</b>	28	28	28	22	16	17
<b>Oil</b>	4	4	4	2	1	1
<b>Gas</b>	28	28	31	36	39	39
<b>Nuclear</b>	11	11	11	7	5	10
<b>Renewables</b>	5	6	10	16	20	21
<b>Imports</b>	3	3	3	5	5	5
<b>Storage</b>	3	3	3	3	3	3
<b>Total</b>	<b>80</b>	<b>81</b>	<b>89</b>	<b>91</b>	<b>88</b>	<b>94</b>

## ANNEX F SUMMARY OF HEADLINE PROJECTIONS BY SCENARIO EXCLUDING THE PURCHASE OF EU ETS ALLOWANCES

In this Annex the headline projections by scenario are presented excluding the impact of EUETS purchased allowances. Where possible tables are referenced to the equivalent in the main paper.

**Table F1 (Ref Table 1.4) Headline UK Emissions carbon dioxide projections excluding purchase of allowances under the EUETS, based on central assumptions of growth, prices and delivery of measures proposed in the Energy White Paper May 2007.** The figures in brackets represent change on 1990.

MtCO <sub>2</sub>	1990	2010	2015	2020
<b>Updated central projection</b>	592	528 (-11%)	516 (-13%)	482 (-19%)
<b>Energy White Paper May 2007 central projection</b>	592	529 (-11%)	507 (-14%)	485 (-18%)

## BREAKDOWN OF CHANGES IN 2020 EMISSIONS

In this section the broad changes between the central baseline projections of the updated projection and the Energy White Paper projection are shown. These are shown by broad category in Table F2.

**Table F2 (Ref Table 2.1) Breakdown of main changes by broad category**

MtCO <sub>2</sub>	2010	2015	2020
Updated emissions projections (central)	528	516	482
Energy White Paper May 2007	529	507	485
Change in baseline	-1	9	-3
Due to:			
Increased emissions from electricity generation (see Table F4)	11	22	11
Adjustment to refinery emissions	-5	-6	-6
Impact of higher prices and other modelling effects between the projections (See Table F4)	-7	-8	-9
Land Use Change adjustment	0	1	1
<b>Total changes</b>	<b>-1</b>	<b>9</b>	<b>-3</b>

## HEADLINE EMISSIONS PROJECTIONS OF CARBON DIOXIDE AND GREENHOUSE GASES FOR ALTERNATIVE SCENARIOS

The updated headline projections are presented for alternative assumptions of Energy White Paper policy saving and fossil fuel prices which illustrate the range of uncertainty. These are shown in Tables F3 – F5. The impact of alternative assumptions of fuel prices on emissions from the non-Traded sectors is shown in Table F5.

**Table F3 (Ref Table3.1): Updated Headline carbon dioxide projections MtCO<sub>2</sub>**

MtCO <sub>2</sub>	1990	2010	2015	2020	2025
Assuming low impact of 2007 Energy White Paper measures, excluding EU ETS	592	529	519	489	493
Assuming central impact of 2007 Energy White Paper measures, excluding EU ETS	592	528	516	482	485
Assuming high impact of 2007 Energy White Paper measures, excluding EU ETS	592	523	507	465	468

**Table F4 (Ref Table 3.2): Headline carbon dioxide emissions projections, excluding the impact of the EUETS and reductions on a 1990 level, of 592 MtCO<sub>2</sub> is shown for a range of assumptions**

Projection	Emissions, excluding EUETS (MtCO <sub>2</sub> )				% reduction on base year level of 592 MtCO <sub>2</sub>			
	2010	2015	2020	2025	2010	2015	2020	2025
Central prices, central EWP delivery	528	516	482	485	11	13	19	18
Central prices, high EWP delivery	523	507	465	468	12	14	21	21
Central prices, low EWP delivery	529	519	489	493	11	12	17	17
High prices, central EWP delivery	522	511	476	478	12	14	20	19
Low prices, central EWP delivery	532	524	490	498	10	12	17	16
High prices, high EWP delivery	518	500	464	466	12	16	22	21

**Table F5 (Ref Table 3.3): Headline greenhouse gas emissions projections, excluding the impact of the EUETS, and reductions on base-year emissions level of 777 MtCO<sub>2</sub>e is shown for a range of assumptions.**

Projection	Emissions, excluding EUETS (MtCO <sub>2</sub> e)				% reduction on base year level 777 MtCO <sub>2</sub> e			
	2010	2015	2020	2025	2010	2015	2020	2025
<b>Central prices, central EWP delivery</b>	625	610	573	577	20	21	26	26
<b>Central prices, high EWP delivery</b>	619	601	556	559	20	23	28	28
<b>Central prices, low EWP delivery</b>	625	614	581	584	20	21	25	25
<b>High prices, central EWP delivery</b>	619	605	567	569	20	22	27	27
<b>Low prices, central EWP delivery</b>	624	611	573	575	20	21	26	26
<b>High prices, high EWP delivery</b>	619	601	564	572	20	23	27	26