

Appendix E

UPDATED ENERGY PROJECTIONS

November 2004

INTRODUCTION

- 1.1 The UK published projections of carbon dioxide¹ and non-CO₂ greenhouse gas emissions² alongside the Climate Change Programme in November 2000. These formed the basis of the UK's Third National Communication under the United Nations Framework Convention on Climate Change (October 2001)³.
- 1.2 The current exercise to update the UK CO₂ projections is ongoing and takes account of the environmental and other policy developments since the previous exercise and updates the assumptions underlying the previous projection.
- 1.3 For the purposes of the EU Emissions Trading Scheme (EU ETS) National Allocation Plan (NAP) these are the final projections.
- 1.4 A provisional projection, based on an initial set of assumptions was published in July 2003⁴. These preliminary results were used within the draft National Allocation Plan issued for consultation in January 2004. Further work and revised assumptions based on consultations since October 2003 provided the basis for further revisions to the projections. These were published in a working paper in May 2004⁵, and set out the assumptions and detailed results underlying the projection that was used in the NAP submitted to the European Commission and related consultation document in April 2004.
- 1.5 This paper, presents the results of further revisions to the projections that have taken place since May 2004. This work has helped inform the final decision on the level of the overall UK emissions cap in October 2004 and revisions to the April NAP. The results are arranged as follows: Part one provides a summary of the headline projection and main changes since the April NAP projection. Part two provides the sectoral projections. Part three provides energy demand results and Part four provides detail on energy supply.
- 1.6 The DTI UK Energy Model is the basis for the UK CO₂ projections. The sector classification and the principal source of energy statistics is the

¹ *Energy Paper 68: Energy Projections for the UK*, November 2000, The Stationery Office: http://www.dti.gov.uk/energy/inform/energy_projections/index.shtml

² *Projections of Non-CO₂ Greenhouse Gas Emissions for the United Kingdom and Constituent Countries*, November 2000, WS Atkins Consultants Ltd.

³ See <http://www.defra.gov.uk/environment/climatechange/3nc/default.htm>

⁴ See <http://www.dti.gov.uk/energy/sepn/projections.pdf>

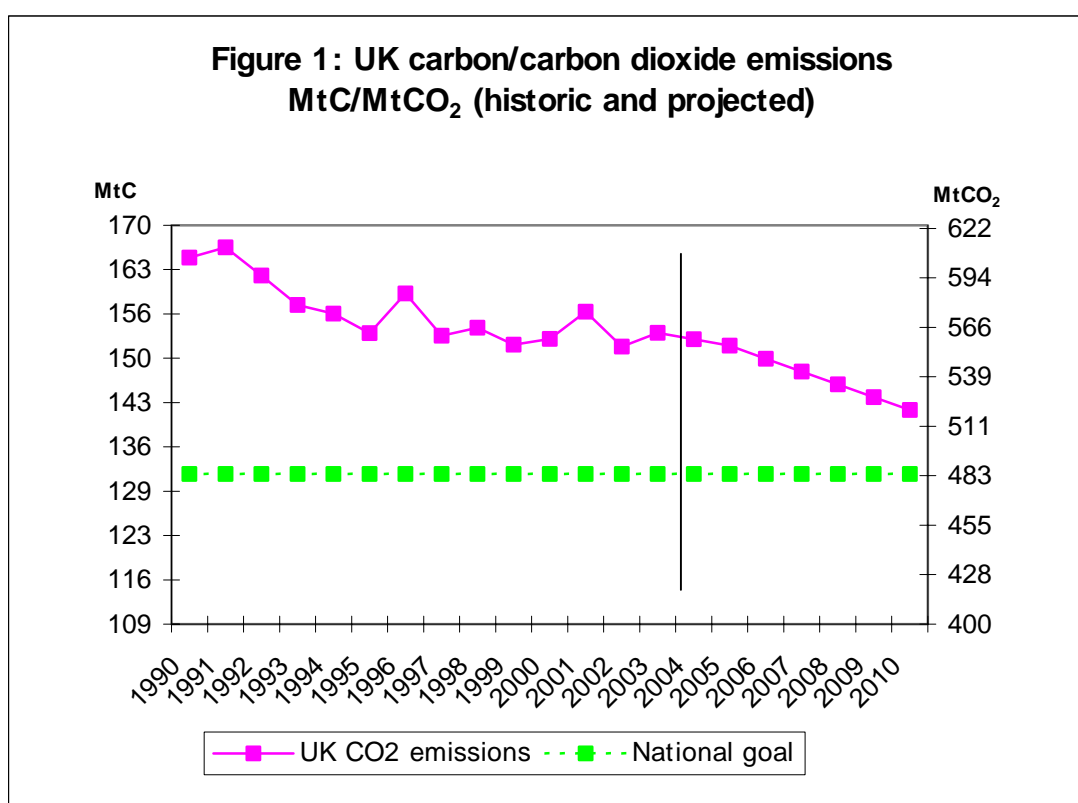
⁵ See Working Paper 1: <http://www.dti.gov.uk/energy/sepn/uep.pdf>

Digest of UK Energy Statistics (DUKES)⁶. The energy sectors modelled are power stations, offshore sector, refineries and other energy producing industries. The energy demand sectors are Residential (or Domestic), Services (Public and Commercial), Road and Other Transport, Industry (excluding Services) and Agriculture.

PART ONE - SUMMARY

HEADLINE PROJECTION AND MAIN CHANGES SINCE APRIL 2004 NAP

- 1.7 This central baseline “with measures” CO₂ projection is illustrated in Figure 1 against the UK domestic goal of a 20% reduction in CO₂ emissions from 1990 level.



Note: 2003 and 2004 figures are provisional estimates only.

- 1.8 Figure 1 illustrates the path of total UK carbon dioxide emissions, historic and projected from 1990 to 2010. The projection reflects recent revisions to carbon emission factors for coal used for electricity generation and natural gas, but does not yet include a further adjustment for a more recent change to other coal and oil emissions factors which have not been incorporated in the historical data. The projection of emissions in 2010 is 141.3MtC (518 MtCO₂)⁷.

⁶ See <http://www.dti.gov.uk/energy/inform/dukes/dukes2004/index.shtml>

⁷ This compares with 141.8MtC published on 27 October 2004. The update reflects information received since leading to revised land use change (LUC) projections.

- 1.9 Overall this headline figure represents around a 14% reduction in CO₂ emissions on the 1990 levels by 2010⁸. The historical fall in emissions between 1990 and 2002 is estimated to be –8.2% taking account of the revisions to coal and gas emission factors already incorporated in the projections, and is estimated to be –8.5% when all revisions have been made.
- 1.10 The projection allows for savings in carbon emissions from environmental measures announced in the Climate Change Programme (Nov 2000) and from subsequent measures. The savings from these measures amount to around 9MtC in 2005 and around 15MtC in 2010. More information is provided in Annex 1.
- 1.11 Overall emissions fell steadily throughout the 1990s in part due to switching out of coal into gas. They have been relatively level in recent years. The latest projection in 2005 is below the 2000 level. In part this reflects estimated savings from the Climate Change Programme measures beginning to work through and offsetting increases in emissions expected from the power generation sector compared with 2000.
- 1.12 Emissions from electricity generation in 2005 are estimated to fall a little from actual levels in 2003, reflecting a modest switch from coal use to gas. Such a switch has begun to be observed in the first half of 2004. It is projected also that imports of electricity will be substantially higher in 2005 than in 2003, continuing the trend emerging during 2004. While there are many uncertainties about projections even a year ahead, the projection for 2005 is broadly consistent with recent generation patterns.
- 1.13 Table 1 compares the latest projection with that which informed the April NAP (May 2004 working paper).

⁸ This does not include any impact of EU ETS

TABLE 1: Latest projection (Final NAP) compared with April NAP projection, MtC and (MtCO₂)

	1990	1995	2000	2005	2010
Final NAP	165.1 (605)	153.5 (563)	152.7 (560)	151.4 (555)	141.3 (518)
April NAP	164.9 (605)	154.9 (568)	153.1 (561)	150.3 (551)	141.4 (519)
“UK domestic goal”(1)					132 (484)

Notes: Figures are presented in carbon equivalent MtC and carbon dioxide (MtCO₂) 1MtC = MtCO₂ x 12/44

Revisions to carbon emission factors for coal and gas have an impact on historic data including 1990.

(1) UK domestic goal as 20% reduction on “current 1990” figure.

IMPLICATIONS FOR THE APRIL 2004 NAP

1.14 The National Allocation Plan submitted to the European Commission in April 2004 explained that the number of allowances would be reviewed at the time of submitting the final plan, in light of the ongoing work on the energy projections, the review of Climate Change Agreement targets for 2006, any potential changes in fuel intensity for the Iron and Steel sector and the receipt of verified data from operators. The changes in energy projections set out above and revisions to emission factors, together with the finalisation of the Climate Change Agreement targets leads to an increase in projected emissions from the UK installations covered by the EU ETS for the period 2005-7 of around **15.3MtC** (56.1 MtCO₂) compared to the position in April 2004.

1.15 The Government has considered how to reflect this increase in emissions in allocations under the National Allocation Plan. The Government is proposing to increase the total number of UK allowances for the period 2005-7 by **5.4MtC** (19.8 MtCO₂) allowances⁹.

MAIN CHANGES SINCE APRIL NAP

1.16 The main changes to the projections since May 2004 have been:

- Fossil fuel price revisions – revisions to near term oil prices due to recent developments in world oil prices (fossil fuel price assumptions given in Annex 2).
- Power generation revisions reflecting emerging new data, revised fuel price assumptions and other factors detailed later in this paper.
- Industrial growth – revisions to growth assumptions informed by independent research commissioned by the DTI and Defra from Oxford Economic Forecasting and CRU respectively. The report

⁹ Update as at May 2005: The UK has proposed an amendment to the NAP to allocate 756.1 million allowances. However the Commission has to date only approved the UK to allocate 736.3 million allowances. The allocation of the additional 19.8 million allowances is the subject of a legal challenge. Without prejudice to this challenge an initial allocation of 736.3 million allowances will be made.

from Oxford Economic Forecasting will be available on the DTI website shortly.

- Carbon emission factors – revisions to coal and gas carbon emission factors as set out above following research commissioned by Defra.
- Climate Change Agreement – renegotiated targets for voluntary agreements by industrial companies and trade sectors.
- Climate Change Programme – revision to estimates of impact of environmental policy measures.
- Re-estimation of Road Transport projection based on DfT assumptions of efficiency impact of Voluntary Agreements.

DIFFERENCES BY SECTOR

- 1.17 The changes from April 2004 projection to the latest projection shown in Table 1 are the result of the impact of changes listed above on the sectors as shown in Table 2 for 2005 and 2010.
- 1.18 Estimated emissions from the power sector in 2005 are higher than in the April projection mainly due to higher estimated electricity demand, the impact of revised CO₂ emission factors, revised plant efficiency assumptions, lower nuclear output and the impact of revisions to energy price assumptions, only partially offset by other factors. The projection in 2005 is now broadly consistent with recent generation patterns.
- 1.19 The power sector projected emission in 2010 has fallen slightly compared with the April projection. This is due to higher renewables generation in line with the Government policy of 10% of generation from renewable sources and upward adjustments to the nuclear output assumptions¹⁰ and inclusion of impact of more climate change programme measures in 2010.
- 1.20 The increase in refinery emission projections of 0.2MtC in 2005 and 2010 since the April NAP is due to a re-classification of a Combined Heat and Power (CHP) plant that was previously modelled in a different sector to the refineries sector, which is where it is classified in the Digest of UK Energy Statistics.

TABLE 2 – Changes by sector April NAP and Final NAP projection

	2005	2010
Power stations	+4.7	-0.5
Refineries	+0.2	+0.2

¹⁰ This adjustment represents a “catching up” of input decisions made prior to May 2004 Working Paper projections rather than a re-appraisal of the prospects of nuclear since May 2004.

Residential	-0.3	-1.1
Services	-0.1	0
Industry	-1.2	+0.9
Transport	-0.8	-0.6
Other Transport	-0.5	-0.5
Agriculture/afforestation/Land use change	-0.8	-1.1
Allocation of previously unallocated policy measures	-	+2.7
Total difference	1.1MtC	-0.1MtC
April NAP	150.3MtC	141.4MtC
Latest projections	151.4MtC	141.3MtC

PART TWO – SECTORAL EMISSIONS PROJECTIONS

1.21 Table 3 provides a comparison between the latest emission projection by sector and the April 2004 projection.

TABLE 3 – Projections of sector carbon emissions

	Actual(1)	Final NAP Projection		April NAP projection	
	2000	2005	2010	2005	2010
Power Stations	43.1	44.8	37.4	40.1	37.9
Refineries	4.4	5.4	5.5	5.2	5.3
Residential	23.0	21.2	20.5	21.5	21.6
Services (including agriculture)	8.1	7.3	7.5	7.4	7.5
Industry	33.8	33.7	31.6	34.9	30.7
Road Transport	31.7	32.4	34.5	33.2	35.1
Off-road	1.5	1.5	1.5	1.6	1.6
Other Transport	2.8	2.4	2.5	2.8	2.9
Total	148.5	148.6	140.9	146.8	142.5
Afforestation since 1990	-0.35 (4)	-0.46	-0.65	-0.45	-0.7
unallocated measures (2)		0	-1.34	0	-4.05
LUC (5)	4.17	3.25	2.43	4.0 (3)	3.6
UEP "all measures" baseline	152.7	151.4	141.3	150.4	141.4

Notes: (1) Actual data for 2000 is provided by NETCEN. The data is based on revised power sector coal emission factors and natural gas in all sectors. Inclusions of further revised fuel emission factors will further revise these.

(2) The latest projection "unallocated measures" reflects some further firming up of policy measures since April 2004. As a result some of the savings in this category in the April projection have now been distributed to appropriate sectors.

(3) Provisional working estimate.

(4) Afforestation since 1990 not counted as a measure in historical emissions. Total forest uptake in 2000, 2005 and 2010 projected to be -3.2 MtC, -3.4 MtC, and -3.4 MtC respectively, but this could not all be counted against emissions under the Kyoto Protocol

(5) LUC emissions estimates are under review

POWER SECTOR¹¹ PROJECTED EMISSIONS

1.22 Detail on the background to the power sector projections is provided in part four.

¹¹ For modelling purposes, the coverage of the industry is major power producers plus all renewable generators. All other generators of electricity are included within the industrial or commercial sectors.

- 1.23 Power station capacities can be regarded as fixed over the medium term, allowing for capacity coming into production as a result of previous investment decisions. The near term outlook for emissions is thus essentially dependent on estimated total electricity demand and the mix of coal, gas and carbon free sources of electricity.
- 1.24 A number of changes have been made since the April power sector projections, changing both the short and long term outlooks:
- The emissions factors for coal and natural gas have increased and decreased respectively following research commissioned by Defra.
 - Projected electricity demand has increased, partly as new data suggested that the original estimates were too low. Higher demand directly translates into higher emissions, in both 2005 and 2010.
 - Revisions to plant efficiency assumptions for coal and CCGT stations, again largely derived from new data, have also increased emissions on balance in both 2005 and 2010.
 - Projected generation from nuclear plants in 2005 has been reduced as the result of technical adjustment, bringing the projection into line with the definitions used in the modelling process and thereby increasing emissions in 2005. Conversely, projected nuclear generation in 2010 has been increased, as described in paragraph 1.19, resulting in a decrease in 2010 emissions compared with the April projection.
 - Revisions to short term energy price assumptions are likely to have contributed to increased emissions in 2005 due to fuel price relativity changes.
 - Other changes have tended to decrease projected emissions in 2005. Principally these are higher assumed electricity imports – where new data suggests a significant rebound in 2004 from depressed 2003 levels - together with the impact of the Climate Change Programme.
- 1.25 The net effect of these revisions has been to increase emissions in the short term broadly consistent with recent experience.

OIL REFINERIES

- 1.26 Oil refinery emissions have been adjusted in the light of increasing yield shifts towards lighter fractions. A throughput of 87Mt of crude has been assumed reflecting a recovery of the industry from unplanned outages in the early 2000s. The result of these improvements is to leave the emission estimates unchanged. In order to maintain consistency of definition with the Digest of UK Energy Statistics,

emissions from CHP plants that are closely associated with the refinery sector are included in the estimates.

SERVICE SECTOR EMISSIONS

- 1.27 Changes to the service sector since the April projection are some 0.1MtC in 2005. This was the impact of minor adjustment in the fuel demand due to revision of the near term fossil fuel prices and the impact of the natural gas emission factor.

RESIDENTIAL SECTOR EMISSIONS

- 1.28 The upward revision to the near-term fossil fuel price assumptions between April and the latest projection had the impact of reducing domestic fuel demand slightly. However, more significant reductions were the result of firming up of several environmental policies which enabled the impact to be more directly attributed to the domestic sector and thus included in the energy model rather than any underlying change in domestic demand since April, and the impact of revised natural gas emission factor.

TRANSPORT SECTOR EMISSIONS

- 1.29 Modelling revisions to the road transport sector incorporated specific assumptions about the progress towards the Voluntary Agreements with motor manufacturers to improve overall vehicle efficiency. Adopting efficiencies agreed with DfT suggested higher impact of these measures than previously estimated. There is therefore a further reduction, including a downward revision to fuel burn in the Other Transport sector amounting to 0.8MtC in 2005 and 0.6MtC in 2010.
- 1.30 Table 4 illustrates the latest Road Transport emission projection assuming the current Voluntary Agreements for the years 2000 –2010 (excluding the expected changes to carbon emission factor changes for oil products) compared with the April NAP.
- 1.31 The new vehicle fuel efficiency improvement assumed in the latest projection is 2.4% per annum between 2004 – 2008 and 0.6% thereafter.

TABLE 4 – Latest Road Transport emission projection compared with April NAP projection in MtC

	2000	2005	2010
Latest projection	31.7	32.4	34.5
April NAP	31.7	33.2	35.1
Change		-0.8	-0.6

PART THREE – ENERGY DEMAND

- 1.32 Annex 4 provides the latest projected energy demand by broad sector by fuel compared with the 2000 and 2003 actuals based on the Digest of UK energy Statistics (DUKES).
- 1.33 Annex 5 provides the latest projected energy demand and emissions projection for the Iron and Steel industry compared with historical data on the UEP basis.
- 1.34 Table 5 illustrates the historic and projected average annual percent energy intensity improvement by broad sector implied by the latest projections.

Table 5 – Historic and projected average annual percent energy intensity improvement by broad sector implied by the latest projections (%)

	Residential	Services	Transport	Industry (1)
1990-1995	0.81	0.14	1.09	1.45
1995-2000	0.98	2.80	0.93	2.05
2000-2005	3.19	3.34	1.56	-0.73
2005-2010	2.66	2.26	0.59	1.72

Notes: Energy intensity is energy divided by an index of sector growth represented by GDP in Residential and Transport sectors, by appropriate GVA growth in service and industry sectors.

(1) Total industry energy excludes an estimate for energy used in transformation which is consistent with the Digest of UK Energy Statistics presentation.

PART FOUR – ENERGY SUPPLY, GENERATION

This section provides detail on the assumptions made and general background to the latest power sector projection.

Capacity and Generation Assumptions

- 1.35 It is assumed that most of the existing coal fired stations survive at least until the beginning of the Large Combustion Plant Directive (LCPD) control period. The maximum potential output from Combined Cycle Gas Turbine (CCGT) plants is increasing as new plants progress through the commissioning stage. Some plants previously in receivership have also resumed operation, or will shortly do so. Longer term, we expect some resumption of CCGT build as a result of more favourable market conditions, a revival of confidence and as some coal and other plant closes. In view of the age structure of the coal station fleet and with tightening emission limits, there seems to be some potential for power stations to be re-powered, or operations otherwise modified. Nonetheless it seems likely that some plant will not remain operational through to the end of the decade.
- 1.36 Assumptions about future nuclear generation in these projections broadly reflect company announcements. In recent years, generation from nuclear power stations has remained below the levels of the late 1990s.
- 1.37 Imports of electricity fell to very low levels in 2003 as a whole, while electricity exports increased, both serving to increase the requirement for domestic generation and therefore increasing emissions. In 2004 however, it has become clear that electricity imports have rebounded very strongly in association with higher domestic wholesale prices.
- 1.38 Government is committed to ensuring that the contribution from renewables increases over time. The share of generation accounted for by renewables is assumed to be 10% in 2010 and increases to 15% by 2015.

Other Assumptions

- 1.39 Sulphur dioxide – Flue Gas Desulphurisation (FGD) Plant
There have been a number of proposals to retrofit FGD to coal stations. It is assumed that FGD capacity in the latter part of this decade is around 12GW. Some FGD plant is currently being fitted, but it is unclear to what extent this will be available during 2005.
- 1.40 Nitrogen Oxides
It is assumed that nearly all coal stations remaining on the system during the latter half of this decade will have some form of over-fire air system fitted, or will achieve corresponding emission reductions. Indeed, some companies have already announced plans to fit this type

of equipment to some generating units. There may be exceptions to this standard, reflecting station-specific conditions. In terms of the impact on the projections, controlling NO_x by retrofitting such equipment will add a modest amount to the costs of generating from coal power stations.

1.41 Pollution Prevention and Control (PPC)¹² and Wider Environmental Considerations

It is assumed in these power sector projections that there are continued incentives to achieve the highest possible operational efficiency of coal - fired and CCGT power stations and to reduce the underlying level of emissions, both to reduce CO₂ emissions and also reflecting a period of transition from the current acid gas control regime to that pertaining under the LCPD. For purposes of the 2010 projection, the coal sulphur content in unabated plant is set to be less than 1.0%, which appears broadly consistent with the aims of environmental policy in the longer term. The projected amount of generation from coal plant in 2010 is consistent with either implementation method for the LCPD, though this may entail the use of other fuels or techniques at coal plants to meet required limits. A significant amount of coal plant capacity is assumed to be opted out of the LCPD requirements and will therefore close before the end of 2015. It also seems likely that some plants deciding to opt out will generate for only a limited period and will close before, or perhaps during 2010. Clearly it is difficult to predict when such closures might actually happen and further sensitivity work is planned to examine the impact of earlier, accelerated closure and also a higher survival rate beyond 2010.

COAL IN POWER GENERATION

- 1.42 In general, the competitive position of coal in the last few years has improved due to significant increases in gas prices and generally low coal prices.
- 1.43 Another key factor supporting the use of coal in generation has been a move by the generators to lower sulphur coals allowing higher coal fired generation within given sulphur limits. Flexibilities available to those constructing FGD plants will also have enhanced the short - term outlook for coal, though the impact of the flexibilities as distinct from the impact of generally favourable market conditions is difficult to gauge. Notwithstanding this, it seems likely that plant and/or company SO₂ emission limits may have recently either limited the total coal generation, or perhaps its distribution between plants and/or companies.
- 1.44 Against the trend of the last few years, however, there has been a significant shift in recent months towards cleaner forms of generation. Coal generation has fallen significantly and gas generation has risen to

¹² PPC is replacing Integrated Pollution Control (IPC), with large combustion plant due to fall under the PPC regulations in 2006/7.

historically high levels. This may partly be explained by a modest shift in the relativity of gas to coal prices, favouring increased gas use. Coal prices have increased in recent times. The bulk of the increase in coal prices will have been in imported fuels, requiring a difficult trade off for station operators between using low sulphur but relatively expensive imports, lower cost but higher sulphur domestic coals and the use of generally expensive gas. It is possible that the recent trend towards higher gas use may not persist, as gas prices have risen significantly in recent months on the back of much higher crude oil prices. While this may mean that coal claws back some competitiveness, other influences, such as emission limits, may also act to moderate coal use.

CARBON PRICE ANALYSIS

1.45 The results of the modelling analysis of power station responses to assumed low to medium carbon prices in the years 2005 and 2010 is illustrated in Annex 7.

THE PATTERN OF ELECTRICITY GENERATION

1.46 The power sector generation by fuel is given in Table 6 below.

TABLE 6: Electricity Generation by fuel, in TWh¹³

	2000	2005	2010
Coal	111.9	116	90
Oil	2.1	2	2
Gas	127.0	135	145
Nuclear	78.3	80	65
Renewables ¹⁴	10.1	15	40
Imports	14.3	10	8
Pumped storage	2.6	2	2
TOTAL	346.3	361	352

1.47 This projection suggests a fall in coal generation from recent high levels¹⁵. The recent increase in wholesale electricity prices is assumed to continue to lead to a reversal of the recent trend towards lower electricity imports, as well as to reduced exports. Prospective increases in CHP and other own generation will also act to dampen demand on the 'grid'¹⁶. There is already a clear indication of an upswing in generation from these sources, on the back of rising wholesale prices.

1.48 It should be stressed that these results do not embody any impact from the EU-ETS.

¹³ The figures in this table relate to gross supply to the grid, plus imports of electricity.

¹⁴ The level of renewables generation in 2010 is approximately 10% of overall generation.

¹⁵ Coal generation in 2003 is estimated at 128TWh and gas generation also 128TWh.

¹⁶ The Cambridge Econometrics (CE) report suggested an increase in CHP generation of some 8TWh between 2003 and 2005. "Modelling Good Quality Combined Heat and Power Capacity to 2010: Revised Projections. A final report submitted to the Department of Trade and Industry, 6 November 2003." This is available from: http://www.dti.gov.uk/energy/environment/energy_efficiency/chpreport.pdf

1.49 Table 7 shows a comparison of the fuels used by generation for the latest projections compared with the April projection.

TABLE 7: Comparison of latest projection and the April Projection

	April NAP (TWh)		Final NAP Projection (TWh)	
	2005	2010	2005	2010
Coal	113	106	116	90
Oil	2	2	2	2
Gas	116	132	135	145
Nuclear	84	61	80	65
Renewables	15	39	15	40
Other ¹⁷	12	13	12	10
TOTAL	344	353	361	352

1.50 Compared with the April projection, the key changes in the latest projections for 2005 are that electricity demand is higher, with coal and gas fired generation higher as a consequence, and nuclear output is lower. In 2010 coal generation is now lower¹⁸, while gas and nuclear generation are higher. Demand in 2010 is restrained by the impact of the Climate Change Programme.

1.51 The projected growth in total final electricity demand between 2002 and 2010 is around 0.7% per annum. This compares with growth in the previous decade of around 1.7% per annum. Demand on the 'grid' is restrained by the growth in other sources of supply such as CHP.

ANNEX 1 - Climate Change Programme measures

ANNEX 2 - Fuel price assumptions and historic path of oil prices

ANNEX 3 - Industrial sector output

ANNEX 4 - Final energy demand (projected and historic)

ANNEX 5 - Iron and steel industry energy and emission projections

ANNEX 6 - Historic and projected UK carbon emissions in MtC ANNEX

7 - Carbon Price Analysis

¹⁷ Generation from pumped storage plants and electricity imports.

¹⁸ This arises partly because quantities of other fuels are used in coal plant. The behaviour of plants which choose to adopt the 20,000 hour derogation under the LCPD is problematic in terms of establishing a firm baseline for 2010.

ANNEX 1

Climate Change Programme Measures included in latest projection	Total carbon savings (MtC)	
	2005	2010
DOMESTIC	1.02	3.01
Policies include EEC, Warm Front, Building Regulations (2002) and Community Energy		
INDUSTRY	3.28	4.89
Policies include CCAs, UK ETS, Carbon Trust programmes and Building Regulations (2002)		
SERVICES	0.49	0.89
Policies include Building Regulations (2002), UK ETS, Carbon Trust programmes, UK ETS and public sector programmes		
TRANSPORT	3.02	4.42
Policies include Voluntary Agreements, the 10 Year Plan, Sustainable Distribution, and Off Road programmes		
AGRICULTURE	0.46	0.65
From afforestation since 1990		
TOTAL	8.26	13.86
Total CCP savings including "unallocated" measures	8.26	15.20
"Unallocated" measures	0	1.34
Policies include additional CCAs, Building Regulations (2005), minimum product standards.		

NOTES:

¹ Definition of "unallocated": Measures which are currently less firm or detailed but are nonetheless "funded"

Figures are based on information provided by Defra for Business (industry +services) and Domestic.

The estimated impact from CCA's in industry and the savings for the VA in Transport are based on DTI analysis/ model outturn.

The DfT 10 yr plan saving of 1.1MtC has been assumed in transport.

"Further Measures"

Savings from a third group of measures, still subject to negotiation when the final modelling assumptions had to be made, have not (yet) been included. These include further CCAs, Carbon Trust programmes, the Energy Performance of Buildings Directive and market transformation effects, with savings likely to fall in the range 0.6-0.8MtC/y.

ANNEX 2a

Fossil fuel price assumptions

Real 2003 prices	Crude Oil	Natural Gas	ARA Coal
	\$/bbl	Beach Price p/therm	NAR \$/tonne
2005	30.0	24.6	77.1
2006	28.6	24.6	79.1
2007	27.3	23.0	67.5
2008	25.9	22.0	43.4
2009	24.6	21.0	35.0
2010	23.2	20.0	35.0
2011	23.6	20.3	35.0
2012	24.1	20.6	35.0
2013	24.5	20.9	35.0
2014	25.0	21.2	35.0
2015	25.4	21.5	35.0
2016	25.9	21.8	35.0
2017	26.3	22.1	35.0
2018	26.7	22.4	35.0
2019	27.2	22.7	35.0
2020	27.6	23.0	35.0

Note: The projected and past oil prices are illustrated in the following chart. This puts into context the current 2005 – 2010 oil projection.

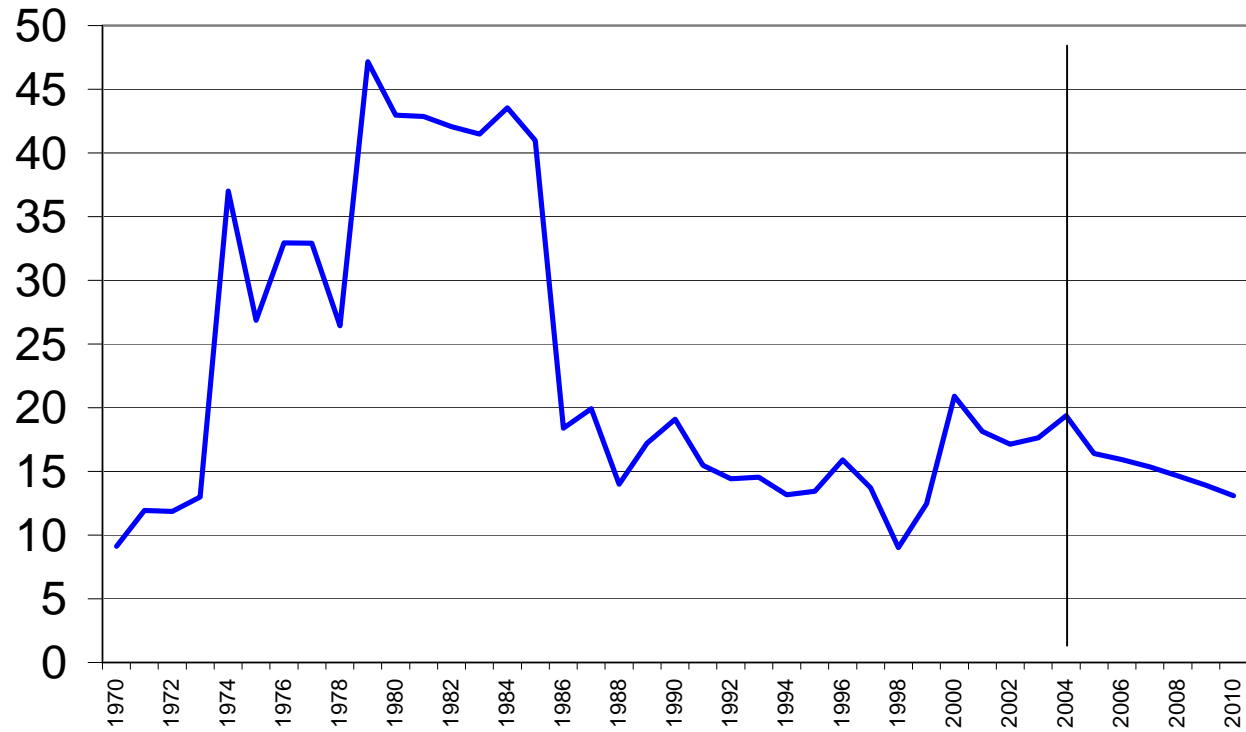
Foreign Exchange Rate Assumptions

	Exchange Rate £1 = \$USD
2005	1.828
2006	1.796
2007	1.777
2008	1.769
2009	1.768
2010	1.772
2015	1.736
2020	1.700

ANNEX 2b

Deflated Sterling Brent Oil Price (Historic and Projected) 1970 - 2010
(deflated by UK GDP, 2003 prices)

Real £/bbl



Source: DTI Brent average oil price.

Dollar price converted to sterling then deflated using UK GDP (2003 base year) deflator. Projections from 2004 – 2010 based on DTI energy model assumptions

ANNEX 3 Industry sector output

(Index, 2000 = 100)

Year	Food, drink & tobacco	Textiles, leather & clothing	Pulp, paper, printing & publishing	Chemicals & chemical products	Non-metallic minerals	Non-ferrous metals	Engineering & vehicles	Construction & other industry	Iron + Steel
2000	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2001	100.9	89.2	93.9	103.6	100.8	109.6	96.9	102.0	89.3
2002	101.6	82.2	94.1	105.1	98.2	104.7	89.9	107.1	77.0
2003	101.3	79.9	96.9	107.7	104.1	104.2	90.5	111.7	86.4
2004	102.9	77.5	98.6	110.5	103.3	110.5	92.0	116.1	95.6
2005	103.4	75.7	100.4	113.2	104.2	112.4	95.2	118.8	107.3
2006	104.6	73.8	102.1	116.1	104.7	113.5	97.9	121.2	111.6
2007	106.1	72.1	103.5	119.0	105.6	114.7	99.9	123.3	112.0
2008	107.7	70.4	105.5	121.9	106.7	115.5	101.7	125.3	113.3
2009	109.4	68.9	107.3	124.9	107.7	115.4	103.3	127.4	113.5
2010	111.0	67.6	109.0	128.0	108.9	116.1	105.1	129.4	114.1
2011	112.9	66.3	110.8	131.2	110.1	116.7	106.8	131.6	114.8
2012	114.7	65.0	112.5	134.5	111.4	117.2	108.6	133.7	115.4
Source	OEJ	OEJ	OEJ (1)	DTI	OEJ	OEJ (2)	DTI	OEJ	CRU (3)

Notes:

OEJ – DTI commissioned research from Oxford Economic Forecasting

CRU - Defra commissioned research from CRU Strategies, industry analysts

1. OEJ physical paper forecast for paper production. The residual sector uses DTI projection

2. OEJ weighted average primary and secondary physical output

3. Crude steel output

ANNEX 5

Iron and steel industry energy and emission projections

A number of data and other technical problems associated with modelling this industry were described in Working Paper 1. These problems have now been resolved and emissions projections made. However, the methodology currently used is not compatible with the presentation in the Digest of UK Energy Statistics, which splits energy into transformation and non-transformation. For this reason the data for the iron and steel industry is presented separately in the tables below. These figures represent a per annum energy intensity improvement of 0.5% between 2000 and 2005, and 0.7% between 2005 and 2010.

The energy and emissions projected for the iron and steel industry are:

Fuels used (Mtoe)				
	2000	2003	2005	2010
Coke	3.78	3.37	3.95	4.09
Natural gas	0.98	0.90	1.01	1.03
Coke oven gas	1.03	0.95	1.07	1.10
Oil	0.26	0.20	0.28	0.30
Coal	0.72	0.57	0.78	0.83
Total	6.8	6.0	7.1	7.3

Emissions (MtC)				
	2000	2003	2005	2010
Coke	4.61	3.97	4.55	4.71
Natural gas	0.59	0.65	0.59	0.61
Coke oven gas	0.52	0.35	0.51	0.52
Oil	0.27	0.22	0.24	0.25
Coal	0.57	0.67	0.82	0.87
Lime/dolomite	0.23	0.21	0.25	0.26
Total	6.8	6.1	6.9	7.2

ANNEX 6

Historic and projected UK carbon and carbon dioxide emissions in MtC and MtCO₂ as illustrated in Figure 1

	Projection of UK carbon dioxide emissions (MtC)	Projected emissions in MtCO ₂ equivalent	UK "Domestic Goal"
1990	165.1	605	
1991	166.6	611	
1992	162.3	595	
1993	157.8	579	
1994	156.5	574	
1995	153.5	563	
1996	159.6	585	
1997	153.1	562	
1998	154.4	566	
1999	151.8	557	
2000	152.7	560	
2001	156.8	575	
2002	151.5	556	
2003	153.6	563	
2004	152.6	559	
2005	151.4	555	
2006	149.4	548	
2007	147.4	540	
2008	145.3	533	
2009	143.3	526	
2010	141.3	518	132

Note: 2003 and 2004 figures are provisional estimates only. Between 2005 and 2010 projection has been interpolated.

ANNEX 7 CARBON PRICE ANALYSIS

Modelling Analysis of Power Station Responses to Future Possible Carbon Prices : 2005 and 2010

This section presents the results of analysis, using the DTI Energy model, to assess the power generation sector's possible response to a range of possible future carbon prices as a result of the introduction of the EU Emissions Trading Scheme from 2005. Analysis concentrated on "assumed low and medium" carbon price scenarios of 5 to 10 euros/tCO₂. Energy price assumptions are those used in the latest energy projections and presented in Annex 2.

The key findings of this analysis were that:

- At a low carbon price of 5 euros/tCO₂, emissions could be reduced by more in 2005 than in 2010, by around 1MtC and 0.2MtC respectively. This result arises for two reasons. One is that the assumed cost of imported coal is high in 2005, but declines significantly by 2010, so that a lower carbon price is required to switch from burning coal to other less carbon intensive fuels and so reduce CO₂ emissions more in 2005 than in 2010. The second reason is that there is more baseline coal use in 2005 than there is in 2010 and so there is less potential to switch away from it in 2010.
- The introduction of the EU ETS could lead to quite a significant reduction of CO₂ emissions as early as 2005. For example over 2MtC can be avoided at a carbon price of 8 euros/tCO₂ (the medium carbon price assumed). Real world constraints¹⁹, however, may limit achievable CO₂ reductions.
- In 2010, the results appear to suggest that the modelled impact of carbon prices is very sensitive in the 8 to 10 euros/tCO₂ price range. At 8 euros/tCO₂, avoidance is about 0.7MtC while at 10 euros/tCO₂, avoidance is about 2MtC. Further analysis would be required to explore responses at a carbon price above 10 euros/tCO₂ in more detail.
- The estimated impact of carbon prices is sensitive to key background assumptions including assumed plant efficiencies. For example, if gas prices were marginally lower than assumed in the base case, CO₂ reductions would be much higher at any given carbon price.

Conclusion of carbon price analysis

The achieved abatement of carbon appears to be very sensitive to the background energy price and other assumptions. Overall, the introduction of a price on generators' carbon emissions through the EU ETS could lead to significant reductions, although power sector carbon abatement as compared to the business as usual projection in the longer term could be relatively small unless carbon prices exceed 8 euros/tCO₂.

¹⁹ As an example, for simplicity the energy model assumes no upper limit on gas supplies.