OUR ENERGY FUTURE – CREATING A LOW CARBON ECONOMY

1. The White Paper is based on a large amount of analysis and modelling.

2. The following four documents form part of that work:

Annex 1 looks at estimates of the cost and potential for various long term low-carbon options. It covers the work of the PIU, our Inter-Departmental Analysts Group (IAG) and Future Energy Solutions (FES), who have undertaken analysis using the MARKAL energy model referred to in Chapter 2 of the White Paper. For some road transport options it also includes estimates from the Department for Transport;

Annex 2 describes how the background outlook for energy demand and gaseous emissions between 2000 and 2050 has been developed. It also briefly reviews the Energy Paper 68 (EP68) energy projections;

Annex 3 provides an initial assessment of the whole of energy policy as set out in the White Paper. It is intended to meet our requirements for both an partial Regulatory Impact Assessment (RIA) and a Sustainable Development Appraisal (SDA);

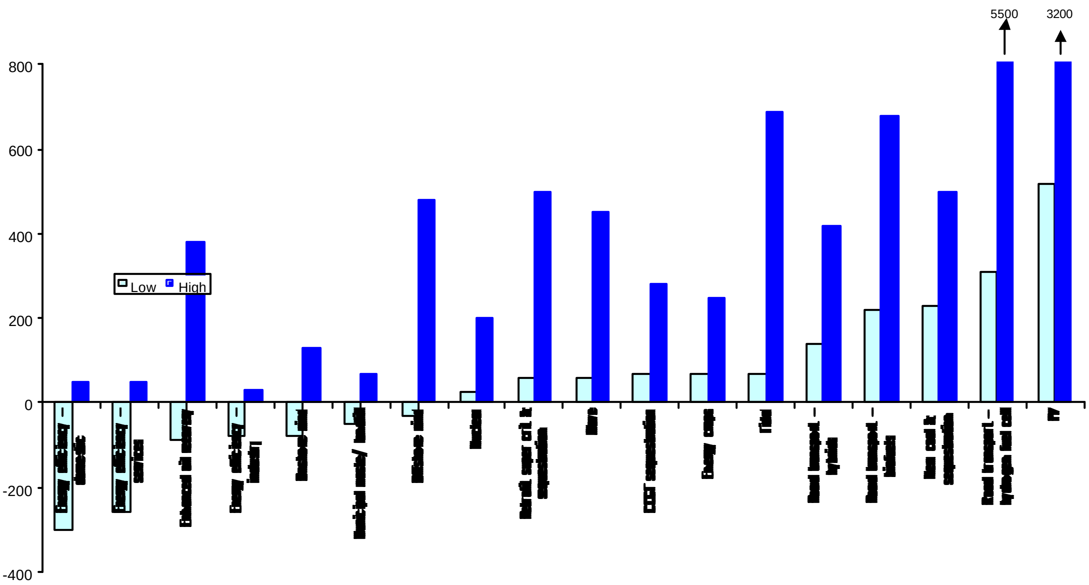
Annex 4 provides background calculations to achieving carbon cuts of between 15-25 million tonnes of carbon in 2020, as referred to in paragraph 1.28 of the White Paper.

Annex 1: Long Term Low Carbon Options

1. This note looks at estimates of the cost and potential for various long term low-carbon options. It covers the work of the Cabinet Office Performance and Innovation Unit (PIU), the Inter-Departmental Analysts Group (IAG) and Future Energy Solutions (FES), who have undertaken analysis using the MARKAL energy model (See Chapter 2). For some road transport options it also includes estimates from DfT[1].

2. Estimates from each source are detailed below. The full range of estimates across sources is shown in Figure A1, ranked from lowest to highest cost[2]. This can only be considered illustrative. It brings together estimates that will not have been calculated entirely consistently (for example different estimates of the cost of the comparator technology and different discount rates). But although different sources do show varying values for particular technologies, the broad rankings are generally similar.

Figure A1. Costs per tonne of Carbon saved in 2020/25



3. The further tables below show from the various sources the estimated costs of a range of low-carbon options and, where available, their potential for reducing carbon emissions. The estimates are not wholly comparable since the IAG and PIU used 2025 and 2020 respectively as medium-term target dates. Low and high cost estimates are provided – this should **not** be taken to imply that the mid point between the two provides a 'best' estimate.

4. **Key messages:**

[1] Building on work conducted by Ricardo Consulting Engineering Ltd
[2] The ranking is in order of cost on the "low" estimate for each technology.

Energy efficiency

- Energy efficiency is generally low cost. Many bottom-up assessments suggest that there are actually economic gains from investments to increase energy efficiency – on reasonable discount rate (or payback period) assumptions, reduced energy use more than pays back the up-front investment cost.

- If energy efficiency is cost-effective but not happening, we have to ask why. One explanation is that it is held back by market failures and barriers.

- Another explanation would be that energy efficiency is not as low cost as indicated – that bottom up assessments underestimate costs attached to management time, to uncertainty of the effectiveness of measures and to the disruption of taking action.

- But even then, inter-departmental work has suggested that the costs per tonne of carbon saved are likely to be low, relative to other measures. The key is achieving those savings – being confident that measures proposed will deliver.

Transport

Transport carbon savings are among the higher cost options. The biofuels figures above relate to current technologies for biodiesel and bioethanol production, mainly from oilseed rape, sugar or cereal crop materials. Future production from lignocellulosic material including coppice wood, and from waste, could have lower carbon cost. Carbon saving from hydrogen fuel cell vehicles is dependent on the availability and cost of non-fossil energy sources.

Electricity generation

- For each of the low-carbon technologies considered there is a fairly wide margin between the low and high cost projections. This reflects considerable uncertainty in the future cost of these technologies – the speed with which costs can be expected to fall.

- For some renewables (primarily on-shore wind) there is a reasonable expectation that costs will come down by 2020/25, to be competitive with gas generation – even without allowance for carbon benefits.

- For other renewables (including off-shore wind and energy crops) it is unlikely these will be cost-competitive in 2020/25 but reasonable allowance for carbon benefits (£50/tC) may bridge the gap.

- Wave, tidal and PV are probably further from the market. Though even here there is some uncertainty, with some seeing potential for wave - with allowance for carbon - to be approaching cost-competitiveness by 2020.

- For new nuclear build there are also big differences. There are good reasons to believe that the new designs currently contemplated (the AP1000, the PBMR) should come in at a cost much lower than current nuclear generation. But until these are built and demonstrated uncertainty will remain. It is also clear that past nuclear designs have not delivered to the costs that were initially projected for them.

- At the low end of the cost range for new nuclear it would be looking broadly competitive with other generation, with a reasonable allowance (£50/tC) for carbon. There are views in the industry that even the low end costs we have included here are too high. But if new designs were to deliver at a cost of 4p/kWh – which is broadly the top of the range considered by the PIU and the IAG – then the implied carbon cost would be around £200/tC and uncompetitive.

- Carbon capture and storage is similarly uncertain. There will inevitably be a cost penalty as against gas generation without capture. The industry has set in hand an ambitious programme targeted at reduced costs. If successful this might bring costs down to a level that could be competitive as a means of carbon reduction. But even then there are environmental and legal uncertainties attach to this option.

- Carbon capture with use for EOR could be a relatively low cost option.

- On carbon alone, transport options tend to be relatively high cost. Hybrids and some biofuels look the most promising options in the medium term; hydrogen fuel cells look realistic only after 2020.

Overall

- There are considerable uncertainties in the costs of the technologies for 2020/25. And there is considerable overlap in the estimated cost ranges, such that the rank ordering as between technologies (in terms of cost per tonne Carbon saved) is uncertain.

- This points towards measures that keep options open and to the use of economic instruments that provide a general signal of the value of reducing carbon, then leaving the market to determine the most cost-effective approaches.

- In the period to 2020/25 it currently looks as if energy efficiency and generation from wind and crops probably have the brightest prospects.

PIU estimates

	£/tC 2020		Emission reduction potential (MtC)	
	Low	High	2020	2050
Energy efficiency				
Domestic	-300	50	15	30
Services	-260	50	4	10
Industry	-80	30	9	25
Electricity generation				
Onshore wind	-80	50	1	5
Offshore wind	-30	150	8	>20
Wave and tidal	70	450	Small	>20
Energy crops	70	200	3	10
Photovoltaics	520	1250	<1	>20
Nuclear	70	200	7	>20
Carbon sequestration	80	280	Small	>20

IAG estimates

	£/tC 2025		£/tC 2050		Emission reduction potential (MtC)	
	Low	High	Low	High	2025	2050
Energy efficiency						
Domestic	n/a	n/a	-100	20	n/a	11
Services	n/a	n/a	-250	20	n/a	8
Industry			-80	35	n/a	7
Electricity generation						
Onshore wind	0	50	0	50	4	6
Offshore wind	0	100	0	100	7	10
Municipal waste	-50	70	-50	70	1	1
Landfill gas	-50	70	-50	70	1	1
Energy crops	100	250	100	210	1	3
Nuclear	70	200	60	200	6	25
CCGT sequestration	70	100	50	100	5	25

FES/MARKAL estimates

	£/tC 2020		£/tC 2040	
	Low	High	Low	High
Electricity generation				
Onshore wind	-40	130	-100	100
Offshore wind	160	480	10	240
Energy crops	135	185	30	100
Nuclear	105	180	70	140
Wave	120	430	80	310
Tidal	250	690	210	560
Photovoltaics	2200	3200	140	800
Retrofit super-critical to coal + sequestration[3]	160	200		
CCGT sequestration	180	200	160	180
New coal sequestration	460	560	370	450
Road transport				
Hybrid ICE	380	420	220	700
Hydrogen fuel cell	470	550	360	580
Biodiesel	290	380	220	380

Notes:

(1) FES/MARKAL estimates based on changes in efficiency of CCGT generation over time and use the gas prices specified in the MARKAL modelling report.

DfT estimates

	£/tC 2020		£/tC 2050	
	Low	High	Low	High
Road transport				
Hybrids	140	400	50	270
Fuel cell vehicle (H2 from natural gas)	540	5450	50	3670
Fuel cell vehicle (H2 from renewables)	310	1190	50	830
Biofuels (5% blend)	220	680		

[3] The comparator in this case is existing coal plant, on the assumption that coal plant would otherwise continue to run.

Other capture and storage estimates

	£/tC
Enhanced Oil Recovery (EOR)[4]	-90 to +380
CCGT sequestration[5]	100-120
Supercritical PF sequestration[6]	250-500
Coal IGCC sequestration[7]	230-500

Notes:

(1) Unless noted otherwise, the £t/C estimates for low-carbon electricity generation technologies are based on a gas generation cost of 2p/kWh for 2020/2025 and 2050. If gas-fired generation is more expensive than this in 2050 the costs of alternative low-carbon technologies over and above gas generation would be reduced accordingly. Each 0.1p/kWh increase in the cost of generation from gas reduces the cost in terms of £/tC by £10. For carbon sequestration costs include efficiency penalty in generation and the pipelines and equipment involved in capturing and storing the carbon emissions.

(2) The estimates for intermittent renewables such as onshore and offshore wind do not include additional systems costs as a result of their intermittent nature. If intermittent sources of generation were to reach 20% of total generation the cost of these options could be between £30 and £90/tC higher. At a 30% penetration rate the additional cost could be between £40 and £110/tC.

[4] Source: Future Energy Solutions, starting in 2006. Comparator is existing coal plant on assumption this would otherwise continue to operate. Part of variation in cost reflects assumed oil price. Further work is being undertaken by FES, which will be reported as part of the CO_2 sequestration study.
[5] Low estimate from IEA Cleaner Coal WG, for 2012; higher from DTI Clean Coal Review. The latter make little allowance for reduction in costs over time.
[6] Low estimate from IEA Cleaner Coal WG, for 2012; higher from DTI Clean Coal Review. The latter make little allowance for reduction in costs over time.
[7] High estimate from DTI Clean Coal Review. Makes little allowance for reduction in costs over time. Low estimate source is Future Energy Solutions. Further work is being undertaken by FES, which will be reported as part of the CO_2 sequestration study. This indicates that new IGCC/EOR could have a lower cost of carbon abatement, perhaps -£200 to + £290tC.

Annex 2: Energy and Emission Projections: derivations of baselines

1. The Basis of Energy Projections in this White Paper

1. This section describes how the background outlook for energy demand and gaseous emissions between 2000 and 2050 has been developed. It also briefly reviews the Energy Paper 68[8] (EP68) energy projections.

2. The 'business as usual' carbon projection to 2020 has been derived from the work of the Interdepartmental Analyst Group (IAG)[9] in which a baseline carbon projection and alternative scenario projections to 2050 were derived based on previous improvements in carbon intensities. Full details of the methodology and key assumptions are given in the IAG report.

3. The IAG projections drew on the DTI Energy Model energy and emissions projections from 2000 to 2010, which had previously been published as EP68. These EP68 projections are very detailed and incorporated all government policies that were considered firm at that time - for example the 10% renewables target by 2010 and the Climate Change Levy (CCL). The EP68 projections to 2010 were then adjusted to allow for the full impact of all the additional climate change measures outlined in the Climate Change Programme (CCP).

4. Taking these projections forward beyond 2010 to 2050 was not feasible using the econometric techniques of the Energy Model. So a process based on extrapolating historic carbon intensity rates of improvement was applied instead. This process removed all past fuel switching, including the switch to gas in electricity generation in the1990s and other non-repeatable effects, to provide a projection of carbon emissions based on key assumptions of:

- economic growth;
- population and household growth;
- service and manufacturing structure ;
- transport growth.

5. Expected closure dates of nuclear plants were also factored in. The projections were based on the four main final energy demand sectors of domestic, services, industrial and agricultural, and transport and included emissions not allocated to a specific sector.

6. The projection considered most appropriate to represent a "business as usual" baseline projection after 2010 is referred to as IAG(A). This estimates total UK carbon emissions of 135mtC in 2020 rising to145mtC in 2050. Any projection over this time scale is bound to have a considerable amount of uncertainty attached to it. This has been demonstrated and explored in the scenarios and alternative assumptions in the IAG report.

The Size of the Carbon Gap in 2020

7. Once it was decided that the IAG(A) carbon projection provided the most appropriate baseline projection, we then needed to establish an appropriate range for emissions in 2020. This range needed to be

[8] Energy Paper 68, published November 2000
[9] IAG – Report Feb 2002 – http://www.dti.gov.uk/energy/greenhousegas/index.htm

consistent with a 60% reduction by 2050 – just below 65mtC. There would be a variety of possible pathways to such a target but reductions in the range of 15–25mtC[10] in 2020 would seem to be appropriate.

2. The EP68 Energy Projections

8. There has been considerable volatility in energy markets since the EP68 projections were published in November 2000. New data has also become available, although in general it is too early to draw firm conclusions about the forecast performance of EP68. We intend to move on to a fuller review of the EP68 projections in the next year or so which will help to inform the review of the Climate Change Programme in 2004.

9. Nevertheless it is possible at this stage to offer some preliminary thoughts on the projections.

10. Ignoring the policies and measures that are part of the Climate Change Programme[11], a range of other possible influences has emerged in the past two years, each with the potential to impact on projected emissions. There are varying degrees of certainty attached to these influences but the most likely areas where significant impacts might arise are briefly described in turn below, together with an indication of the impact. Where numerical estimates are provided, impacts are rounded to the nearest 0.5mtC.

Energy Price Issues

11. Since EP68 was published annual average energy prices have at times been above the longer-term assumptions but within the short-term range assumed[12]. Crude oil prices have remained at high levels for most of the period. This reflects not only OPEC pursuing adjustments in production levels in order to achieve a target price range of $22 to $28/bbl, but also in part a risk premium associated with the potential disruptive impact of any military action. At times the relativities between energy prices have differed from those assumed in EP68, favouring coal use at the expense of gas use.

12. There are two particular energy price issues which could have a bearing on the EP68 projections:
- The overall level of sustainable energy prices;
- Short-term energy prices and the relative price of fuel oils.

i) The overall level of sustainable energy prices

13. It is important to distinguish between long-run sustainable prices and periods when prices are either well below or well above sustainable levels. When economic agents are assessing longer-term energy-related investment prospects they tend to focus on the outlook for long-term sustainable energy price levels, rather than dwell too much on the impact of cyclical or other short-term influences, which are unpredictable. EP68 therefore used a wide energy price range to encompass the possible range of sustainable energy prices.

14. When considering a crude oil price range which would encompass long run sustainable prices ten to fifteen years ahead, a price of $20/bbl at the higher end does not seem to be misplaced, as it would seem

[10] Further information can be found in section 2.16 of the White Paper and Annex 4.
[11] These policies and measures were not factored in to the EP68 projections.
[12] See Chapter 3 of EP68 - which sets out the energy price assumptions used; and Chapter 8 - which discusses sensitivities on the main assumptions.

adequate to provide an incentive for new capacity to be brought on stream. The price would also lead to a relatively diverse fuel mix, at least until 2010. Although it is important to avoid placing too much weight on recent short-term and temporary influences, the oil price assumed in the EP68 low energy price case of $10/bbl[13] now looks to be too low in 2010 by several dollars.

15. On the basis of this evidence we can assume that a range of $15 to $20/bbl[14] for long-run oil prices is sufficient to encompass the band of uncertainty about the cost of extracting new supplies.

16. A model simulation of the impact of assuming crude oil prices at $15/bbl instead of $10/bbl suggests a broadly unchanged outlook. Higher energy prices reduce energy demand slightly but this is offset by an increase in carbon intensity, as there is a modest shift from gas to coal.

ii) Short-term energy prices and the relative price of fuels

17. Although the projections for future energy prices focus on sustainable prices, it is nonetheless important to assess the impact of wider fluctuations. In the same sense, it is important also that long term energy projections recognise the potential for energy prices to differ from long-run equilibrium levels, albeit for relatively short periods. But as far as the outlook for emissions in concerned, in most circumstances it is the relative prices of coal and gas that matter, rather than the absolute level of prices.

18. Gas prices have exceeded coal prices by a sizeable amount at times during the last two years. This, together perhaps with some impact of NETA and a generally more competitive generation market, has led to a significant increase in coal use, mainly in the power station sector. So the contribution of coal to the power station fuel mix has been higher than might have been anticipated based on the EP68 projections. EP68 predicted that by 2005 coal's share of generation would fall to 21% compared with an actual of 34% in 2000 - and 35% in 2001. Early evidence available for 2002 suggests that coal's share may overall have been around 1% lower than in 2001[15]. This fall coincided with a narrowing of the gap between spot gas prices and coal prices.

19. When we come to allowing for short-term energy price fluctuations around assumed long-run sustainable prices in energy projections, recent experience would suggest that an oil price range of $10/bbl to $25/bbl or even $30/bbl would be reasonable. At these levels of crude oil prices it is difficult to be confident about the level and relativities of energy prices as a whole. Overall it seems more likely that gas prices would be higher relative to coal prices when oil prices are high, and lower relative to coal when oil prices are low.

20. To test for the possible impact of significant short-term movements of energy prices outside the sustainable range, we examined two cases. The first tests for low gas prices relative to coal, the second for a high gas price relative to coal[16]. Simulations of the DTI Energy Model suggest that in 2010 **emissions could perhaps be between 0.5mtC lower and 3.0MtC higher than the average of the EP68 CL and CH cases respectively.** It is worth noting that the high gas price assumed here has rarely been experienced, even in recent periods of very high oil prices. There is a high degree of uncertainty attached to such model results. No allowance has been made in the EP68 model for any impact from carbon trading - nor for any other policies and

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[13] Real 1999 prices.
[14] Real year 2002 prices.
[15] Based on major power producer gross supply to the grid, plus generation from renewables from other sources.
[16] Coal prices are held at around $35/tonne ARA in both cases. In the low gas price case, delivered gas prices are set at 0.45p/kWh (equal to about 13p/therm). In the high gas price case, delivered gas prices are set at 1.0/kWh (equal to about 30p/therm). For simplicity, sensitivity analysis is confined to the power station sector.

measures[17] that would tend to constrain any upward pressures on CO_2 emissions, particularly perhaps from power stations.

21. There are many other uncertainties relating to future energy prices and other impacts on power station emissions, not least in relation to the Large Combustion Plant Directive (LCPD), which is discussed below.

GDP Growth

22. The central level of GDP assumed for 2002 in EP68 seems to be broadly in line with the likely outcome of GDP growing by around 1.5%. The 2002 Budget Statement makes clear that trend growth to the end of 2006 could be a little higher than previously expected - at 2.75% - due to increased growth in the labour force. If GDP is assumed to grow at the new trend rate until 2006, followed by a lower growth of 2.25% a year to 2010, the change in the level of GDP could be approximately +1.3%. The resulting CO_2 emissions in 2010 **would be higher than previously projected by around 0.5mtC.**

The Composition of GDP Growth

23. EP68 was based on the premise that output growth in production industries, although lower than in services, would remain relatively firm. In the central growth case for example, long-run overall economic growth of 2.25%pa was composed of production industry growth of around 2%pa, compared with 2.5%pa growth in services.

24. It is clear, though, from the evidence available in recent years, that growth in services continues to be rather stronger than assumed in EP68. Over the period 1990 to 2002 for instance production industry output grew by 6% while service sector output grew by 42%.

25. The likely composition of future GDP growth will certainly require more consideration before the next set of energy projections, again taking into account the views of external experts. Model simulations suggest that if services were simplistically assumed to grow at 2.75% pa, while production industries grew at 1.4% pa[18], in broad terms **emissions in 2010 would be lower by 0.5 to 1.0mtC.**

Policy Assumptions

26. The Energy White Paper shows that there have been relatively few significant developments in terms of announced policy since the EP68 projections were made. But a number of amendments to existing policies have emerged, such as the exemption of Combined Heat and Power (CHP) sales from the Climate Change Levy (CCL). The effect of this on emissions is rather unclear, as it can be argued that any additional CHP capacity beyond that expected in EP68 would mainly displace some Combined Cycle Gas Turbine (CCGT) build by the major power generators.

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[17] Except that the prospect of carbon trading and perhaps a general tightening of environmental controls is assumed to be sufficient to deter new investment in FGD beyond the amounts expected in EP68.
[18] Long-run GDP growth is held constant at 2.25% pa, as in the EP68 central cases.

The Large Combustion Plant Directive (LCPD)[19]

27. Although a final decision has yet to be taken on how to implement the LCPD in the UK, it is possible that the outcome could imply lower coal-based generation than in EP68. The EP68 analysis was based on an assumption that plant without FGD would make use of the 20,000-hour opt-out. Given the other assumptions made, the EP68 projection for coal use in power stations was probably at the high end of the scale of possibilities. There remain significant uncertainties about the legal interpretation of the LCPD - perhaps, but not necessarily with the effect that there is less flexibility for unabated coal plants than was assumed in EP68. The impact of the interaction between the LCPD and the Integrated Pollution Prevention and Control (IPPC) Directive is also unclear.

The NECD

28. If the outcome for sulphur dioxide emissions from power stations means that the UK would fall short of the NECD target of 585kt for 2010, then it is possible that additional obligations will be placed on power stations. No allowance is made for that eventuality here.

Nuclear Energy: Magnox Plant Closures

29. The likely lifetime of some nuclear stations has been in question for some time. Exact closure dates are still uncertain, but if the Oldbury and Wylfa stations ceased generation just before 2010 rather than just after, as assumed in EP68, the impact on emissions in 2010 would be of the order of 1.0mtC, assuming that new CCGT plant replaces the closed capacity.

Road Transport

30. The trend in actual fuel use by road transport users remains roughly flat, suggesting no change in emissions since 2000. This is probably due in part to higher than expected fuel prices, resulting from higher than assumed crude oil prices, although the trend in total road transport fuel use has been broadly flat for a number of years. It is perhaps too early to make a reasonable assessment of whether the EP68 projections remain broadly robust, although it seems more likely than not that the EP68 projections for road transport emissions in 2010 are over – estimates in 2010.

31. EP68 did not allow for any impact from the EU Voluntary Agreements on average new car CO_2 emission rates, whose impact was included in the Climate Change Programme instead. The CCP estimate for savings, including the impact of the EU Voluntary Agreements up to 2008, and a number of fiscal measures encouraging lower carbon vehicles, was 4MtC.

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[19] The LCPD requires reductions in SOx and NOx emissions from large combustion plants. Negotiations provided two main ways of meeting the requirements (either via plant standards or a national bubble/plan), and other derogations may also be used.

Summary of Impact on Projected CO_2 Emissions and Targets

32. The table below summarises potential impacts on the baseline CCP CO_2 projections[20] of the influences described above, but restricted to those areas where it is possible to make estimates. For a number of these a range of possible impacts has been estimated. Impacts are rounded to the nearest 0.5mtC.

Influence	Impact Re CCP Baseline
Higher energy prices in the low case	0
Relative Fuel Prices	-0.5 to +3.0
Higher GDP level	+0.5
Composition of GDP	-0.5 to –1.0
Earlier nuclear closures	+1.0
The LCPD[21]	0 to –2.0
TOTAL[22]	**+0.5 to +1.5**

33. The table shows a relatively narrow range of possible impacts. However, there are different ways of summing the impacts of the individual factors considered. If for example the bottom end of the overall range is formed by the most negative impact for each influence identified, and the top of the range formed by the most positive impact, the range would be –2.0 to +4.0mtC. Although it is perhaps unlikely that all factors would be acting in one particular direction at the same time, this approach does at least offer an insight into the uncertainties involved[23].

34. Clearly it is possible that some other influences not separately identified here may have an impact. For example, even excluding the impact of the voluntary agreements on car emission rates, road transport emissions may turn out lower than previously expected. Any new electricity links to other countries might act to reduce emissions and re-fuelling or re-powering of existing fossil power stations could either increase or decrease emissions, depending on the precise circumstances.

Conclusion

35. Although projections are inevitably uncertain, in broad terms those in EP68 seem to be robust. A number of relatively minor adjustments, partly to take account of more recent information, could be justified without changing the overall emissions outlook.

36. To put this into context, the average of the two cases in EP68 suggested an 8.5% fall in CO_2 emissions between 1990 and 2010 and the tabled adjustments identified here would instead result in a reduction of between 7.6% and 8.2%. Based on the wider range of between -2MtC to +4MtC, the reduction would be between -6.1% to -9.6%.

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[20] This corresponds to the average of the EP68 CL and CH cases.
[21] Indicative estimates only, as it is too early to make more accurate estimates. Includes allowance for minor general tightening of environmental controls.
[22] This would be the range of possible impacts if the EP68 projections were to reflect the revised assumptions identified in the table.
[23] Other uncertainties exist of course and some of these are discussed in EP68, chapter 8.

37. It is possible that emissions in other sectors, such as road transport, may turn out lower than estimated in 2010, though it is too early to come to firm conclusions.

38. A great deal of consideration will need to be given in future exercises to the uncertainties around the energy and emission projections, building on the sensitivity work carried out for EP68 and possibly including more work on the importance to the projections of energy market volatility.

ANNEX 3
Sustainable development appraisal

REGULATORY IMPACT ASSESSMENT/
INTEGRATED POLICY APPRAISAL

Summary

Title: Our Energy Future: Creating a Low Carbon Economy

Status of Assessment

1.1 This is an initial assessment of the whole energy strategy as set out in this white paper. It is intended to be both a partial Regulatory Impact Assessment (RIA) and Sustainable Development Appraisal (SDA). It is therefore broad brush in nature and refers to detailed quantification work undertaken either for this white paper or in the development of related Government policies. Where, in due course, detailed measures flow from the white paper more specific RIAs would be carried out. The recently updated guidance for regulatory impact assessments includes a provision to consider environmental impacts as part of delivering the government's commitment to sustainable development, and carbon impact assessments will be part of this.

1.2 The overall assessment is that policies presented here have the potential to be beneficial in most if not all of the categories considered, and they can be implemented at a low overall net cost to the economy.

Brief Description

1.3 This assessment sets out the Government's energy policy. The main focus is on the period to 2020, but it considers long term carbon abatement to 2050. It is a strategic policy, which does not seek to define every detail of the policies to be pursued over the next twenty years and beyond.

Objectives

1.4 The overall objectives set out in the white paper are:

- to put the UK on a path to cut CO_2 emissions - the main contributor to global warming - by some 60% by about 2050, with real progress by 2020;

- to maintain the reliability of energy supplies;

- to promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve our productivity; and

- to ensure that every home is adequately and affordably heated.

1.5 It aims to achieve all of these objectives simultaneously and to look for opportunities for them to reinforce each other. Energy efficiency for example can reduce greenhouse gas emissions, help people in fuel poverty, cut energy bills and support energy security. Renewable energy can help to create new markets and new industries alongside environmental and energy security benefits.

1.6 This approach to energy policy is set firmly within the wider context of the Government's objectives and guiding principles of sustainable development. Its policies look to the medium and long term as well as the next few years. It also looks at risks and uncertainties involved. In particular it recognises that potential carbon reduction emission goals in 2020 may primarily be met by greater energy efficiency in homes, business and transport, and renewable energy. But the uncertainties are such that it is necessary to keep other options open in case they are needed.

1.7 Within this overall framework, the white paper sets out policies to:

- Put the UK on a path towards **reductions of some 60% in carbon dioxide emissions from current levels by about 2050.**
- Support the introduction of an **EU-wide carbon emissions trading scheme.**
- Take strong action to **promote energy efficiency in households, businesses and the public sector.**
- Tackle emissions from transport, in particular through support for EU voluntary agreements to reduce new **car emissions;** to promote the use of biofuels and through implementation of the Government's Powering Future Vehicles strategy.
- Promote further the option of renewable energy and outline the expectation for the share of electricity to be taken by **renewables** by 2020.
- Carry out a detailed implementation plan for carbon capture and storage.
- Protect **security of supply**, including championing EU and global market liberalisation.
- Make it clear that energy policy is increasingly **international**, with Europe a primary theatre.
- Reaffirm its commitment to competitive **market** mechanisms, with intervention minimised.
- Encourage OFGEM to give greater consideration to environmental issues.
- Support: a new energy **research** centre of excellence; increased R&D spend; and greater international collaboration to help achieve carbon reductions through technology.
- Encourage more regional and local interest in energy policy, including new **regional** energy strategies.
- Encourage the establishment of a new energy and utility Sector **Skills** Council.
- Make clear its role in engendering the **cultural and behavioural change** necessary to move towards a low carbon economy.
- Set out new **institutional** arrangements for co-ordinating energy policy across Whitehall.

Success criteria

1.8 The main success criteria are:

Stakeholder acceptance
Implementation of specific measures
Reduction over time of UK carbon dioxide emissions
Secure energy supplies

Risks

1.9 The main risks are set out below:

- Risks to the environment, caused by climate change;
- Uncertainties which could affect delivery of objectives particularly on energy efficiency and renewables;
- Risks to energy security from geopolitical instability, terrorism, major technical problems and extreme weather conditions;
- Risks to UK competitiveness from poor resource productivity or high energy prices; and
- Risks to social objectives, both for the fuel poor and consumers more generally.

Options

2.1 There are many possible routes to the low carbon future set out in this white paper, and the timescale and uncertainty make precise quantification of the individual options subject to considerable uncertainty. Leaving all the change to the last moment is conceivable but it risks more dramatic and more disruptive change which would be needed later on. Early, well-planned action provides a framework within which businesses and the economy generally can adjust to the need for change. This will for example allow business to plan to act in the course of normal capital replacement cycles. The analysis below provides an overview of the total package of measures identified to 2020. It mentions in outline some preliminary views about impacts to 2050.

Identifying the Options

2.2 The base case is "business as usual", covering the already announced policy. There are measures here which although already announced, may still require regulatory or other measures to fully bring them into effect. The detailed impact of each measure will have to be fully assessed individually, and subject to further RIAs. Measures already announced include:

the Government's current policies on climate change are set out in the Climate Change Programme, available at www.defra.gov.uk/environment/climatechange/cm4913/index.htm;
its Air Quality Strategy can be found at www.defra.gov.uk/;
its Fuel Poverty Strategy can be found at www.dti.gov.uk/energy/fuelpoverty/index.htm;
its Manufacturing Strategy can be found at www.dti.gov.uk/manufacturing/strategy.htm;
its policy on productivity (Productivity and Enterprise: a world class competition regime) improvement at www.dti.gov.uk/cp/pdfs/compwp.pdf; and
arrangements for regulating energy markets are based on the Utilities Act 2000.

Issues of equity or fairness

2.3 This policy applies to the whole of the UK, and where appropriate, is implemented by the Devolved Administrations of Scotland, Wales and Northern Ireland under their own governance. The policy pays particular attention to the needs of the fuel poor. In general it proposes mechanisms such as emissions trading which allow a market based approach to implementation. The summary table at the end of this annex provides more detail of expected impacts on equity and fairness.

Benefits

3.1 The benefits of reducing carbon emissions are global in nature and not attributable uniquely to the UK. The UK produces around 2% of global greenhouse gas emissions. UK action to reduce carbon dioxide emissions by 60% would, at today's levels, reduce global emissions by around 1%. This will not, by itself, materially change the impact of global greenhouse gas emissions, but it will demonstrate international leadership from a major economy and bring opportunities for businesses based here. Other countries, especially in Europe, have announced their intention to aim for substantial cuts in emissions by the latter half of this century, and measures will only be effective if others act. International action has been shown to be possible, under the UN Framework Convention on Climate Change, but it will not happen if there is no leadership.

Identifying the Benefits

3.2 Beyond the long-term benfits of tackling climate change, the main immediate benefit is expected to be improved resource productivity, achieving more output with less energy input. This is expected to be achieved with a range of measures described below.

3.3 There are a range of ancillary benefits from greenhouse gas reduction, which flow from reduction in pollutants associated with the combustion and handling of fuels, such as oxides of nitrogen, sulphur, volatile organic compounds and particulates. A more extensive analysis of the ancillary benefits of greenhouse gas mitigation can be found in a paper published in parallel with the white paper which can be found at www.dti.gov.uk/energy/whitepaper.

Quantifying the Benefits

3.4 There are many possible ways of assessing the overall benefits. One of the most obvious is that, for a given level of economic activity, less fuel will be needed as an input. The table of expected carbon savings is reproduced below, together with the fuel which will primarily be saved by the measure. This is only a rough approximation. The intent of the table below is to give some scale and feel for the potential. The numbers are not necessarily additive.

3.5 These savings take no account of the costs involved to achieve them, which are discussed further below. The table of cost of carbon saved, shown in annex 1, and summarised again in table 4, indicates the likely overall picture. For example, energy efficiency measures have the potential to have negative costs of carbon saved (in other words savings over several years more than pay for the initial outlay), indicating that the capitalised costs of implementing the changes will be less than the savings identified above. For measures with a high cost of carbon saved, such as transport, the capitalised costs are higher than the fuel savings, which means that there is a net overall cost.

Table 1: Implied Fuel Savings from Measures in White Paper

	Est MtC reduction[24]	Main fuel saved	Equivalent Mtonnes/year of fuel	Range of possible values in 2020, £/t	Implied Fuel Saving £m/year
Energy efficiency in households	4-6	Gas	5-8	100-125	500-1000
Energy efficiency in industry, commerce and the public sector	4-6	Gas	5-8	100-125	500-1000
Transport: continuing voluntary agreements on vehicles; increased biofuels for road transport	2-4	Oil	2-5	60-160	120-800
Increasing renewables	3-5	Gas[25]	4-7	100-125	400-900
EU carbon trading scheme	2-4	Coal	2-4	25-30	50-120

Compliance Costs for Business and Consumers

3.6 By 2020 the policy measures suggested here – on emissions trading, renewables and energy efficiency – might add approximately:

- 5-15% to household electricity prices (per unit);
- less than 5% to household gas prices (per unit);
- 10-25% to industrial electricity prices (per unit) ; and
- 15-30% to industrial gas prices (per unit).

3.7 There are several important considerations in looking at these numbers. The high end prices are deliberately at the top end of the range, and the estimates are highly uncertain. Prices of fuels will also depend on actions taken by other countries – international demand for gas, for example, might rise more if all major economies where to adopt fuel switching as a primary carbon abatement measure. Such a rise might, however, be offset by relatively lower costs for other carbon abatement measures, on the basis that RD&D costs could be shared more widely. Within the price uncertainty, much will also depend on the price of carbon in an emissions trading market, and on detailed decisions, yet to be taken, on the precise implementation of particular measures.

3.8 Electricity prices have fallen significantly in real terms over the last 20 years to their current historically low level. Under a worst case scenario the cost of electricity to domestic consumers could increase to levels of the mid 1990s. This would still be well below that for the whole of the period from 1975 to 1995. For industrial consumers, prices might return to the levels of the early 1990s but remain below those for the whole of the 1970s and 1980s.

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[24] The figures represent reductions beyond the baseline of 135 MtC

[25] Assessed against long run marginal plant, assumed to be CCGT. In reality, some reduction in coal firing may come about from renewables.

Sectors Affected and Compliance Costs for a typical business

3.9 All sectors are affected, depending on energy intensity. The variety and number (1.35 m) of businesses[26] across the UK make it difficult to define a typical business. However, the table 3 below illustrates the potential impact on several industrial sectors. For the service industries, average cost increases caused by price rise can be expected to be less than 1% of the sector's turnover. The extent of any cost increases will also be mitigated by energy efficiency measures which industries may adopt which will reduce the impact on their energy bills

Impact on energy prices

3.10 Based on a broad assessment of the priority measures to reduce carbon outlined in the white paper, estimated price impacts are outlined above. An alternative approach, and a useful check on the above estimates has been to use the MARKAL energy model[27] to assess the impact on electricity prices in 2020 and 2050, for different levels of carbon constraints. The methodology is different to that used in the estimates quoted above, in that the specific measures are not identified, but rather the overall impact of a constraint on carbon emissions is assessed. The two different methodologies provide estimates which are of the same order of magnitude. Reference should be made to the detailed report at www.dti.gov.uk/energy/whitepaper.

Table 2. Estimated Electricity Prices for 2020 for different carbon constraints

	No constraint	**20% Carbon dioxide reduction**	**30% Carbon dioxide reduction**
Electricity prices (£/GJ)	12	14 (+17%)	16 (+36%)

3.11 There is a significant difference in electricity price in 2020 for the 20% and 30% carbon constraints. This is a result of the need for relatively more expensive low carbon technologies to be brought to the market place quicker if a 30% target is set. It should be noted that these price estimates assume that there are no barriers to the introduction of lower carbon technologies. Predicted electricity price rises could, therefore, be greater than shown in table 2. The carbon dioxide reductions are modelled in MARKAL against a baseline of 155 MtC (the level in the late 1990s). Reductions from this level of 20-30% correspond roughly with the savings in the range of 15-25 MtC below the 2020 baseline of 135 MtC, which are described in both table 1 and the white paper itself.

3.12 The main sectors affected would be those for which energy forms a significant proportion of their production costs or industry turnover. These sectors are shown in the following table 3.

[26] There are 1352000 businesses with employees in the UK, source DTI Small Business Service, 1999.
[27] *Options for a low carbon future* Future Energy Solutions, 2003 www.dti.gov.uk/energy/whitepaper

Table 3: Impact of Potential Price Movements for Main Energy Intensive Sectors (excludes energy supply industries themselves)

	Expenditure on energy		**Estimated cost increases**	
	As % of production costs	As % of industry turnover	As % of production costs	As % of industry turnover
Mining and quarrying	5.9	3.8	0.5	0.3
Paper	3.6	2.4	0.4	0.2
Basic chemicals	4.9	3.9	0.5	0.4
Man-made fibres	4.4	3.2	0.4	0.3
Glass	8.1	4.6	0.8	0.4
Ceramics	6.3	3.3	0.5	0.3
Bricks	22.7	10.3	1.2	0.5
Cement, lime and plaster	14.6	7.5	1.1	0.6
Iron and steel	4.6	3.5	0.5	0.4
Precious and non-ferrous metals	4.4	3.5	0.6	0.5
Casting of metals	7.9	4.2	1.0	0.5

The estimated impact of increased energy costs is as a result of a 20% reduction in carbon dioxide emissions by 2020.

3.13 The figures in the above table do not necessarily reflect the full impact on the competitiveness of these industries in world markets. To the extent that other countries adopt carbon abatement policies they will also face cost increases in energy-intensive industries. The extent of any cost increases will also be mitigated by energy efficiency measures which industries may adopt which will reduce the impact on their energy bills.

Total Compliance Costs

3.14 For the economy as a whole, total costs are expected to be between 0.5% and 2% of GDP in 2050[28]. In 2020 costs would tend to rise significantly only if energy efficiency measures are unsuccessful.
The analysis in annex 1 of cost of carbon saved provides some indication of the potential total resource costs. Where these are negative, the measure is cost effective in carbon reduction terms, excluding any additional ancillary benefits. The potential range of options is identified below, but these are explained in greater detail in Annex 1.

[28] GDP is predicted to be around £2500bn in 2050, assuming average annual growth of 2.25%, the central assumption in the modelling. On this basis, the range of costs would equate to a total £12-50bn by 2050, or some £0.2-1bn on an annualised basis. The length of time over which these estimates are made make them very tentative.

Table 4: Range of Cost of Carbon Savings

	Est MtC reduction[29]	**Range of cost of carbon savings in 2020 £/tC**
Energy efficiency in households	4-6	-300 to +50
Energy efficiency in industry, commerce and the public sector	4-6	-260 to +50
Transport: continuing voluntary agreements on vehicles; biofuels for road transport	2-4	+140 to +680*
Increasing renewables	3-5	-80 to +230*
EU carbon trading scheme	2-4	+10 to +25

Note: EUETS savings are the expected value of carbon within the scheme, rather than cost of carbon saved.
* Annex 1 identifies values higher than this, but these are less likely to be taken up in the period to 2020
The mid point value can **not** be taken as the best estimate of cost of carbon saved.

3.15 For many businesses, the overall savings over time in the period up to 2020 are likely to be such that they could pay for the initial outlay to achieve them.

Implementation Costs

3.16 Implementation costs are wrapped up in the total above, as the additional resource cost is capitalised in the expected prices to consumers. In the years to 2020 much of the expenditure in the electricity supply industries includes replacement of capital items on a normal business cycle. The extent to which capital assets could be kept in service beyond their assumed design life will impact on cashflow and financing requirements for a particular business.

Impact on Small Business

3.17 There are a great variety of small businesses which will have varying energy needs. The Federation of Small Businesses in its response to the white paper consultation emphasised that energy should be "affordable", and also argued that the government should take a strong lead in promoting renewable energy. The price which small businesses pay for energy is likely to depend on the level of demand and the type of contract that they have with their supplier, and hence all small businesses could be expected to benefit from strong competition in the energy marketplace, a principle which is reaffirmed in this white paper. A typical energy bill, excluding the Climate Change Levy (CCL), for a business consuming[30] 880 MWh per year of electricity present is around £41,000 per year , and gas of 1500 MWh per year around £18,000 per year. The order of magnitude of the savings expected from the overall package of efficiency measures is at least broadly equivalent to the price rises, which would result in no net overall impact.

[29] The figures represent reductions beyond the baseline of around 135 MtC.
[30] Prices reflect those charged for different levels of consumption. DTI data collected for smallest business consumption range (880 or less MWh/year electricity, 1500 MWh/year or less gas). Small businesses would probably also pay CCL of £4000 for electricity and £2000 for gas above the numbers quoted.

Impact on Competition

3.18 The proposals outlined will broadly affect all businesses to some extent and are not expected to unduly affect competition outside the energy industries themselves. However, detailed RIAs will be developed as and when proposals are developed or taken forward which can explore the competition effects in detail.

Other Costs

Enforcement costs/monitoring

3.19 There will be some additional costs associated with ongoing monitoring and evaluation, but most of the data required is collected now. These costs are not quantified but will be small in comparison to those identified above.

Effects on international competitiveness

3.20 The total impact on GDP by 2050 of these measures is estimated to be in the range 0.5-2% of the 2050 level of GDP, or an impact of 0.01-0.02 per year percentage points reduction in GDP growth over 50 years. But impacts on competitiveness will depend on the scale of actions to reduce carbon emissions taken by others. That position will be kept closely under review, but in the period to 2020, priority is given to measures which are international in nature, such as EU emissions trading, or through enhanced energy efficiency, which need not impact adversely on overall competitiveness.

Costs of Not Implementing

3.21 A Government Economic Service working paper[31] has suggested £70/tC (within a range of £35 to £140/tC) as an illustrative estimate for the damage cost of carbon emissions. It also suggested that this figures should be raised in real terms by £1/tC per annum as the costs of climate change are likely to increase over time. These values are under review in the light of developments in the academic literature and in the Government's economic appraisal guidance. Currently the estimate only represents a subset of damage costs, and the review will also consider issues of coverage. While the suggested range covers impacts such as effects on agriculture, wildlife and health, sea level rise and some extreme weather effects, it does not include the possible impacts of 'climate catastrophes' (e.g. melting of the West Antarctic ice sheet or changes to the Gulf Stream), of social impacts such as famine or mass migration, or of impacts after 2100. Nor does it include other benefits of reducing emissions, such as improved air quality. These could increase the social cost of carbon considerably. Impacts will also vary significantly across sectors and regions.

3.22 These values do not set a limit on the acceptable costs of reducing emissions. Wider impacts on other energy policy objectives are also relevant. Costs which initially look high may also be reduced by economies of scale and innovation

3.23 On this basis , the cost of inaction in 2020 could be estimated as 15-25 MtC x £87/t or nearly £1.3-2.2 bn per year, as a central estimate within a possible range of £ 0.5-3.5 bn per year.

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[31] *Estimating the Social Cost of Carbon Emissions*, Government Economic Service Working Paper 140, www.hm-treasury.gov.uk

Results of Consultations

4.1 An extensive public and stakeholder consultation was carried out in the period of May to September 2002. More than 6500 responses were received. Individual stakeholder responses, and summaries of the various public events can be found at www.dti.gov.uk/energy/developep

4.2 The key overall messages from the public were:

- People were most interested in environmental aspects of energy policy. The need to address pollution and climate change featured prominently in discussions on energy policy.

- There was firm support for energy efficiency and renewable forms of energy; many respondents were concerned that by focusing on lower energy prices, the government might be sending the wrong signal about using energy efficiently

- When it came to nuclear power, many people said they wanted more information before they felt able to participate in a debate. The strongest view was over the question of how to dispose of nuclear waste safely.

- Energy supply was taken for granted due to the reliability of current supplies.

- There was a clear demand for more information from government, to ensure policies were followed across government, and to encourage more efficient use of energy.

4.3 Key messages from stakeholders included:

- the importance of energy security/reliability but acknowledgement that no acute risks were posed at the moment;
- agreement that more action should be taken to address climate change, especially through market mechanisms, such as carbon trading;
- strong support for maximising our use of renewable generation and the need for Government to continue its support through the Renewables Obligation, capital grants and R&D;
- strongly divided views on nuclear generation; and
- a number of calls for more Government support for commercialisation of near-market technologies and also for a clearer view of strategic long-term policy.

4.4 A detailed appraisal of the public and stakeholder consultation can be found at www.dti.gov.uk/energy/developep

Monitoring and Evaluation

4.5 The white paper proposes the strengthening of the analytical and strategic capability of the DTI in the area of energy policy, which will serve as the focal point of a network - a Sustainable Energy Policy Network - of departmental policy units that will be involved in delivering the white paper's commitments. It is expected that DTI, Defra, the FCO, the Treasury, the ODPM, DfT, the Scotland Office, the Wales Office, and the devolved administrations will all play a full part in this network. The regulators, particularly OFGEM and the Environment Agency, will also play an important part. The primary task of the network will be to ensure that the aims and targets we have set out in this white paper are delivered. This will require the network to ensure that government as a whole pursues effectively the policies and programmes that we need to deliver all the objectives, including a significant stepping up of our international capability.

4.6 To provide a clear line of accountability for the network, we will also put in place a new, ad hoc, Ministerial group which will oversee the delivery of the commitments in this white paper. This group will be chaired jointly by the Secretary of State for Trade and Industry and the Secretary of State for the Environment, Food and Rural Affairs. To support the Ministerial group, the governance of the Sustainable Energy Policy Network will be strengthened with the creation of a Sustainable Energy Policy Advisory Board, made up of senior, independent experts and stakeholders.

4.7 To ensure the transparency of the follow up to the white paper, the Sustainable Energy Policy Network will publish annually a report on the progress being made towards the identified aims and targets

More detailed analysis of Sustainable Development

4.8 The following tables identify further assessments of impacts on Sustainable Development

			Qualitative assessment	Quantitative measure(s)
E C O N O M I C	Public accounts and public service	Will the policy involve cost to exchequer funds? Will it result in receipts or savings to the Exchequer?	The only additional cost directly as a result of measures in the white paper is additional capital grants for renewable technologies.	Total cost to exchequer of all new measures announced in this White Paper £ 60m
		Will it impose administrative or other burdens on public service providers, for example frontline staff in health, education, local government or criminal justice?	**Health:** reduction in emissions will be generally beneficial, especially in transport area but not primary purpose. **Education:** skills agenda, but unlikely to be additional load overall **Local Govt:** Some extra administrative impact from stronger local government role in energy policy, for which a separate consultation process is planned. Development of renewable energy may increase number of planning applications from renewables development and energy efficiency measures. **Criminal Justice:** No significant impact. Some minor potential for local protest action associated with unpopular development	Further quantification for transport measures can be found in Chapter 5 of Government's air quality strategy. No significant impact for the education sector Not further quantified
	Consumers	Will the policy or project affect the cost, quality or availability of commercially available or publicly-provided goods or services?	Yes. Policies to reduce carbon emissions through energy efficiency, renewable energy or other measures may raise energy prices for consumers. At the same time, energy efficiency measures should reduce average household bills.	For gas and electricity prices in 2020 there are a range of potential outcomes for domestic and industrial consumers, ranging from 2% to 30%, as illustrated above
		Will it result in a change in the choice available to consumers or the availability of information to enable them to exercise choice?	Yes. New more efficient products and services (for example cars, domestic appliances, opportunities for domestic energy efficiency) will be stimulated. Inefficient products will be removed from the market. Information enabling consumers to make choices will be improved. More efficient products should reduce overall costs for consumers, even though in some cases the initial purchase price may be higher. Measures to ensure continuing energy reliability will reduce the risks to consumers from supply interruption.	
		Will it introduce a new technology or process that will make existing goods redundant over time?	Yes. As above, eventual transition to H2 economy could by the second half of this century render a large part of the oil infrastructure obsolete	Too far off for detailed work but overview in MARKAL suggests that an eventual transition to hydrogen is needed to meet long term carbon dioxide targets, for which there is a low cost to overall GDP (0.5-2.0 % of 2050 GDP).

	Business	Will the policy or project impose or relieve a cost or burden on business, charities or the voluntary sector? Will it result in a change in the investment in people, equipment, infrastructure, or other asset?	Some small increases in energy prices, which could be significant for some energy intensive sectors. This is quantified in para 3.12 of this annex The Government will be working with industry to help them manage the transition to a low carbon economy. Measures to achieve energy security will reduce the risk to business of costs due to failures in energy supply. The continued central role for liberalised and competitive markets will promote efficiency in the generation market and hence competitive energy prices. Little impact on charities or the voluntary sector Yes, changes to the Electricity Supply Industry mix will require skilled people. There will be a need for additional and energy-related skills generally.	Analysis in Chapter 7 identifies measures on skills, in particular establishment of a new energy sector skills council. See also comments on Small Business.
SOCIAL	**Public health and safety**	Will the policy enhance or harm safety, or affect the use of the work environment to maintain or improve health? Will it affect health related behaviour such as diet, physical activity, alcohol, tobacco and drug consumption, sexual behaviour, excessive gambling? *Will it affect access to NHS services, including the use of preventative services such as health screening, immunisation, sexual health services?* *Will it affect the ability of people to return to work from illness (whether the illness is work-related or not)?*	Intended to help to prevent long term climate change. Will as side benefit reduce other harmful emissions. General education on the links between energy use and climate change could encourage less car use and more walking. No clear link to other areas. Fuel poverty measures will enable people to heat their homes adequately, thus reducing ill health such as heart disease and respiratory problems. No impact expected	The national air quality strategy sets out the benefits of improving local and transboundary air quality. Reduction in fossil fuel burn will help most objectives directly, by reducing the input load. Further detail on the ancillary benefits can be found in a separate paper published at www.dti.gov.uk/energy/whitepaper Detailed analysis can be found in the fuel poverty strategy. A first annual progress report will be published shortly.
	Crime	Will the policy affect the rate of violent and non-violent crimes? Will it divert people away from or prevent crime? Will affect people's fears about being a victim of crime? Will it create a new offence or create an opportunity for crime for example through fraud? Does the policy create new investigative powers that could increase the risk of violence against public sector workers?	Policies generally aimed at making buildings, appliances, cars etc more energy efficient. Public consultation suggests that this is what people want, so unlikely to cause general unrest. Specific protest at any proposed power generation sites or energy infrastructure sites possible. No No	No measurable impact anticipated on crime statistics.

	Social capital, community and education	Will the policy affect the number of people involved in voluntary and community activities? Will it affect people's access to information or social networks? Will it affect the availability of affordable homes of suitable quality? Will it affect the capacity for parents/guardians to provide a stable environment for their children? Will it affect the level of skills and education in the workforce, among children, or otherwise? Will it affect access to, and the range of, facilities for the arts, culture, sports and leisure pursuits?	No major effect, although greater role for local and regional bodies should encourage more local involvement in energy policy issues. Provision of more information should improve public awareness of energy issues. The reinforced commitment to the fuel poverty strategy will mean people are better able to afford to heat their homes adequately. Impact if any positive Yes, skills paragraph 7.15 –7.25 Unlikely	Chapter 7 describes the background to UK skills generally and energy skills particularly. Training needs for 19,000 people identified in the text. Total requirements (once quantified) are likely to be much greater than this over the next 20 years.
ENVIRONMENTAL	**Climate change**	Will the policy lead to a change in the emissions of any of the six greenhouse gases, for instance by consumption of fossil fuels? Will it affect, or be affected by, vulnerability to the predicted effects of climate change for example flooding?	Main objective is carbon emission reduction over time. There should be a positive impact, but only through international action.	Policies are aimed to put UK on a path to reducing its carbon emissions by some 60% by around 2050 and reducing by 15-25mtC from the business as usual case in 2020.Chapter 2 et seq
	Air quality	Will the policy or project lead to a change in the emissions of air pollutants? Will it result in greater or fewer numbers of people being affected by existing levels of air pollution? Will it have a bearing on areas of existing poor air quality?	Yes reductions in a variety of air pollutants from reduced used of fossil fuels. Fewer, there should be general improvements in air quality. Transport measures will help in urban areas.	Exact quantification will depend on particular route chosen. General material on benefits in paper at www.dti.gov.uk/energy/whitepaper The IPCC (2001)[32] estimates that ancillary benefits may be 30% to over 100% of abatement costs See also land use below for biomass
	Landscape	Will the policy involve visually intrusive construction works? Will it involve demolition or modification of historic buildings? Will it impact on a location in such a way as to change its sense of place or identity in any other way?	Windfarms are regarded by some as visually intrusive. The precise impact is very specific to particular projects. Unlikely to involve demolition. Building regulations specifically deal with application of energy efficiency measure to historic buildings. Possible in rural areas, for example change of land use for biomass growing.	Onshore wind power may increase from 500MW now to 5500MW by 2020. A strategic environmental assessment of the Government's strategy for offshore wind is currently being carried out. See also land use below for biomass

[32] IPCC (2001); 'Climate Change 2001 Mitigation, Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change;' Cambridge University Press, Cambridge.

	Land use, waste and water	Will the policy lead to the consumption of a substantial volume of natural, non-renewable resources, including land? Will it lead to a change in the volume of waste produced or to the way it is processed? Will it affect the efficient use of energy or water? Will it lead to an increase or decrease in water pollution? Will it increase or decrease water abstraction or otherwise affect the flow, run-off or recharge of water?	Objective is to make energy production and use more sustainable. But this may involve quite large land areas. The white paper has no firm consequences for nuclear waste but retains nuclear as an option for the future. Were any nuclear power stations to be built in future, this would produce more nuclear waste. Any specific new nuclear proposal will have to fully assess the impact of nuclear waste. Yes, this is a main objective. Energy benefits are the core of the white paper. Likely decrease, since for example there will over time be less oil infrastructure, but see comment on quantification. For biomass water use can increase significantly but this is considered in specific assessments Difficult to assess, but directionally decrease since for example cooling systems should require less load.	**Wind energy:** The total area of land and sea that might be devoted to power generation from wind energy to meet a 10% and 20% renewable share of generation is extremely small compared to the total size of the UK's marine and land resource. By 2020, wind developments may account for less than one ten thousandth of the total surface area of the UK. **Biomass:** Up to 1,000,000 hectares of land may need to be set aside for biomass in order to meet the 2020 aspirations for renewables. This is equivalent to up to 4% of the UK's total land resource. Energy Crop proposals are subjected to a specific environmental assessment. Details can be found at www.defra.gov.uk/erdp/erdphome.htm Quantified benefit to water pollution will take a significant further study.
	Biodiversity	Will the policy or project involve disturbance or relief of disturbance to habitats or species by change of land use, light or noise? Will it lead to severance, fragmentation, isolation or change in size of habitats?	Renewables will have some marginal impact which will have to be assessed on a case by case basis	A strategic environmental assessment is under way on the impacts of offshore windfarms.
	Noise	Will the policy lead to increase or decrease in exposure to noise of sensitive buildings such as schools and hospitals? Will it lead to an increase or decrease in the number of people affected by existing noise? Will it lead to a change in standards or use that would increase or decrease the noise generated by products?	Unlikely to increase, see below Tend to decrease, Home will be better insulated which will reduce noise as well as heat transfer loss, hybrid and fuel cell cars/vehicles will be much quieter	Detailed quantification should be contained in specific proposals but not expected to be major change.

Distributional impacts

	Description of differential impacts across groups (quantified where possible)
Deprivation and income groups:	Fuel poverty strategy will help lower income groups.
Age:	Many skills reside at present in an aging workforce and skill needs may create opportunities for older people to remain in the workforce longer. The elderly are a vulnerable group targeted by the fuel poverty strategy.
Gender:	No major impact foreseen.
Disability:	No major impact foreseen.
Race:	No major impact foreseen.
Regions and localities:	Regional impacts will include but not be limited to managing concentrations of energy intensive businesses (for example in the North East) and adapting to availability of local renewables. There will also be distributional aspects that will affect the Devolved Administrations. For example, in Scotland there is currently more energy supply than demand. The regional distributional aspects are quantified further in a paper on competitiveness published as an annex to the MARKAL report at www.dti.gov.uk/energy/whitepaper. In paragraph 9.19 et seq further measures are outlined to provide local and regional bodies with a greater stake in energy strategy.
Rural areas:	Rural areas are particularly susceptible to the kind of energy security, fuel poverty and transport problems, which are less significant in densely-populated parts of the country. The Government has a number of policies to help alleviate these problems. The white paper itself focuses on energy efficiency measures (which can benefit rural housing stock) and greater vehicle efficiency, which can reduce direct transport fuel costs for those in rural areas. Paragraphs 8.9 and 8.10 also contain further detail. The potential benefits from renewables in rural areas derive from the Community Renewables Initiative, launched by the Countryside Agency in 2002 (in Scotland the Scottish Community Renewables Initiative). Biomass for energy and biofuel crops offer opportunities for agricultural diversification and stimulation of the rural economy, further details in paragraph 4.49 of the white paper.
Small firms:	There are no significant additional administrative burdens placed on small businesses and many may gain by being able to provide new products and services. In paragraph 3.9 the possibility of extending the energy efficiency commitment beyond the domestic sector is outlined, which would allow businesses that are below the threshold for negotiating climate change agreements to have a route to access efficiency savings. These proposals will be the subject of further consultation if they are to be progressed. Plans for Small and Medium sized Enterprise Energy Advice Centres are outlined in paragraph 7.13 of the white paper
Other effects that vary across different groups:	Distributional aspects in business are explored in the MARKAL report and its annexes. Carbon intensive businesses will have to consider strategies for reducing their carbon emissions.

Annex 4: Background Calculations To Achieving Cuts Of Between 15-25 Million Tonnes Of Carbon In 2020

a) How much do we need to reduce carbon dioxide emissions in 2020?

1. Our starting point is that we accept the recommendation of the Royal Commission on Environmental Pollution that the UK should put itself on a path towards reductions in carbon dioxide emissions of some 60% from current levels by around 2050. This equates to emissions of around 65MtC in 2050[33]. To be consistent with our longer-term aims, we need to plan to reduce greenhouse gas emissions beyond the level we already expect to reach at the end of the first Kyoto commitment period (2008-2012).

2. Discussions under the Kyoto protocol to tackle climate change beyond 2008-12 will start soon. On the basis of current policies, including the full impact of the Climate Change Programme, we would expect our carbon dioxide emissions to amount to some 135 MtC in 2020. To be consistent with demonstrating leadership in the international process, we expect to aim for cuts in carbon of 15-25 MtC beyond that by 2020. This would also put us on course to reduce our carbon dioxide emissions by some 60% by 2050. (See graph below. [34])

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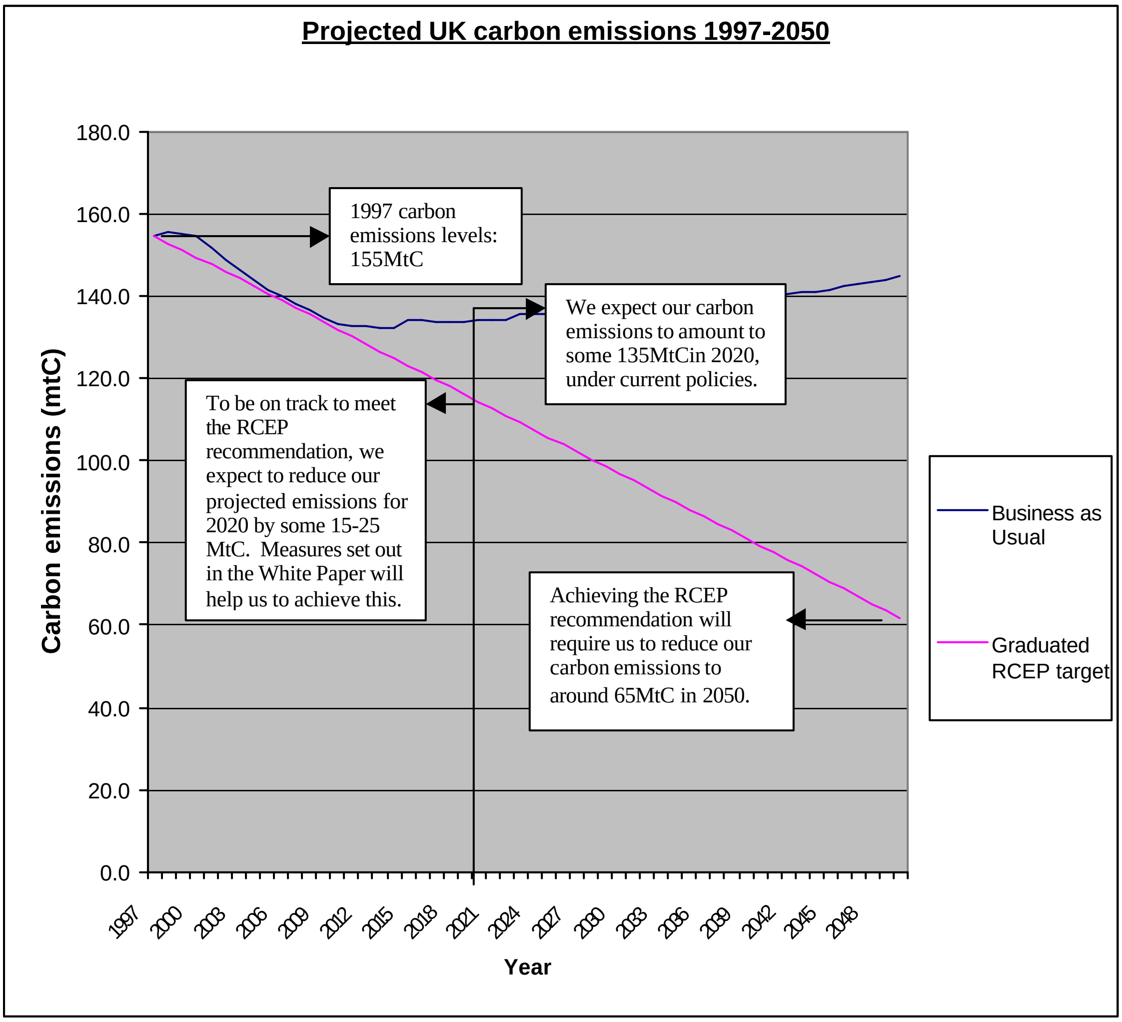
[33] RCEP's recommendation of putting the UK on a path to 'reducing carbon dioxide emissions by some 60% from current levels by about 2050' was based on a more detailed calculation of 58% reductions from 1997 levels. (The Royal Commission on Environmental Pollution's 22nd report: Energy - The Changing Climatehttp://www.rcep.org.uk/newenergy.html) This would lead to 2050 emissions of 64 MtC. The Kyoto protocol, and the UK's current domestic targets, use 1990 as a baseline. A precise reduction of 60% in emissions from 1990 would results in emissions of 65.8 MtC in 2050. As the RCEP recommendation implies, absolute precision five decades before 2050 is not possible. This White Paper uses 'around 65 million tonnes' to describe the level of carbon emissions which a 60% cut would deliver by 2050.

[34] The "business as usual" carbon projection up to 2010 has been derived from the work of the Interdepartmental Analyst Group (IAG – report February 2002 http://www.dti.gov.uk/energy/greenhousegas/index.shtml). The business as usual baseline projection post 2010 is referred to as IAG(A).



3. **Table A** illustrates how cuts of between 15 and 25 MtC could be achieved by 2020. The exact target figure will be determined in the light of international negotiations, and the actual mix of measures needed to reach the target will be shaped by economic and technological developments. We will put in hand measures now to ensure we are well placed to deliver on our commitments.

Table A: Measures to reduce carbon emissions in 2020

	Estimated MtC reductions [35]
Energy efficiency in households	4-6
Energy efficiency in industry, commerce and the public sector	4-6[36]
Transport: continuing voluntary agreements on vehicles; biofuels for road transport	2-4
Increasing renewables	3-5
EU carbon trading scheme	2-4[37]

b) Calculating the carbon emission cuts of White Paper measures:

Energy efficiency in households: Savings of 4-6MtC in 2020:

4. **Table B** lists the technical potential for carbon savings in UK housing stock as it stood in 2000. The majority of these carbon savings – around 15-20MtC – are considered economic, and deliverable by 2020.

Table B: Technical potential for carbon savings in UK Housing Stock (based on existing technologies in 2000):

MEASURE	No. Dwellings (M)	Carbon saving (MtC)
Appliances	24.2	5.6
Condensing Boilers	15.6	3.8
Solid Wall Insulation	10.6	2.7
Cavity Insulation	8.7	2.6
Solar Water Heating	19.6	1.8
Lighting	24.2	1.7
Double Glazing	24.2	1.4
Loft Insulation	18.9	1.3
Draughtproofing	24.2	0.3
Low-E Glazing	11.2	0.3
Hot Water Tank Insulation	5.0	0.3
Heating controls	2.5	0.2
TOTAL		**21.9**

(Source: Carbon Emission Reductions from Energy Efficiency Improvements to the UK Housing Stock, Building Research Establishment, 2001)

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[35] The figures represent reductions beyond the baseline of 135MtC discussed in paragraph 2

[36] The energy efficiency savings in industry and commerce refer to technical improvements that will be stimulated by a range of measures, of which the most significant is likely to be the expected EU cap and trade scheme for greenhouse gases.

[37] The savings of 2-4MtC attributed to the EU emissions trading scheme relate specifically to carbon savings in power stations and refineries, and are in addition to the energy efficiency savings expected to be achieved by end-users.

5. The potential carbon savings from domestic energy efficiency in 2020 is significantly greater than this, at around 30MtC. Firstly, demand for energy services – primarily comfort in the home and so the use of energy – will have escalated significantly by then, so heating and insulation measures introduced then will save more in 2020 than they do at present. Secondly, the list does not take account of new build, which is improving the efficiency of the average stock by about 0.3% a year, and with prospects for faster gains from tighter regulations in the future. Thirdly, Table B does not include the contributions to be made by CHP (both district schemes and domestic micro-CHP), by further improvements to domestic appliances, or by new technologies that will no doubt come to maturity over the period.

6. Some of these savings will be taken up anyway due to ongoing improvements in energy efficiency, (for example when acquiring new boilers, appliances etc.) delivering around 10MtC of carbon savings over the period to 2020. But these carbon savings will be more than offset by underlying growth in levels of comfort, the rise in home entertainment and increasing numbers of households. The policies set out in the Climate Change Programme will approximately double the current rate of improvement, and lead to savings of 5MtC from the domestic sector by 2010. All of these savings are included in the baseline assumptions.

7. Beyond this, a continued uptake of remaining cost effective measures, together with savings from community CHP and new technologies such as micro-CHP, should deliver additional carbon savings of around 4-6 MtC by 2020.

Energy efficiency in industry and services (including the public sector): Savings of 4-6 MtC in 2020:

8. Current measures in place to promote energy efficiency in the business and public sectors (for example Climate Change Agreements, Enhanced Capital Allowances Scheme, UK Emissions Trading Scheme) are designed to achieve the additional annual carbon savings of around 6MtC by 2010, as envisaged in the Climate Change Programme.

9. Energy efficiency in industry and services occurs through a very wide range of technological developments and resource productivity improvements. Most of the savings occur at the time of investment in new or replacement plant, since modern equipment (for example, boilers, motors and pumps) is usually more energy-efficient than previous designs. As existing technologies are adopted, new processes and new energy-saving opportunities will be developed on an ongoing basis. Overall, the historical rate of energy efficiency improvement in industry and services is around 1% a year. Continuing this rate over the period 2000-2020 would provide an efficiency improvement of around 20-25% within the baseline. The Climate Change Programme is already having a strong influence, however, and the IAG(A) baseline takes this into account, so a further 10-15% efficiency improvement is projected. The additional 4-6MtC saving by 2020 will require an extra 10% beyond this revised trend, so that the total improvement is 20-25% per decade, rather than over a 20-year period.

10. Individual energy saving technologies are harder to list for industrial processes than for households, since there are hundreds of different types of process opportunities, rather than a dozen or so key measures. Cross-cutting technologies such as high efficiency motors and variable speed drives can make energy savings of several percent, because motors represent by far the largest fraction of industrial electricity use. But there are also many process- and product-specific improvements to be achieved – e.g. reducing scrap rates in foundries so as to minimise re-melting of metal – as well as general improvements to building design and to management of building services. The full range of these potential opportunities has been collated within cost-abatement curves for manufacturing and for non-domestic buildings[38], showing the carbon saving potential available within a range of cost-effectiveness criteria.

Transport: continuing voluntary agreements on average new car CO_2 emissions; biofuels for road transport Estimated savings of 2-4MtC in 2020.

New voluntary agreements on average new car CO_2 emissions

11. By pursuing the low carbon strategy set out in chapter 5 of the white paper, we believe we can improve the carbon efficiency of transport by up to 10% by 2020. The exact amount of the carbon saving depends on firstly the actual kilometres travelled - and this has been taken as the projection in the Interdepartmental Analyst Group report[39], of 523 billion kilometres for 2020. It also depends on the levels of average new car emissions which were set in future voluntary agreements or equivalent measures, and what would have happened in the absence of such measures. The estimates of possible carbon savings do not represent or imply targets for future new car performance - they illustrate what a range of levels of new car performance, from some 100g/km to 115g/km, could translate into.

Biofuels

12. We estimate that we could feasibly introduce 5% of biofuels into petrol and diesel (in blends) by 2020. Penetration rates beyond 5% would involve modifications to car engines. Biofuels, as presently produced,emit on average 55% less CO_2 than conventional petrol and diesel. Depending on our overall petrol and diesel consumption forecast, we would expect universal 5% blend biofuels, as currently produced, to be able to save around 1 million tonnes of carbon in 2020. Lower penetration would have a proportionately lower carbon saving. New technologies for biofuel production could produce higher per-litre and total carbon savings.

Increasing renewables. Estimated savings: 3-5 MtC in 2020.

13. Based on projections of energy demand using the IAG(A)[40] baseline and estimates of electricity demand from the MARKAL[41] model, we calculate that around 4

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[38] IAG Report Annex D, and ETSU and Building Research Establishment work for DEFRA Global Atmosphere Division.

[39] Interdepartmental Analyst Group (February 2002) http://www.dti.gov.uk/energy/greenhousegas/index.shtml

[40] Interdepartmental Analyst Group (February 2002) http://www.dti.gov.uk/energy/greenhousegas/index.shtml

million tonnes of carbon could be saved by increasing renewables in electricity generation from around 10% in 2010 to around 20% of generation in 2020. This is based on an assumption that 1TWh of electricity from gas-fired stations produces 0.1MtC[42] and that renewables replace gas as the form of electricity generation.

EU carbon trading scheme: Estimated savings: 2-4MtC in 2020

14. A carbon saving of 2-4 million tonnes annually in 2020 has been estimated for the additional impact of the EU emission trading scheme, on top of planned savings from business energy efficiency. This relates only to the impact of the scheme on fuel switching in the electricity generation sector. In practice, the overall impact could be greater – for example carbon savings from greater business energy efficiency, since emissions trading will be one of the mechanisms which will incentivise such savings.

15. The impact on power generators has been modelled using of the DTI Energy Model[43]. The scale of impact is clearly dependent on the price of carbon in the traded market. This is highly uncertain. In the early days of the UK emissions trading scheme, carbon has been trading at between £14 and £44 per tonne of carbon. But this may not be representative of the underlying trend in market price which may take longer to emerge and it does not incorporate wider EU dynamics.

16. A recent survey of models by brokers Natsource-Tullett has indicated a price approaching £25 per tonne of carbon for an EU scheme in 2010.

17. For our own modelling work, we have considered a range of prices, up to £50 per tonne of carbon by 2020. But a more central projection, at an assumed price of £25 per tonne of carbon applied to the power generation sector model indicates a carbon saving of around 4 million tonnes. This reflects a substantial reduction in the use of coal in generation.

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[41] MARKAL Model (AEAT/ Imperial College 2002).
[42] DTI calculations derived from "Digest of UK Energy Statistics" (DUKES 2002)
[43] "Energy Projections for the UK – Energy Paper 68" (DTI, 2000)