SYNTHESIS OF THE ANALYSIS OF THE ENERGY WHITE PAPER

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1. Introduction

1. The Energy White Paper (EWP), *Meeting the Energy Challenge*[1] is setting the long-term framework to deliver our energy policy goals. The new or revised policies and proposals within this framework presented in the EWP have been developed on the basis of the best available evidence and analyses which is presented or signposted in this document. This strengthens the framework and actions taken as set out in the Energy White Paper 2003.

2. Energy Goals

2. The Government has four long-term goals for energy policy, which were first set out in the Energy White Paper 2003:
   - To put the UK on a path to cut our carbon dioxide emissions by some 60% by about 2050, with real progress by 2020;
   - To maintain reliable energy supplies;
   - To promote competitive energy markets in the UK and beyond, helping to raise the rate of sustainable economic growth and thus improve our productivity; and
   - To ensure that every home is adequately and affordably heated.

[1] See www.dti.gov.uk/energy/whitepaper

3. Baseline

3. In the Energy Review Report, published in July 2006, we presented our projections of UK carbon emissions, and set out a number of new policies to achieve further progress towards meeting our long-term goals. The measures in the White Paper build on existing policies introduced to tackle carbon emissions under the Government's Climate Change Programme. The continuation of these policies is expected to save an estimated 25 million tonnes of carbon (MtC) in 2020.[2]

4. The latest projections of future UK carbon emissions for 2020 show an increase relative to those published in the Energy Review Report. Based on our latest forecasts for energy prices and demand, and not taking into account any of the policies in this White Paper, carbon emissions in the UK are projected to be between 149 -151MtC in 2020, 3-5MtC higher than our central projections in July 2006,[3] see Figure 1 (page 10). Part of the reason for the increase in emissions projections is the additional new coal capacity expected by 2020 (up to 8GW), due to the improved relative price of coal in the revised fossil fuel price assumptions.

5. Real progress by 2020 against our 2050 carbon goal of reducing UK emissions by 60% is defined as UK emissions falling to within a range of 110-120MtC a year by 2020. The Government has introduced the draft Climate Change Bill[4] which creates a new legal framework for the UK achieving, through domestic and international action, at least 60% reduction in carbon dioxide emissions by 2050, and 26-32% reduction by 2020, against a 1990 baseline.

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[2] UK Energy and CO_2 Emissions Projections, May 2007 (see www.dti.gov.uk/energy/whitepaper)

[3] See www.dti.gov.uk/energy/whitepaper Annex B Energy White Paper *Meeting the Energy Challenge*. DTI Updated Energy Projections.

[4] See www.defra.gov.uk/environment/climatechange/uk/legislation/index.htm

4. Current Policy

6. The Government is committed to a market framework for energy, intervening only where necessary to deliver its energy goals. Here follows a brief description of the key policies for different sectors as they stand before the EWP measures are introduced.

a) Business and Power Generators

7. The EU Emissions Trading Scheme (EU ETS) is a "Cap and Trade" system. EU Member States are required to set an emissions cap for all installations covered by the scheme. EU ETS covers energy intensive industry including energy activities, production and processing of ferrous metals, the mineral industry, and other activities such as production of pulp and paper.

8. The Renewables Obligation requires licensed electricity suppliers to source a specific and annually increasing proportion of their generation from renewable sources or to pay a penalty (the buy-out price). The penalties are paid into a fund which is then shared among the suppliers who have met their obligation.

9. Under Integrated Pollution Prevention and Control (IPPC), all power generators must have a permit, which sets out conditions of operation, including emission limit values and the use of best available technology instruction.

10. The Climate Change Levy (CCL) is a tax on the use of energy in industry, commerce and the public sector, with exemptions for charities and very small firms amongst others. Climate Change Agreements (CCA) provide an 80% discount for the energy intensive sector from the CCL when businesses commit to energy efficiency measures.

11. The CCL is recycled to industry via the Carbon Trust (CT), an organisation established to work with industry to help cut their carbon emissions and to support the development of low carbon technologies.

12. The current energy market framework has provided a high level of security and diversity, as evidenced by the record for continuous supply and lack of involuntary interruptions. This environment allows participants to consider the costs and benefits of mitigating the risks of supply shortfalls and deliver an appropriate level of security of supply. The framework relies on the price mechanism to balance demand and supply. Prices provide signals to market participants who then respond with the appropriate consumption and investment decisions.

13. The Office for Gas and Electricity Markets (Ofgem) is the authority that regulates the UK gas and electricity markets, promoting competition where appropriate with the aim of protecting customers.

b) Transport

14. Current Government policies tackle transport emissions using a range of policy levers. Economic instruments incentivise take-up of lower carbon transport fuels and vehicles, including reforms to Company Car Tax and Vehicle Excise Duty. These are supported by EU Voluntary Agreements (VA) on new car fuel efficiency, measures encouraging people to make more sustainable travel choices e.g. through work travel plans, or encouraging walking and cycling, and investment into public transport to give people a viable alternative to travelling by car. The Renewable Transport Fuel Obligation (RTFO) will be introduced in 2008-9 and requires transport fuel suppliers to ensure a proportion of their sales are from renewable sources. It is also Government policy to support the inclusion of aviation in the EU ETS.

c) Buildings, Households and Appliances

15. Building Regulations, amongst other objectives, set minimum energy efficiency standards for all new buildings, as well as for some aspects of refurbishment, e.g. replacement of boilers and windows in existing housing.

16. Article 8 of the Energy Performance of Buildings Directive (EPBD), which requires either inspection of, or advice on boilers, is planned to be implemented in the housing sector through advice, given as part of the regular boiler service, on the early replacement of very old and inefficient boilers and the effective use of heating controls.

17. The Energy Efficiency Commitment (EEC) is one of the principal policy mechanisms by which we deliver energy efficiency into the home. Under EEC, energy suppliers are required to achieve targets for the promotion of energy efficiency improvements in the household sector in Great Britain.

18. Fuel Poverty programmes such as Warm Front and its devolved equivalents reduce the costs of maintaining adequate warmth for low income households by giving grants for insulation and heating measures tailored for property. As a consequence they also provide some carbon reductions through installation of energy efficiency measures.

19. Products Policy covers a wide range of actions, including energy efficiency labelling, minimum efficiency standards, and voluntary agreements with the supply chain.

5. Opportunities

20. The Energy Challenge showed that the Government was not on track to deliver its energy policy goals and therefore further opportunities needed to be identified; the cost-effectiveness of different opportunities for carbon abatement was a key consideration.

21. A further consideration when looking at possible areas of action is both the short and long-term policy horizon. For example, there are policies that may be the most cost-effective to follow at present, there are also cost-effective policies looking to the future which need policy intervention today if they are to make a valuable contribution to tomorrow.

22. When identifying opportunities for carbon abatement all sectors were considered. Cost-effective measures may impact some sectors more than others due to there being a greater potential for cost-effective savings in particular sectors.

23. There are many technologies being developed which are at various stages and levels of cost-effectiveness. As technologies develop there are more opportunities for policy-making. The Marginal Abatement Curve (MAC) which is discussed in Section 10, sets out different policies and technologies and their cost-effectiveness.

6. Robust Processes to Develop Policy

24. The approach adopted by analysts conducting UK cost benefit analysis (CBA) is consistent with that provided in the Green Book[5] and Impact Assessment (IA) guidance.[6] The Climate Change Programme Review (CCPR) guidance,[7] which has been agreed by analysts across Government, was also used, particularly with regards to carbon savings arising from options.

25. However, as the EWP 2007 focused on the possible effects that options could have against all of the Government's energy policy goals; carbon abatement, security of supply, competitive markets, and fuel poverty, these had to be taken in account when conducting the analysis.

26. The impacts of all measures were considered relative to the base case.[8] Core assumptions applied when carrying out the analysis were peer reviewed to ensure that they were consistent. Where individual analysis has further assumptions these are clearly stated.

6.1 Analysis of Costs

27. The costs of the policy that were analysed were the real resource costs. This, in general terms, means the materials and manpower used for new investment (and financing costs). It includes up-front costs and ongoing running costs, including marketing.

6.2 Analysis of Benefits

28. Benefits were counted as welfare-enhancing or harm-reducing activities that were additional to business as usual. Specific attention was given to the four policy goals set out in the Energy White Paper as well as any other key direct benefits.

29. The benefits for many policies were typically, reduced energy consumption, reduced emissions of carbon dioxide, and increases in security of energy supply. For energy efficiency there was also comfort taking e.g. enjoying a warmer house. The ancillary benefits of other air quality impacts were also considered for the whole EWP package. To the extent possible, a monetary value was given to all key benefits. When putting a monetary value on carbon, the social cost of carbon (£46-

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[5] See www.hm-treasury.gov.uk/economic_data_and_tools/greenbook/data_greenbook_index.cfm
[6] See www.cabinetoffice.gov.uk/regulation/ria/
[7] See www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf
[8] The base case is the 'do nothing' case, i.e. the baseline situation before any measures from this White Paper are taken forward, described in Section 3.

£162/tC, with a central estimate of £84/tC, in 2005 prices), based on analysis conducted by DEFRA,[9] was used.

30. The analysis of the individual measures did not look at the overall impact of the package as a whole on the UK economy. However, to inform estimates of the macroeconomic impacts to the UK of reducing carbon emissions, we have undertaken modelling analysis using the Oxford Economics suite of energy and macroeconomic models. The analysis explores the short to medium-term impacts of the UK reducing carbon emissions by 30% by 2020. In addition to the short to medium-term analysis, we have used the MARKAL model to explore the macroeconomic impacts of achieving a 60% reduction in emissions by 2050.[10]

31. When assessing alternative forms of electricity generation e.g. renewables, it was assumed that generation from a gas-fired (Combined Cycle Gas Turbine (CCGT)) plant would be displaced. For energy efficiency measures the analyses differentiated between whether electricity, gas or other energy sources such as oil or solid fuel were saved. For transport measures, assumptions on the benefits of any reduced fuel use were made. This gave an indication of any possible carbon savings as well as any impact on security of supply.

32. By reducing our demand for gas and oil, we reduce our exposure to security of supply risks, including the risks associated with imported energy. While the interactions of producers and consumers in energy markets will determine future levels of oil and gas demand, we can evaluate the impact of our policies in terms of our reduced demand for fossil fuels or increased UK oil and gas production and therefore reduced need for energy imports. Where possible, security of supply was measured using a Value of Lost Load[11] (VoLL) to estimate the benefits of more reliable energy supplies. However, for proposals where this was not appropriate the impact of the measure, was assessed in terms of reduced gas consumption (or conventional fuel in the case of transport options) or qualitatively.

6.3 Carbon Cost-Effectiveness

33. Carbon cost-effectiveness[12] analysis offered an estimate of the cost (expressed as a positive value) per tonne of carbon saved over the lifetime of the policy or measure and provided a useful metric when comparing

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[9] See www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf and www.hm-treasury.gov.uk/documents/taxation_work_and_welfare/taxation_and_the_environment/tax_env_GESWP140.cfm

[10] See Section 8 xi and 8xii

[11] The Value of Loss Load (VoLL) is the estimated amount that customers would be willing to pay to avoid a disruption in their electricity service.

[12] Cost effectiveness = NPV costs less NPV of non-carbon benefits divided by carbon saved. For more detail on calculating a carbon cost effectiveness measure see www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf

policies that involved net costs. Where there is a negative value for cost-effectiveness this implies a net benefit per tonne of carbon; cost-effectiveness may not be the only criterion for ranking policies.

6.4 Discounting

34. All monetary costs and benefits were discounted at the Treasury Green Book rate of 3.5 per cent per year.[13]

35. An appropriate commercial cost of capital was used when calculating the cost of finance for private firms. For example the cost of financing the construction of a power station and operating it over its lifetime was annualised using a commercial rate to reach a figure for levelised cost. The levelised cost of a low carbon generation technology was then compared over time against that of a CCGT and the differences between these two costs discounted at the Green Book rate.

6.5 Energy Price and Baseline Emission Scenarios

36. Each CBA was conducted under three different energy price scenarios, each of these scenarios lead to a different projection of carbon emissions in 2020. The scenarios are based on high, central and low fossil fuel price assumptions. Table 1 presents the carbon savings from policies in 2020 based on the central fossil fuel price scenario, the ranges are based on policy uncertainties.

6.6 Sensitivity Analysis

37. Those conducting the CBA of options looked at how changes in key assumptions affected the outcomes of their analysis and where appropriate conducted sensitivity analysis and ranges have been presented in the results.

6.7 Peer Review Process

38. All of the CBA carried out for the EWP was peer reviewed. This review process was chaired by the chief economist of the DTI and involved the chief economists from DEFRA, DfT and HM Treasury and external experts as appropriate. The peer review group was also supported by an interdepartmental group of analysts who were able to study the CBAs in detail and feed comments to the main panel. The peer reviewing of analysis ensured that all the CBA carried out was fit for purpose. It also ensured that the analysis was based on a consistent set of assumptions

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[13] Costs and benefits that occurred more than 30 years in the future were discounted at lower rates.

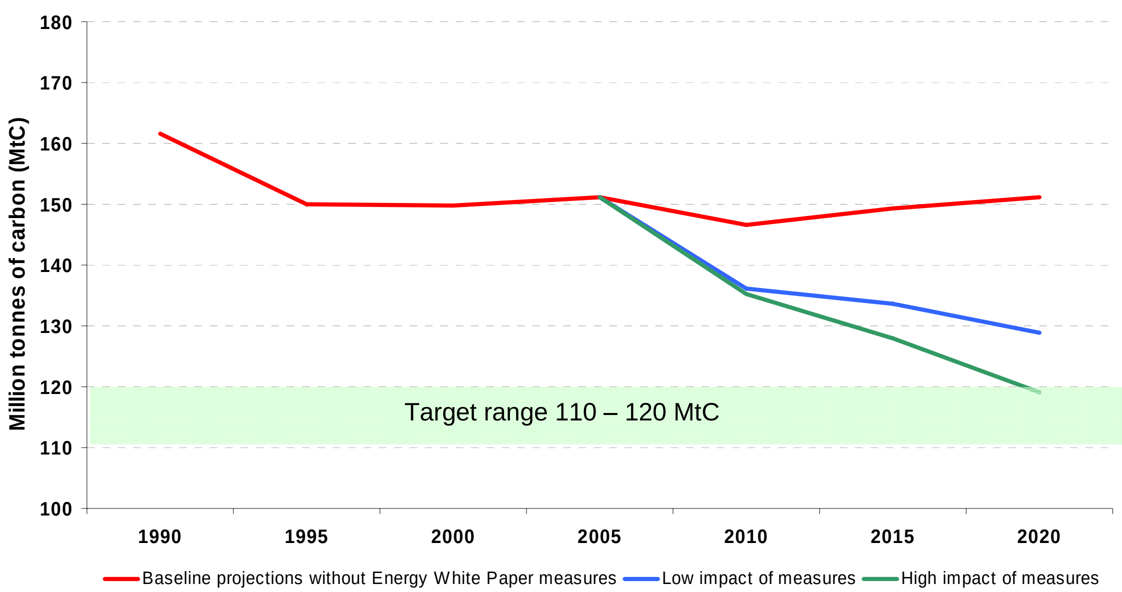
and any residual uncertainties were clearly identified. An important part of the peer review process was to identify any policy overlaps and avoid double-counting of emission savings. This process meant that analysis looking at a diverse range of options and sectors could be compared and the results used to inform policy decisions.

7. EWP Policies

39. This section covers the policies as featured in Table 10.1 in Chapter 10 of the EWP. It includes the table and graph of projected carbon savings as featured in Chapter 10 of the EWP and then sets out the analysis behind each proposal.

40. Table 1 shows the carbon impact of the proposals included in the White Paper, proposals announced since publication of the Energy Review Report and the potential impact of future phases of the EU ETS. The estimates are based on central fossil fuel price assumptions and are presented as a range to reflect policy uncertainty over the timing and impact of the measures. Figure 1 shows the projected carbon emissions in different scenarios, the baseline and the low and high range of the impact of EWP measures.

FIGURE 1 – PROJECTED UK CARBON EMISSIONS AND CARBON IMPACT OF OUR MEASURES



Source: DTI Energy Model, Updated Energy on carbon Emissions Projections, May 2007. See Annex B. UK carbon emissions, inclusive of carbon savings achieved through the EU ETS and other offsetting measures. High and low policy measure projections based on estimates presented in Table 1.

TABLE 1 – ESTIMATED CARBON IMPACT OF OUR MEASURES AND MEASURES ANNOUNCED SINCE THE PUBLICATION OF THE ENERGY REVIEW REPORT

MtC abated in 2020	
Energy Efficiency	
Better Billing	0.0 – 0.2
Real Time Displays in Households	0.0 – 0.3
Energy Performance of Buildings Directive (EPBD)[1]	0.6 – 1.6
Zero Carbon Homes[2]	1.1 – 1.2
More Energy Efficient Products[3]	1.0 – 3.0
Continued obligation on energy suppliers to make carbon reductions in the household sector[4]	3.0 – 4.0
Business Smart Metering[5]	0.1 – 0.2
New measure for achieving carbon savings from large non-energy intensive organisations (Carbon Reduction Commitment (CRC))[6]	1.0
Energy Supply	
Changes to Renewables Obligation[7]	0.4 – 1.1
CCS demonstration project[8]	0.3 – 1.0
Transport	
Successor to EU voluntary agreements on new fuel car efficiency[9]	1.8 – 4.1
Renewable Transport Fuel Obligation[10]	0.0 – 1.0
EU ETS and offsetting measures	
EU Emissions Trading Scheme[11]	13.7
Aviation in EU ETS (domestic)[12]	0.2 – 0.4
Carbon Neutral Government[13]	0.2
Total	**23.4 – 33.0**

NOTE: Savings expressed in terms of million tonnes of carbon (MtC) under central fossil fuel prices and rounded to the nearest decimal point.

[1] Excluding 0.2MtC included in the baseline. EPBD also supports 0.5-0.7MtC of the savings from the continued obligation on energy suppliers to 2020, to make carbon reductions in the household sector.

[2] Savings as estimated in the *Building a Greener Future* consultation. These savings include the savings of the 'Carbon neutral developments' policy as shown in the Energy Review Report, Table 8.1.

[3] The range of carbon savings for products policy has been updated since the Energy Review Report as part of an annual process. This also includes a larger coverage of product groups and is net of overlaps with other policies.

[4] The level of ambition from 2011 is committed to be equal to that under CERT, delivering 3-4MtC in 2020.

[5] This estimate excludes 0.1-0.2MtC accounted for within the EPBD and CRC estimate.

[6] The Government is committed to achieving a 1.2MtC saving from this sector - this estimate excludes 0.2 MtC accounted for in the EPBD estimate.

[7] This estimate assumes a range based on different technology assumptions – the low figure is based on high technology cost assumptions, and the high figure on low technology cost assumptions.

[8] This is based on one unit of around 0.3 Giga Watt to-1.9 Giga Watt of demonstration plant(s) displacing equivalent gas fired generation.
[9] Illustrative estimate reflecting annual improvements in new car fuel efficiency of 1.5%-3.6% p.a. Actual efficiency improvements will depend on the level of target set at EU level and application in the UK.
[10] Illustrative estimate of additional carbon savings that would occur were we to extend the RTFO beyond 5%. Upper estimate assumes Obligation rising to 10% by 2015. Lower estimate reflects RTFO remaining at 5% from 2010. Carbon savings from a 5% RTFO are included in the baseline.
[11] This estimate reflects the assumption that the cap for Phase II of the scheme is unchanged in future phases. On the basis of our latest baseline projections, this would require 13.7MtC of savings in 2020. The actual level of savings to be achieved through EU ETS beyond Phase II (2008-2012) will be decided in line with future National Allocation Plans.
[12] Illustrative saving from UK domestic aviation, assuming cap at 2005 emissions on projected 2020 levels, in line with the current EU Commission proposal. Carbon savings from international aviation have not been estimated in the absence of agreement on how to allocate emissions.
[13] Savings from central government office estate, whose emissions constitute around one quarter of the total from the wider central government estate.

7.1 Better Billing

Description of policy and rationale for Government intervention

41. This measure aims to improve domestic gas and electricity bills through the provision of historical information on use in an easily understood format. The premise is that such information would help households have a greater awareness of their energy consumption and enable more efficient use of energy. The proposal is for the relevant historic information to be supplied on the same sheet as the bill itself.

Key assumptions

- The provision of historical information is assumed to incur a one-off cost of £0.17 per bill per customer in the central case. This largely relates to the system and additional information requirements associated with provision of historical information. Sensitivities around this value have been tested.

- There is uncertainty over the potential change in customer behaviour resulting from this measure, and how long any change might persist. Therefore, relatively small changes in energy saved have been assumed, 0.25% saved in the central case, with sensitivities of 0.1% and 0.5% around this. These reductions are assumed to persist over 15 years in the central case with a low and high sensitivity of 10 and 20 years respectively.

- The value of energy saved is in line with DTI energy price forecasts. The energy component of the electricity retail tariff is assumed to be 35%, and 50% of retail gas prices, and these have been used to value energy savings. Savings could be higher if there are associated savings to the network, transmission and overhead savings.

- The assumptions have been combined to give the biggest range of costs and benefits – so the low energy reduction assumptions are associated with the high supplier side costs and vice-versa.

42. Assumptions on the reduction in energy saved are based on a literature review of metering, billing and direct display projects (Darby 2006[14]). Although there were many studies included in this review, none are directly applicable to the introduction of better billing in the UK context. The studies often combine a number of other energy efficiency measures implemented at the same time as providing improved billing information and there are difficulties in singling out specific impacts of these measures. Differences in climates, problems of small trial sizes and self-selecting response groups add to the uncertainty. The assumptions adopted in this CBA are relatively cautious in the context of this study.

TABLE 2 – CBA RESULTS FOR BETTER BILLING

Estimate	**Low**	**Central**	**High**
Carbon saved per annum (MtC) in 2020	0	0.1	0.2
Total net benefit (£m present value over lifetime) ('-' cost)	50	315	840
Cost-effectiveness (£/tC) ('-' benefit)	-55	-155	-160
Distribution of net benefit (£m present value over lifetime) ('-' cost)			
• Exchequer	-	-	-
• Firms	-55	-35	-20
• Consumers	75	250	610

'Low' refers to low energy reduction and high supplier cost
'High' refers to high energy reduction and low supplier cost.
The cost to firms is the cost to energy suppliers of improving bills. This cost could be passed onto consumers, depending on individual firms' pricing strategies.

7.2 Real Time Displays in Households

Description of policy and rationale for Government intervention

43. This measure is to give all newly built domestic properties and all households that have their electricity meter replaced a real time display (RTD) where it is technically feasible to do so. The display would be provided free of charge by the energy supplier. The display shows real-time information about electricity consumption and cost and meets a

[14] Sarah Darby, 2006 'The effectiveness of Feedback on Energy Consumption' Defra

minimum performance requirement of 95% accuracy. In addition, from January 2008 to March 2010, any household requesting a display for their existing electricity meter would also be given one free of charge, where it is technically feasible to do so. The displays will provide customers with readily accessible information about their electricity usage, and facilitate more efficient use of energy by householders.

Key assumptions

- It is assumed that it is technically feasible to install a RTD in 75% of existing households and 95% of new ones.

- Reductions in electricity consumption of 1%, 3.5% and 6% were modelled. Those with prepayment meters were assumed to have half this effect as they were thought to be more energy conscious. The reductions in energy use were assumed to persist for 10, 15 and 20 years.

- We assume that around a quarter of all households would request a display over the period.

- Energy saved is valued at 35% of residential electricity prices, which are in line with DTI energy price forecasts. This broadly reflects the energy component of the retail tariff. If there are associated network and overhead savings, then consumer benefits and total net savings will be higher.

- The reduction in consumption will also reduce carbon emissions, assumed to be in line with the marginal technology (gas CCGT generation).

- The cost of the displays is a function of the cost of capital, the cost of installation, and the lifetime of the asset. The RTD is assumed to cost between £12 and £22, and in addition there will be installation costs of £11 per display.

- Costs are annuitised over 7 years per meter, during which the installation and capital costs are recouped. Also a cost of capital of 10% is assumed.

- Assumptions have been combined to give the biggest range of costs and benefits – so the low energy reduction assumptions are associated with the high supplier side costs and vice-versa, as in Table 3.

44. The analysis is driven by assumptions on the level of energy reduction we might expect from better use of energy by households with a RTD. The assumptions adopted have been based on a literature review by Sarah

Darby.[15] There were relatively few studies on the impact of RTDs, but reductions of around 10%, over a relatively short pace of time were achieved. The programmes tended to be limited in length, with the longest one in the Darby review lasting 3 years. However, a key finding was that behaviours became entrenched and people had difficulty remembering how they used energy before the study. This suggests that, once adopted, good practice could continue through time.

45. On the costs side, the capital and installation cost of the device are a key driver. These have been based on information from discussions with suppliers and Ofgem.

TABLE 3 – SUMMARY OF ASSUMPTIONS ON RTDS

Sensitivity	**Low**	**Central**	**High**
Energy reduction	1% (0.5% for prepayment)	3% (1.5% for prepayment)	6% (3% for prepayment)
Cost of RTD	£22	£15	£12
Installation cost	£11	£11	£11
Persistence of energy reduction	10 years	15 years	20 years

TABLE 4 – CBA RESULTS FOR RTDS

Estimate	**Low**	**Central**	**High**
Carbon saved per annum (MtC) in 2020	0	0.2	0.3
Total net benefit (£m present value over lifetime) ('-' cost)	-250	365	1100
Cost-effectiveness (£/tC) ('-' benefit)	505	-65	-125
Distribution of net benefit (£m present value over lifetime) ('-' cost)			
• Exchequer	-	-	-
• Firms	-400	-315	-280
• Consumers	110	495	1005

The cost to firms is the cost to energy suppliers of providing the RTD. This cost could be passed onto consumers, depending on individual firms' pricing strategies.

7.3 Energy Performance of Buildings Directive

46. This is an EU Directive with the objective of improving the energy performance of buildings via various methods. The RIA can be found here:

[15] Sarah Darby, 2006 'The effectiveness of Feedback on Energy Consumption' Defra

www.communities.gov.uk/pub/175/RegulatoryImpactAssessmentEnergyPerformanceofBuildingsDirective_id1509175.pdf

47. The savings differ between the RIA and the EWP because the figures exclude 0.2MtC from this policy that has already been included in the baseline. Energy Performance of Buildings Directive (EPBD) also supports 0.5-0.7MtC of the savings accounted for in the EWP by the continued obligation on energy suppliers to 2020.

TABLE 5 – CBA RESULTS FOR EPBD

Estimate	
Carbon saved per annum (MtC) in 2020	0.6-1.6
Total net benefit (£m present value over lifetime) ('-' cost)	-85.3
Cost-effectiveness (£/tC) ('-' benefit)	28.36

7.4 Zero Carbon Homes

Description of policy and rationale for Government intervention

48. The objective of the policy is to set a timetable for moving towards zero carbon development as a contribution to meeting the UK target to reduce carbon emissions by 60% by 2050.

49. More than a quarter of UK carbon dioxide emissions come from energy used in homes. The available technology can make a significant difference to the amount of energy used for these purposes – particularly in newly built homes. There is a need to ensure faster take-up of existing technology and encourage development of new technologies that can meet higher efficiency standards at more reasonable costs.

50. By setting a framework for amendments to Building Regulations the Government believes that national standards for building performance and fabric match and support ambitions amongst local authorities and consumers. By setting out the pace at which building regulations move to zero carbon development the Government hopes that it will support those ambitions, and provide greater clarity and certainty for developers.

Key assumptions

51. Assessment of the impacts of the Zero Carbon Homes policy has assumed the timetable set out in the '*Building a greener future: towards zero carbon development*' public consultation document released in December 2006. This consulted on the timing of the introduction for progressive improvements in the energy efficiency of new homes.

52. Modelling has assumed the rate of new house building will be inline with the Government's projected house building estimates to 2016. Beyond this date, forecasts of future house building become more uncertain.

CBA results

53. Preliminary modelling suggests that the benefits of the policy will be 1.1 to 1.2 MtC per year by 2020. Details of the costs and benefits of the policy are presented in the partial Regulatory Impact Assessment (RIA) which accompanies the '*Building a greener future: towards zero carbon development*' public consultation document www.communities.gov.uk/index.asp?id=1505157 .

54. The Government will commission further research that will aim to refine the methodology and estimates of the impacts of this policy. This will be complemented by any quantitative evidence that has been gathered from the responses to the public consultation. Further elaboration of the costs and benefits will be presented in the full RIA.

7.5 More Energy Efficient Products

Description of policy and rationale for Government intervention

55. Products Policy aims to continue, strengthen and internationalise the Government's existing programme on energy using products, within a wider, integrated product policy towards more Sustainable Consumption and Production.[16] This involves a range of domestic and non-domestic energy using products from gas/electric cooking to non-domestic Information and Communication Technology (ICT).

Key assumptions

56. The analysis carried out has been based on a technical assessment of the energy usage of the products covered, both before and after a combination of policy measures are introduced, which results in an estimate of associated carbon savings. The original analysis has gone through a number of adjustments in order to align with the baseline, policy impact assessment rationales and to net-off carbon savings that have been attributed to policies elsewhere in the EWP.

57. Where actual cost estimates are provided below, it is assumed that policies fall into one of three generic types (influence, regulatory or intervention). Although this is a less refined approach than flexing the assumptions by product area, it still gives a broad magnitude feel for costs.

[16] See www.defra.gov.uk/environment/consumerprod/index.htm

It is important to note that, in practice, the impacts on the supply of more efficient products e.g. designing and putting into production, typically, will lead development and delivery of specific tangible policy instruments such as regulation. Interpretation and communication of the Government's policy to sector-specific market actors is, itself, an influencing policy, the principal costs of which are in the costs of running the Market Transformation Programme (MTP). Note that in addition, these cost estimates have not been adjusted since the original analysis was carried out which means they act as a conservative higher bound estimate.

58. Impacts on competitiveness will ultimately depend on the type of policy. For instance, if a policy induces resource efficiencies by companies, then even if the policy has similar competitiveness impacts within Europe (e.g. as a result of the EU EuP Framework Directive), there may be a competitiveness advantage gained compared with non-European countries.

TABLE 6 – PRODUCTS POLICY SUMMARY

	Estimate
Carbon saved per annum (MtC) in 2020	1-3 MtC, the range of carbon savings for products policy has been updated since the Energy Review Report, as part of an annual process. The higher bound of the range reflects a larger coverage of product groups and is the current estimate of additional savings net of overlaps with other policy interventions announced in the EWP (these product policy initiatives in progress are ultimately backed up by the EU EuP Framework Directive). The lower bound of the range reflects a conservative assessment of additional carbon savings which would be delivered if, in the event, these other policy interventions achieve their targets by encouraging more efficient energy using products, rather than by other routes.
Total net benefit	Positive on the assumption that Products Policy concentrates on cost-effective technologies and succeeds in acting high up the supply chain (the 3MtC saving is based on employing the most cost-effective measures only).
Costs, per year, based on generic policy types	- Influencing policies (e.g. Retailer Agreement): Government administration of £20,000; and industry cost for compliance testing of £100,000. - Regulatory policies (e.g. EU EuP Directive): Government administration of £20,000 & industry cost for compliance testing of £100,000. - Intervention policies (e.g. Enhanced Capital Allowance (ECA)): Government administration cost for each product area of £50,000; and the intervention itself generally yielding a cost to one party and a benefit to another, so assessed as cost-neutral overall.
Distribution of net benefit	
• Exchequer	Aside from the cost of running the MTP and the admin costs referred to above, no extra costs as tax breaks are not currently offered (aside from minimal costs for ongoing policies e.g. ECA).
• Firms	- Producers: costs are likely to decrease over time as economies of scale are achieved in producing more efficient products. These costs may be passed on to consumers. . - Retailers: costs depend on whether policy acts at the retailer link in the supply chain and whether the retailer is allowed to dispose of residual stocks of less efficient products.
• Consumers	There may be upfront costs, which decline over time, passed on by producers. Ultimately a net benefit is expected as we expect the policy to be cost-effective.

Ancillary impact

59. Improved products leading to energy savings, will result in financial savings to the customer, whether domestic or industry, and costs to both Government due to lost revenue (e.g. VAT receipts) and to energy companies due to lost revenue.

Next steps

60. The MTP Team will continue to update the analysis of product roadmaps each year as policy initiatives develop.

7.6 Business Smart Metering

Description of policy and rationale for Government intervention

61. This measure is that energy suppliers to extend to all business users in Great Britain, advanced and smart metering services, within the next 5 years. This will not apply to the smallest business users, nor to larger businesses with half hourly meters. The meters would apply to both electricity and gas use. Smart meters offer the opportunity to provide business with direct, continuous feedback on how much electricity they use and how much it costs by transmitting this information to a display device easily accessible by the business, for example through a portable display, television or computer link. The aim of this measure is to enable business to make better decisions on their energy use and raise awareness of the costs of their actions.

Key assumptions

- It is assumed that smart meters, together with appropriate data provision on energy use, will lead to a reduction in energy consumption of 2.8% (electricity) and 4.5% (gas) per meter in the central case. This is in line with the changes observed in the Carbon Trust (CT) Trials. Respondents to these trials were self-selecting and could mean that savings from the trials are higher than would be achieved in a national roll out. But the standard deviation of responses was relatively low. Given these uncertainties, sensitivities around the behavioural response have also been undertaken, and are detailed below.

- Smart meters are rolled out to those businesses that do not have half hourly electricity metering or daily read gas metering, but excluding business electricity customers with profile class 3 and 4 meters (the smallest business users) and those gas customers whose consumption is less than 732MWh per year. Below the mandatory half hourly electricity metering market, suppliers allocate business customers to six profile classes, 3 to 8, based on their electricity consumption.

Businesses in those classes that are excluded from this measure most closely resemble domestic customers.

- Energy consumption information for the different profile classes is taken from Elexon and CT data for 2006-7. This forms the basis of the future path of energy used in the analysis. But the projected profile of use has been adjusted to take account of past trends of energy use in this sector, particularly energy efficiency measures that could be expected to apply going forward. This has been based on business as usual calculations produced in cooperation with Defra, based on NERA consultancy work.

- The persistence of consumption reductions have been modelled at 15 years in the central case with sensitivity around these of 10 and 20 years.

- The CT Trial information included high and low capital costs of smart meters and on installation and maintenance. These have been used in our analysis, with the central assumption being the mid-point between these.

- Smart meters will reduce supplier costs in several respects, for example through avoided manual reads, lower disconnection charges, reduced losses and reduced contact centre time. These have been taken into account in the analysis.

- Assumptions have been combined to give the biggest range of costs and benefits, so that the low energy reduction scenario is associated with high supplier costs and vice-versa.

62. The assumptions used in this analysis are based on the Carbon Trust Advanced Metering Field Trials. These trialled the use of smart meters in the business sector, beginning in 2004, to better understand the potential for more efficient energy use in this sector, the potential carbon savings involved and the barriers which exist to the broader uptake of this technology. The trials suggested that Smart Metering would be cost-effective for firms with profile class 5 electricity meters and above (i.e. excluding the smallest business customers), and those with at least 732MWh annual gas consumption.

63. The results from these trials, in terms of potential levels of energy reduction, associated savings and costs of smart meters, have formed the basis for the assumptions in this CBA.

Overlaps with other policy measures

64. There are several measures aimed at business that aim to address more efficient use of energy in this sector. Key among these are the Carbon Reduction Commitment (CRC) and the Energy Performance of Buildings

Directive (EPBD). There will be overlaps between these measures, and the CBA presents figures gross and net of these overlaps.

CBA Results

TABLE 7 – SMART METERS FOR BUSINESS SECTOR – GROSS OF OTHER POLICY MEASURES

Estimate	Low	Central	High
Carbon saved per annum (MtC) in 2020	0.1	0.3	0.3
Total net benefit (£m present value over lifetime) ('-' cost)	840	1520	2230
Cost-effectiveness (£/tC) ('-' benefit)	-340	-350	-470
Distribution of net benefit (£m present value over lifetime) ('-' cost)			
• Exchequer	-	-	-
• Firms	40	185	255
• Consumers	645	1055	1550

The impact on firms relates to the net effect on energy suppliers only.

TABLE 8 – SMART METERS FOR BUSINESS SECTOR – NET OF OTHER POLICY MEASURES

Estimate	Low	Central	High
Carbon saved per annum (MtC) in 2020	0.1	0.1	0.2
Total net benefit (£m present value over lifetime) ('-' cost)	470	915	1465
Cost-effectiveness (£/tC) ('-' benefit)	-340	-350	-470
Distribution of net benefit (£m present value over lifetime) ('-' cost)			
• Exchequer	-	-	-
• Firms	40	185	255
• Consumers	350	580	950

The impact on firms relates to the net effect on energy suppliers only.

7.7 Continued Obligation on Energy Suppliers to 2020

65. The analysis carried out for this policy includes taking account of research on the Supplier Obligation that will be the policy for 2020 that follows on from EEC/CERT. Since development work on the Supplier Obligation is still in progress, there is also an explanation on EEC and its phases included below.

Supplier obligation

66. The Government is committed to maintaining an obligation on energy suppliers to deliver energy and carbon savings from households until at least 2020. The supplier obligation will replace the existing Energy Efficiency Commitment (the phase from 2008-2011 is known as 'CERT' Carbon Emissions Reduction Target) when it comes to an end in 2011.

67. The Government is taking forward a work programme to design the supplier obligation and is considering all possible forms of the policy, including setting supplier targets in terms of absolute reductions in carbon**,** a demand reduction obligation such as a cap and trade mechanism and an evolution of the measures-based approach currently in use.

68. A study undertaken by NERA: '*Evaluation of supplier obligation policy options,*' (see www.dti.gov.uk/energy/whitepaper), provides an analysis of the barriers and market failures impeding households from taking up energy efficiency measures and evaluates the capacity of alternative policy options to tackle these barriers.

69. The Defra supplier obligation website includes background on the work programme and will include further studies as they become available: www.defra.gov.uk/environment/energy/supplier-obligation/index.htm

EEC/CERT

70. The analysis for CERT follows the same general approach adopted for the 2 earlier phases and is based around the illustrative mix[17] of measures. In essence, this is built up from the estimated maximum practical number of installations of each technical measure, allowing for the remaining potential and any supply-side constraints, and starting with the most cost-effective, until the overall target is reached. The corresponding costs to the energy suppliers are then estimated. There is a trade-off between carbon savings, social issues and cost (ultimately passed on as higher bills to householders). The cost-effectiveness of the scheme is -£200/tC (i.e. a net benefit).

71. The underlying figures for the savings for individual measures are based on the latest technical research, including field studies; and for costs, on market research on both the likely costs to suppliers, and typical final prices paid by householders. The evaluation of the first phase of EEC confirmed that the final total mix of measures was not too different from the original illustrative mix, although the variation across different suppliers was wider.

[17] See www.defra.gov.uk/corporate/consult/eec3-2007/index.htm

72. A series of documents setting out initial proposals for CERT and the corresponding technical analysis has already been published on the Defra Website over the past 6 months or so. Final details, with the draft RIA, are being published in the statutory consultation document at the same time as the White Paper.

73. Documents on EEC are published on Defra's website: www.defra.gov.uk/environment/energy/eec/index.htm

7.8 Carbon Reduction Commitment

Description of policy and the rationale for Government intervention

74. As set out in the Energy Review Report, the Government's aim is to reduce carbon emissions from the large, non-energy intensive business and public sector which are not currently, or planned to be, covered by CCAs[18] or the EU ETS. In total this target group covers emissions corresponding to about 14MtC per year. Government wants to cut emissions from the target group by incentivising investment in energy efficient technologies and systems, and by encouraging business and the public sector to improve their energy management and reduce waste.

75. A new UK Carbon Reduction Commitment (CRC) (Described as the Energy Performance Commitment (EPC) in the consultation document) would apply mandatory emissions cap and trade to energy use emissions from these sectors, thereby contributing to several energy policy goals, by reducing carbon emissions and increasing the efficiency of energy use which could improve economic performance and by reducing energy demand contributes to the security of supply. The concept of a 'cap and trade' emissions trading scheme means that emissions abatement could occur where it is most cost-effective. Starting in 2010, the CRC would save 0.5MtC / year by 2015, rising to 1.1MtC / year by 2020.[19]

76. There is a large body of evidence suggesting strong potential for reducing carbon emissions cost-effectively through increased energy efficiency in large, non-energy intensive organisations. This includes ENUSIM/BRE databases and cost curve models, as well as evidence at firm level from

[18] Those organisations which have in excess of 25% of their emissions covered by CCAs will be excluded from CRC.

[19] It should be noted that 0.1 MtC of these 1.1 MtC are expected to overlap with the carbon savings from the Energy Performance of Buildings Directive (EPBD), and have been attributed to this latter measure in the summary table of savings above (where total savings of 1.0 MtC are therefore being attributed to CRC). It is also estimated that EPBD will deliver a further 0.1MtC of savings will arise from this sector by acting upon the landlord-tenant problem. Therefore, in total (and accounting for overlaps) the sector will deliver 1.2MtC of carbon savings, as stated in the Energy Review Report.

CT work, CCAs and the voluntary UK ETS[20]. The current policy framework provides useful price signals, but does not address important barriers in terms of market misalignment and organisational behaviour[21] and so does not sufficiently encourage the large non-energy intensive sector to engage in energy efficiency and reduce their emissions.

77. The aim of the CRC is to increase organisational awareness and attract sustained attention by senior managers to carbon and energy issues, thereby acting as a key driver of behavioural change among participant organisations. Direct financial levers introduced by the CRC (through the additional element of carbon pricing and the risks and rewards implied by the revenue recycling mechanism) would play a role in attracting sustained management attention but would be accompanied by several other levers including a monitoring and reporting requirement, the push to raise energy management and emissions up the organisational hierarchy and reputational drivers.

78. Taking no further action to address emissions from the non-energy intensive business and public sectors is likely to result in a steady rise in carbon emissions from these sectors post-2010 (emissions by end use from this group of organisations are projected to increase by approximately 11% in 2030 over 2010 levels[22]).

79. The CRC would be an auction based “cap-and-trade” programme, in which organisations whose mandatory half hourly metered electricity consumption is greater than 6000MWh per year would be required to hold allowances corresponding to their emissions. Government proposes that CRC will target both direct CO_2 energy use emissions and indirect CO_2 emissions (i.e. from electricity). To avoid overlap with existing measures, the CRC would target neither emissions covered by the Climate Change Agreements nor direct emissions covered by the EU Emissions Trading Scheme. In addition, organisations with over 25% of their energy use emissions in Climate Change Agreements would be completely exempt.

80. Features of the scheme would include:
- A three year introductory phase with a simple fixed-price sale of allowances to help participants to become accustomed to the scheme and government to collect accurate data for setting a cap on allowances in subsequent phases.

[20] For an academic review of the literature on barriers and case studies of different sectors See Sorrel at al. *The Economics of Energy Efficiency*, Edward Elgar, Cheltenham, UK and Northampton, MA, USA, 2004.

[21] See the Carbon Trust discussion of barriers and market failures (section 1.2, page 15 -18 in their report, or the Energy Efficiency Innovation Report for a discussion, available online at: www.hm-treasury.gov.uk./media/FB4/AE/pbr05_energy_675.pdf

[22] Published in July 2006 at: www.dti.gov.uk/energy/environment/projections/recent/page26391.html

- An approach to monitoring and verification largely based on self-certification with risk-based audit for a certain proportion of organisations each year.

- Full auctioning of allowances, with revenue recycled to participants by means of a simple, direct annual payment in proportion to their annual average emissions reductions since the start of the scheme, with a bonus/penalty depending on an organisation's position in a CRC league table.

- A safety valve mechanism, in the form of a moderated "buy only" link with the EU ETS as well as provisions for banking of allowances to increase the scheme's flexibility.

81. Having already held a consultation on measures to reduce carbon emissions in the large non-energy intensive business and public sectors, the Government will be holding a further consultation on CRC design and implementation issues shortly. Depending on the legislative timetable, the scheme could begin in January 2010.

Key assumptions

- The CRC is currently assumed to commence in 2010, running for a period of 15 years. Energy and carbon savings continue to accrue up to 8 years after the end of the CRC policy period.[23]

- Energy price assumption (5.1p/kWh for electricity and 1.8p/kWh for gas) reflect DTI expectations on future fossil fuel prices at the time when the CRC was being modelled (April 2006). These prices are slightly higher than the latest central price projections in UEP26[24] and UEP27,[25] but fall within the range of both.

- In the modelling, all carbon and energy savings are assessed relative to a prudent business as usual baseline.

- The CBA results reported below are for the proposed 6000MWh threshold exclusion criteria.

- All costs and benefits are discounted to a base year of 2005.[26]

- The default administrative costs scenario is presented here.

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[23] As a result of the lifespan of capital measures implemented before the end of the scheme.
[24] Estimated by Defra analysts, based on the primary fuel price projections in UEP26.
[25] They are approximately 5-15% above UEP27 central price projections (from estimates by Defra analysts).
[26] Hence they will differ from those figures presented in the RIA which are discounted to the first year of the policy's implementation.

TABLE 9 – CBA RESULTS FOR CRC

	Estimate
Carbon saved per annum (MtC) in 2020	1.11[27]
Total net benefit (£m present value over lifetime) ('-' cost)	2,667[28] [2,308 – 3,401]
Cost-effectiveness (£/tC) ('-' benefit)	-101
Distribution of net benefit (£m present value over lifetime) ('-' cost)	
• Exchequer	-192[29]
• Firms	1,899
• Consumers	-

82. Ancillary air quality benefits have also been modelled using IGCB guidance. These are estimated at £160m - £225m.[30] Fuel poverty would not be impacted by this policy as it is targeting the business sector only. There has been no quantitative assessment of effects on security of supply owing to the CRC's negligible impacts in this area. However, there would be a slight positive impact on security of supply as the energy efficiency measures would reduce overall demand and therefore the need to import energy.

83. The impact on competitiveness of included firms is likely to be small, and if anything, positive. The original 3000MWh exclusion threshold was designed in order to ensure that the majority of sub-sectors were NPV positive. NERA/Enviros analysis suggests that, using the default administrative costs scenario, only one sub-sector (out of 27) will have a negative NPV (at a commercial discount rate), whereas all sub-sectors have positive NPV at a social discount rate. This result remains the same for the new 6000MWh threshold. For the 3000MWh high administrative costs scenario, three sub-sectors experience negative NPV at a commercial discount rate, but these impacts are small relative to the scheme's overall benefit. We would expect similar results for the 6000MWh threshold. By imposing such a threshold, it is ensured that smaller energy users are excluded from the scheme; this has the effect of considerably reducing the administration burden, whilst retaining the majority of emissions coverage and savings.

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27 This includes an overlap with EPBD of 0.1MtC, attributed here to CRC. On top of the 1.11MtC above, EPBD is expected to deliver an additional 0.1MtC from the CRC target sector (as it helps to overcome some elements of the landlord-tenant problem).

28 Net benefit at 3.5% HM Treasury-recommended social discount rate, including carbon benefits (£960m) but excluding air quality benefits, with a base year of 2005. The figure is net of reduced Climate Change Levy (CCL) receipts. There is some uncertainty over the number of organisations which may be excluded from CRC as a result of their CCA-covered emissions exceeding 25%. The impact could be negligible, or up to 20% of organisations/emissions coverage. However, Government proposes to retain the effort level described above (1.1MtC), so that any impact would fall only on costs and benefits, rather than carbon savings. The costs and benefits presented above relate to the case of a negligible impact from CCA exclusions.

29 Approximate loss to the Exchequer from reduced CCL payments.

30 With a sensitivity range of £42m - £403m.

84. The estimates of benefits presented here are based upon detailed cost-benefit modelling of potential energy efficiency improvements. These typically show a positive private return from investments in energy efficiency. However, it is also possible that the analysis does not consider some of the “hidden costs” of investment in energy efficiency (e.g. opportunity cost of scarce management time). These effects are extremely difficult to quantify but suggest that the estimates of benefits might be interpreted as upper bounds.

7.9 Changes to Renewables Obligation

Description of policy and rationale for Government intervention

85. The Government’s target is to meet 10% of electricity supplied from renewable sources in 2010 and an ambition to meet 20% in 2020. The Renewables Obligation (RO)[31] was introduced in April 2002 to provide a flexible, market-based mechanism to support the development of renewable technologies. It places an obligation on electricity producers to supply a specified and increasing proportion of their annual sales from electricity from renewable sources. All qualifying renewable generators receive Renewables Obligation Certificates for each MWh of electricity produced. The RO runs to 2027.

86. Companies can meet their obligation by: presenting Renewable Obligation Certificates (ROCs); by paying a buy-out fund contribution equivalent to £30/MWh (in 2002-03 rising each year with RPI); or, a combination of the two. ROCs are issued to renewable generators for each 1MWh of electricity generated; these are then bought by supply companies. Money from the buy-out fund is recycled pro-rata to companies presenting ROCs, hence the value of a ROC = buy-out price + money recycled from buy-out fund. The recycling mechanism gives suppliers an additional incentive to invest in renewables and acquire ROCs.

87. The RO has been successful to date in stimulating growth in renewable electricity, which has more than doubled since 2002. However there are constraints on the availability and deployment of cheaper renewable technologies which means that, in order to move towards the Government’s longer-term renewables aspirations, we will need to bring forward investment in technologies such as biomass and offshore wind. Therefore the Government is proposing a set of measures, whose aim is to reform the RO to increase the delivery of renewables generation, with broadly similar consumer costs. Proposed reforms include:

[31] There are three separate obligations covering England and Wales, Scotland and Northern Ireland. ROCs, SROCs and NIROCs are fully tradable across the UK.

- extending the level of the Obligation to 20% on a “guaranteed headroom basis” (i.e. to increase the level of the obligation only where the level of generation justifies it);

- retaining the RPI link from the buy-out price in the Obligation from 2015 onwards;

- introducing a mechanism to ensure that ROC prices do not crash if there is ROC generation in excess of the 20% Obligation level; and

- banding the RO to provide multiples of ROCs for emerging technologies such as offshore wind, wave and tidal, and fractions of ROCs for more economic technologies such as co-firing, landfill gas, at the same time as removing the cap on co-firing non energy crops. Details of banding levels are set out in the consultation document Reform of the Renewables Obligation (see ww.dti.gov.uk/energy/whitepaper).

88. These measures should drive investment in renewable generation, increasing deployment, make the RO more efficient and therefore better value for money for consumers.

Key assumptions

89. DTI contracted 2 research firms to inform the modelling work:

- Ernst and Young on the cost of renewable technologies (see www.dti.gov.uk/energy/whitepaper). This work replaces the cost estimate from by Enviros (2005)[32] which underpinned the work for the Energy Review Report. This work shows that the costs of renewable technologies have increased since the Enviros analysis on which the previous work was based.

- The Oxera model simulates the likely pattern of future renewables investments, based on estimates of future revenue streams, and technology costs.

90. The Oxera report (see www.dti.gov.uk/energy/whitepaper) sets out in detail the assumptions used in the modelling. These include renewable generation costs, and renewables supply curves which are derived from the Ernst and Young analysis. It also sets out electricity price, carbon price, and electricity sales assumptions which were taken from the DTI energy model (UEP 27), and assumptions as to the value of Climate Change Levy Exemption Certificates, which are assumed to be fixed at £4.3/MWh.

[32] Enviros (2005) ‘The Costs of Supplying Renewable Energy’. A copy can be obtained at www.dti.gov.uk/renewables/renew 2.2.5.htm

91. The analysis does not assume any relaxation of the constraints on deployment from the current planning and grid access regimes as the outcomes and impacts of this work were not known when the model was compiled. Any significant impact of these work streams will lead to an increase in the rate of renewables deployment.

92. The lifetime carbon savings used for the cost-effectiveness (see Table 10) only include projects that have been directly supported by the RO up to 2027 and do not attempt to quantify the effect of e.g. re-powering (replacing turbines when they reach their design life) wind farms after 2027. As the infrastructure supporting renewables generation will generally have a longer lifespan than the generation plant the resource costs of re-powering will be lower than for new developments and the cost per tonne of carbon can also be expected to be lower.

CBA Results

93. Modelling results show that our forecast of renewable generation under the current RO is lower than that used in the Energy Review Report – changes are driven for the most part by updated evidence on technology costs. Under central technology cost and electricity price assumptions it is estimated that by 2020-21, 42.3 TWh ROC eligible renewable generation will have been incentivised through the RO, 11.5% of total electricity.

TABLE 10 – CBA REVISED BASE CASE

	Estimate
Carbon saved per annum (MtC) in 2020	3.9
Total net benefit (£m present value over lifetime) ('-' cost)	-9,000
Cost-effectiveness (£/tC) ('-' benefit)	161
Distribution of net benefit (£m present value over lifetime) ('-' cost)	
• Exchequer	-1,900
• Firms	-13,800
• Consumers	-23,700

Source: Oxera – central electricity price and technology cost assumptions.
Note: The cost to consumers is equal to the total cost of the subsidy to generators (which is the level of generation multiplied by the ROC price). The Oxera model assumes 100% pass-through of this cost.

94. The cost of the RO under the proposed reforms set out in paragraph 87 is given in Table 11 below. The combined impact of the changes is to increase generation from renewable technologies, increase the efficiency of the RO, while retaining broadly similar consumer costs. The level of ROC eligible renewable generation increases to 50.2TWh by 2020-21, 13.5% electricity. Carbon saved increases from 3.9MtC in 2020 under the

base case, to 4.7MtC in 2020 under the proposed changes. The changes lead to an increase in lifetime resource costs of £4.8bn and an increase in lifetime consumer costs of £1.4bn. Overall this implies a reduction in the deadweight element of the RO (i.e. the amount by which the total amount of subsidy is in excess of resource costs) of £3.4bn, representing an increase in the efficiency of the RO.

TABLE 11 – CBA PROPOSED CHANGES TO THE RENEWABLES OBLIGATION

	Estimate
Carbon saved per annum (MtC) in 2020	4.7
Total net benefit (£m present value over lifetime) ('-' cost)	-12,900
Cost-effectiveness (£/tC) ('-' benefit)	188
Distribution of net benefit (£bn present value over lifetime) ('-' cost)	
• Exchequer	-2,200
• Firms	-18,500
• Consumers	-25,100

Source: Oxera – central electricity price and technology cost assumptions.
Note: the table includes the total cost of the RO under the changes – not the marginal impact of the changes.

95. The change is expected to have a small additional price effect on the electricity price, raising the impact on electricity prices from the RO, from 5% in the base case to 7% under the proposed reforms. There are potential additional system balancing costs resulting from increased levels of intermittent generation, which are estimated at between £60-£170m over the lifetime of the RO.

7.10 CCS Demonstration Project

96. Carbon Capture and Storage (CCS) with electricity generation has not yet been proven on a commercial basis, although some key elements of the process have been demonstrated. So the next step is commercial-scale demonstration. In the Budget in 2007, the Government therefore announced that it would launch a competition to demonstrate commercial-scale CCS on power generation in the UK. The Government intends to launch the competition in November 2007, with the aim of having the demonstration operating early in the next decade. If, for example, a 0.3-1.9 Giga Watt (GW) demonstration plant were in place by 2020, instead of the equivalent gas fired plant, this would save 0.3-1MtC per year by 2020.

7.11 Successor to the Current Voluntary Agreements on New Fuel Car Efficiency

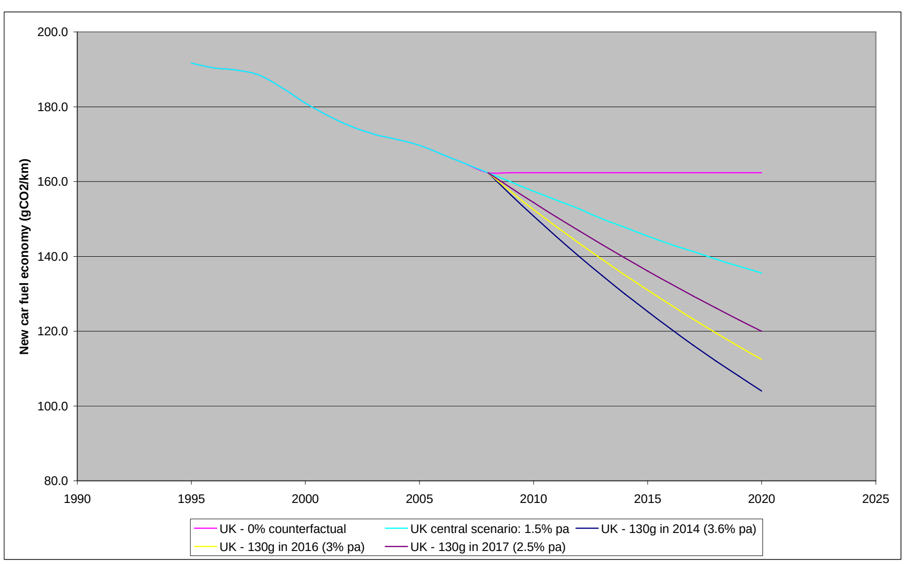
Description of policy

97. This note provides a summary of the appraisal of a successor to the current Voluntary Agreements (VAs) to reduce CO_2 emissions from new cars. The current VAs were agreed between the European Commission and car manufacturer associations in the late 1990s and are due to expire in 2008-9. This analysis assumes the VAs would be succeeded by further EU-wide targets and looks at the costs and benefits in the UK under different scenarios.

98. This note summarises the results of an extension to the analysis carried out for the Climate Change Programme 2006 (CCP2006) and the Energy Review Report. The previous analysis looked at the costs and benefits of a 1.5% annual improvement in fuel efficiency (broadly, a continuation of progress under the VAs). The analysis summarised below updates the previous work and considers three additional scenarios: annual improvements in fuel efficiency of 2.5% per year; 3% per year; and, 3.6% per year.[33]

99. Figure 2 shows the new car fuel economy improvements for each scenario until 2020.

FIGURE 2 – UK NEW CAR FUEL ECONOMY IMPROVEMENTS TO 2020



[33] The European Commission issued a communication in February 2007 that called for an EU average target of 130gCO_2/km by 2012. It is not yet clear what form this target will take although it implies an annual efficiency improvement at EU level of around 2.7% each year from 2004 (or higher annual improvements if, as expected, efficiency improvements in the last few years have been lower than this).

100. The levels of new car fuel efficiency (gCO_2/km) we would reach in the UK for each improvement scenario are shown in Table 12.

TABLE 12 – UK NEW CAR FUEL EFFICIENCIES (GCO_2/KM) UNDER DIFFERENT SCENARIOS

Year	1.5%	2.5%	3.0%	3.6%
2008	162.4	162.4	162.4	162.4
2012	152.6	146.5	143.5	140.0
2015	145.8	135.8	131.0	125.4
2020	135.2	119.6	112.5	104.0

Key assumptions

101. The model estimates the costs and benefits of the measure for the period 2005 to 2020, and over the lifetime of the policy (i.e. over the lifetime of the cars that enter into the market between 2009 and 2020). Four scenarios have been modelled: a 1.5% annual improvement; a 2.5% annual improvement; a 3% annual improvement; and, 3.6% annual improvement. All improvements are assumed to start from an average level of 162gCO_2/km in 2008. In the absence of the future VA, it is assumed that average fuel economy would have remained constant at 2008 levels.[34] The model assumes a 5% RTFO is in place by 2010 and remains at this level thereafter, in both the counterfactual scenario and in the policy.

102. The key factors influencing the cost of the policy and its impact on carbon emissions are:

- Numbers of new cars purchased each year: Forecasts of annual new car purchases to 2010 are taken from the Society of Motor Manufacturers and Traders (SMMT) and assumed constant thereafter. It is assumed that a new fuel efficiency target will not affect the numbers of new cars purchased each year i.e. new car numbers are the same in the actual and counterfactual scenarios.

- Additional costs of technology to improve fuel economy: Two different estimates of fuel-saving technology costs have been used in this analysis, one developed for the Department for Transport (DfT) by Ricardo[35] and the other developed by TNO[36] (for the European

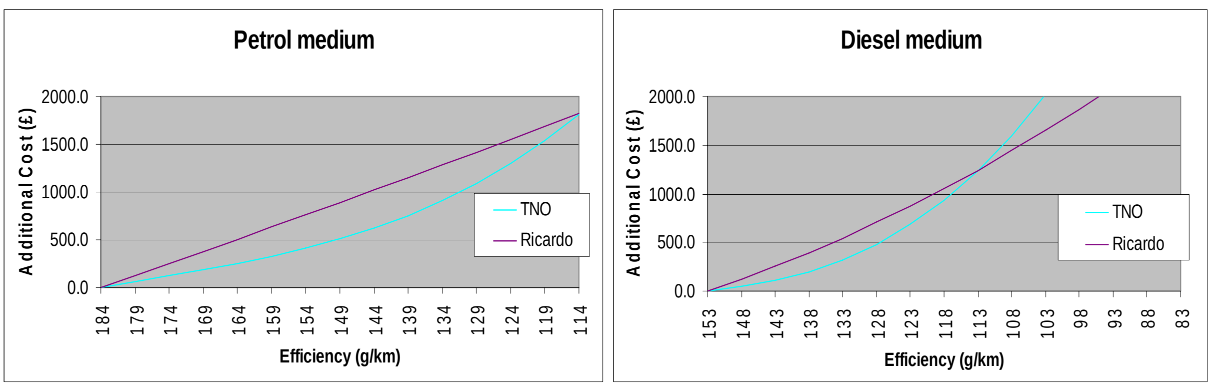
[34] This counterfactual scenario was peer-reviewed by the automotive consultants, Ricardo. While some fuel economic technology would have been adopted by car producers in the absence of a replacement to the current VAs, we would expect this to be offset by the fuel penalty likely to be associated with future air quality and safety standards.
[35] See: www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_611428.pdf
[36] TNO, IEEP & LAT (2006) 'Review and analysis of the reduction potential and costs of technological and other measures to reduce CO2 emissions from passenger cars - final report'.

Commission). Both Ricardo and TNO produced cost estimates for six car segments (small, medium & large; petrol & diesel). As shown in Figure 3, the TNO cost estimates tend to be lower than the Ricardo estimates apart from large efficiency improvements in diesel vehicles where the TNO curves imply higher costs.

The percentage reduction in each segment is calculated by looking across the six segments and seeking out the cheapest abatement option until the required percentage improvement has been made for the new car fleet as a whole. For example, initially larger efficiency improvements will occur within the large petrol segment as the cost of reducing large petrol car emissions is lower than for other segments. The improvements in fuel efficiency for each car segment are inputted into the Ricardo and TNO functions to produce estimates of abatement costs.

Costs of monitoring new car CO_2 emissions have not been included in the analysis since the data is already required for the classification of vehicles into graduated vehicle excise duty bands.

FIGURE 3 – RICARDO AND TNO COST ESTIMATES FOR MEDIUM-SIZED PETROL AND DIESEL CARS



- Composition of the fleet: It is assumed that 41% of the fleet are diesel in 2009 and 42% thereafter. This assumption is taken from the DfT Vehicle Market Model. Cars are split into small, medium and large segments, based on SMMT data from 1995-2004 (via Ricardo). The percentage of cars in each size segment is assumed to be the same in the counterfactual as in the actual. This means that any efficiency improvements arise from technology improvements alone, and not as a result of a switch from large cars to small cars, for example.

- Rebound Effect: The rebound effect is the demand response to the increase in fuel efficiency. We assume there are three parts to this effect: an increase in mileage due to a fall in the price of driving per km (estimated as having an elasticity of -0.2); extra comfort taken when driving e.g. increasing the use of air-conditioning, seat heaters etc and more aggressive driving (estimated as having an elasticity of -0.05); and the choice of a bigger car when making a purchase decision (this is taken into account in the new car fuel economy averages).

CBA results

103. The results from our analysis have changed since the Energy Review Report as a result of an improved methodology for assessing costs to manufacturers and updated oil price forecasts.

Results using Ricardo cost estimates

104. The main results of our analysis, using the Ricardo cost estimates, are given in Table 13 below. These are based on DTI's central oil price forecasts. It is estimated that a 1.5% annual improvement would result in an annual carbon saving of 1.8MtC in 2020 at a lifetime cost of £105 per tonne of carbon saved. More rapid improvements (2.5%, 3% and 3.6%) would result in a greater impact on carbon, but at a higher cost.

105. The costs of the policy mainly come from the cost of new technologies while the benefits arise from fuel-cost savings and carbon savings.

TABLE 13 – RESULTS OF ANALYSIS (0% CF)

		1.5% p.a. (continuation of past progress)	**2.5% p.a. (130g/km by 2017)**	**3% p.a. (130g/km by 2016)**	**3.6% p.a. (130g/km by 2014)**
Impact on annual carbon in 2020 (MtC)		1.8	2.9	3.5	4.1
NPV 2009-2020(£m)[1] ('-' cost)		-4,593	-8,122	-9,980	-12,086
NPV 2009-2032(£m) [1] ('-' cost)		-895	-2,228	-3,081	-4,073
Cost-effectiveness (£/tC) ('-' benefit)		105	129	141	151
Average cost per vehicle (£)		261	445	539	645
Impact on security of supply (million litres saved 2009-2032)	Petrol	14,773	28,904	35,403	41,050
	Diesel	14,768	19,520	21,958	26,264
	Total	29,541	48,424	57,361	67,314
Distributional impacts	Likely to be a net benefit for consumers, but a net cost to firms and the Exchequer. The Exchequer loses out in fuel tax revenue due to reduced fuel consumption. Consumers and firms incur the technology costs of achieving the new targets, but save on fuel costs.				
Ancillary Impacts	Small but negative impact on air quality (from increased mileage), positive impact on innovation (not quantified). Potentially large negative impact on congestion (as a result of the fall in the marginal cost of driving).The more rapid the efficiency improvement, the larger the expected ancillary impacts.				

[1] These estimates exclude ancillary impacts but include an estimate of the value of carbon saved, consistent with Defra guidance on the social cost of carbon. In our analysis the primary ancillary impacts arise from increased congestion. If costs of congestion are included, a 1.5% annual improvement is estimated to cost £460/tC over the policy lifetime. We have presented the results without congestion impacts as we would expect congestion to be tackled through other policies.

Results using TNO cost estimates

106. A report for the European Commission[37] on the costs of CO_2 emission reduction measures in the automotive industry suggests that the costs of fuel saving technology may be significantly lower than the Ricardo estimates used in the above analysis. When these technology costs are

[37] TNO, IEEP & LAT (2006) 'Review and analysis of the reduction potential and costs of technological and other measures to reduce CO_2 emissions from passenger cars - final report'

used, the 1.5% scenario results suggest a positive lifetime (2009 - 2032) NPV of £2,917 million and a benefit per tonne of carbon abated of £85.

TABLE 14 – RESULTS OF ANALYSIS (0% CF) TNO CURVES

		1.5% p.a. (continuation of past progress)	**2.5% p.a. (130g/km by 2017)**	**3% p.a. (130g/km by 2016)**	**3.6% p.a. (130g/km by 2014)**
Impact on annual carbon in 2020 (MtC)		1.8	2.9	3.5	4.1
NPV 2009-2020(£m)[1] ('-' cost)		-787	-2,791	-4,459	-6,927
NPV 2009-2032(£m)[1] ('-' cost)		2,917	3,102	2,442	1,084
Cost-effectiveness (£/tC) ('-' benefit)		-85	-35	-3	36
Average cost per vehicle (£)		135	267	354	473
Impact on security of supply (million litres saved 2009-2032)	Petrol	19,880	34,195	39,684	44,749
	Diesel	10,292	14,821	18,153	23,003
	Total	30,172	49,016	57,837	67,751
Distributional impacts	Likely to be a net benefit for consumers, but a net cost to firms and the Exchequer. The Exchequer loses out in fuel tax revenue due to reduced fuel consumption. Consumers and firms incur the technology costs of achieving the new targets, but save on fuel costs.				
Ancillary Impacts	Small but negative impact on air quality (increased mileage), positive impact on innovation (not quantified). Potentially large negative impact on congestion (as a result of the fall in the marginal cost of driving). The more rapid the efficiency improvement, the larger the expected ancillary impacts.				

[1] These estimates exclude ancillary impacts but include an estimate of the value of carbon saved, consistent with Defra guidance on the social cost of carbon. If costs of congestion are included, a 1.5% annual improvement is estimated to cost £270/tC.

107. There are also likely to be significant benefits in terms of encouraging the development of lower cost low carbon technology, in the EU and further afield. It has not been possible to quantify these impacts in the above analysis.

108. It is worth noting that this analysis assumes the percentage of cars in each segment stays constant such that all improvements in fuel efficiency are driven by technology. In reality, manufacturers can improve their sales-

weighted average by encouraging consumers to switch to smaller cars or opt for a diesel over a petrol model. As such, these costs are likely to represent an upper bound estimate.

Sensitivity analysis: Impact of fuel efficiency improvements in the baseline

109. Work undertaken for the DfT by Ricardo on the prospective evolution of low-carbon technology[38] suggested that we would expect to see 0.6% annual improvement in fuel economy even if there was no voluntary agreement in place. The inclusion of fuel economy improvements in the baseline worsens the cost-effectiveness of the measure. The results for this test, using the Ricardo cost curves as the upper-bound cost estimates, suggest that a 1.5% annual improvement would save 1MtC at a cost per tonne of carbon abated of £132.

Other considerations

110. The above analysis makes no assumption about the mechanism by which EU-wide targets for new car fuel efficiency will be achieved e.g. whether these would be voluntary or mandatory and, if mandatory, what form this should take. However, provided that the targets are met, we would expect the technology costs to be the same regardless of whether the instrument is mandatory or voluntary. However, the costs (and benefits) are likely to vary depending on how the target is specified and implemented. We will be exploring these issues through consultation with industry and other stakeholders.

7.12 Renewable Transport Fuel Obligation

Description of policy

111. This note provides a summary of analysis looking at the costs and benefits of moving beyond the Renewable Transport Fuels Obligation (RTFO) as it is currently expressed, as a requirement that from 2010-11, 5% by volume of fuels sold must be from a renewable source. This note updates the analysis, circulated in 2006 for the Energy Review Report, for the latest assumptions and fuel demand and price forecasts.

112. There are several options for moving beyond the RTFO as it is currently specified. These could include, for example, moving to a higher volume target, or specifying the Obligation in terms of carbon savings rather than volumes of renewable fuel. **This note provides a summary of purely illustrative analysis of the additional costs and benefits that could arise, were we to set the Obligation at 10%. This analysis is**

[38] Ricardo (2003) 'Carbon to Hydrogen Roadmaps for Passenger Cars - Update'

without prejudice to any announcements on future targets. However, there are a number of conditions that would need to be met before this could happen. These are discussed in more detail in the 'other considerations' section below.

Key assumptions

113. The costs and benefits of this measure have been assessed against the counterfactual scenario of a 5% (volume) Obligation. Any costs and benefits are therefore additional to those accruing from the Obligation as it is currently specified. The key factors influencing the cost of this policy and its impact on carbon emissions are: the cost of the biofuels; the cost of conventional fuels; and the carbon savings from substituting biofuels for conventional fuels.

- Cost of biofuels: Our best estimates of future resource costs of biofuels are presented in Table 15. These cost estimates include capital and operating costs of biofuel supply, as well as the cost of the inputs. The estimates are based on the assumption that new 'second generation' technologies become available by 2020 and the cost of production falls to around two thirds of its 2006 cost.

TABLE 15 – RESOURCE COSTS OF BIOFUELS (£/LITRE, 2006 PRICES)

	Bioethanol	**Biodiesel**
2010	0.32	0.44
2020	0.26	0.30

- Cost of conventional fuels: Central, low and high oil price forecasts to 2020 were converted into petrol and diesel prices using the DfT fuel price forecasting model. The pre-tax petrol and diesel price forecasts under each oil price scenario are given in Table 16.

TABLE 16 – RESOURCE COSTS OF CONVENTIONAL FUELS IN 2006 PRICES (£/LITRE)

	Low oil price ($25/barrel)		**Central oil price ($53-57/barrel)**		**High oil price ($70-80/barrel)**	
	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel
2010	0.15	0.17	0.28	0.31	0.33	0.37
2020	0.15	0.17	0.26	0.29	0.37	0.41

- Carbon savings from biofuels: The use of biofuels in place of conventional fuels is assumed to save 57% of carbon relative to the same volume of conventional fuels in 2010, increasing linearly to 75%

in 2020 for both bioethanol and biodiesel.[39] These assumptions are in line with the resource cost scenarios described above. They assume that new 'second generation' technologies become available by 2020. Estimates of future carbon savings from biofuels are highly uncertain. We therefore carried out sensitivity analysis for lower carbon savings of 50% in 2010, increasing to 65% in 2020.

Other assumptions

- Based on recent advice from DfT engineers, a lower energy content has been factored in for all biofuel blends[40] (previous analysis assumed that for blends of less than 5% there is no difference in energy content between conventional fuel and blended fuel).

- Demand forecasts for petrol and diesel are taken from the National Transport Model.

- We have used a price elasticity of -0.25 in our analysis to take account of motorists responding to a fuel price increase by using less fuel.

- It is assumed that biofuels will have a small beneficial effect on emissions of particulate matter (PM10) from diesels. There may also be a small negative impact on NO_x emissions, but this has not been quantified.

CBA results

114. It is estimated that moving from a 5% to a 10% volume target by 2015 would generate additional carbon savings of 1.0MtC in 2020 at a lifetime cost of £175 per tonne of carbon saved. The costs of the policy mainly come from the increased resource cost of biofuel over conventional fuel while the benefits arise from fuel savings (as a result of reduced motoring in response to higher fuel costs), reductions in carbon emissions and reductions in particulate matter (air pollution).

[39] In this analysis we have taken account of the lifecycle emissions of biofuels, irrespective of where they are produced. This means that when calculating the biofuels needed to reduce carbon by 5%, we are including carbon emitted during the production of biofuels abroad which are then imported and used in the UK.
[40] The energy held in a litre of bioethanol is around one third less than in a litre of petrol and around one fifth less in biodiesel than in diesel.

TABLE 17 – RESULTS OF ANALYSIS

		Low oil price scenario	**Central oil price scenario**	**High oil price scenario[2]**
Impact on annual carbon in 2020 (MtC)		1.1	1.0	0.5
NPV to 2020 (£m) [1] (‘-‘ cost)		-1,655	-686	55
Cost-effectiveness (£/tC) (‘-‘ benefit)		311	175	54
Impact on security of supply (mill litres saved in 2020)	Petrol	840	852	1,226
	Diesel	1,196	1,215	0
	Total	2,036	2,067	1,226
Distributional impacts		It is assumed that the additional resource costs are fully passed on to motorists.		
Impact on fuel prices		Likely to be a small rise in pump prices (<1p/litre). Under the high oil price scenario there may be a slight fall in pump prices, though this would tend to be offset by the slightly lower energy content of the blended fuel.		
Other ancillary impacts		Positive impact on particulate emissions and positive impact on innovation (not quantified). Possible negative impact on NO_x emissions (not quantified).		

[1]These estimates exclude ancillary impacts but include an estimate of the value of carbon saved, consistent with Defra guidance on the social cost of carbon.
[2]Under the high oil price scenario, the energy-adjusted price of biodiesel becomes cheaper than conventional diesel. We assume that a rational supplier would supply biodiesel in the absence of the RTFO and therefore we don't claim any additional savings (carbon or fuel) as a result of this policy. This also explains why the carbon savings are lower in the high oil price scenario than in the low oil price scenario.

115. The impact on security of supply is ambiguous. An increase in the use of biofuels in place of conventional fuels could save around 6,200 million litres of diesel and 8,400 million litres of petrol over the period 2010-2020. However, it is likely that some of the biofuel which will replace these conventional fuels will need to be imported from abroad.

116. Sensitivity analysis looking at lower expected carbon savings suggests that carbon saved in 2020 could range from 0.4MtC (under a high oil price scenario) to 0.9MtC (under a low oil price scenario).

Distributional impacts

117. It is expected that the additional resource cost of biofuels would be passed on to businesses/consumers in the form of higher prices at the pump, though this effect is likely to be very small (less than 1p/litre).

118. Costs to the Exchequer of administering the scheme have not been included in the analysis. The impact of a 10% Obligation on Exchequer revenues is dependant on the level of any duty differential on biofuels (set at 20p/litre until 2008-09). The Government expects that the emphasis will move from the duty incentive towards the buy-out price as the principal support mechanism in future years.

Other considerations

- <u>The availability of biofuels:</u> In the UK, domestic supply of biofuel is currently dominated by biodiesel, produced from virgin vegetable oil and waste vegetable oil, though the latter is limited by its supply as a waste product. Beyond the UK, production capacity for biodiesel and bioethanol is rising quickly both in the EU and the rest of the world. Although, there are likely to be limits to the availability of arable land for conversion to biofuels, some feedstocks can be produced in areas not suitable for food production.

- <u>Assurance of their sustainability:</u> Concerns have been expressed about the sustainability of biofuel production especially with rising global demand. To counter this, the UK is developing carbon and environmental assurance schemes. The European Commission is also looking at a EU-wide environmental certification scheme. There are also concerns that there may be negative social consequences of biofuel production especially in developing countries, for example, the use of child labour, poor working conditions and health and safety risks. However, increased use of biofuels can also stimulate new international trade with developing countries, with increased economic productivity of rural areas through production of fuel feedstock, growth and employment through development of local biofuel industries, and reduction in exposure to high international energy prices (petroleum imports) through use of biofuels locally.

- <u>The net carbon life-cycle emissions of biofuels:</u> The level of carbon savings can vary significantly between different biofuel sources and production techniques. An Obligation expressed solely in volume does not take into account the relative carbon life-cycle emissions of different types of biofuels. However, the carbon assurance scheme currently being developed as part of the Obligation will require obligated companies to report on the level of carbon savings achieved. The European Commission recent proposal[41] to amend the Fuel

[41] See weblink - ec.europa.eu/environment/air/pdf/fuel/com_2007_18_en.pdf

Quality Directive (98/70/EC) includes a requirement for a 10% reduction in fuel lifecycle carbon emissions between 2010 and 2020. The proposal does not specify the methodology for calculating lifecycle carbon emissions, this will be adopted separately by means of a technical Directive agreed by Committee procedure (i.e. agreed by vote of Member State officials rather than by vote of the European Parliament and Council of Ministers).

- The proportion of cars able to use higher biofuel mixes: Vehicles in the EU are currently warranted to run on blends of up to 5% though it is possible that blends of up to 10% could be used in the future. Much higher biofuel blends are likely to require the use of modified (flex-fuel) vehicles.

- Developments at EU level: The Commission's Fuel Quality Directive proposal calls for a mandatory 10% reduction in lifecycle carbon emissions between 2010 and 2020. This is a very ambitious target and would require 20-30% biofuel by volume, depending on the availability of fuels with higher carbon savings than current biofuels. Negotiations on this proposal have only just begun. At present the proposal does not contain any other sustainability criteria (e.g. habitat protection/biodiversity requirements), however these may be introduced by an amendment to the Biofuels Directive (2003/30/EC) which the Commission are expected to publish later this year.

  The Commission has also proposed a mandatory target of 20% for renewable energy share of final energy consumption in the EU and a separate binding minimum target for biofuels of 10% of all petrol and diesel consumed by 2020. The biofuels target is subject to certain provisos: production being sustainable; second-generation biofuels becoming commercially available; and, the Fuel Quality Directive being amended accordingly to allow for adequate levels of blending. These proposals were endorsed by the spring session of the European Council.

8) Further Analysis

119. This section covers various analysis linked to areas covered in the EWP which are not firm policies that are being taken forward.

8.1 Dynamics of GB Generation Investment

Description of policy and rationale for Government intervention

120. The UK faces a significant challenge over the next two decades in ensuring sufficient investment in new power stations comes forward in time to replace the expected retirements of old coal and nuclear stations around the middle of the next decade. Additionally, cleaner generation technologies would be ideal.

121. Analysis carried out by Redpoint Energy *Dynamics of GB Electricity Generation Investment: Prices, Security of Supply, CO_2 Emissions and Policy Options* (see www.dti.gov.uk/energy/whitepaper) of the key drivers of investment behaviour analysed factors that, left unaddressed, could delay or deter investment decisions over the medium and longer term and lead to a higher risk of electricity supplies being interrupted. These factors are:

- Investors confidence about the continued existence and form of the EU ETS post 2012;
- whether they are able to form a long-term view of future fossil fuel, carbon and electricity prices and the electricity supply/demand balance; and
- whether there continue to be regulatory uncertainties and delays such as in the planning system.

122. As a result, our policies are targeted at addressing these factors that affect investment decisions. These are:

- to strengthen the EU ETS;
- to provide better quality forward looking information; and
- to improve the planning system for electricity generation projects, including new regulations to streamline and improve the efficiency of planning inquiries.

123. By reducing uncertainty and providing better quality information in this way, we will facilitate the timely investment in electricity generation and reduce the risk of capacity driven outages.

Key assumptions

124. A range of scenarios were assessed. These showed how the electricity generation sector might evolve under a variety of assumptions including:

- Technology costs;
- future price expectations; and
- uncertainty over the future development of the carbon market.

8.2 Gas Security of Supply

125. Following the Energy Review Report a consultation on 'The effectiveness of current gas security of supply arrangements' was launched. This consultation considered the effectiveness of the current gas market and regulatory framework in providing secure gas supplies to the UK and considered seven policies that could be implemented to strengthen this framework.

126. This consultation was supported by analytical work carried out by Oxera. The Oxera report: '*An assessment of the potential measures to improve gas security of supply*' (see www.dti.gov.uk/energy/whitepaper) analysed the level of security of supply that current market arrangements would provide in the period 2006-2020. To undertake this analysis Oxera modelled the future investments profile in gas supply infrastructure over the period, given certain assumptions about: the future supply and demand balance for gas in the UK market; the price and availability of gas from different sources; the costs of different types of infrastructure; and, the discount rate investors face.

127. The report then looked at the costs and benefits of these seven policy options in terms of their impact on the expected costs of gas supply interruptions over that period, and the changes in consumer welfare brought about by any subsequent changes in the level of gas prices and the costs of investment. The report also considers some of the potential unintended consequences that could arise with the implementation of these measures.

128. The conclusions from the Oxera analysis and the consultation responses can be found in the Energy White Paper and in the Government response to the consultation mentioned above (see www.dti.gov.uk/energy/whitepaper)

8.3 Distributed Generation

129. Further discussion of the market failures present in the Distributed Generation (DG) sector, and the rationale underlying the measures in

chapter 3 of the White Paper, is set out in chapter 2 of the DG Review Report (see www.dti.gov.uk/energy/whitepaper).

8.4 Wade Modelling of the System Costs of Distributed Generation

130. In the light of a growing interest in the possibility that a more decentralised approach to meeting the UK's energy needs may offer benefits relative to the established, centralised system, the Energy Review Report announced the joint DTI / Ofgem Review of Distributed Generation.[42]

131. In order to support this Review we have looked to gain a greater understanding of the costs and benefits, and therefore the relative merits for the UK, of an increased penetration of distributed generation (DG) technologies. The WADE[43] model, previously applied by Greenpeace to the UK[44], is the only pre-existing model that addresses this question by comparing the total future system costs of adopting a DG or centralised (CG) system.

132. We have worked with WADE to investigate the costs of DG for the UK. However, we have found that limitations of the model, relating in particular to the treatment of the heat generated by CHP installations, prevent us from reaching robust conclusions as to the relative costs of a DG system using this model. Hence this work can provide only a starting point in developing an understanding of the costs of a DG system.

133. A full discussion of our work with WADE is provided in 'Using the WADE model to investigate the relative costs of DG' at www.dti.gov.uk/energy/whitepaper/consultations.

8.5 Surface Transport in EU ETS

134. This area of work is at an early stage looking at the possibility of including surface transport in future phases of the EU ETS. Early analysis suggests that including road transport in the EU ETS could save in the region of 1-2MtC in 2020, depending on the level of under-allocation to the sector. Further work needs to be carried out on the benefits and costs including the impact on carbon prices and UK competitiveness.

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42 Review of Distributed Generation; DTI/ Ofgem; 2007
43 World Alliance for Decentralized Energy: www.localpower.org
44 http://www.greenpeace.org.uk/files/pdfs/migrated/MultimediaFiles/Live/FullReport/7441.pdf

8.6 Renewable Heat

135. The initial results of an Ernst & Young study, commissioned by DTI and Defra indicate that renewable heat could provide significant carbon savings (see www.defra.gov.uk/environment/climatechange/index.htm). It also found that various market failures exist, including the limited application and effectiveness of carbon pricing in this sector, which have slowed its development. This analysis is at a very early stage. The Government will continue to develop its thinking in this area. A further phase of this work is being taken forward.

8.7 Local Community

Reason for analysis

136. The Energy Review Report announcement included a commitment for Defra, DCLG, DTI, DfT and HMT to undertake a joint study looking at the "role of "community level" approaches to mobilising individuals, and the role of local authorities in particular in making them work effectively".

Analysis carried out

137. The first of two phases, '*Mobilising individual behavioural change through community initiatives: lessons for climate change*' (see www.defra.gov.uk/environment/climatechange/uk/individual/index.htm) has been completed.

138. The first phase was a limited review which looked at community initiatives and how they can encourage individuals to change their behaviour. The approach involved a brief literature review, 21 semi-structured telephone interviews of community initiatives and a stakeholder workshop.

139. The study highlights that sustained support for community action through effective long-term networks within an affirmative national policy are key elements for success. Associating community initiatives with relevant education programmes in schools and linking new initiatives to existing community activities, skills and priorities are also common features of successful projects. Initial conclusions are that effective community initiatives are likely to be a necessary component of a coherent national approach to tackling climate change.

Next steps

140. Phase 2 is being considered using the results from Phase 1.

8.8 Nuclear New Build – Consultation

141. The consultation on Nuclear New Build is being launched alongside the EWP, the Regulatory Impact Assessment is included in this document (see www.dti.gov.uk/energy/whitepaper/nuclearpower2007).

8.9 Low Carbon Transport Innovation Strategy

142. The Low Carbon Transport Innovation Strategy (LCTIS) is being published alongside the EWP (see www.dft.gov.uk/pgr/scienceresearch/technology).

8.10 Markal

143. We have used the UK MARKAL model (and the newly developed Markal-Macro model) to explore the technological and macroeconomic implications of reducing UK domestic carbon emissions by some 60% by 2050. The Markal-Macro model covers the entire energy system, including electricity, heat and transport. The MARKAL model is particularly useful in exploring the development of the energy system in the long-term i.e. to 2050 by comparing base case and other scenarios. It is a scenario tool not a forecast model. As part of the White Paper, we have used a number of scenarios in order to capture the wide range of costs that might materialise under different fuel prices and technology costs. The modelling shows that it is likely that a rich mix of technologies will be required if we are to meet our carbon goals at least cost.

144. More detail on the assumptions and the results of the Markal model is included in the DTI analytical paper presenting the key results from the MARKAL modelling that informed the Energy White Paper*, 'The MARKAL Energy Model in 2007 Energy White Paper'* (see www.dti.gov.uk/energy/whitepaper).

145. An in-depth technical report is also published by the UK Energy Research Centre, that include more detail on model data sets and assumptions, model validation and stakeholder processes, and additional scenario results:

- Strachan N., R. Kannan and S. Pye (2007), *Final Report on DTI-DEFRA Scenarios and Sensitivities using the UK MARKAL and MARKAL-Macro Energy System Models*, available at www.ukerc.ac.uk/content/view/142/112

- Kannan R., N. Strachan and S. Pye (2007), UK MARKAL model documentation, UKERC working papers, available at www.ukerc.ac.uk.

8.11 Short to Medium-Term Macroeconomic Impacts

146. Report on modelling analysis exploring potential short to medium-term costs of achieving the UK's carbon reduction goal.

147. Oxford Economics – *'Report on Modelling the Macroeconomic Impacts of Achieving the UK's Carbon Emission Reduction Goal'* (see www.dti.gov.uk/energy/whitepaper).

8.12 Biomass Strategy

148. The Biomass Strategy provides a clear, coherent and co-ordinated framework for the development of biomass as a whole and identifies the key challenges to delivery (see www.defra.gov.uk/environment/climatechange/index.htm).

9. Wider Impacts

9.1 Impact of Prices

149. Our existing policies to reduce carbon emissions are having an impact on energy prices:

- The commitment to increase the share of renewable electricity under the Renewables Obligation by 15% by 2015, for example, is expected to increase electricity prices by around 5%, compared to what would otherwise have been the case.

- The existence of the EU ETS also affects UK electricity prices as electricity generators pass on the market value of carbon allowances. Assuming an EU ETS carbon price in 2020 of around €15-25t/CO_2,[45] the impact on retail electricity prices could be between a 14-23% increase for industrial, and a 10-15% increase for household consumers, compared to if there were no carbon price.[46]

150. We have analysed the full impact of the new measures set out in the White Paper, including the impact on energy prices, on an individual basis. While some measures could contribute to increases in energy prices, our analysis shows that many will also help to reduce energy bills by targeting improved energy efficiency.

151. For example, the cost of better billing, household real time displays and business smart metering will modestly increase energy prices, but will also lead to reduced energy bills if consumers act to realise energy efficiency savings. The continued obligation up to 2020 on energy suppliers to make carbon reductions in the household sector could increase household energy bills by approximately 1.5%-2% relative to today's energy bills, if all the costs are passed through to customers. But over time, we expect these costs will be outweighed by the benefits of a permanent reduction in energy demand. We expect the impact on energy bills from our measures on better billing and real time displays to be around a 0.1% increase.

152. Our proposals for changes to the Renewables Obligation, including banding, could add extra costs to final consumer bills. Based on our proposals for strengthening the RO including through banding,[47] the impact of the proposed changes to the Obligation could increase electricity prices by around a further 2% in 2020, compared to the existing regime. As domestic customers pay a higher unit price than industrial customers

[45] The carbon price range reflects the uncertainty surrounding estimates of the future carbon price. The low end is based on the current forward EU ETS carbon price for Phase II; the higher end reflects the assumptions made in the DTI Energy model.
[46] DTI analysis is based on the Defra RIA on Phase II EU ETS www.defra.gov.uk/environement/climatechange/trading/eu/phase2/pdf/overarching-ria.pdf. This assumes that a €1/tCO_2 carbon price adds around £0.46/MWh to the electricity price, through the impact on the price of gas-fired and coal-fired generation.
[47] This is described in chapter 5.3 of the Energy White Paper.

the percentage increase for domestic customers is likely to be lower than for industrial customers.[48]

153. Based on our analysis of individual measures, and given improvements in energy efficiency as a result of our proposals, we expect the overall impact on energy prices of our package of measures (excluding the EU ETS) to be equivalent of up to an additional 4% and 3% on the average annual household electricity and gas bill respectively in 2020.[49] Some of these costs will be offset by energy savings through improved efficiency.

9.2 Ancillary Benefits

Reason for analysis

154. The proposals in the Energy White Paper (EWP) will provide significant carbon savings over the period up to 2020 and it is likely that there will be significant ancillary benefits. Therefore, an analysis of the likely scale of these benefits was undertaken to attempt to monetise them. The EWP package will deliver reduced energy consumption, which has been used here to calculate the ancillary benefits.[50] The summary ancillary benefits have already been set out in the EWP, however, this note sets out the methodology and results of these calculations from improvement in local air quality which will occur as a result of the package of proposals.

155. Ancillary effects are effects that are not the objective of the action, but arise as a result of that action or policy. Ancillary effects of climate change mitigation policies arise in addition to reductions in emissions of CO_2 and other greenhouse gases (GHGs). If policies propose a reduction in CO_2, this may be achieved, for example, through reductions in carbon intensive energy production. However, this reduction in CO_2, may also lead to reductions in other harmful gases such as NO_x and SO_2, which may improve local air quality and yield other potential improvements to public health. In this case, ancillary effects translate into ancillary benefits. There can also be ancillary costs where GHG mitigation causes deterioration in local air quality.

156. It is important that ancillary effects are considered when assessing GHG mitigation policy. Both the recent Stern review and the IPCC note the importance of co-benefits, as the former found that including them

[48] In 2006 the average retail domestic electricity price was 7.73p/kWh; and the average retail industrial electricity price was 5.06p/kWh.
[49] This is an illustrative figure based on the estimated impact of the policies when implemented on an individual basis. It is difficult to estimate the combined effect on prices of the new measures, but this estimate does provide a broad indication of the expected impact.
[50] This analysis takes into account the reduction of energy demand and the ancillary benefits that accrue from this. It does not, however, take into account changes in the electricity generation mix.

could lower the cost of overall mitigation by 1% of GDP.[51] The latter, in the IPCC 3rd assessment report, indicated that ancillary benefits may be of the order of 30-100% of abatement costs.[52]

157. The ancillary effects should be measured for each individual policy and the RIA[53] guidance sets out the ways in which to measure the benefits of a given policy. The guidance states that direct as well as indirect benefits should be included and that if the benefit, in this case indirect, is to reduce air pollution the benefit should be expressed as a reduction in tonnes of the pollutant being emitted into the atmosphere, which can then be monetised. Finally, the forthcoming Impact Assessment (IA) guidance emphasises the importance of monetising ancillary effects.

Analysis carried out

158. The measurement of the ancillary effects is supported by guidance from the Interdepartmental Group on Costs and Benefits (IGCB), outlined in the damage cost guidance,[54] which sets out a methodology and approach to measuring air quality damage costs. Estimates of energy saved, in terawatt hours (TWh), from all of the policies laid out in the EWP over the period 2005-2020 have been converted into tonnes of the different pollutants (NO_x, SO_2 and PM10) using the relevant emission factor.[55] The methodology from the damage cost guidance was then followed.

159. The results,[56] for the period up to 2020, are presented for high and low estimates of the ancillary benefits, and the sensitivity range is the range between the low and high estimates that is reflecting the minimum and maximum estimates of damage costs.

[51] Stern (2006); The Economics of Climate Change, p276 (originally from Barker et al (2006) meta-analysis), Cambridge University Press, Cambridge.
[52] 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.
[53] www.cabinetoffice.gov.uk/regulation/ria/ria_guidance/index.asp
[54] www.defra.gov.uk/environment/airquality/panels/igcb/guidance/pdf/damagecost-guidance.pdf
[55] AEA have provided the emissions factors for 2005, in tonnes per TWh, for different sectors and for different fuels. These emission factors may change over time due to a change in the electricity generation mix. However, this impact has not been included in this analysis.
[56] These estimates are a first approximation and depend heavily on the final implementation approaches and "whole sector" emissions profiles; air quality impacts will require further evaluation when options are considered for each policy.

Results by pollutant

TABLE 18 – RESULTS BY POLLUTANT

Pollutant	Low (PV in £m)	High (PV in £m)
NO_x	218.59	318.50
PM10	141.74	205.72
SO_2	146.00	215.74
Total	506.33	739.95
Benefit in 2020	82.40	120.43

160. The table above shows that the ancillary benefits of the Energy White Paper package are substantial and fall within a range of £506-740m up to 2020. NO_x reductions provide the largest monetised benefit (£219-319m), with PM10 and SO_2 accounting for a smaller proportion of the benefits: £142-206m and £146-216m respectively.

161. In 2020 the annual benefit is in the range of £82-120m, indicating that the EWP package accrues a large proportion of the ancillary benefits towards the end of the timeframe analysed.[57]

Results by sector

TABLE 19 – RESULTS BY SECTOR

Sector	Low (PV in £m)	High (PV in £m)
Household	240.80	352.05
Industry	43.18	63.29
Commerce	74.86	109.68
Public	39.16	57.34
Transport	108.34	157.58
Total	506.33	739.95

162. The sector breakdown shows that around nearly half of the ancillary benefits accrue due to proposals in the household sector (£240-352m), while the sector with the second largest ancillary benefits from the EWP proposals is transport: £108-158m.

[57] The benefits do not occur evenly over the period but steadily increase, with the first benefits occurring in 2010.

Sensitivities and uncertainties

163. There are significant uncertainties around these estimates, although they provide an indicative estimate of the ancillary benefits of the EWP. Given the scope of these uncertainties a full detailed analysis would be necessary when implementation options are finalised. However, it is still appropriate to list some of the key sensitivities and uncertainties around this analysis here:

- The analysis includes transport measures, which are particularly sensitive to fuel switching, as fuel efficiency is not necessarily positively correlated with ancillary benefits.

- As mentioned previously, this analysis only takes into account energy reduction and does not take into account any changes in the electricity generation mix, which could change the scale of the ancillary benefits.

- Finally, this analysis used the DTI's central estimate of energy savings, as we included the impact of the EU ETS,[58] but ancillary benefits could be higher or lower depending on a projection of 'low' or 'high' energy savings.

Next steps

164. Any further analysis on individual policies should consider the impact on air quality.

[58] The energy savings impact of the EU ETS was only available in the 'central' energy savings scenario.

10. Better Regulation

165. The policies and proposals put forward in the EWP and all analysis behind them are in keeping with the better regulation agenda. Better regulation has been considered in the peer review process of the EWP.

166. The analysis for all measures has been considered together, ensuring that there is understanding amongst analysts of the interrelationships between policies. This enabled further analysis on areas of overlap where policies are impacting on similar sectors. This prevented any double-counting of carbon savings, so improving the accuracy of our estimates of progress towards our goals.

167. Administrative burdens have been considered when formulating policy with the aim to keep them to a minimum whilst still exploiting the benefits of the measures. In keeping with the administrative burden reduction target of 25% for each Department, the impact of the EWP measures and proposals will be described and quantified in Departmental Simplification Plans to be published later in the year.

168. A review of major climate change instruments will look to ensure there are no unnecessary duplications, inconsistencies or conflicts between existing regulatory regimes and suggest how these can be resolved in order to ensure that the regulatory burden on business is kept to a minimum. The review will be done keeping in mind the need for a comprehensive and robust policy framework capable of delivering the Government's long-term climate change policy targets.

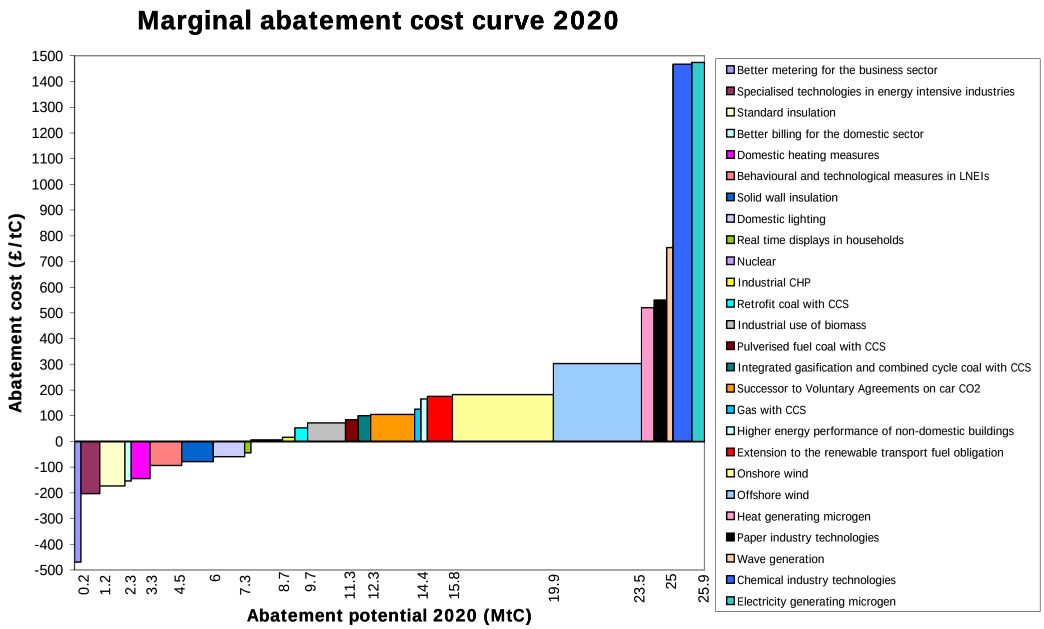
169. The review will primarily look at the EU Emissions Trading Scheme (EU ETS), climate change agreements (CCAs), and domestic trading mechanisms such as the proposed Carbon Reduction Commitment (CRC); and specifically at areas of existing and potential overlap between them. It will also consider key overlaps with the administrative requirements of other measures such as the Integrated Pollution Prevention and Control (IPPC) policy, the Large Combustion Plant Directive (LCPD), Combined Heat and Power (CHP) polices, the Renewables Obligation, and waste policies with a view to suggesting some broad principles for dealing with such overlaps. While unnecessary duplication from overlapping policy instruments needs to be avoided, the review will also consider whether alternative approaches carry their own regulatory disadvantages for business.

170. In taking forward the further work set out in the EWP measures will be assessed on the principles of better regulation on a case by case basis as well as regarding the collective regulatory impact on business and other parties. This is in line with the report by the Better Regulation Commission on "Regulating to Mitigate Climate Change".

10.1 UK Marginal Abatement Curve

171. A marginal abatement curve shows, for a given year, the incremental cost of reducing additional units of carbon, and shows where the most cost-effective abatement opportunities lie. The shape of the curve changes over time, and as part of the White Paper we have constructed a curve for the UK showing the domestic abatement potential of a range of measures and technologies in 2020. The abatement cost figure shows the estimated cost over the lifetime of the measure or technology.

FIGURE 4 – MARGINAL ABATEMENT COST CURVE



172. Under the central fossil fuel price assumptions published alongside the White Paper, each technology or policy option was compared against a counterfactual in order to calculate the carbon abatement potential – for example, in the case of electricity generation, the alternative source of generation was assumed to be a new combined cycle gas turbine (CCGT) station. For energy efficiency and transport options, assumptions were made about the fuels displaced and their associated emissions.

173. The curve should not be taken as a prediction of the exact volume of carbon abated from each technology or policy, since the precise impact of policies, and the timing of the entry and cost of a new technology, are both subject to some uncertainty. This is particularly true for emerging technologies, such as carbon capture and storage (CCS), which is yet to be developed on a commercial scale. The potential for nuclear power by 2020 is only indicative and depends on whether, the Government decides to allow private sector companies the option of investing in new nuclear power stations. It should also be noted that this cost-curve does not yet

present an exhaustive picture of carbon abatement potential in the UK. For instance, we estimate that there is a potential for cost-effective carbon savings from improved efficiency of products and appliances, and that a large share of that potential (up to 3MtC by 2020) is clearly cost-effective. This has not been incorporated into the cost-curve, as detailed cost estimates consistent with cost estimates for other measures (and reflecting the cost of delivering these savings through specific policies) are not yet available.

174. Some of the measures in Figure 4 show carbon abatement at negative cost by encouraging more efficient use of energy - for example, smart metering in the business sector. The aim of the policies in the White Paper is to create the conditions necessary for producers and consumers of energy to pursue the most cost-effective ways of lowering carbon emissions. Not all measures are cost-effective (i.e. achieve carbon savings at negative cost), particularly since the financial implications of carbon emissions for environment and public health (i.e. the social cost of carbon) are not factored into this analysis.

175. The measures in the MAC curve differ from those in Table 20 because the MAC curve represents a hybrid of both technologies and policies. Policy proposals are not solely based on the cost-effectiveness of technologies, all the Government's energy policy goals are considered.

10.2 Summary Table

TABLE 20 – SUMMARY OF THE CARBON SAVINGS OF EWP POLICIES, THEIR COST-EFFECTIVENESS AND TOTAL NET BENEFITS

Policy	**Additional Carbon Saved in 2020 (MtC)**	**Cost-Effectiveness (£/tC) (‘-‘ benefit)**	**Total Net Benefit (£m Present Value over lifetime) (‘-‘ cost)**
Better Billing	0.0-0.2	-155 (-55 to -160)	315 (50 to 840)
Real Time Display	0.0-0.3	-65 (505 to -125)	365 (250 to 1100)
EPBD	0.6-1.6	28.36	-85.3
Zero Carbon Homes	1.1-1.2	At formal consultation, these figures are due in the Summer.	
More Energy Efficient Products	1.0-3.0	These carbon savings are based on cost-effective measures only.	
Continued Obligation on Suppliers	3.0-4.0	The carbon savings are set at a level of ambition. Analysis is being taken forward on the details of the policy. The cost-effective potential is greater than the proposed target.	
Business Smart Metering	0.1-0.2	-350 (-340 to -470)	915 (470 to 1465)
CRC	1.0	-101	2,667 (2,308 – 3,401)
Changes to RO	0.4-1.1	188[1]	-3,900
CCS Demonstration Project	0.3-1.0	The competition for the CCS Demonstration project is being launched and so cannot be disclosed.	
Successor to EU VAs on new car fuel efficiency	1.8-4.1	-85 to 151 (depending on cost estimates and scenario considered)	-4,073 to 3,102 (depending on cost estimates and scenario considered)
RTFO	0.0-1.0	175	-686
EUETS	13.7	No NPV or cost-effectiveness figures are available. The cost-effectiveness of abatement through EU ETS will be determined by the carbon price. The future value of the carbon price is uncertain	
Aviation in EUETS	0.2-0.4	Illustrative saving from UK domestic aviation, assuming cap at 2005 emissions on projected 2020 levels, in line with current Commission proposal. No NPV or cost-effectiveness numbers are available at this stage. Carbon savings from international aviation have not been counted in the absence of agreement on how to allocate emissions.	
Carbon Neutral Government	0.2	This is largely an offsetting measure which is net cost to the UK, although part will be achieved through cost-effective measures.	

1: This figure represents the cost-effectiveness of the RO under the proposed changes