



**A Comparison of the Costs of
Alternative Policies for Reducing UK
Carbon Emissions**

**Europe Economics Report
for Open Europe**

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EXECUTIVE SUMMARY

- 1 Europe Economics has been commissioned by Open Europe to explore the cost-effectiveness of alternative ways of reducing carbon emissions.
- 2 In our research, we explored several categories of carbon reduction policies, namely:
 - (a) Government support for energy efficiency measures;
 - (b) Government support for low- or zero-carbon generation technologies (including renewables, nuclear and carbon sequestration);
 - (c) Government support for low-carbon car fuels and vehicle types;
 - (d) Taxes on the consumption of goods or services associated with high carbon emissions (e.g. air travel, car fuel); and
 - (e) Carbon pricing mechanisms (a carbon tax or emissions trading scheme).
- 3 Within each category, we considered a number of specific policy examples. Where possible, we provided range estimates for the cost to the UK of reducing carbon emissions by 1 per cent using each policy option. These estimates are based on publicly available data sources and are only intended to be indicative in nature.
- 4 In line with standard economic theory, we conclude that, in general, carbon pricing mechanisms would be expected to achieve emissions reductions at the lowest economic cost. Once a price has been placed on carbon, companies and consumers would have incentives to reduce carbon emissions in the most cost-effective ways (which the government is unlikely to be able to identify in advance). However, further research would be required to confirm whether this result remains true when the possibility of using emissions-reduction policy to raise tax revenue is taken into account, as this introduces additional complexity into the analysis.
- 5 Currently, the key policy instrument used for pricing carbon within the EU is the Emissions Trading Scheme EU-ETS). However, research by Open Europe has highlighted a number of drawbacks to the EU-ETS in its current form. Open Europe found that Phase 1 of the scheme imposed substantial costs on the UK economy without actually limiting emissions across the EU, mainly because other Member States issued too many permits.¹ More recent research by Open Europe argues that Phase 2 of the scheme is

¹ Open Europe, "The high price of hot air: Why the EU Emissions Trading Scheme is an environmental and economic failure", July 2006, <http://www.openeurope.org.uk/research/ets.pdf>



- also unlikely to work due to an oversupply of Kyoto credits from (sometimes dubious) carbon-reduction projects outside the EU.²
- 6 More generally, monitoring carbon emissions directly so as to enforce an emissions tax or trading scheme is administratively burdensome, particularly when many small companies are involved. This has at least two adverse effects:
 - (a) It increases the administrative costs of such policy instruments, both for the government and for companies;
 - (b) It means that, for practical reasons, coverage of such policies generally has to be limited to larger installations. (The EU-ETS, for instance, only covers a subset of the economy.) The effect is that carbon reductions may not necessarily be achieved in the most cost-effective way, because there may be cheaper ways to cut emissions in some of the sectors not covered by the scheme.
 - 7 An alternative way of placing a price on carbon would be to tax the consumption of all primary fuels (e.g. coal, gas, oil) in proportion to their carbon content. This would allow a carbon price to be extended across the entire economy, while avoiding the administrative costs associated with monitoring carbon emissions directly.
 - 8 Our research also suggests that it is likely to be beneficial for the government to use its emission reduction policy to raise revenue (whether by using a tax instrument or by auctioning carbon permits). This would allow taxes elsewhere in the economy to be set at a lower level than otherwise, leading to a reduction in the deadweight loss of taxation elsewhere in the economy.³ The current approach of grandfathering permits under the EU-ETS transfers valuable assets to existing polluters for free, giving a windfall gain to their shareholders while disadvantaging new entrants and potentially distorting competition.
 - 9 Our cost estimates suggest that energy efficiency is one of the most cost-effective ways to reduce carbon emissions, although there may be “hidden costs” (e.g. hassle and time) which are not included in our estimates.
 - 10 By contrast, renewables generation technologies are typically a very costly way to reduce carbon emissions. In many cases, this is true even once the potential for costs to fall through time has been taken into account.
 - 11 At the present time, the carbon abatement cost of biofuels appears to be many times greater than the avoided damage cost of climate change. Indeed, our research suggests that biofuels represent one of the most expensive ways to reduce carbon emissions, even

² Open Europe, “Europe’s dirty secret: Why the EU Emissions Trading Scheme isn’t working”, August 2007, <http://www.openeurope.org.uk/research/etsp2.pdf>

³ Taxes give rise to a deadweight loss when they discourage economic activity, thus reducing the overall welfare of society.



after factoring in the potential for cost reductions through time. Not only do biofuels have a high production cost, but the carbon savings they generate in the transport sector will typically be partially offset by fossil fuel consumption during the production process.

- 12 The key message from our cost estimates, however, is the huge uncertainty that exists about the precise cost of many carbon reduction measures. This illustrates the danger of the government “picking winners” by supporting a particular solution to the problem of reducing emissions, and reinforces the case for using a carbon price to allow the market to identify the best approach.
- 13 In our view, once a price has been placed on carbon it is only appropriate to provide additional support for specific technologies where this can be justified on the basis of further market failures (i.e. other than climate change externalities, which are already captured in the carbon price). For instance, additional support for renewables should only be provided to the extent that this can be justified by likely spillover benefits from innovation and cost reductions through time.
- 14 In conclusion, we consider that a policy for reducing carbon emissions which deserves serious consideration is to introduce an economy-wide carbon price by abandoning the EU ETS and taxing the consumption of all primary fuels in proportion to their carbon content. This would avoid the administrative costs of monitoring emissions directly, and would raise additional tax revenue which could be used to reduce taxes elsewhere in the economy.



1 INTRODUCTION

- 1.1 The purpose of this report is to explore the cost-effectiveness of alternative ways of reducing carbon emissions.
- 1.2 Our research explored several categories of carbon reduction policies, namely:
 - (a) Government support for energy efficiency measures;
 - (b) Government support for low- or zero-carbon generation technologies (including renewables, nuclear and carbon sequestration);
 - (c) Government support for low-carbon car fuels and vehicle types;
 - (d) Taxes on the consumption of goods or services associated with high carbon emissions (e.g. air travel, car fuel); and
 - (e) Carbon pricing mechanisms (a carbon tax or emissions trading scheme).
- 15 Within each category, we considered a number of specific policy examples. Where possible, we provided range estimates for the cost to the UK of reducing carbon emissions by 1 per cent using each policy option. These estimates are based on publicly available data sources and are only intended to be indicative in nature.
- 1.3 The structure of this report is as follows:
 - (a) Section 2 compares costs to the UK of various different instruments for controlling carbon emissions;
 - (b) Section 3 draws some conclusions;
 - (c) Appendix 1 provides further detail on our methodological approach;
 - (d) Appendix 2 provides background material on the EU ETS and on biofuels policy.



2 ALTERNATIVE CARBON REDUCTION POLICIES

- 2.1 In this section we discuss alternative policies for cutting carbon emissions, where possible presenting range estimates of the total cost to the UK economy (in £m) of achieving a 1 per cent reduction in emissions in 2020 by using each policy instrument.⁴ These figures should be interpreted as the annualised cost of achieving carbon savings and not as the upfront capital cost.
- 2.2 The cost estimates in this section should be compared to the damage cost of the climate change associated with carbon emissions. The UK government uses a shadow price of carbon (SPC) to calculate such damage costs. The SPC is £25 per tonne of CO₂ (£25/tCO₂) in 2007 and rises at two per cent per annum, thus reaching a level of £33/tCO₂ in 2020. These figures imply that 1 per cent of projected UK carbon emissions in 2020 is associated with estimated climate change damage of £163m.⁵ Hence, the cost estimates presented later in this section should be compared against the benefit of avoiding climate change damage of £163m.
- 2.3 The carbon reduction policies we examine can be placed into five categories:
- (a) Government support for energy efficiency measures;
 - (b) Government support for low- or zero-carbon generation technologies (including renewables, nuclear and carbon sequestration);
 - (c) Government support for low-carbon car fuels and vehicle types;
 - (d) Taxes on the consumption of goods or services associated with high carbon emissions (e.g. air travel, car fuel); and
 - (e) Carbon pricing mechanisms (a carbon tax or emissions trading scheme).
- 2.4 We discuss each of these categories in turn below, before presenting an overall comparison of the different options available to the UK.

Energy Efficiency Measures

- 2.5 By reducing energy consumption, energy efficiency measures lead to direct financial savings alongside any environmental gains from reduced carbon emissions, in exchange for the up-front cost of implementing these measures. In some cases, these direct financial benefits may outweigh the costs of energy efficiency measures, meaning energy

⁴ The rationale for focusing on projected 2020 costs is that the costs of many renewables technologies are projected to fall through time – indeed, this is often quoted as an argument in favour of policy support for renewables. A focus on current cost estimates could therefore be criticised for failing to take into account dynamic effects.

⁵ This calculation is based on projected emissions of 495 million tonnes of carbon dioxide in 2020.



efficiency can yield net benefits even before the carbon benefit is taken into account. This is shown by the negative cost estimates (i.e. benefits) in the first column of Table 2.1.

Table 2.1: Estimated cost of reducing UK emissions in 2020 by 1 per cent through energy efficiency measures (£m)

£m	Low	High
Domestic energy efficiency	-468	79
Services energy efficiency	-406	79
Industry energy efficiency	-125	47

Note: Negative numbers indicate a benefit

Source: Europe Economics calculations (see appendix 1 for details)

- 2.6 Where energy efficiency measures yield net financial benefits in this way, the question arises as to why companies and individuals do not implement such measures of their own accord. Broadly speaking, there are two possible ways of responding to this question:
- (a) The first school of thought argues that estimates such as those presented in the above table fail to factor in certain “hidden costs” associated with energy efficiency measures, such as the cost of management time within a company or the hassle and disruption experienced by a household.
 - (b) An alternative perspective is to argue that companies and individuals do not take up such measures due to various market failures. For example, information asymmetries between landlords/tenants and home-sellers/homebuyers regarding the energy efficiency of a property may deter owners from investing in domestic energy efficiency, because they cannot easily recoup the benefit through higher rent or the price of house sales. People may also be prevented by credit constraints from investing in measures with high upfront capital costs.
- 2.7 If the second viewpoint is adopted, then the government may have a role to play in overcoming these market failures through the implementation of policies to encourage the uptake of energy efficiency measures (even where those measures already yield net financial benefits).

Low- or Zero-Carbon Generation

- 2.8 An alternative to reducing energy consumption is to meet the UK’s energy requirements in a less carbon intensive way. In this section, we focus on low- or zero- carbon technologies for electricity generation.
- 2.9 Table 2.2 begins by setting out the costs of cutting UK emissions by 1 per cent using various renewables generation technologies. As stated earlier, these figures are for 2020



and take into account future cost reductions, as projected by the Cabinet Office Performance and Innovation Unit (PIU) in 2002. The figures show that even after more than a decade of technological learning and cost reductions, wave and tidal generation and energy crops are likely to remain expensive solutions for reducing carbon emissions.⁶ However, it is possible that some wind generation may become cost-effective over this time period.

Table 2.2: Estimated cost of reducing UK emissions in 2020 by 1 per cent through renewables generation, in 2020 (£m)

£m	Low	High
Onshore wind	-125	79
Offshore wind	-47	238
Wave and tidal	111	720
Energy crops	111	318

Note: Negative numbers indicate a benefit

Source: Europe Economics calculations (see appendix 1 for details)

2.10 Table 2.3 presents estimates of the costs in 2020 for carbon sequestration (i.e. the capture of carbon produced by fossil fuel generation) and for nuclear generation. The figures suggest that nuclear generation is likely to be more cost-effective than carbon sequestration, but that its cost exceeds the projected (2020) cost of wind generation (see above).

Table 2.3: Estimated cost of reducing UK emissions in 2020 by 1 per cent through carbon sequestration and nuclear generation, in 2020 (£m)

£m	Low	High
Nuclear	111	318
Carbon sequestration	126	446

Source: Europe Economics calculations (see appendix 1 for details)

Biofuels and Low Carbon Vehicle Types

2.11 Table 2.4 presents our estimates of the costs of reducing UK emissions by 1 per cent by supporting various biofuels and low carbon vehicle types. Despite the fact that these figures take into account potential cost reductions in the period up to 2020, the cost of using bio-fuels to reduce UK carbon emissions by 1 per cent remains one of the most expensive methods available to government.

⁶ "Energy crops" refers to the use of energy crops for electricity generation, and should not be confused with the later discussion of biofuels.



Table 2.4: Estimated cost of reducing UK emissions in 2020 by 1 per cent through biofuels and low carbon vehicle types (£m)

£m	Low	High
Biodiesel	477	630
Hybrids	230	663
Fuel cell vehicle (H2 from natural gas)	889	9,258
Fuel cell vehicle (H2 from renewables)	510	1,980

Source: Europe Economics calculations (see appendix 1 for details)

2.12 Table 2.5 provides estimates of current costs (rather than projected 2020 costs) for different types of biofuel, derived from data in a report by Global Subsidies Initiative.⁷ These figures illustrate even more starkly the high costs associated with using biofuels to reduce emissions. These cost estimates are many times greater than the avoided damage cost of climate change. The cheapest option shown in the table is biodiesel from used cooking oil. In practice, however, there are limitations to the amount of used cooking oil available for this purpose.⁸

Table 2.5: Estimated cost of reducing UK emissions by 1 per cent through biofuels, at current cost levels (£m)

£m	Low	High
Ethanol from sugarbeets	2,114	2,973
Ethanol from grains	7,834	16,994
Biodiesel from used cooking oil	769	812
Biodiesel from rapeseed oil	2,206	2,973

Note: For comparability, this table uses the same projected 2020 carbon volume as the previous tables, to illustrate how higher unit costs drive the higher cost of these policy options at the present time.

Source: Europe Economics calculations (see appendix 1 for details)

2.13 Table 2.6 presents another set of estimates for the current costs of different types of biofuel, derived using data from another source (this time a report by the IMF).⁹ These estimates are broken down by location as well as type of fuel and the crops used. Only Brazilian production of ethanol from sugarcane and possibly Indian production of biodiesel from the jatropha tree are cost-competitive compared with conventional road fuels. Most of the other biofuels cost substantially more than the avoided damage cost of climate change. It should also be noted that these figures appear to include only the cost of producing biofuels, thus excluding any additional costs associated with distribution or vehicle alterations.

⁷ Global Subsidies Initiative, "Biofuels – at what cost?", October 2007

http://www.globalsubsidies.org/IMG/pdf/Global_Subsidies_Initiative_European_Report_on_support_to_Biofuels.pdf

⁸ Indeed, we have not verified that it would actually be possible to achieve a cut of 1 per cent in UK emissions using used cooking oil.

⁹ IMF, "World Economic Outlook: Globalisation and inequality", October 2007
<http://www.imf.org/external/pubs/ft/weo/2007/02/pdf/text.pdf>



Table 2.6: Estimated cost of reducing UK emissions by 1 per cent through biofuels, at current cost levels (£m)

Type of biofuel	Cost estimate
Ethanol, sugarcane-based, Brazilian	-180 to -82
Ethanol, corn-based, U.S.	522
Ethanol, wheat-based, European	834
Ethanol, sugar beet-based, European	1,888
Ethanol from cellulosic waste	659
Biodiesel, palm oil-based, Malaysian	123 to 195
Biodiesel, soybean oil-based, U.S.	372
Biodiesel, rapeseed oil-based, Europe	1,262 to 2,310
Biodiesel, jatropha-based, India	-5 to 252

Note: For comparability, this table uses the same projected 2020 carbon volume as the previous tables, to illustrate how higher unit costs drive the higher cost of these policy options at the present time.

Source: Europe Economics calculations (see appendix 1 for details)

- 2.14 These findings are in line with analysis conducted by the OECD, which has stated that biofuels are not cost-effective.¹⁰
- 2.15 In general, bio-fuels can be up to 3 times more expensive than conventional fuels.¹¹ While high oil prices may narrow the gap, one must remember that oil costs also feed into the cost base for bio-fuels. With the notable exception of Brazilian production, it is unlikely that even with \$70 per barrel oil prices bio-fuels will become competitive without government support.
- 2.16 Alongside the high production costs associated with biofuels, another factor responsible for the high carbon abatement cost shown above is that the carbon savings biofuels generate in the transport sector will typically be partially offset by the use of fossil fuels during the production process. It is also worth noting that the carbon intensity of biofuels production may vary widely. Hence, a further criticism that can be levelled against bio-fuels policy is that support for their cultivation does not take into account how they are produced, thus ignoring differences in environmental impacts during growth.

Taxes on Goods and Services Associated with High Emissions

- 2.17 Another approach to reducing UK emissions would be to impose taxes on the consumption of goods and services which involve high carbon emissions. We consider the examples of car fuel, aviation, electricity and gas.

¹⁰ OECD, "Biofuels: is the cure worse than the disease?", September 2007

¹¹ Energy Review 2004



- 2.18 Taxes obviously impose a direct cost on those people who bear the burden of the tax. However, this is a transfer effect rather than a net economic cost to the UK, since the tax revenue will be reallocated elsewhere in the economy.
- 2.19 In estimating the economic cost of these tax options, there are two offsetting effects which need to be taken into account:
- (a) First, these taxes will tend to deter consumption of the goods and services in question. While this is what leads to the desired reduction in carbon emissions, it also imposes an economic cost on the UK because consumers forgo the benefits which they previously obtained from consumption of these goods and services.
 - (b) Second, the tax revenue gained from these tax policies allows the government to set lower taxes than would otherwise be required elsewhere in the economy. Economic theory suggests that taxation typically leads to a deadweight cost for society (i.e. it reduces the overall welfare of society by deterring economic activity). Consequently, the fact that these policies allow the government to reduce taxes elsewhere leads to an offsetting welfare gain by reducing the deadweight cost of taxation in other parts of the economy.
- 2.20 The figures in Table 2.7 show our estimates of the net effect of taxing the four selected goods and services, taking both of the above impacts into account. The low figures suggest that these tax options would generally yield net benefits, even before the environmental gain from lower carbon emissions is taken into account. In other words, taxing these particular goods and services would be a relatively efficient way to raise tax revenue, compared to the taxes which are used elsewhere in the economy. On the other hand, in the high scenario these policy options give rise to net economic costs.

Table 2.7: Estimated cost of reducing UK emissions by 1 per cent through taxes on the consumption of goods and services associated with high emissions (£m)

£m	Low	High
Car fuel tax	-2,284	670
Aviation tax	-142	33
Electricity tax	-725	35
Gas tax	-522	17

Note: Negative numbers indicate a benefit

Source: Europe Economics calculations (see appendix 1 for details)

- 2.21 Table 2.8 provides further detail on the derivation of these numbers, showing the relative size of the two effects discussed above.

**Table 2.8: Breakdown of estimates for the impact of tax-based policies (£m)**

	Low			High		
	Loss of economic welfare in relevant market	Reduced deadweight loss from taxation elsewhere	Net cost of policy	Loss of economic welfare in relevant market	Reduced deadweight loss from taxation elsewhere	Net cost of policy
Car fuel	1,247	3,531	-2,284	1,177	507	670
Aviation	85	227	-142	51	18	33
Electricity	186	911	-725	152	117	35
Gas	120	641	-522	96	79	17

Source: Europe Economics calculations (see appendix 1 for details)

- 2.22 Below, we discuss some of the key factors driving these results by focusing on the case of car fuel taxation.
- 2.23 Increasing car fuel taxation causes the largest loss of economic welfare in the relevant market (see columns 2 and 5 in the table). This is caused by two factors:
- First, existing taxes on car fuel are very high (accounting for an estimated 67 per cent of the retail price in 2005-06). Economic theory suggests that, all other things being equal, the loss of economic welfare from increasing the tax rate on a product will be greater if the product is already highly taxed (see appendix 1 for further explanation).
 - Second, our calculations suggest that the increase in the tax rate on car fuel required to achieve a 1 per cent reduction in UK emissions is very high, due to the fact that demand for car fuel is price insensitive. (In fact, the required tax rate would lead to an increase in the price of car fuel of over 50 per cent.) This implies that some of the consumption which is deterred by the policy was highly valued by the consumers concerned.
- 2.24 On the other hand, the high increase in tax which is necessary to reduce consumption of car fuel also means that this policy raises a large amount of tax revenue. Given that we are assuming offsetting reductions in other taxes, this leads to a substantial reduction in deadweight loss elsewhere in the economy (in the region of £0.5 billion to £3.5 billion, depending on the assumptions used).
- 2.25 In calculating these figures, we have not specified precisely which taxes elsewhere in the economy would be reduced to ensure that the policy was fiscally neutral. Instead, we have used estimates for the deadweight loss of taxation in general across the economy, as discussed in Appendix 1.
- 2.26 The net effect is that:
- In our low scenario, increasing tax on car fuel leads to a large welfare gain for society, even before any environmental effects are factored in;



- (b) In our high scenario, increasing tax on car fuel is one of the more costly policy options for reducing carbon emissions.

Carbon Pricing Mechanisms

- 2.27 Economists have long favoured the use of market-based mechanisms to address pollution issues. Setting aside some of the complexities introduced by using emissions-reduction policy to raise tax revenue, carbon pricing mechanisms would in general be expected to achieve emissions reductions at the lowest possible economic cost. Once a price has been placed on carbon, companies and consumers would have incentives to take the impact on emissions into account in their decision-making and to reduce carbon emissions in the most cost-effective way.
- 2.28 The argument for using a price mechanism is especially strong in the current context, because the high degree of uncertainty surrounding cost estimates for individual technologies (see above) means that the government is unlikely to be able to identify the cheapest solution in advance by “picking winners.”
- 2.29 There are two main types of market-based mechanisms:
- (a) Those that restrict quantities – e.g. a pollution permits scheme with an aggregate quota;
 - (b) Those that force up prices – e.g. a pollution tax.
- 2.30 Within the first category, there are two main approaches to allocating permits – handing out permits for free to existing polluters (known as “grandfathering”) and auctioning permits to the highest bidder. The EU-ETS is clearly a quantity restriction scheme, with most of the permits allocated on the basis of grandfathering rather than auctions.
- 2.31 Below we discuss in turn the relative merits of quantity versus price interventions, and of grandfathering versus auctions. We then go on to discuss the implications of administrative costs.

Quantity versus price interventions

- 2.32 Whether it is better to use quantity restrictions or taxes is a complex question. An important consideration relates to where the major uncertainties lie. In particular, what are we more uncertain about – how much pollution is optimal, or what the (marginal) external cost of pollution is at the optimal level?¹²

¹² More technically, the standard result from economic theory is that a tax will be a superior instrument when the marginal cost the externality imposes on consumers is relatively constant with quantities of the externality (e.g. each additional tonne of carbon imposes the same environmental cost) and the potential value of output from firms producing the externality is high. In contrast, a quota restriction will be superior when the nature of potential output from firms producing the externality is fairly fixed but the



- 2.33 Of course, the truth is that in the case of carbon we know neither the ideal quantity nor the external cost with any accuracy. What we do think we know is that the ideal quantity of carbon emissions is rather less than we have been emitting recently, and so we have signed up to certain obligations under the Kyoto Treaty to control our emissions. Indeed, the UK's ambition has gone well beyond its Kyoto obligations – the goal is to reduce carbon emissions 20 per cent below 1990 levels by 2010 as opposed to the 12.5 per cent cut in greenhouse gas emissions required under Kyoto by 2008-2012.
- 2.34 On the one hand, it could be argued that, since the UK and other EU Member States have targets for reducing the quantity of emissions, a quantity-based restriction is most natural. In theory, it ought to be relatively straightforward to set the quantity restriction at a level which ensures that the targets are met.
- 2.35 On the other hand, taxes are a relatively flexible instrument, in that governments should be able to adjust tax rates fairly easily through time. Hence, there is scope to adjust a carbon tax up or down through time in line with emerging evidence on whether the existing tax rate is likely to lead to over- or under-shooting of the quantity target.
- 2.36 In addition, there are likely to be uncertainties about the economic cost of achieving any given quantity-based target. Administrative complexities in emissions trading schemes tend to mean that they apply over an extended number of years, which raises the risk that, if the target has been set at too high a level, significant economic costs may be incurred under a quantity-based scheme before policy can be reversed.

Grandfathering versus auctions

- 2.37 As explained above, under the EU-ETS, for both Phase 1 and 2, the overwhelming majority of permits are distributed free, on a grandfathering basis.
- 2.38 Even though permits are distributed free, the fact that there is a market for them raises prices paid by final consumers, because firms must receive a high enough price to make it worthwhile for them to produce output (through the carbon-emitting means) rather than simply selling the permits. Consequently, firms receive higher prices and free permits – meaning that the policy makes firms better off and consumers worse off.¹³
- 2.39 In addition, the allocation of permits is based on the amount of pollution firms have been responsible for in the past. Perversely, this means that the shareholders of firms engaged in production of a polluting nature make a windfall gain as a result! Moreover, firms that have been more carbon efficient in the past and hence have less scope to cut emissions

marginal cost of the externality increases with quantity (so, an extra tonne of carbon emissions is much worse when carbon emissions are already very high than when carbon emissions are low). See Mas-Colell, Whinston and Green (1995), *Microeconomic Theory*, section 11.E. See also Weitzman (1974), "Prices vs. quantities", *Review of Economic Studies*, 41, pp477-91.

¹³ Note that this is an effect independent of the fact that other weakness of the scheme mean that there is a transfer from the UK to other EU Member States.



today are penalised in comparison with firms that have previously been inefficient and hence have more scope for savings.

- 2.40 Further, new entrants are disadvantaged or discouraged from entering. In the case of carbon control this is a particular weakness, since the key ways in which carbon will be controlled in the future whilst economic growth continues must be through innovation, and will probably include entirely new firms with new approaches.
- 2.41 If, on the other hand, the government were to auction permits, then the permits would go to the firms that could make most efficient use of them, and the money raised could be used to reduce taxes elsewhere – enhancing economic efficiency by charging for use of a “bad” (carbon emissions) and cutting taxes on “goods” (useful output).

Administrative complexity

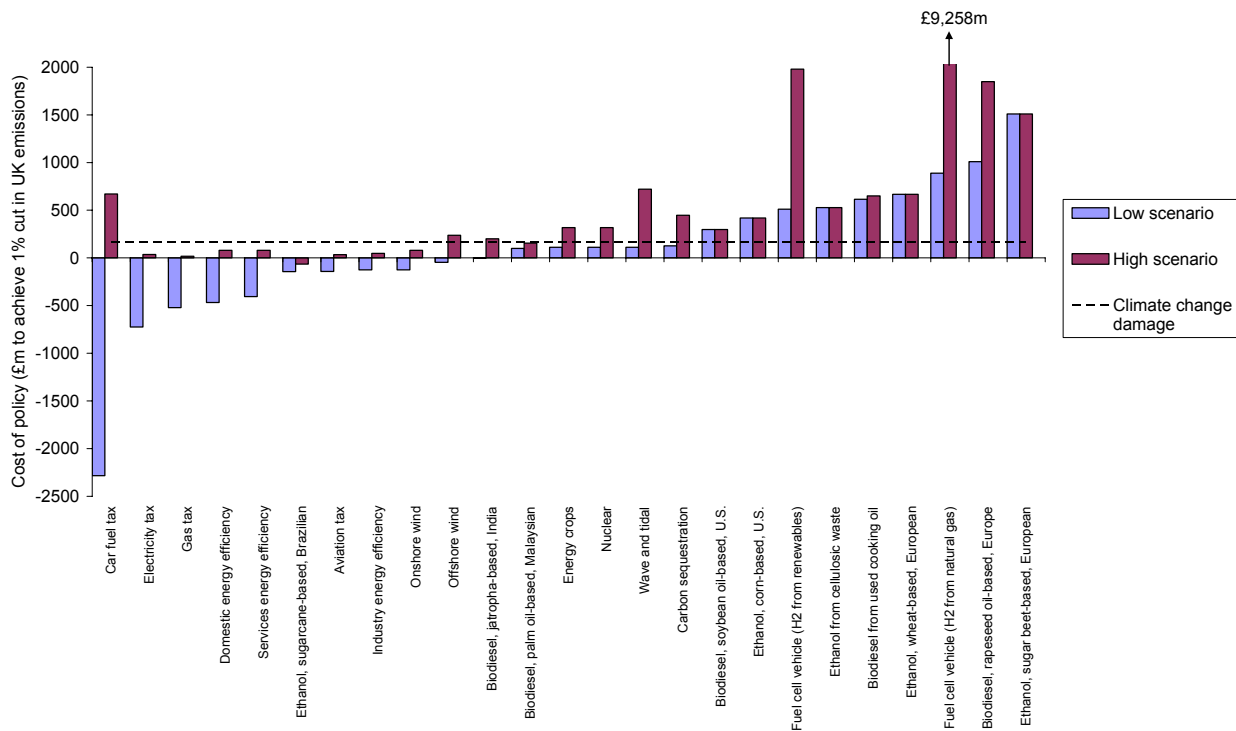
- 2.42 Monitoring carbon emissions directly so as to enforce an emissions tax or trading scheme is administratively burdensome, particularly when many small companies are involved. This has at least two adverse effects:
- (a) It increases the administrative costs of such policy instruments, both for the government and for companies;
 - (b) It means that for practical reasons coverage of such policies generally has to be limited to larger installations. (The EU-ETS, for instance, only covers a subset of the economy.) The effect is that carbon reductions may not necessarily be achieved in the most cost-effective way, because there may be cheaper ways to cut emissions in some of the sectors not covered by the scheme.
- 2.43 An alternative way of placing a price on carbon would be to tax the consumption of all primary fuels (e.g. coal, gas, oil) in proportion to their carbon content. This would allow a carbon price to be extended across the entire economy, while avoiding the administrative costs associated with monitoring carbon emissions directly.



3 CONCLUSIONS

3.1 We have quantified the impact to the UK of various ways to achieve a one per cent reduction in carbon emissions, as illustrated in Figure 3.1.

Figure 3.1: Estimates of the annualised costs of achieving a 1 per cent reduction in UK carbon emissions using alternative policy options

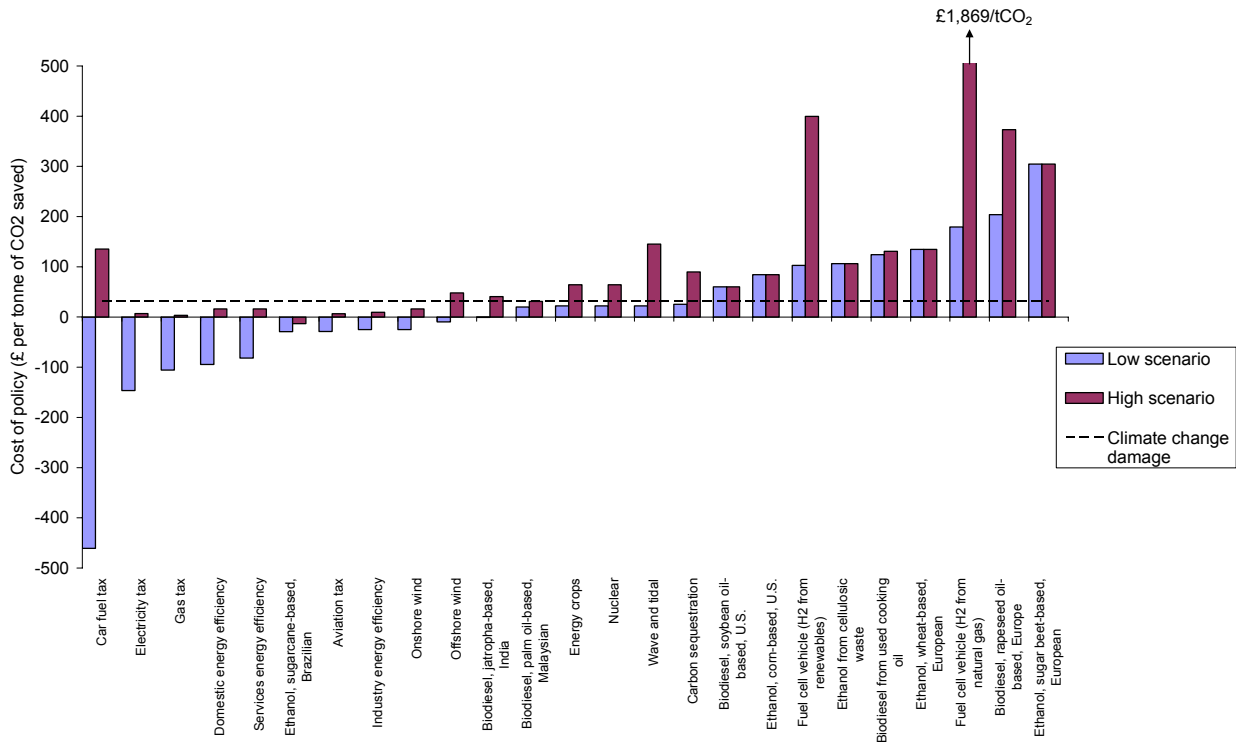


Notes: The figures for all policy options apart from biofuels are taken from tables 2.1, 2.2, 2.3 and 2.7. In order to provide disaggregated estimates for biofuels wherever possible, we have used the figures from table 2.6 supplemented with the figure for used cooking oils from table 2.5 and the figures for fuel cell vehicles from table 2.4. Figures taken from tables 2.5 and 2.6 have been scaled down by 20 per cent to account for potential cost reductions between now and 2020, although further analysis would be required to produce robust estimates of 2020 costs for these biofuels. In cases where we only have a single estimate for the cost of a policy option, we have used the same figure in both the low and high cost scenario.

3.2 Carbon reduction policies are often compared in terms of the cost per tonne of CO₂ saved, and Figure 3.2 presents the data on this basis. These figures should be compared to the shadow price of carbon in 2020 of £33 per tonne of CO₂.



Figure 3.2: Estimates of the costs of reducing carbon emissions (£ per tonne of CO₂ saved)



3.3 A number of points emerge from these figures.

- (a) First, the low cost estimates of some of these options are negative, which indicates that they may yield net benefits even before environmental benefits are factored in.
- (b) There is considerable uncertainty, with many of the high estimates being vastly above the damage cost of climate change even when the low estimates are considerably negative. In practice, some of the actual figures are likely to be closer to the low estimates whilst others will be closer to the higher estimates, and it is difficult for policy-makers to know in advance which is the case. Consequently, it is dangerous to have a policy of “picking winners” e.g. by subsidising specific technologies.
- (c) The tax-based measures tend to perform best. This is because, as well as achieving reductions in carbon emissions, they raise tax revenue which we have assumed is used to reduce taxes – and the associated deadweight cost of taxation – elsewhere in the economy.

3.4 The magnitude of the welfare gain from using emissions-reduction policy to raise tax revenue (so that taxes elsewhere can be reduced) depends on a number of factors. These factors include the elasticity of the environmentally-harmful good being taxed, which affects the tax rate required to achieve a 1 per cent reduction in emissions and



hence the amount of tax revenue raised. Another important driver is the deadweight cost of taxation elsewhere in the economy, which is subject to substantial uncertainty.

- 3.5 We have not put a figure on the cost of achieving reductions in carbon emissions using a carbon price (i.e. a carbon tax or a carbon emissions trading scheme). However, setting aside the complexities introduced by the tax-raising effect discussed above, the attraction of a well-implemented carbon pricing policy is that it is likely to achieve carbon reductions at the lowest possible economic cost, *without requiring the government to know* the cost of carbon-reduction options in different sectors of the economy.¹⁴ In other words, the key advantage of carbon pricing is that it incentivises the market to find the lowest cost approach to reducing carbon emissions, without any requirement on the government to “pick winners” based on advance cost estimates. In the light of this, we consider that it would be unhelpful to present an estimate of the economic cost of carbon pricing.
- 3.6 However, our analysis does illustrate that any carbon pricing mechanism should be used to raise revenue. As with the tax options presented in the above graph, this would achieve an additional benefit by allowing taxes to be reduced elsewhere in the economy, leading to reductions in the deadweight cost of taxation. Revenue could be raised either through use of a carbon tax or through auctioning of carbon emissions permits under a trading scheme.
- 3.7 Any carbon pricing mechanism which requires monitoring of emissions is likely to be administratively burdensome. As well as directly increasing the cost of the policy, this is likely to mean that its coverage would have to be limited (e.g. to large firms) for practical reasons. This would reduce the benefits from such an approach, since there would be no guarantee that the most cost-effective ways to reduce emissions were within the sectors covered by the scheme.
- 3.8 In the light of these considerations, we conclude that a policy which deserves serious consideration is a carbon tax implemented by taxing consumption of all primary fuels in proportion to their carbon content. This would:
- (a) Allow a non-distortionary carbon price to be extended across the whole economy.
 - (b) Incentivise the market to achieve carbon reductions in the least costly way.
 - (c) Avoid the economic costs which are likely to arise if the government tries to “pick winners” based on advance cost estimates. (Our estimates illustrate the huge uncertainty which exists, and hence the government is extremely unlikely to make the optimal choice if it tries to “pick winners”.)

¹⁴ As stated in the previous paragraph, the magnitude of the welfare gain arising from use of emissions-reduction policy to raise tax revenue (so that taxes elsewhere can be reduced) would depend on a number of factors, some of which are subject to substantial uncertainty. Hence, it is less clear-cut how a carbon pricing mechanism compares with alternative policies once this tax-raising effect is factored in. We recommend that policy-makers undertake further research on this issue.

Conclusions



- (d) Avoid the administrative burdens associated with monitoring carbon emissions directly.
- (e) Raise tax revenue which can be used to reduce taxes elsewhere in the economy, thus reducing the general deadweight cost of taxation.



APPENDIX 1: METHODOLOGICAL APPROACH

A1.1 In this appendix, we provide details of the methodological approach we used to derive our cost estimates. We begin by briefly discussing our data sources; then we reiterate the theory of deadweight loss in economics which is the theoretical foundation for some of our calculations; and we then discuss the actual procedural steps for the calculations.

Data Sources

List of sources

A1.2 The data used in our calculations have been extracted from publicly available documents. A list of data sources is given in Table A1.1.

Table A1.1: List of data sources used in calculations

Data	Source
<i>Technology costs per tonne of carbon saved</i>	
Cost per tonne of carbon saved in 2020 for different carbon-reduction technologies	Supplementary Annex 1 to the 2003 Energy White Paper http://www.dti.gov.uk/files/file21214.pdf
Cost per tonne of carbon saved today for different biofuels	Global Subsidies Initiative, "Biofuels – at what cost?", October 2007 http://www.globalsubsidies.org/IMG/pdf/Global_Subsidies_Initiative_European_Report_on_support_to_Biofuels.pdf
Cost per litre for different biofuels Reduction in greenhouse gas emissions for different biofuels Energy content of ethanol relative to gasoline, and biodiesel relative to diesel	IMF, "World Economic Outlook: Globalisation and inequality", October 2007 http://www.imf.org/external/pubs/ft/weo/2007/02/pdf/text.pdf
Carbon emissions per litre of petrol and diesel	Letter from Mr John Healey MP, Economic Secretary, to the Select Committee on Environment, Food and Rural Affairs, October 2003 http://www.publications.parliament.uk/pa/cm200203/cmselect/cmenvfru/929/3091706.htm
<i>Price elasticities of demand</i>	
Price elasticity of demand for road fuel	Graham, D., and Glaister, S., "Review of income and price elasticities of demand for road traffic", Centre for Transport Studies, July 2002 http://www.cts.cv.ic.ac.uk/documents/publications/iccts00267.pdf
Price elasticity of demand for air travel	Department of Transport, "Air traffic forecasts for the United Kingdom 2000" http://www.dft.gov.uk/pgr/aviation/atf/airtrafficforecastsfortheuni281
Price elasticity of demand for electricity and gas	Hansard 15 May 2000: Column 27W http://www.publications.parliament.uk/pa/cm199900/cmhansrd/vo000515/text/00515w08.htm
<i>Existing taxation</i>	
Percentage of retail price of petrol	Calculated using BERR data



and diesel representing tax in 2005-06	http://www.dtistats.net/energystats/gep411.xls
Percentage of expenditure on air travel representing Air Passenger Duty (APD)	Rough estimate derived from figures in Sewill, B., "The Hidden Cost of Flying", Aviation Environment Federation, February 2003 http://www.aef.org.uk/downloads/HiddenCost.pdf
Current rate of VAT on domestic consumption of gas and electricity	HMRC http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?nfpb=true&pageLabel=pageVAT_ShowContent&id=HMCE_CL_001596&propertyType=document#P257_19395
Carbon emissions data	
Projected carbon emissions in 2020	Supplementary Annex 4 to the 2003 Energy White Paper http://www.dti.gov.uk/files/file21214.pdf
Shadow price of carbon (see below)	Defra, "How to use the Shadow Price of Carbon in policy appraisal; interim guidance", August 2007 http://www.defra.gov.uk/environment/climatechange/research/carboncost/pdf/HowtouseSPC.pdf
Percentage of carbon emissions accounted for by passenger cars	Defra, e-digest of Environmental Statistics http://www.defra.gov.uk/environment/statistics/index.htm
Percentage of carbon emissions accounted for by aviation	Hansard, 19 Mar 2007: column 589W http://www.publications.parliament.uk/pa/cm200607/cmhansrd/cm070319/text/70319w0005.htm#07031936000060 Defra, e-digest of Environmental Statistics http://www.defra.gov.uk/environment/statistics/index.htm
Percentage of carbon emissions accounted for by domestic electricity and gas consumption	AEA Energy & Environment, "Local and Regional CO2 Emissions Estimates for 2005" http://www.defra.gov.uk/environment/statistics/globalatmos/download/regionalrpt/local-regionalco2emissions2005.xls Defra, e-digest of Environmental Statistics http://www.defra.gov.uk/environment/statistics/index.htm
Other data	
Average weekly household expenditure on road fuel, air flights, electricity and gas in 2005-06	Office for National Statistics, "Family Spending", 2006 edition http://www.statistics.gov.uk/downloads/theme_social/Family_Spending_2005-06/Familyspending2005-06.pdf
Number of households in UK	Office for National Statistics, 2001 Census Results http://www.statistics.gov.uk/census2001/profiles/uk.asp
Deadweight loss of taxation (in general across the economy)	Scenarios informed by Table 4 in Reform, "The Negative Impact of Taxation on Economic Growth", September 2003 http://www.reform.co.uk/filestore/pdf/negativeimpact.pdf
Retail Price Index	Office for National Statistics http://www.statistics.gov.uk/STATBASE/tsdataset.asp?vlnk=7173&More=Y
Exchange rates	http://www.xe.com/ucc/ or http://www.x-rates.com/cgi-bin/hlookup.cgi



A1.3 One of the limitations of our analysis is that it is based on data from different sources which may have employed different underlying assumptions.

Shadow price of carbon

A1.4 The cost of the various methods for carbon dioxide reduction should be compared to the damage cost of climate change associated with the avoided emissions. The UK government uses a shadow price of carbon (SPC) to calculate such damage costs. The SPC is £25/tCO₂ in 2007 and rises at two per cent per annum, thus reaching a level of £33/tCO₂ in 2020.¹⁵

A1.5 The SPC should not be confused with the market price of carbon (e.g. within the ETS) or the marginal abatement cost, which reflects the cost of reducing emissions rather than the damage caused by the emissions.

Deadweight Economic Loss

A1.6 When a government imposes a tax, the revenue raised can be regarded as a transfer as it is reallocated elsewhere in the economy. Net welfare losses arise when a tax distorts economic activity. For instance, if a tax deters consumption of a product, then there will be a welfare loss as some consumers will no longer gain the benefit that they otherwise would have gained from consumption.

A1.7 Within any market, economic welfare comprises the following two elements:

- *Consumer surplus*: this is the benefit consumers receive when the price they have to pay for a product is less than what they would have been willing to pay.
- *Producer surplus*: this is the benefit producers receive when the price they are paid for a product is greater than the minimum price at which they would have been willing to sell it.

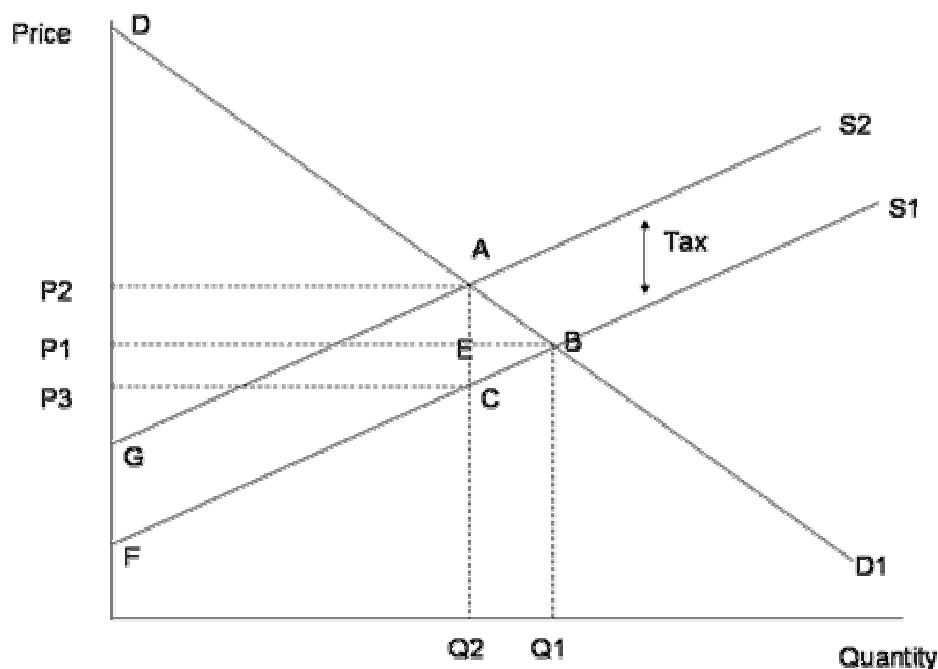
A1.8 It can be shown that the effect of introducing a tax into a market is that the sum of consumer and producer surplus falls by more than the additional tax revenue which is raised. In other words, the tax reduces overall economic welfare. This reduction in welfare is referred to as deadweight loss.

A1.9 The diagram below illustrates how deadweight loss arises:

¹⁵ <http://www.defra.gov.uk/environment/climatechange/research/carboncost/pdf/HowtouseSPC.pdf>



Figure 3.3: Deadweight loss



A1.10 If a particular good is subject to a tax, the supply curve shifts upwards from S_1 to S_2 , since producers have to be paid more to supply any given quantity of the good. This shift in the supply curve increases the equilibrium price from P_1 to P_2 and reduces the equilibrium quantity sold from Q_1 to Q_2 . Previously, consumer surplus had been the area covered by the triangle DBP_1 , whereas now it has been reduced to DAP_2 . Correspondingly, producer surplus has fallen from BFP_1 to AGP_2 . The area AP_2P_3C represents the tax revenue, which as discussed above is a transfer. The net welfare loss to society (the deadweight loss) is given by ABC , which represents the loss of consumer and producer surplus which is not offset by tax revenue.

A1.11 All other things being equal, the higher the existing level of tax on the product, the greater the additional deadweight loss from increasing tax further. This is because, as the overall tax rate increases, the additional units of consumption which are deterred by the tax will tend be more highly valued by consumers relative to the price at which producers would be willing to supply them.

Calculations for Energy Efficiency and Other Green Technologies

A1.12 In the first instance, we took cost estimates from the 2003 Energy White Paper which gives high and low figures for the projected 2020 cost of reducing carbon emissions by



one tonne using various technologies.¹⁶ The rationale for focusing on projected 2020 costs is that the costs of many renewables technologies are projected to fall through time – indeed, this is often quoted as an argument in favour of policy support for renewables. A focus on current cost estimates could therefore be criticised for failing to take into account dynamic effects.

A1.13 In the case of biofuels, we also used current cost estimates for different types of biofuels taken from recent reports by Global Subsidies Initiative¹⁷ and the IMF.¹⁸

A1.14 Annex 4 of the 2003 Energy White Paper also gives projected carbon emissions to the year 2050 under various scenarios. The Paper notes that under current policies, carbon emissions are expected to reach 135 million tonnes of carbon (MtC) by 2020, which equates to 495 million tonnes of carbon dioxide. The Annex states that to be on track to reduce emissions by 60 per cent by 2050, projected emissions for 2020 would need to be reduced by between 15 and 25 MtC.

A1.15 Thus, using this estimate of UK emissions in 2020, it is straightforward to calculate the direct resource costs of reducing emissions by 1 per cent using any given technology on its own in the absence of any other measures (1 per cent of UK carbon emissions multiplied by the cost per tonne for each technology). As part of this calculation, we also uplift for inflation since the 2003 Energy White Paper was published.

A1.16 However, these direct resource costs do not take account of any deadweight loss associated with recovering these costs either through customer prices or through general taxation. We therefore carry out calculations to estimate this additional cost element associated with reducing carbon emissions. For the purposes of this analysis, we make the following assumptions:

- The cost of generation and energy efficiency options are recovered through increases in domestic electricity bills;
- The cost of biofuels is recovered through increases in the cost of road fuel.

A1.17 We first calculate expenditure by households in the relevant market using ONS statistics on current weekly spend multiplied by the number of households in the UK and the number of weeks in a year.¹⁹ The percentage price increase required to fund the direct resource cost can then be (approximately) estimated by dividing the direct resource cost by our estimate of total household expenditure in the relevant market.

¹⁶ The 2003 White Paper notes that these figures can only be considered illustrative given that they have not been calculated entirely consistently with one another, e.g. they are based on different estimates of the cost of comparator technologies and different discount rates.

¹⁷ Global Subsidies Initiative, "Biofuels – at what cost?", October 2007

http://www.globalsubsidies.org/IMG/pdf/Global_Subsidies_Initiative_European_Report_on_support_to_Biofuels.pdf

¹⁸ IMF, "Word Economic Outlook: Globalisation and inequality", October 2007



A1.18 To calculate the deadweight loss, we use price elasticities, which measure how the quantity of consumption changes in response to changes in price. The formal definition of the price elasticity of demand is:

$$\varepsilon = \frac{P}{Q} \cdot \frac{\Delta Q}{\Delta P}$$

where ε =price elasticity, P = price and Q = quantity demanded.

A1.19 The deadweight loss is also affected by the elasticity of supply, which measures how the quantity supplied varies as price changes. (Put another way, the elasticity of supply measures the slope of the supply curve in the above diagram.) There appears to be little, if any, relevant data on elasticities of supply, and in the light of this fact we proceeded on the basis of scenarios. In particular, we assumed unitary elasticity of supply in the low scenario²⁰ and perfectly elastic supply in the high scenario.

A1.20 The percentage reduction in the volume of consumption can then be estimated by combining our assumptions on the elasticities of demand and supply with our estimates of the percentage increase in price necessary to fund the direct resource cost of each technology.

A1.21 Under the simplifying assumption of a linear demand curve,²¹ it is then straightforward to estimate the deadweight loss. For instance, in the case of perfectly elastic supply the deadweight loss can be estimated as the change in price multiplied by the change in the volume of consumption, divided by two. In addition, where the product is already taxed there is an additional welfare loss associated with loss of tax revenue from the existing tax, due to the fact that the units which are no longer consumed cease to generate the tax revenue which they did previously. (This lost tax revenue is not offset by any gain in consumer or producer surplus, and hence represents a deadweight loss.)

A1.22 In cases where technologies had negative costs (i.e. they yield net benefits), we assumed a deadweight loss of zero on the grounds that there would be no cost which needed to be recovered through a price increase.

A1.23 The final step of the calculation was to compute the total cost of each policy option as the direct resource cost plus the deadweight loss associated with recovering this resource cost through price increases in the relevant market.

<http://www.imf.org/external/pubs/ft/weo/2007/02/pdf/text.pdf>

¹⁹ For the purpose of simplicity, we assume that weekly spend remains static through time.

²⁰ i.e. an elasticity of supply of one.

²¹ Strictly speaking, this assumption is inconsistent with the use of a single figure for demand elasticity, since the elasticity of demand varies at different points along a linear demand curve.



Calculations for Tax-Based Policies

A1.24 As mentioned in section 2, in estimating the economic cost of these tax options, there are two offsetting effects which need to be taken into account:

- First, these taxes will tend to deter consumption of the goods and services in question. While this is what leads to the desired reduction in carbon emissions, it also imposes an economic cost on the UK because consumers forgo the benefits which they previously obtained from consumption of these goods and services.
- Second, the tax revenue gained from these tax policies allows the government to set lower taxes than would otherwise be required elsewhere in the economy. As explained above, economic theory suggests that taxation typically leads to a deadweight cost for society (i.e. it reduces the overall welfare of society by deterring economic activity). Consequently, the fact that these policies allow the government to reduce taxes elsewhere leads to an offsetting welfare gain by reducing the deadweight cost of taxation in other parts of the economy.

A1.25 The first of these effects was calculated in a similar way to that described above for calculating the deadweight loss resulting from price increases. The main difference is that in this calculation the starting point was to define the desired percentage reduction in quantity, based on what would be needed to reduce overall UK emissions by 1 per cent. This was then combined with elasticity estimates to calculate the percentage change in price and the unit tax rate required to achieve this reduction.

A1.26 To estimate the second of these effects, we began by calculating the tax revenue that would be raised from the tax by multiplying the unit tax rate by the volume of consumption. To compute the resulting benefit of lower deadweight loss elsewhere in the economy, we multiplied this revenue estimate by scenario figures for the percentage deadweight loss of taxation (i.e. generally across the economy).²² Given that there are a wide range of figures in the literature for the percentage deadweight cost of taxation,²³ we used figures of 30 per cent for our low policy cost scenario and 5 per cent for our high policy cost scenario.

²² By the percentage deadweight cost of taxation we mean the deadweight loss from taxation expressed as a percentage of tax revenue.

²³ See, for instance, table 4 in <http://www.reform.co.uk/filestore/pdf/negativeimpact.pdf>



APPENDIX 2: BACKGROUND ON EU ETS AND BIOFUELS

A2.1 The sections below provide background information on two policy areas which are of particular interest given the analysis presented in this report:

- *The EU-ETS.* As discussed in section 2, economic theory suggests that carbon pricing is the most cost-effective way to achieve reductions in carbon emissions. The EU-ETS represents the leading European policy aimed at pricing carbon, but suffers from a number of drawbacks due to its design.
- *European and UK policy on biofuels.* Our analysis of the costs of alternative policies (see section 2) suggests that biofuels represent a particularly expensive way to reduce carbon emissions.

The EU-ETS

Basics of the scheme

A2.2 The EU-ETS became operational in January 2005 and now includes all 27 Member States. It is intended to be an ongoing scheme, to run indefinitely, and two phases have already been organised. Phase 1 ends this year with Phase 2 coinciding with the first Kyoto commitment period of 2008–2012.

A2.3 Under the scheme, each participating country has a National Allocation Plan (NAP), which specifies allowed quantities of greenhouse gas (GHG) emissions for individual power plants and other large point sources. Facilities covered have various options:

- They can ensure that their emissions exactly meet the cap they have been allocated.
- If they reduce emissions to below their allocation, they can then sell the excess allowances to other firms.
- If they wish or need to exceed their allocation, they can purchase additional allowances from other firms.
- If they exceed their allocation without having purchased additional allowances, they must pay a penalty charge.

A2.4 In its first year of operation, 362 million tonnes of CO₂ were traded on the market for a sum of €7.2bn.²⁴

²⁴ The EU-ETS is loosely modelled on the SO₂ market that has developed in the US since 1995, which now trades around 12 million tonnes of sulphur each year.



- A2.5 It is anticipated that caps will be progressively tightened for each new period, forcing overall reductions in emissions.
- A2.6 Annex III of the Emission Trading Directive²⁵ sets out the 12 criteria that NAPs must satisfy, of which the most central is that the proposed total quantity is in line with a Member State's Kyoto target. The European Commission decides whether these criteria are satisfied by the NAPs of Member States.
- A2.7 Member States have now completed the process of negotiating NAPs with the European Commission for Phase II.
- A2.8 It should be noted that the EU-ETS is not an economy-wide cap-and-trade system. It regulates downstream about 12,000 emission sources, accounting for about half of all EU emissions. Sectors covered include energy activities, production and processing of ferrous metals, mineral industry and pulp, paper and board activities. On the other hand, transport (responsible for 21 per cent of EU greenhouse gas emissions), households and small businesses (17 per cent) and agriculture (10 per cent) are all excluded from the scheme in its current form.²⁶

Phase 1

- A2.9 Phase 1 rules allowed Member States to auction an upper limit of 5 per cent of allowances, although Denmark was the only country that made full use of this provision. The remainder of permits were allocated on a gratis or “grandfathering” basis.²⁷
- A2.10 The price of allowances steadily increased to a peak of around €30 per tonne of CO₂ in April 2006, but then fell dramatically to under €10 per tonne when it became clear in May 2006 that many Member States had distributed allowances so generously that there was no need for many facilities to reduce emissions. A lack of reliable data-reporting systems, fundamentally important to a scheme like the EU-ETS, also undermined the scheme in its early stages. The trade price stood at €1.2 per tonne in March 2007, reflecting a continued lack of confidence in allocations under the first phase of the scheme.
- A2.11 In the early stages of Phase 1, allowance trades were handled by brokers outside of formal exchanges. Presently it is thought that about half the trading volume occurs on exchanges and the other half over the counter.

Phase II

- A2.12 The scope of the EU-ETS will expand significantly in Phase II. Clean Development (CDM) credits and Joint Implementation (JI) credits²⁸ – generated through emission-

²⁵ EU Directive 2003/87/EC

²⁶ It is anticipated the EU will include air transport in the EU-ETS from 2011.

²⁷ “Grandfathering” allocates allowances based on past levels of emissions.



reduction projects outside the EU – are also expected to be introduced through the “Linking Directive”. It is also anticipated that in Phase II aviation emissions will be included, while four non-EU members (Norway, Iceland, Liechtenstein, and Switzerland) are also expected to join the scheme. The limit on auctioning is retained in Phase II, although it has been raised to 10 per cent of total permits. In practice, auctioning of permits is likely to be much lower than even this figure.

A2.13 Many commentators place much significance in the inclusion of aviation due to the large and rapidly growing emissions of the sector. It is expected that the inclusion of aviation would increase demand for allowances by about 10 to 12 million tonnes of CO₂ per year.

A2.14 In Phase II the trade price will be affected by the fact that emission sources covered by the EU-ETS may satisfy their commitments via supplementary credits available under Kyoto Protocol rules, including JI and CDM credits. Therefore, the price and affordability of these Kyoto credits may have a bearing on the price of EU allowances.

Assessments of the EU-ETS

A2.15 There has been wide acceptance that the first phase of the ETS did not work well in terms of reducing emissions. The cross-party Commons Environmental Audit Committee noted: “there is little or no evidence that Phase I is leading to any cutbacks in actual emissions at all, whether in the UK or elsewhere in the EU.”²⁹ In fact, in its first year of operation (2005 to 2006) emissions covered by the ETS rose by more than 3 per cent in the UK and by 0.8 per cent across the EU as a whole.³⁰

A2.16 A report published by Open Europe in July 2006 assessed the performance of Phase I of the scheme and concluded that the EU-ETS is “not a cost effective way to reduce pollution”.³¹ While not opposing permit trading schemes in principle, the report identified a number of serious problems with the Phase I of the EU-ETS. These included:

- The loose targets set by most Member States have allowed overall emissions to rise.
- The system employs central planning to allocate permits rather than a market-based mechanism – for example, allocations have not been done by auctioning off permits, but through “1960s-style” NAPs.

²⁸ CDM and JI credits both involve developing and implementing projects that reduce GHG emissions outside the EU, thereby generating carbon credits that can be sold on the carbon market. This means that a project that reduces GHG emissions can generate an additional income stream in the form of carbon credits.

²⁹ House of Commons Environmental Audit Committee, Second Report, *The EU Emissions Trading Scheme: Lessons for the Future* (01.03.07)

³⁰ <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/776&format=HTML&aged=0&language=EN&guiLanguage=en>

³¹ Open Europe, “The high price of hot air: Why the EU Emissions Trading Scheme is an environmental and economic failure”, July 2006, <http://www.openeurope.org.uk/research/ets.pdf>



- Instability arising from regulatory uncertainty and inconsistency has led to (and indeed, has positively encouraged) excessive volatility in the price of carbon, undermining incentives for firms to plan carbon emissions on the long-term basis required.

A2.17 There have been a number of reports from a range of organisations critiquing the second phase of the ETS. These have generally focused on the lack of auctioning for permits and the relatively unrestrictive limits on imports of Kyoto credits, which some criticise on the grounds that they will simply lead to emissions offsets being “bought in” from outside the EU, thus reducing incentives for emissions reductions within EU Member States.

A2.18 A report by the Institute for Public Policy Research argued that the relatively unrestrictive import limits mean that the carbon market will be “leaky”. It recommended more centralisation of NAPs in Brussels, and eventual moves towards a system in which 100 per cent of permits are auctioned.³²

A2.19 A recent report by WWF focused on the issue of the import limits on Kyoto credits, arguing that between 88 and 100 per cent of emissions reductions in the nine largest member states could be bought in from abroad through use of Kyoto credits.³³

A2.20 Kjetil Røine, Carbon Market Research Manager at think-tank Point Carbon, took a similar line, saying that “we do not expect that the credit limits will be the constraining element for the CER/ERU inflow to the EU ETS... The overall picture is that there seems to be nearly sufficient supply of credits to meet the estimated shortage in the EU ETS over the first Kyoto period” [i.e. to 2012].³⁴

A2.21 A report from the Carbon Trust criticised the fact that the overwhelming majority of permits will still be given out free rather than auctioned. It argued that this process is so distortionary that it will actively hinder low carbon investment:

“Any free allocation represents a subsidy – and where only fossil-fuel generation is subsidized, this distorts investment choices in favour of fossil-fuel generation. Where coal receives a higher allocation than gas, the investment choice is, in addition, distorted towards coal. The level of such subsidies under proposed second-phase NAP is so high that the construction of coal power stations is more profitable under the ETS with such distorting allocation decisions than in the absence of the ETS.”³⁵

A2.22 In August 2007, Open Europe published a report on Phase II of the EU-ETS.³⁶ Using the recently finalised NAPs, it calculated the total scarcity of carbon for phase two of the ETS,

³² Gibbs, T. & Retallack, S., Trading up – reforming the European Union’s Emissions Trading Scheme, IPPR (December 2006)

³³ WWF, Emission Impossible: access to JI/CDM credits in phase II of the EU Emissions Trading Scheme (June 2007)

³⁴ Røine, K. “CDM/JI supply: Will there be enough?”, *Carbon Market Europe*, Point Carbon (1 June 2007)

³⁵ Carbon Trust, EU ETS Phase II allocation: implications and lessons (May 2007)

³⁶ Open Europe, “Europe’s dirty secret: Why the EU Emissions Trading Scheme isn’t working”, August 2007, <http://www.openeurope.org.uk/research/etsp2.pdf>



and compared this with the likely availability of Kyoto credits for imports. It concluded that most or all of the scarcity created by the system could be covered through these external credits.

A2.23 Open Europe argued that offsetting emissions outside Europe would not be objectionable, provided Kyoto credits actually deliver carbon reductions. However, it expressed doubt as to whether this will actually be the case, as Kyoto credits are not awarded for actual emissions reductions, but rather on the basis of avoidance of even higher emissions than would otherwise have occurred. Open Europe argued that many of the credits are awarded to environmentally harmful projects or to projects that would have taken place anyway, and that a large number of credits have been generated through accounting loopholes in the system.

A2.24 In the light of these issues, Open Europe saw no reason to be confident that Phase II of the scheme will deliver any more environmental benefits than Phase I. At the same time, it stated that Phase II does nothing to tackle the considerable administration costs associated with the EU-ETS.

European and UK Policy on Bio-fuels

EC policy

A2.25 As part of a number of measures drawn up by the EC in response to international agreements to reduce greenhouse gas emissions, the EC passed Directive 2003/30/EC (the so-called Bio-Fuels Directive). The Directive sought to reduce life-cycle emissions of carbon dioxide from transport across the EU and, at the same time, reduce the EU's dependence on external energy sources (in this case oil).

A2.26 The Directive required Member States to set indicative (non-binding) staggered targets for sales of bio-fuels for 2005 and 2010. The Directive specifies the following reference values:

- By 31 December 2005, 2 per cent of all petrol and diesel for transport purposes (calculated on the basis of energy content); and
- By 31 December 2010, 5.75 per cent of all petrol and diesel for transport purposes (calculated on the basis of energy content).

A2.27 A 2007 progress report shows that the EU is likely only to achieve a 4.2 per cent biofuels share by 2010.³⁷

A2.28 As quoted by the BBC,³⁸ the EC acknowledge that “bio-fuels are an expensive way of reducing greenhouse gas emissions”. However, despite this the EC states that they have

³⁷ COM(2006) 845, http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0845en01.pdf



“a justifiably high political priority.” In its Biomass Action Plan, it describes bio-fuel as the “only direct substitute for oil in transport” and as such it is “one of only two measures that have a reasonable chance of [reducing greenhouse gas emissions from transport] on a significant scale in the near future”.³⁹

A2.29 A major development took place in EU biofuels policy at the European Summit of March 2007. EU leaders signed up to mandatory targets for 10 per cent use of biofuels in all road transport fuel by 2020 – almost doubling the current (non-binding) target of 5.75 per cent by 2010.⁴⁰

A2.30 Meeting the targets will almost inevitably require government support (see below for discussion of the UK) as the cost of production of crop-derived bio-fuels is up to 3 times more than that of mineral fuels. Put bluntly, at present, without fiscal incentives, bio-fuels will simply not compete with fossil fuels on the forecourt.

UK policy

A2.31 The UK government announced in November 2005 that it was introducing the Renewable Transport Fuels Obligation (RTFO) requiring the bio-fuel content of road fuels to be 5 per cent by volume by 2010. It is estimated that meeting this target would reduce carbon emissions by up to 1MtC (which is equivalent to taking 1 million cars off the road).

A2.32 The main policy support given to bio-fuels in the UK is a 20 pence reduction in duty for bio-diesel and bio-ethanol compared to conventional Ultra-Low Sulphur Diesel fuel.

A2.33 The 2006 Budget also confirmed that there would be continued support through a duty incentive of 20 pence per litre supplemented by a new 15 pence per litre buy-out penalty for suppliers failing to meet the obligation. In the future, the emphasis will shift to a buy-out price which is to be set at 30 pence per litre in 2010/11.

A2.34 In October 2003, John Healey, then Economic Secretary to HM Treasury, explained the rationale for the Government’s 20 pence per litre incentive for bio-fuels in a letter to the Environment, Food and Rural Affairs Committee. He presented calculations which compared an abatement cost of around £500 per tonne of carbon saved from bio-fuels (or £350 per tonne when a higher reduction in carbon dioxide emissions was assumed) with the government’s social cost of carbon (SCC) figure of £70 per tonne.⁴¹ John Healey stated “we think it important not to be so attached to economic theory as to be detached from reality, and we will always consider the full range of social, economic and environmental issues”.

³⁸ <http://news.bbc.co.uk/1/hi/business/4603272.stm>

³⁹ The other source identified by the EC is reduced emissions from petrol-powered engines.

⁴⁰ http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/93135.pdf

⁴¹ The UK government now uses the shadow price of carbon (SPC) to value carbon damage costs instead of the SCC.



- A2.35 In response to a Parliamentary question, Ian Pearson MP (then at Defra) further replied that the Government's duty rate cut for bio-diesel and bio-ethanol had led to a growth in the sales of bio-fuel, with a total of 30 million litres being sold a month in 2006 alone.⁴² This represented an increase in market share from 0.24 per cent in 2005 to 0.5 per cent in 2006 (although this is well below the EC reference value).
- A2.36 Other figures show that, for the whole of 2006, UK bio-fuel sales were around 120 million litres.⁴³ However, this figure should be put into perspective. While large in absolute terms, sales of bio-fuels are dwarfed by the 47 billion litres of conventional petrol and diesel consumed annually in the UK.

⁴² As reported in Hansard on 9 March 2007.

⁴³ UKpia