Summary: Intervention & Options

Department /Agency:	Title: Impact Assessment of proposals for a UK Renewable Energy Strategy - Transport URN 08/1052	
Stage: Consultation	**Version:** 1	**Date:** June 2008
Related Publications: UK Renewable Energy Strategy Consultation Document; [Analysis publications, to be added]		

Available to view or download at:

http://www.berr.gov.uk/energy

Contact for enquiries: **Telephone:**

What is the problem under consideration? Why is government intervention necessary?

The potential measures in the consultation document seek to address two problems: climate change and energy security. Using renewable energy can reduce greenhouse gas emissions and provide an alternative to using fossil fuels as a source of energy - this will be increasingly important as reserves of fossil fuels become depleted. The market will not solve the climate change problem itself because of the extra costs of renewable energy compared to fossil fuels. Existing intervention has also had limited impact.

The European Commission has therefore proposed a system of mandatory targets in order to rapidly increase the use of clean renewable energy. The EU Commission has proposed that the UK increase its renewable ebnergy mix from less than 2% today to 15% by 2020, with an individual binding target for the Trasnport sector of 10%. This IA considers the impact of meeting the transport sectors target.

What are the policy objectives and the intended effects?

To achieve an increase in the share of renewable energy in the UK transport sector to 10% by 2020, compared with just under 1% today and around 4% from 2010/11 under existing policies.

Meeting the 10% renewable energy target would equate to annual CO2 savings of around 2.0-5.8 MtCO2 in the UK in 2020 and 3.3-3.6 billion litres less fossil fuels being consumed in the UK. To achieve this there would need to be considerable investment into the development of the biofuels industry.

What policy options have been considered? Please justify any preferred option.

This impact assesment considers two main options for meeting the target. The two options are:

- meeting the target by blending biofuels into petrol and diesel so that the fuel supplied is 10% biofuel by energy content;

- meeting the target by blending up to 10% by volume (around 8% by energy) and making up the difference through sales of E85 fuel (a high biofuel blend which can only be used in flex-fuel vehicles).

This assessment also considers the impact of Transport meeting an 8% and 5% target.

When will the policy be reviewed to establish the actual costs and benefits and the achievement of the desired effects?

Once the results of the consultation have been analysed, the Government will produce a Renewable Energy Strategy in Spring 2009, which will set out considered measures and costings.

Ministerial Sign-off For consultation stage Impact Assessments:

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible Minister:

.....Date:

Summary: Analysis & Evidence

Policy Option: 1	Description: **Meeting the target by blending biofuels, so that fuels sold are 10% biofuels by energy content** (see annex F for explanation of summary sheet)

COSTS

ANNUAL COSTS	
One-off (Transition) **Yrs**	Description and scale of **key monetised costs** by 'main affected groups'
£ 0	Additional fuel resource costs = **£11,114m to £0m**
Average Annual Cost (excluding one-off)	Welfare loss due to reduced driving = **£133m to £6m**
£0.5m to £ 963m	**Total Cost** (PV) **£11,247m to £6m**

Other **key non-monetised costs** by 'main affected groups' Possible indirect impacts on biodiversity, food prices and release of greenhouse gases if growing biofuels requires land use change.

BENEFITS

ANNUAL BENEFITS	
One-off **Yrs**	Description and scale of **key monetised benefits** by 'main affected groups'
£ 0	Reduced fuel resource costs = **£0m to £165m**
Average Annual Benefit (excluding one-off)	Monetised value of reduced GHG emissions = **£857m to £1,452m**
£74m to £140m	**Total Benefit** (PV) **£857m - £1,616m**

Other **key non-monetised benefits** by 'main affected groups'

Ancillary impacts arising from a reduction air pollution, noise, road infrastructure and accidents = £62m to £105m. Market / employment opportunities in agriculture and biodiesel production; diversity and security of national fuel supply; likely positive impact on innovation; likely positive impact on congestion.

Key Assumptions/Sensitivities/Risks Results are presented as a range based on different oil and biofuel price scenarios. The Oil price scenarios range from $45 to $150, biofuel prices of 30ppl-50ppl for bioethanol and 40ppl-60ppl for biodiesel, and GHG savings from biofuels range from 20% to 50%.

Price Base Year 2007	Time Period Years 23	**Net Benefit Range** (NPV) **-£10,390 to +£1,610m**	**NET BENEFIT** (NPV Best estimate) **-£10,390 to +£1,610m**

What is the geographic coverage of the policy/option?			UK	
On what date will the policy be implemented?			2010	
Which organisation(s) will enforce the policy?			RFA	
What is the total annual cost of enforcement for these organisations?			n/a	
Does enforcement comply with Hampton principles?			Yes	
Will implementation go beyond minimum EU requirements?			No	
What is the value of the proposed offsetting measure per year?			n/a	
What is the value of changes in greenhouse gas emissions?			£857m to £1,452m	
Will the proposal have a significant impact on competition?			No	
Annual cost (£-£) per organisation (excluding one-off)	Micro	Small	Medium	Large
Are any of these organisations exempt?	Yes	No	N/A	N/A

Impact on Admin Burdens Baseline (2005 Prices) (Increase - Decrease)

Increase of £ n/a Decrease of £ n/a **Net Impact** £ n/a

Key: **Annual costs and benefits: Constant Prices** **(Net) Present Value**

Summary: Analysis & Evidence

Policy Option: 2	Description: **Meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85** (see annex F for explanation of summary sheet)

COSTS

ANNUAL COSTS	Description and scale of **key monetised costs** by 'main affected groups'
One-off (Transition) **Yrs**	Additional fuel resource costs = **£11,631m to £0m**
£ 0	Vehicle resource costs = **£655m to £66m**
Average Annual Cost (excluding one-off)	Welfare loss due to reduced driving = **£470m to £20m**
£ 7m to £1,041m	**Total Cost** (PV) **£12,756m to £86m**

Other **key non-monetised costs** by 'main affected groups' Possible indirect impacts on biodiversity, food prices and release of greenhouse gases if growing biofuels requires land use change.

BENEFITS

ANNUAL BENEFITS	Description and scale of **key monetised benefits** by 'main affected groups'
One-off **Yrs**	Reduced fuel resource costs = **£0m to £504m**
£ 0	Monetised value of reduced GHG emissions = **£943m to £1,501m**
Average Annual Benefit (excluding one-off)	
£81m to £176m	**Total Benefit** (PV) **£943m to £2,005m**

Other **key non-monetised benefits** by 'main affected groups'

Ancillary impacts arising from a reduction air pollution, noise, road infrastructure and accidents = £39m to £131m. Market / employment opportunities in agriculture and biodiesel production; diversity and security of national fuel supply; likely positive impact on innovation; likely positive impact on congestion.

Key Assumptions/Sensitivities/Risks

Results are presented as a range based on different oil and biofuel price scenarios. The Oil price scenarios range from $45 to $150, biofuel prices of 30ppl-50ppl for bioethanol and 40ppl-60ppl for biodiesel, and GHG savings from biofuels range from 20% to 50%.

Price Base Year 2007	Time Period Years 23	**Net Benefit Range** (NPV) **-£11,814 to +£1,919**	**NET BENEFIT** (NPV Best estimate) **-£11,814 to +£1,919**

What is the geographic coverage of the policy/option?			UK	
On what date will the policy be implemented?			2010	
Which organisation(s) will enforce the policy?			RFA	
What is the total annual cost of enforcement for these organisations?			£ N/A	
Does enforcement comply with Hampton principles?			Yes	
Will implementation go beyond minimum EU requirements?			No	
What is the value of the proposed offsetting measure per year?			£ N/A	
What is the value of changes in greenhouse gas emissions?			£943m to £1,501m	
Will the proposal have a significant impact on competition?			No	
Annual cost (£-£) per organisation (excluding one-off)	Micro	Small	Medium	Large
Are any of these organisations exempt?	Yes	No	N/A	N/A

Impact on Admin Burdens Baseline (2005 Prices) (Increase - Decrease)

Increase of £ N/A Decrease of £ N/A **Net Impact** **£ N/A**

Key: **Annual costs and benefits: Constant Prices** **(Net) Present Value**

Summary: Analysis & Evidence

Policy Option: 1a	Description: **Blending biofuels so that fuels sold are 8% biofuels by energy content** (see annex F for explanation of summary sheet)

COSTS

ANNUAL COSTS	
One-off (Transition) **Yrs**	Description and scale of **key monetised costs** by 'main affected groups'
£ 0	Additional fuel resource costs = **£7,926m to £0m**
Average Annual Cost (excluding one-off)	Welfare loss due to reduced driving = **£83m to £4m**
£0.3m to £675m	**Total Cost** (PV) **£8,009m to £4m**

Other **key non-monetised costs** by 'main affected groups' Possible indirect impacts on biodiversity, food prices and release of greenhouse gases if growing biofuels requires land use change.

BENEFITS

ANNUAL BENEFITS	
One-off **Yrs**	Description and scale of **key monetised benefits** by 'main affected groups'
£ 0	Reduced fuel resource costs = **£0m to £103m**
Average Annual Benefit (excluding one-off)	Monetised value of reduced GHG emissions = **£610m to £1,033m**
£52m to £98m	**Total Benefit** (PV) **£610m to £1,136m**

Other **key non-monetised benefits** by 'main affected groups'

Ancillary impacts arising from a reduction air pollution, noise, road infrastructure and accidents = £16m to £80m. Market / employment opportunities in agriculture and biodiesel production; diversity and security of national fuel supply; likely positive impact on innovation; likely positive impact on congestion.

Key Assumptions/Sensitivities/Risks Results are presented as a range based on different oil and biofuel price scenarios. The Oil price scenarios range from $45 to $150, biofuel prices of 30ppl-50ppl for bioethanol and 40ppl-60ppl for biodiesel, and GHG savings from biofuels range from 20% to 50%.

Price Base Year 2007	Time Period Years 23	**Net Benefit Range** (NPV) **-£7,398 to +£1,131m**	**NET BENEFIT** (NPV Best estimate) **-£7,398 to +£1,131m**

What is the geographic coverage of the policy/option?			UK	
On what date will the policy be implemented?			2010	
Which organisation(s) will enforce the policy?			RFA	
What is the total annual cost of enforcement for these organisations?			n/a	
Does enforcement comply with Hampton principles?			Yes	
Will implementation go beyond minimum EU requirements?			No	
What is the value of the proposed offsetting measure per year?			n/a	
What is the value of changes in greenhouse gas emissions?			£610m to £1,033m	
Will the proposal have a significant impact on competition?			No	
Annual cost (£-£) per organisation (excluding one-off)	Micro	Small	Medium	Large
Are any of these organisations exempt?	Yes	No	N/A	N/A

Impact on Admin Burdens Baseline (2005 Prices) (Increase - Decrease)

Increase of £ n/a Decrease of £ n/a **Net Impact** £ n/a

Key: **Annual costs and benefits: Constant Prices** **(Net) Present Value**

Summary: Analysis & Evidence

Policy Option: 1b	Description: **Blending biofuels so that fuels sold are 5% biofuels by energy content** (see annex F for explanation of summary sheet)

COSTS

ANNUAL COSTS	
One-off (Transition) **Yrs**	Description and scale of **key monetised costs** by 'main affected groups'
£ 0	Additional fuel resource costs = **£1,189m to £0m**
Average Annual Cost (excluding one-off)	Welfare loss due to reduced driving = **£9m to £0m**
£0m to £111m	**Total Cost** (PV) **£1,199m to £0m**

Other **key non-monetised costs** by 'main affected groups' Possible indirect impacts on biodiversity, food prices and release of greenhouse gases if growing biofuels requires land use change.

BENEFITS

ANNUAL BENEFITS	
One-off **Yrs**	Description and scale of **key monetised benefits** by 'main affected groups'
£ 0	Reduced fuel resource costs = **£0m to £25m**
Average Annual Benefit (excluding one-off)	Monetised value of reduced GHG emissions = **£91m to £155m**
£8m to £17m	**Total Benefit** (PV) **£91m to £180m**

Other **key non-monetised benefits** by 'main affected groups'

Ancillary impacts arising from a reduction air pollution, noise, road infrastructure and accidents = £0m to £8m. Market / employment opportunities in agriculture and biodiesel production; diversity and security of national fuel supply; likely positive impact on innovation; likely positive impact on congestion.

Key Assumptions/Sensitivities/Risks Results are presented as a range based on different oil and biofuel price scenarios. The Oil price scenarios range from $45 to $150, biofuel prices of 30ppl-50ppl for bioethanol and 40ppl-60ppl for biodiesel, and GHG savings from biofuels range from 20% to 50%.

Price Base Year 2007	Time Period Years 23	**Net Benefit Range** (NPV) **-£1,107 to +£180m**	**NET BENEFIT** (NPV Best estimate) **-£1,107 to +£180m**

What is the geographic coverage of the policy/option?			UK	
On what date will the policy be implemented?			2010	
Which organisation(s) will enforce the policy?			RFA	
What is the total annual cost of enforcement for these organisations?			n/a	
Does enforcement comply with Hampton principles?			Yes	
Will implementation go beyond minimum EU requirements?			No	
What is the value of the proposed offsetting measure per year?			n/a	
What is the value of changes in greenhouse gas emissions?			£91m to £155m	
Will the proposal have a significant impact on competition?			No	
Annual cost (£-£) per organisation (excluding one-off)	Micro	Small	Medium	Large
Are any of these organisations exempt?	Yes	No	N/A	N/A

Impact on Admin Burdens Baseline (2005 Prices) (Increase - Decrease)

Increase of £ n/a Decrease of £ n/a **Net Impact** £ n/a

Key: **Annual costs and benefits: Constant Prices** **(Net) Present Value**

Evidence Base (for summary sheets)

Strategic Overview

The EU 2020 renewable energy target includes a binding target to source 10% of the energy used in the transport sector (excluding aviation and international shipping) from renewables by 2020, subject to sustainability concerns being addressed. This Impact Assessment focuses on potential measures to meet the 10% renewable transport target. The costs, benefits and wider impacts of the overall package across all three sectors are set out in the general IA.

There is considerable risk and uncertainty surrounding the issue of biofuel sustainability, and ongoing debate in the EU could mean that the renewable transport target changes before the Renewable Energy Strategy is adopted.

Objectives

The objective of the potential measures in the transport sector is to increase use of renewable energy to 10% by 2020, subject to reassurance on sustainability, in a cost effective way, in a way that is most compatible with our other policy objectives, and in a way that makes most sense for the long term.

The policy should make a contribution to reductions in GHG emissions from the transport sector.

The policy should also make a contribution to improving the diversity and security of UK fuel supplies by sourcing fuels and feedstocks from a wider range of countries than at present.

The policy should also encourage the UK biofuels industry to:

- Supply relevant feedstocks, in the farming sector;
- Produce biofuels in the chemical and refining sectors; and
- Develop technologies to improve the performance and production of biofuels.

Issue

A market failure occurs when the free market acts in a way which does not maximise society's welfare. One example of this is climate change resulting from greenhouse gas emissions, which is formally known as a negative externality. Where there is no incentive for the free market to rectify this it may be appropriate for public policy to do so through government intervention in the market.

Further action is therefore needed in order for the UK to meet its 2020 and 2050 climate change goals and move towards becoming a low carbon economy in the absence of incentives for the free market to do so.

The Stern Review on the Economics of Climate Change emphasised that "The scientific evidence points to increasing risks of serious irreversible impacts from climate change associated with business-as-usual (BAU) paths for emissions". In identifying possible solutions, the Review stressed the importance of taking action on three fronts: creating a common carbon price to reflect the marginal damage of greenhouse gas emissions; promoting a shift towards low carbon technologies; and removing barriers to behaviour change. This policy measure is focused on the second of these strands - incentivising innovation and encouraging the development of lower cost, low carbon technology.

It is common for new technologies to take considerable time to develop in terms of their functionality, efficiency and affordability as well as their public acceptability. An inability of some new technologies to overcome barriers to market entry in the short or medium term can result in the persistence of imperfect competition. One reason for the delay in such technologies entering the market can be unease over the level of risk in investment decisions with uncertain outcomes and payback periods. If the government can intervene in the market to reduce these uncertainties, possibly through regulations which create a minimum level of demand, then it would be reasonable to expect investment to increase.

The draft Renewable Energy Directive includes a binding target of a 10% share for renewable energy in each Member State's energy consumption in transport by 2020. As biofuels are the only renewable transport fuel option commercially available on a significant scale today, it is likely that this target will have to be met almost entirely through biofuels.

The market for transport fuels in the UK is very price competitive. The additional costs of renewable energy including biofuels over fossil fuels effectively restrict the impact that renewables can have on the marketplace without Government intervention. Below are current measures to increase the use of renewable energy in the transport sector.

The Duty Incentive

In July 2002, the Government introduced a duty incentive of 20p/litre below regular diesel fuel for biodiesel. A similar incentive for bioethanol began on 1 January 2005. However, there have been concerns that a duty incentive still does not provide sufficient certainty to stimulate the market, the 20p/litre value is insufficient to cover the increased costs of biofuels and a duty incentive does not guarantee that a desired level of renewable energy will be achieved.

RTFO

In April this year, the Government introduced a Renewable Transport Fuel Obligation (RTFO), requiring transport fuel suppliers to ensure that 5% of total road fuel sales by volume (equivalent to about 4% by energy) are from renewable sources by 2010-11, with targets of 2.5% and 3.75% for 2008-09 and 2009-10 respectively. The Government has already said it would increase the level of the RTFO beyond 5% after 2010/11, provided certain conditions were met, including confidence that the biofuels would be produced in a sustainable way. The Renewable Fuels Agency (RFA) has been created to administer the RTFO.

The Government also announced that from April 2010, it would reward biofuels under the RTFO in accordance with the greenhouse gas savings they offer, rather than by volume; and from April 2011, it would reward biofuels under the RTFO only if the feedstocks from which they are produced meet appropriate sustainability standards. These changes would be subject to EU and international obligations.

Suppliers can also buy themselves out of the obligation, at a price set by the Government at a level intended to be higher than the additional cost of supplying biofuel (over and above the fossil-fuel based alternative). The combination of duty incentive and the buy-out price paid by fuel suppliers, who fail to meet their RTFO obligation, is guaranteed at 35 pence per litre until 2010-11, when the duty differential will cease and the RTFO buy-out price is set at 30 pence per litre.

Identification of Potential Measures

As discussed in more length in the consultation document the most realistic renewable energy alternative in the transport sector to 2020 are biofuels. Thus the options considered in this

impact assessment consider ways to increase the use of biofuels in the road transport sector. These options are:

- meeting the target by blending biofuels into petrol and diesel so that the fuel supplied is 10% biofuel by energy content;

- meeting the target by blending up to 10% by volume (approximately 8% by energy) and making up the difference through sales of E85 fuel (a high biofuel blend which can only be used in flex-fuel vehicles).

Proposed changes to the Fuel Quality Directive are likely to require rail and national navigation to switch to zero sulphur diesel (road use diesel) from the end of 2009. It is likely that rail and national navigation will be offered automotive quality diesel fuel with whatever level of biodiesel is required for road use. The industry's working assumption therefore is that its fuel will include 5% biodiesel by volume by 2010/11 will continue to use the same blend thereafter. Thus the impact of each of the packages on the use of biofuels in the road sector will directly impact the equivalent blend used in the rail and national navigation sectors.

This assessment also considers the impact of Transport meeting an 8% and 5% target. Detailed analysis of these options are presented in Annex D and E.

Electric vehicles

Although the most realistic renewable energy alternative in the transport sector to 2020 are biofuels the consultation document also highlighted that the emergence of electric vehicles could potentially contribute to long term carbon reduction and renewable energy targets. However, even if technologically robust and economically viable electric vehicle options do emerge in the next decade, there is considerable uncertainty about the potential for significant large scale impacts on renewable energy or carbon targets, power demand or grid operation prior to 2020. Due to these uncertainties electric vehicles have not been analysed for this impact assessment.

Analysis of Potential Measures

Option 1: Meeting the target by blending biofuels, so that fuels sold are 10% biofuels by energy content

This option delivers the biofuel through blending in the general petrol and diesel fuel streams and does not need specialist high biofuel blend fuels or vehicles. The current Fuel Quality Standards only allow a 5% volume biofuel blend although this is expected to increase to 10% with the new Fuel Quality Directive. However, within this scenario we have assumed that developments in biofuel technology or fuel standards will allow fuel suppliers to blend more than 10% biofuel by volume. We have had indications from industry and other sources that this may be possible in 2020 without significant modifications to future vehicles. Due to the uncertainties, difficulties and costs around alternative fuels and vehicles outlined in Option 2 – increasing the use of biofuels in the main fuel streams to an amount needed to meet the 10% renewable energy target would be our preferred option.

How would this work?

The RTFO is due to increase its obligation to fuel suppliers to supply 5% of their road transport fuel from a renewable source by 2010. This would mean that in 2010 5% of fuel sales were from a renewable source, around 4% by energy. As discussed in the consultation document, there are a number of ways in which the RTFO could be designed to deliver 10% biofuels by energy by 2020. This impact assessment will not go through each of these in detail and purely

analyses the potential costs and benefits of meeting a 10% renewables target if bioethanol and biodiesel were blended to 10% by energy. The exact design of the RTFO in the future may change some of the impacts of meeting the 10% target compared to those presented in this assessment, this will be analysed in more depth for the Renewable Energy Strategy in Spring 2009. These are some of the options for the design of the RTFO:

- Increase the volume obligation of the RTFO - This would be the most straightforward policy to implement. However, the government would need to assess the biofuel volume required to meet the 10% renewable energy and/or any GHG abatement target which presents a risk to meeting the target.

- Adjust the RTFO to set a 10% biofuel energy obligation - This would be the most direct structure to meet the 10% renewable energy target. However, this would not directly incentivise biofuels with the highest GHG savings and may impact on any GHG abatement target.

- Adjust the RTFO to set a GHG abatement obligation - This would be the most direct structure to meet GHG abatement target. However, this obligation would not guarantee the UK would meet the 10% renewable energy which presents a risk to meeting the target.

- Adjust the RTFO to set a dual 10% biofuel energy and GHG abatement obligation - This would be the most direct structure to meet both a renewable energy and GHG abatement target.

- Adjust the RTFO to broaden the obligation to all transport fuels - The RTFO could be further adjusted with one of the obligation targets described above to directly include the rail and national navigation sectors into the scope of the RTFO, including electricity as a (partially) renewable fuel and including petrol and diesel. This would directly obligate fuel suppliers to ensure that fuel for the rail and national navigation sectors included enough biofuel to meet the target. Also, by including electricity and petrol/diesel this could incentivise fuel producers to improve these life-cycle GHG emissions which would contribute to a GHG abatement target.

- Adjust the RTFO to give higher rewards to those biofuels with the greatest GHG savings - The RTFO could be further adjusted with one of the obligation targets described above to give higher rewards to those biofuels that offer the greatest GHG savings. This may improve the GHG abatement of any volume or energy obligation, but would not guarantee that a specific GHG abatement target would be met.

It is assumed that the majority of the renewables that fuel suppliers use to meet this obligation will be in the form of biofuels. As discussed in detail within the Transport chapter of the consultation document, the directive proposes that only biofuels that meet certain sustainability and GHG saving criteria will be allowed to count towards the target. Likewise the RTFO would use the same criteria and only award certificates to those biofuels that met these criteria.

Summary of costs and benefits

Tables 1.1 to 1.4 below summarise the estimated costs and benefits of meeting the 10% renewable energy target under four oil prices, three biofuel price and two biofuel GHG emission scenarios. More discussion of the assumptions used in the analysis can be found in the Assumption and Impacts section below.

Low Oil Price ($45bbl)

Table 1.1a: Impact to 2030 of meeting the target by blending fuel to 10% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£5,800m	-£8,527m	-£11,247m
- Of which fuel costs	-£5,748m	-£8,440m	-£11,114m
- Of which welfare loss	-£52m	-£87m	-£133m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£1,584m	£1,637 m	£1,691m
Net Present Value[1]	-£4,216m	-£6,890m	-£9,556m
Net Present Value (with ancillary)	-£4,130m	-£6,794m	-£9,451m
CO2 saved ($MtCO_2$)	78$MtCO_2$	81$MtCO_2$	83$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	5.3$MtCO_2$	5.6$MtCO_2$	5.8$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£74/tCO_2	£106/tCO_2	£135/tCO_2
Benefit Cost Ratio	0.27	0.19	0.15
Biofuel with 20% GHG saving			
Present value benefits	£746m	£801m	£857m
Net Present Value[1]	-£5,055m	-£7,726m	-£10,390m
Net Present Value (with ancillary)	-£4,968m	-£7,630m	-£10,285m
CO2 saved ($MtCO_2$)	37$MtCO_2$	39$MtCO_2$	42$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	2.5$MtCO_2$	2.7$MtCO_2$	3.0$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£158/tCO_2	£216/tCO_2	£267/tCO_2
Benefit Cost Ratio	0.13	0.09	0.08
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 1.1b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 10% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£3,077m	+£3,155m	+£3,231m
NPV impact on Firms	-£4,426m	-£5,970m	-£7,508m
NPV impact on Consumers (50%)	-£2,988m	-£4,158m	-£5,323m
NPV impact on Consumers (20%)	-£3,827m	-£4,995m	-£6,157m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 1.1c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 10% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+112,404	+112,000	+111,596
Reduction in fossil fuels (m litres)	-3,446m	-3,517m	-3,589m
Impact on Road Petrol price (ppl)	+2.9ppl (+3.3%)	+3.8ppl (+4.3%)	+4.6ppl (+5.3%)
Impact on Road Diesel price (ppl)	+1.9ppl (+2.1%)	+2.7ppl (+3.0%)	+3.5ppl (+4.0%)
Impact on Non-Road Diesel (ppl)	+1.4ppl (+3.4%)	+2.2ppl (+5.3%)	2.9ppl (+7.1%)

Central Oil Price ($75bbl)

Table 1.2a: Impact to 2030 of meeting the target by blending fuel to 10% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£3,317m	-£6,021m	-£8,717m
- Of which fuel costs	-£3,291m	-£5,970m	-£8,633m
- Of which welfare loss	-£26m	-£51m	-£84m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£1,524m	£1,571m	£1,619m
Net Present Value[1]	-£1,795m	-£4,450m	-£7,099m
Net Present Value (with ancillary)	-£1,718m	-£4,365m	-£7,005m
CO2 saved ($MtCO_2$)	75$MtCO_2$	77$MtCO_2$	80$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	5.1$MtCO_2$	5.3$MtCO_2$	5.5$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£44/tCO_2	£78/tCO_2	£109/tCO_2
Benefit Cost Ratio	0.46	0.26	0.19
Biofuel with 20% GHG saving			
Present value benefits	£683m	£732m	£782m
Net Present Value[1]	-£2,636m	-£5,289m	-£7,936m
Net Present Value (with ancillary)	-£2,559m	-£5,204m	-£7,842m
CO2 saved ($MtCO_2$)	34$MtCO_2$	36$MtCO_2$	39$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	2.3$MtCO_2$	2.5$MtCO_2$	2.7$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£99/tCO_2	£167/tCO_2	£226/tCO_2
Benefit Cost Ratio	0.21	0.12	0.09
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 1.2b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 10% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£3,085m	+£3,196m	+£3,304m
NPV impact on Firms	-£2,906m	-£4,455m	-£6,000m
NPV impact on Consumers (50%)	-£2,140m	-£3,321m	-£4,498m
NPV impact on Consumers (20%)	-£2,981m	-£4,160m	-£5,335m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 1.2c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 10% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+112,768	+112,405	+112,043
Reduction in fossil fuels (m litres)	-3,382m	-3,446m	-3,510m
Impact on Road Petrol price (ppl)	+2.4ppl (+2.5%)	3.3ppl (+3.4%)	+4.2ppl (+4.3%)
Impact on Road Diesel price (ppl)	+1.2ppl (+1.2%)	2.0ppl (+2.0%)	+2.8ppl (+2.9%)
Impact on Non-Road Diesel (ppl)	+0.8ppl (+1.6%)	1.6ppl (+3.1%)	+2.3ppl (+4.5%)

High Oil Price ($105bbl)

Table 1.3a: Impact to 2030 of meeting the target by blending fuel to 10% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£897m	-£3,579m	-£6,256m
- Of which fuel costs	-£883m	-£3,550m	-£6,204m
- Of which welfare loss	-£14m	-£29m	-£52m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£1,476m	£1,519m	£1,561m
Net Present Value[1]	£579m	-£2,060m	-£4,694m
Net Present Value (with ancillary)	£648m	-£1,984m	-£4,610m
CO2 saved ($MtCO_2$)	73$MtCO_2$	75$MtCO_2$	77$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	5.0$MtCO_2$	5.1$MtCO_2$	5.3$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£12/tCO_2	£48/tCO_2	£81/tCO_2
Benefit Cost Ratio	1.65	0.42	0.25
Biofuel with 20% GHG saving			
Present value benefits	£632m	£677m	£722m
Net Present Value[1]	-£264m	-£2,902m	-£5,534m
Net Present Value (with ancillary)	-£195m	-£2,825m	-£5,450m
CO2 saved ($MtCO_2$)	31$MtCO_2$	33$MtCO_2$	36$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	2.0$MtCO_2$	2.3$MtCO_2$	2.5$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£29/tCO_2	£107/tCO_2	£176/tCO_2
Benefit Cost Ratio	0.71	0.19	0.12
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 1.3b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 10% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£3,032m	+£3,168m	+£3,003m
NPV impact on Firms	-£1,379m	-£2,934m	-£4,484m
NPV impact on Consumers (50%)	-£1,274m	-£2,465m	-£3,651m
NPV impact on Consumers (20%)	+£2,118m	+£3,306m	+£4,491m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 1.3c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 10% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+113,064	+112,688	+112,406
Reduction in fossil fuels (m litres)	-3,329m	-3,388m	-3,446m
Impact on Road Petrol price (ppl)	+2.0ppl (+1.9%)	+2.8ppl (+2.7%)	+3.7ppl (+3.5%)
Impact on Road Diesel price (ppl)	+0.5ppl (+0.4%)	+1.3ppl (+1.2%)	+2.1ppl (+2.0%)
Impact on Non-Road Diesel (ppl)	+0.2ppl (+0.3%)	+0.9ppl (+1.6%)	+1.7ppl (+2.8%)

High-High Oil Price ($150bbl)

Table 1.1a: Impact to 2030 of meeting the target by blending fuel to 10% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-	-£6m	-£1,679m
- Of which fuel costs	-	-	-£1,661m
- Of which welfare loss	-	-£6m	-£18m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	-	£1,616m	£1,477m
- Of which fuel costs	-	£165m	-
- Of which CO_2 savings	-	£1,452m	£1,477m
Net Present Value[1]	-	£1,610m	-£202m
Net Present Value (with ancillary)	-	£1,672m	-£180m
CO2 saved ($MtCO_2$)	-	72$MtCO_2$	73$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	4.9$MtCO_2$	5.0$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	-£2/tCO_2[1]	£23/tCO_2
Benefit Cost Ratio	-	251	0.88
Biofuel with 20% GHG saving			
Present value benefits	-	£772m	£633m
- Of which fuel costs	-	£165m	-
- Of which CO_2 savings	-	£607m	£167m
Net Present Value[1]	-	£765m	-£1,045m
Net Present Value (with ancillary)	-	£827m	-£1,023m
CO2 saved ($MtCO_2$)	-	30$MtCO_2$	31$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	2.0$MtCO_2$	2.2$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	-£5/tCO_2	£54/tCO_2
Benefit Cost Ratio	-	120	0.38
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 1.1b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending 10% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	-	+£3,030m	+£3,167m
NPV impact on Firms	-	-£1,002m	-£1,563m
NPV impact on Consumers (50%)	-	-£643m	-£2,006m
NPV impact on Consumers (20%)	-	-£1,487m	-£2,849m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 1.1c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 10% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	-	+113,195	+113,008
Reduction in fossil fuels (m litres)	-	-3,305m	-3,340m
Impact on Road Petrol price (ppl)	-	+1.6ppl (+1.2%)	+2.7ppl (+2.1%)
Impact on Road Diesel price (ppl)	-	+0.4ppl (+0.3%)	+0.6ppl (+0.5%)
Impact on Non-Road Diesel (ppl)	-	+0.1ppl (+0.1%)	+0.3ppl (+0.4%)

Option 2: Meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85

How would this work?

Option 1 assumed that all the biofuels used to meet the 10% renewable energy target would be blended in the general petrol and diesel fuel streams. However, it may only be possible to blend up to 10% biofuels by volume, which would roughly equate to 8% by energy. The other 2% of renewable energy may then have to be consumed through alternative fuels and vehicles. This was the scenario detailed in the EU Commissions Directive Proposal Impact Assessment. Within this scenario the Commission propose that the other 2% of renewable energy would need to be provided by alternative vehicles and fuels. Such applications include:

- Use of E85 fuels and vehicles – E85 fuel consists of a blend of 85% bioethanol and 15% petrol. The current use of high ethanol blends with petrol such as E85 is only a small share as a result of the need for specialist vehicles and adaptations in the fuel distribution infrastructure. Due to the energy penalty of bioethanol and the possible higher cost of the biofuel there may be limited uptake in these vehicles by 2020.

- Use of certain second generation biofuels that are compatible with existing fuel standards – This option assumes the production of certain second generation biofuels that are chemically almost identical to fossil fuels and thus do not face the issues over fuel quality standards and blending limits. There are there are significant efforts at the EU and international level to promote the production and use of second generation biofuels but their contribution by 2020 is expected to be limited. Also, the 2nd generation biofuels currently closest to market are chemically identical to 1st generation ethanol and will not serve as an alternative to the amendment of fuel standards.

- Use of 100% biodiesel, hydrotreated oils or pure plant oils – use of higher or pure blends of biodiesel or equivalent in dedicated fleets or the general vehicle stock by 2020 is still relatively unknown. Hydrotreated oils are still prohibitively expensive (3-4 times biodiesel) and vehicle manufactures will currently not warrant the use of 100% biodiesel or pure plant oil.

To analyse the possible costs and benefits of this package we have assumed that the remaining 2% renewable energy will be contributed by the uptake and use of E85 fuel by 'flex-fuel' vehicles. We have used this assumption as this is an established alternative with an industry in many countries (notably Brazil, South Africa and Sweden).

Summary of costs and benefits

Tables 2.1 to 2.4 below summarise the estimated costs and benefits of meeting the 10% renewable energy target under four oil price, two biofuel GHG emission scenarios, and three biofuel price and 'flex-fuel' vehicle scenarios. More discussion of the assumptions used in the analysis can be found in the Assumption and Impacts section below.

Low Oil Price ($45bbl)

Table 2.1a: Impact to 2030 of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£6,051m	-£9,289m	-£12,756m
- Of which fuel costs	-£5,819m	-£8,729m	-£11,631m
- Of which welfare loss	-£167m	-£298m	-£470m
- Of which vehicle costs	-£66m	-£263m	-£655m
Biofuel with 50% GHG saving			
Present value benefits	£1,651m	£1,712m	£1,775m
Net Present Value[1]	-£4,400m	-£7,577m	-£10,982m
Net Present Value (with ancillary)	-£4,313m	-£7,483m	-£10,882m
CO2 saved ($MtCO_2$)	$81MtCO_2$	$84MtCO_2$	$88MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$5.7MtCO_2$	$5.9MtCO_2$	$6.2MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£74/tCO_2	£110/tCO_2	£146/tCO_2
Benefit Cost Ratio	0.27	0.18	0.14
Biofuel with 20% GHG saving			
Present value benefits	£815m	£878m	£943m
Net Present Value[1]	-£5,237m	-£8,411m	-£11,814m
Net Present Value (with ancillary)	-£5,149m	-£8,317m	-£12,714m
CO2 saved ($MtCO_2$)	$40MtCO_2$	$43MtCO_2$	$47MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$2.8MtCO_2$	$3.1MtCO_2$	$3.4MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£151/tCO_2	£214/tCO_2	£274/tCO_2
Benefit Cost Ratio	0.13	0.09	0.07
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 2.1b: NPV impact to 2030 on Government, firms and consumers of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£4,216m	+£4,450m	+£4,679m
NPV impact on Firms	-£3,721m	-£5,002m	-£6,308m
NPV impact on Consumers (50%)	-£5,133m	-£7,165m	-£9,342m
NPV impact on Consumers (20%)	-£5,970m	-£7,999m	-£10,147m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 2.1c: Energy and pump price impact in 2020 of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+112,165	+111,858	+111,551
Reduction in fossil fuels (m litres)	-3,531m	-3,577m	-3,623m
Impact on Road Petrol price (ppl)	+2.0ppl (+2.3%)	+2.6ppl (+3.0%)	+3.3ppl (+3.7%)
Impact on Road Diesel price (ppl)	+1.3ppl (+1.5%)	+1.9ppl (+2.1%)	+2.5ppl (+2.8%)
Impact on Non-Road Diesel (ppl)	+1.0ppl (+2.4%)	+1.5ppl (+3.7%)	+2.1ppl (+5.0%)

Central Oil Price ($75bbl)

Table 2.2a: Impact to 2030 of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£3,467m	-£6,652m	-£10,054m
- Of which fuel costs	-£3,310m	-£6,206m	-£9,087m
- Of which welfare loss	-£91m	-£183m	-£311m
- Of which vehicle costs	-£66m	-£263m	-£655m
Biofuel with 50% GHG saving			
Present value benefits	£1,583m	£1,637m	£1,692m
Net Present Value[1]	-£1,884m	-£5,015m	-£8,362m
Net Present Value (with ancillary)	-£1,803m	-£4,929m	-£8,270m
CO2 saved ($MtCO_2$)	78$MtCO_2$	81$MtCO_2$	84$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	5.4$MtCO_2$	5.7$MtCO_2$	5.9$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£44/tCO_2	£82/tCO_2	£120/tCO_2
Benefit Cost Ratio	0.46	0.25	0.17
Biofuel with 20% GHG saving			
Present value benefits	£746m	£802m	£859m
Net Present Value[1]	-£2,270m	-£5,850m	-£9,195m
Net Present Value (with ancillary)	-£2,640m	-£5,764m	-£9,103m
CO2 saved ($MtCO_2$)	37$MtCO_2$	40$MtCO_2$	42.4$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	2.6$MtCO_2$	2.8$MtCO_2$	3.1$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£94/tCO_2	£168/tCO_2	£237/tCO_2
Benefit Cost Ratio	0.22	0.12	0.09
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 2.2b: NPV impact to 2030 on Government, firms and consumers of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£4,111m	+£4,365m	+£4,616m
NPV impact on Firms	-£2,441m	-£3,737m	-£5,047m
NPV impact on Consumers (50%)	-£3,876m	-£5,910m	-£8,096m
NPV impact on Consumers (20%)	-£4,713m	-£6,745m	-£8,929m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 2.2c: Energy and pump price impact in 2020 of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+112,442	+112,167	+111,892
Reduction in fossil fuels (m litres)	+3,490m	+3,531m	+3,572m
Impact on Road Petrol price (ppl)	+1.7ppl (+1.8%)	+2.3ppl (+2.4%)	+2.9ppl (+3.0%)
Impact on Road Diesel price (ppl)	+0.8ppl (0.8%)	+1.4ppl (1.4%)	+2.0ppl (2.0%)
Impact on Non-Road Diesel (ppl)	+0.6ppl (1.1%)	+1.1ppl (2.2%)	+1.6ppl (3.2%)

High Oil Price ($105bbl)

Table 2.3a: Impact to 2030 of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£980m	-£4,123m	-£7,479m
- Of which fuel costs	-£870m	-£3,753m	-£6,622m
- Of which welfare loss	-£45m	-£107m	-£201m
- Of which vehicle costs	-£66m	-£263m	-£657m
Biofuel with 50% GHG saving			
Present value benefits	£1,532m	£1,580m	£1,629m
Net Present Value[1]	£552m	-£2,543m	-£5,851m
Net Present Value (with ancillary)	£626m	-£2,464m	-£5,765m
CO2 saved ($MtCO_2$)	76$MtCO_2$	78$MtCO_2$	80$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	5.2$MtCO_2$	5.5$MtCO_2$	5.7$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£13/tCO_2	£53/tCO_2	£93/tCO_2
Benefit Cost Ratio	1.56	0.38	0.22
Biofuel with 20% GHG saving			
Present value benefits	£693m	£743m	£793m
Net Present Value[1]	-£287m	-£3,381m	-£6,686m
Net Present Value (with ancillary)	-£212m	-£3,301m	-£6,601m
CO2 saved ($MtCO_2$)	34$MtCO_2$	37$MtCO_2$	39$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	2.4$MtCO_2$	2.6$MtCO_2$	2.9$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£29/tCO_2	£112/tCO_2	£191/tCO_2
Benefit Cost Ratio	0.71	0.18	0.11
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 2.3b: NPV impact to 2030 on Government, firms and consumers of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£3,966m	+£4,239m	+£4,510m
NPV impact on Firms	-£1,168m	-£2,468m	-£3,783m
NPV impact on Consumers (50%)	-£2,609m	-£4,655m	-£6,855m
NPV impact on Consumers (20%)	-£3,447m	-£5,492m	-£7,690m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 2.3c: Energy and pump price impact in 2020 of meeting the target through a mix of blending fuel to 10% biofuels by volume and making up the difference through sales of E85 – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+112,667	+112,418	+112,168
Reduction in fossil fuels (m litres)	-3,456m	-3,493m	-3,531m
Impact on Road Petrol price (ppl)	+1.4ppl (+1.3%)	+2.0ppl (+1.9%)	+2.6ppl (+2.5%)
Impact on Road Diesel price (ppl)	+0.3ppl (+0.3%)	+0.9ppl (+0.8%)	+1.5ppl (+1.4%)
Impact on Non-Road Diesel (ppl)	+0.1ppl (+0.2%)	+0.7ppl (+1.1%)	+1.2ppl (+2.0%)

High-High Oil Price ($150bbl)

Table 2.1a: Impact to 2030 of meeting the target through a mix of blending fuel to 10% biofuels by volume and E85 – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-	-£86m	-£2,759m
- Of which fuel costs	-	-	-£2,023m
- Of which welfare loss	-	-£20m	-£77m
- Of which vehicle costs	-	-£66m	-£659m
Biofuel with 50% GHG saving			
Present value benefits	-	£2,005m	£1,537m
- Of which fuel costs	-	£504m	-
- Of which CO_2 savings	-	£1,501m	£1,537m
Net Present Value[1]	-	+£1,919m	-£1,222m
Net Present Value (with ancillary)	-	+£1,988m	-£1,186m
CO2 saved ($MtCO_2$)	-	74$MtCO_2$	76$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	5.1$MtCO_2$	5.3$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	-£6/tCO_2	£36/tCO_2
Benefit Cost Ratio	-	23	0.56
Biofuel with 20% GHG saving			
Present value benefits	-	£1,165m	£699m
- Of which fuel costs	-	£504m	-
- Of which CO_2 savings	-	£661m	£699m
Net Present Value[1]	-	+£1,079m	-£2,060m
Net Present Value (with ancillary)	-	+£1,148m	-£2,024m
CO2 saved ($MtCO_2$)	-	33$MtCO_2$	35$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	2.3$MtCO_2$	2.5$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	-£13/tCO_2	£80/tCO_2
Benefit Cost Ratio	-	1.58	0.25
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 1.1b: NPV impact to 2030 on Government, firms and consumers of meeting the target through 10% biofuels by volume and E85 – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	-	+£3,880m	+£4,411m
NPV impact on Firms	-	-£716m	-£1,329m
NPV impact on Consumers (50%)	-	-£1,627m	-£4,476m
NPV impact on Consumers (20%)	-	-£2,467m	-£5,314m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 1.1c: Energy and pump price impact in 2020 of meeting the target through a mix of blending fuel to 10% biofuels by volume and E85 – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	-	+112,765	+112,626
Reduction in fossil fuels (m litres)	-	-3,441m	-3,462m
Impact on Road Petrol price (ppl)	-	+1.1ppl (+0.9%)	+1.9ppl (+1.5%)
Impact on Road Diesel price (ppl)	-	+0.3ppl (+0.2%)	+0.4ppl (+0.3%)
Impact on Non-Road Diesel (ppl)	-	+0.1ppl (0.1%)	+0.2ppl (0.3%)

Assumptions and Impacts

Counterfactual

All of the impacts estimated in this assessment use the announced RTFO as a counterfactual. The government has announced that the RTFO will obligate fuel operators to supply 5% biofuels by volume (4% by energy). Thus only the costs and benefits of biofuel use above 4.0% by energy are included.

Biofuel market penetration path

For this analysis a biofuel market penetration path needed to be assumed to meet the 10% renewables target in 2020. Table 3 below illustrates the assumed biofuel market penetration on an energy basis.

Table 3: Biofuel market penetration by energy

	Biofuel market penetration (by energy) to meet 5%	Biofuel market penetration (by energy) to reach 8%	Biofuel market penetration (by energy) to meet 10% target
2010	4.0%	4.0%	4.0%
2011	4.0%	4.5%	4.5%
2012	4.0%	5.0%	5.0%
2013	4.0%	5.0%	5.5%
2014	4.0%	6.0%	6.0%
2015	4.0%	6.0%	6.5%
2016	4.0%	7.0%	7.0%
2017	4.0%	7.0%	7.5%
2018	4.0%	7.5%	8.0%
2019	4.0%	7.5%	9.0%
2020	5.0%	8.0%	10.0%
2021-2030	5.0%	8.0%	10.0%

Monetised Costs

Fuel Resource Costs

Analysing the potential fuel resource costs of a policy involves comparing the total fuel cost to consumers and businesses for the policy option and the counterfactual. This involves estimating the cost of fuel and multiplying it by the quantity of fuel consumed, for each scenario. Thus in estimating the fuel resource cost of these biofuel options the following were analysed: the pre-tax cost of biofuels compared to fossil fuels, the extra fuel consumed due to the energy penalty of biofuels and the reduced km driven due to the higher fuel costs.

Pre-tax price of conventional (fossil) fuels

BERR have published the latest government Oil price assumptions and include low, central, high and high-high scenarios[1]. The oil price assumptions to 2030 have been converted into petrol and diesel prices using BERR-DfT's fuel price forecasting model. The pre-tax petrol and diesel price forecasts under each oil price scenario are given in table 4.1 below.

Pre-tax price of Renewable (bio) fuels

[1] http://www.berr.gov.uk/files/file46071.pdf

The resource cost of biofuels will depend on where the biofuels for UK consumption are supplied from. These can currently vary widely with bioethanol currently trading between 24ppl (Brazil), 34ppl (US) and 60ppl (France). German biodiesel is currently trading for around 70ppl. However, all of these prices are widely dependant on exchange rates. Given the uncertainty over the current source of UK consumed biofuel it has been assumed that the current average price of bioethanol is 40ppl and biodiesel 50ppl.

Future prices of biofuels are even more uncertain and will depend on the developments in the oil, biofuel and agriculture markets and the interactions between these. These are three highly uncertain markets and the complex interactions between them amplify the uncertainties in future biofuels prices. These markets and the impacts on the prices of biofuels need to be studied more as they are complex and are interconnected – a brief description of these are provided below. Due to these complexities and uncertainties we have assumed three biofuel price scenarios for all oil price scenarios for analytical simplicity. These should not be taken as the maximum of the potential biofuel prices, but an illustration of the potential range. More research is required to better define the potential costs of biofuels.

Biofuel price driving factors:

Biofuel Market – this can be separated between the supply and demand of biofuels.

Demand and the willingness-to-pay for biofuels will be dependant on (i) government mandates for biofuels due to energy security and GHG savings and (ii) demand from private fuel suppliers which will be dependant on the price differential between fossil fuels and biofuels. The lower the price differential between fossil fuels and biofuels the greater the potential long term demand will be.

Supply and cost of biofuels will be dependant on (i) the amount of investment and realised improvements in the technology and production of biofuels which will be partially dependant on the long term demand for biofuels, (ii) the price of oil which will be an input cost to biofuels and (iii) the cost and supply of the agricultural feedstocks used for biofuels.

Oil market – the long term oil price will impact on (i) the price of fossil fuels and (ii) the cost of biofuels through direct refining and transportation costs and the cost of feedstock production in the agricultural market. The oil market will directly impact on the costs of fossil fuels and biofuels and thus the price differential. The price of oil itself will in the long term be dependant on the demand for and supply of crude oil and processed fuels.

Agricultural Market – long term agricultural prices for biofuel feedstocks will impact on the cost of biofuels and the price differential. Agricultural prices will in the long term be dependant on the potential demand, supply and costs of producing agricultural feedstocks. Demand will be dependant on population growth, food tastes and demand for feedstocks from non-food industries. Supply will be dependant on available land, yields and the sustainability criteria set for biofuel feedstocks by governments. The costs of production will partially be dependant on the oil price as oil based fuel is an input cost to the production of feedstocks.

Biofuel price scenarios:

The rationale behind each of the biofuel price scenarios are described below and table 5.1 illustrates the price scenarios assumed in 2020.

Low Biofuel Price – This scenario assumes that investment in biofuel technology and production reduces the cost of biofuels compared to current levels (in real terms). This also assumes that the feedstock prices reduce from their current high prices and that greater global demand does not significantly increase the price of biofuels in what develops to be a global competitive

market. These are consistent with the Commission's biofuel price estimates in their Biofuel Progress Report and other publicly available projections.

Central Biofuel Price – in this scenario biofuel pre-tax prices remain at current levels (in real terms). This scenario assumes that any improvements in biofuel technology and production are offset by higher agricultural prices and / or biofuels demand, or that the expected improvements in biofuel costs are not realised.

High Biofuel Price – in this scenario biofuel pre-tax prices increase from current levels (in real terms). This scenario assumes that the expected improvements in biofuel technology and production are not realised and agricultural prices and increase demand for biofuel increase the pre-tax price of biofuels.

For the High-High Oil price/Central Biofuel price scenario we have assumed that a consistent oil price of $150 provides incentives for enough investment to bring down the costs of biofuels. However, due to higher global demand from fuel suppliers pre-tax biofuel prices only reduce to the point where they are the same as fossil fuel prices on an energy equivalent basis (see energy penalty section below). In this scenario, 'Fuel resource costs' become a benefit as the cost of biofuels and the energy penalty offset each other and thus the only impact is a fuel resource cost saving due to the reduced km driven. The NPV of the option is dominated by the GHG and Fuel resource benefits.

Table 4.1 below illustrates the pre-tax prices of fossil fuels and biofuels given the four oil price and three biofuel price scenarios from option 1. Table 4.2 illustrates the NPV of meeting the 10% Transport Renewable Energy target given these different price scenarios for option 1. Table 4.3 illustrates the increase in road fuel pump prices of meeting the 10% Transport Renewable Energy target given these different price scenarios for option 1.

Table 4.1: Pre-tax retail prices of Petrol, Diesel, Bioethanol and Biodiesel in 2020 (£/litre, 2007 prices)

Oil Price Scenario	Biofuel Price Scenario	Diesel	Biodiesel	Petrol	Bioethanol
Low	**Low**	£0.24	£0.40	£0.23	£0.30
	Central		£0.50		£0.40
	High		£0.60		£0.50
Central	**Low**	£0.33	£0.40	£0.31	£0.30
	Central		£0.50		£0.40
	High		£0.60		£0.50
High	**Low**	£0.42	£0.40	£0.39	£0.30
	Central		£0.50		£0.40
	High		£0.60		£0.50
High-High	**Low**	£0.62	-	£0.56	-
	Central		£0.57[1]		£0.37[1]
	High		£0.60		£0.50

[1] In the High-High oil price scenario we assume that the lowest that pre-tax biofuel price will fall is to the point in which they are equal to fossil fuel prices on an energy equivalent basis.

Table 4.2: NPV to 2030 of 10% Renewable Energy Target with the different Oil and Biofuel price scenarios (2007 prices) under Option 1 (50% GHG savings)

	Low Biofuel Price	Central Biofuel Price	High Biofuel Price
Low Oil price	-£4,216m	-£6,890m	-£9,556m
Central Oil price	-£1,795m	-£4,450m	-£7,099m
High Oil price	+£579m	-£2,060m	-£4,694m
High-High Oil price	-	+£1,610m	-£202m

Table 4.3: Impact in 2020 of the 10% Renewable Energy Target on petrol and diesel pump prices with the different Oil and Biofuel price scenarios (2007 prices) under Option 1

	Low Biofuel Price		Central Biofuel Price		High Biofuel Price	
	Petrol Price ppl	Diesel Price ppl	Petrol Price ppl	Diesel Price ppl	Petrol Price ppl	Diesel Price ppl
Low Oil price	+2.9ppl	+1.9ppl	+3.8ppl	+2.7ppl	+4.6ppl	+3.5ppl
Central Oil price	+2.4ppl	+1.2ppl	+3.3ppl	+2.0ppl	+4.2ppl	+2.8ppl
High Oil price	+2.0ppl	+0.5ppl	+2.8ppl	+1.3ppl	+3.7ppl	+2.1ppl
High-High Oil price	-	-	+1.6ppl	+0.4ppl	+2.7ppl	+0.6ppl

Energy Penalty of biofuels

A lower energy content has been factored in for all biofuel blends. This increases the total amount of fuel needed to travel the same amount of miles, and reduces the overall GHG emission savings achieved. Bioethanol has around 2/3 of the energy of petrol and biodiesel 9/10 of the energy of diesel. Table 5 below illustrates the energy content of the different fuels as presented in the EU Commissions proposed Renewable Energy Directive Impact Assessment.

Table 5: Energy content of fossil and biofuels (MJ/l)

	Energy content (mega-joules/ litre)	% of fossil fuel
Petrol	32	
Bioethanol	21	65.6%
Diesel	36	
Biodiesel	33	91.7%

Welfare loss due to reduced driving

In the scenarios where fuel costs are higher due to biofuels, driving costs increase. An increase in the cost of driving will cause motorists to reduce them amount of km's travelled. This has been estimated using a price elasticity of petrol and diesel. A price elasticity of -0.25, falling to -0.15 by 2025, has been used in the analysis to take account of motorists responding to a fuel price increase. This is a cost to society as motorists are losing the benefit they received from the reduced km's travelled. This welfare loss has been estimated by multiplying the amount of less fuel used due to the price increase with the price of petrol and diesel.

Other Assumptions

• Obligated fuel suppliers are likely to pass costs on to their customers in the UK and thus 100% cost passthrough has been assumed.

▪ As the UK will be legally obligated to meet a certain renewable energy target it has been assumed in this analysis that the present RTFO buy-out price will not apply post 2010.

▪ Demand forecasts for road and non-road fuels are taken from BERR's energy projection as used in the Energy White Paper. The BERR road fuel forecast is split out into petrol and diesel using consumption splits from the Dft National Transport Model.

▪ A discount rate of 3.5% is assumed for every year to present estimates in net present terms. This is consistent with all government analysis.

Vehicle resource costs

Option 2 implies that around 2% of the renewable energy needed to meet the Transport renewables target will need to come from alternative fuels and vehicles. For this impact assessment we have assumed that this will be in the form of a greater uptake of E85 fuel (85% Bioethanol and 15% Petrol) and 'flex-fuel' vehicles (that can run on a range of bioethanol blends). As described above, due to the energy penalty and higher cost of bioethanol the cost of motoring with E85 fuel is expected to be higher than with conventional petrol. Information from industry suggests that E85 fuel will incur a 25% mileage penalty – that is a litre of E85 fuel will allow someone to travel 75% of the distance compared to a litre of petrol.

Within this assessment we have not made any assumption about how this uptake of E85 vehicles and fuel will occur and for analytical simplicity we have assume that any additional cost of the fuel and vehicles will be passed on to consumers. We have assumed that the extra cost of a 'flex-fuel' vehicle will be between €100-€500 (the lower estimate is from the Commissions RED impact assessment the higher amount based on industry estimates). Ultimately, the number of vehicles needed to meet the 2% renewable energy shortfall will depend on the proportion of time that 'flex-fuel' vehicles owners actually use E85 fuel compared to standard petrol.

To test the sensitivity of these costs we have estimated the number of vehicles needed if they are:

(i) Powered purely on E85,
(ii) Powered 75% of the time on E85 and 25% of the time on the normal 10% bioethanol blend, and
(iii) Powered 50% of the time on E85 and 50% on the normal 10% bioethanol blend.

If 'flex-fuel' vehicle owners purely use E85 then there would need to be around 1.4 million flex-fuel vehicles up to 2030, if they only used E85 75% of the time then this would increase to 1.9 million, and if they only used E85 50% of the time then this would increase to 2.8 million. Thus the total present value cost of a greater uptake in E85 vehicles is estimated to be between £66m to £655m (assuming an exchange rate of €1.4 = £1). Table 6 below illustrates the number of E85 vehicles needed given a central oil price scenario and three biofuel/flex fuel scenarios:

Table 6: Number of 'Flex-Fuel' vehicles assumed given a central oil price and the three flex-fuel assumptions

Central Oil Price	Low Biofuel Price (Flex Fuel vehicles use E85 100% of the time)	Central Biofuel Price (Flex Fuel vehicles use E85 75% of the time)	High Biofuel Price (Flex Fuel vehicles use E85 50% of the time)
2019	0.5 million	0.8 million	1.2 million
2020	0.9 million	1.1 million	1.6 million
Total	1.4 million	1.9 million	2.8 milllion

For the low, central and high biofuel price scenarios in tables 2.1-2.4 above, we have assumed that the low cost biofuel scenario will also see the lowest cost of 'flex-fuel' vehicles.

Low Biofuel Price scenario – 'Flex-fuel' vehicles cost an additional €100 and the E85 fuel is used 100% of the time in these vehicles. This means that 1.4m 'flex-fuel' vehicles will be needed at an additional cost of €100, meaning an additional £66m vehicle cost.

Central Biofuel Price scenario - 'Flex-fuel' vehicles cost an additional €300 and the E85 fuel is used 75% of the time in these vehicles. This means that 1.9m 'flex-fuel' vehicles will be needed at an additional cost of €300, meaning an additional £263m vehicle cost.

High Biofuel Price scenario - 'Flex-fuel' vehicles cost an additional €500 and the E85 fuel is used 50% of the time in these vehicles. This means that 2.8m 'flex-fuel' vehicles will be needed at an additional cost of €500, meaning an additional £655-£659m vehicle cost.

Non-monetised Costs

Fuel Poverty

As illustrated in table 4.3 above, fuel costs are likely to increase in most scenarios as a result of meeting the 10% Transport renewables target. To the extent that this affects non-transport fuels then it is possible that this could increase fuel poverty to some sectors of society. This potential social cost has not been assessed.

Infrastructure Costs

Information from industry has implied that there should not be any significant cost to fuel distribution of increasing the level of biofuels blended from that expected in the RTFO to the level needed to meet the 10% renewables target. We have also assumed that there would not be any significant cost in switching one of the fuel streams to supply E85 fuel at certain forecourts.

Biodiversity and Land use change

There could potentially be biodiversity loss and GHG emissions from land use change with the expansion of biofuel crop growth. There are great uncertainties in this area of analysis of biofuels. Therefore this potential social cost has not been assessed.

Food Prices

There could potentially be impacts on food prices with the expansion of biofuel crop growth. There are great uncertainties in this market and the magnitude that biofuels could have on food prices. Therefore this has not been assessed.

Monetised Benefits

Reduced emissions of CO2 and other greenhouse gases

The benefits of renewable fuels are primarily their carbon savings compared with the use of conventional fossil fuel (petrol and diesel) – see Annex A.

The GHG emission savings from the use of renewable fuels are usually quantified as net emissions i.e. an estimate of the GHG emissions from the production and combustion of the renewable fuel versus the relative production and combustion emissions of conventional fossil fuels on a well-to-wheel (lifecycle estimation). Thus, if a renewable fuel is produced, for example, using little fossil fuel derived energy/fertilizers, it might provide 85% net emission savings relative to conventional road fuels – that is it only emits 15% of the GHG emissions that conventional fuel does. If it is produced using a lot of fossil fuel, it might provide only 25% net emission savings - emits 75% of the GHG emissions that conventional fuel does.

There can also be a significant variance in the net emission savings associated with renewable fuels depending upon the feedstocks used. Given this uncertainty, we have used two GHG saving scenarios: a 50% lifecycle GHG emission saving and a 20% lifecycle GHG emission saving. The estimated GHG emission savings were monetised using Defra's shadow price of carbon.[2]

Ancillary impacts - Air Quality, Accidents, Noise and Infrastructure

Although these ancillary impacts in the summary sheets are listed in the non-monetised benefits section, these have been monetised but are not presented in the headline present value estimations.

There are likely to be benefits in improved air quality, reduced accidents, reduced noise and reduced transport infrastructure costs from the increase in biofuel use. These benefits are expected due to the increase fuel costs from the use of biofuels, which reduce demand for fuel and thus travel. This reduced travel generates the benefits. To monetise these benefits the reduced kilometres travelled have been multiplied by the damage costs of these externalities as published in DfT's transport analysis guidance (www.webtag.org.uk).

There is additional complexity in the impact on air quality with the use of biodiesel. Current research suggests that biodiesel increase the amount of nitrogen oxides (NO_x) emissions compared to diesel, but results in a decrease in particulate matter (PM) emissions. Each of these impacts have also been estimated for each of the scenarios. Using Defra's air quality damage costs it was found that the benefit in the reduction of PM emissions more than offset the cost of the increase in NO_x emissions.

Non-monetised Benefits

Improved fuel security

Wider use of biofuels will result in a rise in the number of countries from which the UK sources energy for transport and a reduction in the UK's use of fossil fuels.

Potential opportunities for UK agriculture and Biofuel Refining

Based on the scenarios described above, the UK will require between 6,641m-6,710m litres of biofuel in 2020 to meet the 10% renewables target. This may be supplied domestically,

[2] http://www.defra.gov.uk/environment/climatechange/research/carboncost/index.htm

imported or, most likely, a combination of the two. It has been estimated that a 100 million litre biodiesel processing plant would create/sustain up to 200 jobs in farming and 40-60 jobs at the plant itself. If all the biofuel consumed in the UK were from UK biofuel plants and supplied entirely by feedstock produced in the UK, this may equate up to around 15,000 jobs in farming and processing plants.

Innovation

The policy is likely to have a positive impact on innovation as new and cheaper ways of producing biofuels and improving carbon savings are developed.

Congestion

An increase in pump prices is likely to have some impact on the amount people drive and may therefore result in a small reduction in traffic congestion. This has not been quantified for this impact assessment.

Distributional Analysis

The distributional analysis presented in the tables above attempt to estimate the impacts that the options will have on consumers, firms and the government.

Consumers

This includes the impact of:

- Change in the cost of road fuel (including fuel duty and VAT),
- 'Flex-fuel' vehicle costs,
- Change in consumer surplus from changes in fuel costs,
- Changes in air quality, accidents and noise,
- Changes in CO2 emissions.

Firms

This includes the impact of:

- Change in the cost of road fuel (including fuel duty but not VAT),
- Change in the cost of non-road fuel for national navigation (including fuel duty but not VAT),
- 'Flex-fuel' vehicle costs,
- Change in firms' consumer surplus from changes in fuel costs.

Government

This includes the impact of:

- Change in tax revenues:
  - Change in tax revenue from fuel duty and VAT,
  - Change in tax revenue from other areas of the economy due to consumers and firms changing expenditure on fuel. This is estimated by multiplying the change in expenditure in fuel for consumers and firms by 10% (assumed average indirect tax rate for non-road expenditure).
- Change in fuel costs for the rail sector. It is assumed that in the immediate future that any extra rail fuels costs are paid for through greater subsidies to the rail sector,
- Changes to infrastructure costs.

Risks

Sustainability

Any potential measure which increases the volume of biofuels used in the UK will need to ensure that they are produced from a sustainable source before the Government will implement such a measure. If it is not possible to enforce sustainability requirements, there is a risk that using biofuels will have unintended impacts on biodiversity, food production/prices and result in unintended releases of greenhouse gases as a result of land conversion. On the other hand, should the sustainability criteria be set at a level which severely restricts the availability of cost effective biofuels then there would be a risk that the target would not be met.

Second generation biofuels fail to be commercially viable

The Commission's proposal also states that the 10% biofuels target is dependent on second generation biofuels becoming commercially available. At this stage it is not known which second generation technologies may become commercially viable or when the fuels produced may be available on the market. A lack of second generation fuels in the market could have a number of impacts such as more agricultural land being given over to first generation crops, greater competition between food uses and possibly higher costs.

Vehicle technical barriers

As discussed in the Transport chapter of the consultation document, there may possibly be vehicle technology barriers to increasing the volume of biofuel in road transport fuel. At the present time it is believed that most vehicles would be able to run on at least a 10% biofuel blend (by energy content) by 2020. If however it become apparent that a 10% (by energy content) blend would not be compatible with the vast majority of vehicles then there would be risk that the 10% energy target would not be met.

The EU Commissions Impact Assessment suggests two fuel streams for both diesel and petrol, one with a 7% biofuel blend and one with a 10% biofuel blend. However, this would represent a significant cost and may not be feasible for a sufficient number of fuel forecourts. Therefore it may be necessary to meet the target by blending biofuels to 10% by volume (assuming that vehicles are more likely to be able to run on this blend) and make up the difference through sales of E85 (an 85% bioethanol blend). This would require uptake of ‘flex-fuel’ vehicles.

Fuel distribution and infrastructure

Under options 1 and 2 it is assumed that the blend level in fuel can be increased to 10% by volume without requiring any significant changes to fuel distribution and supply infrastructure. The present view from industry is that once the infrastructure is in place to deliver a 5% blend (as required under the RTFO) there will be no significant challenges in increasing this level to at least 10%. Option 1 however assumes that the blend level can be increased further to meet the 10% energy target without the need for any additional measures. At levels above 10% there are some concerns surrounding the cold flow properties of FAME biodiesel. If these concerns are accurate then there is a risk that there may need to be modifications to fuel distribution or a greater use of E85.

Unable to reach additional 2% from other measures

Under option 2 it is assumed that the general vehicle stock is able to run on a 10% by volume (about 8% by energy) biofuel blend. The remaining 2% of renewable energy would then have to be made up from other measures of which the increased uptake of Flex-Fuel Vehicles able to

run on E85 is considered. At the present time E85 vehicles are more expensive to purchase than regular petrol vehicles, require 'filling up' more often to travel the same distance (due to the lower energy content) whilst not having a proportionately lower price per litre. There is therefore a risk that it will not be possible to stimulate an uptake in demand for E85 vehicles and fuels.

Implementation and Monitoring and Evaluation

This document sets out potential measures to reach the 10% renewable transport target, as part of a wider set of measures to meet the UK's share of the EU 2020 renewable energy target. The measures to implement the transport target will be set out in the Renewable Energy Strategy, which will be published in Spring 2009 and will set out which measures we will implement and how we would do so.

Specific Impact Tests: Checklist

Use the table below to demonstrate how broadly you have considered the potential impacts of your policy options.

Ensure that the results of any tests that impact on the cost-benefit analysis are contained within the main evidence base; other results may be annexed.

Type of testing undertaken	*Results in Evidence Base?*	*Results annexed?*
Competition Assessment	Yes/No	Yes/No
Small Firms Impact Test	Yes/No	Yes/No
Legal Aid	Yes/No	Yes/No
Sustainable Development	Yes/No	Yes/No
Carbon Assessment	Yes/No	Yes/No
Other Environment	Yes/No	Yes/No
Health Impact Assessment	Yes/No	Yes/No
Race Equality	Yes/No	Yes/No
Disability Equality	Yes/No	Yes/No
Gender Equality	Yes/No	Yes/No
Human Rights	Yes/No	Yes/No
Rural Proofing	Yes/No	Yes/No

Annexes

Annex A – Introduction to Biofuels

Biodiesel, bioethanol and biogas (referred to in the draft Order as “natural road fuel gas…,produced wholly from biomass”) are the only biofuels currently available to the UK road transport fuel market.

Biodiesel can be made from any vegetable oil, with rape seed, palm and used cooking oil being the most common. Although chemically different, it has similar properties to mineral diesel when burnt in a compression diesel engine. However, it can damage parts of an engine and consequently engine manufacturers only warrant their vehicles for use with 5% blends.

Bioethanol can be made from wheat, corn or sugar cane / beet. As with potable alcohol, it can be made from virtually any organic substance (grass, wood, green bits of municipal solid waste), but the technologies for doing so are not proven at a commercial scale. In Europe it is used in a 5% blend in petrol (E5), allowing its use without any engine modification. At low blending levels of 5% or less, it is not anticipated that mechanical considerations are a significant obstacle to ethanol up-take. There are significant distribution issues for bioethanol which mean that it is usually blended with petrol as they are loaded into road tankers for distribution to forecourts.

Biogas is just like compressed natural gas (CNG), except that it is generally produced by collecting the methane which is naturally emitted from landfill sites or other forms of rotting vegetation. It is only suitable for use in CNG-powered vehicles (of which there are only 800 or so in the UK).

Virtually all biofuels offer some emission savings, because the CO2 that is emitted into the atmosphere when they are burned is offset by the CO2 that the crop has absorbed as it grows. In this sense they are different from fossil fuels, which emit into the atmosphere CO2 which has been safely locked away under the earth's surface for millions of years. The CO2 savings from biofuels are, however, offset by the energy that is needed for cultivation, harvesting, processing and transportation. The best biofuels are those which are produced using the least energy (eg low inputs of fertiliser, processed in an energy-efficient way and transported short distances). The worst biofuels can theoretically result in greater lifecycle CO2 emissions than fossil fuels (ie more energy is needed to produce them than is saved by using them).

Annex B – Competition Assessment

Promotion of biofuels through regulation would result in fossil fuels for road transport being substituted for renewable fuels. It should therefore have a significant impact on the current markets. However, it is not anticipated that the effects would negatively affect the competitiveness of the fossil fuel or emerging biofuel markets.

The UK oil market is highly competitive. Traditionally it has been dominated by the UK's major oil companies, but in recent years the 'independents', have gained market share, particularly in the retail sector. In particular the sector has been affected by the entry into the market of the major supermarkets which has intensified competition. The independents have led on the introduction of biofuels into the UK market, with the supermarkets in particular increasing the availability of biofuels at the retail end of the market.

The biofuel market in the UK is very new and makes up a very small proportion of overall fuel sales (approaching 1%). The majority of biofuel sales are currently from imports, brought in by the independents, but there is also growing UK capacity, particularly for biodiesel. This currently consists mostly of a small cottage industry, but three major plants are in operation and a number of others are in the development or construction stages.

Measures to promote biofuels further are likely to further develop and mainstream the biofuel market in the UK, and lead to both increased imported biofuels and domestic capacity. As with any new and emerging market, the cottage industry is likely to be replaced in time with large scale industry. This should return benefits from economies of scale and investment capacity for technological developments.

Annex C – Small Firms Impact Test

There are three types of small firms impacted by the RTFO:

- Small firms that retail petrol through one or more forecourts;
- Small renewable fuel producers; and
- Farmers producing crops for fuel (feedstock).

The retailers are impacted by the need for a one-off clean of their tanks and other measures, as described in the costs section.

The renewable fuel producers and the producers of feedstock crops should see an expanded market for their products. Biofuel sales could increase from the current level of approximately 300 million litres per annum to 2,400 million litres a year by 2010-11 and the obligation ensures a level of demand at that level for future years. Most of this fuel will be sold to be blended into petrol and diesel by the major oil companies, who will be able to choose how they source their fuels, which may include importing. Nevertheless, this represents a significant opportunity for both farmers and biofuel producers.

Those producers that sell their fuels across the duty point will also be able to earn certificates, which may have a market value for obligated suppliers.

They will have to register with the Administrator and comply with the reporting and auditing requirements if they wish to earn and trade certificates. They will be able to comply with all these requirements electronically. Inspections will be risk-assessed ensuring that small firms are not unduly burdened with compliance activity. There is a de minimis for obligated fuel suppliers – only those that supply more than 450,000 litres of fossil fuel will need to meet the obligation. This is not seen as a risk in not meeting the target.

The Department for Transport sent out enquiries to four business federations prior to the consultation in February 2007, to gather their concerns or issues, but received no replies.

The Federation of Small Businesses replied to the consultation. Their major concern was the planned decrease in the duty incentive, which is a matter for the Chancellor of the Exchequer.

Annex D – 8% biofuels by energy content in fuel

Low Oil Price ($45bbl)

Table 7.1a: Impact to 2030 of meeting the target by blending fuel to 8% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£4,236m	-£6,125m	-£8,009m
- Of which fuel costs	-£4,202m	-£6,069m	-£7,926m
- Of which welfare loss	-£35m	-£56m	-£83m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£1,130m	£1,167m	£1,205m
Net Present Value[1]	-£3,106m	-£4,957m	-£6,804m
Net Present Value (with ancillary)	-£3,039m	-£4,884m	-£6,725m
CO2 saved ($MtCO_2$)	$55MtCO_2$	$57MtCO_2$	$59MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$3.5MtCO_2$	$3.7MtCO_2$	$3.8MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£77/tCO_2	£107/tCO_2	£136/tCO_2
Benefit Cost Ratio	0.27	0.19	0.15
Biofuel with 20% GHG saving			
Present value benefits	£533m	£572m	£610m
Net Present Value[1]	-£3,703m	-£5,553m	-£7,398m
Net Present Value (with ancillary)	-£3,636m	-£5,480m	-£7,319m
CO2 saved ($MtCO_2$)	$26MtCO_2$	$28MtCO_2$	$30MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$1.7MtCO_2$	$1.8MtCO_2$	$2.0MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£163/tCO_2	£219/tCO_2	£268/tCO_2
Benefit Cost Ratio	0.13	0.09	0.08
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 7.1b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 8% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£2,209m	+£2,264m	+£2,316m
NPV impact on Firms	-£3,212m	-£4,281m	-£5,347m
NPV impact on Consumers (50%)	-£2,185m	-£2,994m	-£3,801m
NPV impact on Consumers (20%)	-£2,783m	-£3,590m	-£4,395m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 7.1c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 8% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+74,117	+73,890	+73,633
Reduction in fossil fuels (m litres)	-2,271m	-3,320m	-3,368m
Impact on Road Petrol price (ppl)	+1.9ppl (+2.2%)	+2.5ppl (+2.8%)	+3.0ppl (+3.5%)
Impact on Road Diesel price (ppl)	+1.2ppl (+1.4%)	+1.8ppl (+2.0%)	+2.3ppl (+2.6%)
Impact on Non-Road Diesel (ppl)	+0.9ppl (+2.3%)	+1.4ppl (+3.5%)	+1.9ppl (+4.7%)

Central Oil Price ($75bbl)

Table 7.2a: Impact to 2030 of meeting the target by blending fuel to 8% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£2,471m	-£4,341m	-£6,208m
- Of which fuel costs	-£2,452m	-£4,308m	-£6,155m
- Of which welfare loss	-£19m	-£33m	-£53m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£1,087m	£1,120m	£1,153m
Net Present Value[1]	-£1,384m	-£3,222m	-£5,055m
Net Present Value (with ancillary)	-£1,324m	-£3,156m	-£5,190m
CO2 saved ($MtCO_2$)	53$MtCO_2$	55$MtCO_2$	56$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	3.4$MtCO_2$	3.5$MtCO_2$	3.6$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£46tCO_2	£79/tCO_2	£110/tCO_2
Benefit Cost Ratio	0.44	0.26	0.19
Biofuel with 20% GHG saving			
Present value benefits	£488m	£523m	£557m
Net Present Value[1]	-£1,982m	-£3,189m	-£5,651m
Net Present Value (with ancillary)	-£1,923m	-£3,753m	-£5,580m
CO2 saved ($MtCO_2$)	24$MtCO_2$	26$MtCO_2$	27$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	1.5$MtCO_2$	1.6$MtCO_2$	1.8$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£104/tCO_2	£170/tCO_2	£228/tCO_2
Benefit Cost Ratio	0.20	0.12	0.09
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 7.2b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 8% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£2,218m	+£2,294m	+£2,369m
NPV impact on Firms	-£2,133m	-£3,205m	-£4,275m
NPV impact on Consumers (50%)	-£1,582m	-£2,399m	-£3,214m
NPV impact on Consumers (20%)	-£2,181m	-£2,996m	-£3,810m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 7.2c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 8% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+74,321	+74,117	+73,913
Reduction in fossil fuels (m litres)	-2,228m	-2,271m	-2,315m
Impact on Road Petrol price (ppl)	+1.6ppl (+1.6%)	2.2ppl (+2.2%)	+2.7ppl (+2.8%)
Impact on Road Diesel price (ppl)	+0.8ppl (+0.8%)	1.3ppl (+1.3%)	+1.9ppl (+1.9%)
Impact on Non-Road Diesel (ppl)	+0.5ppl (+1.0%)	1.0ppl (+2.0%)	+1.5ppl (+3.0%)

High Oil Price ($105bbl)

Table 7.3a: Impact to 2030 of meeting the target by blending fuel to 8% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£748m	-£2,604m	-£4,457m
- Of which fuel costs	-£738m	-£3,550m	-£4,424m
- Of which welfare loss	-£9m	-£29m	-£33m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£1,052m	£1,082m	£1,112m
Net Present Value[1]	£304m	-£1,522m	-£3,345m
Net Present Value (with ancillary)	£358m	-£1,463m	-£3,280m
CO2 saved ($MtCO_2$)	51$MtCO_2$	53$MtCO_2$	54$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	3.3$MtCO_2$	3.4$MtCO_2$	3.5$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£15/tCO_2	£49/tCO_2	£82/tCO_2
Benefit Cost Ratio	1.41	0.42	0.25
Biofuel with 20% GHG saving			
Present value benefits	£452m	£483m	£514m
Net Present Value[1]	-£296m	-£2,121m	-£3,934m
Net Present Value (with ancillary)	-£241m	-£2,061m	-£3,878m
CO2 saved ($MtCO_2$)	22$MtCO_2$	24$MtCO_2$	25$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	1.4$MtCO_2$	1.5$MtCO_2$	1.6$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£34/tCO_2	£110/tCO_2	£177/tCO_2
Benefit Cost Ratio	0.60	0.19	0.12
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 7.3b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 8% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£2,182m	+£2,276m	+£2,369m
NPV impact on Firms	-£1,050m	-£2,125m	-£3,197m
NPV impact on Consumers (50%)	-£967m	-£1,790m	-£2,611m
NPV impact on Consumers (20%)	-£1,567m	-£2,389m	-£3,209m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 7.3c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 8% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+74,487	+74,302	+74,117
Reduction in fossil fuels (m litres)	-2,193m	-2,232m	-2,271m
Impact on Road Petrol price (ppl)	+1.3ppl (+1.2%)	+1.9ppl (+1.8%)	+2.4ppl (+2.3%)
Impact on Road Diesel price (ppl)	+0.3ppl (+0.3%)	+0.9ppl (+0.8%)	+1.4ppl (+1.3%)
Impact on Non-Road Diesel (ppl)	+0.1ppl (+0.2%)	+0.6ppl (+1.0%)	+1.1ppl (+1.9%)

High-High Oil Price ($150bbl)

Table 7.4a: Impact to 2030 of meeting the target by blending fuel to 8% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-	-£4m	-£1,176m
- Of which fuel costs	-	-	-£1,165m
- Of which welfare loss	-	-£4m	-£11m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	-	£1,136m	£1,051m
- Of which fuel costs	-	£103m	-
- Of which CO_2 savings	-	£1,033m	£1,051m
Net Present Value[1]	-	£1,131m	-£125m
Net Present Value (with ancillary)	-	£1,180m	-£109m
CO2 saved ($MtCO_2$)	-	51$MtCO_2$	51$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	3.1$MtCO_2$	3.3$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	-£2/tCO_2[1]	£23/tCO_2
Benefit Cost Ratio	-	270	0.89
Biofuel with 20% GHG saving			
Present value benefits	-	£536m	£451m
- Of which fuel costs	-	£103m	-
- Of which CO_2 savings	-	£433m	£451m
Net Present Value[1]	-	£531m	-£725m
Net Present Value (with ancillary)	-	£579m	-£709m
CO2 saved ($MtCO_2$)	-	21$MtCO_2$	22$MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	1.3$MtCO_2$	1.4$MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	£5/tCO_2	£53/tCO_2
Benefit Cost Ratio	-	127	0.38
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 7.4b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending 8% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	-	+£2,179m	+£2,274m
NPV impact on Firms	-	-£727m	-£1,106m
NPV impact on Consumers (50%)	-	-£477m	-£1,434m
NPV impact on Consumers (20%)	-	-£1,078m	-£2,033m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 7.4c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 8% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	-	+74,563	+74,455
Reduction in fossil fuels (m litres)	-	-2,177m	-2,200m
Impact on Road Petrol price (ppl)	-	+1.0ppl (+0.8%)	+1.8ppl (+1.4%)
Impact on Road Diesel price (ppl)	-	+0.2ppl (+0.2%)	+0.4ppl (+0.3%)
Impact on Non-Road Diesel (ppl)	-	+0.1ppl (+0.1%)	+0.2ppl (+0.3%)

Annex E – 5% biofuels by energy content in fuel

Low Oil Price ($45bbl)

Table 8.1a: Impact to 2030 of meeting the target by blending fuel to 5% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£539m	-£869m	-£1,199m
- Of which fuel costs	-£535m	-£863m	-£1,189m
- Of which welfare loss	-£3m	-£6m	-£9m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£168m	£175m	£181m
Net Present Value[1]	-£371m	-£694m	-£1,017m
Net Present Value (with ancillary)	-£364m	-£687m	-£1,009m
CO2 saved ($MtCO_2$)	$9MtCO_2$	$9MtCO_2$	$9MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$0.8MtCO_2$	$0.8MtCO_2$	$0.9MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£63/tCO_2	£98/tCO_2	£130/tCO_2
Benefit Cost Ratio	0.31	0.20	0.15
Biofuel with 20% GHG saving			
Present value benefits	£78m	£85m	£91m
Net Present Value[1]	-£461m	-£784m	-£1,107m
Net Present Value (with ancillary)	-£454m	-£777m	-£1,099m
CO2 saved ($MtCO_2$)	$4MtCO_2$	$4MtCO_2$	$5MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$0.4MtCO_2$	$0.4MtCO_2$	$0.4MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£136/tCO_2	£202/tCO_2	£257/tCO_2
Benefit Cost Ratio	0.14	0.10	0.08
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 8.1b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 5% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£313m	+£324m	+£336m
NPV impact on Firms	-£431m	-£621m	-£810m
NPV impact on Consumers (50%)	-£268m	-£409m	-£549m
NPV impact on Consumers (20%)	-£359m	-£499m	-£639 m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 8.1c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 5% biofuel by energy content – with a Low oil price ($45bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+17,026	+16,988	+16,949
Reduction in fossil fuels (m litres)	-522m	-533m	-544m
Impact on Road Petrol price (ppl)	+0.4ppl (+0.5%)	+0.6ppl (+0.6%)	+0.7ppl (+0.8%)
Impact on Road Diesel price (ppl)	+0.3ppl (+0.3%)	+0.4ppl (+0.5%)	+0.5ppl (+0.6%)
Impact on Non-Road Diesel (ppl)	+0.2ppl (+0.5%)	+0.3ppl (+0.8%)	+0.4ppl (+1.1%)

Central Oil Price ($75bbl)

Table 8.2a: Impact to 2030 of meeting the target by blending fuel to 5% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£273m	-£600m	-£927m
- Of which fuel costs	-£272m	-£597m	-£921m
- Of which welfare loss	-£1m	-£3m	-£6m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£161m	£167m	£173m
Net Present Value[1]	-£112m	-£433m	-£754m
Net Present Value (with ancillary)	-£107m	-£427m	-£746m
CO2 saved ($MtCO_2$)	$8MtCO_2$	$9MtCO_2$	$9MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$0.8MtCO_2$	$0.8MtCO_2$	$0.8MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£33/tCO_2	£70/tCO_2	£105/tCO_2
Benefit Cost Ratio	0.59	0.28	0.19
Biofuel with 20% GHG saving			
Present value benefits	£71m	£77m	£83m
Net Present Value[1]	-£202m	-£523m	-£843m
Net Present Value (with ancillary)	-£197m	-£517m	-£836m
CO2 saved ($MtCO_2$)	$4MtCO_2$	$4MtCO_2$	$4MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$0.3MtCO_2$	$0.4MtCO_2$	$0.4MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£75/tCO_2	£153/tCO_2	£219/tCO_2
Benefit Cost Ratio	0.26	0.13	0.09
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 8.2b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 5% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£310m	+£326m	+£341m
NPV impact on Firms	-£264m	-£455m	-£645m
NPV impact on Consumers (50%)	-£178m	-£320m	-£462m
NPV impact on Consumers (20%)	-£268m	-£410m	-£551m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 8.2c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 5% biofuel by energy content – with a Central oil price ($75bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+17,060	+17,025	+16,991
Reduction in fossil fuels (m litres)	-511m	-522m	-600m
Impact on Road Petrol price (ppl)	+0.4ppl (+0.4%)	+0.5ppl (+0.5%)	+0.6ppl (+0.6%)
Impact on Road Diesel price (ppl)	+0.2ppl (+0.2%)	+0.3ppl (+0.3%)	+0.4ppl (+0.4%)
Impact on Non-Road Diesel (ppl)	+0.1ppl (+0.2%)	+0.2ppl (+0.5%)	+0.4ppl (+0.7%)

High Oil Price ($105bbl)

Table 8.3a: Impact to 2030 of meeting the target by blending fuel to 5% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-£14m	-£338m	-£662m
- Of which fuel costs	-£13m	-£337m	-£659m
- Of which welfare loss	-£1m	-£2m	-£4m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	£156m	£162m	£167m
Net Present Value[1]	£142m	-£177m	-£495m
Net Present Value (with ancillary)	£147m	-£171m	-£489m
CO2 saved ($MtCO_2$)	$8MtCO_2$	$8MtCO_2$	$9MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$0.7MtCO_2$	$0.8MtCO_2$	$0.8MtCO_2$
Cost effectiveness (£/tCO_2)[2]	£2/tCO_2	£41/tCO_2	£78/tCO_2
Benefit Cost Ratio	11.2	0.48	0.25
Biofuel with 20% GHG saving			
Present value benefits	£66m	£71m	£77m
Net Present Value[1]	£52m	-£267m	-£586
Net Present Value (with ancillary)	£56m	-£262m	-£579
CO2 saved ($MtCO_2$)	$4MtCO_2$	$4MtCO_2$	$4MtCO_2$
CO2 saved ($MtCO_2$) in 2020	$0.3MtCO_2$	$0.3MtCO_2$	$0.4tCO_2$
Cost effectiveness (£/tCO_2)[2]	£4/tCO_2	£93/tCO_2	£169/tCO_2
Benefit Cost Ratio	4.7	0.21	0.12
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 8.3b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending fuel to 5% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	+£302m	+£320m	+£338m
NPV impact on Firms	-£97m	-£288m	-£478m
NPV impact on Consumers (50%)	-£86m	-£228m	-£371m
NPV impact on Consumers (20%)	-£176m	-£319m	-£461m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 8.3c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 5% biofuel by energy content – with a High oil price ($105bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	+17,087	+17,056	+17,025
Reduction in fossil fuels (m litres)	-503m	-512m	-522m
Impact on Road Petrol price (ppl)	+0.3ppl (+0.3%)	+0.4ppl (+0.4%)	+0.5ppl (+0.5%)
Impact on Road Diesel price (ppl)	+0.1ppl (+0.1%)	+0.2ppl (+0.2%)	+0.3ppl (+0.3%)
Impact on Non-Road Diesel (ppl)	+0.0ppl (+0.0%)	+0.1ppl (+0.2%)	+0.3ppl (+0.4%)

High-High Oil Price ($150bbl)

Table 8.4a: Impact to 2030 of meeting the target by blending fuel to 5% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Present value costs	-	-£0.4m	-£188m
- Of which fuel costs	-	-	-£187m
- Of which welfare loss	-	-£0.4m	-£1m
- Of which vehicle costs	-	-	-
Biofuel with 50% GHG saving			
Present value benefits	-	£180m	£158m
- Of which fuel costs	-	£25m	-
- Of which CO_2 savings	-	£155m	£158m
Net Present Value[1]	-	£180m	-£30m
Net Present Value (with ancillary)	-	£184m	-£28m
CO2 saved ($MtCO_2$)	-	$8MtCO_2$	$8MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	$0.7MtCO_2$	$0.8MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	-£3/tCO_2[1]	£23/tCO_2
Benefit Cost Ratio	-	462	0.84
Biofuel with 20% GHG saving			
Present value benefits	-	£90m	£68m
- Of which fuel costs	-	£25m	-
- Of which CO_2 savings	-	£65m	£68m
Net Present Value[1]	-	£89m	-£121m
Net Present Value (with ancillary)	-	£93m	-£119m
CO2 saved ($MtCO_2$)	-	$3MtCO_2$	$3MtCO_2$
CO2 saved ($MtCO_2$) in 2020	-	$0.3MtCO_2$	$0.3MtCO_2$
Cost effectiveness (£/tCO_2)[2]	-	-£7/tCO_2	£55/tCO_2
Benefit Cost Ratio	-	230	0.36
Non-monetised Impacts	Positive impacts on innovation, security of supply and congestion. Possible negative impacts on biodiversity and release of GHG if biofuels require land use change.		

[1] Reflects total benefits minus total costs discounted over the lifetime of the measure. These costs and benefits exclude 'ancillary impacts'' e.g. air quality. [2] Excluding ancillary impacts.

Table 8.4b: NPV impact to 2030 on Government, firms and consumers of meeting the target by blending 5% biofuel by energy content – with a High-High oil price ($150bbl)

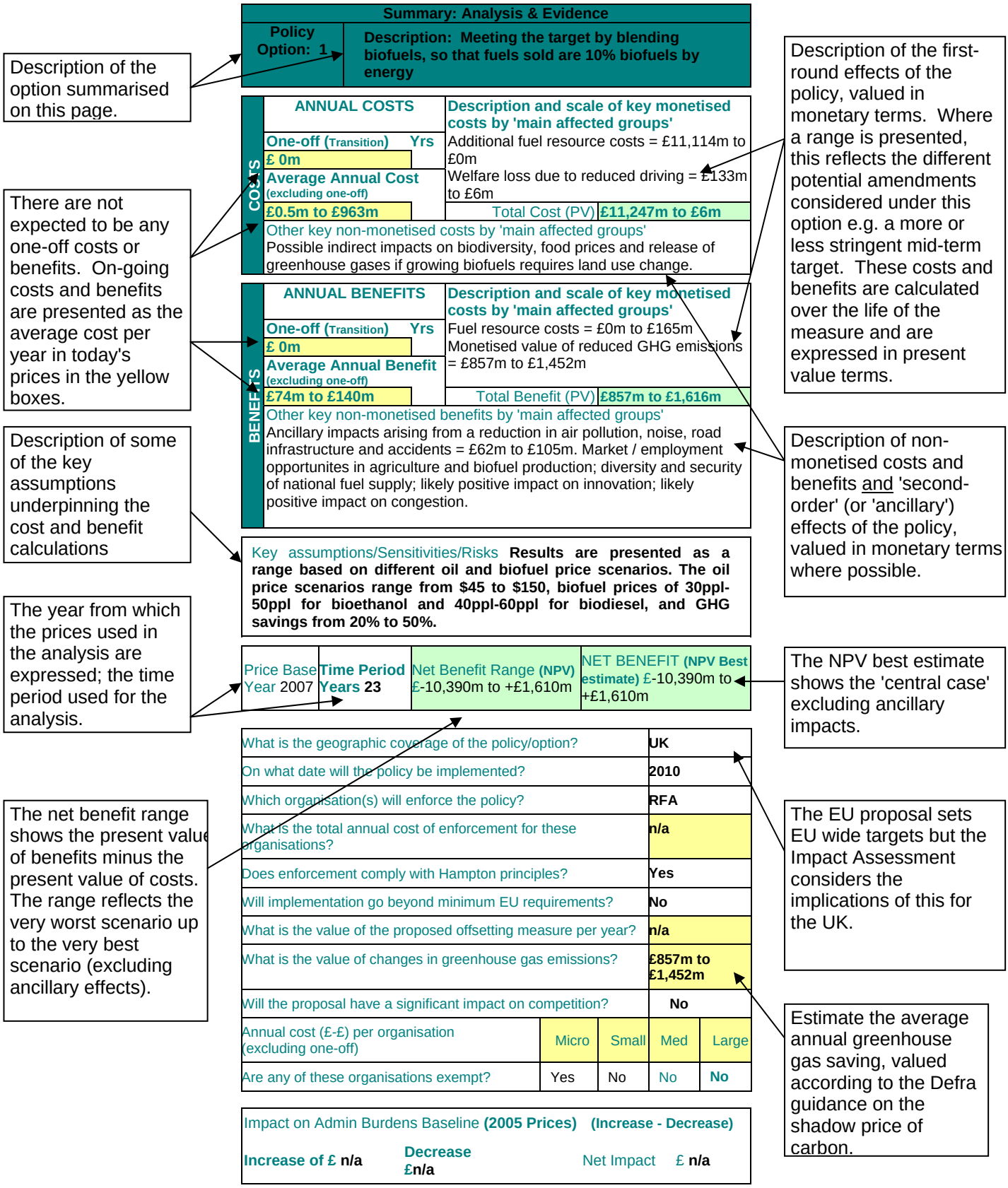
	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
NPV impact on Government	-	+£303m	+£320m
NPV impact on Firms	-	-£98m	-£172m
NPV impact on Consumers (50%)	-	-£50m	-£201m
NPV impact on Consumers (20%)	-	-£140m	-£291m

Positive numbers signify benefits, negative numbers signify costs. Figures include ancillary impacts.

Table 8.4c: Energy and pump price impact in 2020 of meeting the target by blending fuel to 5% biofuel by energy content – with a High-High oil price ($150bbl)

	Low Biofuel price scenario	Central Biofuel price scenario	High Biofuel price scenario
Increase in renewable energy (TJ)	-	+17,102	+17,081
Reduction in fossil fuels (m litres)	-	-499m	-505m
Impact on Road Petrol price (ppl)	-	+0.2ppl (+0.2%)	+0.4ppl (+0.3%)
Impact on Road Diesel price (ppl)	-	+0.1ppl (+0.0%)	+0.1ppl (+0.1%)
Impact on Non-Road Diesel (ppl)	-	+0.0ppl (+0.0%)	+0.1ppl (+0.1%)

Annex F – Key to the interpretation of 'Summary: Analysis and evidence' pages



Description of the option summarised on this page.

There are not expected to be any one-off costs or benefits. On-going costs and benefits are presented as the average cost per year in today's prices in the yellow boxes.

Description of some of the key assumptions underpinning the cost and benefit calculations

The year from which the prices used in the analysis are expressed; the time period used for the analysis.

The net benefit range shows the present value of benefits minus the present value of costs. The range reflects the very worst scenario up to the very best scenario (excluding ancillary effects).

Description of the first-round effects of the policy, valued in monetary terms. Where a range is presented, this reflects the different potential amendments considered under this option e.g. a more or less stringent mid-term target. These costs and benefits are calculated over the life of the measure and are expressed in present value terms.

Description of non-monetised costs and benefits and 'second-order' (or 'ancillary') effects of the policy, valued in monetary terms where possible.

The NPV best estimate shows the 'central case' excluding ancillary impacts.

The EU proposal sets EU wide targets but the Impact Assessment considers the implications of this for the UK.

Estimate the average annual greenhouse gas saving, valued according to the Defra guidance on the shadow price of carbon.