Department for Transport

Annex A: Supporting Recycled Carbon Fuels through the Renewable Transport Fuel Obligation

Cost-Benefit Analysis

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Introduction

Recycled carbon fuels (RCFs) are fuels made from fossil wastes like unrecyclable plastic and industrial gases. They provide significant carbon savings compared to traditional fossil fuels like petrol and diesel. However, due to their cost, additional support is needed to deliver these fuels at scale to the UK market.

There are environmental benefits to producing fuels from some fossil wastes if they can be more efficiently processed into a fuel employing advanced facilities, instead of disposing of them via conventional means, such as landfill or incineration. RCFs can encourage a more effective use of waste by offering greater energy recovery. They can deliver greenhouse gas (GHG) emission savings, as the resulting fuel can be used to displace conventional transport fuel.

Many fuels could potentially be produced from RCF feedstocks but there is particular interest in those which could provide drop-in replacements for existing fossil fuels, helping to decarbonise sectors which have fewer alternative decarbonisation options such as electrification. For example, RCFs can be made which are sufficiently similar to fossil diesel and petrol and can be mixed to very high blends, which could be used to decarbonise heavy goods vehicles. There is also considerable interest in using RCF feedstocks to produce sustainable aviation fuel – a key Government priority.

Background on the RTFO

The Renewable Transport Fuel Obligations Order 2007 established a certificate trading scheme, known as the Renewable Transport Fuel Obligation (RTFO) and is the Government's main mechanism for decarbonising transport fuel. While increasing vehicle efficiency and encouraging zero emissions vehicles will help secure net zero targets, these changes will take time. Liquid fuels will continue to be needed in the short term for the vehicles already on the road and in the longer term for use in sectors that currently cannot be easily electrified.

The RTFO operates by promoting a market for renewable fuels. It places obligations on larger suppliers of fossil fuel to ensure the supply of renewable fuels. Suppliers meet their obligations by acquiring certificates which are awarded for the supply of sustainable renewable fuels. The trade of these certificates provides a revenue stream for suppliers of renewable fuels.

In 2021, renewable fuels supplied under the RTFO saved 5.07 million tonnes CO2e. RTFO target increases over the coming years are anticipated to deliver additional savings equivalent to the annual emissions of a further 1.5 million average cars by 2032.

Since 1 January 2019 there has also been an additional sub-target supporting the uptake of "development" fuels which need greater support and fit the UK's long-term strategic needs. Development fuels are made from sustainable wastes or renewable energy, deliver higher carbon reductions than traditional biofuels, and include fuels of strategic importance such as aviation fuel, substitute natural gas, drop-in diesel or petrol, and renewable hydrogen. Fuels that meet the development fuel definition are eligible to receive development renewable transport fuel certificates (dRTFCs) and are made from feedstock which are awarded two dRTFCs per litre of fuel supplied.

The development fuel target has intentionally been set at an ambitious level with a higher buy-out price and a target that increases year-on-year. This is designed to provide a strong incentive to develop these advanced fuel types. To-date, no supplier has fully met the development fuel target with dRTFCs alone with all suppliers at least partially buying out of their obligation.

Policy proposals

Currently, the RTFO only supports low carbon fuels of renewable origin. Developments in fuel technologies now enable advanced low carbon fuels to be developed from fossil-derived wastes – so-called recycled carbon fuels (RCFs). RCFs are different to renewable fuels in that they are produced from fossil wastes that cannot be prevented, reused, or recycled but still have the potential to reduce GHG emissions relative to conventional fossil fuels. Examples of feedstocks include the fossil fraction of municipal solid waste (MSW) (e.g., non-recyclable plastic) and industrial waste gases. RCFs can deliver comparable carbon savings to renewable fuels already supported under the RTFO and therefore meet the wider policy intent of the RTFO – to cut carbon emissions from harder to decarbonise transport modes.

In July 2022, the Department for Transport (DfT) issued a consultation entitled “Supporting recycled carbon fuels through the Renewable Transport Fuel Obligation”. This followed on from our Government response to the March 2021 consultation, “Targeting net zero – next steps for the Renewable Transport Fuel Obligation”, which confirmed the intention to support RCFs under the RTFO. The July 2022 consultation requested views on the policy behind supporting RCFs.

This included seeking stakeholder input regarding feedstock eligibility and biogenic content, the RCF reward rate and the proposed GHG methodology and threshold. A cost-benefit analysis was published alongside the 2022 consultation, to support the policy proposals. This is an updated cost-benefit analysis, provided as evidence to our final policy position.

In terms of risk, there is a risk if the policy is not designed adequately that support will not be sufficient to deliver RCFs. There is also a risk that, if the incentive is too great, RCFs could divert wastes from more efficient uses, such as recycling. These risks are being mitigated via further consultation on the detail of the support and eligibility criteria. This involves a range of technical experts, other Government departments, fuel suppliers and wider stakeholders.

Objective of this cost-benefit analysis

The main policy objective is to maximise the carbon savings delivered by the RTFO. To do this, increasing the range of fuels that can be considered, particularly in relation to the development fuel target, ensures we minimise buy-out and maximise the replacement of traditional fossil fuels with lower carbon alternatives.

In supporting RCFs DfT will also help to foster investment and innovation in the advanced fuel sector which may be vital to our ambitions to decarbonise hard to electrify modes such as aviation and HGVs. Supporting RCFs will also encourage the innovation needed to

increase the deployment of low carbon fuels in transport sectors which are more challenging to decarbonise such as aviation and HGV's.

This cost-benefit analysis has been undertaken to test and, where appropriate, monetise, the impact of the RCF policy, while having regard to the core policy objective – maximising the carbon savings delivered by the RTFO. The cost-benefit analysis sets out the impacts of the policy measures in further detail.

The supply scenarios are based on RCF plants being able to utilise all available feedstock in order to meet the development fuel obligation. As a result, these should be considered as an upper bound of possible RCF supply. It is unlikely this level of supply will be realised in the early years as there are other barriers to RCF plant deployment that have not been considered as part of this modelling due to a lack of available evidence. RCFs are a new technology, and some production pathways still need to be proven at scale.

Methodology and options considered

Methodology

The impacts of the policy are compared against a baseline scenario which includes only firm and funded policies. This assumes that the RTFO is in place with the development fuel RTFO (dRTFO) also in place, and RCFs cannot be used to meet the dRTFO. Currently, a small proportion of development fuels are produced to meet the dRTFO. It is assumed this continues. However, without further policy change the majority of the dRTFO target continues to be bought out, as there are not enough dRTFO fuels available. This is the baseline used within this modelling and all impacts of this policy change are measured over and above these current firm and funded commitments.

The policy scenario assumes that legislation is updated so that RCFs can be used within the dRTFO. This incentivises fuel suppliers to invest in the production of RCFs to meet the dRTFO target and avoid the cost of paying buy-out.

This CBA estimates RCF volumes supply based on projections of potential supply developed by Ricardo for their Low Carbon Fuel Feedstock model, which was developed for DfT in 2022.This gives a steadily rising potential availability of RCFs over the period.

Given the RCF production industry is undeveloped there is little reliable information to draw from in order to develop this CBA accurately in terms of costs. Therefore, this CBA relies on several core assumptions relating to the costs of RCFs. These assumptions were used in the previous iteration CBA for consistency. It is assumed that RCFs are provided at an average cost of 60p per litre.

To estimate the economic outcomes of the addition of RCFs in the development fuel RTFO (dRTFO), this analysis first estimates how many certificates would be required to meet the dRTFO target using the DfT biofuels model.

As noted above, a small amount of development fuel is provided already under the dRTFO. Provisional RTFO data from 2021 shows that that 87m litres of development fuel was provided in 2021, and this is assumed to continue indefinitely over the period of the

appraisal. RCFs are then supplied above the current supply up to the limit of the dRTFO target, as there is no incentive for suppliers to go further than this. The analysis also ensures that RCF is only supplied if there is enough feedstock to reach that level, based on projections provided in the [Low Carbon Feedstocks Model]. Under the most recent supply estimates there is enough RCF feedstock supply to reach the dRTFO target by 2030. After this, the left-over feedstock will likely be supplied to other markets, e.g., to produce SAF.

Based on the additional RCF fuel supplied to meet the dRTFO, GHG savings are estimated using long standing carbon intensity estimates, which will also be implemented in the LCF strategy. This assumes that the carbon emissions of recycled carbon fuels are 24gCO2e/MJ, and the carbon emissions of fossil petrol are 89gCO2e/MJ, diesel are 92gCO2e/MJ and Jet-A is 89gCO2e/MJ. This delivers on average a 73% reduction on emissions versus fossil fuel.

As noted, given RCFs will be new to the market, their costs are unknown. Therefore, as per the last iteration of this CBA, the new supplied RCFs are assumed to cost on average 60p per litre. This assumes that the price for RCF varies from 40p per litre more than fossil fuel equivalents, which was the average differential for the mark up for petrol and diesel between 2019-21 (rounded to the nearest 10 pence), rising up to a maximum of 80p per litre, which is the buyout price of the RTFO. The basis for the upper bound is due to the buy-out being 80p per litre for a dRTFO, meaning a supplier would not provide fuel for a cost greater than this. This price recognises that the cost of RCFs is likely to be higher than other biofuels, especially in the short run. It is recognised that these are broad assumptions, but they represent estimates which are consistent with examples of existing biofuels and a theoretical maximum price and are best available given a lack of reliable market data.

The carbon saving benefits were monetised using the central carbon price from the latest DESNZ guidance and discounted in line with the HMT green book guidance. The appraisal was calculated using a 10-year period from 2024.

Scenarios considered

As this CBA is focussing on the final Government position on RCFs, no optioneering analysis has been conducted. Therefore, we have tested one potential scenario as part of this analysis. This scenario is appraised over and above the baseline:

Baseline – No RCFs supported under the RTFO. Under the RTFO, fuel suppliers are required to meet a development fuel target. Like the RTFO main obligation, the development fuel target operates as a certificate trading mechanism, whereby certificates (dRTFCs) are issued to suppliers of renewable transport development fuel to demonstrate that an obligated supplier has met their obligation. Where suppliers fail to redeem sufficient dRTFCs, they must pay buy-out price of 80 pence per dRTFC. If RCFs remain ineligible for support under the RTFO, there will remain no incentive to supply them. Therefore, in the absence of any policy change, suppliers will face the cost of continuing to supply other non-RCF development fuels or the cost of buying out.

Scenario 1 - reward RCFs under the RTFO with a reward rate of 1 dRTFC per litre of eligible fuel supplied. This is expected to deliver additional delivery of RCFs to meet

the target and avoid the cost of buying out of the dRTFO. This results in additional carbon savings and additional costs of supply RCFs.

Results

RCF supply and GHG saving projections

The analysis underpinning this CBA assumes a medium level of uptake in RCF supply, which is shown in Table 1. The supply of RCFs in this analysis is based on the assumptions outlined in the methodology above. In particular, inclusion of RCFs within the dRTFO leads to incentives to supply RCFs and additional RCF supply. Initially the scale of RCF supply is limited by the availability of these fuels, which steadily rises until 2030. At this point the dRTFO target is completely met and the rate of growth of RCFs is then constrained by the size of the dRTFO target.

Under scenario 1, supply would begin with 53.7 million litres in 2024 and increase to 1,122 million litres by 2033. The GHG savings anticipated under this option will increase from 0.12m tCO_2e in 2024 to 2.59m tCO_2e in 2033 (figure 1).

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Scenario 1: projected RCF supply (millions, litres)	53.7	81.7	280	474	664	848	963	1,048	1,132	1,122
Scenario 1: GHG savings (millions tCO_2e)	0.12	0.19	0.65	1.10	1.54	1.97	2.24	2.43	2.62	2.59

Table 1 Projected supply of RCFs and corresponding GHG savings used in the cost benefit analysis

Costs

Monetised Costs

On-going Costs

The majority of the costs associated with allowing RCFs to be supported under the RTFO relate to the cost of supplying the new RCF fuel. As discussed above the average cost of RCFs is assumed to be 60p per litre (above the cost of fossil fuel equivalents – petrol or diesel). These costs are social costs and are modelled in the Net Present Value calculations below, over the full appraisal period this cost is £3.22bn.

Benefit to business

Overall, there will be benefits to business from allowing RCF to be eligible to claim support under the RTFO. Under the RTFO order, suppliers are already obligated to supply a

portion of development fuel or buyout at a fixed price, and the majority of the dRTFO is currently bought-out. Widening eligibility to RCFs will allow businesses to choose to provide RCFs in place of buying out, if it is cheaper to do so, and therefore this policy can only reduce costs to business. If the cost of RCFs are higher than buying out, then they will not be supplied. It is proposed that 1 certificate will be earned per litre supplied. Therefore, a rational supplier would only supply RCFs where the net cost of supplying the fuel is less than 80p per litre.

This benefit to business is not captured within the CBA below, as the cost saving to business from not buying out is a transfer and is offset by a loss of revenue to Government (discussed below). For simplicity the cost saving from reduced buy-out and the loss of revenue to Government are both excluded from the CBA.

Loss of revenue to government

Under the RTFO, suppliers can buyout of their development fuel target obligation at a price of 80 pence per dRTFC. Under both scenarios, RCFs will earn 1 certificate per litre produced, meaning the cost would be 80p per litre (or 80p per dRTFC).

Any buy-out receipts from suppliers are surrendered by the Department to the Exchequer, in line with HM Treasury rules. However, the buy-out was not designed to be a revenue raising mechanism. The development fuel buy-out price is intended to support high value and high carbon saving development fuels. The higher certificate value and double certificate reward for fuel means that while there is insufficient development fuel supply to meet demand, there should be a demand for them equivalent to £1.60 a litre above the cost of the equivalent fossil fuel. This mechanism stops prices spiralling upwards while creating a high value market for dRTFO fuels.

As such, the supply of RCFs is a redistribution of costs, which results in lost revenue for Government. Due to the varying supply rates under the two options, the loss of revenue varies significantly. Based on the levels of RCF supply assumed in this analysis, the total loss of revenue in scenario 1 for Government over the appraisal period would be £4.29bn (table 2).

As discussed above, the buy-out receipts for the UK Government are an economic transfer from fuel producers and therefore are not included in the final net present value of this analysis. However, for completeness the below table represents the loss of tax receipts, which is equal to the benefit to business of reduced buy-out payments.

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Projected revenue from buy-out receipts (PV £m)	344	405	459	507	550	589	622	654	681	651	5,462
Scenario 1: Projected revenue with policy change (PV £m)	301	341	250	166	90	21	0	0	0	0	1,169
Scenario 1: Net lost revenue from buy-out receipts (PV £m)	43	63	209	341	460	568	622	654	681	651	4,293

Table 2 Summary of losses to Government revenue (equal to reduced buy-out payments from business) as a result of policy change

However, in addition, this policy will support jobs, adding to the economy and generating income tax receipts. Furthermore, the buy-out was not designed to be a revenue raising mechanism. The intention when the RTFO was designed was for the utilisation of buy-out to reduce as more development fuels are bought to market.

Unmonetised Costs

There may be some administrative costs to business of supplying RCFs. For example, a small amount of Full Time Standard Equivalent (FTSE) may be required to ensure that RCFs are certified and verified as sustainable. However, this cost is likely to be negligible.

Benefits

The main benefits of including RCFs under the RTFO are

(1) contributing to additional carbon savings associated with supplying RCFs instead of traditional fossil fuels.
(2) supporting RCFs to get to market at scale.

Monetised Benefits

GHG savings

RCFs offer the potential to reduce emissions by substituting a portion of petrol and diesel emissions with materials made from fossil-derived wastes (e.g., MSW or industrial waste gases) that would otherwise be landfilled or incinerated.

Introducing supports for RCFs under the RTFO would widen the types of fuels available for businesses to supply to meet the development fuel target. However, there would be no requirement for businesses to supply RCFs. Therefore, GHG savings in this section are

based on an assumed level of RCF supply, based on information on the availability of feedstocks and production assumptions.

GHG savings have been measured against a counterfactual state where no RCFs are supplied in the absence of support under the RTFO. As noted above, modelling assumes a small proportion of the dRTFO is met based on existing fuel supply. Savings from additional RCF supply are measured relative to the lifecycle emissions of the GHG value of fossil fuels. The carbon savings benefits were monetised and discounted in line with the HMT green book.

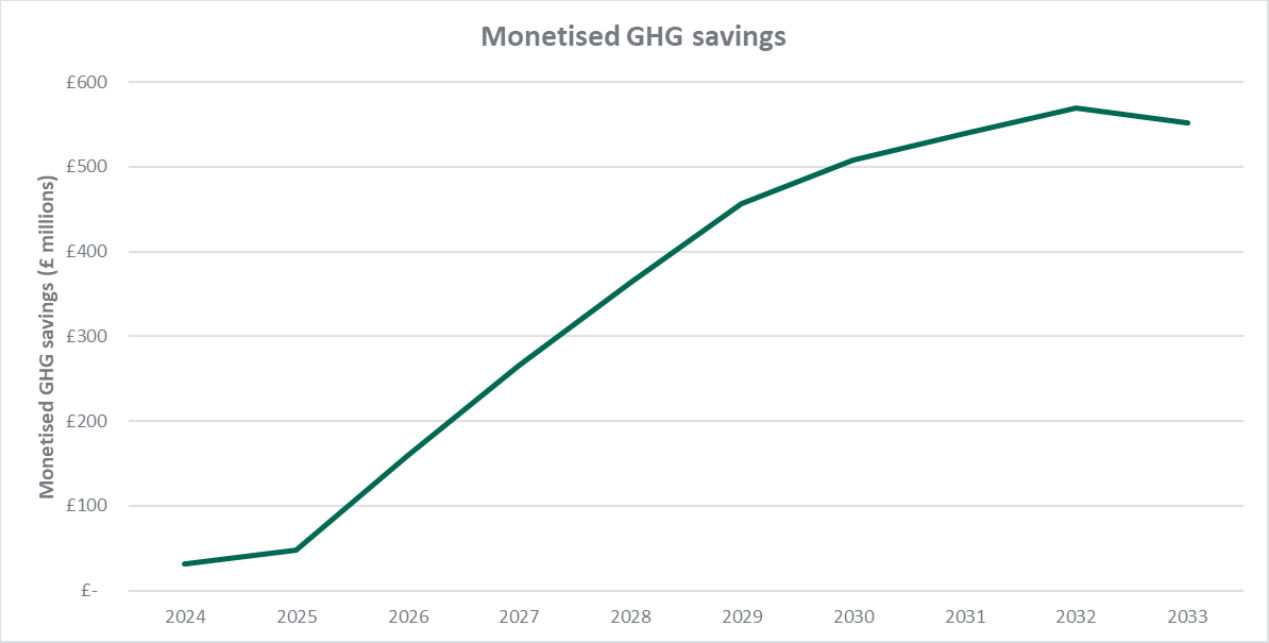

Figure 1 A line graph to show the monetised GHG savings from RCF supply from 2024-2033, with a reward rate of 1 dRTFC/litre.

The present value of GHG savings that could arise across the appraisal period of 10-years is £3.49bn under scenario 1. The majority of these GHG savings are derived from municipal solid waste (MSW) feedstocks.

Unmonetised Benefits

Air quality

RCFs are not expected to alter the air quality characteristics of fuels generally. The fuels are required to be produced to be chemically similar to the fossil fuels they displace in order to receive support. As a result, air quality impacts are expected to be negligible and are not quantified. Where RCFs are used in existing internal combustion engines, air quality pollutants are linked more to the engine and exhaust system than the fuel itself. The final fuels will still need to fall within existing fuel standards in terms of their quality and chemical composition.

Diverting waste from landfill

In addition to GHG benefits, adding RCFs to the RTFO could divert waste from landfill or incineration. However, it is difficult to estimate and monetise how much waste would be

diverted upon allowing support RCFs. There is likely to be competing demands for the use of municipal solid waste outside of the fuel industry, for example, as input for electricity from waste generation.

Facilitating the decarbonisation of challenging sectors

RCFs have the potential to make an important contribution to net zero goals as they are suitable for producing aviation fuel and “drop-in” road fuel suitable for heavy goods vehicles – sectors with fewer decarbonisation options.

Supporting the emerging advanced fuels industry

Including RCFs under the RTFO would provide crucial revenue support for an emerging industry seeking to use advanced conversion technologies, which could be further developed to produce fuels such as sustainable aviation fuel (SAF). The UK is a strong early player in this market and this policy has the potential to support the development of a world leading UK SAF sector.

Including RCFs in the RTFO would provide support to other advanced fuels industries, such as the sustainable aviation fuel (SAF) industry, which will be crucial for decarbonising transport. The production of RCFs would likely require research to develop optimal production methods. This research and development knowledge will be transferred to the emerging SAF market.

Wider economic benefits of supporting an emerging industry

Supporting an emerging industry like RCFs would lead to wider economic benefits in the areas where the plants are located, such as supporting jobs and the facilitation of future investment. This has the potential of partially offsetting the tax losses set out above.

Risks and uncertainty

The supply of RCFs for the analysis in this CBA is based on SAF capacity assumptions on proposed SAF production, up to the limit on feedstock supply. This is based on a baseline of existing firm and funded policy.

The introduction of the SAF Mandate, which is scheduled for introduction in 2025, could take some of the projected RCF supply away from the RTFO for use in SAF. The interaction on available biomass will be explored within the SAF mandate CBA. As such, this presents a maximum scenario for the supply of RCFs in the dRTFO, and it is very feasible that the supply of RCFs could be lower than presented here.

DfT has also committed to a range of policies within the Carbon Budget Delivery Plan, which will lead to a faster shift to zero emission road transport vehicles, and so the amount of dRTFCs required to meet the target will fall. Therefore, there is a significant risk that this analysis is overestimating the volume of RCFs which will enter the market towards the end of the appraisal period where the RCF supply becomes capped by the development fuel target.

Recently the Government has announced the implementation of the ZEV Mandate for cars and vans. This analysis does not incorporate this policy into the baseline, as it was published on 25 October 2023 – and therefore we have not had time to incorporate it into an updated baseline for this analysis.

Including the adjustments above, may be expected to change the amount of RCF delivered to the car market. However, they would not be expected to change the conclusion of the analysis that this policy delivers overall net benefits to society.

Further, as represented by the sensitivity tests, the conclusions of the analysis are sensitive to carbon values. If carbon is valued at a lower price, the value for money of this change to the dRTFO falls into an overall cost for society. If carbon is valued at the higher price, the benefits to society increase significantly.

Summary

The proposed option to allow RCFs to be eligible to claim support under the RTFO is anticipated to have a positive net present value for society due to the additional costs of supplying RCF being outweighed by the gained GHG savings. However, it should be noted broad assumptions have been used in the analysis regarding the cost of producing RCFs, which are uncertain. If no RCFs are produced counter to the scenarios presented above, the production costs and tax receipts would not change over the baseline.

The policy is expected to deliver overall benefits to suppliers because they no longer pay buy-out costs and although they face additional costs of producing RCF fuels, these are cheaper than the cost of buy-out. Fuel suppliers must either meet their development fuel obligation through supplying development qualifying fuel or paying the buy-out price. As a result, any RCF fuel supplied under the development fuel target would mean that suppliers do not need to buy-out of that part of their obligation. Assuming that some of this cost is passed through to motorists, overall, this policy would be expected to deliver a small potential benefit to the motorist.

If RCFs are supplied, there will be a loss in revenue to Government from a reduction in buy-outs required to meet the development fuel target which is offset by the same benefit to business from paying fewer buy-out certificates. Based on the level of RCF supply assumed in this analysis, the total loss of revenue for Government under scenario 1 over the appraisal period would be £4.29bn and the total benefit to business from reduced buy-out payments is also £4.29bn. As these two figures net-off they are not reported in headline tables on costs and benefits. It should be noted that the RTFO and its option to buy-out of obligations were not designed to raise revenue. In addition, there are a range of non-monetised benefits, which will offset some of the financial cost and be of high strategic (e.g., supporting SAF production) or reputational importance (e.g., making effective use of difficult to manage wastes).

Based on the assumed RCF supply, the present value of GHG savings that could be delivered across the appraisal period in scenario 1 is £3.49bn. In addition, the production of RCFs repurposes hard to manage waste that could have otherwise been disposed of via incineration or landfill.

Under scenario 1, where the supply of RCFs is at a medium level, the net present value is £0.3bn. This delivers overall benefits to society.

Summary table

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Present Value Cost (£m)	32	47	157	256	345	426	467	490	511	488	3,219
Present value benefit (£m)	32	47	160	265	364	456	508	540	569	551	3,492
Net present value	-0.40	0.08	3.25	9.57	18.7	30.2	41.0	49.4	58.4	62.8	273

Table 3 A summary of present value costs and benefits of scenario 1 (£m - rounded)

Sensitivity tests

In order to test the value for money of this proposal we have used the low and high range of carbon price series as published under Green book guidance.

Sensitivity test results

	Low Carbon value summary	High Carbon value summary
Present Value Cost (£m)	3,219	3,219
Present value benefit (£m)	1,746	5,238
Net present value	**-1,473**	**2,019**

The sensitivity tests show that the conclusions of the appraisal are dependent on carbon values to ensure that the changes to the RTFO are an overall benefit to society. In the scenario where the lower carbon values are used the changes to the RTFO will lead to a negative net present value of £1.4bn, representing a scenario where the costs of supplying

RCFs are greater than the carbon savings. In the high carbon valuation sensitivity, the net present value increases to a positive £2bn.