Title: Renewable Transport Fuel Obligation: Post Implementation Review **IA No:** **Lead department or agency:** DfT **Other departments or agencies:**	**Impact Assessment (IA)** **Date:** 30/04/2014 **Stage:** Post Implementation Review **Source of intervention:** EU **Type of measure:** Primary legislation **Contact for enquiries:** Aaron Berry 0207 944 3711 aaron.berry@dft.gsi.gov.uk

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Summary: Intervention and Options

RPC Opinion: Not Applicable

Cost of Implemented Policy				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB on 2009 prices)	**In scope of One-In, Two-Out?**	**Measure qualifies as**
-£1,914m	-£2,209m	£343m	Yes/No	NA

What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)	**Traded:**	**Non-traded:**
		-5.1

What were the policy objectives and the intended effects?

The objectives of the policy are to increase the supply of biofuel with the aim of reducing transport GHG emissions and demonstrating compliance with EU Renewable Energy Directive (which sets a 10% 2020 target for renewable energy in transport) and Article 7a of the Fuel Quality Directive (which requires a 6% reduction in transport fuel GHG emissions by 2020).

How have the policy objectives been achieved? Please highlight any unintended consequences.

The RTFO has been effective in increasing the biofuel supply. Best estimates of GHG savings (taking into account estimates of emissions attributed to Indirect Land Use Change) show that RTFO GHG savings were negative (i.e. a net increase in GHG emissions) in year 1 (08/09). However, subsequent policy changes (e.g. double certification of waste-derived biofuels, sustainability crietria and a duty incentive for used cooking oil derived biodiesel) have been effective in mitigating the effects of indirect land use change and GHG savings improved significantly in years 3 to 5 of the scheme. Carbon cost effectiveness (taking into account estimated emissions from Indirect Land Use Change) fell from £2,035/tCO2e in 09/10 to £211/tCO2e in 12/13.

The RTFO has been effective in demonstrating compliance with EU Directives. However, RTFO targets will need to be increased significantly to meet 2020 EU 2020 renewable energy and carbon reduction targets. These targets are currently the subject of negotiations at an EU level.

What was the original commitment date to review this policy?	04/2014

If you did not meet the original commitment date to review this policy please explain why.

n/a

SELECT SIGNATORY Sign-off For Post Implementation Review Impact Assessments:

I have read the IA and I am satisfied that it represents a fair and proportionate assessment of the impact of the policy.

Summary: Analysis & Evidence

Policy Option 1

Description:

FULL ECONOMIC ASSESSMENT

Price Base Year 2014	**PV Base Year** n/a	**Time Period Years** 5	**Net Benefit (Present Value (PV)) (£m)**		
			Low:	**High:**	**Best Estimate:** -1914

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low				
High				
Best Estimate	285		386	**2,215**

Description and scale of key monetised costs by 'main affected groups'

Key costs captured are: (1) the additional cost of biofuel relative to fossil fuel; (2) infrastructure costs; (3) biofuel blending costs; (4) government administration costs; (5) fuel supplier administration costs; (6) fuel retailer costs. With the exception of (4) all costs are borne by fuel suppliers obligated under the RTFO and are assumed to be passed through to fuel consumers through higher pump prices.

Other key non-monetised costs by 'main affected groups'

Costs which have not been explicitly monetised in this cost benefit analysis include potential price impacts in markets where biofuels feedstocks have alternative uses (e.g. food markets, the market for tallow).

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low				
High				
Best Estimate				**301**

Description and scale of key monetised benefits by 'main affected groups'

The only monetised benefits captured are GHG savings. These have been valued using Department of Energy and Climate Change carbon values.

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

Benefits which have not explicitly monetised in this cost benefit analysis include development of a UK biofuels industry (capital investment and jobs), increased agricultural production, diversification of the fuel supply, increased production of protein rich animal feed (as a co-product of bioethanol production)

Key assumptions/sensitivities/risks | **Discount rate** | n/a

The key uncertainty in this analysis are assumptions around the impact of indirect land use change of GHG savings. These values are the outputs of complex

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**In scope of OITO?**	**Measure qualifies as**
Costs: 343	**Benefits:**	**Net:** -343	Yes/No	IN/OUT/Zero net cost

1) Executive Summary

Introduction

The government has made commitments to tackling climate change, and introduced a comprehensive package of policies and legal commitments to achieve carbon reductions. Transport makes up a large proportion of UK greenhouse gas emissions (21% by source in 2010)[1], and reducing these requires a step change in technology and investment. Sustainable biofuels can deliver substantial reductions in emissions from transport and have an important role to play in the transition to a low carbon economy.

The Renewable Transport Fuel Obligation (RTFO) was introduced in April 2008 to support the supply of sustainable biofuels in the UK, and to meet our European obligations. The RTFO implemented the EU Biofuels Directive and requires fuel suppliers to ensure that a minimum proportion of their transport fuel is from a renewable source.[2]

The RTFO was amended extensively in 2011 to implement the EU Renewable Energy Directive (RED).[3] This gave greater certainty over the sustainability of biofuels by introducing mandatory sustainability criteria, as well as incentivising non crop biofuels by introducing 'double counting' for those derived from wastes and residues. At the same time further amendments were made to implement the EU Fuel Quality Directive by including a reporting requirement on emissions of fossil fuels and extending the scope of the obligation to include fuels used in non-road mobile machinery (NRMM).[4] Further amendments are expected to address Indirect Land Use Change (ILUC) following the outcome of European negotiations.

Purpose of Review

As part of government's overall commitment to improving regulation and to reducing the burdens it imposes, ministers committed to reviewing the effectiveness of the RTFO amendments by April 2014 in a Post Implementation Review (PIR). The scope of the review covers the extent to which the RTFO has achieved its objectives, to assess costs and benefits, and to identify any unintended consequences. In addition, the review is intended to consider how implementation and enforcement could be improved.

Government guidance on policy evaluation are published in the Magenta Book.

https://www.gov.uk/government/publications/the-magenta-book

Conclusions

To what extent has the policy achieved its objectives?

The RTFO was intended to:

- increase the supply of biofuels in line with Government targets; and
- achieve carbon savings in transport;

The amendments to the RTFO in 2011 were intended to:

- improve sustainability outcomes; and

[1] https://www.gov.uk/government/publications/total-greenhouse-gas-emissions-from-transport
[2] Directive 2003/30/EC
[3] Directive 2009/28/EC
[4] Directive 2009/30/EC

- incentivise the supply of non-crop biofuels by ‘double counting’ biofuels derived from waste and residues.

Biofuel supply

The RTFO has been successful in moving biofuel supply from a niche activity to a normal business operation for all major UK suppliers of road fuels, and production capacity has increased significantly over the life of the policy. The obligation percentage has increased from 2.5% to 4.75% and the vast majority of suppliers have met their obligations every year through the supply of biofuels rather than buying out.

Carbon reduction

In Year 5 the RTFO achieved carbon savings of around 1.7 mtCO_2e /year (equivalent to taking around 600,000 cars off the road), even when the wider ‘indirect’ (i.e. ILUC) impacts of biofuel production are taken into account. Although this is lower than the 2.7 mtCO_2e /year originally anticipated by this stage in the RTFO's lifetime, it reflects a lower supply of biofuels than originally intended because Government has held back from increasing targets pending the outcome of EU negotiations on ILUC. With ILUC taken into account, UK supplied biofuels are currently delivering an average of 60% less carbon emissions compared to the equivalent fossil fuels.

Sustainability

Following the amendments to implement the RED, 100% of biofuel has been certified as being sustainable in Year 5 of the obligation. Double certification of waste derived fuels has maintained an effective incentive for the use of waste derived fuels, which accounted for 50% of supply in Year 4 and 40% in Year 5.

What have been the costs and benefits of RTFO implementation?

The RTFO represents a net cost to society as the costs (£2,215m) are estimated to outweigh the benefits (£301m) by £1,914m over the first 5 years of the scheme.

The RTFO has been effective overall at reducing carbon emissions, though the available measures to reduce emissions in transport remain relatively more expensive than those available in other sectors. Under the RTFO the cost of carbon abatement in year 5 is around four times that of the Government's benchmark value to evaluate cost effectiveness of carbon abatement measures of this kind. However, as a means of meeting Renewable Energy Directive targets, the RTFO has been relatively cost effective when compared with renewable energy subsidies in the heat and power sectors. At the time the RTFO was set up, controls were put in place to protect the consumer by limiting the extent to which these costs could be passed on at the pump. This cap is currently 1.7 pence per litre, whilst year 5 (12/13) pump price impacts were around half that level, at 0.9p per litre (which equates to around an additional £9 per year on the average car's fuel bill). However, it should be noted that biofuel policy is part of a wider package of measures to reduce CO_2 emissions in transport which has had the combined effect so far of saving the average motorist money (for example fuel efficiency targets are estimated to have saved the average motorist £35/year in 2013), more than offsetting the cost impact of biofuels. The costs of administering the obligation have been reduced significantly over the period, by some 40% over baseline.

Industry

The effects on industry are mixed. Market share for small suppliers has been broadly maintained over the period while the number of small firms has reduced. Some suppliers have diversified into other areas whilst some have gone out of business. Overall there has been significant consolidation and a move away from a cottage industry to large scale commercial supply. Around £1 billion of investment has been made in large scale production facilities, but some businesses have struggled and have had to impose temporary plant closures. Overall UK production capacity has increased.

Have there been unintended consequences?

The UK has been at the forefront of countries in the world to press for consideration of indirect effects of biofuel production. At the time the RTFO was being implemented in 2008, scientists were questioning whether the lifecycle methodologies used for biofuels appropriately reflected their net effect on GHG emissions. The UK's Gallagher Review concluded that crop derived biofuels could 'indirectly' cause expansion of agricultural production onto carbon rich land.

Amendments to implement the RED requirements have helped to reduce the ILUC effects of fuel supply under the RTFO. Encouraging the use of waste derived biodiesel over crop derived biodiesel has helped to ensure that the RTFO currently offers significant carbon savings. The Government has pressed for effective action on ILUC while further amendments to control for ILUC effects are negotiated in Europe. In the meantime, the Government has held back in setting higher targets, which could see a return of higher levels of crop based biodiesel.

Is Government intervention still required? Or has the market changed as a result of the policy?

Sustainable biofuels are an effective means of reducing carbon emissions from transport, but on a per unit basis, they remain more expensive than fossil fuels. If their use is to be supported, the need remains for an effective mechanism to ensure supply and to meet our European obligations. Without Government intervention we would expect the quantity of biofuel supplied to fall dramatically.

What is the scope for simplification or improvement?

The regulatory framework of the RTFO has become more complex over time in attempts to ensure that biofuels supplied offer the benefits underpinning Government support. Legislative proposals are under discussion at European level intended to improve the regulatory framework to address ILUC sustainability concerns. If agreed these may add further complexity to the regulatory framework.

The main calls from industry to improve the RTFO have been to set a target supply trajectory towards the RED target of 10% in 2020 to provide greater certainty. Smaller producers have called for a variety of measures to increase support for UK UCO supply. Policy development in this area would need to be assessed against the criteria set out in the Bioenergy Strategy, aimed at making a cost effective contribution to UK carbon emission objectives by maximising the overall benefits and minimising costs.

Do compliance levels indicate that the enforcement mechanism chosen is appropriate?

The RTFO has been operated using risk based enforcement mechanisms, and compliance has generally been good. One supplier has been issued with a civil penalty for failing to meet their obligation and a small number of suppliers have been issued with civil penalties for late registration with the scheme. The vast majority of suppliers have met their obligations in full each year. Concerns emerged about whether all of the used cooking oil supplied in Year 4 was genuine, and as a result, changes were made by the Administrator to introduce a tighter compliance policy. This measure has been effective in providing greater assurance over the origin of all biofuel supply under the RTFO.

How has biofuel policy evolved over time?

Fuel duty incentives (2002 to 2012)

Prior to the RTFO, biofuels were incentivised through reductions in fuel duty relative to fossil fuel. 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. The first two fiscal years of the incentive made limited impact on biofuel supply: in this period biofuels made up just 0.04-0.06% of total UK fuel sales.

Duty incentives were announced on a rolling three year basis to provide some certainty for investors. However, there were concerns that:

- the duty incentive promised for three years still did not provide sufficient certainty to stimulate the market;
- the 20p/litre value was insufficient to cover the increased costs of biofuels;
- the duty incentive did not guarantee that a desired level of biofuel sales, and hence carbon savings, would be achieved.

The Renewable Transport Fuel Obligation (2007 to present)

The original regulations

The RTFO, as introduced in April 2008, set targets for increasing the use of renewable fuels in UK road transport with the aim of reducing carbon emissions. The obligation started at 2.5% (by volume) in 2008/09 and increased in 0.5% increments to 5% in 2010/11. It was expected to overcome limitations of the duty incentive and provide a more certain framework to secure a mainstream market.

The RTFO was also the UK's mechanism to meet the EU Biofuels Directive which required Member States to set targets for biofuels uptake.[5]

The RTFO regulations require suppliers of 450,000 litres or more of fuel per annum ('obligated suppliers') to ensure that a minimum proportion of their transport fuel was from a renewable source. Each year obligated suppliers have to demonstrate that they have met their obligation by redeeming a number of Renewable Transport Fuel Certificates (RTFCs) equivalent to the volume of biofuel they were obliged to supply.

Each litre of biofuel or kilogram of biogas supplied across the UK duty point was awarded one RTFC. RTFCs can also be obtained by non-obligated suppliers of biofuel who can trade them with obligated suppliers, who in turn can use them to meet their obligations.

Obligated suppliers also have the option to 'buy out' their obligation, paying a fixed fee per litre of biofuel that would otherwise need to have been supplied to earn RTFCs. This acts as a means of protecting the market, and ultimately the fuel consumer (assuming cost would be passed to the fuel pump) should the additional marginal cost of supplying biofuel relative to fossil fuel exceed 35 pence per litre (taking into account the duty incentive).

All suppliers who wished to receive RTFCs were required to report carbon and sustainability data on the biofuels supplied, such as: information on the feedstock; country of origin; previous land use (for crop based feedstocks); whether the fuel met a sustainability standard; and the greenhouse gas emissions. It was also a requirement for this data to be verified. However, reporting 'unknown' was permitted and RTFCs were awarded regardless of the carbon and sustainability data.

The original RTFO impact assessment can be found at the following link:

http://www.legislation.gov.uk/ukdsi/2007/9780110788180/pdfs/ukdsiem_9780110788180_en.pdf

Indirect effects of biofuels

Following the introduction of the RTFO, concern grew about the wider impacts of biofuels on sustainability. New studies indicated that 'indirect land use change' (ILUC) could result from increased demand for crops used to make biofuel, and this could have a negative effect on greenhouse gas emissions, undermining the effectiveness of biofuels as a carbon reduction tool. In the light of the new evidence, targets under the RTFO were re-profiled to reach 5% in

[5] Directive 2003/30/EC

2013/14[6]. In addition, the UK was one of the Member States that ensured a review mechanism was included in the EU Renewable Energy Directive (RED) to assess indirect effects and bring forward proposals if necessary to address the issue.

Negotiations on a European Commission proposal to address indirect effects are currently live.

2011 Amendments to implement the Renewable Energy Directive

The RTFO was amended in December 2011 to implement the requirements of the EU RED. The key change was the introduction of minimum requirements for carbon saving and sustainability of biofuel supply. These are that:

- Biofuels must achieve at least a 35% greenhouse gas emissions saving (this threshold rises to 50% or 60% over time for 'old' and 'new' installations, respectively)[7];
- Biofuels may not be made from raw material obtained from land with high biodiversity value in or after January 2008;
- Biofuels may not be made from raw material obtained from land with high carbon stock such as forests or land that was undrained peatland in January 2008 unless strict criteria are met.

Biofuel that does not meet these sustainability criteria is counted as fossil fuel and accrues an obligation to supply sustainable biofuel, in the same manner as any other fossil fuel.

Another significant change is that in order to receive RTFCs, biofuel suppliers must submit carbon and sustainability data which demonstrates that the mandatory sustainability criteria have been met, together with an independent assurance report over that data. Verification must be in accordance with the International Standard on Assurance Engagements (ISAE 3000). The RTFO Administrator must be satisfied that the data is accurate before issuing RTFCs.

Suppliers must apply for RTFCs at least annually in order to receive RTFCs on that year's supply, but may choose to do so more frequently (up to monthly). This option was included to help cash-flow for suppliers and to enable suppliers to monitor their progress towards meeting their obligations.

A further change introduced to incentivise biofuels with a low risk of indirect effects is the 'double counting' towards targets of biofuels derived from specified wastes and residues (and ligno-cellulosic and non-food cellulosic feedstocks). These biofuels receive two RTFCs per litre of biofuel or kilogram of biogas. These biofuels (with the exception of agricultural, aquacultural, fisheries[8] and forestry residues) will also be considered to have automatically met the land use criteria (i.e. preservation of biodiversity and carbon stocks). Their carbon intensity must still be reported and must meet the GHG savings threshold.

In addition provisions were also made to include partially renewable fuels in the RTFO

A summary impact assessment of these changes can be found at the following link:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/2471/overarching-ia.pdf

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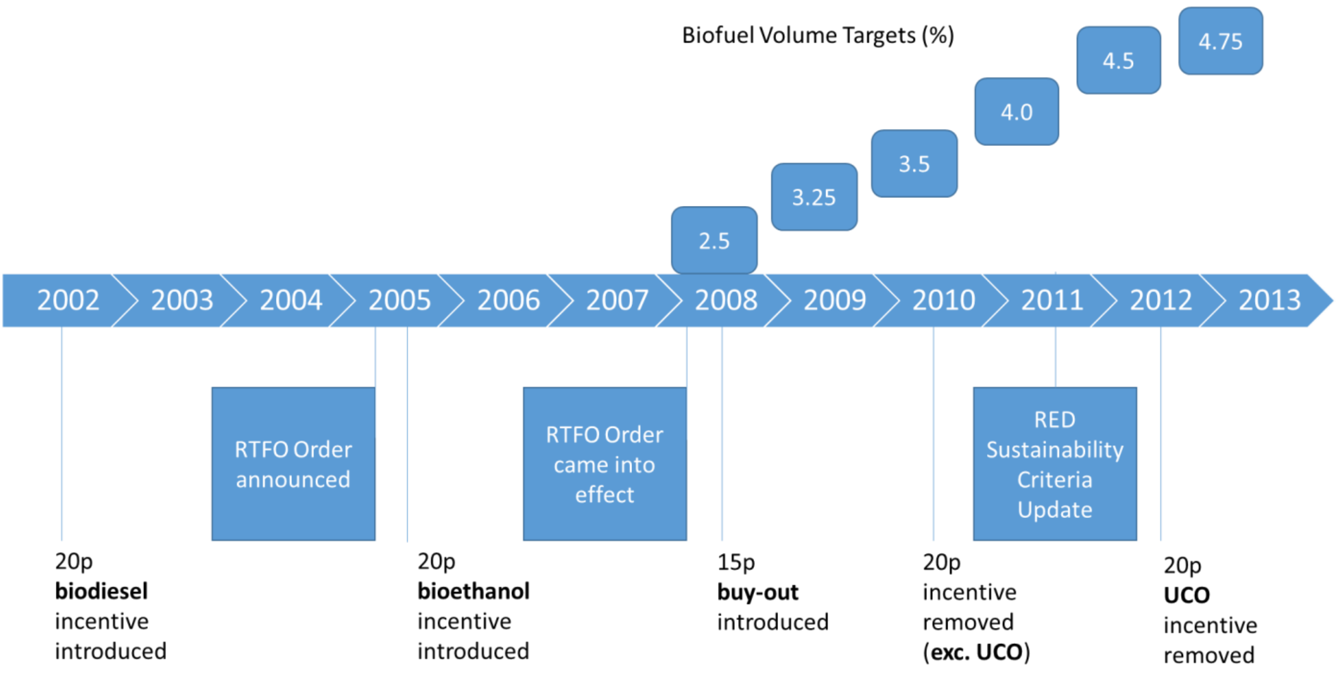
[6] The obligation level was adjusted in 2013 to 4.75% in order to maintain the overall level of biofuel supply, once the RTFO scheme was expanded to include fuels used in non-road mobile machinery, and for other end uses covered by the Fuel Quality Directive.

[7] Under the 'grandfathering clause' biofuels produced in installations that were already operational on 23 January 2008 did not have to meet the 35% threshold until 1 April 2013.

[8] In many cases materials from aquaculture and fisheries will automatically meet the land based criteria because these materials are not usually sourced from the land.

Figure 1.1 Policy timeline



Public Consultation

This document follows an initial draft Post Implementation Review which was the subject of a public consultation in late 2013/early 2014. Documents for the original consultation can be found at the following link https://www.gov.uk/government/consultations/renewable-transport-fuel-obligation-a-draft-post-implementation-review. The draft review was has been revised in light of comments received during this process. More detail on the consultation and subsequent amendments to the review can be found in chapter 6.

Structure of the Review

2) Biofuel Supply

Introduction

The RTFO mechanism was intended to provide longer term, more certain support for biofuel supply than the duty incentive mechanism which it replaced. It sets targets that fuel suppliers have to meet (or pay the buy-out price if they choose not to supply biofuel).

This section considers the extent to which the RTFO has ensured the intended supply of biofuel and where the biofuels have come from. The impacts of amendments made to the RTFO in 2011 on biofuel supplied under the RTFO are also considered here.

Counterfactual

In this chapter, the RTFO's impact on biofuel supply is assessed against a counterfactual state of the world where it is assumed that only fossil fuels are supplied to the transport sector (in absence of the RTFO).

Data Sources

Biofuel supply data from the RTFO has been taken from DfT biofuels statistics (which can be found at https://www.gov.uk/government/collections/biofuels-statistics).

Impact of RTFO on Biofuel Supply

Figure 2.1 below shows actual supply over the period compared with the level of obligation set by the RTFO. It includes the period from 2002, when duty incentives began.

Figure 2.1: RTFO supply volumes[9]

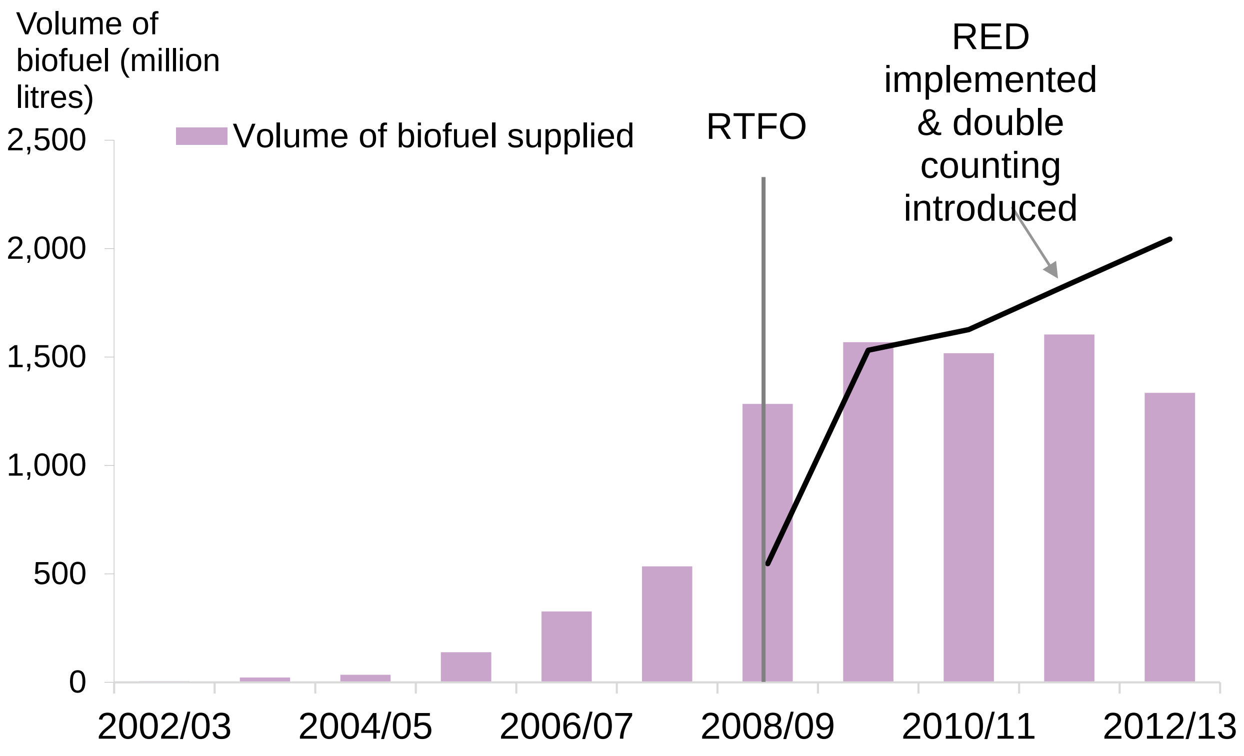


Figure 2.1 illustrates the increase in supply following the introduction of the obligation. Whilst it appears from the chart that actual supply varies somewhat from the obligation levels, all of the major suppliers have met their obligations in full in each year of the RTFO so far and have not bought out of their obligations.

The variation is due in part to the flexibility built into the RTFO that allows, for example, 'carry-over' of RTFCs issued for sustainable renewable fuel used in one year to be used to meet up to 25% of a supplier's obligation in the following year.

More significantly, Article 21(2) of the RED requires member states to "double count" biofuels derived from wastes and residues in national obligation mechanisms. In the RTFO this means that two RTFCs are issued per litre of waste / residue derived fuel supplied, and therefore a supplier can meet their obligation with as little as half the volume of fuel indicated by the percentage obligation level. The effect of this can be seen in Year 5 (2012/13) of the RTFO that shows an overall reduction in supply against an increased obligation level, whilst suppliers over the RTFO as a whole are on track to meet their obligations. A reduction in the biofuel supply (resulting from certain biofuels receiving two certificates per litre) is in line with what was expected when double counting provisions were introduced to the RTFO.

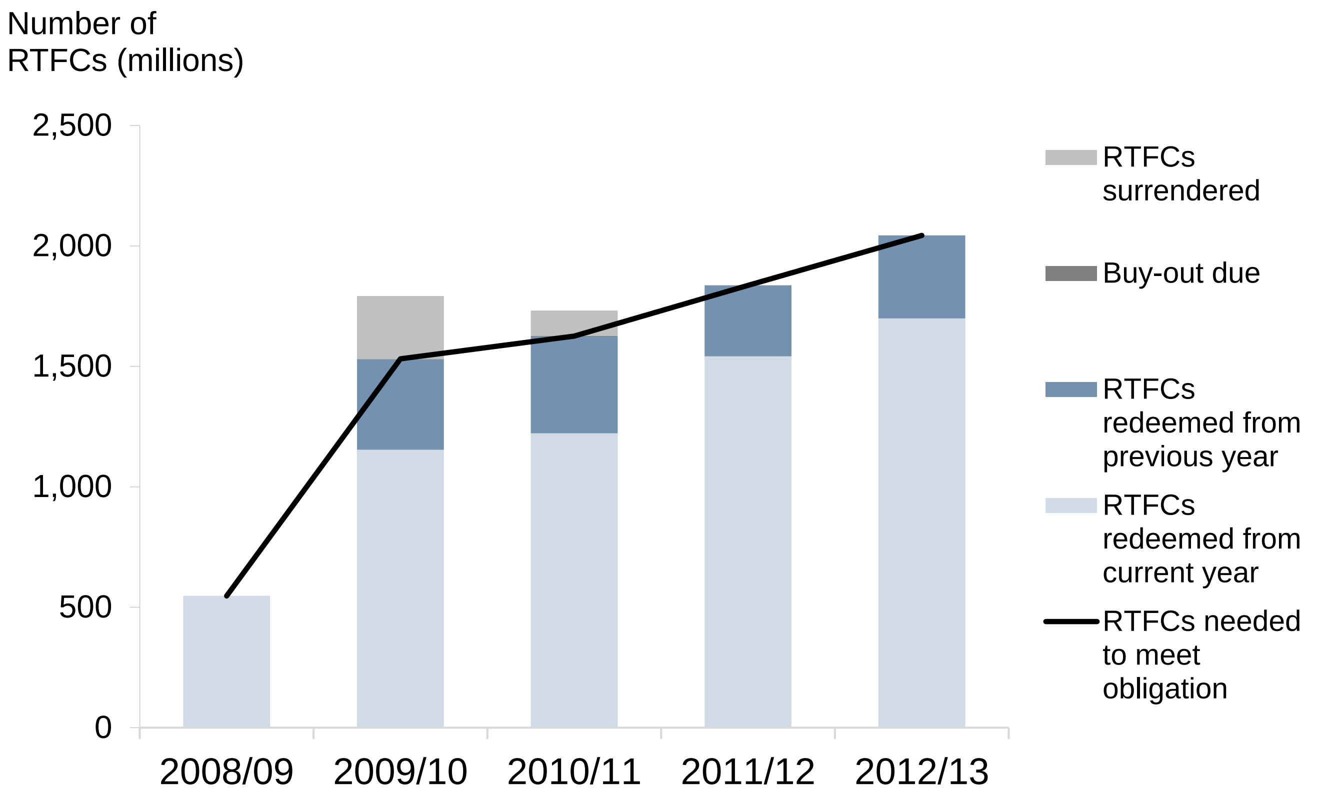
Figure 2.2. illustrates how the obligation has been met each year through the redemption of RTFCs. It demonstrates how the apparent 'gap' between actual biofuel supply and obligation level is met by RTFCs issued in the previous obligation year, and how there are more than sufficient RTFCs available to meet the 2012/13 obligation.

In autumn 2008 a discrepancy was identified in the RTFO Order. This had been drafted in a way inconsistent, on one point, with the intent of the policy. The legal effect was that fossil fuel that crossed the 'duty point' blended with biofuel was not obligated. The practical effect of this was to more than halve the volume of fossil fuel that was obligated, the effect of which can be seen in the chart below with the relatively small amount of fuel required to meet the obligation in

[9] During the 2008/09 obligation year a drafting discrepancy was identified in the RTFO Order. This resulted in any fossil fuel which had biofuel blended into it being excluded from the obligation and resulted in an 'oversupply' against the legal obligation. This was corrected for the start of the 2009/10 obligation year.

2008/9. The legislation was corrected in an amending order that took effect from the start of the 2009/10 obligation period, but the effect of the discrepancy continued because suppliers had excess RTFCs from year 1 which they were able to carry over to year 2.

Figure 2.2: RTFCs used to meet the obligation[10]



Supply mix

Figure 2.3 shows the split of biodiesel and bioethanol over time. It illustrates a gradual but consistent shift towards increased use of bioethanol. It also shows the emergence of partially renewable fuels and waste-derived biomethanol in Year 5.

Relative to biodiesel, the supply of bioethanol into the UK market required significant investment in logistical facilities due to handling issues with the fuel.[11]The RTFO successfully stimulated this investment. As bioethanol is typically cheaper (on a volume basis) to supply, suppliers have subsequently sought to maximise bioethanol alongside waste based biodiesel.

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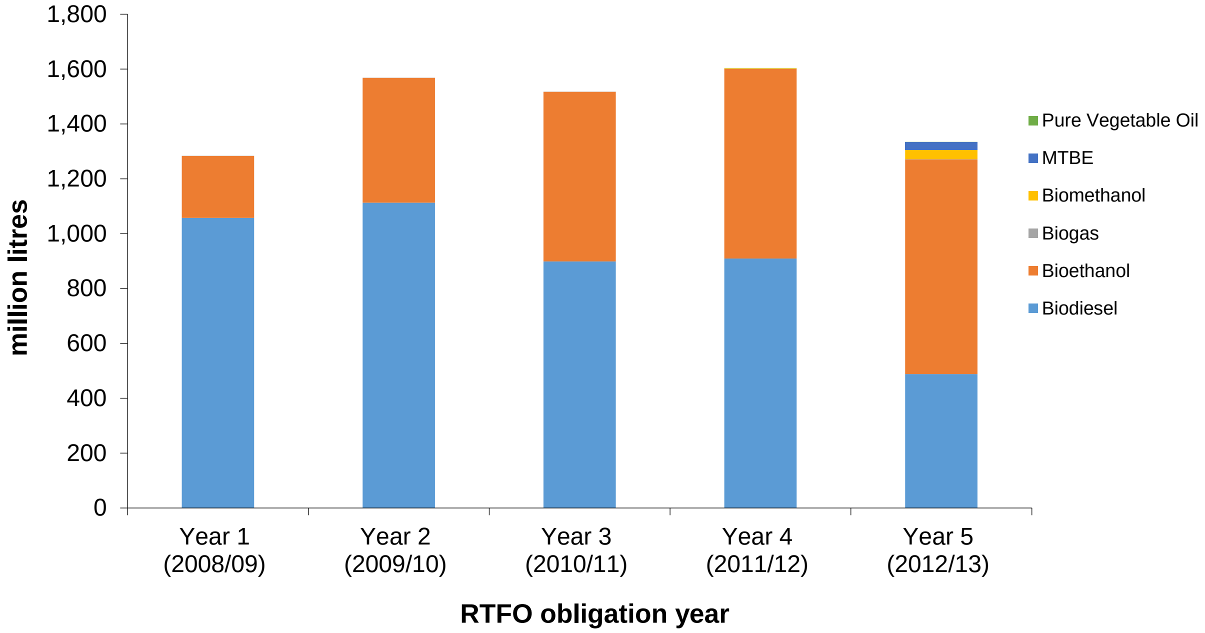
10 Note that individual suppliers can meet their obligation by redeeming RTFCs from the current or preceding obligation period or by paying the 'buy-out' price. In addition, RTFCs may be surrendered to obtain a share of any buy-out fund – these surrendered RTFCs are not counted towards meeting any obligation. The buy-out due includes both those who paid on time, those who paid late, and those who failed to pay and were issued with civil penalties.

11 Bioethanol is hydroscopic and thus cannot be supplied through underground pipelines used to transport fossil fuel products in the UK. Blending of bioethanol with petrol is carried out at 'racks' at refineries and fuel supply depots.

Figure 2.3: Total RTFO Biofuel Supply (split by fuel type)



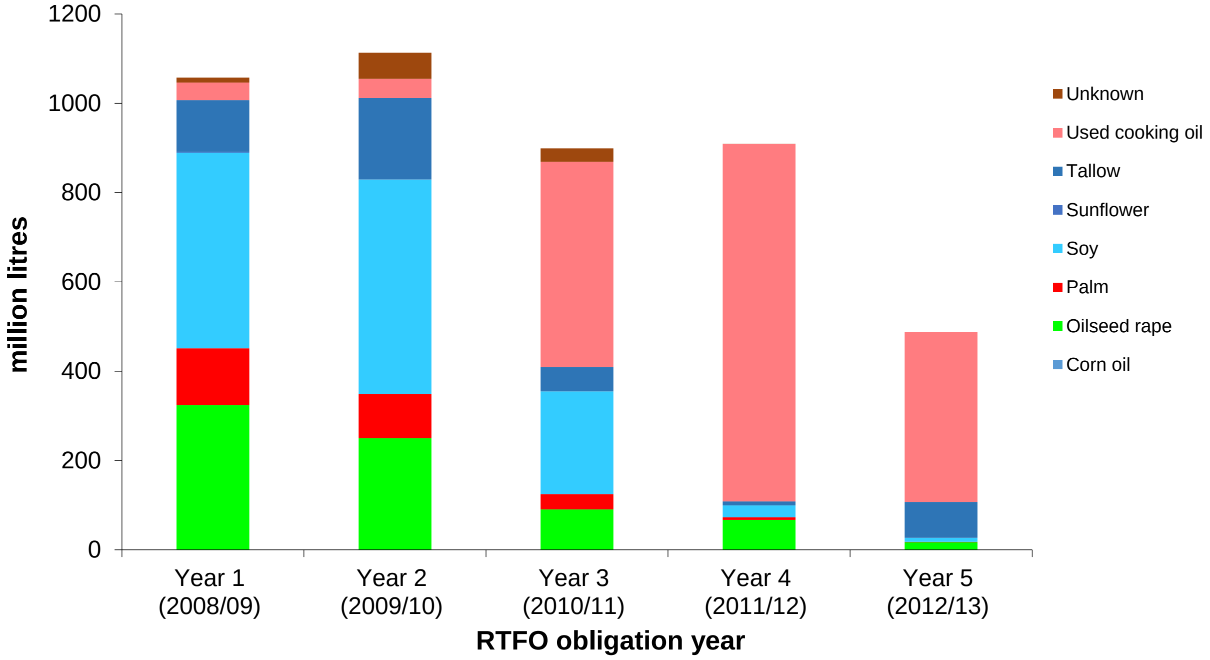
Feedstocks

Biofuels can be made from a variety of crops, and from biomass derived from wastes. The type of feedstock can make a significant difference to the carbon savings associated with different fuels. Since implementation of the RED in December 2011, the RTFO provides additional incentives for waste-derived biofuels, but does not otherwise discriminate between fuels on the basis of feedstock.

Biodiesel is made from oily crops and wastes. Figure 2.4 shows the feedstock mix of biodiesel supplied under the RTFO over time. It illustrates the change from largely crop based materials, particularly soy and rape, towards used cooking oil.

The large shift from crop-derived biodiesel to waste-derived biodiesel supplied under the RTFO has been driven by two separate policy interventions: (1) a fuel duty differential which provided an additional 20p/litre incentive to supply UCO-derived biodiesel from April 2010 to April 2012 and (2) double certification of biofuels derived from wastes, residues, non-food cellulosic material and ligno-cellulosic material from December 2011 onwards.

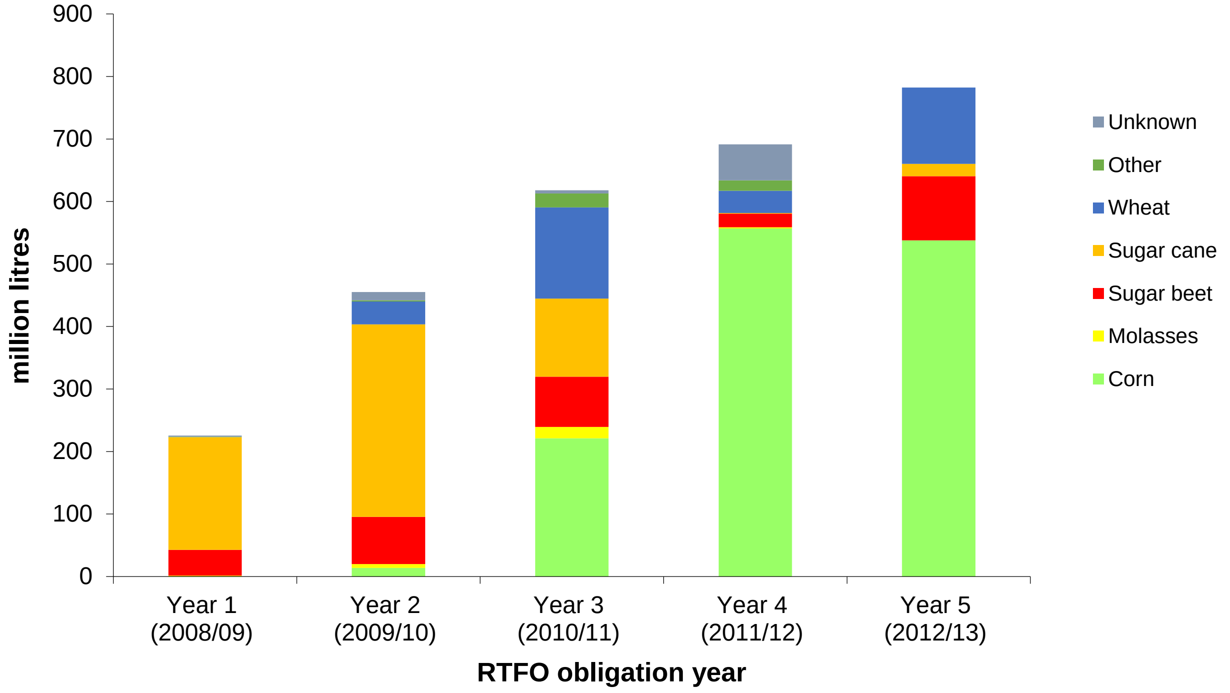
Figure 2.4: Biodiesel supply (split by feedstock)



Bioethanol is made from starch or sugar rich crops. It can also be made from lignocellulosic materials and wastes, though this requires advanced technologies that are not yet commercialised. Figure 2.5 below illustrates a shift from largely sugar cane derived ethanol in the first few years of the RTFO to a market strongly dominated by corn ethanol.

This shift appears likely to have been driven by changes in incentives for biofuels offered in other countries, most notably the US, resulting in an economic advantage for US corn ethanol exported to the EU. This included additional incentives for importing Brazilian cane bioethanol to the US, where it was categorised as an 'advanced fuel' under the federal Renewable Fuel Standard, and also a blending incentive for US corn ethanol which was available even where the fuel was exported. In early 20103, the EU introduced a regulation imposing an anti-dumping duty on US bioethanol exports to counterbalance the competitive advantage created by the US tax incentive for bioethanol exports.

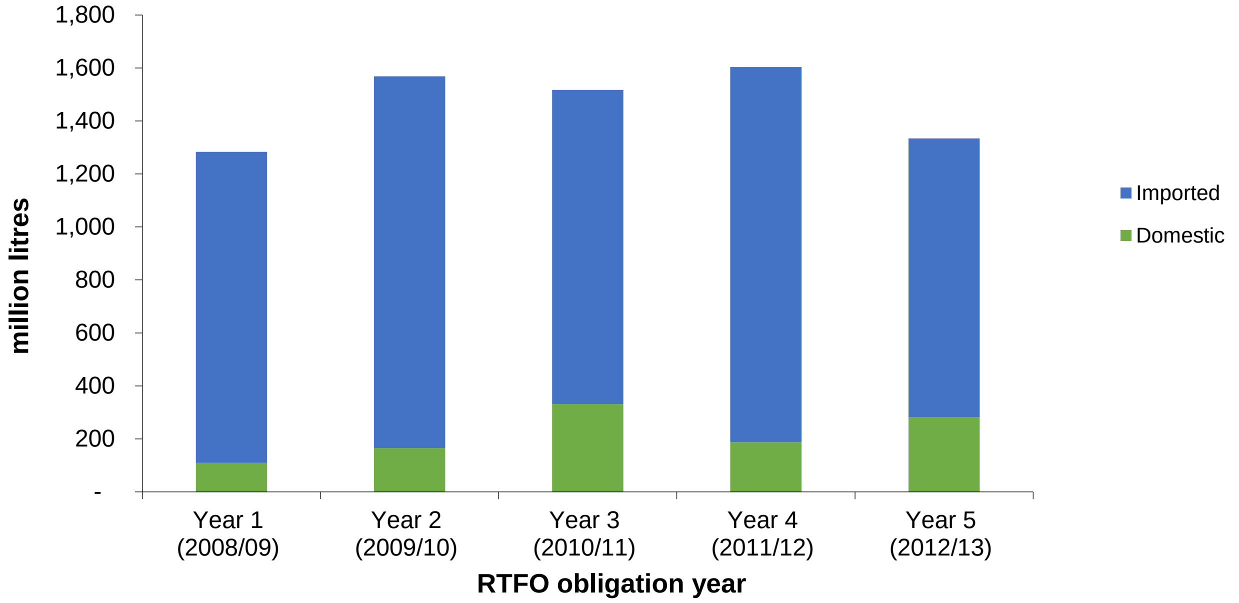
Figure 2.5: Bioethanol supply (split by feedstock)



Imports versus domestic feedstocks

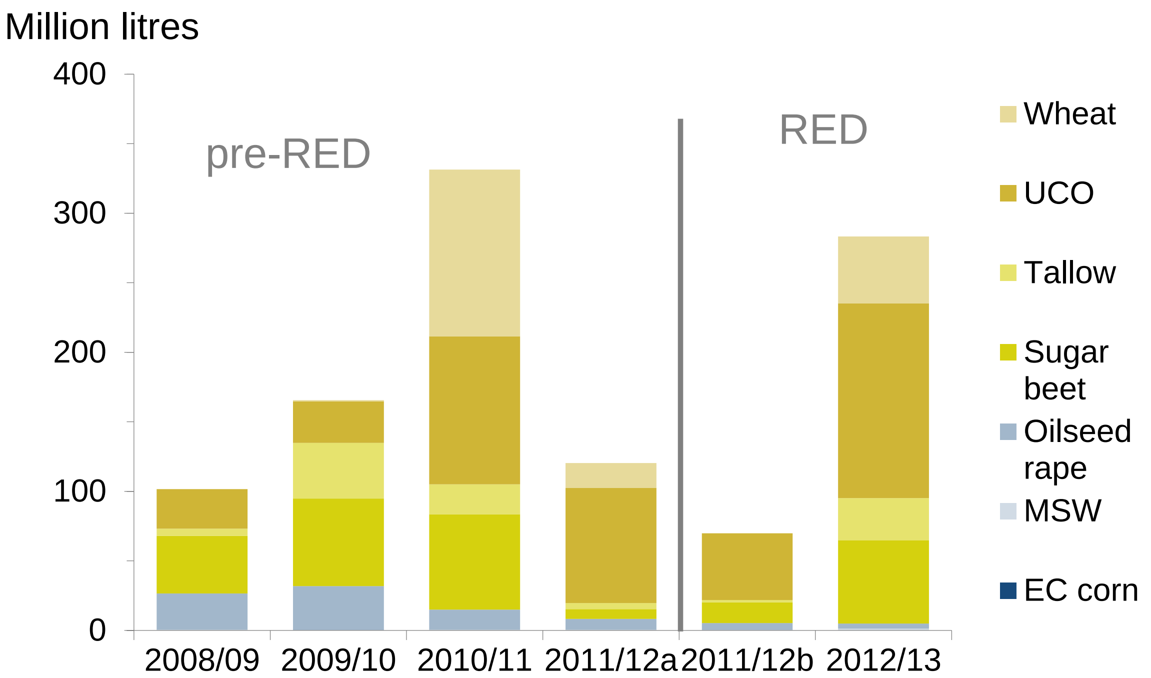
It was anticipated that the RTFO would provide benefits for UK farmers by providing a further market for their product. However, this was not a specific policy objective and these potential benefits were not monetised in the original impact assessment. Figure 2.6 illustrates the proportion of UK feedstock used to meet the obligation over time. As can be seen from the chart, the proportion of feedstocks grown or derived from UK sources has grown over the period, rising from 9% of biofuels supplied in Year 1 to 21% in Year 5.

Figure 2.6: Origins of biofuel supplied under the RTFO



Although overall UK feedstocks have increased over the period, the major and enduring increase has been from used cooking oil. As illustrated in Figure 2.7 below, sugar beet has been a consistently used feedstock, whilst rape oil has declined and the use of UK wheat has varied significantly.

Figure 2.7: UK feedstocks over time



How has the RTFO supply compared to Impact Assessment expectations?

Original 2007 impact assessment

Impact assessment

The RTFO was intended to create a strong and stable market for biofuels in the UK. In 2007/08, immediately prior to the introduction to the RTFO, biofuels made up 1.1% of supply. The RTFO set a target for 2008/9 of 2.5% rising to 5% in 2010/11. At 5% it was expected to have created a demand for 2.5 billion litres of biofuel a year.

Review results

When the impacts of the subsequent amendments have been accounted for, the RTFO has driven biofuel supply broadly in line with the expectations of the original IA. Targets have been met without the need for buyout (see figure 2.2). It should be noted that RTFO targets were subsequently revised downwards from target levels in the original legislation in light of the findings of the Gallagher Review (http://webarchive.nationalarchives.gov.uk/20110407094507/renewablefuelsagency.gov.uk/reportsandpublications/reviewoftheindirecteffectsofbiofuels).

2011 RED amendments - double certification

Impact assessment

The impact assessment projected that the proportion of biofuels eligible for double certification would increase relative to crop derived biofuels, and that the volume of biofuels supplied to meet the RTFO would fall, reflecting the fact that lower volumes of (double certified) biofuels would be needed to demonstrate compliance with the obligation. It was also projected that double certification would stimulate the development of second generation 'advanced' biofuels which would begin to enter the market in 2015 under central assumptions.

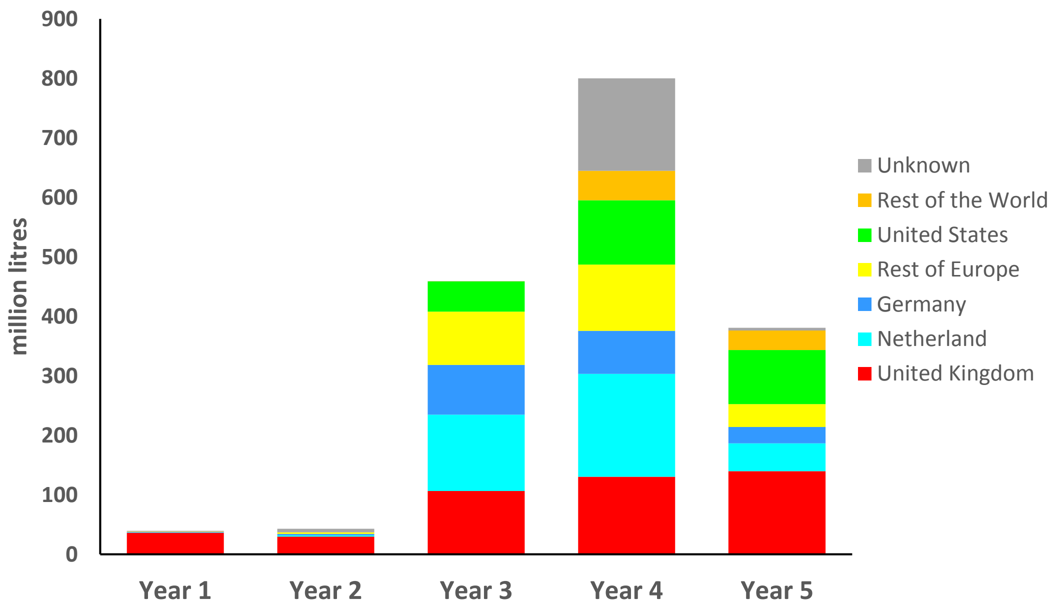
Review results

Looking at historical RTFO supply data, it is difficult to isolate the impacts of double certification on the make-up of the RTFO biofuel supply due to a fuel duty differential which was in place for used cooking oil (UCO) derived biodiesel over the period April 2010 to April 2012, prior to the introduction of double certification in December 2011. The duty differential significantly increased the supply of UCO-derived biodiesel over this period (as can be seen in Figure 2.4). However, if the biofuel supply prior to April 2010 (i.e. before the UCO only duty differential was introduced) is compared to the biofuel supply post-April 2014 (i.e. after the UCO only duty differential was removed and double certification introduced) it can be seen that the composition of the biofuel supply has changed markedly. Prior to April 2010 the RTFO biofuel supply (by volume) was made up of 14% double certified materials (20% of biodiesel). After the policy change this proportion increased to 40% (96% of biodiesel). This impact is in between what was predicted in the central and high scenarios in the impact assessment which accompanied the amending legislation.

There has been a significant increase in the supply of 'first generation' double certified biofuels derived from waste oils (e.g. UCO and tallow derived biodiesel, and methanol derived from crude glycerine). Industry has invested in modifications to production facilities to convert a greater range of waste fats and oils, and is actively exploring new sources of waste fats and oils beyond UCO and tallow. However, there has been little observed investment in advanced biofuel production capacity, which suggests that the future supply of these fuels may fall short of the projections in the central scenario in the 2011 double certification impact assessment. There has also been relatively low growth in the supply of waste-derived biomethane which is also double counted.

Figure 2.8 illustrates the sources of UCO supply over the period. It can been seen that the duty differential stimulated significant imports of UCO supply in addition to increased UK supply. The chart also illustrates a further significant increase in UCO supply in Year 4, which included a period from December 2011 to April 2012 when both a duty incentive and double certification were in place. Notably, UK UCO supply in Year 5 has thus far maintained the level achieved in Years 3 and 4 following the removal of the duty incentive and introduction of double certification.

Figure 2.8: Sources of UCO supply (million litres)



In line with the original impact assessment, it would appear that double certification has also led to a fall in the overall volume of biofuel supplied under the RTFO as suppliers can fulfil their obligation with less fuel. This can be seen in Figure 2.2 which shows actual biofuel supply levels relative to what would have been required under the RTFO in the absence of double certification.

Partial renewables

Impact assessment

The 2011 amendments also included a provision to allow obligated suppliers to use partially renewable fuels (i.e. part bio, part fossil) to demonstrate compliance with the RTFO. It was anticipated that partially renewable fuels could form part of the RTFO supply mix as a result.

Review results

Some partially renewable fuels have been supplied under the RTFO (i.e. 28 million litres of bio-MBTE was supplied in year 5), which is in line with impact assessment expectations.

Sustainability Criteria

Impact assessment

The 2011 Sustainability Criteria impact assessment anticipated that all biofuels supplied under the RTFO would be compliant with the sustainability criteria as suppliers would have a strong financial incentive to do so (i.e. only sustainable biofuel is rewarded under the RTFO with any unsustainable biofuel not counting towards a supplier's obligation).

Review results

Since the introduction of the sustainability criteria 95% and 100% of the biofuel supplied in Years 4b and 5, respectively, have been demonstrated to be sustainable (see Table 2.1 below).

This data indicates that the market was largely prepared for the mandatory sustainability introduced by the 2011 amendments. Reporting against sustainability criteria for the preceding three and a half years is likely to have played a key part in enabling this transition.

For the biofuel that was not demonstrated to be sustainable, suppliers may have chosen to not apply for RTFCs, or their applications for RTFCs were unsuccessful. In Year 4b, a significant proportion of this biofuel can be accounted for as a consequence of an obligated supplier going into administration. This also impacted suppliers who had purchased from this supplier, as the sustainability data was not available and therefore RTFCs could not be applied for.

Table 2.1 Biofuel that has been demonstrated to be sustainable since RED implementation

RTFO period	**Year 4b** **15 Dec 2011-14 Apr 2012**	**Year 5** **15 Apr 2012-14 Apr 2013**
Proportion of biofuel to which RTFCs have been issued	95%	100%

Conclusion

The RTFO has been successful in significantly increasing the supply of sustainable biofuels in line with the obligation levels set. From 1.1% immediately before the RTFO was implemented to 3% in Year 5. The vast majority of suppliers have met their obligations in full in every year.

Over the period there has been a significant change in feedstocks and types of biofuels used to meet the obligation. Waste based biofuels made up 12% of total biofuel supply in the first year of the obligation. This moved to 40% in Year 5, driven primarily by policy changes including double certification of waste based biofuels. The biofuel of preference has moved sharply from biodiesel to bioethanol, moving from 18% in Year 1 to 59% in Year 5, driven primarily by economics as bioethanol is cheaper than biodiesel on a volume basis.

The proportion of feedstocks from UK sources has also grown over the period, from 9% in Year 1 to 21% in Year 5. As with the wider obligation, the mix of feedstocks is increasingly towards waste based fuels and ethanol feedstocks.

3) Benefits

Introduction

This section of the review assesses RTFO GHG savings. The primary policy objective for the RTFO is to reduce transport sector greenhouse gas (GHG) emissions. Biofuels offer the potential to reduce emissions by substituting a portion of petrol and diesel with renewable material derived from biomass.

The lifecycle GHG benefits of most crop derived biofuels are lower than they were understood to be in 2007 due to increased scientific understanding of the overall effects, in particular GHG emissions from indirect land use change (ILUC). Analysis is presented using both carbon savings estimates derived from the methodology in the current Renewable Energy Directive and more recent methodologies which seek to capture the impact of ILUC on GHG savings. The central estimate of benefits presented in this document takes account of estimated ILUC impacts.

This chapter also contains an assessment of benefits which have not been explicitly quantified in the cost benefit analysis. The 2011 amendment of the RTFO to introduce minimum greenhouse gas savings is also considered.

Counterfactual

GHG savings have been assessed against a counterfactual state of the world where it is assumed that that no biofuels are supplied in absence of the RTFO, so savings are measured relative to the lifecycle GHG value of fossil fuels.

GHG Accounting Methodology & Data Sources

Lifecycle GHG savings

Estimates of GHG savings attributed to the RTFO have been assessed on a ‘well to wheel’ life cycle basis. That is to say that the total emissions associated with biofuel production and supply (e.g. agricultural emissions, refining emissions, distribution emissions) have been subtracted from the total emissions associated with fossil fuel production, supply and use (e.g. extraction emissions, refining emissions, combustion emissions) to give an estimate of the net GHG resulting from the displacement of conventional fossil fuel with biofuel.

Estimates of lifecycle GHG savings for biofuels supplied under the RTFO have been taken from values published in the DfT biofuels statistics (which can be found at https://www.gov.uk/government/collections/biofuels-statistics).

Estimated ILUC Emissions

The biofuels GHG savings reported in the DfT biofuels statistics do not include any estimate of GHG emissions associated with Indirect Land Use Change. GHG emissions associated with ILUC are thought to be significant, therefore estimated ILUC impacts have been included in the central estimates of GHG savings presented in this review. Estimated GHG savings without ILUC taken into account are also presented in the review. Values for ILUC emissions taken from EU analysis have been used for this purpose (which can be found at http://ec.europa.eu/energy/renewables/biofuels/doc/biofuels/swd_2012_0343_ia_en.pdf)

The impact of ILUC is highly uncertain and the subject of much debate. Readers should be aware that the ILUC values used in this analysis are subject to challenge. However, we believe that these represent a reasonable consensus of modelled ILUC values which are currently in the public domain.

More information on ILUC assumptions and an additional sensitivity analysis of the indirect effects of tallow-derived biodiesel can be found in the annexes which accompany this review.

Review results

Table 3.1 shows the estimated total lifecycle GHG savings (without GHG emissions from indirect land use change (ILUC) taken into account) in each year of the RTFO.

Table 3.1: RTFO GHG savings (not including estimated ILUC effects)					
Total biofuel GHG savings – direct	**mtCO$_2$e/year**				
Fuel Type	**Year 1 2008/09**	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
Biodiesel	1.261	1.433	1.479	1.948	1.071
Bioethanol	0.287	0.519	0.594	0.490	0.806
Biogas	0.001	0.001	0.001	0.002	0.003
Biomethanol	0.000	0.000	0.000	0.002	0.037
MTBE	0.000	0.000	0.000	0.000	0.040
Pure Vegetable Oil	0.000	0.000	0.000	0.000	0.001
Total (net) GHG savings	**1.55**	**1.95**	**2.07**	**2.44**	**1.96**

Figure 3.1 illustrates the aggregate average GHG savings (not including ILUC) of biofuels supplied under the RTFO over time in percentage terms relative to fossil fuels. It shows the average savings growing from 46% in Year 1 to 66% in Year 5.

Figure 3.1: RTFO Average GHG savings (not including ILUC) over time

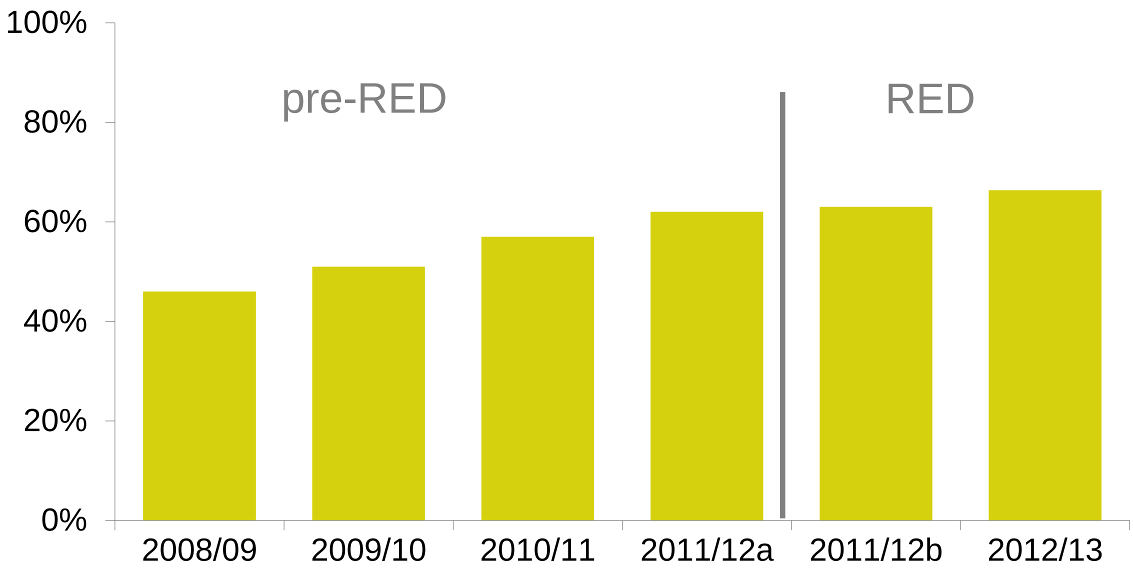


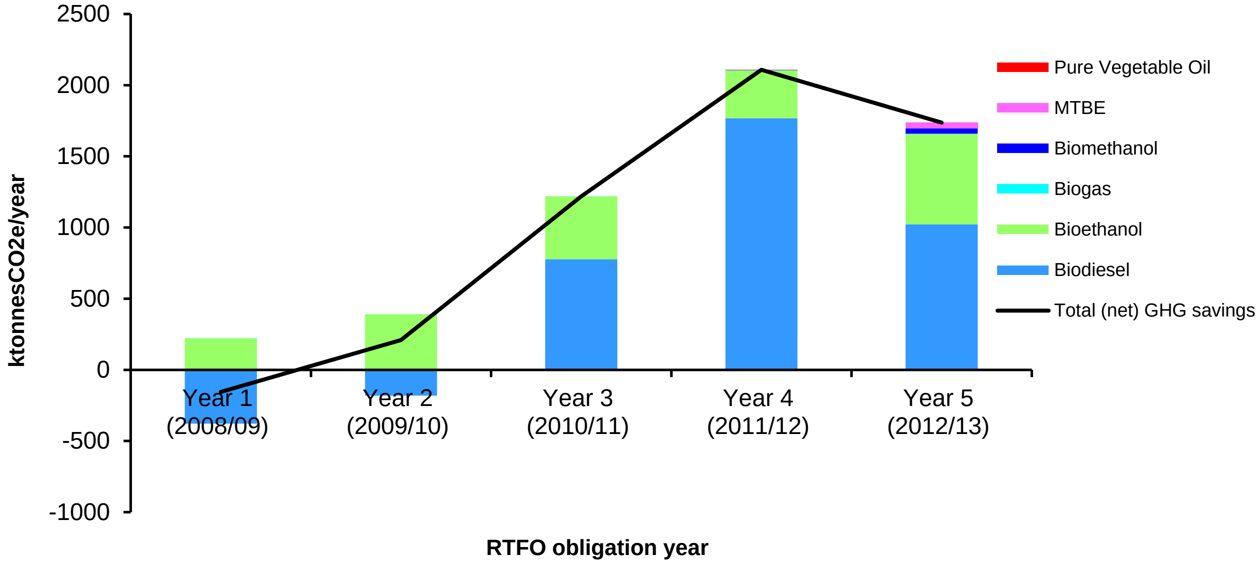
Table 3.2 shows the estimated total lifecycle GHG savings (with GHG emissions from indirect land use change (ILUC) taken into account) in each year of the RTFO. The overall effect is significant, particularly in the first year when the figures indicate a net increase in emissions. This is due to the predominance of crop based biodiesel providing the majority of supply under the RTFO at that time. It is thought that the ILUC effects of crop based biodiesel are more significant than for bioethanol.

Table 3.2 RTFO GHG savings (including estimated ILUC impacts)

Total biofuel GHG savings including ILUC	**$mtCO_2e$/year**				
Fuel type	**Year 1 2008/09**	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
Biodiesel	-0.378	-0.181	0.778	1.767	1.022
Bioethanol	0.222	0.390	0.440	0.336	0.634
Biogas	0.001	0.001	0.001	0.002	0.003
Biomethanol	0.000	0.000	0.000	0.002	0.037
MTBE	0.000	0.000	0.000	0.000	0.040
Pure vegetable oil	0.000	0.000	0.000	0.000	0.001
Total (net) GHG savings	**-0.15**	**0.21**	**1.22**	**2.11**	**1.74**

Figure 3.2 illustrates the GHG savings contribution by fuel type, including estimated ILUC impacts. In Years 1 and 2 of the RTFO biodiesel is the predominant fuel, and as it is mainly crop based the overall lifecycle emissions are estimated to be negative in Year 1 and to deliver a small saving in Year 2. From Year 3 of the RTFO, bioethanol supply becomes more significant and the feedstock for biodiesel becomes predominantly used cooking oil in response to fuel duty incentives (April 2010 to April 2012) and double counting (December 2011 onwards). The overall ILUC effect is therefore reduced significantly and the RTFO begins to deliver substantial carbon savings.

Figure 3.2: Total biofuel GHG savings (including estimated ILUC impacts)



The average lifecycle GHG savings (including estimated ILUC impacts) of fuels delivered under the RTFO are shown numerically in Table 3.3 (in percentage terms). The estimated average lifecycle GHG savings in Year 5 are 66% without ILUC (see Figure 3.2) and 60% with estimated ILUC impacts included.

Table 3.3: Average RTFO GHG Savings (including estimated ILUC impacts)

Year 1	Year 2	Year 3	Year 4	Year 5
-5%	5%	33%	55%	60%

Comparing Table 3.3 to Figure 3.1 shows that the gap between GHG savings with and without estimated ILUC impacts has closed significantly over the period, and that the biofuels currently being provided through the RTFO deliver significant net GHG savings, even when ILUC is taken into account.

Monetised GHG savings

Government carbon values (https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal) can be used to give an estimate of the monetary value for GHG savings for use in policy appraisal.

Tables 3.4 and 3.5 show the estimated monetary value (evaluated using the ‘non-traded’ carbon value) of RTFO GHG savings with and without estimated ILUC impacts included. The results presented in the summary tables of this review include estimated ILUC impacts.

Table 3.4: Monetised RTFO GHG Savings (not including estimated ILUC impacts)						
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**	**total**
£m/year (2014 prices)	87	111	120	143	117	**577**

Table 3.5: Monetised RTFO GHG Savings (including estimated ILUC impacts)						
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**	**Total**
£m/year (2014 prices)	-9	12	70	124	104	**301**

Unquantified Benefits

In addition to the GHG benefits which are assessed in this chapter, the RTFO has also led to a number of other benefits which have not been quantified in this review. These include investment in UK biofuel production capacity, increased animal feed production, innovation and security of (fuel) supply. The text below describes some of the key non-quantified benefits. Further detail can be found in the 'wider impacts' chapter.

GDP benefits – biofuel production

In the first 5 years of the RTFO 15% of all biofuels supplied have been produced using UK feedstock. The extent to which UK biofuel production adds to GDP depends upon the extent to which it creates *additional* economic value (e.g increased agricultural production, biofuel refining) relative to what would have happened if biofuel were not being produced (e.g. Is UK agricultural production higher than it would otherwise have been as a result of the RTFO? Is used cooking oil collection higher than it would otherwise have been as a result of the RTFO?). Any additional value created by the RTFO would also be subject to GDP multipliers which would amplify the impact of GDP. However, it has not been possible to estimate the extent to which the RTFO has led to additional economic activity therefore these effects have not been explicitly quantified in this review.

GDP benefits – Investment

There has been significant investment in biofuel production capacity. Individual producers have invested up to £350m and the REA (Renewable Energy Association) estimates that nearly £1bn has been invested in UK biofuels production facilities in the UK as a whole. Fuel suppliers had also invested significantly in capacity to blend and supply fuel. Investment is a component of GDP, so any *additional* investment occurring as a result of the RTFO would add to GDP and be subject to a GDP multiplier. However, it has not been possible to estimate with any precision the extent to which the RTFO has led to additional investment therefore these effects have not been explicitly quantified in this review.

Increased animal feed production

DDGS (Dried Distiller Grains) are a protein rich co-product of bioethanol production which can be used as animal feed. Production of DDGS reduces the need for imports of protein rich animal feed (i.e. soy beans) and is reported to also reduce costs for farmers. Reduced imports and reduced input costs are likely to have a positive impact on GDP. However, it is not possible to estimate GDP impacts as the scale and value of DDGS (and other co-product) production is unknown and the extent to which biofuel and DDGS production displaces other economic activity (e.g. wheat exports) is also unknown. One respondent to the public consultation on the draft version of this review stated that the "UK biofuels industry when at full capacity can reduce this animal feed import dependency by nearly 1.5 million tonnes or the equivalent of more than £600 million, or 20 million hectares cultivated outside the EU". It should be noted that, during the review period, the UK biofuels industry has been operating at levels far below full capacity.

How have RTFO benefits compared to Impact Assessment expectations?

Original 2007 impact assessment

Impact assessment

The 2007 impact assessment estimated that the RTFO would save 3.2 mtCO_2e (on a lifecycle basis) per annum in 2010 when the obligation was (at that time) due to reach 5%, rising to 4.3 mtCO_2e per annum in 2020. This assumed that average lifecycle CO_2 savings for biofuels supplied under the RTFO were around 50% and grow to 75% by 2020.

Review results

Direct GHG savings (not inclusive of estimated ILUC impacts), which have ranged from 1.55 to 2.44 mtCO_2e, have been somewhat lower than the 2007 impact assessment projections. However, the primary reason for the lower savings is the reduced biofuel supply which resulted from re-profiling the RTFO targets to increase at a slower rate in response to concerns about ILUC. As illustrated in figure 2.1, in 2010/11 actual biofuel supply was 3.27% (against a 3.5% obligation) rather than the 5% in the original legislation.

When adjusted for the difference in obligation levels, GHG savings reported in 2010/11 were almost exactly in line with what was estimated in the original impact assessment. It can be seen from Figure 3.1 that average GHG savings (not including estimated ILUC impacts) reached 66% in year 5 of the RTFO.

When estimated ILUC impacts are taken into account both aggregate GHG savings and average GHG savings are lower than what was anticipated in the 2007 impact assessment (which did not take ILUC impacts into account).

2011 RED Amendment – Double Certification & Sustainability Criteria

Impact assessment

The overarching RED amendments impact assessment (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/2471/overarching-ia.pdf) - which looked at the combined effect of double certification and the sustainability criteria RTFO GHG savings - projected a 0.61 to 0.68 mtCO_2e (central scenario) per year increase in lifecycle GHG savings (not including estimated ILUC impacts) during the period 2012 to 2014.

Review results

Looking at historical RTFO supply data, it is difficult to isolate the impacts of double certification and the sustainability criteria on RTFO GHG savings due to a fuel duty differential which was in place for used cooking oil (UCO) derived biodiesel over the period April 2010 to April 2012, prior to the introduction of double certification in December 2011. The duty differential significantly increased the supply of UCO-derived biodiesel over this period which had a significant impact on GHG savings reported under the RTFO (both with and without the estimated effects of ILUC taken into account).

However, if GHG savings prior to April 2010 (i.e. before the UCO only duty differential was introduced) is compared to the biofuel supply post-April 2014 (i.e. after the UCO only duty differential was removed and double certification/sustainability criteria were introduced) it can be seen that GHG savings reported under the RTFO have changed markedly. Between year 2 and year 5 of the RTFO average GHG savings increased from 51% to 66% (not including estimated ILUC impacts) and 5% to 60% (including estimated ILUC impacts). Aggregate GHG savings increased from 1.95 to 1.96 mtCO_2e (not including estimated ILUC impacts) and from 0.21 to 1.74 mtCO_2e (including estimated ILUC impacts). This suggests that Double Certification and the Sustainability Criteria have exceeded impact assessment expectations in increasing RTFO GHG savings.

Conclusions

Discounting the effects of ILUC, the RTFO's performance on average GHG savings has been broadly in line with the original impact assessment. Overall savings have been lower (2.07 mtCO_2e compared to 3.2 mtCO_2e in 2010), but this can be attributed almost entirely to the reduction in RTFO targets implemented in 2009 in response to concerns about ILUC. Average GHG savings have been close to what was anticipated: measured savings of 48% in 2010 compared to 50% forecast and 66% in 2013, well on track to the 75% by 2020 forecast in the original assessment.

When ILUC is taken into account, the GHG savings of the RTFO are lower, but the most significant variations between direct and indirect performance are in the first two years of the RTFO before measures to incentivise waste-derived biofuels began.

The amendments introduced in 2011 to award double certificates (see chapter 6 for more detail) for biofuels derived from waste, combined with an increase in bioethanol supply which has lower ILUC effects, improved the RTFO's overall GHG performance. Taking estimates for ILUC into account, the RTFO delivered lifecycle GHG savings of 1.74 mtCO_2e (from table 3.2) in Year 5 and average carbon savings of 60%.

4) Costs

Introduction

This section considers the cost of meeting the RTFO. The majority of costs identified relate to the additional cost of supplying biofuel (relative to the cost of supplying fossil fuel). Costs relating to investment in supply infrastructure, increased operational expenditure for obligated suppliers, additional retailer costs and government administration costs have also been taken into account.

RTFO costs are presented both in terms of aggregate economy-wide costs and in terms of pence per litre pump price impacts (i.e. it is assumed that costs incurred by fuel suppliers obligated under the RTFO are passed through 100% from obligated suppliers to fuel consumers). Carbon cost effectiveness is measured in terms of £/tCO_2e and is a critical measure to assess RTFO performance. As with the GHG analysis, results are modelled both with and without estimates for the effect of ILUC. A £/MWh cost effectiveness metric has also been produced which can be used to evaluate Renewable Energy Directive compliance costs.

Counterfactual

The cost of the RTFO has been assessed relative to a 'baseline' state of the world where it is assumed that only fossil fuels are supplied into the transport sector.

Cost Estimation Methodology & Data Sources

The additional cost of supplying biofuel has been calculated by subtracting the cost of displaced fossil fuel from the cost of the biofuel supplied to meet the RTFO. This measure provides an estimate of the extra costs associated with the supply of biofuel which would not occur if the RTFO were not in place.

Fuel costs have been evaluated using market price data sourced from commercial data suppliers has been used to inform this calculation. It is assumed that biofuel displaces fossil fuel 1:1 on an energy basis. Where price data for a particular fuel has not been available a proxy has been used.

Costs relating to investment in supply infrastructure, increased operational expenditure for obligated suppliers and additional retailer costs have been supplied by the UKPIA (UK Petroleum Industry Association - a body representing fuel suppliers). Government administration cost estimates are based upon government accounts.

Review results

Biofuel Supply Costs

Figure 4.1 and Table 4.1 show the estimated cost of biofuel supplied under the RTFO over obligation Years 1 to 5.

Figure 4.1 shows the additional costs in nominal terms (i.e. the actual costs which have not been adjusted to account for inflation), whilst table 4.1 also shows costs in 2014 prices (i.e. adjusted for inflation so that they are comparable to the general price level in 2014) to allow for consistent comparison of costs across time.

Figure 4.1: Additional cost of biofuel supplied under the RTFO (nominal prices)

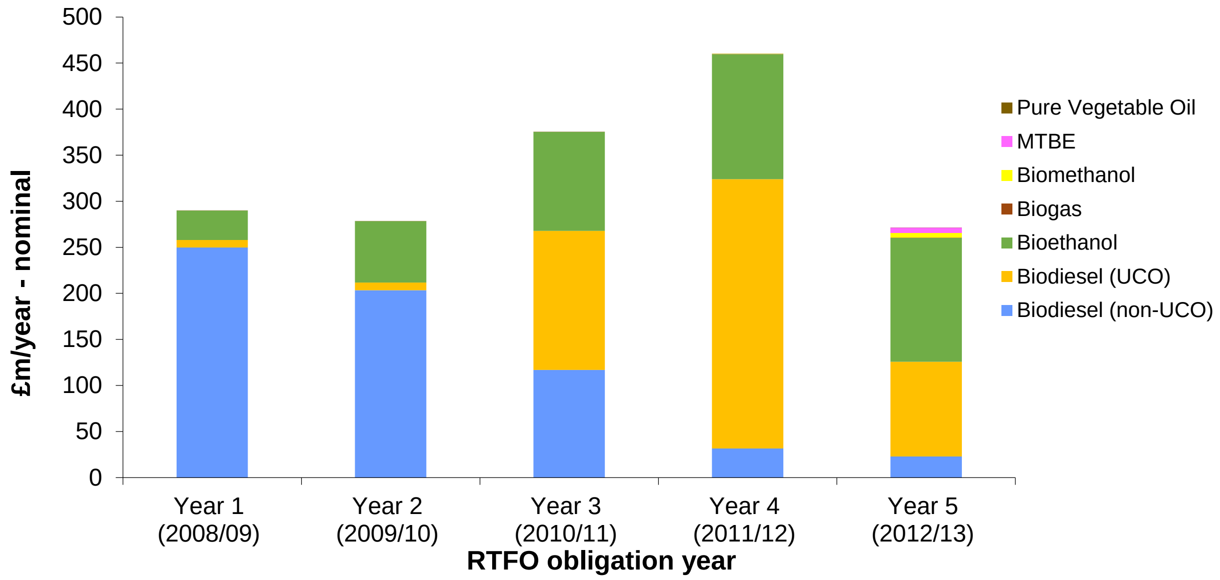


Table 4.1: Additional biofuel costs

	Year 1 2008/09	Year 2 2009/10	Year 3 2010/11	Year 4 2011/12	Year 5 2012/13
£m/year (nominal prices)	290	278	375	460	271
£m/year (2014 prices)	331	311	407	487	283

Infrastructure Investment Costs

In addition to the cost of purchasing biofuel, fuel suppliers obligated under the RTFO have also had to invest in facilities for supplying biofuel. UKPIA (which represents fuel suppliers) estimates that for UKPIA members this investment has been in the region of £240m over the lifetime of the RTFO. For the purposes of this cost benefit analysis, this £240m infrastructure investment cost is assumed to have been spread equally over the 5 years which the RTFO has been in operation. These costs were not included in the draft version of the review and has been included as a result of responses received in response to the public consultation.

Table 4.2: Fuel Supplier Infrastructure Investment Costs

	Year 1 2008/09	Year 2 2009/10	Year 3 2010/11	Year 4 2011/12	Year 5 2012/13
£m/year (2014 prices)	48	48	48	48	48

Blending Costs

UKPIA also responded to the public consultation on this review by highlighting that there is an additional operating cost associated with biofuel blending which they estimate to be in the range of £3 to £4/tonne (of biofuel) which was not captured in the draft version of this review. A mid-point of £3.50 per tonne has been taken as a central estimate of this cost in this review. Aggregate estimates of additional biofuel related operating costs for the entire biofuel supply are shown in table 4.3.

Table 4.3: Blending Costs					
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
£m/year (2014 prices)	4	5	5	6	5

Government Administration Costs

The annual cost of enforcement of the RTFO by the Administrator is shown in table 4.4. In Year 4 administration passed to the Department for Transport from the Renewable Fuels Agency. Whilst costs were anticipated to increase following the 2011 amendments, Year 5 costs have reduced.

Table 4.4: Government Administration Costs					
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
£m/year (nominal prices)	1.32	1.36	1.47	1.05	0.58
£m/year (2014 prices)	1.51	1.52	1.59	1.11	0.61

Fuel Supplier Administration Costs

UKPIA estimate the annual administration costs to be in the region of £0.5million for each large obligated company. This includes the cost of reporting, trading, verification, policy, audit, marketing, general management and technical issues. This cost has been multiplied up across 10 large suppliers. These costs were not included in the draft version of the review and have been included as result of responses received in response to the public consultation.

Table 4.5: Fuel Supplier Administration Costs					
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
£m/year (2014 prices)	5	5	5	5	5

Fuel Retailer Costs

Fuel retailer costs (e.g. tank cleaning and replacing filters) are estimated to consist of:

1) A £5,000 (per site) one-off initial set-up cost which is required for retail sites to receive blended fuels containing biofuel

2) A £1,200 ongoing annual maintenance cost (covering for example inspection and testing)

These costs have been scaled up across the entire UK fuel supply (assuming 9000 filling stations nationwide) in table 4.6. All upfront costs are assumed to have been incurred in Year 1 of the RTFO.

Table 4.6: Fuel Retailer Costs					
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
£m/year (2014 prices)	56	11	11	11	11

Aggregate RTFO Costs

Table 4.7 shows the total of all the quantified costs which have been attributed to the RTFO in this review. This includes Biofuel Supply Costs (table 4.1), Infrastructure Investment Costs (table 4.2), Blending Costs (table 4.3), Government Administration Costs (table 4.4), Fuel Supplier Administration Costs (table 4.5) and Fuel Retailer Costs (table 4.6). The costs presented in this table form the basis of the cost estimates which are presented in the summary sheet of this document.

Table 4.7: Aggregate RTFO Costs					
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
£m/year (2014 prices)	446	382	478	558	352

Transition Costs

The transition costs shown in the summary sheet of the start of this document are split into 1) recurring costs and 2) transition (i.e. one off) costs. £285m of transition costs have been identified. These consist of £240m of fuel supplier infrastructure investment costs (table 4.2) and £45m of initial set-up costs for fuel retailers (captured in table 4.6 (year 1)).

Pump Price Impacts

As biofuels are typically more expensive than fossil fuels, the RTFO has the effect of increasing the price of fuels at the pump – it is assumed that fuel suppliers pass on the additional cost of complying with the RTFO 100% through to final fuel consumers. Average pump price impacts have been estimated by taking the estimated additional cost of supplying biofuels under the RTFO (i.e. the costs presented in table 4.7 minus government administration costs) and dividing this by the total volume of fuel supplied. As biofuels and fossil fuels have varying energy densities (e.g. the energy content of a litre of fuel varies by fuel type) the average price impact has been per litre of petrol equivalent (i.e. for 32.95 mj of fuel).

Table 4.8 (nominal prices) and 4.9 (2014 prices) show the estimated impact of the RTFO on pump prices. For Years 1-4 of the RTFO these additional costs would not have been felt directly at the fuel pump by consumers because the 20ppl fuel duty incentive was in place[12] – for all

[12] The 20ppl duty differential provided an additional 0.20p per litre financial incentive for the supply of biofuel up until April 2010. From April 2010 to April 2012 the duty differential applied only to biodiesel made from used cooking oil.

biofuels until the end of Year 2 and then for UCO biodiesel for Years 3 and 4 (i.e. the majority of additional cost was paid out of general taxation). The figure for Year 5 (0.90p including VAT – nominal prices) reflects the actual additional cost experienced by motorists following the removal of the duty incentive for all biofuels. This cost is equivalent to roughly 0.7% of the average retail price of fuel. For an average car, this is equivalent to roughly an £9 (including VAT) increase in the annual fuel bill.[13] By way of comparison, renewable energy incentives are estimated to add 3% to the average household energy (gas + electricity) bill in 2013[14].

Table 4.8: Pump Price Impacts (nominal prices)

Additional resource	Year 1 2008/09	Year 2 2009/10	Year 3 2010/11	Year 4 2011/12	Year 5 2012/13
Pence cost per MJ	0.03	0.02	0.03	0.04	0.02
Pence/litre petrol equivalent (pre-VAT)	0.89	0.78	0.99	1.18	0.75
Pence/litre petrol equivalent (post VAT)	1.05	0.90	1.16	1.41	0.90

Table 4.9: Pump Price Impacts (2014 prices)

Additional resource	Year 1 2008/09	Year 2 2009/10	Year 3 2010/11	Year 4 2011/12	Year 5 2012/13
Pence cost per MJ	0.03	0.03	0.03	0..04	0.02
Pence/litre petrol equivalent (pre-VAT)	1.02	0.87	1.07	1.25	0.78
Pence/litre petrol equivalent (post VAT)	1.20	1.00	1.26	1.50	0.94

Cost effectiveness - £/tCO_2e

A key measure of the effectiveness of the obligation is the cost of carbon saved. Table 4.10 illustrates the costs to Year 5, excluding estimated ILUC effects. By this measure, aggregate cost effectiveness by these measures have moved up and down over the period as fuel prices and the RTFO biofuel mix have changed.

[13] This assumes an average family car covering average mileage of 9000 miles a year.

[14] https://www.gov.uk/government/publications/estimated-impacts-of-energy-and-climate-change-policies-on-energy-prices-and-bills

Table 4.10: Cost/tonne of carbon (excluding estimated ILUC effects)					
Additional resource	**Year 1 2008/09**	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
Aggregate £/tCO_2e (2014 prices)	**288**	**196**	**230**	**228**	**180**
Bioethanol £/tCO_2e (2014 prices)	127	144	196	293	174
Crop Biodiesel £/tCO_2e (2014 prices)	308	195	324	316	195
Waste Biodiesel £/tCO_2e (2014 prices)	44	81	152	169	120

Table 4.11 takes account of estimated emissions from Indirect Land Use Change (ILUC). In Year 1 with ILUC included there were net aggregate emissions, and in Year 2 aggregate costs were very high due primarily to higher levels of crop based biodiesel supplied during this period, which is understood to have significant indirect effects. Aggregate carbon cost effectiveness improves significantly from Year 3. This improvement can be attributed partly to the fuel duty differential for UCO-derived biodiesel (Years 3 and 4) and double certification of waste-derived biofuels which increased the supply of low ILUC risk waste-derived biofuels (from December 2012 onwards), and partly to the increased relative share of bioethanol which is estimated to have lower ILUC effects than crop biodiesel.

Table 4.11: Cost/tonne of carbon (including estimated ILUC effects)					
Additional resource	**Year 1 2008/09**	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
Aggregate £/tCO_{2e} (2014 prices)	**n/a**	**2,035**	**424**	**280**	**211**
Bioethanol £/tCO_{2e} (2014 prices)	165	191	264	428	221
Crop Biodiesel £/tCO_{2e} (2014 prices)	n/a	n/a	n/a	n/a	n/a
Waste Biodiesel £/tCO_{2e} (2014 prices)	44	81	152	169	120

Looking across other sectors of the economy biofuels appear to be a relatively expensive carbon abatement measure. Abatement costs attributed to the RTFO over the period 08/09 to12/13 have been consistently higher than DECC carbon values for the non-traded sector[15]which range from £56 to £60/CO_2e (2014 prices – central scenario) over the period 2008 to 2012.

Table 4.12 below presents cost per megawatt hour. RTFO £/MWh costs have ranged from £37 to £45/MWh (nominal prices) over the period 08/09 to 12/13. By way of comparison, electricity and heat sector renewable energy subsidies ranged from £52 to £59/MWh (nominal prices) over

[15] Non traded sector carbon values are used as a benchmark to evaluate cost effectiveness of carbon abatement measures which fall outside the EU Emission Trading Scheme, such as fuel efficiency measures for cars, boiler efficiency and the RTFO. Measures which have an abatement cost below the non-traded carbon value are considered cost effective relative to alternative abatement options across the economy.

the period 08/09 to 11/12.[16] This suggests that biofuels have been a relatively low cost means of complying with EU renewable energy targets.

Table 4.12: Cost/MWh					
	Year 1 2008/09	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
£/MWh (nominal prices)	41	30	40	45	37
£/MWh (2014 prices)	46	33	44	48	39

How have RTFO costs compared to Impact Assessment expectations?

Original 2007 impact assessment

Impact assessment

The original impact assessment projected aggregate costs to be within the range of £200m to £563m per year (2007 prices). The cost differential between biofuels and fossil fuels is the critical factor in determining the additional costs of the RTFO. The original IA anticipated additional costs of 4 -10 pence per litre for bioethanol and 15 to 20 pence per litre for biodiesel for 2010.

Review

The costs in the original RTFO impact assessment relate to targets which were subsequently revised downwards following the Gallagher Review, therefore, it is not possible to make a direct comparison of the aggregate costs presented in the review with the aggregate costs in the original impact assessment. However, other aspects of costs can be used to make a comparison. Observed additional costs (based on wholesale market price data) have been within the ranges identified in the impact assessment (4 to 10p per litre for bioethanol and 15 to 20p per litre for biodiesel), though at the upper end. Underlying fuel prices (both bio and fossil) have been significantly higher than was anticipated in the central scenario used for the initial RTFO impact assessment.

Making comparisons between the £/tCO_2e numbers presented in the original IA and the £/tCO_2e numbers presented in this review is complicated as the IA numbers were presented as a discounted flow of GHG savings over the period 2008 to 2020. However, as average GHG savings have been broadly in line with what was projected, whilst the additional costs of biofuel have been towards the top end of the range projected, we can say that £/tCO_2e costs (excluding ILUC) have also been towards the top end of the range initially projected. When estimated ILUC effects are taken into account £/tCO_2e costs are higher.

2011 RED Amendment – Double Certification

Impact assessment

The 2011 double certification impact assessment assumed that the price of biofuels eligible for double certificates would rise to reflect obligated suppliers' increased willingness to pay.

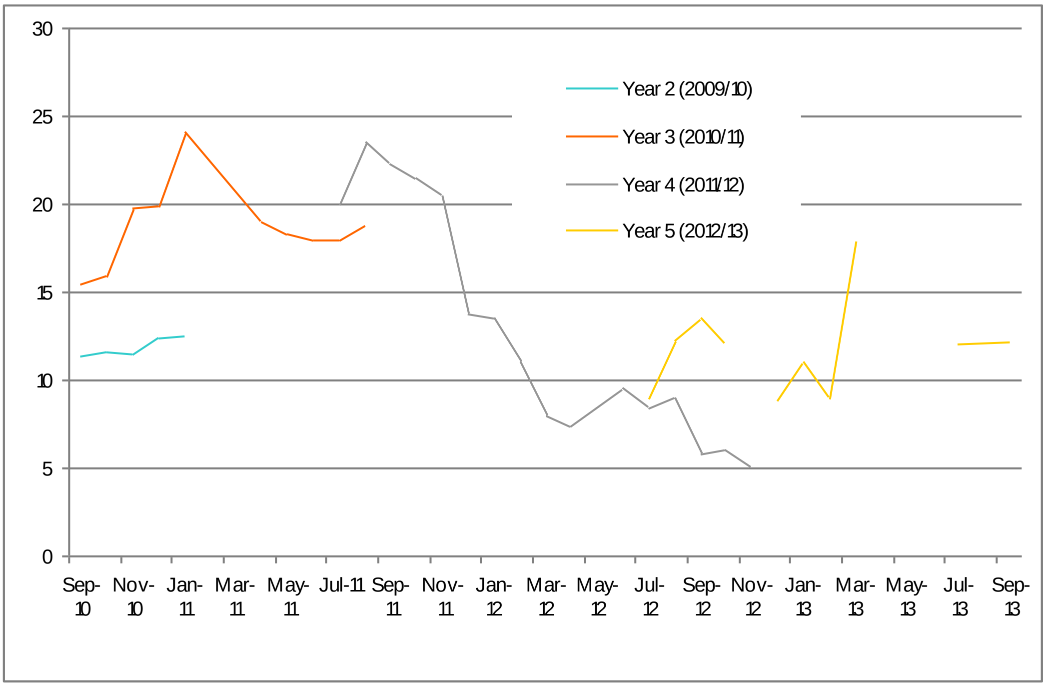
[16]Based upon figures taken from DECC annual report https://www.gov.uk/government/publications/annual-report-and-accounts-2012-13 (page 32)

Therefore there would be no net change in the cost of meeting the RTFO (as, relative to the baseline, suppliers would pay twice as much extra for half the volume of fuel).

Review

Following the introduction of double certification, the RTFC price dropped (as can be seen in the 'Year 4' series of Figure 4.2) and crop-derived biodiesel reduced (from 6% in Year 4a to 2% of total biofuel so far in Year 5) from the RTFO biofuel mix. This may have reflected an oversupply of certificates caused by a combination of double counting and the duty differential but could also reflect a fall in the cost of meeting the RTFO. The certificate price has since recovered and some crop biodiesel has been seen in the RTFO biofuel supply mix which suggests that scarcity of double counted materials may have been driving up the price in line with suppliers' willingness to pay.

Figure 4.2: RTFC prices over time



2011 RED Amendment – Sustainability Criteria

Impact assessment

The impact assessment predicted that there might be some short term price pressures as biofuel producers gradually adapt to the requirements of the criteria. The projected impacts on the biodiesel and bioethanol prices are shown in Figures 4.3 and 4.4 below. Costs were projected to be passed to the consumer such that pump prices would increase by an estimated 0 to 0.4p per litre (including VAT) over the period 2012 to 2020 in the central scenario.

Figure 4.3: Projected impact of sustainability criteria on biodiesel prices (pence per litre, 2010 prices)

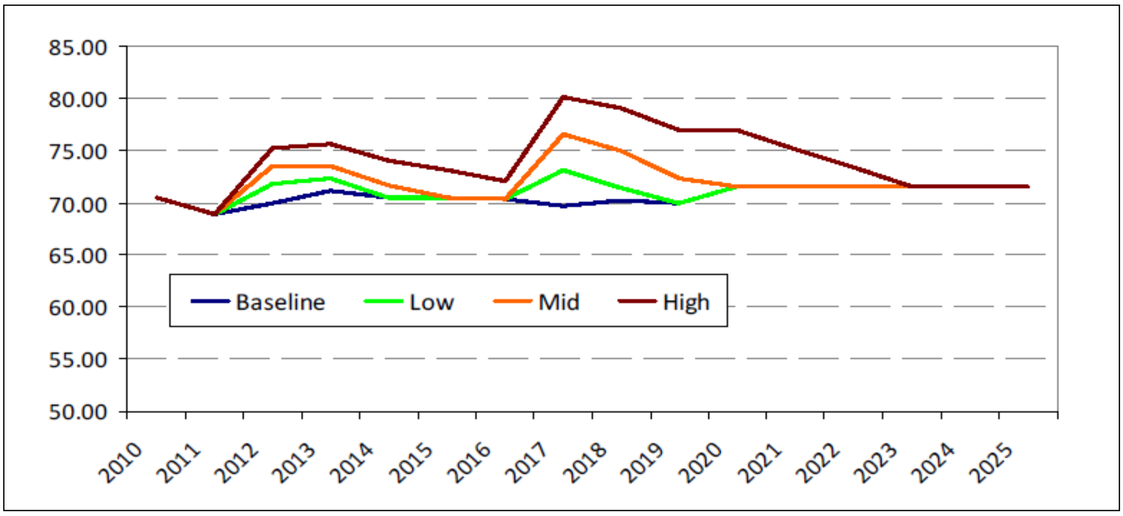
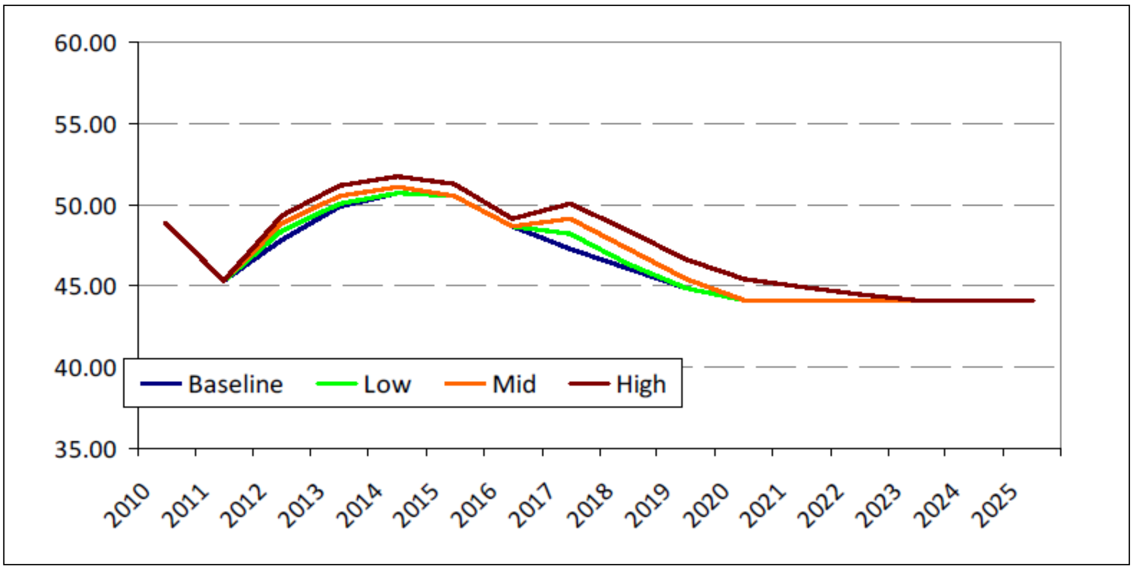


Figure 4.4: Projected impact of sustainability criteria on bioethanol prices (pence per litre, 2010 prices)



Review

Observed market price data for biodiesel suggests that the price premium for RED compliant biodiesel to date has been broadly in line with the central scenario presented in the impact assessment. It has not been possible to obtain comparable price data for bioethanol. Evidence received from stakeholders during the public consultation supports this assessment. It was not possible to establish whether the price premium is declining over time (as projected in the impact assessment).

Conclusions

Recent performance of the RTFO suggests that biofuels offer relatively expensive carbon savings when compared to alternative abatement opportunities within the economy, but relatively low Renewable Energy Directive compliance costs when compared to comparable cost data from the heat and power sectors.

The additional cost of supplying biofuel has been over the period 08/09 to 12/13 has been within (although at the upper end) the bounds of original estimates in the 2007 impact assessment.

However, outturn biofuel and fossil fuel prices have been considerably higher than was envisaged under central assumptions in 2007.

The primary impact of the RED amendments on cost effectiveness has been to encourage waste derived biodiesel over crop biodiesel. These changes have been effective in reducing £/tCO_2 carbon abatement costs (particularly when estimated ILUC impacts are taken into account) but have placed upwards pressure on £/MWh Renewable Energy Directive compliance costs (as waste biodiesel costs more per unit energy than crop biodiesel).

5) Wider Impacts

Introduction

In addition to the quantified impacts presented in the original RTFO impact assessment and this review, biofuels policy has had a number of other impacts. Some of the major unquantified impacts are discussed in this chapter.

Indirect Land Use Change (ILUC)

Indirect Land Use Change (ILUC) occurs where production of biofuel from crops grown on existing agricultural land results in the displacement of production on to previously uncultivated land. Cultivation of new land (resulting indirectly from increased demand for crop biofuels) can cause GHG emissions which are not captured by current GHG reporting methodologies. In some cases it can result in biofuels having greater GHG emissions than fossil fuel. In February 2008 the Secretary of State for Transport invited the Renewable Fuels Agency to undertake a Review of the Indirect Effects of Biofuels. The Gallagher Review of the indirect effects of biofuel production can be found at the following link http://webarchive.nationalarchives.gov.uk/20110407094507/renewablefuelsagency.gov.uk/reportsandpublications/reviewoftheindirecteffectsofbiofuels

The impacts of ILUC were not captured in GHG estimates presented in the original RTFO impact assessment. However, the GHG estimates presented in this review do include estimates of ILUC impacts.

UK Biofuels Industry

At the time of the original impact assessment (2007), the UK had the capacity to produce 334 million litres of biofuel at major plants, not including small plants. Facilities under construction were expected to add a further 774 million litres by 2008. It was estimated that a 100 million litre biodiesel processing plant would create/sustain 200 jobs in farming and 62 jobs at the plant itself. If the plants were supplied entirely by feedstock produced in the UK, this would equate to 2,200 farming jobs and 682 jobs at the plants.

In response to the public consultation on the draft of this review the REA (Renewable Energy Association) estimated that nearly £1bn has been invested in UK biofuel production capacity. A separate report – UK biofuel industry overview – by Ecofys which accompanies this review considers the impacts on UK industry of the RTFO.

Figure 5.1: Location of large-scale bio-refineries

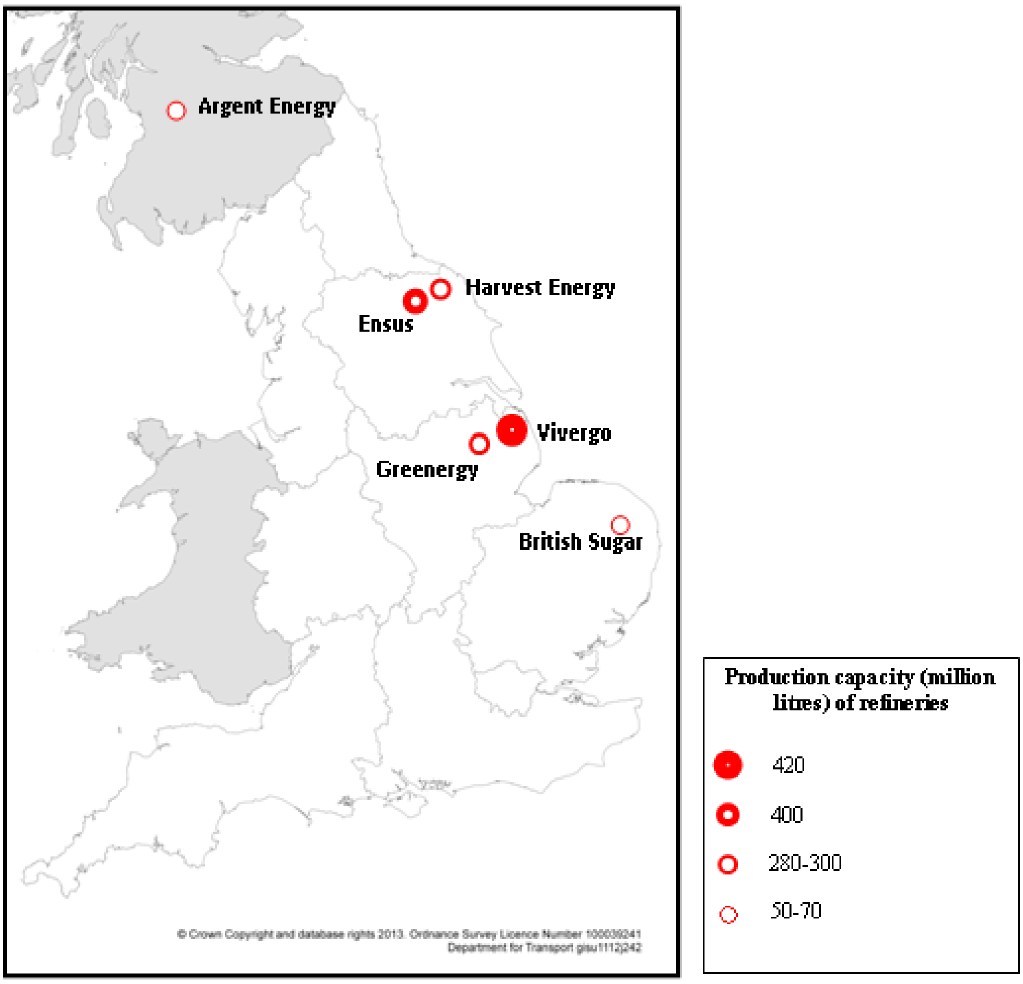


Table 5.1: Information on large-scale biorefineries				
Company	**Location**	**Capacity (million litres)**	**Year of Operation**	**Type**
British Sugar	Wissington, Norfolk	70	2007	Bioethanol
Argent Energy	Motherwell, Scotland	50	2005	Biodiesel
Ensus	Wilton, Teesside	400	2009	Bioethanol
Greenergy	Immingham, Hull	300	2006	Biodiesel
Vivergo	Hull	420	2013	Bioethanol
Harvest Energy	Seal Sands, Teesside	284	2006	Biodiesel

The report notes that total UK biofuel production capacity has increased significantly and is now in excess of 1,500 million litres per year, of which 60% is bioethanol and 40% biodiesel (with a small volume of biomethane). Actual production to date has been below capacity.

Whilst a number of small biodiesel operators have closed, others have diversified into other business, or continue to supply biofuel but to other markets. Cashflow has been cited as a significant issue for smaller operators and the Administrator has moved to speed up the issue of certificates to help to smooth this where possible.

The Ecofys report on industry quotes a joint study by the REA and Innovas which estimates that 3,500 jobs are supported by the UK biofuel industry across the supply chain (including production, supply and distribution – but not including feedstock collection). Analysis undertaken by Ecofys indicates that around 517 people are directly employed at the main UK biofuel plants, which, in turn, supports additional jobs in sectors such as farming, transport and distribution. They estimate that several thousand jobs are supported by the UCO collection industry.

Diversity and security of national fuel supply

The Impact assessments noted that increased biofuel supply could contribute to diversity and security of national fuel supply, for example, through sourcing biofuels and feedstocks from a wider range of countries.

Data was not available on the origin of biofuels supplied into the UK prior to the RTFO: the original IA noted that in terms of vegetable oil imports just four countries (Papua New Guinea, Indonesia, Malaysia and Colombia) provided around 85% of the UK's imports of palm oil and four countries (France, Belgium, Finland and the Netherlands) provided over 90% of the UK's imports of rape oil. However, total biofuel supply was very low and at the time could not, therefore, contribute to diversity or security of national fuel supply.

Since the RTFO was implemented, biofuel has been sourced from an increasing number of countries (55 in the latest supply) which helps contribute to security of national fuel supply, as does the increase in UK production capacity discussed above. The supply of biofuels other than biodiesel and bioethanol has been limited thus far. A full breakdown of the origin of biofuels supplied under the RTFO can be found in the DfT biofuel statistics https://www.gov.uk/government/collections/biofuels-statistics

Innovation

The original impact assessment noted that the policy was likely to have a positive impact on innovation as new and cheaper ways of producing biofuels and improving carbon savings are developed.

The impact assessment for the 2011 amendments noted that double counting may increase investment and innovation in the production of advanced biofuels as this would become more profitable. Other emerging technologies were also expected to benefit.

The supply chain has been innovative in terms of sourcing new materials – the number of applications and queries regarding new materials to be considered as wastes has increased markedly over the last year. Whilst to date, advanced biofuels have not been supplied under the RTFO, new biofuel feedstocks include contaminated materials, food waste, the renewable component of tyres and low grade starch slurry, which is unusable material produced when starch is extracted from the wheat. Low grade starch slurry has already been supplied under the RTFO.

UK biofuel production facilities provide some excellent examples of innovation to deliver improved carbon savings. British Sugar, which produces bioethanol and sugar from sugar beet, minimises waste by recycling stones for building materials, soil for landscaping, and lime for soil conditioning. They utilise the left over beet pulp for animal feed, and use combustion gases and recovered heat from Wissington's CHP plant to grow over 140 million tomatoes annually. Ensus, which produces bioethanol from wheat, produce almost as much animal feed as ethanol which can replace imported soy feed. In addition, they capture waste CO_2 gases for use in the food, drinks and industrial markets.

Compliance

Suppliers and the wider industry have, on the whole, engaged and complied with the requirements of the RTFO. One supplier has been issued with a civil penalty for failing to meet their obligation and a small number of suppliers have been issued with civil penalties for late registration with the scheme.

The impact assessment for the RED amendments did not anticipate an increase in administrative burden other than potentially the need for increased anti-fraud measures. The costs for administrating the RTFO have been lower than expected – see Table 4.6 in the 'costs and cost effectiveness' chapter.

The RTFO Administrator has implemented counter fraud measures including checks on sustainability and volume claims made since the outset. These have been effective in driving improvements in industry practice as seen in improved data capture (pre-RED) leading to increased supply of demonstrably sustainable biofuel over time.

Following RED implementation the Administrator consulted on and implemented a sustainability compliance policy which sets out the approach to checking the accuracy of sustainability claims. This includes the Administrator checking a sample of evidence behind sustainability claims selected on a risk basis. The market has responded to this and other factors by moving to voluntary schemes which provide an extra level of assurance and reduce verification effort (as the verifier does not need to check claims all the way down the chain of custody).

One consequence of providing additional incentivises for biofuels derived from waste materials is an increased risk of fraud. Following RED implementation the Administrator noted that the volumes of used cooking oil (UCO) derived biofuel being reported as coming from the Netherlands were implausibly high based on the population size. As Rotterdam is the main shipping port for Europe it is likely that significant quantities of UCO will pass through the Netherlands. It is therefore possible that the UCO was being misreported as of Dutch origin, rather than the material itself not being genuine UCO. Through communicating this risk, and enforcing the requirements for suppliers and verifiers to be able to trace material back to its origin to verify sustainability claims, the volume of Dutch UCO has decreased to realistic levels and there is greater assurance that virgin oils are not being passed off as wastes.

As used cooking oil volumes have increased significantly to become the main biodiesel feedstock, the Department asked Ecofys to produce a report to feed into this PIR on the UCO market and the impact of the RTFO. The report accompanies this draft PIR and comments are invited from stakeholders on its findings. The main conclusions are:

Within the EU, ~90% of the collected UCO is used for biodiesel and ~10% by the oleochemical industry. UCO from certain controlled sectors of the food industry could still be used in animal feed, but it is believed that in the UK this potential is now used for biodiesel.

It is estimated that up to 61% of total potential UK UCO is already being collected and supplied under the RTFO. Assuming some exports, this suggests that a large part of the UK UCO potential is already being collected and used for biodiesel. There remains, however, scope for increases in collection.

The market for UCO collection is strong, prices have risen and UCO theft has become an issue.

Voluntary scheme certification is being increasingly sought by the market but this carries an administrative burden.

Food and feed

The 2011 amendments impact assessments noted that there may be possible indirect impacts on food prices depending on the types of fuels supplied but these were not quantified. The double counting provisions were introduced to help increase supply of non-food biofuels (as well as reducing the impact of ILUC).

There are concerns over whether agricultural food products should be used for energy when there are people around the world suffering from hunger. There are also concerns that competition for the same product for fuel or feed increases prices which leads to increased poverty and hunger. Others argue that increased demand for agricultural products (e.g. for biofuel) will stimulate increased supply.

The proportion of biofuel supplied under the RTFO coming from feedstocks that could potentially be used for food or feed has decreased markedly over time – from 88% in Year 1 to 58% in Year 5.

Commodity prices in the UK for the three major crop based biofuel feedstocks for the period 2008 to 2010 are shown in Table 8.2.[17]

Table 5.2 Commodity prices in the UK for crop-based biofuel feedstocks, 2008-10

Crop	Price £/tonne				
	2008	2009	2010	2011	2012 (provisional)
Feed wheat	127	108	113	148	163
Oilseed rape*	319.6	248.7	302.3	402.3	385.6
Sugar beet $	27.3	29.1	30.1	29.6	31.1

* average market price (£ per adjusted tonne)

$ average weighted by volume of sales

To the extent that biofuels and biomass policies result in an increase in aggregate demand for agricultural feedstocks and/or agricultural land, they would be expected to result in higher agricultural product prices than would otherwise have been the case. This appears only to have led to a modest rise in food prices, since crops represent only a small share of the cost of food production. The impact of biofuels on crop prices is small compared to the impact of changing agricultural input costs such as fertiliser prices.

Analysis by Defra's modelling team using the OECD-FAO Aglink-Cosimo model suggests that the absence of biofuels support at the EU level could have a modest (yet significant) medium-term price reduction impact on the feedstocks used for biofuels production[18]. For example, in the absence of EU support for biofuels, on average over the projection period, projected EU wheat prices are around 7% lower than in the baseline scenario, vegetable oil prices around 12% lower on average, and oilseed prices approximately 4% lower than baseline levels. This is broadly consistent with earlier modelling by the OECD (2008).

The projected impacts of the effect of US biofuel support is larger than EU biofuel support. This is mainly because bioethanol is mostly produced from one feedstock in the US (maize) rather than from a more diversified feedstock base as in the EU and secondly, due to the USA's large export share in global agricultural markets, particularly maize.

Over and above medium term impacts on agricultural product prices, there is a distinct question about the extent to which biofuel policies have contributed to recent international agricultural price spikes. In that context, a thorough cross-Whitehall analysis of the agricultural price spikes

[17] Source Agriculture in the UK 2012 – https://www.gov.uk/government/publications/agriculture-in-the-united-kingdom-2012

[18] Defra, Removing Biofuel Support Policies: An Assessment of Projected Impacts on Global Agricultural Markets using the AGLINK-COSIMO model, 2012. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48345/5134-removing-biofuel-support-policies-an-assessment-o.pdf

of 2007/08[19] concluded that biofuels had a relatively small contribution in 2008, particularly as far as wheat was concerned. Nevertheless, the report also concluded that the additional global demand for biofuels has and will put upward pressure on the prices for those agricultural commodities used in biofuels production.

The cross-Whitehall report also raised a question about the extent to which the inelasticity of demand for biofuels makes an important segment of agricultural product demand more inelastic so that international prices are more volatile than they would otherwise be.

Increased demand for biofuels has primarily been driven by Government policies incentivising biofuel production rather than market developments such as rising oil prices. The future impacts of biofuels demand on agricultural crop prices will still depend to a large extent on policy developments. In the EU, negotiations are ongoing around how to address the indirect land use change (ILUC) effects of biofuels, and it seems likely that a cap will be placed on the contribution of food-based biofuels to renewable energy targets, with incentives for non-food based biofuel production (e.g. wastes and residues). Depending on the outcome of negotiations, and policy developments in other regions (especially the USA), the impact of biofuels on agricultural commodity prices may diminish in the future.

Impacts on the tallow market

Tallow is a product of the meat rendering process: in the EU it is classified by degree of quality, from high to low. Category 1 tallow presents a high risk for human health and has no alternative use aside from for energy purposes. It therefore counts as a waste and double counts under the RTFO. Category 2 can be used for soil enhancement and for technical purposes, and Category 3 has uses in animal feed, cosmetics and pet food. Tallow in Categories 2 and 3 do not double count.

It is important that incentivising wastes for energy purposes does not lead to significant negative impacts on other markets and/or indirectly lead to increased carbon emissions. As recognised in the RED amendments IA, in the case of tallow, an inadvertent impact might be that double counting Category 1 could create an incentive to produce more of this category thereby reducing the amount of Category 3 available for other industries. These sectors might replace tallow with oils from land based crops such as palm, potentially leading to further expansion of palm into lands with high carbon stocks.

In 2012 Ecofys produced a report on the behalf of the Department which concluded that, based on the available data, double counting of Category 1 tallow biodiesel was not having a detrimental effect on the volumes of UK Category 3 tallow produced. This report has been updated and the latest data and analysis supports the original conclusion.

[19] HMG. The 2007/8 Agricultural Price Spikes: Causes and Policy Implications, 2010 (http://archive.defra.gov.uk/foodfarm/food/security/price.htm. http://archive.defra.gov.uk/foodfarm/food/pdf/ag-price100105.pdf

Biodiversity, water resources, water quality and soil quality

The Joint Nature Conservation Committee (JNCC), the UK Government's statutory advisor on UK and international nature conservation, commissioned a report in 2013 to look at the impacts on UK biodiversity from the production of biofuels and bioliquids from domestic feedstocks.

The report looked at the potential of using bird population data as a proxy for broader biodiversity. It considered the annual Breeding Bird Survey data collected and held by the British Trust for Ornithology (BTO), JNCC and the Royal Society for the Protection of Birds (RSPB), amongst other bird data sources. It also drew upon other experimental data (incorporating the Defra annual agricultural survey data), that could estimate the area of biofuel crops (oilseed rape, sugar beet, wheat) grown in 2010 in the UK and used for biofuel production in 2011 (these were the latest available data). Biofuel crops grown for export markets were not included in these data.

The Defra data estimate that there was a 363% increase in the biofuel crop area from 2009 to 2010, and although it was a large increase, this still only represented 1.7% of the total arable area of the UK in 2010. The area of land involved was therefore quite small.

The multiple potential markets for the crops involved also mean that it was highly unlikely that much change in crop composition across the agricultural landscape had been driven by biofuels. Additionally, agronomic management practices for both food/animal feed crops and biofuel crops (e.g. water inputs, fertiliser, herbicide, pesticide, cropping regime etc.) are currently similar, so it was considered that birds would not be affected any differently by a crop grown for conventional purposes or biofuel/bioliquid purposes.

For these reasons, although no analyses of the bird data were conducted, the report concluded that there was no evidence to suggest that biofuel or bioliquid production in the UK, using UK crops, was presently likely to be having an adverse impact on bird populations. Further, any effects on the agricultural landscape that could impact birds (and other biodiversity) would be due to changes in cropping driven by the broader crop markets, in which demand would reflect numerous other interacting influences, including biofuel/bioliquid demand.

The analysis in the report did however identify reasons to interpret the findings with caution. The reliability and completeness of the figures in the Defra annual agricultural survey had not been fully determined, despite much of their source being based on Government Statistics, and the methodologies for producing them were still evolving. The Breeding Bird Survey data are also better suited to analyses over periods longer than two years because of natural inter-annual fluctuations in bird numbers.

Looking forward, the report highlighted that marginal and idle land may be used for biofuel crops in the future, which could have an impact on bird populations (and other biodiversity) as some of these habitats have been shown to be important for certain bird species. Any such land-use changes should become apparent in future agricultural survey data collected by Defra, which could then be tested against the Breeding Bird Survey (or other) data.

The report also highlighted that, although future Defra agriculture data will incorporate more (later) years, the lag in reporting would mean that it will always be difficult to take the immediately preceding two years, as required by Article 22, into account. Initial indications were that changes in the landscape, due to crops used for biofuels and bioliquids, would be very small in the short to medium term. Therefore, the statistical power to detect effects at real 'conversion' rates was anticipated to be low. Some species would respond positively and some negatively to any given change.

The UK will continue to improve mechanisms to assess the impacts of biofuels and bioliquids on biodiversity for future reporting periods, but note that this assessment may be very difficult for the reasons described.

6) Public Consultation & Suggested Improvements

Prior to publication of this review, a draft version was published in December 2013 and was the subject of a public consultation which ran from December 2013 to February 2014 and invited public feedback on the analysis of the costs and benefits RTFO and suggestion on how biofuel policy and the RTFO could be improved.

https://www.gov.uk/government/consultations/renewable-transport-fuel-obligation-a-draft-post-implementation-review

Comments received on Cost Benefit Analysis

Ethanol prices – representatives of the ethanol industry noted that the ethanol prices which were used in the draft review to estimate costs were inaccurate as the ethanol price used in the modelling included import duty levied at a continental European rate (the ‘T2’ Rotterdam traded price). As there was a misalignment between duty levied in the UK and much of the rest Europe up until early 2013 (i.e. the import duty rate applied by the UK was lower) this resulted in ethanol costs being overestimated in the draft version of the review. This assumption has been revised.

ILUC factors – an environmental NGO noted that the ILUC factors used in the draft review did not exactly match the ILUC factors used in the EU impact assessment. This has been corrected.

Additional costs – a body representing fuel suppliers noted that several costs related to the RTFO had not been captured in the draft PIR. These included Infrastructure Investment Costs (table 4.2), Blending Costs (table 4.3), Fuel Supplier Administration Costs (table 4.5) and Fuel Retailer Costs (table 4.6). These costs have been captured in this version of the review.

Suggested Policy Improvements

Suggestions for improvements which could be made to the RTFO received in response to the public consultation include:

- Splitting the obligation by fuel type;
- Setting obligation trajectories to 2020;
- Setting a minimum RTFC price;
- Awarding additional RTFCs for high blend biofuels;
- A tax differential for UK UCO B100 producers;
- Linking RTFCs to GHG savings;
- Incentivise collection and recovery of wastes; and
- Pre-approval of biofuel (earlier issue of RTFCs).

Conclusions

The estimated costs of the RTFO over the period 08/09 to 12/13 have been within the bounds of original estimates in the 2007 impact assessment, although outturn biofuel and fossil fuel prices have been considerably higher than was envisaged under central assumptions in 2007.

Recent performance of the RTFO suggests that biofuels offer relatively expensive carbon savings when compared to alternative abatement opportunities within the economy, but relatively low Renewable Energy Directive compliance costs when compared to comparable cost data from the heat and power sectors.

The primary impact of the RED amendments on cost effectiveness has been to encourage waste derived biodiesel over crop biodiesel. These changes have been effective in reducing £/tCO_2 carbon abatement costs (particularly when estimated ILUC impacts are taken into account) but have placed upwards pressure on £/MWh Renewable Energy Directive compliance costs (as waste biodiesel costs more per unit energy than crop biodiesel).

Annex A – Modelling Assumptions

Biofuel supply data

Biofuel supply data have been taken from published RTFO statistics https://www.gov.uk/government/collections/biofuels-statistics

Biofuel GHG data (not including estimated ILUC impacts)

Biofuel GHG data (not including estimated ILUC impacts) have been taken from published RTFO statistics https://www.gov.uk/government/collections/biofuels-statistics

ILUC Assumptions

Estimated ILUC impacts have been taken from an EU impact assessment which can be found at http://ec.europa.eu/energy/renewables/biofuels/doc/biofuels/swd_2012_0343_ia_en.pdf (p.26/27)

Figure A1: ILUC factors taken from EU impact assessment

	Average estimated ILUC emissions	Direct emission savings	Total emissions
Maize	10	-57	-47
Sugar beet	7	-63	-56
Sugar cane	15	-70	-54
Wheat - Not specified	14	-40	-26
Wheat - Natural gas/CHP	14	-56	-43
Wheat - Straw/CHP	14	-68	-55
Waste/2nd generation bioethanol - land using	15	-73	-58
Waste/2nd generation bioethanol - non-land	0	-81	-81
Waste/2nd generation biodiesel - land using	15	-85	-69
Waste/2nd generation biodiesel- non-land using	0	-81	-81
Palm oil	54	-39	15
Palm oil with methane capture	54	-61	-7
Rapeseed	55	-50	5
Soybean	56	-43	13
Sunflower	54	-58	-4

Table 4: Typical annual direct savings compared to estimated indirect land-use change emissions per crop (gCO_2/MJ). Source: ATLASS (2011), COWI and Commission's calculations

Fossil GHG assumptions

Fossil GHG data have been taken from https://www.gov.uk/government/collections/biofuels-statistics

Biofuel & Fossil Fuel price data

Biofuel and fossil fuel price data have been sourced from commercial data suppliers. We are not able to publish data due to contractual restrictions.

Monetary carbon values

Department of Energy and Climate Change carbon values have been used. These can be found at https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Renewable Transport Fuel Certificate (RTFC) prices

Renewable Transport Fuel Certificate (RTFC) price data have been taken from the NFPA website http://www.nfpas-auctions.co.uk/etoc/trackrecord.html

GDP deflators

Standard government GDP deflators have been used https://www.gov.uk/government/publications/gdp-deflators-at-market-prices-and-money-gdp-march-2013

Annex B - Tallow sensitivity (Indirect effects)

In the central scenario presented in this report it is assumed that tallow (rendered animal fat) is a waste produce and therefore use of tallow-derived biodiesel creates high GHG savings. The GHG savings reported under the RTFO attribute a GHG saving of typically around 83% to tallow (relative to fossil diesel).

However, it has been argued that tallow is not a waste product (it is also used as a fuel to produce heat and as an input for the oleochemical industry) and use of tallow as a biodiesel leads to increased use of substitutes such as palm oil and heating oil (which have been identified as substitutes for tallow in industrial applications). Research carried out for the Renewable Fuels Agency (http://webarchive.nationalarchives.gov.uk/20110407094507/http:/www.renewablefuelsagency.gov.uk/sites/rfa/files/_documents/Appendix_7_-_Tallow_Case_Study_200912231729.pdf) estimated that, when indirect effects are taken into account, tallow has a GHG saving of 14% (relative to fossil diesel).

In order to analyse the effect of these estimated effects a sensitivity has been carried out where the indirect effect estimated in the research referenced above (an indirect GHG emission of 58gCO2e/mj is attributed to tallow-derived biodiesel). The results of this sensitivity analysis are shown in table A1.

Table A1 GHG savings – indirect effects of tallow sensitivity

Total GHG savings including estimated ILUC effects	**ktCO2/year**				
Fuel type	**Year 1 2008/09**	**Year 2 2009/10**	**Year 3 2010/11**	**Year 4 2011/12**	**Year 5 2012/13**
tallow - including estimated tallow indirect effects	264	423	121	20	181
tallow - not including estimated tallow indirect effects	46	78	17	3	29
RTFO - including estimated tallow indirect effects	-155	210	1219	2108	1740
RTFO - not including estimated tallow indirect effects	-373	-136	1116	2091	1588