Biofuels – At What Cost?

Mandating ethanol and biodiesel consumption in the United Kingdom

AUGUST 2011

Prepared by:

Chris Charles
Peter Wooders

For the Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD)
Geneva, Switzerland

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LIST OF ACRONYMS

AA	Automobile Association
ACEA	European Automobile Manufacturers Association
Bxx	A blend of diesel with xx per cent by volume of biodiesel, e.g. B5 has 5 per cent biodiesel by volume
B15	A blended fuel comprised of 15 per cent biodiesel and 85 diesel
CAP	Common Agricultural Policy
C&S	Carbon and Sustainability
DECC	Department for Energy and Climate Change
DfT	Department for Transport
Exx	A blend of petrol with xx% by volume of ethanol, e.g. E15 has 15 per cent ethanol by volume
EPA	Environmental Protection Agency
FQD	Fuel Quality Directive
GBP	Pounds Sterling
GHG	Green House Gas
EU	European Union
p.a.	per annum
ppl	pence per litre
R&D	Research and Development
RED	Renewable Energy Directive
RFA	Renewable Fuels Agency
RTFO	Renewable Transport Fuel Obligation
RMI	Retail Motor Industry Federation
RSA	Regional Selective Assistance scheme
RTFCs	Renewable Transport Fuel Certificates
SPS	Single Payment Scheme
U.K.	United Kingdom

CONVERSION FACTORS

Density (kg/litre, or metric tonnes/m^3)

Petrol = 0.73 kg/l

Diesel = 0.84 kg/l

Ethanol (average) = 0.76 kg/l

Vegetable oil = 0.88 kg/l

Metric tonne to litres

1 tonne of petrol = 1362 litres

1 tonne of diesel = 1195 litres

1 tonne of ethanol = 1324 litres

1 tonne biodiesel = 1132 litres

Energy density per litre

Energy density of biodiesel is 90.5 per cent that of diesel

Energy density of bioethanol is 64.8 per cent that of petrol

1. EXECUTIVE SUMMARY

1.1 CONTEXT

The U.K. government is currently considering what policies will ensure it meets the European Union's Renewable Energy Directive (RED) commitment of using 10 per cent by energy content (as opposed to overall volume) of renewable transport fuels by 2020. Current policies concerning the blending of biofuels with petroleum fuels may not deliver the required level of biofuels within the U.K. transport fuels market. In order to help meet this commitment, consideration has been given to increasing the U.K.'s current biofuels blending mandate in order to help reach this target. The mandate involves the increasing use of biodiesel to replace diesel, and ethanol to replace the use of petrol. The U.K. government has conducted extensive public consultations to assess the impacts of increasing the overall percentage of renewable transport fuels (Department for Transport, 2011). There has been considerable debate on whether to raise the biofuel blending mandate—especially given questions surrounding their anticipated environmental benefits. In order to meet EU 2020 targets, the blending rate is set to increase from 4 per cent in 2011/2012 to 5 per cent by volume in 2013/14. A mechanism for delivering the RED 10 per cent 2020 target post-2014 has not yet been put in place. What does this debate on biofuel environmental benefits mean in practice? Moving from low to high blended fuels has been cited as having a number of benefits, including greater greenhouse gas (GHG) savings; a more effective use of biomass resources; the encouragement of localised production; and a degree of energy self-sufficiency and diversification of supply. Biofuels have also been recognized as affecting land use patterns, resulting in GHG emissions from the clearing of forests, biodiversity loss, and leading to increases in the price of staple foods (Impact Assessment of proposals for a U.K. Renewable Energy Strategy–Transport, 2009). The extent of these impacts is still being assessed and debated.

The extent of global government intervention in the liquid biofuel markets for ethanol and biodiesel has been significant (Steenblik, 2007). The impact of government support policies, evident at all stages of the biofuels production to consumption cycle, have often not been fully understood or analyzed. Research into the extent of biofuel subsidies has shown that they impose significant costs on government budgets, distort agricultural markets and can result in a host of negative impacts including potentially greater GHGs in certain instances (Steenblik, 2007). Due to the fiscal costs of supporting the biofuels industry, many governments have been moving away from direct payments to industry and phasing out tax exemptions (Jung, Dörrenberg, Rauch and Thöne, 2010). Government intervention has continued to be significant, with many countries, including the European Union, introducing biofuel blending mandates, which moves the cost of supporting the industry onto the consumer and wider sections of the economy. While potentially stimulating the development of local biofuel industries and providing markets for locally produced feedstocks, mandates can also lead to agricultural land being used to produce energy crops, displacing food crops. They can also encourage the creation of interest groups organised and motivated to defend existing subsidies and lobby for additional ones (Victor, 2009).

1.2 STUDY SCOPE

The biofuel blending mandate for the 2011/2012 financial year is currently set by the U.K. government at 4 per cent by volume and is set to move to 5 per cent from 2013 onward.

Box 1: Targets by Energy or Volume

The Renewable Energy Directive (RED) sets targets by energy content, rather than volume. Products with lower energy content such as renewables will, on a volumetric basis, require higher levels of consumption in order to achieve the same energetic value. The energy density of biodiesel is around 90 per cent that of fossil diesel, while for ethanol it is only around two-thirds that of petrol. The number of litres of biofuel needed to travel a certain distance if only fossil-fuels were used, goes up and can thus increase fuel costs for the motorist. The U.K.'s Renewable Transport Fuel Obligation (RTFO) is based on a set of volume percentage targets. In order to achieve the same percentage target for renewable energy use by energetic value, additional biofuels will need to be consumed given their lower overall energy value (Department for Transport, 2009).

The U.K. government is undertaking a consultation process to identify the best approach in implementing the transport element of the RED (10 per cent renewable energy for transport fuels). This study considers a range of impacts resulting from increasing the blending mandate from 4 or 5 per cent to 10 per cent or 15 per cent in order to satisfy the EU's renewable transport target. A number of subsidy mechanisms supporting the biofuels industry are considered in this study. However, the scope of the study is broader than biofuel subsidy policy and analyzes a range of impacts and costs which are not subsidies.

The potential fiscal burden on the U.K. government and the additional costs imposed on consumers and other sections of the economy are analyzed. There are a number of uncertainties concerning aspects of this analysis due to a lack of available information on emerging issues and certainty relating to future feedstock and transport fuel market conditions. The research investigated a number of areas which included:

- Evolution of the U.K.'s biofuels industry and its current and planned production capacity
- Support programs to develop advanced biofuels for the transport sector
- Agricultural subsidies provided to the producers of biofeedstocks under the CAPs Single Payment Scheme
- Government agency costs for administering the RTFO
- Changes in tax revenues if the U.K. government reintroduced tax exemptions in order to reduce the price of biofuels in relation to fossil fuels
- Handling expenses met by fuel retailers in order to deliver blended fuels to consumers
- Upward pressure on consumer prices from more expensive biofuel blended with cheaper fossil fuels sold to consumers
- Engine damage resulting from the use of blended fuels

There are a number of other impacts relating to an increase in the biofuels blending mandate which have not been assessed as part of this study but have been considered by stakeholders more generally. These impacts have included:

Key non-monetised costs: Possible indirect impacts on biodiversity, food prices and release of GHGs if growing biofuel use induces land use change.

Key non-monetised benefits: Ancillary impacts arising from a reduction in congestion, air pollution, noise, road infrastructure and accidents. Market and employment opportunities in agriculture and biodiesel production; diversity and security of national fuel supply; likely positive impact on innovation[1] (Impact Assessment of proposals for a U.K. Renewable Energy Strategy–Transport, 2009).

1.3 MAIN RESULTS

Key findings

1. **Subsidies for the production of biofeedstocks are not quantified nor considered as part of the consultation process for implementing the transport element of the RED**

The study identified that SPS payments[2] to U.K. farmers for the production of biofeedstocks are rising in line with the increasing amount of arable land being used to produce energy crops. The following table illustrates the rising level of SPS payments.

TABLE 1. SPS PAYMENTS SUPPORTING BIOFEEDSTOCK PRODUCTION

RTFO years	2008/2009	2009/2010	2010/2011
SPS Payments	GBP 6,373,371	GBP 9,322,657	GBP 13,672,412

These figures do not represent any additional cost to government as a result of energy crop production. SPS payments would likely have been provided to farmers to grow crops irrespective of whether they were for food or energy markets. What it does show is that the crops being grown on farms receiving SPS payments are shifting more to ones that are potential feedstocks for biofuels. The production of biofeedstocks is a critical stage in determining the sustainability of biofuels and their price competitiveness in relation to fossil fuels. Subsidies provided at this stage of the production process need to be quantified and potentially considered as a cost of implementing higher blends. It is recommended levels of SPS payments for growing biofeedstocks should be monitored as part of the RTFO.

2. **Data capture could be improved to measure the level of U.K. produced biofuels which are exported**

U.K. biofuel consumption and production in the road transport sector can be analyzed using figures published by the RFA and HM Revenue and Customs (HMRC). These figures are available in the RFA's publication, Year Two of the RTFO, and from the HMRC's website (HMRC, 2011). They do not include figures for biofuel produced domestically in the U.K. and exported. If a significant volume of biofuel is being exported and not recorded by official statistics it will be difficult for the impact of the RTFO mandate to be monitored. Using the reported volume (litres) of biofuels produced domestically, in the U.K., the RFA works backwards to estimate of the amount of arable land used to grow biofeedstocks in the U.K, for the corresponding volume of biofuel. . The area of land used to grow energy crops will be underestimated if biofuels which are produced domestically and exported are not included as part of that calculation. The AEA conducted a survey of U.K. biofuel producing companies on behalf of DECC to determine U.K. production of biofuels in the 2009 calendar year (AEA, 2010). Their figures for production of biofuels in the U.K. are compared to RFA figures in the table below:

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[1] Documents published as part of the government consultation process on the implementation of the transport elements of the Renewable Energy Directive (RED) are available on the Department for Transport's website at http://www.dft.gov.uk/consultations/open/2011-05/?view=Standard

[2] Farmers in the United Kingdom are eligible for subsidies under the Single Payment Scheme (SPS), which is part of the European Union's Common Agricultural policy (CAP). Annual energy crops grown for biofeedstock production, e.g. oilseed rape, sugar beet and cereals, are eligible for the SPS payment, as are other crops which meet the necessary SPS regulations.

TABLE 2. SUMMARY OF U.K. BIOFUEL PRODUCTION FIGURES–2009

Biofuels	(a) Estimated U.K. production 2009, million litres	(b) Estimated U.K. production supplied to U.K. market, million litres	Difference, million litres
Biodiesel	223	41	182
Bioethanol	76	66	10

a. Figures generated through the survey conducted by the AEA
b. RFA figures for RTFO year 2009/2010

The volume of biofuels potentially being exported and not included in government reporting figures is illustrated in the final column of table 2. The AEA did note there were a number of uncertainties in producing these figures.[3] Changes in cropping patterns and increases in food prices are important issues which are linked to expanding biofuel production. While the overall amount of arable land used to grow biofeedstocks in the U.K. is still small, relative to the overall amount of agricultural land available, it is however, growing. Better data for exported biofuels will allow for improved future monitoring of land use changes in the U.K. and measuring energy crop related SPS payments.

3. Biofuel production in the U.K. is well below installed production capacity

During the first quarter of 2011, the GSI conducted a survey of U.K. biofuel producers to determine the current organization of the industry, the types of feedstock being used, and any emerging trends concerning the construction of new production facilities.

Installed capacity for biodiesel was estimated at 495,000 tonnes annually. Based on partial RFA figures for nine months of year three of the RTFO (2010/2011), biodiesel production is estimated to reach 13 million litres for the full 12 months of the reporting period. This equates approximately to an estimated 11,500 tonnes of biodiesel produced for RTFO year three (author's calculations).

Installed production capacity for ethanol was estimated to be 380,000 tonnes annually. Based on partial RFA production figures for nine months of year three of the RTFO, ethanol production is estimated to reach approximately 184.9 million litres.[5] This equates to a projected 139,630 tonnes of domestically produced ethanol for RTFO year three (author's calculations). The estimated figure shows production levels are well below installed production capacity.

4. The cost of producing biofuels is affected by a number of changing variables

Future cost projections made by the U.K.'s DfT for using higher biofuel blends have assumed a set of prevailing market conditions, notably that there will be feedstock available to scale up biofuel production within and for the U.K. and for all other countries across the world, and that investors will be sufficiently attracted to build new biofuel production facilities in the quantities required. Further analysis incorporating changes in market conditions is required. For example, this analysis should take into account feedstock market volatility and map them onto changing prices for oil on the global market, to ascertain when it is cost-effective to produce

[3] The production figures generated by AEA are for the calendar year 2009 and do not correspond exactly to the reporting period (April 15, 2009 to April 14, 2010) for the RFA figures. The AEA biodiesel production estimate includes an estimate of production from non-respondents, small-scale commercial producers and people producing for personal use. Small-scale production is estimated to be low, about 6 million litres, but the possible contribution from non-respondents is 168 million litres, which is 75 per cent of the total estimated production and therefore a very significant source of uncertainty in the results.

[4] Conversion: 1 tonne biodiesel = 1132 litres

[5] Conversion: 1 tonne of ethanol = 1324 litres

biofuels under the incentives and subsidies in place. The U.K.'s 10 per cent energy target will require going beyond current blends (E10 and B5), potentially with major additional costs in terms of infrastructure and the costs of constructing and maintaining the vehicles able to use these fuels. However, investors may not be incentivized to develop new facilities in the U.K. or more generally across the world. The variables examined as part of this study indicate that there is a high level of uncertainty in measuring additional costs for deploying higher biofuel blends and biofuels potential competitiveness in relation to similar petroleum products.

Key costs

The principal costs which the study sought to quantify and highlight are contained in Table 3.

TABLE 3. SUMMARY OF AREAS INVESTIGATED

Area	Financial cost	Explanation
Support programs provided by the DfT to develop advanced biofuels for the transport sector	2010/11 financial year, GBP 4 million	This section contains a partial review of U.K. government programs supporting the biofuels industry
Agricultural subsidies provided to the producers of biofeedstocks under the CAPs Single Payment Scheme	2010/2011 financial year, GBP 13.7 million annually	Initial calculations highlight the size of energy crop related SPS payments. Potentially an underestimate due to domestically produced and exported biofuels not captured in government data and related land use calculations
Recognizing the cost of government agencies administering the RTFO	GBP 1.57 million annually	The costs for administering the RTFO are principally allocated to the Department for Transport (DfT) (the RFA was responsible for this function up until being disbanded). There are clearly other government agencies monitoring policies relating to the biofuels industry (such as DEFRA and SPS payments) so administration costs are likely higher
Costs to obligated Suppliers of verifying Carbon & Sustainability (C&S) targets	GBP 7 million annually	Obligated suppliers will be required to pay qualified organizations to certify their production chains conform to required standards
Costs for biofuel producers complying with carbon and sustainability criteria	GBP 315 million	The future costs which could be imposed on obligated suppliers if there are supply problems associated with sourcing certified biofuels is not clear and this figure is likely to be revised by the U.K. government in order to improve its robustness. There is also a lack of clarity on the costs to the U.K. government if they are unable to comply with related EU Directives

TABLE 3. SUMMARY OF AREAS INVESTIGATED (CONTINUED)

Area	Financial cost	Explanation
Production costs for biofuels compared to petroleum products are higher and will result in additional costs to deploy higher biofuel blends	Additional production cost ranges from GBP 1.0 to GBP 2.0 billion for the year 2020	These figures could be considered a lower range though there are considerable uncertainties in calculating future costs
Additional expenses for Fuel Retailers to handle biofuels	Unknown	The future costs imposed on the U.K.'s energy delivery system and infrastructure (i.e. corrosion of storage tanks, etc.) from higher biofuel blends is unknown and will need to be estimated and calculated

2. INTRODUCTION

The Renewable Transport Fuel Obligation (RTFO)

In November 2005, the United Kingdom announced the introduction of the Renewable Transport Fuel Obligation (RTFO), stating that, together with fuel duty incentives, it will be the country's primary mechanism to deliver the objectives set forth in the European Commission's Biofuels Directive (European Commision, 2003). The two principal EU Directives for increasing biofuel usage that U.K. policy attempts to take into account are the Renewable Energy Directive (RED) and Fuel Quality Directive (FQD).

The RTFO obliges suppliers of fossil fuels (if they supply over 450,000 litres of petroleum per annum) to certify that a specified percentage of the road fuels they supply in the U.K. market include renewable fuels. As well as requiring fuel suppliers to meet targets relating to the volumes of biofuels supplied, the RTFO requires companies to provide reports on the carbon and sustainability (C&S) of the biofuels. Administered by the Renewable Fuels Agency (RFA) up until March 31, 2011, when it was closed, responsibility for managing the RTFO has passed to the U.K.'s Department for Transport (DfT) (The Renewable Fuels Agency (RFA), 2011).

Implementing targets for biofuel blending

The RTFO outlines, on a volume basis, the levels of obligation, i.e., the percentages of fuels that must come from biofuels. The following percentages for blending biofuels with fossil fuels by volume were called for in the revised RTFO (Department for Transport, 2011):

- 2.5 per cent in fiscal year 2008/2009,
- 3.25 per cent in fiscal year 2009/2010,
- 3.5 per cent in fiscal year 2010/2011,
- 4 per cent in fiscal year 2011/2012,
- 4.5 per cent in fiscal year 2012/2013, and
- 5 per cent from 2013 and onwards.

The price for each litre of fuel that oil companies must pay if they do not meet their obligation by delivering enough biofuels, was the so-called buyout price. It was set at 15 pence per litre in the first year covered by the obligation. In addition, a duty differential of 20 pence was applied per litre. This meant the total maximum fiscal incentive per litre was 35 pence. The buyout price acted as a safety valve for suppliers unable to redeem enough Renewable Transport Fuel Certificates (RTFCs) confirming they had delivered the required amount of blended biofuel (Kutas, Lindberg, Steenblik, 2007). After March 31, 2011 the duty differential ceased and from the obligation period starting April 15, 2010 the fiscal incentive decreased from 35 pence to 30 pence per litre. In real terms, the total support per litre is declining each year (The Renewable Fuels Agency, 2010).

Excise tax duties for biofuels

On January 1, 2005, the U.K. government introduced an excise tax of 27 pence per litre on the sale of ethanol. Previously, no excise tax had been applied. Petroleum was taxed at 50 pence per litre, with ethanol afforded a 23 pence per litre tax reduction in relation to petroleum. Biodiesel was exempted from excise taxes until July 26, 2002, when an excise tax of 25.8 pence per litre was introduced. Diesel was taxed at 51.8 pence per litre, providing biodiesel with a 26 pence reduction on the fuel duty rate in relation to diesel. After

November 1, 2008 the fuel duty rate was simplified to a single rate for diesel and two rates for petrol, the reduced fuel duty from this point decreased slightly, to 20 pence per litre for both biodiesel and ethanol. After April 1, 2010 the different rates of duty for biofuels ended with the ethanol and biodiesel taxed at the same per litre rate as petrol and diesel (biodiesel from waste cooking oil will benefit from a 20 pence per litre (ppl) duty differential for a period of two years). As more biofuels are needed on an energetic basis compared to fossil-fuels they are therefore subject to a heavier tax burden (HMRC (HM Revenue & Customs), 2011).

Government grants and support to infrastructure

The U.K. government has provided a variety of schemes to encourage the growth of the U.K. biofuels industry. In 2005, it used the Regional Selective Assistance (RSA) scheme to encourage investment and job creation in areas designated for regional aid under the EU law on Assisted Areas. The North East Regional Development Agency also offered grant funding to biofuels producers.[6] The Biofuels Corporation PLC benefited from a grant of GBP 2 million to help build Europe's largest biodiesel plant at Seal Sands in England.[7] The United Kingdom government also provided Enhanced Capital Allowances (ECA) support to domestic biofuel producers to write off the costs of capital assets against their business's taxable profits (Kutas, Lindberg, Steenblik, 2007).

The Refueling Infrastructure Grant Programme was set up to increase the infrastructure alternative refuelling stations for road vehicles. Under this program, grants at 30 per cent of eligible costs were funded by the Department for Transport, with support from the Scottish Executive, based on a total budget of GBP 690,000 for 2005–2006. (Kutas, Lindberg, Steenblik, 2007).

In 2010, the Regional Selective Assistance (RSA) scheme continued to support biofuel companies. For example, providing "Argent Energy Limited" with GBP 8 million of assistance towards investment costs out of a total investment of around GBP 15 million.[8] In 2010, according to a U.K.'s Member State report, the British government had so far invested around GBP 800 million in capital grants and Research and Development (R&D) in the field of renewable energies, though the amount of capital grants for biofuel production could not be determined (Jung, Dörrenberg, Rauch, and Thöne, 2010).

In the 2010–11 financial year, the DfT provided GBP 4 million in support of the Carbon Trust's Algal Biofuel Challenge and Pryolysis Challenge. These programs seek to develop sustainable advanced biofuels for the transport sector, including but not limited to public transport (The United Kingdom Parliament, 2011). The Pryolysis Challenge supports research into the development of biofuel derived from waste biomass using a process involving the thermal decomposition of large molecules. The Algal Biofuel Challenge investigates methods for developing biofuel feedstocks based on algal technology.

Through its consultation process with the biofuels and fossil fuels industry, the U.K. government has identified the need for investment in infrastructure of GBP 315 million (in 2010 prices) to upgrade the U.K. refinery infrastructure in order to blend and distribute higher blend biofuels on a wider scale (Impact Assessment of proposals for a U.K. Renewable Energy Strategy–Transport, 2009). The government expects this investment to come from the private sector.

[6] Effective April 1 2004, Selective Finance for Investment in England replaced the Regional Selective Assistance Grants and the Enterprise Grants in England.

[7] www.onenortheast.co.uk.

[8] Regional Selective Assistance: www.rsascotland.gov.uk

2.1 THE DEVELOPMENT OF THE U.K. BIOFUELS INDUSTRY

Development of biofuel production capacity from 2006 to 2010

In 2007, biodiesel production in the U.K. was estimated at 150,000 tonnes. In 2008, production increased to an estimated 192,000 tonnes, with an installed production capacity of 726,000 tonnes (Jung, Dörrenberg, Rauch, and Thöne, 2010).

In 2006, there were no ethanol production facilities operating. In 2007, ethanol production in the U.K. was 15,780 tonnes (Kutas, Lindberg, and Steenblik, 2007). In 2008, there was one ethanol plant in operation, with the U.K.'s installed production capacity estimated at 55,230 tonnes. The U.K. produced less than 60,000 tonnes in 2008, but industry representatives made statements that it expected to enlarge its ethanol production capacity by almost 650,000 tonnes (Jung, Dörrenberg, Rauch, and Thöne, 2010).

An overview of the U.K. biofuel industry—May 2011

During March and April 2011, the GSI conducted a survey of U.K. biofuel producers to determine the current organization of the industry, the types of feedstocks being used, and any future trends relating to the construction of new production facilities.[9] The GSI contacted senior representatives of companies owning biofuel production facilities with a production capacity of over 30,000 tonnes per annum. Many of the biofuel producers confirmed their production facilities were currently producing biofuel at below the production facilities' installed capacity but did not wish to state their production figures for commercial reasons (Biofuels Industry Survey, 2011).

Biodiesel production capacity

There were three major biodiesel production facilities in production: Argent Energy (located in Motherwell with an installed capacity of 45,000 tonnes per annum), Harvest Energy (located in Seal Sands with an installed capacity of 250,000 tonnes per annum) and Greenergy Biofuels (located in Immingham with an installed capacity of 200,000 tonnes per annum). The total installed production capacity of these facilities is 495,000 tonnes of biodiesel per annum.

Several biodiesel production facilities were not active or producing well below their installed production capacity. Two companies with major production facilities which were not currently producing were Brocklesby in East Yorkshire (with installed capacity of 30,000 tonnes per annum) which stopped production in 2010, and ESL Biofuels, with a facility in Cheshire (installed capacity of 200,000 tonnes per annum) which was only producing at a rate of about 2,500 tonnes per annum when active. The U.K.'s total combined production capacity was estimated at 722,000 tonnes per annum. Based on partial RFA production figures for nine months of year three of the RTFO (2010/2011), biodiesel production is estimated to reach approximately 13 million litres[10] for the full 12 months of the reporting period. This equates approximately to an estimated 11,500 tonnes of domestically produced biodiesel for RTFO year three (author's calculations). Comparing this figure against the currently installed capacity for biodiesel, it appears that a large portion of the U.K.'s installed capacity is currently not producing to full capacity.

[9] The results of the survey have been synthesized. The statements in the following sections of the study concerning the position of the U.K. biofuels industry may not represent the views of all U.K. biofuel producers. Representatives of the following biofuel companies were contacted: Abengoa Bioenergy, Argent Energy,Bioethanol Ltd, Biofuel Refineries Ltd, British Sugar, Harvest energy, Ensus Limited, Gasrec, Greenergy Biofuels, INEOS Bio Limited, INEOS Enterprises, Vireol, Vivergo Fuels Limited, Green Spirit Fuels, ABS Biodiesel LTD, D1 Oils PLC, DMF Biodiesel, ESL biofuels, Losonoco, Roquette, Tees Valley Biofuels, Goes on Green, Brocklesby, Rix Biodiesel

[10] 1 tonne biodiesel = 1132 litres

No biofuel companies contacted had plans to develop new biodiesel production facilities. Plans to build five major biodiesel producing facilities had been cancelled. The production facilities were at different stages of development ranging from the initial project planning phase to having secured planning permission to start construction.[11] If cancelled production facilities had gone ahead, U.K. biodiesel production capacity, including existing production facilities, could have reached 1,867,000 tonnes per annum.

Ethanol production capacity

In 2010, there were two major ethanol production facilities in operation: one owned by British Sugar (located in Wissington, with an installed production capacity of 55,000 tonnes per annum) and one owned by Ensus Limited (located in Teesside, with an installed production capacity of 325,000 tonnes per annum). The Teesside facility started production only in 2010 and was reported to be producing at full capacity. However, a recent news report noted that, due to adverse market conditions, the facility will close at the end of May 2011 for four months (BBC, 2011). Both facilities combined production capacity was estimated at 380,000 tonnes per annum. There were no completed but inactive ethanol production facilities (Biofuels Industry Survey, 2011).

As of April 2011, there were plans to build an additional five ethanol production facilities. These planned facilities were owned by Abengoa Energy (located in Immingham, with a production capacity of 316,000 tonnes per annum), Bioethanol Ltd (located in Immingham, with a production capacity of 200,000 tonnes per annum, to be completed in 2013), Ineos Bio Limited (located in Seal Sands, with a production capacity of 150,000 tonnes per annum, to be completed in 2014), Vireol (located in Grimsby, with a production capacity of 150,000 tonnes per annum, to be completed in 2013) and Vivergo Fuels Limited (located in Hull, with a production capacity of 330,000 tonnes per annum, to be completed in 2011). Taking into account the two ethanol production facilities currently producing and the five production facilities which are at the planning stage, the U.K.'s potential production capacity could reach 1,526,000 tonnes per annum in 2013. Based on partial RFA production figures for nine months of year three of the RTFO, ethanol production is estimated to reach 184.9 million litres for the full 12 months of the reporting period. This equates approximately to 139,630 tonnes[12] of ethanol produced for year three (author's calculations). In comparing this figure against installed production capacity for ethanol, it would appear a large portion of the U.K.'s installed capacity was not producing at close to full capacity.

Plans to build five major ethanol production facilities have been cancelled or at least put on hold. The production facilities were at different stages of development ranging from the initial project planning stages to having secured planning permission to start construction.[13] If these cancelled production facilities had gone ahead, U.K. production capacity, including existing ethanol production facilities, would have reached 1,836,000 tonnes per annum.

Taking into account installed production capacity and planned production capacity for ethanol which is yet to come on line, it is possible that anywhere between 1.2 million tonnes and 4.4 million tonnes of wheat could be used annually for ethanol production.[14]

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[11] Cancelled production facilities included the following: Argent Energy, (located in Cheshire, with a production capacity of 150,000 tonnes per annum, stage: planning permission obtained), Ineos Enterprises (located in Grangemouth, with a production capacity of 500,000 tonnes per annum, stage: planning permission obtained), ABS Biodiesel Ltd (located in Bristol, with a production capacity of 230,000 tonnes per annum), D1 Oils PLC (production capacity of 220,000 tonnes per annum), DMF Biodiesel (with a production capacity of 45,000 tonnes per annum, stage: planning permission obtained but subject to legal challenge).

[12] Conversion: 1 tonne of ethanol = 1324 litres

[13] Cancelled production facilities included the following: Green Spirit Fuels (located in Immingham, 105,000 t per annum), Green Spirit Fuels (located in Humberbank, 105,000 t per annum), Roquette (located in Corby, 100,000 t per annum)

[14] Estimated potential future wheat consumption is based on the registered production capacity of surveyed facilities identified as using wheat as their principal feedstock.

2.2 WHERE IS THE BIOFUELS INDUSTRY HEADING?

Biodiesel

Biodiesel production capacity in the U.K. may not grow significantly in the near future. As there are currently no plans to build additional biodiesel producing facilities and two existing production facilities have halted production, biodiesel production appears, under certain circumstances, to be commercially difficult. The main reason provided by biodiesel producers for the present difficult market situation was high production costs, principally due to rising feed stock prices. Many smaller producers noted that high feedstock prices prevented increasing levels of production or consideration of building new production facilities or expanding existing ones. Argent Energy was waiting for the full implementation of the Renewables Energy Directive which could bring in higher biofuel blending mandates. This would increase demand for biofuels, as additional biofuels would be needed to blend with fossil fuels, hopefully improving profitability (Posnett, 2011).

Box 2: Increases in feedstock prices can render biofuel production uneconomical

Malaysia, as a major producer and exporter of palm oil, an important biofeedstock for biodiesel production, appeared to be well positioned to develop a domestic biodiesel industry. From 2006 to 2008, the world saw new price highs for a number of commodities, with prices for palm oil rising substantially. High feedstock prices put biofuels beyond the reach of any but the wealthiest nations that could afford to maintain subsidies. In 2008 Malaysian biofuel producers were not able to draw on significant domestic government support to maintain their operations. Malaysia was not planning additional market interventions to support prices, other than a planned increase in blending mandates.

Many operators of Malaysian biofuel facilities suspended operations in 2008, stranding public and private investments. While 92 biodiesel projects had been approved in Malaysia during 2006 and 2007, a GSI survey of production facilities in September 2008 revealed that there were 14 functional biodiesel production facilities, only eight of which had produced biodiesel in 2008 (approximately 130,000 tonnes—less than ten per cent of their potential production capacity). The remainder had suspended operations due to high feedstock prices, and a further four had closed. The profitability of Malaysian biodiesel production was precarious, depending on volatile palm oil and petroleum prices, and decisions of policymakers both in Malaysia and overseas. A similar situation could result in the U.K.

The GSI advised the Malaysian government against introducing a B5 mandate, which could lock in a new form of fuel subsidy that was delinked from market forces, such as rising feedstock prices, thus creating new inefficiencies in their energy market which would be difficult to reform in future years (Laan, Lopez, & Gregore, 2008). In early 2011, The Food and Agriculture Organization of the United Nations (FAO) Food Price Index, which includes many first generation feedstocks which are also used as food crops, shows prices for cereals in excess of 2008 highs (The Food and Agriculture Organization of the UN (FAO), 2011). The cost structure of the biofuels industry is heavily reliant on affordable feedstocks. However, current high prices for feedstocks and future commodity price volatility appear to be an ongoing problem. In response to this, U.K. biofuel producers may call on the government to introduce policies to support the supply of cheap biofeedstocks.

Ethanol

Ethanol production appears to be more commercially viable than biodiesel. Based on the GSI survey, it appears the U.K. ethanol industry is now expanding, with a number of production facilities being built, with the Ensus plant being one of the biggest. Ethanol production may rise in the future as more production capacity comes on line (Biofuels Industry, 2011).

Many biofuel producers thought the U.K. was a challenging market to operate in due to its lower tariffs on imported ethanol from outside the EU than other European countries (The Renewable Fuels Agency, 2011). U.K. biofuel producers felt they were well placed to supply certified sustainable biofuels. However, as fuel suppliers were still allowed to buy un-certified biofuels on the spot market, the demand for certified feedstocks and the need for longer-term supply contracts were more limited. Many producers considered this an important factor preventing further investment in the sector. Biofuel producers were generally in support of a steady and predictable increase in the percentage of blended biofuels mandated by the RTFO, in order to ensure a market for U.K. biofuels and encourage greater investor security. Biofuel producers also thought subsidized imports of biofuels were detrimental to the commercial viability of biofuel production in the U.K.. Rising feedstock prices were identified as the principal factor in planned projects being put on hold or abandoned all together (Biofuels Industry Survey, 2011).

3. U.K. SINGLE PAYMENT SCHEME AND THE PRODUCTION OF BIOFEEDSTOCKS

The production of biofeedstocks is considered a critical stage in determining the sustainability of biofuels and the amount of GHG savings biofuels can provide in replacing fossil fuels. Different feedstocks and biofuel production processes are recognized as having varying GHG profiles. In some countries, biofeedstock production has been linked to changes in land-use patterns, the clearing of high-value environmental areas for farming, and the intensification of inputs such as fertilizers and pesticides, designed to increase production levels (Friends of the Earth Europe, 2010). The extent that increased biofeedstock production resulting from increasing blending mandates effects land-use patterns is a hotly contested issue. Biofeedstock production also creates a price link between agricultural markets and the much larger market for liquid fuels. Many governments have made efforts to reform agricultural subsidies in order to reduce the distortions in international agricultural markets (The World Trade Organisation (WTO), 2004). Research from the current study has identified that agricultural subsidies to grow biofeedstocks have been increasing in the U.K. as more arable land is used to produce energy crops for the domestic biofuels industry.

U.K. farmers are eligible for subsidies under the Single Payment Scheme (SPS), sometimes referred to as the Single Farm Payment Scheme, which is part of the European Union's Common Agricultural policy (CAP). Introduced in 2005, the SPS was part of the CAP reforms designed to decouple subsidies from production-related aid, and allows farmers greater freedom to switch to alternative enterprises, such as bioenergy crop production. The aim of the regulation was also to help simplify and modernize the CAP's administration (Europa, 2009). There are *no* specific SPS payments or schemes to support biofeedstock production, rather annual energy crops grown for biofeedstock production e.g. oilseed rape, sugar beet and cereals are eligible for the SPS payment as are other crops which meet the necessary SPS regulations (Business Link UK, 2011). Certain requirements need to be met in order for U.K. farmers to qualify for SPS payments (such as holding SPS entitlements). Whether or not they produce anything, farmers will also need to meet European Union (EU) standards regarding animal and plant health, called cross-compliance (Department for Environment Food and Rural Affairs, 2011). The per hectare payments for the U.K. are calculated by taking post voluntary and compulsory modulated SPS payments and dividing them by the utilized agricultural area registered with Eurostat. The per hectare SPS rate is calculated in Euros and then converted to British Pounds Sterling.

The amount of payments provided under the SPS to U.K. farmers for growing biofeedstocks can be calculated by multiplying the number of hectares used for biofeedstock production by the standard per hectare SPS payment to farmers. In the U.K., there are jurisdictional differences (between, England, Northern Ireland, Scotland and Wales) in the per hectare SPS rate. The SPS per hectare rate for England has been used for the calculation as the majority of feedstocks are likely to have been grown in this region.

The following formula was applied:

Hectares used for biofeedstock production p.a. X **SPS per hectare rate** =
SPS payments for U.K. biofeed production p.a.[15]

The RFA publishes data on the quantity of biofeedstocks grown in the U.K. for the U.K. biofuels industry, and the amount of acreage used to produce individual feedstocks. In year one of the RTFO (2008/2009), 8.5 per cent of the biofuels supplied in the U.K. market were produced using U.K. grown feedstocks. The gross arable land used to grow the feedstocks was estimated at 32,920 hectares (The Renewable Fuels Agency, 2010). In year two of the RTFO (2009/2010), 11 per cent of U.K. biofuels were supplied using biofeedstocks grown

[15] Note: only single cropping patterns are assumed by this formula. Calculations are based on RFA estimates of arable land used for feedstocks (the RFA provide technical guidance on calculating land use based on biofuel volumetric data/litres).

in the U.K. The estimated gross arable land used for their production was 41,840 hectares (The Renewable Fuels Agency, 2011). The RFA published data on U.K. biofuel production for the first six months of year three of the RTFO (2010/2011). Based on this partial data, the authors calculated the potential amount of arable land which could be used for biofeedstock production for the U.K. biofuels market for the full 12 months of year three of the RTFO (2010/2011). The gross arable land for biofeedstock production was estimated to be 67,931 hectares. From year one to two of the RTFO, the amount of arable land in the U.K. used to grow biofeedstock increased by approximately 27 per cent. From year two to three of the RTFO, the amount of arable land used for feedstock production increased by an estimated 62 per cent.[16]

The level of SPS subsidies provided to U.K. farmers for growing biofeedstocks was estimated for the three years of the RTFO and is illustrated in the following table.[17]

TABLE 4. SUMMARY OF SPS PAYMENTS MADE TO U.K. FARMERS GROWING BIOFEEDSTOCK

Feedstocks		Oilseed rape		Sugarbeet		Wheat		
RTFO Years	Per hectare SPS payment GBP	Hectares	SPS payments	Hectares	SPS payments	Hectares	SPS payments	Total Subsidy
2008/2009	GBP 194	23,400	GBP 4,530,282	9,520	GBP 1,843,089	–	GBP 0	GBP 6,373,371
2009/2010	GBP 223	29,700	GBP 6,617,660	11,800	GBP 2,629,239	340	GBP 75,758	GBP 9,322,657
2010/2011	GBP 209	9,845	GBP 2,060,199	10,010	GBP 2,094,698	45,481	GBP 9,517,515	GBP 13,672,412

Source: Author's calculations, U.K. Government data: DEFRA.

For year one of the RTFO (2008/2009) SPS payments amounted to GBP 6.4 million. In year two of the RTFO (2009/2010), SPS payments were estimated to be GBP 9.3 million. This figure is estimated to increase to GBP 13.7 million in year three of the RTFO (2010/2011). The data used to calculate the acreage for domestically produced biofeedstocks does not take into account biofuels which were produced domestically and sold to the international market, or domestically produced feedstocks exported for processing. If the U.K. biofuels industry exported biofuels in any RTFO years, it is possible that the total U.K. acreage for growing biofeedstocks was higher than current figures indicated. This would also lead to an increase in the estimated level of SPS payments made to farmers using the method adopted by this study to measure agricultural subsidies.

[16] The total amount of land in the U.K. used for agricultural purposes is in the vicinity of 16,130,052 hectares. The amount of arable land used to grow biofuel feedstock is a small percentage of that overall figure.

[17] At present, the RFA can only provide data for the first nine months of year three of the RTFO. Without any predictive data on future land uses, the amount of land used to grow biofeedstocks during first nine months of the year was extrapolated out to a full year in order to arrive at a figure for all of year three of the RTFO. Data for the first nine months of year three of the RTFO can be found here: http://www.dft.gov.uk/pgr/statistics/datatablespublications/biofuels/

4. TAX EXEMPTIONS FOR BIOFUELS

Governments can grant certain goods lower duties or tax exemptions as part of a country's taxation system. In the U.K., transport fuels such as petroleum and diesel are charged an excise tax, or duty on their sale. The producer or seller who pays the tax to the government is typically expected to try to recover any increase in the tax by raising the price paid by the buyer. The subsidy provided to biofuel producers through reduced tax rates or excise exemptions, is estimated as the amount of excise tax exempted on a per litre basis in relation to their equivalent products. For ethanol it is petroleum and for biodiesel it is diesel. From April 1, 2010 the different rates of excise duty applied to the sale of U.K. biofuels ended, except for biodiesel from waste cooking oil. Biodiesel, diesel, ethanol and petrol are taxed at the same rate per litre (HMRC (HM Revenue & Customs), 2011).

Tax exemptions are often cited as way to help reduce the price of biofuels relative to fossil fuels and overcome consumer resistance to their use. Concerning the design of excise tax exemptions, it is possible to distinguish between systems with and without production quotas. Systems with so-called production quotas ensure tax relief is only granted up to a certain level of production. Quotas are intended to limit the amount of foregone tax revenue and hence ease the burden on taxpayers. In systems without a quota, an undefined amount of consumption is exempted from taxation. Foregone tax revenue then depends highly on levels of consumption and can rise as consumption does (Jung, Dörrenberg, Rauch, & Thöne, 2010).

The U.K. government has followed other EU Member States in moving away from tax incentives towards market based blending mandates. A number of commentators have cited the importance of tax exemptions for U.K. producers. In 2006, Deloitte noted the U.K.'s tax exemptions at that time (23 cents per litre for ethanol and 26 cents per litre for biodiesel) "pale in comparison" to Germany's 100 per cent tax exemption. A balance of tax incentives and obligations was noted as being required to help develop the U.K. biofuel industry (Deloitte, 2006).

A study prepared by Transport and Travel Research Ltd. for the Low Carbon Vehicle Partnership notes the removal of the fuel exemptions combined with a policy requiring suppliers to purchase certificates effectively reduces the cost competitiveness of high blend biofuels. The report goes on to note that when the excise tax duty is removed for biofuels they are normally more expensive in relation to conventional fuels. In order to overcome the difficult challenge of margin management, the report notes that future tax exemptions giving some form of future guarantee on exemption levels would allow for greater market certainty and help grow the industry (Transport and Travel Research Ltd., 2009).

Reduced tax rates can mean foregone revenue for the government. In order to highlight the burden of tax exemptions on government coffers, the GSI undertook a number of hypothetical calculations to estimate the amount of foregone tax revenue by the U.K. government if tax exemptions for biofuels were reintroduced. The next section of the report notes that around 6.5 billion litres of biofuels would be required to meet the mandate. With a *theoretical reintroduction* of a tax exemption of 20 pence per litre, foregone revenue for the U.K. government would be GBP 1.3 billion in 2020. A ±10p per litre change in this rate would change the estimate by ±GBP 0.65 billion in 2020.

5. BIOFUEL PRODUCTION

However biofuels and petroleum products are incentivised—using tax breaks, mandates or other policies and measures—it is the difference in their relative production costs which represents the additional costs of biofuels to society. The additional cost of biofuels production for meeting the mandate is calculated in this study as:

cost of producing biofuels to the volume of the mandate *minus*
the cost of purchasing petroleum products with an equivalent energy content

The following elements are required to make this calculation, and there are attendant uncertainties:

- the volume of biofuels required to substitute for the equivalent amount of energy contained in petroleum products, which is dependent on the shares of ethanol and biodiesel;
- the cost of purchasing petroleum products;
- the cost of producing biofuels, including whether there are discontinuities if certain blending rates are exceeded.

For both petroleum products and biofuels, it is assumed that market price can be used as a proxy for production cost. No attempt has been made to calculate producer or consumer surpluses or any other wider benefits to society.

5.1 VOLUME OF BIOFUELS REQUIRED TO MEET THE 2020 MANDATE (10 PER CENT BY ENERGY)

Both ethanol and biodiesel have a lower calorific value per litre than the petrol or diesel for which they respectively substitute. The DfT supplied IISD, under the terms of the Environmental Information Regulations 2004, with a copy of a model it used to estimate the impacts of implementing the Fuel Quality Directive (Department for Transport, May 2011; referred to in this report as the "FQD Model").[18]

Within this model, the relative calorific values of petroleum products and biofuels are as shown in Table 5. A biofuel volume of 14.6 per cent of ethanol is needed for it to represent 10 per cent of the energy in a blend with petrol. A biodiesel volume of 10.9 per cent is needed for it to represent 10 per cent of the energy in a blend with diesel. In both cases, the blended fuel has a lower calorific value per litre than the pure petroleum product, and thus a higher volume of fuel will be required for it to meet the equivalent energy content. A corollary of the lower calorific value is that, if tax per litre is equal for petroleum products and biofuels, the tax per unit of energy is higher for biofuels.

TABLE 5. ENERGETIC VALUE OF BIOFUELS AGAINST PETROLEUM PRODUCTS

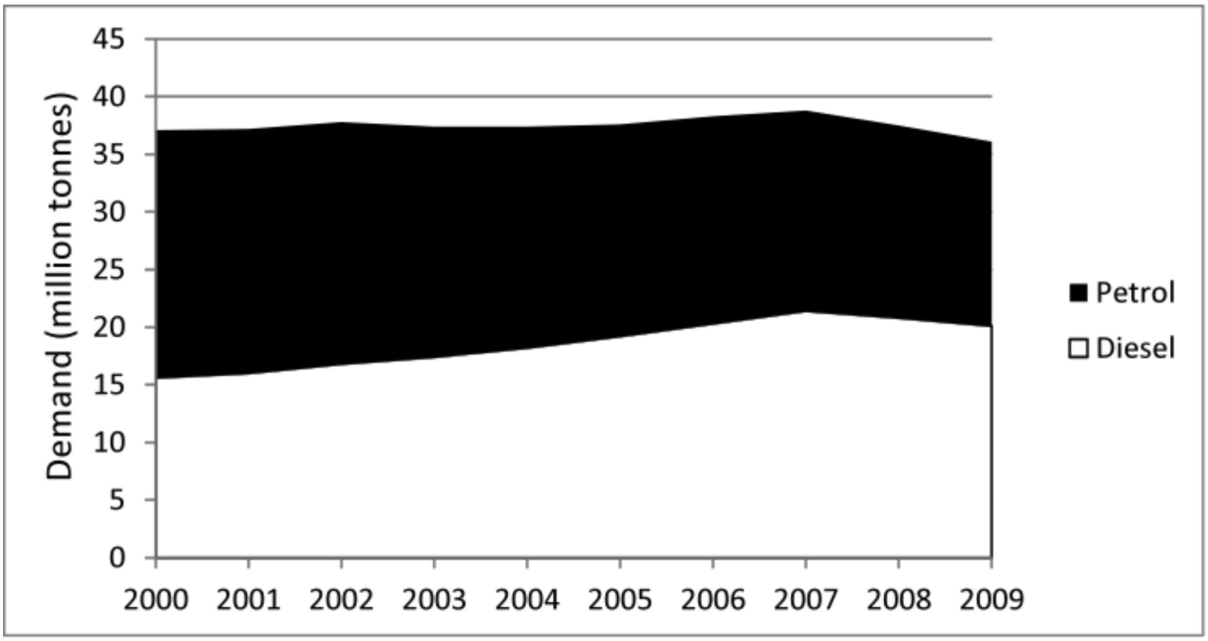
Fuel	Calorific Value (CV) (MJ/litre)	CV as fraction of petroleum product	Share of biofuel required to meet 10 per cent of petroleum product energy content
Ethanol	21.28	64.8%	14.6%
Biodiesel	33.10	90.5%	10.9%

Source first two columns DfT (May 2011); third column author calculations

[18] In supplying the model, the DfT stated that, "all data and documents resulting from use of the model by IISD must not be presented as authorised or quality assured by the Department for Transport."

The demand for petroleum products in the U.K. has been roughly stable over the past decade, with a steady switch from petroleum to diesel, principally due to an increased share of diesel registrations within new cars and light goods vehicles (see Figure 1).

FIGURE 1. U.K. DELIVERIES OF PETROL AND DIESEL, 2000–2009

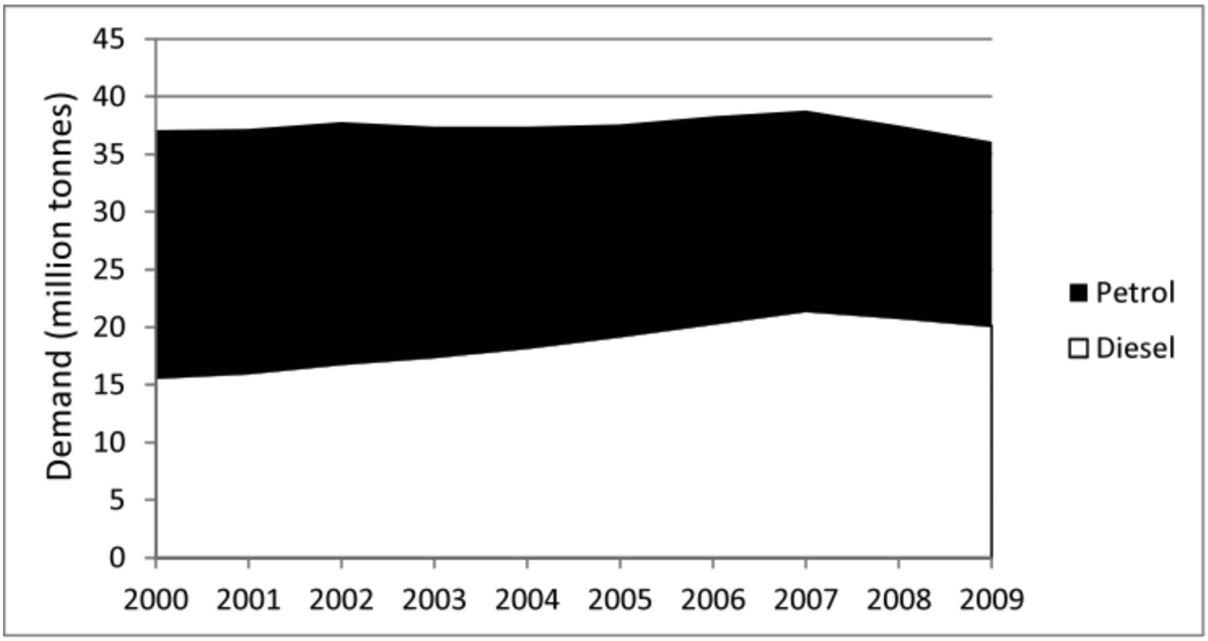


Source: (TSO, 2010)

Both trends—the stability of demand, and a switch to diesel—are projected by the U.K. government to continue to 2020. Figure 2 shows U.K. government projections, as reported by DECC and as used within the FQD Model as supplied to IISD. Four oil price scenarios are used: low, central, high and highhigh. The figures are for a "no biofuels" case, which is of course hypothetical but sets a baseline against which to compare biofuel demand.

Demand remains roughly constant, with some decline projected if prices for transport fuels are at the high end of the range. All four projections for 2020 show petrol demand represent 38 per cent of the total, down from 45 per cent in 2010.

FIGURE 2. PROJECTED U.K. DELIVERIES OF PETROL AND DIESEL IN 2020—NO BIOFUELS CASE



Source: DfT (May 2011)

Table 6 gives the detailed figures in million tonnes (Mt) and in million litres (M.litres).[19] Diesel demand in 2020 is projected to be around 28 billion litres, and petrol demand 19 billion litres.

Source: (Department for Energy and Climate Change, June 2010)

TABLE 6. PROJECTED U.K. DELIVERIES OF PETROL AND DIESEL IN 2020—NO BIOFUELS CASE

			2020			
	Units	2010	Low	Central	High	HighHigh
Diesel	Mt	21.58	24.38	23.98	23.32	22.73
Petrol	Mt	17.35	14.76	14.51	14.11	13.76
TOTAL	Mt	38.93	39.14	38.49	37.43	36.49
Diesel	M.litres	25,787	29,138	28,655	27,862	27,162
Petrol	M.litres	23,628	20,102	19,769	19,222	18,739
TOTAL	M.litres	49,415	49,240	48,424	47,084	45,901

Source: (Department for Energy and Climate Change, June 2010)

[19] Using conversion factors for petrol's specific volume of 1362 litres/tonne and diesel 1195 litres/tonne (TSO, 2010).

The 10 per cent mandate by energy could be met by any combination of ethanol and biodiesel demand.[20] The DfT's 2009 Impact Assessment notes that it has been biodiesel that has met the majority of the U.K.'s biofuel demand to date, but expects that ethanol will become cheaper going forward.[21] It makes the assumption that ethanol and biodiesel will contribute equally relative to the demand for petrol- and diesel-based fuels in 2020, i.e., that each will meet 10 per cent of the energy content of the projected demand for petrol and diesel (Department for Transport, 2009).

It was noted earlier that the volumes needed to meet 10 per cent by energy for petrol and diesel were approximately E15 (i.e. a blend of petrol with 15 per cent ethanol) and B11 (a blend of diesel with 11 per cent biodiesel) respectively. Both are higher than the blends currently used in the U.K., and both present potential concerns and are likely to result in additional, non-linear costs: E10 is a limit to what many motorists and engine manufacturers consider can be run in a car without modifications and without causing damage; B7 represents a "blend wall" beyond which changes to technology would be required. If we assume that the B7 blend wall (6.4 per cent of biodiesel blend by energy) will not be surmounted, then ethanol would have to make a larger contribution to meeting the U.K.'s mandate. Given that petrol-based fuels are projected to account for only 38 per cent of U.K. demand in 2020, an ethanol blend of E26 would be required in order for the U.K. to meet its 10 per cent biofuels by energy target. A blend at this volume of ethanol could cause engine damage; the level of these costs is not known and could be significant. In this case, the U.K. would almost certainly retain an E10 blend usable by unmodified vehicles and also introduce a relatively pure ethanol blend and the associated new infrastructure—extra pumps at service stations and the associated distribution systems—and vehicles able to run on these relatively pure blends, possibly as dual-fuelled vehicles. Examples of relatively pure blends are the E85 used in the U.S., the ED95 used as a diesel substitute in Sweden or E100 adopted in Brazil in order to meet its biofuels target. The quantities of biofuels required in 2020 are presented for two scenarios in Figure 3, which also includes the quantities of biofuels which have historically been consumed in the U.K. to 2009. In the absence of any better guidance, a linear profile between 2009 and 2020 has been assumed: the FQD model similarly assumes linear trends to 2020.

Under an equal energy content case where each biofuel meets 10 per cent of its respective petroleum product demand in 2020, a scenario used by DfT in their impact assessments, each biofuel would need to supply just over 3 billion litres in 2020, with an average increase of approximately 250 million litres of ethanol per year and 200 million litres of biodiesel (both approximately 180,000 tonnes per year of additional consumption).

While it may be costly to go beyond an E10 mix, whether the biodiesel blending wall of 7 per cent by volume can be overcome at reasonable cost appears to be the most significant constraint on increasing the share of energy met by biofuels. The second scenario shown in Figure 3 indicates that with a B7 blend wall constraint, biodiesel demand would increase to 2 billion litres per year and bioethanol to 4.8 billion litres per year in 2020.

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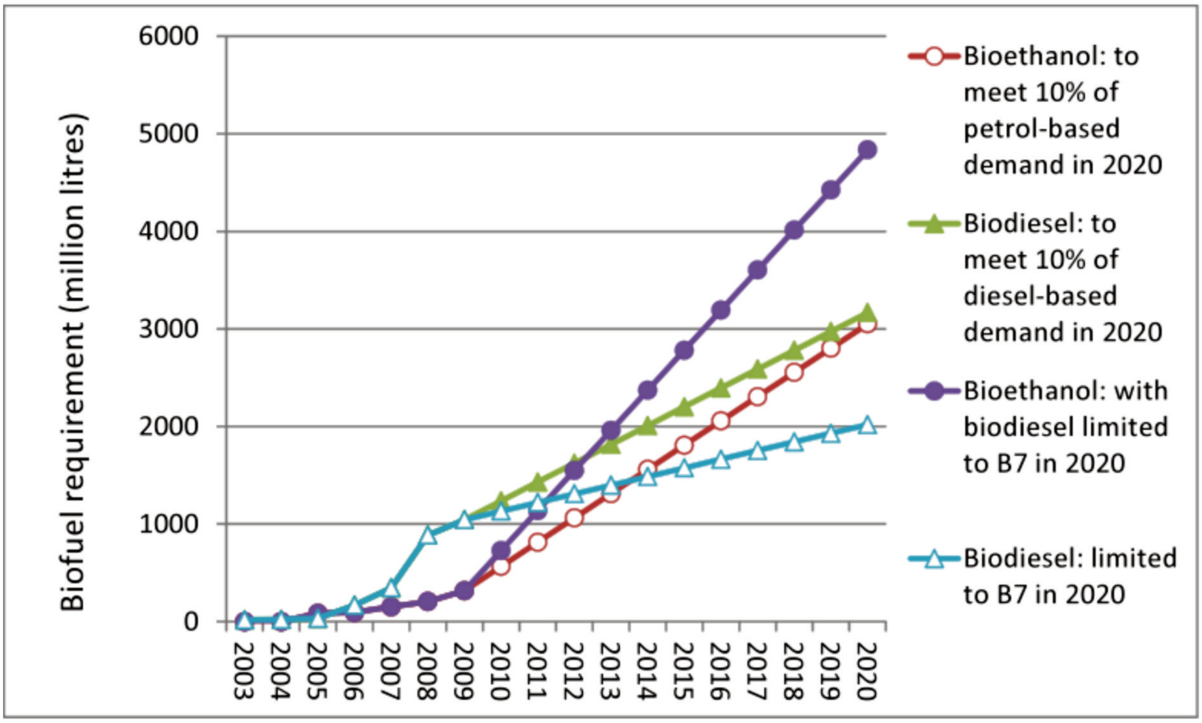
[20] Electric vehicles could also contribute to the total, but official U.K. projections (Department for Transport, 2009) are that their share will be under 0.5 per cent of the 10 per cent energy target. This contribution is assumed to be negligible within the analysis.

[21] Market trends support this expectation, with new planned plants focusing on ethanol production rather than biodiesel.

FIGURE 3. PROJECTED U.K. DELIVERIES OF BIOETHANOL AND BIODIESEL IN 2020—CENTRAL OIL PRICE CASE



Source: Historical data 2003–2009 from TSO (2010); 10 per cent of total transport energy demand for liquid fuels, (Department for Energy and Climate Change (DECC), 2009 Central Price scenario) met by biofuels in 2020; scenarios are authors calculations; linear profiles assumed 2009–2020

5.2 PRICES FOR PETROLEUM PRODUCTS

The U.K.'s Department of Energy and Climate Change updates its projections of energy prices regularly. The last set of projections was made in 2009 (DECC, 2009). These include scenarios covering low, central, high and highhigh prices for crude oil, of $60, $80, $120 and $150 (all figures US$) per barrel (of Brent crude) in 2020 respectively. These scenarios have been used by the DfT in its 2009 Impact Assessment and in the model supplied to IISD.

The range of the U.K.'s projections is supported by those of two commonly quoted sources, the IEA and the EIA:

1. The IEA's World Energy Outlook 2010[22] projects crude oil import prices will rise from just over $60 U.S./barrel in 2009 to around $110 U.S./barrel (2009 prices) in 2020 if current policies continue, reducing to around $100 U.S./barrel under their "New Policies" scenario and around $90 U.S./barrel under their "450 ppm" scenario, in which world energy demand is significantly curtailed.
2. The U.S. Department of Energy's *Annual Energy Outlook 2011*[23] projects crude oil prices imported into the U.S. will be $43.35/barrel, $98.65/barrel, $160.60/barrel in the low oil price, reference case and high oil price cases respectively (all 2009 prices, in US$). The figures are scenarios and are not designed to reflect the bounds of the range.[24]

[22] Can be downloaded from: http://www.worldenergyoutlook.org/2010.asp. See Figure 1.2, Page 72

[23] Last downloaded May 18, 2011 from: http://www.eia.doe.gov/forecasts/aeo/topic_prices.cfm

[24] "The AEO2011 price paths are not intended to reflect absolute bounds for future oil prices, but rather to allow analysis of the implications of world oil market conditions that differ from those assumed in the AEO2011 Reference case. The Reference case assumes a continuation of current trends in terms of economic access to non-OPEC resources, the OPEC market share of world production, and global economic growth."

Projected prices for petrol and diesel follow those of crude oil, with adjustments for refining costs overlaid onto crude oil prices.

5.3 THE COST OF PRODUCING BIOFUELS

Petroleum products are used as an input to the biofuel production process, and will also affect the costs of other inputs such as feedstock and transport services. A higher oil price will therefore lead to a higher production cost for biofuels, noting that the relationship is not as strong as for petroleum products, which are almost entirely linked to the oil price.

As the oil price rises, the cost of producing a litre of biofuel can be expected to decline relative to the cost of producing a litre of petroleum products. The DfT's Impact Assessment projects biofuel prices under the four crude oil price scenarios, using a world biofuel model with links to the commodity markets. It should be noted that these projections are extremely uncertain, and thus the results derived are indicative.[25] The results of these projections are shown in Table 7, with the final two rows showing the incremental production cost per litre of bioethanol and biodiesel per litre of petroleum product displaced as follows:

- in 2020, bioethanol is projected to be between 16 and 35 pence per litre more expensive than the petrol it displaces;
- in 2020, biodiesel is projected to be between 29 and 42 pence per litre more expensive than the petrol it displaces.

These figures are of the order of the current buyout price for suppliers unable to meet their RTFO targets (which are 30 pence per litre).

TABLE 7. PROJECTED PETROLEUM PRODUCT AND BIOFUEL PRICES IN PENCE PER LITRE IN 2010, 2020

		2010	2020			
		Central	Low	Central	High	HighHigh
Fossil Fuel Price						
Petrol	ppl	36	32	40	57	70
Diesel	ppl	39	34	44	63	78
Biofuel Price						
Bioethanol	ppl	50	43	45	51	56
Biodiesel	ppl	72	69	73	83	96
Spread (volume)						
Bioethanol-petrol	ppl	14	12	5	-7	-14
Biodiesel-diesel	ppl	33	35	29	20	19
Spread (energy, per litre of conventional fuel)						
Bioethanol-petrol	ppl	41	35	30	21	16
Biodiesel-diesel	ppl	41	42	37	29	29

Source: DfT (May 2011)

25 DfT have informed IISD that the biofuel price projections will be revised (personal communication, 2011).

Other projections of the prices of producing biofuels could be sourced, and the range presented above could be questioned on this basis. The key consideration, though, is the possibility of discontinuities. The projections made by the U.K.'s DfT implicitly assume perfect market conditions, notably that there will be feedstock available to scale up biofuel production within and for the U.K. and for all other countries across the world, and that investors will be sufficiently attracted to build new biofuel production facilities in the quantities required. Both of these assumptions can be questioned based on past evidence; see, for example, the text box on Malaysia presented earlier in this study and the many planned investments in U.K. production which have not materialized.

6. ADDITIONAL COST OF BIOFUELS PRODUCTION

Multiplying the required volumes and production costs described above gives us an estimate of the additional costs of biofuel productions, albeit with some important caveats. Table 8 shows that the additional production cost ranges from GBP 1.0 to GBP 2.0 billion for the year 2020. This would add 2 to 4 pence per litre on average to all fuel sold in the U.K. in 2020.[26]

The costs are highest if crude oil prices are lowest (the "low price" projection is a world price of $60 U.S./barrel). This result is primarily driven by the higher difference in relative production costs between biofuels and petroleum products at low oil prices. At low oil prices, demand for transport fuels in the U.K. is projected to be around 10 per cent higher in 2020 than if oil prices are high, but this difference in demand explains only a relatively small part of the overall production cost difference.

With a B7 blending wall limit, estimates of additional costs decline slightly (by between GBP 25 and GBP 100 million), but it should be noted that this estimate does not include the additional costs in engine damage of the introduction of an ethanol blend exceeding E10 or of introducing a relatively pure blend such as E85 and building new infrastructure and purchasing new vehicles.

TABLE 8. ADDITIONAL COSTS OF BIOFUELS PRODUCTION BY OIL PRICE SCENARIO, 2020 (COMPARISON TO NO BIOFUELS COUNTERFACTUAL)

Additional cost, £million	2020			
	Low	Central	High	HighHigh
Each biofuel meets 10% by energy	1,902	1,648	1,244	1,149
Biodiesel limited to B7	1,876	1,604	1,185	1,040

Source: Author's calculations

Notes:

1 Additional cost of meeting 2020 10 per cent by energy mandate compared to no biofuels counterfactual

2 Assumes 10 per cent of the energy content of projected petrol demand in 2020 is met by bioethanol and 10 per cent of the projected diesel demand by biodiesel

3 Biodiesel limited by blending wall, deficit met by increased bioethanol production such that total energy content of biofuels remains constant

The figures presented in Table 8 should be seen as a lower range estimate: the caveats to these figures may add considerable extra costs to these estimates, notably:

- there is no guarantee that feedstock will be available in sufficient quantities to meet U.K. and world demand—the feedstock may go to other markets, notably food. The market for feedstock has seen extremely volatile prices over the last few years, and these uneven prices must be mapped onto the volatile oil market to ascertain when it is cost-effective to produce biofuels under the incentives and subsidies in place;
- the feedstock itself may also be subsidised, for example through subsidised fertiliser or irrigation;
- faced with uncertainties, investors may demand high rates of return in order to build new production facilities in the U.K. or more generally across the world. Recovering this cost of capital would add to the expected cost of biofuels production;
- the U.K.'s 10 per cent energy target will require moving beyond current blends (E10 and B5), potentially with major additional costs in terms of infrastructure and the costs of constructing and maintaining the vehicles able to use these fuels.

[26] Noting that U.K. consumers spent GBP 50 billion—approximately GBP1000 per person—on liquid transport fuels in 2009, with GBP 33 billion of this going to taxes and duties (TSO, 2010).

7. THE COSTS OF IMPLEMENTING SUSTAINABILITY CRITERIA

As part of the RTFO, a supplier providing over 450,000 litres per annum of petroleum fuel is required to submit Carbon and Sustainability (C&S) information to the RFA. When obligated suppliers provide their annual report to the RTFO administrator it should be accompanied with a verifier's statement, produced by an organisation qualified to carryout out audits against the International Standard on Assurance Engagements (ISAE 3000). These reporting requirements were introduced to monitor the effects of the RTFO and to encourage suppliers to source the most sustainable biofuels possible associated with EU directives (The Renewable Fuels Agency, 2011). They were designed as a way to introduce suppliers to carbon and sustainability criteria prior to the introduction of mandatory carbon and sustainability criteria (European Commission, 2009). The RFA have contacted obligated suppliers to determine the impacts of the RTFO on their expenses, revenues and profits. The overall impact was reported by more than half of suppliers as minimal. In terms of the costs for administering the RTFO, they were estimated to be around a few tens of thousands pounds per year for third party verification, and an additional staff member employed between half and full time (The Renewable Fuels Agency, 2011). Administrative costs have been recognized as a greater burden for small scale operators as the administrative and reporting requirements are similar irrespective of the size of the company (AEA, 2009). The AEA notes staff costs for meeting RTFO requirements were in line with the figure of GBP 60,000 per year. On average the additional staff time was 0.5 and 2 plus person. These costs related to IT reporting, consultations with the RFA, and verification costs (AEA, 2009). Suppliers noted that C&S reporting did bring with it additional costs, but these could not be reflected in biofuel prices, until premium prices for sustainable feedstocks could be achieved (AEA, 2009). Better figures for these costs are evolving and the DfT in April 2011 have reported verification costs for suppliers could amount to approximately GBP 7 million (Department for Transport, 2011).

Biofuels which account towards national targets for EU member countries will need to comply with a number of sustainability criteria. The minimum GHG saving from the use of biofuels must be 35 per cent. From January 1, 2017, the GHG saving from the use of biofuels counting against national targets will need to be at least 50 per cent (European Commission, 2009). There are a number of unknowns relating to how these policies will affect producers and the biofuels market. Introducing sustainability criteria has initially been estimated by the U.K. government to cost in the vicinity of GBP 256 million (this figure is viewed by the government as illustrative and will be revised as more information becomes available) (Department for Transport, 2011). This figure takes into account supply and demand issues, such as the inability of suppliers to source suitably certified biofeedstocks and supply chain issues. It is an estimate and may be refined as further information and data become available. There does not appear currently to be any modelling assessing the potential impacts or costs for the U.K. of implementing Article 17, *Sustainability criteria for biofuels and bioliquids*, of the RED (European Commission, 2009).

8. ADMINISTERING GOVERNMENT POLICIES REGULATING THE U.K. BIOFUELS INDUSTRY

The U.K. government calculates and reports the running costs of government agencies monitoring the introduction of subsidy programs and other related policies. These costs normally are not incorporated as part of the process when formulating and implementing changes to policy. The consultation process held by the U.K. government, which analyzed the annual costs and benefits of increasing the blending mandate, did however include the costs of the administrative agencies monitoring biofuel policies (Department for Transport, United Kingdom, 2011). These costs are worth considering as part of the overall framework for developing policies. In the context of biofuels, the cost of monitoring and evaluating biofuel subsidy programs, and related policies and regulations, may increase as additional complexities relating to RED sustainability criteria are introduced.

The RFA, as the main agency in charge of managing biofuel policies, was an independent U.K. regulator of sustainable fuels and responsible for the administration of the RTFO. It was funded by grant aid from the U.K.'s DfT, illustrated in the following table.

TABLE 9. COSTS FOR ADMINISTRATING THE RTFO

Financial year	Budget (millions)
2008/2009	GBP 1.32
2009/2010	GBP 1.36
2010/2011*	GBP 1.75

* The budget for financial year 2010/11 was adjusted to GBP 1.57 million
Source: RFA and U.K. Parliament

The RFA as of March 2011 had 12 staff with two open vacancies (The United Kingdom Parliament, 2011). From March 31, 2011 the RFA was closed and responsibility for managing the RTFO passed to the DfT (The Renewable Fuels Agency (RFA), 2011). In accordance with International Finance Standards (IFRS), the RFA prepared annual accounts which are reviewed and approved by the Controller and Auditor General (The Renewable Fuels Agency, 2011).While the RFA and DfT are the principal organizations monitoring U.K. biofuel policies, other government agencies are also involved, with a percentage of their operating costs going towards activities connected with the biofuels industry. The supply of SPS payments to farmers producing biofeedstocks is administered by a separate government agency called the Department for Environment Food and Rural Affairs (DEFRA) (Department for Environment Food and Rural Affairs, 2011).

9. THE IMPACT OF BIOFUEL BLENDS ON THE UNITED KINGDOM'S FUEL RETAILERS

Fuel retailers are positioned at the point in the biofuel production and consumption cycle where motorists are first introduced to biofuels. There are approximately 8,500 of them in the United Kingdom, and their interests are represented by the Retail Motor Industry Federation (RMI) (The Retail Motor Industry Federation (RMI), 2010). The RMI has raised concerns about the introduction of biofuel blends retailers are required to sell to the public, arguing the mandate to sell biofuels has led to "increased costs to the retailing sector by way of extra handling charges and new equipment" (RMI, December 2010–January 2011).

A lot of problems resulting from the storage and sale of biofuels have either been caused or at the least exacerbated by a lack of essential information. During the introduction of biofuel blends many fuel retailers were not provided with prior warning from upstream fuel distributors they were receiving fuels blended with biofuel, nor did delivery documentation convey the necessary information, i.e., neither that the fuel contained a bio element nor the percentage of the bio element. Many fuel retailers only became aware that they were storing and supplying biofuel when problems with motorists and pump systems started emerging.

In order for filling stations to sell four fuel types (diesel, petroleum, bioethanol and biodiesel) a number of handling charges, such as professional cleaning of storage tanks and regular filter cleaning are incurred by fuel retailers. For retail sites, initial tank cleaning is required before biofuel blends can be delivered via their pump system. This is to prevent biofuels scouring out deposits from fossil fuels which could then block vehicle engine filters (AEA, 2009).

The use of biofuels will also require additional filter cleaning in order to prevent corrosion and blockages. The amount of costs for each site will vary depending on the size and fuel delivery system at each. It has been noted some larger sites have found it necessary to call for maintenance assistance weekly during the phase where biofuels were introduced. Research conducted by AEA consulting identified one operator of a vehicle fleet who incurred costs of up to GBP 600,000 in the first year biofuels were used (AEA, 2009).

The effects of biofuels on engine performance and maintenance are still being explored, though fuel suppliers appear to be one of the organizations motorists will turn to in the event engine problems are perceived to be caused by biofuel blends. Complaints made by motorists with fuel retailers can sometimes require third-party verification to determine responsibility. Biofuels can also cause filter blocking and pressure build-up at the pump, resulting in fuel blow back spilling onto motorists as they are fueling their vehicles.

Current U.K. legislation allows biofuel blends under 5 per cent to be sold without advertising to consumers that the fuel is a biofuel blend. Fuels which are over the 5 per cent blending limit must be labeled accordingly. These higher biofuel blends mainly relate to biodiesel, which can be blended with diesel up to 7 per cent. There have been cases when motorists only later realized that they were using blended fuels and not a standard diesel or petroleum fuel. Distributing companies supplying biofuel blends to retailers can also occasionally leave water in an ethanol and petroleum mix. Retailers unintentionally supplying motorists with a fuel blend which contains water could be responsible for engine damage and poor engine performance.

The deployment of biofuel blends in rural areas and areas such as the Scottish Highlands can cause problems for smaller retailers who are unable to afford additional costs associated with the provision of biofuels, risking closure due to rising costs and decreasing profit margins. The RMI has asked the government to support the installation of alternative fueling points for biofuels. The establishment of a government taskforce to better oversea the next stage of biofuel implementation (such as the development of an E10 grade), has been recommended by RMI in order to address any future deployment issues (RMI, December 2010–January 2011).

10. HIGHER BIOFUEL BLENDS AND ENGINE COMPATIBILITY

There are a number of issues associated with the deployment of higher biofuels blends in the U.K., which, if not properly addressed, will prevent greater consumer uptake of the fuels. The U.K. government has noted some uncertainty around the options available for passing the E10 or 10 per cent biofuel blending wall, required in order for the U.K. to meet its RED obligation for use of renewable transport fuels. Key issues such as the compatibility of vehicles to use higher blends, and the development and maintenance of delivery infrastructure to supply biofuels, will need to be revisited in greater detail as more evidence and research emerges (Department for Transport, United Kingdom, 2011).

Other markets may provide some insights into potential future problems. Allowing higher biofuel blends (moving from E10 to E15) in the U.S has led to opposition from motor vehicle associations concerned that vehicle engines might be damaged and consumers endangered. The Engine Products Group, comprising of the Alliance of Automobile Manufacturers, the Association of International Automobile Manufacturers Inc., the National Marine Manufacturers Association and the Outdoor Power Equipment Institute, was formed to challenge the U.S. Environmental Protection Agency (EPA) ruling which opened the door for higher blends to be used. The Engine Products Group asked the Federal Appeals Court to force the EPA to reconsider its October 2010 decision introducing a "partial waiver" allowing the sale of so-called E15 fuels on the basis that it violates the Clean Air Act (Alliance of Automobile Manufacturers v. U.S. Environmental Protection Agency, 2010).

There have been reported cases in the U.K. of engine wear caused by E5 (petrol containing five per cent ethanol), resulting in the failures of rubber hoses and carburettor diaphragms in much older cars (pre-1993) (Guyll, 2011). In response, the DfT commissioned a report on the effects of petrol- ethanol blends (Wall, 2010). The study found that in other markets where E10 had been introduced, the majority of vehicles over ten years or older were not compatible with E10 due to the incompatibility of their fuel systems. Field testing also revealed issues surrounding engine corrosion, drivability and ignition problems. The study also estimated that currently in the U.K. 8.6 million vehicles were not able to run on E10. Half of these vehicles would still be in use in 2013 if E5 was phased out and E10 introduced (Wall, 2010). It is recommended research on the extent of the damage caused by biofuel blends should continue due to the level of uncertainties.

It is difficult to determine how widespread biofuel-blend related engine damage is. The Automobile Association (AA) of the U.K. has analyzed its breakdown statistics to try and identify how serious the problem is. There are technical challenges, however, in allocating an engine part failure to old age or ethanol related damage, or a combination of both (Guyll, 2011). Generally, only when the replacement part, usually a rubber hose or diaphragm fails shortly after it has been replaced, and displays the same type of deterioration, vehicle owners suspect biofuels as the cause and take the necessary steps.

Vehicles which could be adversely affected by petrol ethanol blends are not covered by a warranty as they are generally too old and the manufacturer's warranty has expired. It is unclear if insurance companies would become involved to cover any damage or related costs. In the event of biofuel-blend related engine damage, parts which are damaged by E5 (the lowest blend) are being replaced by ethanol-resistant material, with no financial assistance from the government.

The Society of Motor Manufacturers and Traders represents vehicle manufacturers in the U.K., and have published the European Automobile Manufacturers Association (ACEA) list of vehicles which can run on the E10 blend (The Society of Motor Manufacturers and Traders (SMMT), 2010). The U.K. government has recommended the automotive industry produce a comprehensive list of vehicles compatible with E10 so motorists can check the compatibility of their vehicle with blended fuels containing a bio element (Wall, 2010). Vehicle owners or users can also check with the manufacturer to determine if their vehicle can use E10, for example, and if not, then avoid its use. There will likely be on-going problems with the compatibility of engine parts as more concentrated biofuel blends are introduced and consumers take time to understand which fuels are compatible with their vehicles.

11. CONCLUSIONS

Calculating the overall cost to consumers and the U.K. government of implementing the RTFO is dependent on how individual costs and benefits resulting from raising biofuel blends are evaluated and quantified. There is a significant amount of information about and analysis of the impacts of various policy options available as part of the U.K. government's consultation process on the impacts of the RTFO. However, it is clear a number of uncertainties remain, and further analysis and monitoring of costs and benefits is required. The U.K. government acknowledge this is an on-going process with the objective of obtaining more robust information on the impacts of biofuel policy. This study assessed a selection of costs from a wider menu of potential issues. The following conclusions were drawn from the study:

- Agricultural subsidies (in the form of SPS payments) to energy crop producers were identified as important, and it was recommended they should be considered as part of the government consultation process to determine the impact of potential policy options as part of the RTFO.
- Changes in land use patterns—with increasing levels of energy crops being produced instead of biofuels—is an important U.K. and international issue. Accurate monitoring of changes in cropping patterns within the U.K. could be improved by estimating the amount of biofuel domestically produced and exported to international markets. This would ensure the DfT's annual calculation to determine the area of arable land used to grow biofeedstocks was accurate and based on the total amount of domestically produced biofuel.
- Significant uncertainties surround many potential future costs affecting the commercial viability of biofuel versus fossil-fuels. Market conditions for biofeedstock production are volatile, making it difficult to predict future supply and demand scenarios through to 2020. The study identified there could be significant additional costs if demand for sustainably produced biofuels exceeds supply or supply chains are intermittently disrupted.
- The future cost of blended biofuels damaging motor vehicle engines or fuel retailors or distributors storage or delivery equipment is challenging to estimate, as there is insufficient data from similar situations in other countries or U.K. monitored cases or incidents. It is recommended the impacts of higher biofuel blends are closely monitored by stakeholder to generate data on vehicle related problems relating to biofuel use. An important assumption affecting the deployment of higher biofuel blends is that infrastructure development and expansion will come from private investment. With a significant amount of U.K. installed biofuel production capacity currently not producing due to adverse market conditions, private investors may be weary of additional investment in infrastructure, unless long term market conditions guarantee the commercial viability of domestic biofuel production in the U.K.

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Initially trained as an engineer, Peter first worked in technology research with British Gas. He then spent 15 years as an Energy & Environment consultant, working on issues from energy efficiency in Hungary to the cost-benefit analysis of clean air policies in Egypt to the economics of nuclear waste disposition in the U.K. His clients have included the World Bank, EBRD, various European Commission departments and a wide range of private sector companies.

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THE GLOBAL SUBSIDIES INITIATIVE (GSI) OF THE INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT (IISD)

The International Institute for Sustainable Development (IISD) launched the Global Subsidies Initiative (GSI) in December 2005 to put a spotlight on subsidies – transfers of public money to private interests – and how they undermine efforts to put the world economy on a path toward sustainable development.

Subsidies are powerful instruments. They can play a legitimate role in securing public goods that would otherwise remain beyond reach. But they can also be easily subverted. The interests of lobbyists and the electoral ambitions of officeholders can hijack public policy. Therefore, the GSI starts from the premise that full transparency and public accountability for the stated aims of public expenditure must be the cornerstones of any subsidy program.

But the case for scrutiny goes further. Even when subsidies are legitimate instruments of public policy, their efficacy – their fitness for purpose – must still be demonstrated. All too often, the unintended and unforeseen consequences of poorly designed subsidies overwhelm the benefits claimed for these programs. Meanwhile, the citizens who foot the bills remain in the dark.

When subsidies are the principal cause of the perpetuation of a fundamentally unfair trading system, and lie at the root of serious environmental degradation, the questions have to be asked: Is this how taxpayers want their money spent? And should they, through their taxes, support such counterproductive outcomes?

Eliminating harmful subsidies would free up scarce funds to support more worthy causes. The GSI's challenge to those who advocate creating or maintaining particular subsidies is that they should be able to demonstrate that the subsidies are environmentally, socially and economically sustainable – and that they do not undermine the development chances of some of the poorest producers in the world.

To encourage this, the GSI, in cooperation with a growing international network of research and media partners, seeks to lay bare just what good or harm public subsidies are doing; to encourage public debate and awareness of the options that are available; and to help provide policy-makers with the tools they need to secure sustainable outcomes for our societies and our planet

www.globalsubsidies.org

The GSI is an initiative of the International Institute for Sustainable Development (IISD). Established in 1990, the IISD is a Canadian-based not-for-profit organization with a diverse team of more than 150 people located in more than 30 countries. The GSI is headquartered in Geneva, Switzerland and works with partners located around the world. Its principal funders have included the governments of Denmark, the Netherlands, New Zealand, Norway, Sweden and the United Kingdom. The William and Flora Hewlett Foundation have also contributed to funding GSI research and communications activities.

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