CHATHAM HOUSE

Chatham House, 10 St James's Square, London SW1Y 4LE
T: +44 (0)20 7957 5700 E: contact@chathamhouse.org
F: +44 (0)20 7957 5710 www.chathamhouse.org

Charity Registration Number: 208223

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The Trouble with Biofuels: Costs and Consequences of Expanding Biofuel Use in the United Kingdom

Rob Bailey

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SUMMARY

Biofuel use in the United Kingdom is set to increase significantly despite continued sustainability concerns

- In the current financial year (2013/14) UK biofuel use will increase to 5 per cent of transport volumes, the highest level ever.
- An earlier government-commissioned review of UK biofuel policy recommended that biofuel use not surpass this level unless major sustainability issues are addressed. However, EU targets for 2020 would see this exceeded several times over.

Current biofuel standards do not ensure biofuel use is sustainable

- Agricultural biofuel use increases the level and volatility of food prices, with detrimental impacts on the food security of low-income food-importing countries.
- Agricultural biofuel use also indirectly drives expansion of agriculture into areas of high carbon stock such as rainforest or peatland, resulting in indirect land-use change, the emissions from which may outweigh any greenhouse gas savings the biofuels are able to offer.
- Biodiesel from waste products such as used cooking oil or tallow offer the most favourable sustainability characteristics; however, the risk of indirect emissions increases at higher levels of use and may already be material.
- Neither indirect land-use change nor food security is addressed in UK sustainability criteria. In the absence of such safeguards, increasing biofuel consumption could have significant environmental and social consequences outside the United Kingdom. It is unclear whether such safeguards will be agreed at the EU level.

Biofuels are not a cost-effective means to reduce emissions from road transport

- The current generation of biofuels provides an expensive means of reducing emissions from road transport. Carbon abatement costs, excluding emissions from indirect land-use change, are broadly in the range of $165–$1,100 per tonne of carbon dioxide equivalent (CO_2e). This compares unfavourably with an appraisal price of around $87 per tonne.
- Accounting for emissions from indirect land-use change increases abatement costs for agricultural biofuels to between $330 and $8,500 per tonne of CO_2e depending on the feedstock used. Biodiesel from vegetable oils is found to be worse for the climate than fossil diesel.
- The 5 per cent biofuel target is likely to cost UK motorists in the region of $700 million (£460 million) in the current financial year (2013/14).
- If the UK is to meet its EU obligations, the annual cost to UK motorists is likely to rise to around $2 billion (£1.3 billion) a year by 2020.

1. INTRODUCTION

Biofuels are liquid fuels produced from biomass that can be substituted for either petrol or diesel for use in transport. The two principal biofuels are ethanol and biodiesel, or Fatty Acid Methyl Ester (FAME). Ethanol is generally produced through a process of fermentation of carbohydrate or sugar crops such as corn, wheat, sugar cane and sugar beet, and can be blended with petrol. Biodiesel is produced through the esterification of fats. Feedstocks include edible oils such as rapeseed, palm and soybean oil, but also waste products such as used cooking oil (UCO) and tallow. Other 'advanced' production pathways exist for ethanol and biodiesel that allow alternative feedstocks to be used; however, these are not yet commercially viable and are not expected to make a significant contribution to production in the near to medium term.

One of the principal attractions of biofuels for policy-makers is the offer of greenhouse gas (GHG) savings compared with conventional petroleum products. When they are burned, crop-based biofuels release the carbon removed from the atmosphere through photosynthesis as the crops were grown – *prima facie* the net effect is zero over the full lifecycle. However, crop-based biofuels are not carbon neutral: a large number of other sources of emissions must also be taken into account, for example from chemical inputs and fertilizers, farm machinery or refineries. The largest potential sources of emissions are those from land-use change such as deforestation or drainage of peatland that may occur to make room for biofuel crops.

Since 2008, the United Kingdom's Renewable Transport Fuel Obligation (RTFO) (see Box 1) has required suppliers of road transport fuels to blend a certain proportion of biofuel into the petrol and diesel they supply. From 15 April 2013, the target will be 5 per cent of total transport fuel volume,[1] the most ever consumed in the United Kingdom. As in other developed countries, UK biofuel policy has attracted considerable criticism from development and environmental groups concerned about the indirect impacts of expanding biofuel use on food prices and deforestation. A major review of these issues in 2008 recommended that the 5 per cent target should not be exceeded unless biofuels can be demonstrated to be sustainable; consequently there are currently no stated plans to increase the RTFO further. However, the United Kingdom will have to do so if it is to meet its obligations under two EU directives: the Renewable Energy Directive (RED) and the Fuel Quality Directive (FQD) which both require major increases in biofuel use by 2020 (see Box 1).

Since the adoption of the RTFO, further evidence on the indirect impacts of biofuel policies on food prices and land use has accumulated. In addition to possible social and environmental costs, expanding biofuel use also brings economic costs because ethanol and biodiesel are more expensive sources of energy than petrol or diesel. As the UK government now considers whether and how biofuel use should be further increased, it is opportune to consider the potential costs and benefits – economic, social and environmental – of doing so. To this end, this paper provides a brief overview of UK biofuel consumption trends before considering some of the sustainability and economic implications of expanding biofuel use in the context of EU targets.

1 In July 2012 the UK Department for Transport announced plans to expand the scope of the RTFO to include non-road mobile machinery. However, the intention is for the overall biofuel volume, across road and non-road uses, to remain the same, meaning the target for road fuels will decline slightly, from 5 per cent to about 4.7 per cent.

Box 1: The RTFO, RED and FQD

Under the RTFO, obligated suppliers (those supplying at least 450,000 litres of fuel a year) are awarded Renewable Transport Fuel Certificates (RTFCs) at the duty point: one RTFC per litre of biofuel supplied. At the end of the year, companies demonstrate compliance by redeeming the appropriate number of RTFCs for the volume of fuel supplied. RTFCs may be traded between suppliers, allowing those companies that supply less than the target to meet their obligation by buying RTFCs from companies that exceed the targeted supply. Alternatively, suppliers can bank and carry over a certain proportion of RTFCs from the previous year, or choose to buy themselves out of the obligation at a buy-out price currently set at 30 pence per litre.

The RTFO currently allows suppliers to claim two RTFCs per litre for biofuels derived from waste products. This double-counting creates an incentive for suppliers to source these biofuels in preference to agriculturally produced biofuels which may have undesirable impacts on food prices and land-use change. As a result of this incentive, nearly all biodiesel currently supplied in the United Kingdom is derived from UCO and category 1 tallow (a type of tallow produced especially for energy production).

The RTFO is the policy instrument with which the United Kingdom plans to meet its obligations under two pieces of EU legislation: the RED, which requires member states to meet 10 per cent of their transport energy demand from renewable sources by 2020, and the FQD, which requires that member states reduce the emissions intensity of their transport fuels by at least 6 per cent by 2020. Both the RED and FQD currently require that biofuels offer emissions reductions of at least 35 per cent compared to conventional fossil fuels. From 2017, this threshold increases to 50 per cent and from 2018 it rises to 60 per cent for new refineries.[2]

Achieving these targets will require increasing UK biofuel use well beyond current levels. Because biofuels have lower energy densities than fossil fuels, the 10 per cent energy target of the RED translates to higher volumetric targets – in the region of 14 per cent for ethanol in petrol and 11 per cent for biodiesel in diesel.[3] By way of comparison, the most recent reporting data for the first six months of the last fiscal year (2012/13) show that ethanol volumes represented 4.1 per cent of the petrol mix and biodiesel volumes 1.6 per cent of the diesel mix.[4]

2 Current proposals to amend the RED and FQD would see the introduction of the higher threshold for new plant brought forward to mid-2014. See European Commission (2012), 'Proposal for a Directive of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources'. http://ec.europa.eu/clima/policies/transport/fuel/docs/com_2012_595_en.pdf.

3 Charles, C. and Wooders, P. (2012), 'Biofuels – At What Cost? Mandating ethanol and biodiesel consumption in the United Kingdom', International Institute for Sustainable Development.

4 UK Department for Transport (2013) reporting shows biodiesel accounted for 213 million litres out of total (diesel and biodiesel) supply of 13,114 million litres; ethanol accounted for 386 million litres out of a total 9,347 million litres. Note that based on certified biofuels, almost all the biodiesel supplied was from waste UCO and category 1 tallow, meaning that it counts twice towards the obligation, so would be counted as 3.2 per cent under current RTFO accounting rules.

2. UK BIOFUEL CONSUMPTION

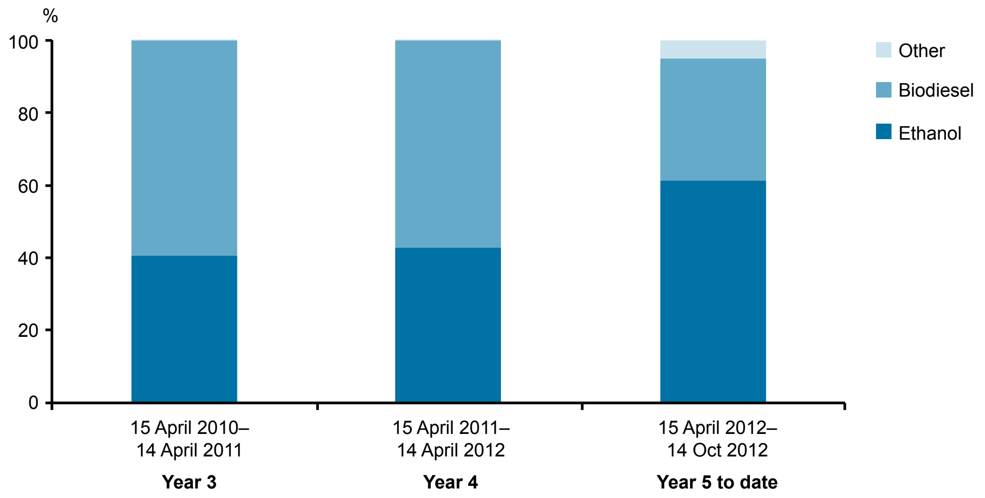
Under the RTFO, fuel suppliers are required to report quarterly to the Department for Transport (DfT) on the biofuels they supply. Aggregated, these data provide an overview of the United Kingdom's biofuel consumption according to feedstock, country of origin, estimated GHG savings and other sustainability data.[5] In recent reporting, the following broad trends are noteworthy:

- There has been a shift from biodiesel to ethanol within the overall biofuel mix.
- US corn has become the dominant ethanol feedstock while the share of Brazilian sugar cane has collapsed.
- Waste products UCO and category 1 tallow account for nearly all biodiesel supplied.

Shift to ethanol

In recent reporting periods there has been a marked increase in the share of ethanol in the overall biofuel supply at the expense of biodiesel. Ethanol's share of the overall biofuel supply has increased from 41 per cent in Year 3 of the obligation to 61 per cent for the first six months of Year 5 (Figure 1).[6] This runs counter to the prevailing trend in petroleum fuels, which is for a gradual drift from petrol to diesel in the UK market.

Figure 1: United Kingdom total (certified and uncertified) biofuel mix



Source: Chatham House analysis based on Department for Transport reporting data.

5 Amendments in December 2011 to make the RTFO compatible with the RED introduced a lag into reporting, as applications for RTFCs are now not completed until several months after the end of the reporting year. As a result, the percentage of biofuels certified (and for which there are reporting data) increases over the course of the reporting year. At the end of the first quarter of Year 5 of the RTFO (fiscal year 2012/13), only 37 per cent of biofuels had been certified, but six months later this had risen to 59 per cent. Consequently, some caution is advised when interpreting the most recent reporting data as there is no detailed information yet for a significant proportion of the biofuels supplied.

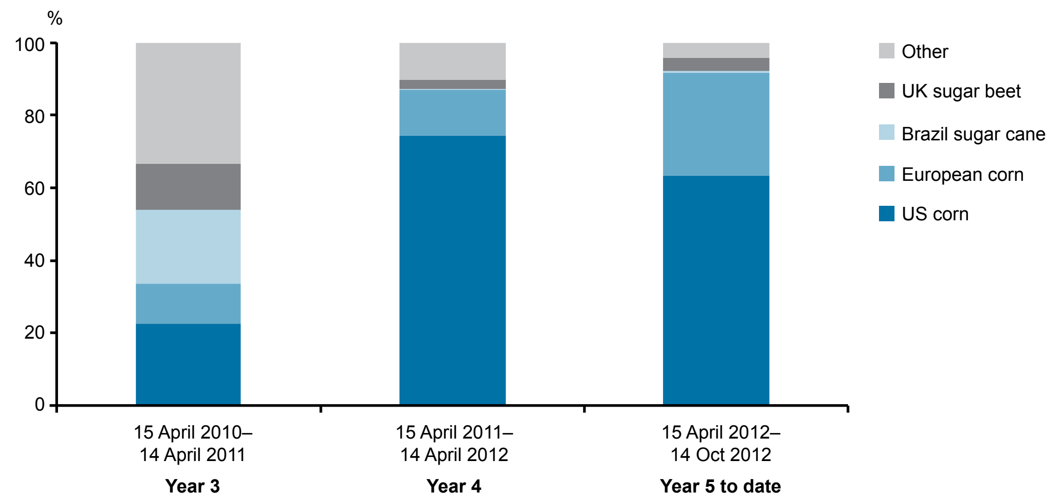
6 This trend is also mirrored in certified biofuels (those having received RTFCs), where ethanol's share increased from 41 per cent to 59 per cent over the same time period.

Increase in US corn ethanol use

The shift to ethanol in recent reporting periods can in part be attributed to the high availability of US corn ethanol in international markets. Buoyed by cheap domestic corn prices and a saturated domestic market, 2011 was a record year for US ethanol exports, which increased fourfold on 2010. Imports were facilitated by the practice of blending ethanol with 10 per cent petrol (so-called E90), which allowed ethanol to enter EU markets at a lower tariff rate. In March 2012 the EU changed its tariff structures to reclassify E90 as eligible for higher duty; in combination with the drought in the United States, this meant that imports dropped off in the second half of the year.

As well as increasing overall ethanol use, the US ethanol export glut contributed to a sharp decline in consumption of Brazilian sugar-cane ethanol, which accounted for 20 per cent of certified UK ethanol supply in Year 3 and less than 1 per cent in the first six months of Year 5. As US exports surged, Brazilian exports collapsed owing to high domestic sugar prices, the appreciation of the real against the dollar and loss of capacity. Brazilian ethanol was also squeezed by imports of corn ethanol from continental Europe, much of which enjoys the protection of EU tariffs on ethanol imports (Figure 2).[7]

Figure 2: Feedstocks used in certified UK ethanol supply



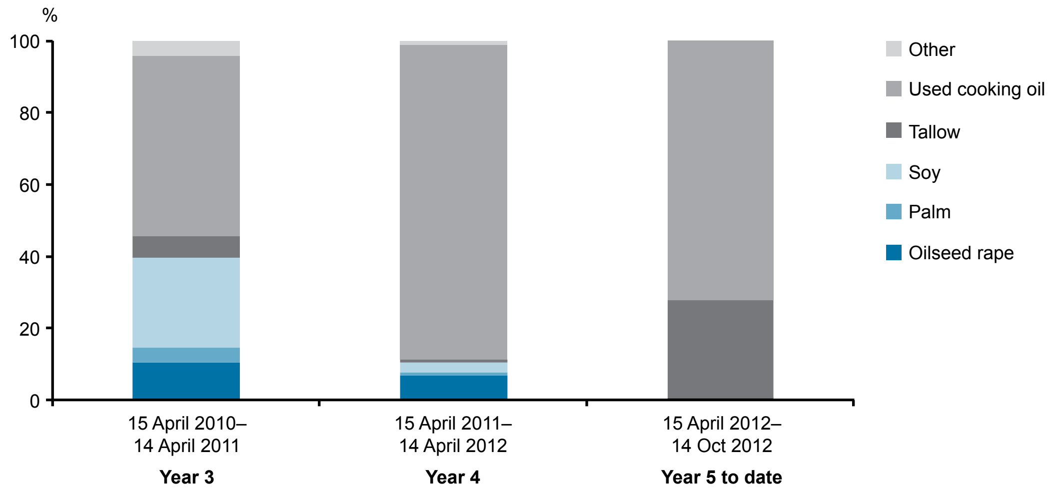
Source: Chatham House analysis based on Department for Transport reporting data.

Importance of waste products in biodiesel supply

Waste products – UCO and category 1 tallow – now account for almost all certified biodiesel: 99 per cent for the first six months of Year 5. There has been a sharp decline in the use of edible oils such as palm, soy and rapeseed in recent reporting periods following the introduction of double-counting for waste-derived biodiesels. UCO is the dominant feedstock, accounting for 72 per cent of certified biodiesel supply in the first six months of Year 5 (Figure 3). However, it has lost share to category 1 tallow (accounting for 27 per cent in the first six months of Year 5 compared with 0.1 per cent for Year 4) following the removal of a fuel duty differential for UCO biodiesel in April 2012.

7 Some European corn ethanol producers, such as Ukraine, are not members of the EU.

Figure 3: Feedstocks used in certified UK biodiesel supply



Source: Chatham House analysis based on UK Department for Transport reporting data.

Outlook for UK biofuel consumption

Preference for ethanol likely to continue

Ethanol is likely to remain the preferred choice of suppliers. Relative to the fossil fuel alternative, it is less expensive than biodiesel on a per litre basis, making it a cheaper way for suppliers to meet their volumetric obligations under the RTFO. Ethanol markets are deeper and more liquid than biodiesel markets, with two major independent export centres – the United States and Brazil – which help ensure stable import streams. A recently imposed EU anti-dumping duty of 9.5 per cent on US ethanol will dampen any future rebound in US imports. However, this will be offset by European corn ethanol output and Brazilian exports, which have picked up following a strong sugar-cane harvest.

The principal current constraints on UK ethanol consumption are fuel standards that place maximum limits on the volume of ethanol that can be blended into standard-grade petrol. BS EN 228 currently allows up to 5 per cent ethanol by volume (known as E5). A new version of BS EN 228 allowing both E5 and E10 grades is expected to be agreed in early 2013, which would enable suppliers to meet an increased share of their obligations through ethanol.[8] But it is uncertain how quickly ethanol use will increase with the introduction of the new standard: the government has requested suppliers to delay the introduction of E10 owing to concerns that a significant proportion of the existing vehicle fleet may be incompatible with the higher blend.[9] These issues are discussed further in the final section of this paper.

Preference for waste products is likely to continue in the short term

UCO and category 1 tallow are likely to remain the preferred biodiesel feedstocks in the short term. Double-counting means they are an attractive way for suppliers to meet their obligations. Advanced biofuels from feedstocks such as algae, which could attract quadruple accounting, are not expected to make a significant contribution to biodiesel supply in the near term, while biodiesel from edible oils will be excluded from the RTFO, RED and FQD should emissions accounting incorporate indirect effects – an issue explored in the next section.

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8 See, for example, UK Department for Transport (2013), *Low Carbon Fuels Newsletter*, 31 January. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/70225/lcf-newsletter-jan-2013.pdf.
9 See, for example, Wall, S. (2010), 'Assessing Compatibility of Fuel Systems with Bio-ethanol and the Risk of Carburettor Icing. Final Report.' Report for the UK Department for Transport.

Uncertainty surrounding the future of double-counting

The government's willingness to grant double-counting to biodiesels derived from UCO and category 1 tallow may be tested in the future, however. Double-counting makes it easier for the United Kingdom to meet the 10 per cent transport target of the RED, as it effectively reduces the target in proportion to the amount of waste-derived biodiesel supplied. But it may make it harder for the United Kingdom to meet its wider obligations under the RED, which sets not only a target for transport energy, but also an economy-wide target that 15 per cent of energy in 2020 must come from renewable sources, to which the transport target contributes. While biofuels from waste products may count twice towards the transport sub-target, at present it is understood that they may only count once towards the overall target. This means that double-counting effectively reduces the transport sub-target by creating a deficit elsewhere. This creates a potential problem for the government, which already regards its renewable targets for heat and electricity as challenging.

This deficit is potentially significant. To illustrate, were essentially all UK biodiesel to remain double-counted[10] and biodiesel and ethanol each to account for half of the 2020 transport sub-target, this would generate a shortfall of 2.5 per cent of transport energy in 2020 (about 12 TWh[11]) to be covered by increased renewable deployment elsewhere. To place this in perspective, total onshore wind generation in 2012 was 11.9 TWh.[12] The United Kingdom has recently proposed that double-counting of waste-derived biofuels be extended to economy-wide targets under the RED.

10 For the first six months of Year 5, over 99 per cent of biodiesel supplied was from UCO or category 1 tallow.

11 UK Department of Energy & Climate Change (2011) estimates that the 10 per cent sub target for transport will represent 48 TWh of energy in 2020.

12 UK Department of Energy & Climate Change (2013), 'Energy Trends: March 2013'.

3. SUSTAINABILITY CONSIDERATIONS

There are major concerns regarding the indirect social and environmental consequences of biofuel policies, in particular:

- amplification of the level and volatility of international food prices; and
- emissions from indirect land-use change (ILUC), whereby increased biofuel demand drives remote expansion of the agricultural frontier into areas of high carbon stock such as rainforests and peatlands, potentially resulting in indirect emissions far greater than any savings the biofuels might realistically offer.

These issues have been a concern for UK policy-makers for some time. In 2008, a major review of biofuel sustainability commissioned by the government concluded that 'biofuels contribute to rising food prices that adversely affect the poorest' and that ILUC may lead to 'greenhouse gas emissions rather than savings'.[13] On the review's recommendation, the government at the time slowed the rate of increase of the RTFO so that the 5 per cent target was not to be reached until fiscal year 2013/14, three years later than originally envisaged. More importantly, the review also recommended that the RTFO should not be increased further unless biofuels were demonstrated to be sustainable after accounting for indirect effects. With the 5 per cent target about to be reached, the government must now decide whether it can justify increasing the RTFO further in order to meet its obligations under the RED and FQD, and what safeguards would need to be in place for it to do so sustainably.

Food security

Biofuel policies create upward pressure on long-run food prices by increasing demand for agricultural commodities such as sugar, wheat, corn and edible oils. Biofuels produced from non-food agricultural feedstocks can equally lead to higher food prices where they compete with food production for land, water or other inputs.

Biofuel policies also increase food price volatility through several channels. Targets, such as those of the United Kingdom and EU, increase the amplitude of price spikes by introducing inelastic demand into agricultural commodity markets. Biofuel targets also exert downward pressure on stock-to-use ratios of oilseeds and cereals, leading to thinner, more volatile markets. And by making food substitutable for petroleum, biofuels increase coupling between energy and agricultural markets.[14] A full discussion of the extent of biofuels' role in recent global food price spikes relative to other contributing factors, such as weather events, export bans and a tightening balance between supply and demand is beyond the scope of this paper. Suffice to say that the weight of expert opinion identifies biofuels as an important contributing factor to recent food market instability.[15] This is not to say that biofuel policies have been the single most important factor, but they are among the most troubling because they are politically created and maintained.

From a global food security perspective, of most concern in the UK case is the significant use of staple cereals in the ethanol mix. In the first six months of Year 5, corn accounted for over 90 per cent of the ethanol supplied (Figure 2). Rising corn prices drag the prices of other cereals with them through substitution, of wheat for corn in animal feed, and of rice for corn and wheat

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13 Gallagher, E. (2008), 'The Gallagher Review of the indirect effects of biofuels production', Renewable Fuels Agency.

14 For a full discussion of these issues see, for example, Tangerman, S. (2011), 'Policy Solutions to Agricultural Market Volatility: A Synthesis', Issue Paper 33, ICTSD; and Bailey, R. (forthcoming),'The Food Fuel Nexus' in Goldthau, A. (ed.), *Wiley Handbook of Global Energy Policy* (Oxford: Wiley Blackwell).

15 See, for example, HLPE (2011), 'Price Volatility and Food Security: Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security', Rome; and FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN-HLTF (2011), 'Price Volatility in Food and Agricultural Markets: Policy Responses'.

in food markets. Across the different agricultural commodities, cereal price spikes are most closely associated with increases in poverty and bouts of instability in low-income food-importing countries. Meeting the RED target would require increasing ethanol consumption several times over from current levels, with negative consequences for food security in poor countries should it continue to come predominantly from corn (or wheat). As such, this should be a particular concern for policy-makers, which should, according to the UK Bioenergy Strategy, 'assess and respond to the impacts' of 'significant additional demand' for biofuels on food security.[16]

On the biodiesel side, the United Kingdom's reliance on waste products presents minimal concerns from a food security perspective as these products do not compete with food production. However, meeting the RED target is likely to require significant increases in the use of agricultural feedstocks owing to constraints on the availability of waste products.

Policy options

Food security is not included in the mandatory sustainability criteria for the RTFO, RED and FQD. One option for policy-makers could be to develop and implement standards to limit or prevent the use of biofuels that undermine food security. For example, the RTFO, RED and FQD already include a standard that prevents the use of biofuels produced on recently deforested land or land of high biodiversity value. Although this approach could be extended to exclude biofuels produced on land recently used for food production or land of high arable value, it would be likely to mobilize opposition from farmers and biofuel companies already invested in producing agricultural commodities for biofuel production.

Alternative approaches would reduce the impacts of biofuels on food prices by making biofuel demand more flexible. Research published by the UK Department for Environment and Rural Affairs estimated that action to curtail biofuel mandates in the United States and EU could have significant dampening effects on global food price spikes. Action among EU member states to remove biofuel blending obligations during a run-up in international coarse grain prices (e.g. corn, barley, oats) could reduce the amplitude of the price spike by up to 15 per cent, while similar action in response to a surge in wheat prices could reduce the magnitude of the spike by up to 25 per cent. In the case of the larger US ethanol mandate, the modelling estimated that cutting the mandate by half could mitigate a spike in coarse grain prices by as much as 40 per cent.[17] Similar research found that had the US government reduced the ethanol mandate by a quarter in response to the 2012 drought and ethanol blenders used credits from previous years towards their obligations, then corn prices could subsequently have been 20 per cent lower.[18]

Building flexibility into biofuel mandates is not necessarily straightforward, however. One set of proposals would introduce formal mechanisms through which targets or mandates can be revised downwards during periods of high prices, though this raises a host of questions associated with how such a process should be initiated and managed, and how it could be insulated from special pleading by biofuel and farm lobbies, on the one hand, and livestock and food and beverage companies, on the other (see Box 2). This approach would also be resisted by biofuel and farm lobbies, which would see the value of their previously guaranteed markets diminished.

Another proposal would create a market-based 'safety valve' mechanism through the use of call options, purchased by governments from their biofuel industries.[19] These contracts could be structured to trigger when food prices exceed a certain threshold, at which point agricultural commodities would be diverted from biofuel production into food chains, reducing the pressure

16 UK Department of Energy & Climate Change (2012), 'UK Bioenergy Strategy'.

17 Durham, C., Davies, G. and Bhattacharyya, T. (2012), 'Can Biofuels Policy Work for Food Security?', UK Department for Environment, Food and Rural Affairs.

18 Tyner, W., Tahreipour, F., and Hurt, C. (2012), 'Potential Impacts of a Partial Waiver of the Ethanol Blending Rules', Purdue University and Farm Foundation. See also Plumer, B., 'Study: U.S. could put a big dent in corn prices by relaxing ethanol rules', *Washington Post*, 21 August 2012.

19 Wright, B. (2011), 'Biofuels and Food Security: Time to Consider Safety Valves?', International Food & Agricultural Trade Policy Council.

on food prices. By paying biofuel producers a fair price for the option, which could be set by auction, biofuel producers would be compensated for the loss of guaranteed demand previously provided by the inflexible mandate; for this reason this approach may be less threatening to biofuel lobbies. On the other hand, taxpayers may balk at the prospect of having to buy options from already heavily subsidized biofuel industries, while for the United Kingdom this approach may be less appropriate given that the vast majority of its agriculturally produced biofuels are imported. The successful development of this strategy would therefore require coordination and agreement between biofuel-producing and biofuel-consuming governments.

Indirect land-use change

Emissions from ILUC are currently not accounted for under the RED, FQD or RTFO but are potentially significant. ILUC emissions are likely to be particularly high for edible oil feedstocks such as rapeseed oil because these oils are highly substitutable and some oilseed production occurs close to areas of very high carbon stock. For example, increasing European consumption of biodiesel is argued to have indirectly increased demand for palm oil, needed to replace European rapeseed oil diverted to biodiesel production. Increasing demand for palm oil is inextricably linked to deforestation in Indonesia, so greater use of biodiesel derived from rapeseed oil may indirectly drive expansion of oil palm plantations into tropical peatland rainforest.[20]

These concerns have been supported by modelling to quantify typical ILUC emissions for different feedstocks in 2020. The results of this exercise for the European Commission found that replacing fossil diesel with biodiesel from some edible oil feedstocks would not reduce but rather *increase* emissions after accounting for ILUC, with all agricultural feedstocks seeing significant deterioration in their emissions savings.[21]

Although the United Kingdom consumes minimal amounts of biodiesel from edible oils, its reliance on corn ethanol, for which sizeable indirect effects have also been estimated, is again a concern. Accounting for ILUC could mean that most of the corn ethanol currently imported by the United Kingdom would no longer qualify for the RTFO or RED and would leave much of the remainder unable to qualify when forthcoming increases in the minimum GHG saving come into force.[22]

Policy options

On the basis of this research, the European Commission developed draft proposals to incorporate ILUC emissions into biofuel GHG calculations through the use of 'ILUC factors'. These proposals were leaked in 2012 and were heavily criticized by European biodiesel producers and farmers. Subsequently the amendment to *account* for ILUC emissions was withdrawn and replaced with a proposal that suppliers and member states *report* their ILUC emissions, but ignore them when calculating whether or not biofuels' GHG savings exceed the minimum threshold.[23] These proposals are now being negotiated in Brussels. Environmental organizations and some member states including the United Kingdom (which commits in

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20 See, for example, International Council on Clean Transportation (2013), 'Vegetable oil markets and the EU biofuel mandate', Briefing, February.

21 Laborde, D. (2011), 'Assessing the Land Use Change Consequences of European Biofuel Policies', Final Report to the European Commission, IFPRI.

22 European Commission (2012) proposes an additional ILUC factor for corn of 10 gCO_2e per MJ, representing a decrease in emissions savings of 12 per cent relative to a default petrol emissions intensity of 83.8 gCO_2e per MJ. For the first six months of Year 5, 58 per cent of corn ethanol consumed in the United Kingdom offered emissions savings of less than 47 per cent, meaning that once ILUC was included, this would fall below the current minimum threshold of 35 per cent. And 74 per cent of corn ethanol offered emissions savings below 62 per cent, meaning after incorporating ILUC emissions it would fail to meet the 2017 minimum saving of 50 per cent which current proposals would bring forward to 2014.

23 European Commission (2012).

its Renewable Energy Roadmap[24] to ensuring effective standards for ILUC) are in favour of reverting to the Commission's original plan and fully accounting for ILUC in GHG calculations. However, the United Kingdom faces opposition from a number of other member states with significant agricultural feedstock production interests that would be penalized or potentially excluded under ILUC accounting (Box 2).

Box 2: The political economy of biofuel policy

Biofuel policies are typically justified by governments on environmental grounds or enhanced energy security, although their original attraction was primarily as a new source of transfers to agriculture. The United States began subsidizing ethanol in the late 1970s as a way to support its corn farmers, while a major attraction of the EU's first biofuel target in 2003 was the opportunity to increase farm-gate prices and support the rural sectors of poorer incoming member states. In both the United States and EU, it was hoped that biofuels could use agricultural surpluses and reduce direct payments under farm programs by propping up commodity prices.

As with other agricultural subsidies, the result has been to create dependencies and well-organized special interests that mobilize to defend support. As investments have accumulated in response to the mandates and subsidies put in place, it has become increasingly difficult for governments to revise biofuel policies in response to growing evidence of their adverse impacts on land use and food security.

The biofuel lobby now extends beyond farmers and dedicated biofuel producers to include major oil companies, agribusiness, seed and input companies. On the other hand, sectors that have been hit by higher commodity prices – such as livestock and poultry producers, food and beverage companies and restaurant chains – have mobilized in opposition to biofuel support.

Since acts of commission tend to risk heavier sanction than acts of omission in politics, the status quo has persisted. In the United States pleas from food and livestock producers to waive the ethanol mandate in 2012 as corn prices climbed following the country's worst drought in half a century were rejected by the administration. Corn-growing states are politically important and it was an election year. In the EU, opposition to reform is concentrated among those countries where agriculture is relatively important – in particular from new member states, originally identified as the largest beneficiaries of biofuel policies.

Another proposal from the European Commission is the introduction of a cap on the contribution towards the RED target of agriculturally produced biofuels, limiting them to no more than 5 per cent (by energy) meaning that the remainder of the target would have to be met from waste biofuels (eligible for double-counting) and as yet unavailable advanced biofuels (potentially eligible for quadruple accounting).[25] This would effectively freeze at current levels the amount of agriculturally produced biofuels that can be counted towards the RED target across the EU, but it would not prevent member states wishing to consume more agriculturally produced biofuels from doing so – they simply would be unable to count the additional biofuels towards their obligations. This may therefore do little to limit further consumption of agriculturally produced biofuels, as many member states view biofuels primarily as a means to support domestic agriculture rather than as an instrument of energy or environmental policy (see Box 2). Moreover it would appear something of a blunt instrument if it fails to differentiate between feedstocks such as corn and rapeseed oil on the one hand and sugar cane on the other – the latter providing more attractive GHG savings and being far less detrimental to the food security of low-income food-importing countries.[26]

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24 UK Department of Energy & Climate Change (2011), 'UK Renewable Energy Roadmap'.

25 European Commission (2012).

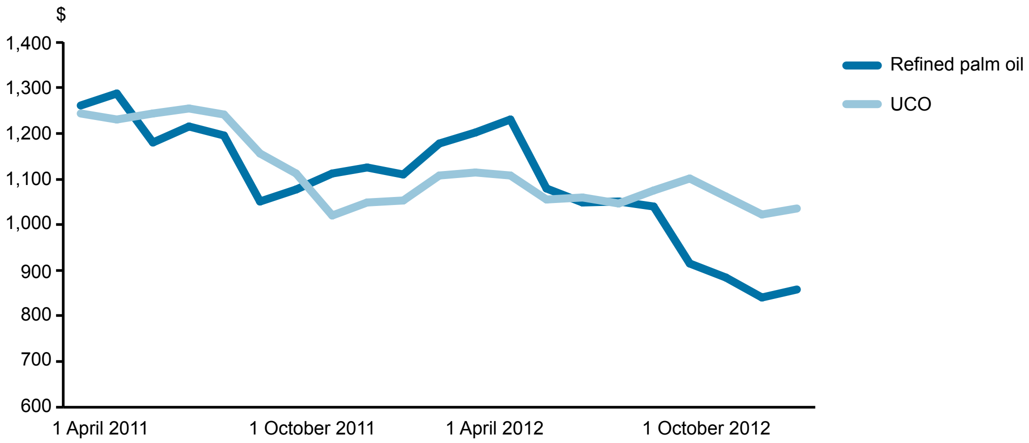
26 Sugar prices mainly drive prices of processed foods predominantly consumed by wealthier populations. Moreover sugar price rises do not transmit strongly to cereal prices: sugars and cereals tend not to compete for the same land and (beyond biofuel markets) are not principal substitutes.

Indirect effects for waste products

The European Commission currently assumes that waste products such as UCO and tallow lead to no indirect effects on food prices or land-use change, justifying the eligibility of these biofuels for double-counting. Where these are genuine waste products – i.e. where they would otherwise be disposed of – this is likely to hold true. But this may not always be the case. A study of tallow in the United Kingdom found a range of possible indirect effects that, once incorporated, meant tallow could offer net emission savings in the range of 56 per cent to –13 per cent (i.e. a net increase in emissions).[27] These indirect effects stem from the variety of alternative uses for tallow such as oleochemicals, soap, animal feed, food and pet food. Increasing use of tallow as a biodiesel feedstock may force these alternative users to seek substitutes, with second-order effects on emissions as demand for these substitutes increases. For this reason, the United Kingdom only offers double-counting to category 1 tallow (produced for purposes of energy generation only) and is monitoring the effects of this on the price and availability of other categories.

In the case of UCO, the principal risk of indirect effects stems from market arbitrage opportunities between used and virgin oils. The double-counting of UCO biodiesel results in a higher price than would otherwise be the case. As a result UCO prices have approached those of virgin oils and occasionally have begun to exceed those for refined palm oil (Figure 4).

Figure 4: Prices per tonne of UCO and refined palm oil



Source: UCO (FFA 5%) prices on a FOB ARA basis from STX Services, and refined palm oil prices on a FOB Malaysia basis from Reuters, adjusted for $70 per tonne shipping costs.

These data should be interpreted with some caution as UCO is a thinly traded commodity – however it appears that a sizeable premium to refined palm oil emerged and persisted for the last quarter of 2012. Under these circumstances it may be economically rational for market participants to source refined palm oil, recycle it quickly and then supply it as UCO at a profit.[28] This could increase demand for palm oil and contribute to deforestation.

27 Brander, M. et al. (2009), 'Methodology and Evidence Base on the Indirect Greenhouse Gas Effects of Using Wastes, Residues, and By-products for Biofuels and Bioenergy', Report to the Renewable Fuels Agency and the Department of Energy and Climate Change, Econometrica.

28 This would require that the premium be sufficient to cover duty, recycling, packaging and distribution costs, for example.

While there are no verified cases of this having happened, there are concerns among European biodiesel producers that fraud of this kind may not be unusual.[29] Supply chains for waste materials typically lack traceability and verification systems comparable to those in agricultural commodity chains, leading to the paradoxical situation in which the most heavily incentivized biofuels are the least scrutinized. Risks are likely to be greatest where supply chains are international in scope. Conversations with market participants for this research revealed a commonly held view that other countries have in the past been the source of significant amounts of UCO biodiesel reported under the RTFO as of Dutch origin. The waste biodiesel industry recognizes this issue and is taking steps to improve traceability, such as the nascent Register of Biofuels Origination (RBO) initiative. Another relevant initiative is the International Sustainability and Carbon Certification System (ISCC).

29 For example, the biodiesel producers' association the European Biodiesel Board voiced these concerns at the 2012 World Biofuels Market Conference. See Bruce Ross (2012), 'Strong Interest in Waste Product Biofuels', *RENDER*, April.http://www.rendermagazine.com/articles/2012-issues/april-2012/international-report/.

4. ECONOMICS OF DIFFERENT BIOFUELS FOR TRANSPORT

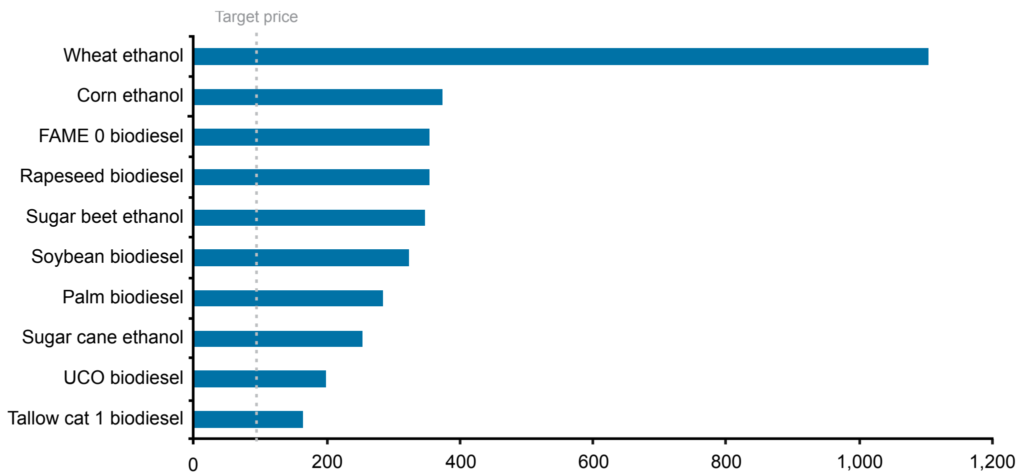
Stated objectives of the UK Bioenergy Strategy are that bioenergy use should 'make a cost effective contribution to UK carbon emission objectives' and 'maximize the overall benefits and minimize costs (quantifiable and non-quantifiable) across the economy'.[30] Each of these is considered below.

Cost-effectiveness of emissions reductions

Biofuels are a more expensive source of energy than fossil fuels. Incorporating them into the fuel mix therefore imposes economic costs, borne by motorists in return for emissions reductions. The cost-effectiveness of this strategy can be assessed by calculating the carbon abatement cost – specifically the cost of reducing emissions by one tonne of carbon dioxide equivalent (CO_2e) – and comparing this with the target carbon price (also per tonne of CO_2e). If the carbon abatement cost is less than the target price, biofuels represent good value for money.

Carbon abatement costs for different biofuels *excluding ILUC* are shown in Figure 5. The calculations are based on average market prices over January 2013 and default emissions intensities and energy contents from the European Commission.[31] Costs vary from under $165 per tonne CO_2e for biodiesel from category 1 tallow (the cheapest) to over $1,100 for wheat ethanol. The current target price for the non-traded sector (which includes transport) consistent with achieving the United Kingdom's emissions reduction objectives is estimated at about $87 per tonne.[32] Thus even if ILUC is ignored, biofuels are an expensive means of reducing emissions from transport.

Figure 5: Estimated abatement costs ($ per tonne of CO_2e) for selected biofuels



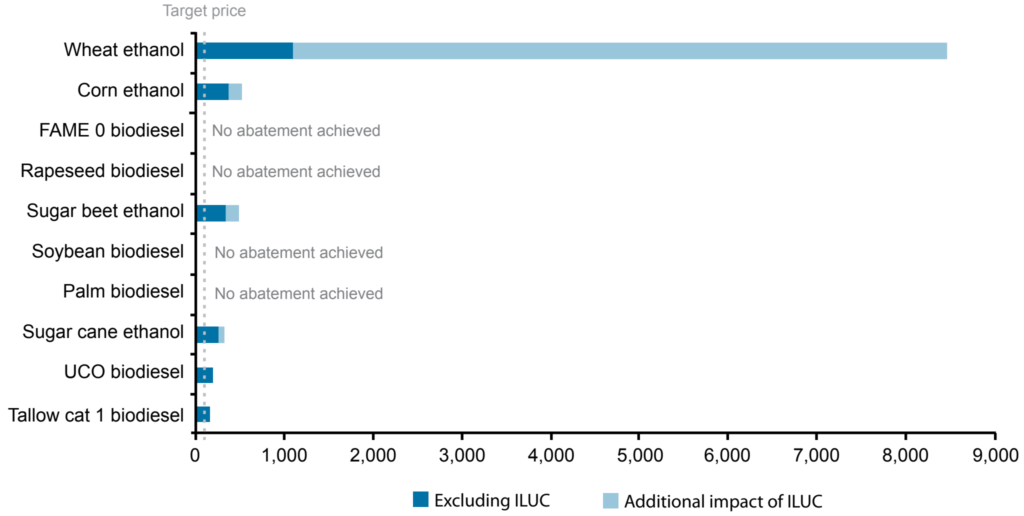
Source: Chatham House analysis based on average market price data for biofuels and petroleum alternatives on a FOB ARA basis from Argus, Platts and STX Services. Energy content and default emissions intensities from EC (2009).
FAME 0 assumes a 50:50 blend of rapeseed and palm oil biodiesels.

Including ILUC emissions results in even higher abatement costs. Figure 6 repeats the analysis above incorporating ILUC factors set out in Annex VIII of the European Commission's proposal

30 UK Department of Energy & Climate Change (2012).
31 European Commission (2009). Note that in some cases actual direct emissions intensities may be lower than the default value if the biofuel supplier can prove this is the case.
32 UK Department of Energy & Climate Change (2011), 'A Brief Guide to the Carbon Valuation Methodology for UK Policy Appraisal'.

to amend the RED and FQD.[33] After accounting for ILUC the carbon abatement costs for ethanol increase markedly: from about $260 to $330 for sugar cane, $350 to $500 for sugar beet, $370 to $530 for corn and $1,100 to $8,500 for wheat. Biodiesel from edible oils is found no longer to be a rational climate mitigation strategy: using these biofuels results in *carbon increase costs*, meaning that motorists would effectively be paying to increase GHG emissions over and above what would have been the case had only fossil fuels been supplied. In contrast, biodiesel from category 1 tallow or UCO is unaffected because it is assumed to produce no indirect emissions (though as discussed in the previous section, this assumption may not hold under all circumstances).

Figure 6: Estimated abatement costs ($ per tonne of CO_2e) for selected biofuels including ILUC



Source: Chatham House analysis based on average market price data for biofuels and petroleum substitutes on a FOB ARA basis from Argus, Platts and STX Services. Energy content and default emissions intensities from EC (2009). Indirect emissions intensities from EC (2012).
FAME 0 assumes a 50:50 blend of rapeseed and palm oil biodiesels.

Generally speaking, the inefficiency of the internal combustion engine (ICE) means scarce biomass can be used more efficiently elsewhere. In the medium to longer term, more attractive means of decarbonizing road transport identified by the Committee on Climate Change in its Bioenergy Review include electric and hydrogen fuel cell vehicles.[34] In the near term, cheaper emissions reductions can be achieved with currently available technologies such as measures to improve the efficiency of ICEs, start-stop technology, engine downsizing coupled to turbo boost or supercharging, and direct injection for petrol engines. As well as avoiding indirect impacts on food prices and land-use change, technologies such as these can actually yield abatement *profits*, as motorists benefit from reduced fuel costs that exceed higher vehicle prices within a few years of driving.[35] Vehicle emissions are reducing rapidly in response to EU regulations requiring manufacturers to reduce the average emissions of their fleets, and also as motorists increasingly prioritize vehicle efficiency. In the United Kingdom, emissions per kilometre for new cars fell nearly 20 per cent between 2007 and 2012.[36] Modelling suggests that emissions and fuel costs could be reduced even more quickly with the introduction of more ambitious vehicle emissions targets for manufacturers.[37]

33 European Commission (2012). Note that these estimates of ILUC emissions are themselves based on Laborde (2011).
34 Committee on Climate Change (2011), 'Bioenergy Review'.
35 Cambridge Econometrics and Ricardo-AEA (2013), 'An Economic Assessment of Low Carbon Vehicles'.
36 The Society of Motor Manufacturers and Traders Limited (2013) 'New Car CO_2 Report 2013: The 12th Report'.
37 Cambridge Econometrics and Ricardo-AEA (2013).

Overall costs

Biofuels are a more expensive source of energy than fossil fuels: they have lower energy densities (a litre of ethanol supplies about two-thirds of the energy of a litre of petrol, while a litre of biodiesel supplies about 90 per cent of that of a litre of diesel[38]) and tend to be more expensive on a per litre basis.

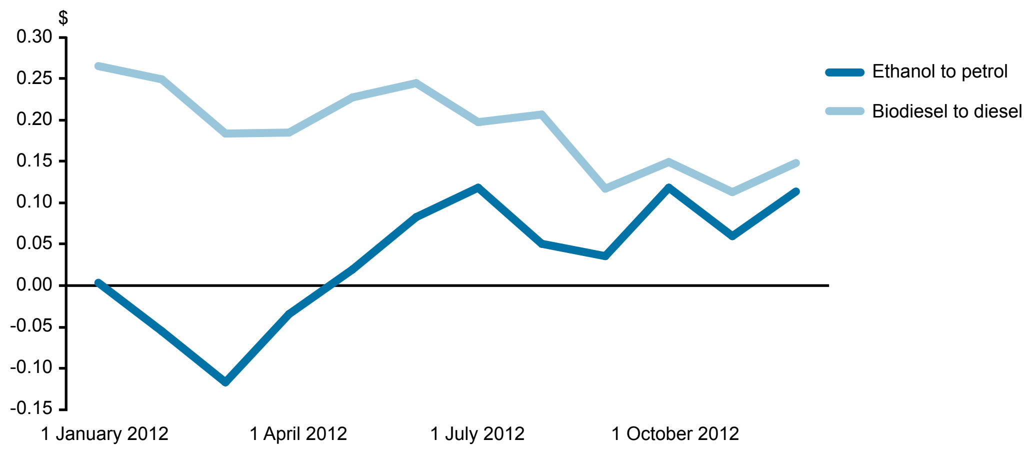
This means that displacing fossil fuels with biofuels entails costs. The likely extent of these costs for UK motorists is considered below – first of meeting the 5 per cent volume target of the RTFO in the coming financial year, and second of achieving the 10 per cent energy target of the RED in 2020.

Costs of achieving the RTFO 5 per cent volume target

The government seeks to minimize the costs of the RTFO by allowing suppliers flexibility in the biofuels they supply: there are no separate targets for ethanol and biodiesel, or limits on the amount of double-counted biofuels, for example. This incentivizes suppliers to supply biofuels with the lowest price premium (on a per litre basis) to the fossil fuel alternative. Generally speaking, on a per litre basis ethanol trades at a lower premium relative to petrol than does biodiesel to diesel (Figure 7), making it the more attractive option for meeting the volume target of the RTFO. This most likely explains the growing preference among fuel suppliers for ethanol over biodiesel (Figure 1). It is notable that nearly all the biodiesel supplied in the United Kingdom is double-counted, the extra credit compensating the supplier for the higher cost of supplying biodiesel.

Figure 8 shows the economic costs of achieving the RTFO 5 per cent volume target for different relative volumetric proportions of ethanol and biodiesel. For simplicity, historical prices and energy demand for the last full year of reporting data (financial year 2011/12 – Year 4 of the RTFO) have been used rather than forecast data for 2013/14. The exercise is therefore equivalent to estimating what the costs of achieving the 5 per cent target in Year 4 of the RTFO would have been.

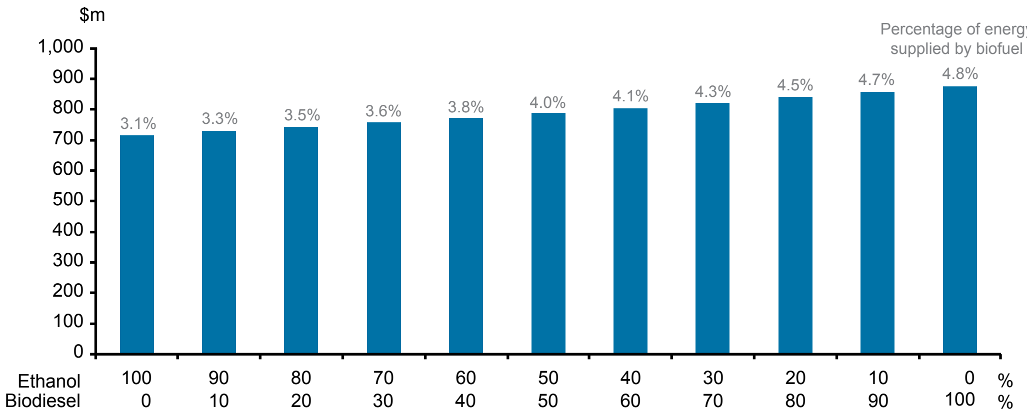
Figure 7: Per litre price premium of biofuels over fossil fuels during 2012



Source: Chatham House analysis based on market prices on a FOB ARA basis from Reuters and Starsupply Commodity Brokers. Benchmarks used: FAME 0, ethanol T2, unleaded petrol and ultra-low-sulphur diesel.

38 European Commission (2009).

Figure 8: Illustrative costs of a 5 per cent by volume target in Year 4 for different biodiesel and ethanol volumes



Source: Chatham House analysis. All market data on a FOB ARA basis. Benchmark biofuel prices (Ethanol T2 and FAME 0) provided by Starsupply. Petrol and diesel prices from OPEC Bulletin 5/12. Energy content data from EC (2009). Year 4 RTFO transport fuel data from Department for Transport.

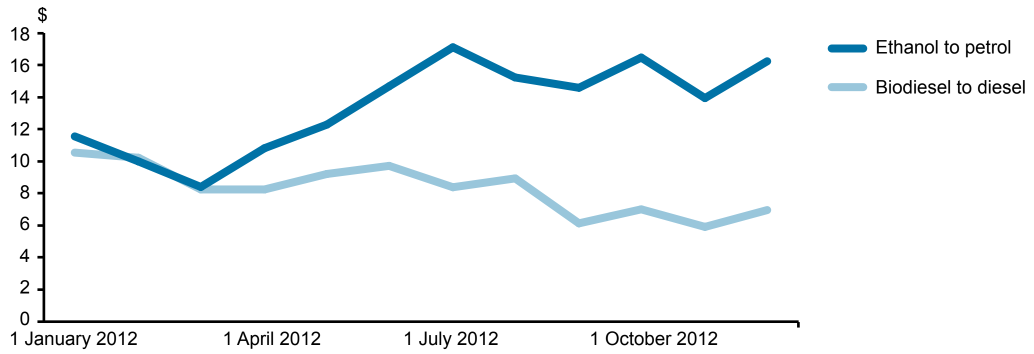
Because biofuels contain less energy than fossil fuels, they dilute transport fuel and create an energy deficit that must be met with more fuel. The economic cost therefore consists of the cost of displacing the necessary volume of fossil fuels with biofuels, and the cost of meeting the resultant energy deficit through additional fossil fuels. The modelling approach takes as boundary conditions a 5 per cent volumetric biofuel blend and actual energy demand for the petrol and diesel fleets during the period. It then calculates different transport fuel mixes to satisfy these boundary conditions; for each fuel mix, it estimates the economic cost of the RTFO over the period based on average market prices for ethanol, biodiesel (FAME 0), petrol and diesel. Lower aggregate costs are achieved with higher volumes of ethanol. This is because high volumes of (energy-poor) ethanol mean less energy is provided from expensive biofuels and more from cheaper fossil fuels: the percentage of energy from biofuels is shown at the top of each column. Total costs are in the range of $715–$875 million (£470–£570 million).

In actuality, the cost of the RTFO in financial year 2013/14 is likely to be less owing to double-counting of waste-derived biofuels, which currently constitute almost of all biodiesel consumed in the United Kingdom. As a result, biofuels will comprise less than 5 per cent of transport fuel volumes, and costs will be reduced. Repeating the exercise assuming double-counting of biodiesel and prices for UCO biodiesel results in total costs approaching $700 million (£460 million), assuming biodiesel continues to constitute just over 30 per cent of actual biofuel volumes.

Costs of achieving the RED 10 per cent energy target

By 2020, significantly larger volumes of biofuels will be required if the United Kingdom is to meet its obligations under the RED to meet 10 per cent of transport energy demand from renewable sources. Because the RED sets an *energy* target, costs will we reduced by using biofuels that trade at a lower premium to the fossil fuel alternative *on a per gigajoule basis*. As Figure 9 shows, this is generally not ethanol, but biodiesel.

Figure 9: Per gigajoule price premium of biofuels over fossil fuels during 2012

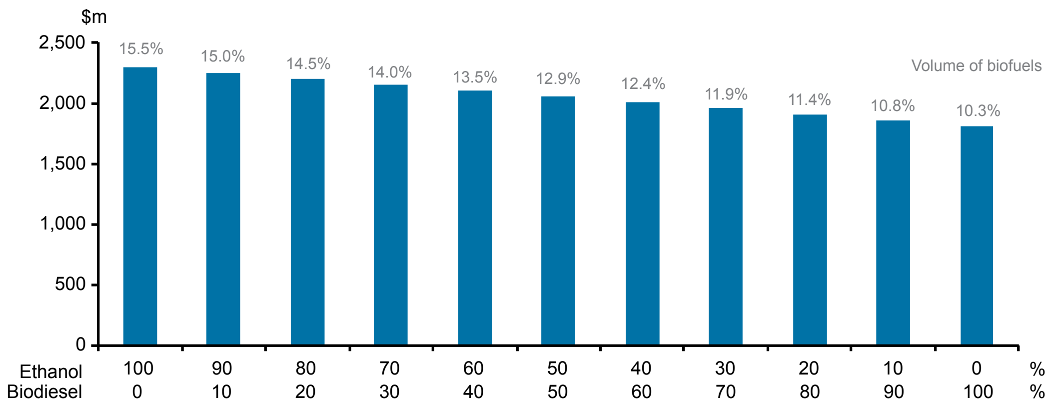


Source: Chatham House analysis based on market prices on a FOB ARA basis from Reuters and Starsupply Commodity Brokers. Benchmarks used: FAME 0, ethanol T2, unleaded petrol and ultra-low-sulphur diesel.

Figure 10 shows the economic costs of achieving the 10 per cent energy target of the RED for different relative energy shares of ethanol and biodiesel, again using historical prices and energy demand for Year 4 of the RTFO. Costs decline as the share of biodiesel increases. Biofuel volumes (shown above the bars) range from 10.3 to 15.5 per cent of total fuel supply – high ethanol shares mean greater volumes are needed to meet the energy target. The costs of supplying 10 per cent of transport energy from biofuels in Year 4 of the obligation would have been in the range of $1.8–$2.3 billion (about £1.1–£1.4 billion), depending on the particular mix of biodiesel and ethanol used. These estimates are consistent with forecast costs of achieving the RED in 2020 of $1.6–$3.2 billion a year, depending on oil price trajectories and the fuel blends used.[39]

This would equate to an annual cost of about £35–£45 per vehicle in 2020.[40] By way of comparison, modelling predicts the deployment of existing technologies to meet EU vehicle efficiency standards will deliver annual fuel *savings* per car of around £340 by 2020.[41]

Figure 10: Illustrative cost of the RED 10 per cent energy target in Year 4 of the RTFO for differing energy shares of ethanol and biodiesel



Source: Chatham House analysis. All market data on a FOB ARA basis. Benchmark biofuel prices (Ethanol T2 and FAME 0) provided by Starsupply. Petrol and diesel prices from OPEC Bulletin 5/12. Energy content data from EC (2009). Year 4 RTFO transport fuel data from Department for Transport.

39 Charles and Wooders (2012).

40 Based on Quarter 2 2012 vehicle licensing statistics of 34.6 million.

41 Cambridge Econometrics and Ricardo-AEA (2013). Note that the cost of these technologies is estimated to increase the cost of a new car by about £850 to £940.

Again, these costs can be reduced by using double-counted biodiesel from UCO or category 1 tallow instead of conventional biodiesels. However, as discussed in the first section, under current rules the resultant shortfall would have to be met by increasing renewable deployment in electricity or heat generation.

The capacity of UK waste-derived biodiesel production to meet the increase in demand required by the RED is also limited. An achievable domestic UCO biodiesel output is likely to be of the order of 210 million litres a year: more than a 60 per cent increase above Year 4 production.[42] Yet this remains tiny in comparison to the overall increases in biofuel consumption demanded by the RED, which could see Year 4 biodiesel consumption more than triple by 2020. The achievable increase in UK UCO biodiesel output could cover only a few per cent of this increase in biodiesel demand.[43] Importing greater quantities of UCO would be one way to increase the contribution of UCO biodiesel towards meeting the RED target, although in the absence of robust traceability and verification systems for international supply chains this would also increase the risk of fraud and indirect emissions. Furthermore, higher demand for UCO will increase the likelihood of a sustained price premium to refined palm oil, creating the incentives for fraud. This does not negate the value of UCO biodiesel in the biofuel mix. Rather, it raises serious questions about the feasibility of meeting the RED target in a cost-effective and sustainable manner with currently available biofuels.

Estimates indicate that between 220,000 and 240,000 tonnes per year of tallow are available for industrial use in the United Kingdom, indicating potential biodiesel production of 240–260 million litres – a similar production potential to UCO. However, this could not all be used for biodiesel without triggering potentially significant indirect emissions as competing users were forced to seek alternatives. Estimating the amount of tallow that can be used sustainably (i.e. without significant indirect effects) in biodiesel production is therefore challenging. The government is currently monitoring the impact of increasing tallow use for biodiesel and may need to withdraw double-counting for category 1 tallow if indirect effects are identified.

Broader costs and benefits

The analysis above focuses on the economic costs to motorists of increased biofuel use. Other additional costs include:

- the public cost of administering the RTFO, estimated at £1.6 million per year; and
- costs to business of verification and compliance with sustainability criteria, estimated at £322 million per year.[44]

Increasing biofuel use to meet the RED and FQD targets will entail further costs associated with the introduction of appropriate technologies and infrastructure to support the higher blends. On the diesel side, moving beyond B7 (7 per cent biodiesel by volume) will necessitate the introduction of modified engines in new vehicles. On the petrol side, fuel suppliers are preparing

42 RTFO reporting data indicate that the UCO biodiesel industry produced about 134 million litres of biodiesel from UK UCO in Year 4, which is likely to have consumed about 138 million litres of UCO. Industry estimates that total UCO production in the United Kingdom is about 250 million litres, indicating a total production potential of about 243 million litres of biodiesel. Theoretically, there is therefore the potential to increase production by a further 109 million litres of biodiesel a year, but in practice this will be limited by the fact that a significant share of the remaining UCO (50≠75 million litres) is likely to come from households rather than commercial premises. Further increases could be achieved by reducing theft of UCO and illegal biodiesel production – potentially providing another 20 million litres or so.

43 Assumes achievable increase of 76 million litres a year in UK UCO biodiesel output and an increase in biodiesel consumption of 2 billion litres a year by 2020 if biodiesel meets 10 per cent of 2020 diesel fleet energy demand. Based on forecast data in Charles and Wooders (2012).

44 Charles and Wooders (2012). Further related costs include the cost of subsidies provided to producers of agricultural feedstocks under the Common Agricultural Policy. These were estimated as £13.7 million in financial year 2010/11. These are not included here as they do not represent an additional cost of biofuel policy and would have been provided irrespective of the crops' final use.

to introduce E10, but research for DfT has identified a number of potential problems for older vehicles. Based on case studies in other countries that have introduced E10, field trials and laboratory tests, the research found issues of material incompatibility, corrosion and drivability problems for vehicles of 10 years or older. This may comprise between four and five million vehicles in today's fleet.[45] Other estimates are higher.[46] The absence of a comprehensive list of E10 incompatible vehicles makes it impossible to estimate precisely; more importantly, it increases the risks associated with a rollout of E10.

Uncertainty and a lack of information about the introduction of E10 in Germany resulted in motorists avoiding its use and initially unmet demand for standard fuels. Since its introduction two years ago, E10 use has stagnated at about 20 per cent of overall petrol demand while E5, originally intended to be the reserve fuel for the estimated 10 per cent of vehicles incompatible with E10, remains the fuel of choice for the majority of petrol vehicle owners. German motorists are thought to remain concerned about the risk of damage to their cars and suspicious of the wider environmental and social impacts of ethanol.[47] The German petroleum industry estimates the costs of introducing E10 came to hundreds of millions of euros.[48]

For these reasons the UK government has asked suppliers to delay the introduction of E10 and requested three months' notice to allow for the necessary preparations. In the meantime efforts continue to collect information on the compatibility of different vehicles and to develop a public information campaign.[49]

Key non-monetized benefits of biofuels may include improved national fuel security, and market and job opportunities in agriculture and biofuel production. Improvements in national fuel security are marginal: less than 2 per cent of transport energy was provided by biofuels during the first six months of Year 5 of the RTFO. And job creation in UK agriculture attributable to the RTFO appears to have been small: the vast majority of agricultural biofuels are produced from feedstocks grown overseas with the exception of a small amount of sugar beet ethanol.[50] There are however plans to begin supplying ethanol from UK wheat this year.

Outside agriculture, a nascent industry has emerged around the collection and processing of waste products – primarily category 1 tallow and UCO – for biodiesel. In 2011, there were 30 medium-to-large UCO collection businesses and biodiesel producers registered in the United Kingdom, employing between 1,000 and 1,200 people. In the following year, 10 of these closed as the duty differential for UCO biodiesel was withdrawn.[51]

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45 Wall (2010) estimated 8.6 million vehicles in 2010, of which about half would still be in operation in 2013.

46 Teresa Sayers, Chief Executive of the Downstream Fuel Association, estimated 20 per cent of current cars and small vans to be incompatible. See 'Spotlight on Fuels: Bio diversity', Forecourttrader.co.uk, 4 September 2012, http://www.forecourttrader.co.uk/news/fullstory.php/aid/6155/Spotlight_on_Fuels:_Bio_diversity.html.

47 *Argus Biofuels Daily International Market Prices and Commentary*, Issue No. 13–38, 22 February 2013.

48 Rauch, A. and Thöne, M. (2012), 'Biofuels – At What Cost? Mandating ethanol and biodiesel consumption in Germany', International Institute for Sustainable Development.

49 UK Department for Transport, *Low Carbon Fuels Newsletter*, 31 January 2013.

50 This supplied 4 per cent of certified ethanol during the first six months of Year 5. In addition, production of ethanol from UK wheat is due to commence in 2013 at the Vivergo plant at Saltend, which employs 80 people.

51 See written evidence submitted by the UK Sustainable Bio-Diesel Alliance to the Environmental Audit Committee's Green Economy Inquiry, http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1025/1025vw36.htm and http://www.thegrocer.co.uk/topics/environment/biodiesel-industry-on-the-brink-as-waste-oil-use-plummets/234148.article.

5. CONCLUSIONS

Current biofuels pose significant sustainability problems

Agricultural biofuels increase the level and volatility of food prices, with detrimental impacts on the food security of low-income food-importing countries. They also result in indirect land-use change, the emissions from which are significant.

Biodiesel from waste products such as UCO or category 1 tallow offers the most favourable sustainability characteristics, but the risk of indirect emissions increases at higher levels of use. UCO prices have increased significantly following the introduction of double-counting and now periodically exceed those of refined palm oil, potentially creating incentives for fraudulent activity capable of generating indirect emissions.

Biofuels are not a cost-effective means to reduce emissions from road transport

The current generation of biofuels provide an expensive means of reducing emissions from road transport. Carbon abatement costs, excluding emissions from indirect land-use change, are broadly in the range of \$165–\$1,100 per tonne of carbon dioxide equivalent (CO_2e). This compares unfavourably with an appraisal price of around \$87 per tonne. More cost-effective opportunities to reduce emissions from transport are available through the deployment of existing technologies to improve vehicle efficiency.

After accounting for indirect emissions, biodiesel from edible oils is no longer a rational mitigation strategy; abatement costs for ethanol are in the range of \$330–\$8,500 per tonne of CO_2e, depending on the feedstock used.

The RTFO is likely to cost UK motorists in the region of \$700 million (£460 million) in the current financial year (2013/14). Costs would be higher without the use of double-counted biofuels, which effectively reduce the target. Additional costs to business add a further \$490 million (£322 million).

By 2020, the annual biofuel cost to UK motorists is likely to be in the region of \$2 billion (£1.3 billion) a year if the United Kingdom is to meet its EU obligations to supply 10 per cent of transport energy from renewable sources. This target may be reduced through the use of double- or (as yet unavailable) quadruple-counted biofuels. However, under current rules this reduction would have to be offset by the increased deployment of renewables in the heat and electricity sectors.

Meeting EU targets sustainably with current technologies is unlikely to be possible

Meeting the RED target will require increasing biofuel consumption several times over. The necessary increases in biofuel blends will require the introduction of new technologies to the vehicle fleet and new supporting infrastructure.

In the absence of significant contributions to supply from as yet unavailable advanced biofuels, the RED and FQD will likely result in material increases in demand for agricultural biofuels, with negative consequences for land-use change and food security.

Significantly higher demand for UCO biodiesel could see UCO prices exceed those for refined palm oil on a sustained basis, creating the conditions for fraud and indirect emissions. Similarly, excessive use of category 1 tallow may result in indirect emissions if it reduces the availability of other categories for alternative uses.

UK biofuel policy may need to be modified

In its present form the RTFO may not be an appropriate instrument for achieving the RED target economically. Its volumetric target incentivizes suppliers to minimize cost per litre by supplying ethanol, thereby also minimizing the amount of energy supplied by biofuels. This runs counter to the objective of the RED to *increase* the share of energy from biofuels. The use of volumetric targets to achieve energy content goals is likely to result in suboptimal outcomes and higher costs for motorists.

Nor is the RTFO in its present form an appropriate instrument for achieving the RED target sustainably. Neither indirect land-use change nor food security is addressed in its sustainability criteria. In the absence of such safeguards, increasing biofuel consumption could have significant environmental and social consequences outside the United Kingdom. It is unclear whether such safeguards will be agreed at the EU level.

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ABOUT THE AUTHOR

Rob Bailey is a Senior Research Fellow of the Energy, Environment and Resources Department at Chatham House, focusing on food and environmental security. He previously held a number of posts at Oxfam GB, including Head of Economic Justice. In 2011, he was named one of the DEVEX 40-under-40 leading thinkers on international development for his work on sustainable development.

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Chatham House, 10 St James's Square, London SW1Y 4LE
T: +44 (0)20 7957 5700 E: contact@chathamhouse.org
F: +44 (0)20 7957 5710 www.chathamhouse.org