Biofuels

Risks and opportunities

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Introduction

Recent media coverage of biofuels has tended to provide two rather polarised perspectives. On one hand, some have heralded biofuels as the green solution to replacing our dwindling oil reserves, both saving the planet by reducing greenhouse gas emissions and supporting fuel security and diversity of supply. But other coverage has called these benefits into question, with some reports linking biofuels with pushing up food prices, causing deforestation, destruction of peat bogs and other negative impacts on biodiversity.

This paper sets out the key issues in the context of current UK Government policy.

Evidence from lifecycle analysis suggests that sustainable biofuels can offer significant reductions in greenhouse gas emissions compared with fossil fuels and so represent an opportunity to address climate change.[1] Other potential benefits include the promotion of energy security and diversity of supply and new opportunities for rural and developing economies. There is also the prospect of developing a bio-chemical refining industry.

The UK's policy is to proceed with caution, seeking to take advantage of the environmental opportunities offered by biofuels, while putting in place the safeguards to avoid the potential disadvantages. We are working to ensure that the biofuels we use come from sustainable sources, and save the largest amount of greenhouse gas emissions possible; and we are working internationally to make sure other countries do the same.

Context

Biofuels are fossil fuel substitutes that can be made from a range of agri-crop materials including oilseeds, wheat and sugar. They can be blended in small quantities (currently up to 5%) with petrol and diesel and used safely in today's road vehicles. Biofuel technology has been around as long as the combustion engine, but concerns about fuel security, climate change and the wish to support rural economies has led to plans for significant expansion in biofuel production across the globe, and has also stimulated research and development into 'second generation' fuels. (These advanced biofuels are not yet commercially available, but offer the prospect of better environmental performance and of using a wider range of feedstocks, including waste.)

As part of the UK's Climate Change Programme, we have set a target for 5% of our road transport fuels to be from a renewable source by 2010 (by volume); this should deliver an annual saving of around 0.7 - 0.8 million tonnes of carbon (2.6 - 3.0 million tonnes of carbon dioxide), through the

[1] For example, the authoritative EUCAR*, CONCAWE* and JRC* have performed a joint evaluation of the Well-to-Wheels energy use and greenhouse gas (GHG) emissions for a wide range of potential future fuels and powertrains options. The first version was published in December 2003 and was updated in 2006. Available at http://ies.jrc.ec.europa.eu/wtw.html

introduction of an obligation on fuel suppliers, the 'Renewable Transport Fuel Obligation' (RTFO), which is due to start in April 2008.

At the EU level, a conditional target of 10% has been set for the energy content share of biofuels in overall EU petrol and diesel consumption by 2020, subject to sustainability of production, commercial availability of 'second-generation' biofuels, and amendment of the Fuel Quality Directive to allow for adequate levels of blending. The UK is also working to ensure that the revised Directive is consistent with the conditional target of 10%, including the requirement for sustainability.

1. Do biofuels reduce carbon emissions?

The EUCAR, CONCAWE and JRC lifecycle analysis of greenhouse gas (GHG) emissions for a wide range of potential future fuels demonstrates that sustainably produced biofuels can result in an overall net reduction in carbon emissions.[2] In simple terms, sustainable biofuels save carbon because the CO_2 that is emitted into the atmosphere when they are burned is offset by the CO_2 that the crop has absorbed as it grows. In this sense they are different from fossil fuels, which emit historic carbon into the atmosphere carbon which has been locked away under the earth's surface for millions of years.

The carbon savings that biofuels offer can vary widely. This is because these carbon savings are offset by the fossil energy that is used for cultivation (such as fertilisers), harvesting, processing and transportation. For example, work done by the Government sponsored Low Carbon Vehicle Partnership has demonstrated that UK wheat based ethanol can save as little as 7% or as much as 77% carbon compared with petrol depending on precisely how much fossil energy is used (in production, refinement and transport).[3] Use of renewable energy from combined heat and power stations to process feedstocks leads to savings at the higher end of the spectrum. That is why, under the RTFO, companies will be required to measure and report on how much carbon their fuel has saved over the entire life-cycle from grain to tank (including any effects of land-use change). And from 2010, when experience with carbon measurement and reporting has been established, the Government has announced its intention that the RTFO will reward fuels according to their carbon savings.

Major land use change, particularly deforestation and draining of peat bogs, can completely negate the carbon saving from biofuels, as well as causing damage to biodiversity and other ecosystem resources. It is therefore critical that biofuels are grown sustainably. Actions the Government is taking to address this are set out below under question 6.

[2] http://ies.jrc.ec.europa.eu/wtw.html
[3] http://www.lowcvp.org.uk/assets/viewpoints/Biofuels%20WTW%20final%20report.pdf

2. How big a contribution to our transport fuel requirements can biofuels make?

By 2010 5% of road transport fuel is expected to be from renewable sources. A conditional target of 10% has been set for the EU as a whole for 2020, subject to the biofuels being sustainable and second generation biofuels becoming available.

The size of the contribution biofuels can make is dependent on measures to ensure that they are produced sustainably, and on advances in technology that enable more productive biomass feedstocks to be used.

3. How much biofuel can we produce?

This depends on a whole range of factors, including technologies employed, competing uses for biomass feedstocks and, critically, availability of environmentally and socially sustainable feedstocks.

The European Environment Agency (EEA)[4] recently assessed the amount of biomass that could technically be available for energy production in each Member State without increasing pressures on the environment. This assumed that the area to be available comprises both set-aside and land released from food and fodder production (as a consequence of a further reform of the common agricultural policy and productivity increases). For the UK, the report concluded that around 0.8m hectares of land would be available in 2010, rising to 1.1m hectares in 2020. In the short term and using current technologies, this would indicate that the UK could produce enough biofuels for around 2.5% of our road transport fuel needs whilst still leaving some land available for other bioenergy crop uses. However, as biofuels are a globally traded commodity the proportion of domestically sourced agricultural crops used to meet UK biofuel targets will be determined by the market rather than theoretical production capacity.

In the longer term advances in technology should allow a wider range of feedstocks to be used. A study for the Department for Transport estimated that the UK might be capable, theoretically, of supplying as much as one third of its transport fuel demands by 2050.[5]

At the global level, a 2007 IEA report predicts that biofuels could make up 7% of the world's transport fuels by 2030. In its most optimistic technological scenario, the report suggests that biofuels could contribute 25% to transport demands by 2050. But it is essential that sustainability standards are set for biofuels, and that targets do not outstrip the market's ability to deliver sustainably produced fuel.

[4] Http://reports.eea.europa.eu/eea_report_2006_7en

[5] http://www.lowcvp.org.uk/assets/reports/Liquid_biofuels_and_hydrogen_to_2050_-_E4tech_DfT_-_December_2003.pdf

4. How big a contribution to tackling climate change can biofuels make?

A 5% biofuels target would save around 0.7 to 0.8 million tonnes of carbon, representing a saving of around 0.4% of the UK's forecast emissions for 2010.[6]

In future, advances in technology could mean that sustainable biofuels can achieve higher levels of carbon savings. The Government is encouraging advances in technology by its intention to reward biofuels under the RTFO according to the levels of carbon they save from 2010.

If the EU target of 10% biofuels by energy content for 2020 is met, carbon savings could be around 7 or 8% of emissions from road transport, about 1.3% to 1.5% of total emissions, though the precise saving will depend on a wide range of factors including the average carbon efficiency of the biofuels. [7]

5. Should we focus on using less energy rather than technological fixes?

Sustainable biofuels are part of a wider package of measures needed to address climate change; this includes energy efficiency, demand management and other renewable technologies. Details are set out in the Energy White Paper and Climate Change Programme.[8]

6. Will biofuels cause deforestation and other environmental damage in other countries?

The sustainability of biofuels is a real concern. That is why the Government is putting policies in place that seek to address this, and working internationally to encourage other countries do the same. The UK is working hard within the EU and with other countries to address deforestation in the climate change negotiations to help ensure that all sources of emissions are recognised and reduced.

At the UK level, the Government is working with industry to develop sustainability guidelines for biofuels. We are among the first in the world to develop a system to do this and are widely seen as an international leader. The RTFO will require companies to report against these sustainability

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[6] Assuming that biofuels achieve an average of 57% carbon savings, and total 2010 emissions of 169.2 million tonnes of carbon forecast in The UK Climate Change Programme (2006).

[7] DfT Statistics 2006 forecast emissions from transport to be between 31.7 and 33.5 million tonnes of carbon. The UK Climate Change Programme forecast emissions for 2020 is 170 million tonnes of carbon. Assuming the EU target of 10% by energy requires around 12% biofuels by volume, and that a near tripling of biofuels penetration would approximately triple current projected carbon savings for 2010 (achieving around 2.2 to 2.5 million tonnes carbon saving).

[8] The Energy White Paper is available at http://www.berr.gov.uk/files/file39387.pdf , and information on the UK's climate change programme is at http://www.defra.gov.uk/ENVIRONMENT/climatechange/index.htm

standards. From 2011 the Government intends that there will be mandatory minimum sustainability standards for UK biofuels, both domestic and imported. These include measures of lifecycle greenhouse gas emissions, biodiversity, land use change, impact on water resources and labour standards.

7. Why not impose minimum sustainability standards now?

There is currently no internationally agreed definition of a 'sustainable biofuel', nor a working standard that could be imposed. The imposition of unilateral requirements on the way in which traded commodities have been processed and produced without any international agreement would be vulnerable to challenge under the rules of the World Trade Organisation.

We are therefore working to develop a standard alongside the RTFO, and to feed this work into European and international efforts to agree a standard. This includes for example, work with other Member States and the European Commission to develop strong, EU-wide sustainability standards for biofuels in the EU legislation to be tabled later in 2007. We are also working with the Global Bioenergy Partnership (GBEP) to develop an internationally recognised lifecycle greenhouse gas methodology for biofuels.

8. Will growing demand for biofuels push up food prices?

Other things being equal, additional demand for biofuel could push up the price of the cereals and oilseeds which are currently used to make them. However, it is important to keep the overall effect in perspective.

Firstly, demand for biofuels is only one factor affecting prices. Recent price rises in the EU this year for example, have more to do with the smaller harvest last year and uncertainty about the size and quality of the 2007 harvest, rather than the specific impact of EU biofuels production. Other factors include higher production costs, e.g. fertilisers.

Secondly, the level of increase attributable to biofuels may not be substantial, because there is potential to increase production in response to additional demand. Analysis by the European Commission assessing the impact of the 10% by energy target for 2020 indicates that prices for agricultural raw materials in the EU would increase by 3 to 6% for cereals and 5 to 18% for oilseeds.

And thirdly, the price of crops is a small component of food retail prices. For example only 1 to 5% of the cost of bread relates to the cost of the cereals used to make it.[9] Therefore even fairly substantial increases in raw materials can have a relatively modest impact on the consumer.

[9] EU Agriculture Commissioner, Marian Fischer-Boel.

We do need to ensure that biofuel targets are matched with what can be produced sustainably however. Clearly a balance is needed between using available land for food and non-food purposes, and if biofuel targets are set too high too quickly there could be serious effects on food security and prices on world markets. This would affect countries in different ways depending on their level of food self-sufficiency, with particular risks for regions heavily dependent on imports. Governments will need to monitor how markets are affected by growing biofuel demand and tailor national targets accordingly. The UK Government will continue to gather evidence on the impacts of biofuel use to help ensure that targets are set at appropriate levels.

In the longer term, second generation biofuel technologies have the potential to reduce pressure on land because they can use a wider range of feedstocks, including waste.

9. Should we wait for second generation biofuels?

It is sometimes suggested that, given some of the risks associated with current biofuel technologies, we should wait until 2nd Generation fuels are developed. It is certainly the case that new biofuel technologies are extremely promising. They can be made from a much wider range of materials, e.g. wood waste, reducing pressure on land availability. They are also likely to deliver better GHG savings, and provide scope for a 'biorefinery' approach producing a wide range of industrial products from renewable sources.

However, these technologies are not yet commercial and may never be if a viable market is not developed. It is hoped that the RTFO will help create a long term market for biofuels, and potentially other renewable transport fuels, that will encourage investment in innovation.

10. Are other uses of biomass more cost effective in saving carbon?

As acknowledged in the UK's Biomass Strategy[10], using biomass in heat and power applications is generally more cost effective than biofuels.

However, biofuels offer one of the few routes in the short term to reduce carbon emissions from transport, where emissions are rising. In contrast, the power generation sector has a number of possible sources, including wind, tidal and solar. Furthermore, advances in technology and production practices could significantly improve the carbon saving performance and cost effectiveness of biofuels in the future.

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http://www.defra.gov.uk/environment/climatechange/uk/energy/renewablefuel/pdf/ukbiomassstrategy-0507.pdf

The shift towards a low-carbon economy will require us to make use of a wide range of measures. Sustainable biofuels can also play a significant role in reducing emissions.

11. What impact will biofuels have on air quality and health?

Emissions from the combustion of biofuels depends on several factors, including the type of biofuel, the level of blend with fossil fuel and the particular vehicle in which it is used. There is a high degree of variation reported in research literature in this area which makes it difficult to place accurate figures on their health impacts. However, trends for the four main types of biofuels are presented below.

First-generation biodiesel

For low proportions of (up to 20%) biodiesel in diesel,[11] the main trends seen in vehicles' exhaust emissions relative to standard fossil diesel are:

- reductions of particulate matter, carbon monoxide (CO) and VOC;
- a slight increase in NO_x emissions;

Although biodiesel tends to emit fewer particulates, these are likely to be composed of different substances than those from conventional diesel. This will result in biodiesel particulates having different health effects from those from conventional fuel.[12]

Second-generation biodiesel

This is a different product from first generation biodiesel, and is chemically similar to high quality conventional diesel, but with very low sulphur and aromatics and low particulates.

Bioethanol (first- and second-generation)

For low proportions of (up to 10%) bioethanol in petrol,[13] the main trends seen in vehicles' exhaust emissions relative to standard fossil petrol are:

- no significant changes in emissions of NO_x and most VOCs;
- a large increase in emissions of acetaldehyde, an VOC ozone precursor.

There is evidence from other countries to show that higher proportions of (up to 100%) bioethanol in petrol leads to a substantial increase in ozone

[11] TNO (2004). *Compatibility of pure and blended biofuels with respect to engine performance, durability and emissions*, Report 2GAVE 04.01.

[12] Durbin TD, *et al* 1999. *Evaluation of the Effects of Alternative Diesel Fuel Formulations on Exhaust Emission Rates and Reactitivity.* Final Report 98102. Riverside, CA:Center for Environmental Research and Technology, University of California.

[13] For example, TNO (2004). *Compatibility of pure and blended biofuels with respect to engine performance, durability and emissions*, Report 2GAVE 04.01. and AEAT (2002) *Ethanol Emissions Testing,* report for UK Department for Transport.

formation from acetaldehyde,[14] although it has not yet been verified which areas of the UK would be susceptible to this effect.

In the UK, we anticipate that biofuels will be used mainly in low level blends. Most vehicle manufacturers limit their warranty coverage to the use of fuel meeting fuel quality standards, which currently allow only up to 5% biofuel in both petrol and diesel. The European Commission is proposing to revise the bioethanol limit in petrol to 10%.

[14] M.Z. Jacobson *et al.*, Effects of Ethanol (E85) versus Gasoline Vehicles on Cancer and Mortality in the United States, *Environ. Sci. Technol.,* **41** (11), 4150 -4157, 2007.