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Refining Britain's fuels

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Biofuels in the UK

- **Biofuels can play a part in reducing CO_2 emissions from road transport**
- **The oil industry is adding biofuels to road fuels under the Renewable Transport Fuel Obligation (RTFO), of 2.5% by volume in 2008/9, 3.25% in 2009/10, 3.5% in 2010/11, 4% in 2011/12, 4.5% in 2012/13 and 5% in 2013/14**
- **The main biofuels available in the UK are bioethanol and FAME (biodiesel); road fuel quality standards currently permit these fuels to be blended up to 5% by volume with petrol and diesel respectively**
- **'Housekeeping' will be required at service stations to avoid operational problems with biofuels**

Biofuels

Biomass can reduce UK emissions of carbon dioxide either by generating heat/power or by conversion into road fuels. Biofuels can be produced from a variety of sources in different countries.

Potential UK grown energy crops include

- rape seed which can be converted into bio-diesel
- wheat and sugar beet which can be used to produce ethanol by fermentation
- miscanthus and wood from short rotation coppicing, which can be burned to produce heat and power, or in the longer term converted to produce biodiesel.

These can be supplemented by bioethanol and biodiesel made from crops grown overseas, e.g. sugar cane, maize, palm oil and soy.

A number of waste products can also be converted into energy or fuels, e.g. used vegetable oil/tallow into bio-diesel, straw and forestry waste converted into heat and power, or in the future biofuels.

However, for UK production, the area of land available is a determining factor, with indications that about 1-2 million hectares could be given over to energy crops without affecting food production. In addition wheat, currently exported, and waste products, could supplement production.

Beyond this level, major change in land use would be required – for example permanent grassland or woodland cultivated for energy crops – which would adversely change the CO_2 balance.

Best use of biomass

The Government's Energy White Paper in 2003 covered the options of using biomass to generate heat/power or conversion into liquid fuels for use in road vehicles. The Royal Commission on Environmental Pollution has backed the use of biomass to generate heat and power.

UKPIA also welcomes the findings of DEFRA's Biomass Task Force's 2005 investigation which highlighted the higher potential and lower cost per tonne of carbon saved of this option.

Table 1 below gives an indication of the potential carbon saving per hectare of crop from a variety of different sources.

Table 1 - Carbon dioxide emissions abated by the use of current biofuels

Crop	Carbon dioxide saved
Biomass (SRC or miscanthus) used to raise power – vs natural gas	10.4 te/ha
Bio-ethanol from sugar beet for blending with petrol	3.0 te/ha
Bio-ethanol from wheat for blending with petrol	2.4 te/ha
Bio-diesel from rape seed for blending with diesel	1.8 te/ha

Source: Concawe/JRC/Eucar 2007

However, the actual reduction in CO_2 emissions measured on a 'well to wheels basis' will vary and is dependent upon the source of the biofuel, as Table 2 below illustrates.

Table 2 - Well to wheels greenhouse gas emissions

Fuel	g CO_2 equivalent/km
Petrol	196
5% Ethanol from sugar beet in petrol	193
5% Ethanol from sugar cane (Brazil) in petrol	188
Diesel	164
5% Biodiesel from rape in diesel	160

Source: Concawe/JRC/Eucar 2007

UK Introduction of biofuels & RTFO

In October 2007, Parliament approved the **Renewable Transport Fuel Obligation (RTFO)**, requiring suppliers of road fuels to incorporate a proportion of biofuel in petrol or diesel, or pay a penalty.

The Renewable Fuels Agency (RFA) was established on 26th October 2007 when the RTFO Order 2007 was made and is responsible for monitoring the implementation of the RTFO by obligated companies.

The RTFO commenced on 15th April 2008 with a target of 2.5% by volume biofuel content in road fuels in 2008/9, followed by – revised levels, April 2009 - 3.25% in 2009/10, 3.5% in 2010/11, 4% in 2011/12, 4.5% in 2012/13 and 5% in 2013/14.

At the 5% level, the Government estimates that around 0.8 million tonnes of carbon emissions per year would be avoided.

Under the RTFO there will be a continued support package of 20p per litre duty incentive for biofuels (guaranteed until 2009/10) supplemented by a 15p per litre buy-out penalty for suppliers failing to meet the obligation, meaning an overall 35p per litre incentive in 2008/10 for the biofuel element but reducing to 30p per litre in 2010/11.

The RFA in January 2008 also issued guidance to obligated companies on how to report on the sustainability of biofuels supplied through the RTFO. The RFA commissioned further research on the indirect effects of biofuels on sustainability which advised a slowing in the pace of biofuel use originally envisaged under the Renewable Transport Fuels Obligation.

The target of 2.5% in year one (2008/09) has largely been met by 5% biodiesel blended into conventional sulphur free diesel (often referred to as B5 blend). This will be followed by bioethanol into unleaded grades, with 5% biofuel content being achieved for all unleaded petrol and diesel from 2013/14.
In 2007, UK sales of biofuels were 500 million litres, compared with approximately 49 billion litres of conventional petrol and diesel.

Biodiesel can be blended at the refinery using current quality controls and the existing fuel distribution system. On the other hand, bioethanol's affinity to absorb water will require blending with petrol at terminals - unless it is converted to ETBE at a refinery by reaction with isobutene, or replaced by biobutanol - because of the risk of transporting bioethanol blends in the UK's multi-product pipeline systems.

In general, biofuels are more expensive than conventional fuels preventing their widespread use in the past. However, the rise in crude oil and refined product prices over the last two years has narrowed this gap slightly, although higher oil costs also feed into the cost loop for biofuel production.

Product quality & technical issues

Under current European Motor Fuel Standards, the maximum limit for blending of bioethanol and biodiesel with conventional petrol and diesel is 5% by volume. **Vehicles require no modification to use this level of blend.**

The oil industry is working with other organisations within the European Standards Organisation, CEN, to examine if the current limits on biofuel composition of road fuels can safely be increased. For biodiesel a revised limit of 7% FAME will be adopted this summer. For ethanol a revised limit of 10% will be adopted in 2010/11.

Use of vegetable oils in diesel engined vehicles

Modern diesel engines are built to very high standards with close tolerances to give the performance, lower emissions and reliability wanted by vehicle owners.

The automotive and oil industries, along with biofuels' producers, have developed a British/European standard for biodiesel derived from vegetable oil, **BS EN 14214**, based on their European experience. The biodiesel standard ensures that biodiesel meets the requirements of modern diesel engines.

The British/European Standard for diesel, **BS EN 590**, allows up to **5% esterified vegetable oil**, meeting the above biodiesel standard BS EN 14214, to be mixed with conventional diesel.

Where high biodiesel blend is used, modifications to the seals of existing vehicles may be necessary to avoid leaks, unless the vehicle has been specifically designed for such use.

The use of unprocessed vegetable oil is not recommended and will invalidate engine warranties. Their use over time can give rise to a range of problems, including the build up of sticky deposits; damage to the diesel injector pump; malfunction of the fuel shut-off valve so that the engine will either not start or if running not stop; along with fouling of fuel injectors or blockages in fuel filters. Additionally, unprocessed vegetable oil has poor cold flow properties, which may lead to starting and operating problems during cold weather.

Bioethanol

Bioethanol is mainly produced by fermentation of sugar derived from crops such as sugar beet, sugar cane, wheat and corn/maize. Ethanol is a high-octane clear, colourless liquid that can be blended with conventional petrol but increases the vapour pressure of the fuel. It has a tendency to pick up water so cannot safely be blended at a refinery and distributed in multi product pipelines. For this reason, blending with petrol will be during road tanker loading at terminals.

In order to avoid the problem of water absorption in storage tanks at service stations, some extra 'housekeeping' may be required. Guidance for operators will be issued in due course.

Ethanol can, however, be converted to ETBE by reaction with isobutene thus overcoming the problem of water absorption, or biobutanol can be produced, which has a vapour pressure similar to petrol.

The European/British Standard for petrol, **BS EN 228**, permits a maximum of **5% by volume of ethanol** (or 1**5% ETBE**). Ethanol/petrol fuel blends to a higher proportion are sold in some countries, for example the United States, Brazil, and Sweden. The most common blend is 10% ethanol and 90% petrol (E10). Only flexible fuel vehicles can run on an 85% ethanol/15% petrol blend (E85). The range of 'flex-fuel' vehicles available in the UK is limited at present, as is the fuel distribution network for E85. Although the CO_2 reduction potential is higher than with lower proportion ethanol/petrol blends, the likely overall impact on reducing CO_2 from the road transport sector will be less than that associated with the move to 5% ethanol/petrol blend under the RTFO due to the limited number of E85 vehicles. The lower energy content of bioethanol is likely to be more evident with E85 blend, with up to 30% more fuel consumption compared with petrol.

Future biofuels

Second generation or advanced bio fuels are under development, utilising processes that turn cellulose into fuel components either through enzyme fermentation or gasification followed by FischerTropsch synthesis. Biomass sources containing cellulose, such as plant and agricultural waste, organic household waste and non-food crops such as wood can be used.

Aside from not diverting land from food production, the utilisation of such material has cost benefits and requires less energy intensive inputs during the growing and production cycle. Furthermore, second generation fuels have the potential for superior CO_2 reduction benefits in comparison with conventional biofuels. However currently there is a cost penalty.

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