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Economics Group, Defra

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1.0 Introduction

Two factors have contributed to the increase in the production and use of biofuels (biodiesel and bioethanol) over the past 5 years: higher crude oil prices and government support. This paper considers the impact of the latter. In doing so it will set out the type of support provided by governments in OECD countries, the value of this support and value for money of this support. The paper will then analyse the situation in the UK, setting out type and level of support provided and value for money. The discussion on OECD countries is based on the Global Subsidies Initiative (GSI) report "Biofuels- At What Cost? Government support for ethanol and biodiesel in selected OECD countries".

2.0 Global Support for Biofuels

Government support for biofuels is usually given through:

- Production subsidies (direct & indirect)
- Grants and loans
- Tax exemptions/reductions
- Agricultural support for feedstocks
- R&D support
- Mandates
- Federal and state support

Government support is provided to achieve a number of objectives, not all of them necessarily compatible. These include: increased security of supply, reduced greenhouse gas emission and support for the rural economy. Support is provided at all points along the production supply chain from the production of feedstocks (EU energy aid programme) to final consumption (fuel duty tax incentives). The GSI report estimates that government support for biofuels in OECD countries, Australia, Canada, EU, Switzerland and the US[2], amounted to US$11bn[3] in 2006 and is estimated to be in the range of US$13-15bn in 2007. The magnitude of this support level becomes evident when set along side the percentage biofuels account for of total liquid transport fuels, less than 3% on an energy-equivalent basis[4]. Bioethanol receives twice as much support as biodiesel (more ethanol is produced) and the US provides the most total support followed by the EU.

[1] Economic Advisor Climate Change Economics Division, Defra
[2] These countries account for 95% of biofuel production in OECD countries
[3] All dollar figures are in US$ unless otherwise stated
[4] Biofuels- at what cost? GSI

Support for biofuels in the US was between $5.5 and $7.3bn in 2006. This is between 42 to 49 percent of total OECD support. At these levels biofuels (corn-based ethanol) costs around $500/tCO2e saved. GSI estimate that $500 would have purchased more than 30 tonnes of CO2e on the European Climate Exchange, or nearly 140 tonnes on the Chicago Climate Exchange. It should be noted that the main driver for US support for bioethanol is not GHG reductions but increased security of supply. However, increased security of supply is likely to be achieved more cost-effectively through demand reduction measures.

Given the nature of the support provided (per gallon payments, tax exemptions and tax credits) the level of support expenditure in the US will increase as output increases. The current US target is for biofuel production to be 35 billion gallons. Ethanol production is expected to be around 12.3 billion gallons in 2008 and is expected to absorb around 28% of US project wheat harvest[5].

Support for biofuels in the EU amounted to around €3.7bn in 2006. The majority of this support comes in the form of reduced tax rates (e.g. fuel duty derogation in the UK). As is the case with the US, EU support for biofuels is an expensive way to reduce carbon with costs ranging between €575 ($390)[6] and €800/tCO2e ($543) for bioethanol made from sugar beet and over €600 ($407) for biodiesel made from rapeseed. The cost of biodiesel made from cooking oil is much lower at €215/tCO2e[7]. Again these costs are much higher than the cost of achieving mitigation through purchases of carbon on carbon markets (costs figures are not economic costs but financial costs and thus direct comparison with cost of purchasing carbon on carbon markets is valid).

Value for money of support expenditure in the EU and US is similar for bioethanol but is lower for EU biodiesel, particularly for cooking oil.

Carbon reduction is a primary objective of government support for biofuels in most OECD countries. It has been suggested that biofuels offer a cost-effective means of reducing carbon. However, the GSI study found that the biofuel mitigation costs can be extremely expensive ranging from $150 to over $1500 per tonne of CO2 reduced. This level of expenditure elsewhere in the economy could yield far greater carbon savings. For example by supporting energy efficiency measures or supporting other biomass energy generation technologies (see section 3.2 for further details).

Providing support for biofuels is currently necessary because costs of production are greater than for fossil fuels, although the degree to which this is still true at the current crude price (+$100) is uncertain and will vary by feedstock. In the medium/long-term the need for support should be reduced as production costs fall due to technological advances. The carbon savings should also increase as a result of these advances. However, as recent commodity price movements have shown the cost of biofuel production is not guaranteed to fall unless commodity prices are low and stable. It is expected that price volatility will reduce with the advent of second generation biofuels as feedstock costs are likely to be a much smaller proportion of total costs. To what degree, and when, this is likely is as yet uncertain. The GSI study estimates that the support cost for second generation cellulosic ethanol will need to

[5] Earth Policy Institute (EPI) figures
[6] Dollar figures are based on €1 = $1.47
[7] All figures are from the GSI country studies and may not be calculated on a life-cycle basis.

be in the region of $140 per tonne. More recent work by McKinsey suggests that second generation fuels will become cost-effective post-2020.

The GSI study shows that global biomass support has been the main driver for the marked growth in the production and consumption of biofuel over the past five years. The study also provides an estimate of the total value of this global financial support which it suggests is extremely high given the quantity of biofuels produced and represents poor value for money in terms of carbon savings. The remainder of the paper analyses the level of support given to biofuels in the UK, compares this to support given to other biomass technologies and estimates the value of this support in terms of carbon saved. It does not comment on the relative cost of other renewables which is discussed in a separate paper 'Estimating the Cost-effectiveness of Biofuels' published alongside this paper.

3.0 Support for Biofuels in the UK

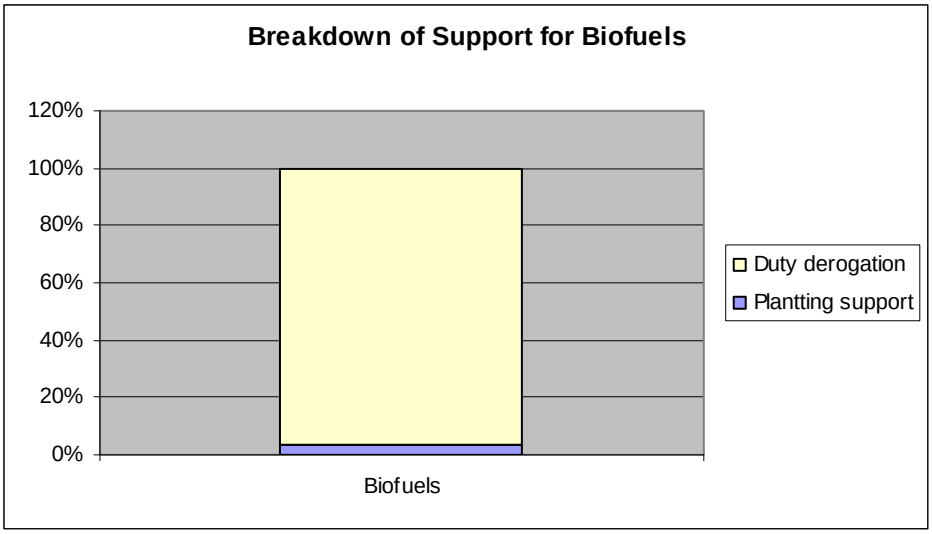
Biofuel production in the UK is supported directly and indirectly through the fuel duty derogation and the energy aid programme. The value of this support is:

- Energy Aid payments[8]- €45 per hectare (not to all feedstocks)
- Fuel Duty derogation- 20ppl from 2002

Energy aid payments are made per hectare of land used to produce energy crops. The fuel duty derogation per litre of fuel sold in the UK and is in effect a consumption subsidy. Going forward, biofuels will be supported by the RTFO which will have a combined duty derogation and buy-out price of 35ppl in 2008/9 and 2009/10. This will fall to 30ppl in 2010/11. Budget 2008 announced that the biofuel duty derogation will be abolished in spring 2010, meaning that the RTFO buy-out price for that year will be 30 ppl. Figure 1 below sets out the proportion of support by scheme type. The figures clearly illustrate the importance of the duty derogation which accounts for over 95% of support received[9]. (Figure 1 does not include the RTFO. Removal of the duty derogation and imposition of a 30ppl buy-out price from spring 2010 will result in the RTFO' being the only support scheme for biofuels. The total level of support will be higher than that assumed in this paper as direct support rises from 20ppl to a maximum of 30ppl).

[8] The Commission proposes abolishing Energy Aid payments as part of the CAP Health-check from 2010.
[9] These estimates and the value for money estimates given later in this section are produced using the BEAT model developed for DEFRA by North Energy Associates.

Figure 1 Proportion of support by scheme type



3.1 Support by biofuel type

UK biodiesel production uses two main feedstocks: waste fats (used oils and tallow) and virgin oils including oil seed rape (OSR) and imported palm oil and soya oil (OSR). Imported oils benefit from just the fuel duty derogation. UK bioethanol production currently uses sugar beet as a feedstock, with future UK bioethanol production likely to use wheat as the pricnipa, feedstock. Sugarcane can also be used as a bioethanol feedstock but this is not expected to be used in UK production.

Table 3 below sets out the level of support provided for biofuels by feedstock and the carbon saved by each fuel type.

Table 3 Support by biofuel feedstocks type

	Life-time support (£m)	Support (£/litre)	GHG savings (kgCO2e/000litre)	GHG[10] savings (%)	Support (£/tCO2e)[11]
OSR	147	0.16	1013	35%	159
Used Oils	131	0.14	3947	137%	36
Sugar Beet	361	0.14	972	57%	147
Wheat	379	0.15	583	34%	257
Average	**£254**	**£0.15**	**1629**	**66%[12]**	**£150**

The analysis shows that support varies from 14ppl to 16ppl. Support is over the lifetime of the biofuel plant and is discounted by the Green Book rate (3.5%). This explains why support per litre is below the 20ppl duty derogation. Energy aid support is between 1 to 2ppl. CO2

[10] The GHG saving estimates are specific to the feedstocks listed and for the particular production process assumed in the BEAT model, as are the outputs provided in the section of the paper.
[11] A lower figure implies better value for money
[12] This figure is calculated for the four biofuel feedstocks assessed here. Consequently, it is likely to be different from an average figure for all biofuels.

savings by feedstock vary due to differing assumptions about production and processing methods, for example, how much energy, direct and indirect, is used in the cultivation, transport and processing of the biofuel. CO2 savings can also vary by power source for the plant and use of co-products. For example, if co-products are used to produce energy then CO2 savings are maximized. DDGS (dried distiller's grain with solubles) which is a bioethanol co-product can be used as animal feed or heat and power generation. If used for energy production the total carbon savings from the production of bioethanol can be more than 100% relative to petrol (assuming DDGS displaces fossil fuels in energy production). In the above analysis the use of by-products as an energy source is not considered.

Biodiesel from waste oils produce the largest GHG savings. This is due to the high methane (CH4) savings that occur as a result of averting these oils from becoming waste. If these savings are removed from the calculation then GHG savings are much lower at 62% (from 137%) and cost of support per tonne of CO2e saved is £81 (up from £36). This is still someway superior to the next most efficient UK biofuel feedstock, sugar beet, which costs £147/tCO2.

Value for money is estimated as support cost per tonne of CO2e saved (total support for biofuel per unit/CO2e savings per unit). A lower figure represents better value for money. The analysis indicates that biodiesel from used oil generates the best value for money at £36/tCO2e. But as indicated above this is mainly due to the high methane savings from diverting the oils from waste. However, even if methane savings are excluded used oils still offer the best value for money of the feedstocks considered.

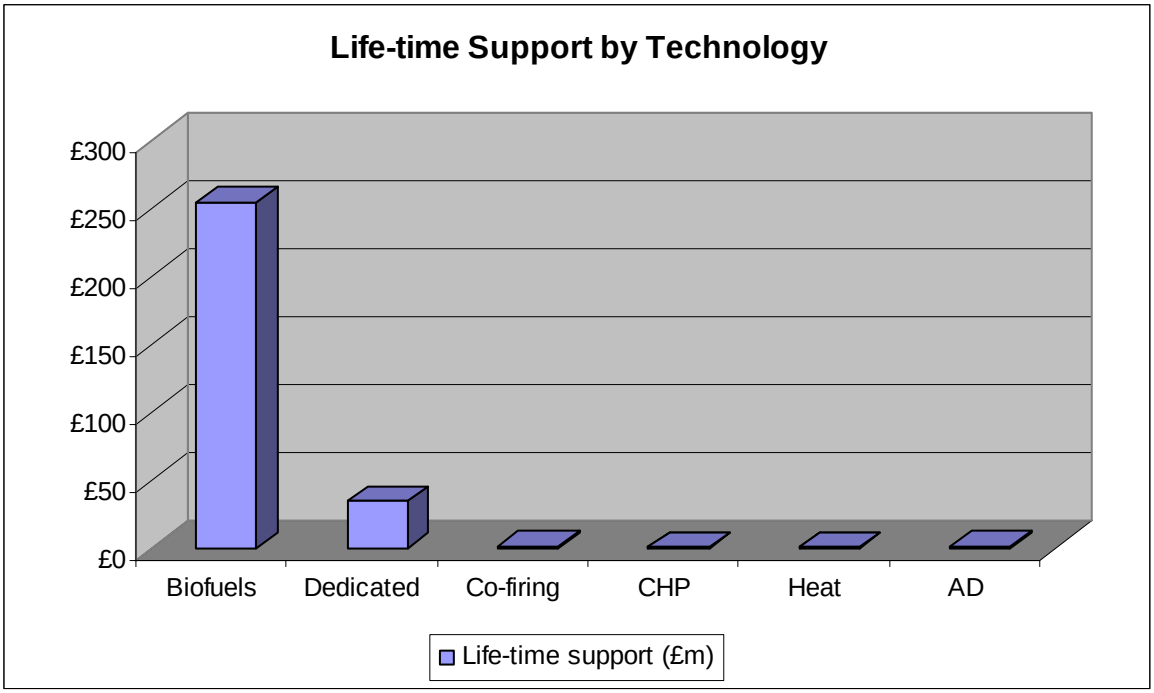
Other than waste oils, sugar beet offers the best value for money at £147/tCO2 followed by OSR at £159/tCO2. Wheat is the least cost-effective and markedly worse than the other feedstocks at £257/tCO2. This is unsurprising given its very low CO2 savings. These outputs are similar to finding from other studies. The analysis does not include bioethanol from sugar cane which would provide better value for money since it has high CO2 savings (87%) and would benefit from the duty derogation only.

3.2 Support relative to other biomass mitigation technologies

The prime motive for supporting biofuels is the potential greenhouse gas (GHG) savings they offer. As the above analysis shows these saving are not uniform across all biofuels. Moreover, GHG savings can also be achieved using other bio-energy technologies such as biomass heat and dedicated power generation. It is therefore useful to compare the performance of biofuels relative to these other biomass technologies.

Analysis of UK biomass support programmes shows that biofuels receive the most total life-time support, receiving more than 7 times the level of support of the next highest technology, dedicated generation. (Total life-time support is the total support per plant over its life-time. For biofuels it will include the total support given to all feedstock used (Energy Aid) and total duty support on production) Figure 2 illustrates the relative levels of life-time support by technology. Since over 95% of biomass support is provided by the 20ppl duty derogation it is this support that causes biofuels to be relatively better supported. Figure 2 clearly illustrates the size of the advantage.

Figure 2 Life-time total support for different biomass technologies (£m)



Although estimating total life-time support by technology is informative it does not provide a complete picture as it does not provide a measure of value for money. The purpose for providing financial support for biomass technologies is that they offer potential carbon savings. Thus, estimating the cost of carbon savings provides a more useful unit for assessing value for money. Figure 3 below illustrates the relative cost per tonne of carbon saved by technology.

Figure 3 Life-time support per tCO2e saved (£/tCO2e) by technology

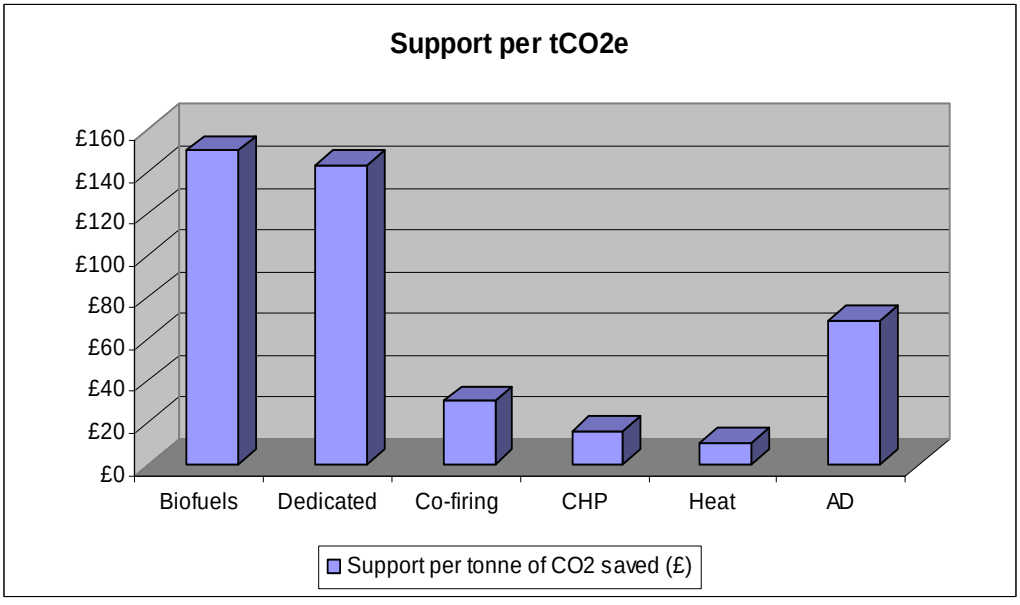


Figure 3 illustrates that of the biomass technologies considered biofuels and dedicated power generation are the least cost-effective means of reducing carbon. They are more than double the cost per tonne than anaerobic digestion (AD) and over six times that of co-firing[13]. This implies that currently most biofuels do not offer very good value for money in terms of carbon saved and in the short-term at least more carbon can be saved from supporting either biomass heat or CHP technologies.

The cost per tonne calculation provide an estimate of the price government (taxpayers) pay per tonne of carbon reduced. New guidance by Defra suggests that this price should generally not be higher than the shadow price of carbon (SPC) which is currently set at £26.5/tCO2e (2008). A higher price may be paid to gain other benefits such as technological development or security of supply. Figure 3 illustrates that in terms of carbon savings support for biofuels generates the lowest value for money at around £150/tCO2e. This is almost six times the SPC. Per pound of expenditure government could achieve better value for money and generate greater carbon savings per £ spent from biomass heat, around 15 times more CO2.

4.0 Conclusion

Global biofuel production and use has increased substantially in recent years due in some part to higher oil prices but predominately due to government support. The prime objective of biofuels support in the UK and other OECD countries is to secure GHG savings. This paper has shown that at both global and UK levels this objective is being achieved although at relatively high costs. **This is not to say that biofuels cannot be used to generate cost-effective carbon saving. They can, but to do so biofuel support needs to be structured to incentivise the maximisation of carbon savings.**

[13] Note that cost here is support cost and not economic cost