Methodology for evaluating economically sustainable biofuel production and use

Blue print and case study from Scotland

Introduction

Drivers of liquid biofuel development

There are several drivers for development of liquid biofuels and these vary in emphasis according to different countries. Drivers relating to the environment have been recognised for some time in countries such as Germany and are likely to become important more widely with the concerns over global warming. Environmental issues impact on not just the use of products which cause fewer greenhouse gas emissions in their production and use, but also relate to sustainability without irreversibly depleting resources. Transport is seen as a particuarly important area, accounting for

Drivers may relate to strategy in particular areas. Issues relating to fuel security with rising fuel prices and supply instability have led to a strategy to increase renewable energy production in a number of countries notably the US. In the EU this is also becoming more important. Strategic drivers may exist as a function of environmental drivers. These frequently relate to international or Government targets, e.g. the Kyoto principles encouraging the reduction in greenhouse gas emissions, UK targets on use of renewable energy.

Support of agriculture has also provided a driver for biofuel development in some countries. Utilisation of conventional crop products for alternative markets can provide a new income stream. This driver has tended to become less important, eg in The Netherlands, 'market pull' from industry is now recognised as a more important driver than 'production push' from agriculture.

Transport biofuels available

Biodiesel
Bioethanol

Current biofuel situation in Europe

Biodiesel
Bioethanol production and development – compared to rest of world

Key issues for development of biofuels

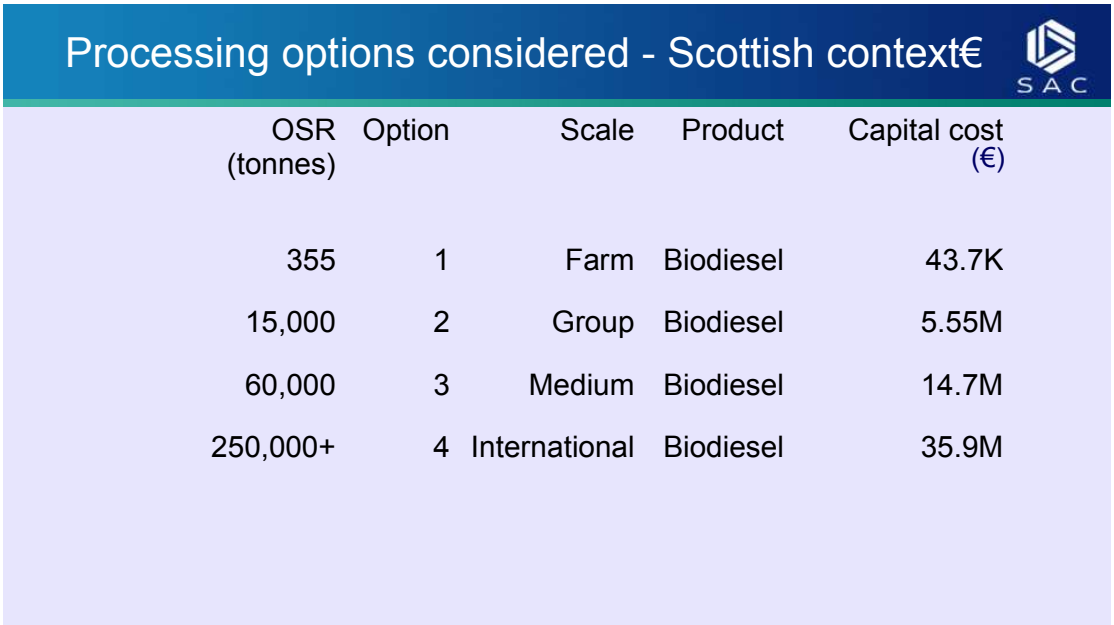
- Feedstock available
- Objectives of country
- Scale
- Support

Case study – The economic feasibility of biofuels in Scotland

Liquid biofuels for transport account for the bulk of current non food crop cultivation in the UK at present, although until now very little crop processing for biofuel has taken place in the UK, with crop products being exported. The introduction of the Renewable Transport Fuel Obligation (RTFO) by the UK government in April 2008 provides a significant driver for the development of the transport biofuel industry in the UK. It sets a target of 5% biofuel as fossil fuel by 2010/11, rising in increments from 2.5% in 2008/09 and 3.75% in 2009/10. These targets are set against present biofuel use of 0.3%, indicating the extent of uptake required. Currently used transport biofuels include bioethanol, which is obtained from starch or sugar sources, and biodiesel, which is derived from oil feedstocks.

Previous studies have considered the potential for development of a facility for biofuel processing for crop products cultivated in Scotland. The limited availability of wheat, the preferred cereal for bioethanol production, and higher trading value in Scotland meant that it does not provide a viable feedstock. The use of barley, Scotland's major cereal, for fuel bioethanol production was considerably less well known and produced lower yields of bioethanol than wheat. These factors, together with the large size of plant and therefore investment required, led to the conclusion that bioethanol production in Scotland was unlikely to be viable (Booth et al., 2005a).

The oilseed rape crop was shown to be was well suited to Scotland as a biodiesel feedstock, with higher average yields than elsewhere in the UK, higher oil contents, due to the northerly latitude and lower concentration of glucosinolates, anti-nutritive factors found in the rapeseed meal after oil extraction. Despite the advantages, no crushing facility exists in Scotland, with all rapeseed being either exported to the Continent or transported south to England for processing. There were clear economies of scale for a large 250 000t plant compared to smaller options, however, if the plant was to be operated on primarily Scottish produced rapeseed, a production scale of 60 000t rapeseed per annum was considered to be the optimum (Booth et al., 2005b). Subsequent developments with operational and proposed UK biodiesel processing plants are discussed by Bell (2008), elsewhere in these proceedings.



OSR (tonnes)	Option	Scale	Product	Capital cost (€)
355	1	Farm	Biodiesel	43.7K
15,000	2	Group	Biodiesel	5.55M
60,000	3	Medium	Biodiesel	14.7M
250,000+	4	International	Biodiesel	35.9M

On-the-road price for 5 biodiesel options (€/litre)

Option	Production cost	Retail margin	Duty	Sub-total	VAT 17.5%	Total cost
1	0.98	0.03	0.41	1.42	0	1.42
2	0.86	0.14	0.41	1.41	0.25	1.66
3	0.65	0.14	0.41	1.20	0.21	1.41
4	0.59	0.14	0.41	1.14	0.20	1.34

Note – mineral diesel at pump – €1.44 (Nov/07)
Note – RTFO buy-out price effect (€0.22 advantage)

Small scale biodiesel production may also be an option for local use. Straight vegetable oil (SVO) production and use as a biofuel is developing in Germany and Ireland and has recently qualified for the 20p/litre fuel duty exemption in the UK enjoyed for biodiesel for a number of year. SVO offers a number of benefits for small scale on farm processing including reduction of safety risks as use of methanol and catalyst required for biodiesel production is avoided, and lower costs of processing as esterification is not required. It is also associated with a number of challenges. Use of SVO at high inclusion rates requires the engine to be modified, unlike biodiesel which can be used in unmodified diesel engine. There are some doubts over the long term performance of engines running on SVO and a need for further monitored trials to verify acceptance.

Costs and returns for biodiesel and SVO were calculated at 3 scales appropriate to the on farm situation (Booth et al., 2007). Costs were calculated to an 'on the road' price taking into account feedstock, capital and operating costs, allowing for income from production of rapeseed meal and adding fuel duty and VAT. At the then, high feedstock cost of rapeseed, (which in March 2007 was £170/tonne), biodiesel could not compete with mineral diesel selling on the fuel forecourt for 90p/l. Although fossil diesel prices have risen since this report was written (to a UK price of close to £1/l in October 2007), rapeseed prices have risen markedly to a value of approximately £244/t (October 2007), meaning that small scale biodiesel will be at a greater price disadvantage to diesel. SVO production was much closer to being competitive, but in many situations with current high costs of rapeseed it too will be uncompetitive.

Small scale (324 t rapeseed) costs of production (€)

Option	Production cost	Retail margin	Duty	Subtotal	VAT	Total
SVO	0.67	0.03	0.40	1.11	0.19	1.30
Biodiesel	0.97	0.03	0.40	1.41	0.25	1.65

Note – mineral diesel at pump – €1.44 (Nov/07)
Note – RTFO buy-out price effect (€0.22 advantage)

The introduction of the RTFO will give an economic benefit to biofuel production, potentially of 15p/l. and there are several other factors which may improve the return of small scale production. The economics of small scale biodiesel and SVO are more favourable in remote areas where diesel and animal feed costs are higher. Use of a renewable, locally produced biofuel may also attract some businesses to support small scale biodiesel. If the farmer is prepared to offset costs of labour and buildings, production costs can be reduced.

Conclusions from Scottish work and implications for other countries

Conclusions - Economic feasibility of biofuels in Scotland

- On the basis of feedstock availability and other factors, bioethanol is currently not appropriate for Scotland
- Biodiesel is more expensive to produce than mineral diesel in Scotland, however with 20p/l fuel duty rebate bigger scales can compete
- Small scale – more expensive, but may suit some circumstances – SVO of interest
- RTFO and the introduction of a buy-out price stimulates the demand for biofuels

Lessons learned - factors to consider

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- Feedstock
  - Which crop is most appropriate?
  - What level of production can be supported?
- Objectives in developing biofuel
- Support offered?
- Processing
  - Economies of scale - big effect
  - Possibility to work in groups (eg joint ventures)?
- Sensitivity to appropriate factors
  - eg utilisation of capacity, feedstock price, value of by-products

References

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