Sustainable Transport Fuels From Local Woodland

A Feasibility Study for East Sussex

CLEANER TRANSPORT FORUM

East Sussex County Council

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National Society for Clean Air and Environmental Protection

This report was researched and written by David Mason with additional material from Tim Brown. NSCA is grateful to the following for comments, input and advice: Peter Billins of British Biogen; Donna Clarke of Greenergy; Malcolm Fergusson of IEEP; Malcolm Watson of UKPIA and Philip Tomalin of East Sussex County Council.

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Executive Summary

The creation of a plant to turn forestry products into industrial alcohol (bioethanol) is technically feasible. Several competing technologies exist although commercial scale plants are not yet operational.

There is sufficient wood resource locally to make a commercial scale plant feasible in East Sussex. The use of bioethanol as a transport fuel produced from local wood will bring local and international environmental benefits by increasing local biodiversity and reducing net carbon emissions of UK road transport.

A key issue will be obtaining planning consent for the construction of a processing plant given the historical difficulty of securing such consents. It is likely that a coastal location such as one of the larger ports, for example Newhaven, Rye or Shoreham, would be most suitable; however, a greater advantage may be had if any plant were constructed on the site of a major refinery such as Fawley or Thurrock. Although feasible, constructing a plant in East Sussex may not be optimal for the UK as lower cost wood feedstock is available in larger quantities in other parts of the UK and Europe. Any decision on location will involve a trade-off between feedstock costs and transport costs for the bioethanol/blended fuel. It has not been possible in this study to complete an evaluation of the best location in the UK for such a plant.

To secure any price premium which is likely to be necessary to make the project viable it must come with strong, demonstrable environmental credentials which are likely to include endorsement by, or the active participation of, environmental groups and a feedstock accreditation scheme.

Considerable further work is necessary in developing a prospective project so that many of the assumptions and estimates concerning financial viability can be fully investigated. A regional development perspective will be helpful.

The most appropriate next step is to investigate the formation of a specialist project development vehicle led by an experienced project developer but backed by a consortium of technical, social and institutional skills.

Introduction

There has been an upsurge in interest in using biofuels for transport, for a number of reasons.

- The UK transport sector is particularly dependent on oil. With reserves increasingly concentrated in politically volatile areas, diversifying into renewable alternatives makes strategic sense
- An EU Directive on biofuels has set indicative levels of biofuel to be blended in petrol and diesel. The UK Government has to decide how to respond to the requirements of the Directive, and was expected to consult on the issue in Spring 2004
- From an environmental perspective, transport biofuels offer the prospect of lower carbon emissions on a well-to-wheel (lifecycle assessment) basis
- Many local authorities, agricultural interests and rural communities are keen on the potential for biofuels to help sustain local rural economies
- Motorists can already buy blended biodiesel and biopetrol in some parts of the UK. These products are being promoted as environmentally superior to regular petrol and diesel.

The overall environmental benefits of devoting large tracts of countryside to growing oilseeds for biodiesel, or wheat, beet or woody crops (such as short rotation coppice willow and *Miscanthus*) for bioethanol are open to question. Beyond emissions benefits, there are questions of the impact from pesticide use, soil compaction, landscape, and biodiversity. However, there is a reasonable possibility that well-managed local woodland could be used effectively to produce a liquid fuel for transport.

The broader energy policy questions are equally complex. From a climate change perspective, it might save more carbon to burn biomass in power stations, than to turn it into liquid fuels. A recent report *Fuelling Road Transport: Implications for Energy Policy*[1] for the Department for Transport suggests that there are carbon benefits from using biodiesel and bioethanol from annual crop production to substitute for oil-derived fuels. However, using woody biomass for energy could give more significant carbon benefits. The authors suggest that 25% of UK agricultural land planted with indigenous wood crops converted to methanol, ethanol or hydrogen could in the long term satisfy most, or even all, UK road transport fuel demand. A more likely scenario is that biofuel will be imported, but that there will be some locally-grown contribution to the UK energy mix.

A recent report[2] by the House of Commons Environment, Food and Rural Affairs Committee has described Government policy on biofuels as "muddled and unfocused". It concludes that Defra needs to clarify the goals of biofuels policy, noting that increasing the tax breaks currently given to biofuels might have the effect of encouraging biofuel imports, rather than stimulating local production.

The East Sussex Perspective

The central idea of producing sustainable transport fuels locally in East Sussex is to restart the management of some of the currently unmanaged woodland; this would bring rural development and biodiversity benefits along with reduced carbon emissions from local road transport. Forestry products would be processed into industrial alcohol (bioethanol) which can be blended with petrol and used within the current car fleet. As any fuel based on forestry operations is renewable there are also benefits in terms of reducing net carbon emissions from road transport; it would also bring real environmental, economic and social benefits to the area if it proves to be successful. No such plant currently exists in the UK so there is the possibility of "first mover" advantage and the creation of high tech jobs and new industries locally which could serve other plants built in the UK. Recent calculations[3] by the Defra Central Science Laboratory suggest that 5.5 farming jobs are created for each 1000 tonnes of bioethanol produced, and a further 66-83 jobs created by a 100,000 tonne bioethanol plant.

There is considerable international experience with alcohol-based fuels in spark ignition engines. Brazil has long had a transport fuel industry utilising industrial alcohol and developing markets now exist in Europe, USA and Australasia. Most if not all cars produced

1 Eyre, N, Fergusson, M. & Mills, R. (2002). *Fuelling road transport: Implications for energy policy*. Report for the Department for Transport. Copies of this publication are available at: www.nsca.org.uk

2 House of Commons Environment, Food and Rural Affairs Committee *Biofuels* (2003)

3 House of Commons Environment, Food and Rural Affairs Committee *Biofuels: Government Reply to Committee's Report* (2004).

by large-scale car manufacturers and used on the roads of the UK can run on petrol with low blends of industrial alcohol without it affecting their warranties. The term bioethanol is widely used to describe industrial alcohol manufactured from biomass crops. Bioethanol is traded widely internationally although the feedstock is usually rapeseed, sugar beet or similar crops. A wider discussion on the various production routes for bioethanol is included in the paper *Fuelling Road Transport: Implications for Energy Policy*, noted above. This paper is intended to move forward the debate started in that report and will not go over the issues identified there in any detail.

Large areas of East Sussex woodland have dropped out of commercial management as there are no longer economically viable local markets for the products of forestry. Sustainably managed woodlands generally have a stronger and more diverse biodiversity and so are more "environmentally friendly". There is an assumption in this study that creating a new market for forestry products will bring local woodland back into active management. It is entirely possible that this assumption is incorrect and alternative feedstocks will be utilised instead. This is an issue that could perhaps be handled in any contract structure. Some areas of northern and western UK already produce considerable amounts of softwood, and are alert to the possibilities of biofuel production[4]. Low transport costs may justify the long-distance transportation (and indeed importation) of biomass for processing in areas where demand is highest, or close to existing refinery capacity.

Although technology choice will be a difficult issue there are several technologies and their derivatives which are likely to be successful, and the most significant issue will be one of establishing an acceptable site and gaining planning consent for any development. The renewable energy industry in southern England has a history of many very good project proposals which have failed to gain planning consent for a variety of reasons. Therefore gaining planning approval is a potential obstacle for the project. This project will rely on public approval to secure any price premium for its product and any disputed planning application might well jeopardise that approval. Wider support from environmental opinion formers might be required. Recently a number of developers have become disillusioned about the prospects of achieving planning consent and so are reluctant to invest time and effort in projects that appear more speculative. This may make the formation of a project development vehicle more problematic.

The East of England Development Agency has completed a detailed study into the benefits of bioethanol and estimated that, if produced using agricultural crops, the cost was likely to be in the range of 43p per litre. Defra commissioned this work and there is a politically powerful lobby group promoting the production of bioethanol from agricultural crops.

Technology Issues

Alcohol can easily be used as a fuel in spark ignition engines as a blend with petrol. Brazil has considerable experience of an 85% alcohol blend, E85. For blends greater than 10-20% alcohol, engine modifications are necessary. However, modern cars should be able to utilise a 10% blend with no significant problems. The introduction of new fuels to a market will only be successful if they are not accompanied by technical problems with the vehicle fleet that can be ascribed to the new fuel. It is therefore more prudent to utilise a 5% blend which would fall inside the current specification for standard petrol and most volume manufacturers accept the use of such a blend will not invalidate their warranties. It may be possible to increase blend rates as technical and customer experience is gained.

There are a range of ways to produce industrial alcohol from agricultural and forestry crops. All have advantages and disadvantages and the decision on which technology to adopt in a particular location, and which feedstock to use, may well vary with location and market conditions. The two main ways currently being proposed to convert forestry residues into industrial alcohol are:

- lignocellulosic / enzyme-based system
- gasification of the wood to SYNGAS, then catalytic conversion to bioethanol using the Fisher-Tropsch process.

There are also processes using pyrolysis but these appear to be at a more experimental stage. Neither technology has been successfully demonstrated in their entirety on a commercial scale. There are examples of similar uses around the world; gasification of coal and catalytic conversion to transport fuels has been demonstrated with some success in

4 See for instance *Woodfuel Opportunities – renewable energy for Scotland.* Scottish Forest Industries Cluster, (2002). www.forestryscotland.com

South Africa; gasification of willow was the technology used at ARBRE but there the SYNGAS was used to feed gas turbines, and the plant did suffer some technical difficulties. As with most emerging technology areas, where competing technologies exist opinions vary as to which one will ultimately become more effective. Opinions also vary as to the practical timescales for commercial operation of an enzyme-based plant, the most bullish suggesting that it will be practical within the next 5 years. The cost of enzyme production is also an area for debate as they have yet to be produced at a commercial cost. There is some dispute about the feedstock flexibility of an enzyme-based plant. Some of the proponents of the competing technologies suggest that different varieties of wood – i.e. willow and poplar – with their different levels of lignin cannot be handled by a lignocellulosic plant at the same time as they require a slightly different make up of enzymes. Although this is not a universally held view, if true, it might present a problem for a plant relying on wood from a number of sources by limiting it to using wood from monoculture plantations. Most woodland in East Sussex contains a mixture of tree types and so without expensive sorting of wood prior to use could not be used by a plant that cannot accept this flexibility.

Extending the size of monoculture woodland plantations in East Sussex is unlikely to be welcomed by environmental campaigners as they restrict rather than enhance local biodiversity and significantly modify the landscape. The proponents of gasification technologies claim that they can successfully handle the biomass fractions of the commercial and domestic waste streams. This would require careful sorting if it were to be utilised although it would also bring sizeable feedstock cost reductions. Using parts of the waste streams may introduce complications in the tax regime for the plant and also, given public hostility to the incineration of waste, raise significant public objections to such a plant.

Details of emissions from a plant are not clear yet. However, both technology options require heat. The obvious practical option will be to produce this heat through burning wood or bioethanol on-site, which will require a chimney. The plant would be a sizeable development requiring a chimney and large wood storage warehouses plus some on-site tankage. A gasification plant requires large quantities of heat to drive the gasifier and is likely to have spare heat, which could be used to generate electricity or provide heat for a district heating scheme. The likelihood is that both routes would be followed.

A gasification plant would use about 8% of the feedstock to generate the heat required for the process. A lignocellulosic process would also require heat for processing the wood and a range of chemicals to condition the wood and to produce the enzymes on-site. There will also be a need for cooling on a small scale so some form of cooling tower is likely but not certain. Current expectations are that there will not be any dangerous or unpleasant solid or liquid wastes produced by either technology option. The major emissions likely to cause a problem will be from traffic movements delivering wood feedstock and taking away the bioethanol product. The gasification route appears to offer a slightly lower technology risk and greater feedstock flexibility.

One of the main benefits of developing new technologies in emerging markets is that the first plants often serve as proving or demonstration plants and then an industry develops once the technology has been shown to be successful and that the market exists. Demonstration plants have to be sufficiently large to work on a commercial scale yet small enough to be viable as a more speculative venture whilst the inevitable technology problems are ironed out. It appears likely that a plant producing something like 1 to 2 million litres p.a. of industrial bioethanol is the smallest viable plant to prove a technology[5]. Cars in the UK currently burn about 21 million tonnes p.a. of petrol and therefore a plant producing 1 million litres p.a. of bioethanol if blended at 5% with petrol would produce something like 0.07% of total UK petrol demand. Selling that quantity of petrol is not a trivial task.

Location

The main issues driving location are: feedstock and product transport, public acceptability, security and proximity to market. It is very unlikely that a plant producing a product marketed as providing environmental benefits and supplying a local market could maintain credibility unless widely accepted by its host community. Therefore development on a rural greenfield site is unlikely to be successful given the history of failed planning applications for renewable energy schemes in the region. The design of the plant and any consent strategy

5 This equates to about 50 000 to 100 000 tonnes p.a. of wood or about 1 to 2 times the size of the recently failed flagship ARBRE plant at Selby in Yorkshire which generated electricity from the gasification of short rotation coppice willow. Plants utilising this level of wood would likely inject between £1m and £2m p.a. into the local forestry industry.

must be carefully designed to enable local residents to feel included in the process.

In East Sussex this suggests a location in one of the ports i.e. Newhaven or Rye, although Shoreham (just outside East Sussex) might also be a possibility. All these locations are reasonably served by trunk roads with the back-up of sea deliveries. Ports also need to have tankage and Customs and Excise infrastructure, and to provide a secure perimeter.

However, it is probable that considerable economies would be gained by building any significant plant at a refinery site such as Thurrock or Fawley due to the proximity of the petrol feedstock and handling skills for blending.

Cost

Precise costings are difficult to estimate accurately at the moment without a detailed project specification. Also much of the technology is proprietary, therefore cost estimates are not available. However, it is estimated that a plant requiring 50 000 tonnes p.a. of wood feedstock would cost of the order of £10m. The cost of any land for the plant could be a sizeable cost element but without a confirmed site it is difficult to estimate. Most trade estimates put bioethanol produced from wood feedstocks in the range of 40 pence per litre although these appear more guesses than estimates. This compares with current pre-duty prices for petrol of about 16 to 18 pence per litre.

The duty exemption, the scale of duty on road fuels and the low blending rate combined mean that the final price of a bioethanol petrol blend is relatively insensitive to bioethanol cost. For example even if the delivered cost of bioethanol was 60 pence per litre it would mean that the forecourt cost of blended fuel would only be 1.25 pence per litre higher than for standard petrol. If bioethanol cost 35 pence per litre to produce there would be effectively no difference in the cost of blended and standard petrol. Greenergy are marketing their Global Diesel (a 5% blend of Rapeseed Methyl Ester made from rape seeds crushed and processed by Novaol at Verdun in France) at a 1 pence per litre premium; it is currently on sale at: Sainsbury's garage – Greenwich, SE London, Tesco garage – Hatfield, Hertfordshire, and Holbrook garage – Stroud, Gloucestershire.

Supermarkets see biofuels as a useful marketing tool to differentiate their fuel sales and to counter criticism of the sometimes long-distance air freight involved in importing some of the foodstuffs. Greenergy have also announced that they will launch a Global Petrol later this year but have not finalised how they will do this. Their bioethanol will be imported, something that is relatively easy to do given that it is an internationally traded commodity.

Accreditation

Any project trading on an environmental benefit must be able to demonstrate this benefit to exacting standards and therefore the project must be accredited and audited.

The use of a renewable biomass crop to displace mineral fuels obviously brings with it a cut in greenhouse gas emissions in the sector being considered. However, it will be necessary to show an overall environmental benefit when compared to the current baseline case. This is generally referred to as additionality – it is something that will have to be demonstrated to differentiate the fuel in the retail market. For instance will harvesting and converting the wood cause increased use of fertilisers in forestry, and are there environmental benefits in leaving the wood to rot in the forest?

There will need to be a thorough analysis of the environmental benefits of the project; this will need to consider issues such as the fact that the UK is a net exporter of petrol (the design of UK refineries means that the volumes of diesel required for the UK market causes excess petrol to be produced) and any use of bioethanol to displace petrol from the retail market will cause an increase in these exports which mainly go to the USA. It may also be necessary to purchase some carbon offsets to ensure a consistent and auditable carbon emissions benefit for the fuel.

The project is likely to gain more environmental credit if the wood used can be shown to have come from a local sustainable source; it may be necessary to involve organisations such as the Forestry Stewardship Council to certify the wood feedstock.

Taxation

This plant is going to produce something very similar to neat vodka in large quantities. It will be necessary to solve the associated taxation issues but this should be possible through negotiation with Customs and Excise. The alcohol can be simply denatured by the addition of small quantities of petroleum. It is likely that the most acceptable solution would

be for an initial plant to be located very close to an established Customs and Excise installation within a secure perimeter so that they can be confident that the alcohol is not used for anything other than road transport fuel.

It is very unlikely that a demonstration/small commercial scale plant will have sufficient economies of scale to be able to compete with non-renewable road transport fuels on price alone, and it will be necessary that some form of tax break for a bioethanol blend fuel be maintained. Such a tax break is to be introduced soon but, as for all taxation concessions, for how long is unknown. HM Treasury announced in the 2003 Budget that it was examining giving additional tax breaks to processes producing renewable fuels using wood as a feedstock but no commitments were made as to their introduction.

Next Steps

The next steps for this project involve developing a specific project whose detail can be tested for feasibility. There is considerable interest in a range of companies and organisations but the level of commitment will only be shown when a project proposal is on the table. The most appropriate mechanism for project development is likely to be the formation of a stand-alone development company which can develop and manage the operation of the project. Whilst a project on an East Sussex scale may be feasible, the issues identified above suggest that a project on a regional scale may prove more viable. It may therefore be sensible for the Regional Development Agency (SEEDA) to consider the options in more detail.

It is likely that a development company will be a consortium of companies and organisations which bring the following skills:

- Established project development company which has a track record of bringing to completion renewable energy projects and emerging renewable technologies
- Fuel supply chain management company, preferably with experience of handling a large number of varied fuel suppliers and operating on the open market, not just with long term fixed contracts[6]
- Oil company with skills and experience in refining and retail marketing
- Local authorities for credibility and smoothing the way on planning issues
- Regional Development Agency to maximise opportunities for strategic planning; and
- Environmental and/or campaigning organisation for credibility, accreditation and linking to the local community.

The use of an environmental or campaigning organisation must be central to the way the project is developed if it is to be successful otherwise there is a danger that credibility will be lost.

This paper is based on the assumption that there will be a market for a bioethanol blend petrol which delivers real environmental benefits. However, there is no evidence to show the scale of the potential market. Greenergy have been successful with their Global Diesel but any feasibility study must research the potential market.

Conclusions

A plant utilising local wood to manufacture bioethanol for use as a road transport fuel in East Sussex is practical. Competing process technologies exist but have yet to be proved at a commercial scale. Although technology choice will be important it is likely that both main technologies will prove to be workable, but the costs of doing so are uncertain not least because the technologies are mostly proprietary and information is very difficult to secure.

There are a number of issues that have to be overcome to realise such a project:

- Developing a project will need the support of a cross section of government, business and the general public A key issue is likely to be obtaining planning consent for a processing facility
- The process needs to be developed in such a way that Customs and Excise are satisfied that all the alcohol produced goes to producing road fuel and is not used for human consumption
- A suitable site needs to be identified and local support developed in a way that assists in obtaining planning consent

6 One of the main risks to the project will be the fuel supply. Failures in the fuel supply route was one of the main reasons why the ARBRE project failed.

- A contract structure needs to be developed such that accredited feedstocks are used and any carbon benefits are accredited and audited; and

- To take any project forward a project development team should be established which can select a site and carry out a detailed feasibility study.

Some wider policy questions must also be resolved:

- How important is using East Sussex timber to the consumer, especially compared with other perceived environmentally friendly options?

- If the cost can be reduced by importing bioethanol or by making it from the waste stream why make it from timber?

- Could local timber be used with equal environmental benefits in providing direct heat?

Developing a wood to industrial alcohol facility in East Sussex may be practical but is likely to be less than optimal as wood yields are not as high as in plantations in other parts of the UK and the rest of Europe. However, transport costs for wood and petrol can be high and developing a plant close to its potential market may make it economic provided that a sensible scale of plant is developed. The exact costs of transport and storage for petrol are unclear at this stage and are likely to remain so unless a site and transport routes are identified. For a plant using domestic feedstock it is unlikely that significant competitive advantages would arise from other locations in the south east corner of England. It is believed that transport costs for bioethanol/petrol would make a plant producing bioethanol in Scotland for consumption in South East England uneconomic but this has not been demonstrated conclusively. The use of imported bioethanol or feedstock may alter that balance but would erode one of the product differentiators, that the project is locally based to serve a local market. Clearly a more detailed regional strategic perspective would help to resolve some of these issues.

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