Peer Review of REA Biofuel Scenario Modeling

A report from Imperial College, LCA[works], September 2009

1. EXECUTIVE SUMMARY

The UK Renewable Energy Association (REA) has requested Imperial College London, LCA[works], to carry out a peer review of biofuel supply and demand scenario modeling as presented in REA's recent position paper on the UK's implementation of the renewable energy directive (RED) and fuel quality directive (FQD). The table below summarizes the results of a comparison between the REA results and the peer review results for EU27 supply and demand:

EU		Demand in 2020	Domestic Supply Potential in 2020 (includes 2004 – 06 base year biofuel use)	Potential Domestic Surplus
	Gasoline/ Ethanol (expressed in fuel volumetric units)	REA Report: 28.5 bn litres = 22.6 Mt/yr Peer Review: Hi diesel (1):24.4 bn litres = 19.4 Mt/yr Lo diesel: 28.2 bn litres = 22.4 Mt/yr	REA Report: 37.0 bn litres = 29.4 Mt/yr REA Corrected (2): 48.0 bn litres = 38.1 Mt Peer Review: 42.7 bn litres = 33.9 Mt	REA Report: 8.6 bn litres = 6.8 Mt/yr REA Corrected (2): 19.5 bn litres = 15.5 Mt/yr Peer Review: 14.5 to 18.3 bn litres = 11.5 to 14.5Mt
	Diesel/ Biodiesel (expressed in fuel volumetric units)	REA Report: 27.1 bn litres = 24.1 Mt/yr Peer Review: Hi diesel:29.6 bn litres = 26.1 Mt/yr Lo diesel: 26.8 bn litres = 23.6 Mt	REA Report: 11.5 bn litres = 10.2 Mt/yr Peer Review: 8.8 bn litres = 7.8 Mt	REA Report: -15.6 bn litres = -13.9Mt/yr Peer Review: -18.0 to -20.8 bn litres = -18.3 to -15.8 Mt
	Total Domestic Biofuel Potential (expressed in energy equivalent units)	REA Report: 35.9 Mtoe/yr Peer Review: Hi diesel 35.6 Mtoe/yr Lo diesel: 35.6 Mtoe/yr	REA Report: 27.8 Mtoe/yr REA Corrected (2): 33.5 Mtoe/yr Peer Review: 28.6 Mtoe/yr	REA Report: -8.1 Mtoe/yr REA Corrected (2): -2.4 Mtoe/yr Peer Review: Hi diesel -7.0 Mtoe/yr Lo diesel: -7.0 Mtoe/yr

(1) The peer review team modeled a "Hi Diesel" case for EU gasoline and diesel demand. The "Hi Diesel" case is based upon the gasoline/diesel split forecast by PRIMES for 2020, whilst the "Lo Diesel" case is based upon the current EU gasoline/diesel split. The REA model uses the same input data as the "Lo diesel" case.

(2) The value which the REA analysis would have produced had the results from the excel spreadsheet been reported correctly in the REA report.

The only significant differences between the REA modeling and the peer review analysis are:

- The peer review ethanol potential for the EU27 is significantly higher than the REA modeling as reported in the REA report, due to the REA making an error of transcription between the excel spreadsheet model and the report
- The peer review ethanol potential is significantly lower than the "corrected" REA figure, due to two factors:
    - The REA model introduced errors by using the difference between EU27 current cereal production and non-fuel consumption as an input to the calculation, when these figures had originated from different sources.
    - The peer review team recommends using lower yields for cereal production on reintroduced set-aside land
- The peer review biodiesel potential is significantly lower than the REA modeling, due to the REA work significantly under estimating vegetable oil demand in the EU27 by 2020 for non-fuel uses.

Both the REA model and the Peer Review work assume that potential domestic biofuel volumes are based upon a combination of: yield increases of between 1.5 – 2% per year; reintroduction of 7.18 Mha of set aside land; displacement of existing animal feed by DDGS and seedcake which are by-products of biofuel production. Both sets of modeling also assume that domestic non-fuel uses of cereals and oilseeds increase in line with exogenous forecasts and that trade balances are as forecast by external sources. The results shown above are therefore an expression of potential if all these factors are included up to the potential. Therefore, in order to realize the potentials shown above, it will be critical that policies are in place to drive these changes to occur.

If this can be realized, then the EU27 has the potential to more than fulfill its ethanol demand to 2020 from domestic production. It is also clear that in order to fulfill its biodiesel demand in 2020, virtually all of that will need to be imported, unless significant progress can be made by 2020 in advanced biodiesel from other feedstocks, such as lignocellulosics and algae (see comments below). Although FT biodiesel (from gasification of biomass followed by Fischer Tropsch conversion) is likely to be in commercial production by 2020, given the technological challenges which remain and the relatively high costs involved, it is unlikely that it will fulfill the majority of the EU27's biodiesel needs by then and so the EU27 will still need to import the majority of its biodiesel by 2020.

Overall, if biofuel could be implemented up to the maximum domestic supply potential (plus existing imports), for each of ethanol and biodiesel (ie., if the vehicle fleet didn't impose any restrictions), then the EU27 would be around 7 Mtoe (million tonnes oil equivalent) short of biofuel.

The REA modeling does not explore the potential of global oilseed and other vegetable oil production to satisfy this potential demand, however, the peer review has explored this potential and finds that there is potentially adequate vegetable oil supply globally in 2020 from projected increases in supply compared with today, however once projected non-fuel demand increases have been taken into

account, there will be very little surplus available for use as biodiesel feedstock. The actual amount of vegetable oil which will be imported into the EU27 as biofuel feedstock will therefore be a function of market forces, with the biofuel sector competing with other sectors for the vegetable oil.

Given the potential of Brazil to produce an ethanol surplus of around 15.7 bn litres by 2020, some of which could be imported into Europe, it would make most sense to explore options for meeting a greater fraction of the EU27 biofuel target either through the gasoline pool, rather than the diesel pool or though e-diesel (ethanol-diesel) as tested in the Bio-ethanol for Sustainable Transport (BEST) project.

The supply and demand situation has also been modeled for the UK. The table below summarizes the results of a comparison between the REA results and the peer review results for UK supply and demand:

UK		Demand in 2020	Domestic Supply Potential in 2020 (includes 2004 – 06 base year biofuel use)	Potential Domestic Surplus
	Gasoline/ Ethanol	REA report: 3.2 – 3.6 bn litres = 2.5 – 2.8 Mt/yr Peer Review: 3.6 – 4.0 bn litres = 2.9 – 3.2 Mt/yr	REA report: 3.0 bn litres = 2.38 Mt/yr Peer Review: 2.9 bn litres = 2.34 Mt	REA Model: -0.2 to - 0.6 bn litres Peer Review: -0.7 to -1.1 bn litres
	Diesel/ Biodiesel	REA model: 2.8 – 3.1 bn litres = 2.5 – 2.8 Mt/yr Peer Review: 2.85 – 3.05 bn litres = 2.5 – 2.8 Mt	REA model: 0.58 bn litres = 0.51 Mt/yr + 1 bn litres existing use Peer Review: 0.53 bn litres = 0.47 Mt + 1 bn litres existing use	REA model: -1.22 to -1.52 bn litres = -1.07 to -1.34Mt/yr Peer Review: -1.32 to -1.52 bn litres = -1.17 to -1.34Mt/yr

As with the EU27, given the potential for domestic supply of ethanol, the likely competition for vegetable oil and of Brazilian ethanol production, it would make most sense to explore options for meeting a greater fraction of the UK biofuel target through the gasoline pool, rather than the diesel pool and / or look seriously at the alternative feedstocks / technologies for biodiesel supply.

The REA model does not attempt to model the potential contribution to either ethanol or biodiesel from advanced biofuels (ie., biofuels manufactured from lignocellulosic feedstocks) or from alternative feedstocks (eg., algae). Within the time available (11 years) it is unlikely that algae as an alternative feedstock will provide a significant contribution given its current early stage of technological development, but must be considered a strong option for the longer term.

Biodiesel from lignocellulosic feedstocks, using gasification and fischer-tropsch (FT biodiesel) is a more realistic option within the 2020 timescale. Although costs per litre for FT biodiesel are likely to be much higher, even by 2020 than conventional biodiesel, there are strong indications that EU policy will support its development to commercial scale by 2020. Significant technical issues still remain to be addressed however and it is very unlikely that this option will contribute the majority of the EU27

biodiesel demand by 2020, evidenced by the fact that even in the IEA Energy Technology Perspectives "Blue MAP" scenario, FT biodiesel contributes less than 10% to global biofuel supply.

Ethanol from lignocellulosic feedstocks, via enzymatic breakdown and fermentation is likely to be commercial at large scale within the 2020 timeframe. Although this technology is not modeled in detail by the REA work, it is likely that by 2020 LC ethanol will begin to make a material contribution to the EU27 ethanol supply, further strengthening the case for exploring options to deliver a larger fraction of the 2020 target through ethanol, rather than biodiesel.