***tce* is published monthly by the Institution of Chemical Engineers**
Editorial: claudia@icheme.org
Subscriptions: jcressey@icheme.org
Advertising: nigel.stephens@mainlinemedia.co.uk
www.tcetoday.com

Biofuels

ADDRESSING the twin challenges of energy security and climate change has been a key concern for the EU in the last two years. Transport, the main destination for EU oil imports, was accounting for almost a quarter of greenhouse gas emissions (GHG) and this proportion was rising remorselessly. To curb emissions and lessen the risk of political and economic stability posed by the reliance on imported oil, the EU needed a 'drop in' alternative that could substitute in the existing transport fleet using existing fuel distribution. Ideally, it should be produced within the EU from existing agricultural surpluses and waste and by-products.

Biofuels appeared to be the elegant solution to these twin problems. However, early biofuel projects, such as Brazil's sugarcane ethanol programme and the corn ethanol programme in the US, were mainly driven by energy security and economical concerns, not climate change.

Nor was much consideration given to the impact on food supply, or the impact of land use change, such as ploughing up rainforests or carbon rich land, on CO_2 emissions.

It is now all too clear that, for biofuels to play a valuable role going forward, the whole system for their production and use must meet criteria about GHG saving, food production and direct and indirect land use change. This, coupled with sustainable economics, should determine the policy and approach to biofuels and, more generally, the decarbonisation of transport. Other approaches, such as electric/hybrid and hydrogen-powered cars could also make a contribution, particularly when power supply has been fully decarbonised (see also p42).

There is much opportunity to improve the impact of existing biofuels, through system integration incorporating plant varieties, co-product protein concentrates to strengthen the food chain, energy integration, including CHP and the use of the residual straw. This is particularly valid for the production of ethanol using temperate cereal crops. At present, biodiesel faces a greater challenge in meeting the criteria due to the tight global supply of vegetable oils and the high proportion of the additional oil required grown on carbon rich land.

Considerable funding (mostly from taxpayers!) is being applied to so-called "second generation" technologies. Some involve new molecules eg biobutanol and dimethylformamide (DMF) – the challenge being integration into existing supply chains. Many revolve around cellulosic materials, eg wood, short rotation oppice (SRC), miscanthus, switch grass, straw, etc. On these, the challenge is both technological and economic. One route is to break up the cellulose with some of or a combination of heat, acid, thermophilic enzymes and then to ferment the resultant C5 and C6 sugars to ethanol. The alternative approach is to reform to synthesis gas for Fischer Tropsch-type conversion to liquids. These technologies are extremely challenging, logistically demanding and very capital intensive and unlikely to be widely deployed at scale within the next decade. Analysis suggests that these materials will make a more immediate and greater GHG and economic impact in heat and power generation. More recently, a number of projects have looked at algae as a source of biofuels. It is not yet clear whether this process can be economically intensified. Clearly, there is a great opportunity to utilise waste materials such as spent cooking oils, waste food and compostable materials, which can make an early and worthwhile, if minor, contribution. Finally, there is a prospect of new crops which can grow on arid and infertile land. Jatropha (pictured) is one such crop for biodiesel. This agronomic, technological and business model is presently being tested in Africa and India. All of these putative alternative approaches need to be tested against the same criteria as existing biofuels.

In summary, we need a broad range of approaches to decarbonising transport – within which biofuels should play an early and significant role. Good biofuels need to be differentiated in terms of those with high levels of GHG saving, optimising the use of land for our food, fuel and energy needs and minimising the cost of net GHG savings. In making choices, it is critical to be technology neutral and to study and optimise the whole system and envelope – an approach which is at the heart of chemical engineering.

Rob Margetts, chairman of the Energy Technologies Institute, UK

feedback

"Tony Bridgwater, leader of the bioenergy research group at Aston University, UK, says: "Insufficient attention has been paid to the food *vs* fuel debate, which is really about how land is used. There is also an implicit but unsubstantiated view that biological routes are preferable to thermal routes."

Shell's Greg Lewin points out that lignocellulosic fuels have made great progress but commercial and technical hurdles remain. "It will be 5–10 years before significant commercial volumes will be available," he says.

Algae have great potential as a sustainable diesel feedstock; they grow rapidly, are rich in vegetable oil and can be cultivated in ponds of seawater, minimising the use of fertile land and fresh water.

"Algae can double their mass several times a day and produce at least 15 times more oil per hectare than alternatives such as rape, palm soya or jatropha," Lewin says. "Over the long term, algae could absorb waste CO_2 directly from industrial facilities such as power plants."

He adds that companies developing biofuels "face the challenge that next-generation biofuels are expensive and it may be difficult to convince people to pay for their key environmental benefit of CO_2 reduction.""