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Bioenergy: Sorting The Chaff From The Wheat

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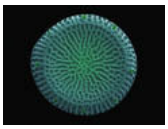

Despite controversy, Dr Robert Trezona, Head of Research and Development at the Carbon Trust, says bioenergy has a vital role to play

Bioenergy refers to energy that comes from biomass. Biomass is a renewable energy source from biologically derived sources such as wood, plant material, straw, sewage sludge or even algae. It offers a sustainable source of energy with significantly lower carbon emissions than fossil fuels, since growing biomass absorbs carbon dioxide from the air. Biomass can also help reduce emissions of other greenhouse gases, particularly methane, by diverting organic waste from landfill. Understandably, there is a lot of research and development currently taking place into the production and potential of bioenergy as a fuel and energy source that could take over from the traditional fossil fuels such as oil and gas.

Carbon emissions from transport are growing more quickly than other sectors and already make up about a quarter of the total emissions in the UK. In aviation, there is little alternative to liquid carbon-based fuels and biofuels are likely to be the only credible alternative to fossil fuels for the foreseeable future. With the UK using 40 million tonnes of fossil oil for transport fuels per year and heating accounting for almost half of UK carbon emissions, bioenergy in its various forms could provide a low carbon alternative to running our cars, planes, commercial vehicles, homes and offices.

However, biofuels are currently controversial, to say the least. Although, on the one hand, they offer the potential to reduce carbon emissions and minimise the impact of climate change, on the other hand there are real and growing concerns over competition for land and escalating food prices.

For example, a World Bank report obtained by the Guardian in early July suggested that biofuels have forced global food prices up by 75 per cent. Then, hot on its heels, came the Gallagher report, released by the UK Renewable Fuels Agency. This examined the indirect effects of biofuels on greenhouse gas emissions and food prices. Among other points, it concluded that the introduction of biofuels should be slowed as increasing demand for biofuels contributes to rising prices for some commodities. Importantly, it acknowledged a future for a biofuels industry, but urged the creation of a strong policy framework to ensure biofuels are sourced and produced in a sustainable way. The outcome of the report was a recommendation that the ramp-up of the government's Renewable Transport Fuels Obligation should be slowed (so that a 5 per cent proportion of biofuels in retail gasoline and diesel will be required by 2013-14 rather than 2010).

However, research by New Energy Finance magazine indicated that, although biofuels did play a role in increased food prices, this was much smaller than suggested by recent headlines. Their analysis suggested that increasing grain prices were driven largely by the price of oil, the decline of the dollar and supply/demand imbalances; and from 2004 to April 2008, the price of grains rose 168 per cent, of which only 8.1 per cent was due to the impact of biofuels.

Despite this ongoing and important debate, the demand for biofuels for transport, heat and power continues to increase, due in part to rapidly increasing oil prices. In the US, biofuel production has increased by more than 400 per cent since 2000 and Diageo, the market leader in Scotch whisky, has recently announced it is to spend £65 million on a bioenergy plant at its largest distillery, turning 90,000 tonnes of organic waste from the brewing production process into steam and electrical power. A number of UK companies are also now working to develop and deploy novel technologies for the production of bioenergy and biofuels. These include Insource Energy, which provides waste-to-energy project solutions and Green Biologics, which is working on a new process for biobutanol.

Bioenergy: the facts

The term bioenergy really covers two areas: biofuel is the transformation of plant materials into liquid fuel, and biomass refers to the use of solid plant materials burnt in a power plant or boiler.

Plants grown for conversion to bioenergy include traditional crops like oilseed rape and wheat, but increasingly farmers are being offered incentives to turn over land to grasses (such as miscanthus), with a high yield, or short-rotation coppiced species such as willow. To package the chemical energy of the plant material for use it needs to be processed thermally, mechanically, or biologically.

Thermal processing, using techniques such as pyrolysis or gasification, can convert materials into liquids, gases or solids. The choice of process and the form of output depends on the type of feedstock being used and the market demands being addressed. Biological methods of transformation include fermentation of materials to alcohol products, known as bioethanol and biobutanol. Mechanical processing is normally used as a precursor to both thermal and biological routes, but may be used in isolation, for instance in the fabrication of solid biofuels for heating applications.

The race is on to develop a new generation of sustainable, non-crop-based biofuels that make use of materials such as agricultural waste, cellulosic materials (the structural part of plants), woody crops (from sustainable wood sources) and algae. However, as the Gallagher report noted: 'Advanced technologies are currently immature, expensive and will require specific incentives to accelerate their market penetration,' so there is a particular need to drive forward the development of sustainable next-generation biofuel technologies.

Last year, the Carbon Trust launched the Advanced Bioenergy Accelerator, an initiative which aims to identify and encourage advanced bioenergy technologies with the potential to deliver sustainable, low carbon biofuels. These technologies will be challenging to develop and the aim is to increase the pace of development dramatically and bring these technologies to market quickly, working with partners in key bioenergy areas such as pyrolysis and algae.

Pyrolysis

Heating biomass in the absence of oxygen produces char, volatile gases, and a fraction (up to 70 per cent) of oil in a process known as pyrolysis. Pyrolysis oil from sustainable sources of biomass has the potential to produce low-cost fuels with low system greenhouse gas (GHG) emissions — if it can be integrated into a conventional oil refinery. However, the properties of the oil produced from current pyrolysis processes are far from suitable for integration. From Holland to Chile organisations are working on this area. Ongoing projects include oil groups such as ConocoPhilips of the US and its Brazilian counterpart Petrobras, which are involved in research, while utilities such as RWE and industrial groups such as Linde are taking stakes in companies or setting up joint ventures. In the UK, Ethos Recycling is set to use the technology at its waste-to-energy plant in Avonmouth. To further accelerate the technology towards commercialisation the Carbon Trust is working with leading academics, SMEs, and multinationals on a new pyrolysis initiative, which aims to produce oil with the properties required for integration into conventional refineries.

Algae

There is also significant potential to generate fuels from algae. The advantages are clear — growing algae does not compete with food for land; algae grow much quicker than other feedstocks; the process has the potential to yield up to six to ten times as much energy per acre as palm oil; it does not rely on fresh water; and the oil produced from algae can be converted to a variety of fuels, including kerosene, the fuel that aircraft run on.

The Carbon Trust is currently working with UK academics and companies on the algae fuels initiative which seeks to identify and address the challenges at each stage of the value chain — growing and harvesting the algae, processing it into oil and identifying and supplying the relevant markets. While the most suitable sites for growing the algae are likely to be abroad, research by the Carbon Trust suggests that UK-based teams have the expertise to lead the world in overcoming the initial key technological challenges related to strain selection for mass cultivation.

The aviation and road transport industries will play a key role in providing information on what they need from the such fuel in terms of specifications, regulatory requirements and other issues. Airbus is looking at the potential of algae oil and believes that sustainable biofuels — including algae — could account for 30 per cent of all aviation fuel by 2030. UK oil giants Shell and BP are among the companies working to bring the technology to market, with Shell's plan to build a demonstrator plant with HR BioPetroleum in particular indicating that this could be a viable proposition.

Biomass heating

Heating accounts for almost half (49 per cent) of the final energy consumed in the UK and almost half (47 per cent) of our CO2 emissions. As much as 14 per cent of the UK's heating requirements may need to come from renewable sources by 2020 if we are to meet the ambitious EU renewable energy targets, up from less than 1 per cent currently.

Using biomass for small-medium scale heating applications provides the most cost effective carbon savings of all potential uses of biomass fuel. This simple combustion technology has been successfully used in other parts of the EU at significant scales and for many years. For example, Sweden currently sources just over 35 per cent of its heating from biomass and Finland provides almost 30 per cent.

The UK has significant indigenous biomass resources. Research carried out as part of the Carbon Trust's five-year Biomass Heat Accelerator programme showed that UK resources have the potential to save over 20 million tonnes of carbon dioxide a year. However, there are only a few hundred megawatts of biomass heating capacity currently installed in the UK, a tiny fraction of the potential. Biomass heating can also be highly cost-effective — materials such as wood, pelletised sawdust and straw bales (from sustainable sources) are relatively cheap compared to heating oil, especially given the recent surge in oil prices. Biomass development can also bring other benefits, such as improving the biodiversity of unmanaged woodlands and contributing to the rural economy.

However, there are currently various barriers to widespread adoption in the UK. The high upfront cost of biomass heating equipment is a particular challenge, with the typical outlay between three and five times the conventional fossil fuel alternative. Also, the current lack of a large UK market means that the fuel supply infrastructure for biomass is immature at present.

There are also various practical barriers to getting more people using biomass instead of oil and gas heating. These include the need to store solid fuel on site and the fact that biomass boilers are often significantly larger than conventional alternatives. The fuel also has to be delivered by some form of vehicle, so the necessary supply chain — sourcing the feedstock, processing it and transporting it to the customer — must be in place. Further work is needed to educate customers and engineers as to the benefits of biomass and also to tackle existing regulations which were not designed to accommodate biomass heating.

The most effective sites for biomass heating typically have a large demand for heat demand all year round. Examples include hospitals, leisure centres, prisons, community housing schemes and a range of process-related applications such as nurseries (glasshouses), food processing factories, dairies and breweries.

The most economically viable sites for biomass are those which are not on the gas grid and therefore rely on oil, LPG or electric heating. There are still a surprisingly high number of such sites in the UK, with large areas of south-west England, Scotland and Wales not connected to the gas grid. There are many thousands of potential sites with the right combination of factors to make using biomass a realistic and cost-effective heating alternative.

However, to ensure more widespread adoption, the installed system costs need to come down by at least 20 per cent, so there must be an increased focus on cutting costs throughout the value chain. Historically, capital grants have been used to bridge the capital gap, typically providing up to 25 per cent of total costs. However, inconsistent availability of such grants has stymied growth and development of the sector.

Carbon Trust research indicates that there is significant potential for capital and operational costs to come down over time, primarily through economies of scale, but also in learning in areas such as civil engineering and system sizing. But the necessary kick-start to growth which can bring about these changes is likely to require additional government intervention to accelerate market development. The types of support currently under review include a renewable heat obligation (similar to the renewables obligation for electricity), a set of feed-in-tariffs or further capital grant schemes. Whichever mechanism is chosen, it will be crucial to ensure that this provides a long-term framework, increasing investor certainty and rewarding the units of renewable heat actually delivered.

Sorting the chaff from the wheat

Bioenergy must continue to provide a key plank in our energy system if we are to reduce carbon emissions and meet the government's ambitious renewable energy targets by 2020. Despite current controversies, the right bioenergy — based on sustainable biomass including pyrolysis oil, algae, wood and even waste — has a vital role to play in the journey to a low carbon economy.