**Struggles for ethanol in Europe**

The European commission's Renewable Energy Directive (RED)/Fuel Quality directive (FDQ) is the driving force for fuel conversion, targeting 5.75% biofuels consumption in transportation by 2010 and aiming for 10% (E10) within a few more years in some European Union (EU) states. Bioethanol is seem as part of the mix, but faces a struggle on several fronts.

Ethanol is traditionally produced by fermentation of sugar, from plant materials including sugar cane (Brazil), corn (US), grain, molasses, wheat, barley and rye. Typically, three tones of grain is needed for production of one tonne of ethanol. Most of the EU-25 countries grow sugar beet crops, yielding substantially more ethanol per hectare than wheat.

Biodiesel currently account for 80% of European biofuels production, while ethanol accounts for the remainder. The auto industry is more comfortable with diesel in Europe and is fighting hard against the E10 target, claiming that old vehicles can't handle the blend and the distribution network may require costly adaptation. The majority of cars in Europe run on diesel. However, many biodiesel projects have stalled din the face of lower oil prices and the economic recession. Several biodiesel plants have shut down in Germany as Taxes on green fuels cut biodiesel sales at service stations.

Furthermore, the ethanol industry faces an uphill struggle against cheap imports of bioethanol form brazil and heavily subsidized imports from the cornfields of North America. Cheap imports make it very difficult for Europeans investors to justify ambitious growth plans and manage without subsidies. Nevertheless, there are plenty of European companies willing to risk bioethanol production, given the need for improving energy security, reduction of greenhouse gas emissions and the classic EU argument - helping boost rural economies.

And then there is the 'food versus fuel' debate. Recent price rises of food grains and subsequent supply decline have been blamed on increased biofuels production, including ethanol; although biofuels producers argue that food price rises can be blamed on rising oil prices, increased food consumption in developing countries and declining yields in food corps. There is also the question of energy balance, where corn-based bioethanol has particularly poor performance.

The food versus fuel debate may be resolved eventually with the introduction of a new generation of biofuels base on non-food woody materials, lignocelluloses, biomass-to-liquid, waste material and algae. However, this solution is still some years away – although plenty of R&D us underway across the EU.

Finally, there is the thorny question of cost. Even the mot advanced production technologies – and frankly production of bioethanol is quite conventional as fermentation technology is as old as the hills – mean bioethanol produced in the EU is simply not cost competitive with traditional fossil fuels. Industry experts estimate that that Europeans bioethanol will only break even at about $115/b. However, new feedstock crops and production methods could make ethanol more competitive in the future.

**Global Experience**

Brazil and the US currently account for over 65% of global ethanol production, with 13% of ethanol produced in Europe. European ethanol plants produced 56% more ethanol in 2008 (2.82bn litres) than in 2007 (1.8bn litres), according to the European Bioethanol Fuel Association, due largely to growth in French production, which nearly doubled to 1bn litres, up from 539mn litres in 2007. France was the leading EU producer, followed by Germany and Spain, with Poland and Hungary much further behind. Spain's success is attributed to the fact

that the country does not collect tax on ethanol, according to the Europeans Biomass Industry Association (EUBIA).
In 2007, biofuels accounted for 3.5% of total fuel consumption in France. Encouraged by tax rebates and penalties, the industry is expanding. However, biofuels are increasingly blamed as the primary cause of rising food prices and are accused of reducing biodiversity and increasing soil and water pollution. Consequently, the French government will likely retreat from an ambitious 10% biofuel incorporation rate target by 2015, and will not introduce any new production incentives.

**Second Generation Biofuels**
Research is also will underway on second generation biofuels using lignocellulosic or woody materials as a future non-food feedstock for bioethanol. The shift is welcome as lignocellulosic biomass is more abundant and less expensive than food crops, and offers higher net energy balance environmentally (up to 90% greenhouse gas savings). Nevertheless, lignocellulosic biomass is far more difficult to convert to sugars. Scaling up is also considered difficult and depends on the development of cost effective and environmentally-sound enzymes, pre-treatment and hydrolysis technologies.
Giovanni de Santi, Director of the EU commission's Joint Energy Research Centre states: Second generation biofuels are not likely to make a significant contribution to biofuels production for another 10 years. However, Steen Riisgaard, CEO of Danish company Novozymes, is more upbeat and believes commercial production of second generation bioehtanol fuel is imminent, although he point out that 'political factors are key to achieving rapid commercial production.' Novozymes plans to begin commercial production of second generation bioethanol in the US in 2011.
Fermentation of sugars to ethanol is a mature technology. However, according to EUBIA: 'There is little chance of technological improvements that may significantly reduce current production costs. These costs are largely determined by biomass feedstock prices, which account for 55% to 80% of the final price of ethanol.'
There is wide variation in the volume of bioethanol production across Europe despite the renewable targets set by the EU under its Directive. EU leaders are targeting 10% blends of renewable energy in transport, as part of an overall 20% renewable energy target by 2020. The Directive is still being reviewed by the European parliament and EU member states, but all countries must present detailed renewable energy road maps for the European Commission.

**Bioethanol in Practice**
The following paragraphs provide a snapshot of some of the leading manufacturers and plants currently producing bioethanol in Europe.

**France**
France leads the way in bioethanol production and, this April, become the first Europeans country where both oil companies and independent operators offer E10 in service stations.
Six companies currently produce bioethanol in France – Tereos, Cristanol, Roquitte, Abengoa, Soufflet and St Louis Sucre. Tereos has a new wheat-based ethanol plant at Lillebonne (240,000t/y), as well as plants in Lillers (64,000t/y), Morains (32,000t/y), Artenay (32,000t/y, Bucy (32,000t/y) and Provins (12,000t/y). Cristal Union (Cristanol) has plants in Aecis-s-Aube (120,000t/y) and Bazancourt (280,000t/y); while Roquette has a 60,000t/y plant at Beinheim

which is being expanded by 35,000t/y. AB Bioenergy (Abengoa) operates a 200,000t/y capacity plant at Lacq. Soufflet has a 105,000 SMBE plant at le Meriot and St Louis Sucre has a 64,000t/y plant in Eppeville.
Two major second generation programmes are also underway in France. The €80mn Futurol pilot project in the Champagne area explores enzymatic hydrolysis on cellulosic biomass, including straw and wood products. A consortium is also focused on research of thermo-conversion of woody biomass into gas, to be followed by production of oil by the Fischer-Tropsch process.
Soufflet also produces 153,000t/y of ethanol at Pont-sur-Seine, but has run up against legal challenges from local opponents to its proposed 47mn g/y wheat ethanol plant in Aube. In addition, the company is considering the ramifications of the French government's decision to eliminate ethanol subsidies by 2012.

**Spain**
At present, Spain operates four bioethanol plants (running at 60% of total capacity, according to renewable energy industry group APPA). The country also lags behind many EU partners in making biofuels available at service station pumps. In May, Abengoa began first supplies of bioethanol in Spain to independent terminals in Barcelona, Catalonia and other locations for direct E5 blending with petrol.
The company has three plants in Spain – in Cartagena, Teixeiro and Babilfuente – which has installed capacity of 150mn, 176mn and 200mn litres annually. A fourth plant is under construction in France in the petrochemical complex in Lacq. Meanwhile, Abengao's 158,000t/y (213.5mn l/y) plant at Salamanca has mostly produced bioethanol for export, but increasingly anticipates meeting more local demand due to mandatory blending targets set by the Spanish government. It also operates four bioethanol plants in Europe, with an operating capacity of about 200mn g/y (53mnl/y), which is expected to increase by 125mn g/y (33mn l/y) by the end to 2009 when a new bioethanol plant comes on-stream in Rotterdam.
Abengoa Bioenergy New Technologies is also providing proprietary lignocellulosic process technology and process engineering design for a new biomass plant in Salamanca, Spain, which will process 70t/d of agricultural residues to produce over 5mn l/y of fuel grade ethanol.
Meanwhile, Acciona operates a bioethanol drying facility in Spain.

**UK**
The UK appears to be struggling to meet the EU biofuels target. Claire Wenner, Head of Biofuels at the Renewable Energy Association, maintains the UK has been 'over cautious … and may struggle to convince the European Commission it will meet mandatory targets.' The country now plans to reach 5% by volume for renewable by 2013/2014 after previously aiming to reach that goal by 2010/2011.
Ensus is bringing onstream a major bioethanol plant at Teesside this summer, which will consume 1.1 mn t/y of wheat to produce 400mn l/y of bioethanol and 350,000 t/y of animal feed. The new plant will dwarf British Sugar's current 70mn l/y plant in eastern England. However, British Sugar is partnering with Bp and DuPont to build a new bioethanol plant at Hull, with an annual capacity of 420mn l/y also using wheat as feedstock, which is due onstream in 2010.
Ethanol Ventures also has plans to deliver at least 378 mn l/y of bioethanol from two new facilities in Grimsby and Teesside from 2010.

**Belgium**
In April, the Belgian government set a 4% mandate to incorporate biofuels. Charles – Albert Peers, Managing Director of Alco Bio Fuel, says he hopes 'this will ensure we can finally sell our entire allocated quota of bioethanol on the Belgian market'. Alco Bio Fuel has a new plant at Rodenduizedok in the Port of Ghent, utilizing a wide variety of grains and sugar syrup as feedstock.
Meanwhile, BioWanze CropEnergies brought a new bioethanol plant in Wanze onstream in April, boosting parent CropEnergies annual capacity to voer 700,000 cm/y (700mn l/y) of bioethanol.

**Germany**
CropEnergies (a member of the Sudzucker Group) is Germany's largest bioethanol producer, with sales of bioethanol up 73% in the past 2008/2009 financial year. The company also operates a bioethanol plant at Zeitz and has a subsidiary at Loon-Plage in Dunkirk. The Zeitz plant manufactures bioethanol from a variety of cereals including wheat, barley, tricale and maize. Since February 2006, an E85 bland of 85% bioethanol and 15% regular petrol has been marketed as CropPower85 at certain OIL! service stations.
Verbio's two bioethanol plants have been working towards full capacity, following a series of shutdowns in 2007/2008 due to sluggish sales, high feedstock prices and cheap Brazilian bioethanol imports. Epuron is planning to build new bioethanol palnt in addition to current biogas and wood cogeneration plants.
Under German legislation, ethanol producers have to choose whether to produce denatured ethanol or ethanol for human consumption. Consequently, KWST, a major ethanol producer, is now understood to be focused on the latter rather than manufacturing ethanol for biofuel.

**Netherlands**
Royal Nedalco is the leading producer of natural alcohol in Europe, and recently acquired a 50% interest in Bruggemann Alcohol. The company is convinced that 'producing fuel ethanol from primarily agricultural feedstocks is not viable in the long term', and is investigating opportunities with lignocellulosics.

**Portugal**
Brasco (100mn l/y capacity) and Cargill (50mn l/y) both operate bioethanol plants in Portugal.

**Sweden**
In Sweden, the two main players in the ethanol market are SEKAB (100mn l/y) and Agroetanol (50mn l/y)

**Denmark**
A 5.5mn l/y second generation demonstration bioethanol plant is being built in Kalundborg, Denmark, for Inbicon, a subsidiary of DONG Energy. The plant will be a showcase for the UN climate summit in Copenhagen in December 2009. The plant uses a proprietary process for the conversion of wheat straw to bioethanol, fuel pellets and animal feed.