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Biofuels bottleneck

With an increased focus on biofuels as an energy solution, have policy makers been too optimistic about how soon second-generation biofuels can be developed?

COUNTLESS COUNTRIES around the world are banking on Brazil to help meet their biofuels mandates, which require an increasing proportion of transport fuels to come from renewables. However, while the world's oil majors have upped their activities in the field significantly, recent research indicates that policy makers need to have a major rethink - or risk missing their targets altogether.

There has certainly been major activity in the sector; **Shell** and **Cosan** announced one of the biggest biofuels deals to date, a multi-billion dollar joint venture called **Raízen**. It aims to produce and sell over 2 billion litres of low-carbon ethanol made from sugarcane in Brazil. For Shell, one of the largest distributors of biofuels, this is its first move into production. And it sends a clear signal that demand for biofuels is set to surge.

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According to the Brazilian sugarcane association, Unica, Brazilian sugarcane yields 7000 litres of ethanol per hectare of cane compared to 3800 litres for a hectare of corn in the U.S.; and 2500 litres for a hectare of wheat in Europe.

“Low-carbon, sustainable biofuels will be increasingly important in the global transport fuel mix,” says Peter Voser, Shell’s ceo. Biofuels currently make up around 4% of transport fuel in Europe, and 3% in the U.S., but new energy policies in both regions are calling for more renewable, lower-carbon fuels for transport. Under the *Renewable Energy Directive (RED)*, EU member states are targeting 10% by 2020, while the U.S. will want 20% by 2022. Globally, Shell expects biofuels to meet about 9% of road transport demand by 2030, up from around 3% today.

As a result of RED, demand in Europe for alternatives to biodiesel has grown most noticeably: “Looking at the national action plans you see a much greater increase in ethanol consumption than in biodiesel consumption,” says Maelle Soares-Pinto, **Hart Energy Consulting’s** director for Europe and Africa, **Global Biofuels Centre**. “This doesn’t mean that ethanol is becoming the predominant biofuel in Europe, but there is a very sharp increase in the forecast consumption of ethanol.”

In addition, due to bioethanol’s high greenhouse gas saving qualities, EU members are looking to the fuel to meet the *Fuel Quality Directive* mandate - reducing the greenhouse gas emission of fuels by 6%, over and above the RED targets. So demand has even come from the likes of Germany, notes Tammy Kline, assistant vice president of **Hart Energy**. Germany is one of the largest, if not the largest, biodiesel producing and consuming countries (not only in Europe but in the world) so it’s been seen as a surprise in some sense that a traditional biodiesel consuming market is suddenly looking to import sugarcane ethanol as a way to meet its targets on the Renewable Energy Directive, she notes. And demand from Japan and China will also add to the pressure on supply chains, she says.

Banking on Brazil

This all makes Brazil – the world’s leading sugarcane ethanol producer – a key focus, and is why companies like Shell are increasing their activity there: “Brazilian sugar-cane ethanol is one of the most sustainable and

lowest CO₂ biofuels available,” says Mark Gainsborough, Shell executive vice-president Alternative Energies. It also “remains by far and away the most commercially viable advanced biofuel option,” adds Frederick L. Potter, Hart Energy’s executive vice president.

According to Brazilian sugarcane industry association, **Unica**, Brazilian sugarcane yields 7000 litres of ethanol per hectare of cane compared to 3800 litres for a hectare of corn in the US and 2500 litres for a hectare of wheat in Europe. “Turning sugarcane into ethanol offers a number of environmental benefits over other biofuel production processes,” adds Shell. “As it grows, sugarcane generally absorbs CO₂ at a greater rate than other biofuel crops such as soy.”

Plus, ethanol made from Brazilian sugarcane “produces around 70% less CO₂ than petrol, when the cultivation and production processes are taken into account”, it says. Unica says the use of ethanol in Brazil since 2003 has avoided over 103 million tonnes of the CO₂ that the petrol it... ..has replaced would have produced. By-products

BP and Neste looking to biofuels future

BP is also expanding its biofuels production capabilities. In September, it agreed to increase its share in Brazilian biofuel company **Tropical BioEnergia S.A.** to 100%, by acquiring the remaining 50% of the company from its current joint venture partners - for a total cash consideration of approximately US\$71 million.

The firm intends to double the size of the operations at Tropical BioEnergia to a capacity of five million tonnes of crushed cane - or 450 million litres of ethanol equivalent - per year, and also to expand operations in the region. It also acquired an additional 3% share in Brazilian sugar and ethanol producer **Companhia Nacional de Açúcar e Alcool (CNAA)** from **LDC Bioenergia S.A.** for a price of approximately US\$25m, to take its overall share ownership in CNAA to 99.97%.

"This is another significant milestone in BP's global biofuel strategy as we expand our operations base and demonstrate our genuine commitment to Brazil's ethanol industry, which can deliver sustainable and competitive biofuels into the global market," says Philip New, vice president of BP Biofuels.

The firm is also investigating the use of non-food feedstocks at its **BP Biofuels Global Technology Centre** in San Diego, CA, having acquired the centre as part of its US\$98.3m

acquisition of **Verenium Corporation's** lignocellulosic biofuels assets. The acquisition also saw it become the sole owner of **Galaxy Biofuels LLC** and **Vercipia Biofuels**.

In addition, BP is investing in the development of biobutanol, a next-generation advanced biofuel; it has established a technology demonstration with **DuPont** in Hull, UK. "Biobutanol is an advanced biofuel with a higher energy content than ethanol, which can be produced using existing feedstocks such as sugar cane, wheat or corn as well as the feedstocks of tomorrow, including dedicated energy grasses," it says. It "can also be blended with gasoline at a higher percentage than ethanol, and used in existing vehicles without requiring engine modifications. This will help to speed up the introduction of biofuels."

BP expects that ethanol production plants, including one it is building with DuPont and **British Sugar** under the name of **Vivergo Fuels** (also in Hull) will be retrofitted to produce biobutanol. For now, the Hull plant, when operational, will have capacity to produce 420 million litres of ethanol.

Biodiesel boost

Meantime, **Neste Oil** in Europe is involved in advanced **biomass to liquid** biodiesel projects. The firm has invested heavily in expanding its

renewable diesel production capacity. It produces **NExBTL** renewable diesel at two units at its Porvoo refinery in Finland, one in Singapore, and a fourth in Rotterdam, which started production in September. The Rotterdam plant has a capacity of 800,000 t/a, increasing Neste Oil's total renewable diesel capacity to 2 million t/a, and "will help us meet demand in the European market, the world's largest for renewable diesel", according to Neste Oil's president and ceo, Matti Lievonon.

The diesel is produced by hydrotreating vegetable or waste oils and "has been proven to reduce greenhouse gas emissions by over 40% over the product's entire life cycle when compared to fossil diesel", according to the company. At the moment, it uses a mix of palm oil, stearin and palm oil fatty acid distillate (PFAD), which are by-products of palm oil production; rapeseed oil; jatropha oil; camelina oil; soybean oil; as well as waste animal fat produced by the food processing industry.

Meanwhile, Neste Oil is continuing an active programme of R&D on biofuels and raw materials suitable for biofuel usage: "Widening the raw material base is one of the company's main future goals," it says, noting that about 80% of its R&D costs (totalling approximately €40m annually) are directed to researching renewable raw materials. The research has a strong focus on a variety of non-food raw materials, as well as raw materials that can reduce areas of land used for energy production, and capable of reducing greenhouse gas emissions significantly.

The potential for using waste fat from the fish processing industry and pine oil are two areas, while entirely new raw materials - such as algae and microbial oils - as well as on biowax produced from forest harvesting waste, are also being investigated. "The biggest challenge is to increase production volumes up to industrial levels, to millions of tonnes per year," it says.

Neste's Rotterdam biodiesel plant



from the sugarcane-to-ethanol process, meanwhile, are also recycled as organic fertiliser, and plant waste (bagasse) is burned to produce power for the processing mills - with any surplus energy supplied to the national grid.

"Countries in Europe, along with the U.S., Japan and China, require more than three billion gallons in Brazilian sugarcane ethanol for their respective markets by 2020," says Klein, noting that too few other countries are in a position to export advanced bioethanol supplies.

However, domestic demand for sugarcane ethanol in Brazil, which is already strong, is also set to grow further, meaning less export availability through 2020, she points out. "There's a lot of internal demand in Brazil itself because of the growth in the flexi-fuel vehicle market, and the economic growth that's going on in the country in general."

Indeed, Brazil leads the world in the use of biofuels for transport and by 2030 they are likely to make up more than 40% of the country's transport fuel mix, double today's proportion. At the pump Brazilian motorists are offered the choice of pure ethanol or a blend of petrol (gasoline) and ethanol, and around 90% of the country's new cars can run on either fuel type.

"There is really going to be a supply constraint on Brazil," says Klein, signalling a major supply chain bottleneck globally. Indeed, Hart Energy's latest research, published in *Global Biofuels Outlook, 2011-2020: Projecting Market Demand by Country, Region and Globally*, projects that "less than 10%-12% of the total supply requirements will be commercially available" by 2020.

Time to get real?

"Governments [around the world] are a little bit separated

or divorced from the market reality," Klein says. Soares-Pinto agrees: "Globally, not just in Europe, policies are [a] bit over ambitious. The volumes are just not there."

Initiatives like Raízen will undoubtedly help. "We expect the development of advanced biofuels to benefit from Cosan's feedstock and its expertise in large-scale biofuels production. This has the potential to accelerate the future commercial viability of cellulosic ethanol," says Gainsborough. "Ready to offer international markets a clean, renewable and economically viable solution" it is "a turning point in the search for alternative energy sources," adds Rubens Ometto Silveira Mello, Cosan's chairman of the Board.

However, by Raízen's own admission, it's current annual production capacity will be enough to meet just 9% of current ethanol demand in Brazil alone, so while new players have entered the space, there needs to be a major increase in capacity expansion, Klein says. "There will be expansion of sugarcane acreage, but it's going to take a few years to catch up," she says. Plus, getting the capital to expand production capabilities has been an issue. "Higher feedstock prices and less Government incentives have cooled capital lending in the finance sector," she notes.

Of course, besides Shell, other oil giants like **BP** and **Neste** [see box] are also funding advanced biofuel projects, and this plays a critical role. "At the end of the day they are the ones paying the penalties when they don't meet the biofuel targets in many countries, so they have a commercial interest," Soares-Pinto says. But development by the oil majors alone will not be enough.

"One of two economic and policy developments needs to occur," says Potter. The price of Brazilian ethanol needs to increase

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“You can’t just toss out a mandate and incentive and then say you’re done.”
Tammy Klein, Hart Energy Consulting.

further than it is now projected, to provide adequate market incentives for additional cane acreage and bioethanol production; otherwise the public policy targets in the U.S. and the EU, which rely so heavily on sugarcane ethanol and other advanced bio-ethanol supplies, need to be modified, he says.

The U.S. Congress “will ultimately have to modify the total *RFS2* requirement by 2022 and modestly increase the longer-term requirements for corn-based ethanol under the programme to compensate for the shortfall in commercial cellulosic biofuels volumes,” Hart’s outlook report says.

Standards pressure

For European players, sustainability requirements add extra pressure: “Under the RED requirements, sustainability and volumes go hand-in-hand. You can’t separate the two,” says Nick Goodall, former ceo of the **UK Renewable Fuels Agency** (the body responsible for administering the

renewable transport fuels obligation, and setting sustainability criteria for biofuels in the UK) and now CEO of certification body, **Bonsucro**. Under the EC’s sustainability criteria, there are constraints on the types of feedstocks and production processes that can be used. Any sugarcane ethanol or biodiesel used to meet targets, including imports, must be certified as sustainable by meeting the production standards of one of the various EC-approved certification bodies, such as Bonsucro.

Bonsucro’s **Production Standard**, approved by the EC in July, assesses the biodiversity, ecosystem and human rights impacts of sugarcane production and demands legal compliance and continuous improvement throughout the production process. This is assessed against key indicators, such as energy consumption, greenhouse gas emissions and water consumption.

“The Bonsucro standard is very specifically a metric standard. There

are absolutes against which it’s measured,” says Goodall. “It is the only standard that we’re aware of, certainly in sugarcane, that has the environmental, social and economic dimensions of what sustainability really is.”

The standard “has been designed by that broad church”, Goodall continues, explaining that Bonsucro is a multi-stakeholder association comprising oil giants like Shell, sugar mill operators like Cosan, institutions such as the **International Finance Corporation** and NGOs like the *World Wildlife Fund*. He stresses: “What we can [now] say with some confidence about biofuels, specifically sugarcane, is that there is now a way of ensuring that the production of it is provably sustainable to the highest standards that can be identified.”

According to Klein, while such standards are good, this means there is a greater risk of failing to meet targets. “It’s going to be very hard,” she says. “Utilisation right now in Europe for ethanol and biodiesel hovers around 50%, so this is not really great for producers as it is. They already face competition from imports from Brazil on the ethanol side, and from palm and soy biodiesel from Argentina, Malaysia, and Indonesia. You throw the greenhouse gas target and sustainability criteria into the mix and it’s going to be very tough. You could see production go offline because it will not be allowed in the market. For Europe that’s a big issue.”

Some will no doubt be pinning hopes on the next generation of biofuels, such as algae or ethanol from grasses (otherwise known as lignocellulosic biofuels), but these are some way off yet, Klein stresses. Much of the legislation, she suggests, was passed on the assumption that such advanced non-food feed stocks and advanced biofuels production processes would be widely and commercially available in the market. “We really don’t see that through the study time period [to 2020] and that makes it difficult to meet some of these very strict and progressive targets.”

She continues: “You can’t just toss out a mandate and incentive and



Distilling sugar-cane ethanol: Fermented sugar-cane juice flows through a series of distillation columns to produce ethanol at Raízen's da Barra mill, Brazil.

then say you're done. It really hasn't worked in a lot of instances to create an efficient market. So what Governments need to do is look a little bit more holistically at the whole value chain." As in other renewable energy sectors, such as wind, this means helping with investment in infrastructure and creating market certainty.

In the U.S., for example, incentives are in place for ethanol and biodiesel, but as with the production tax credit for windpower, these have to be renewed each year. "It means the incentives are in constant danger of not being renewed. It's really put the chill on investment for both first

generation and next generation bio-fuels," Klein says. "You need to create an environment of regulatory and market certainty. There needs to be a longer time horizon. That's probably one of the most important things Governments can do."

Likewise in Europe, "policies need to be reviewed", says Soares-Pinto, although simply reducing planned consumption of ethanol in favour of biodiesel to meet targets presents its own issues. "We have very big question marks on biodiesel availability for imports," she says. "With biodiesel it's easier to reach targets because you can use it in vehicles and off-road applications, like rail." But while there

are already some advanced biodiesel projects underway in Europe "they already look more expensive even than cellulosic ethanol".

Critical to driving development of advanced biofuels and biodiesel is "to have the money to take them from demonstration scale to the first commercial plant - and for that they need stable policies," she stresses. The EC is trying to help by funding pre-commercial demonstration projects, "so maybe in the next four years we'll see if they can make it to commercial". The funds required though "are quite substantial and, as we know, Europe is having more fundamental issues with funding than just looking at advanced biofuels, so the funding of those projects is going to be difficult".

Feedstock concerns

The other key problem is where to find enough feedstock that is economically attractive for use as biodiesel or ethanol. With food prices high, this has become a major concern. "The price of sugar is very high so producers don't want to make ethanol. It becomes uncompetitive with gasoline," says Soares-Pinto. Similarly, "the price of palm oil is linked to food prices making biodiesel completely uneconomic in Europe". Indeed, "the whole industry [ethanol and biodiesel] is affected by high feed stock prices".

And of course, food issues rightly take priority over the need for bio-fuels, particularly in regions such as Africa, where there is so much potential for biodiesel. "There's been talk of Africa developing its biodiesel industry for years now. Some states in Africa have biofuel mandates, but some are moving backwards," says Soares-Pinto, citing South Africa as an example. "South Africa was advancing its biofuels policy then because of the food issue it pulled back. Obviously food issues are much more important in Africa. For Europe the export potential would be great but the caution is necessary to make sure that people are not harmed by another cash crop that doesn't produce and deliver the income expected."

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