

South America has been a biofuels goldmine for the best part of half a decade but, after a mixed 2013, the region looks to be in a transitional period

by **Dan Traylen**

# Heading South?

**T**he world's fourth-largest continent is a global hub for both ethanol and biodiesel production, as varied climates and terrains provide ideal conditions for farming a variety of feedstocks.

However, much has happened across the industry over the past six months in the wake of international policy changes, biofuel mandate cuts and economic uncertainty and it is safe to say much of South America has felt the effects.

## **The trouble with ethanol**

Brazil's sugarcane ethanol industry, the world's largest, is facing a challenging period that has seen fluctuating activity in both production and consumption levels over the past few years. The global financial crisis, significant weather problems, recent focus on cheap shale gas

in North America – along with a proposed slash in the country's 2014 Renewable Fuel Standard mandates – meaning a possible decrease in exports, and the discovery of huge pre-salt oil reserves off Brazilian shores have presented the industry with a different situation in 2014 than could have been predicted when the market was flourishing a decade ago.

Rather than continuing the international biofuels crusade, governments have seemingly taken a step back to concentrate once again on using cheaper oil and gas products that could be detrimental to the global environment and blur import barriers, particularly between South America, the US and Europe.

Domestic policy has also had a part to play in lowering demand for ethanol in Brazil. Mills have been falling victim

to the government's inflation-control schemes that saw state-controlled oil company Petrobras importing refined petrol to sell at a heavily-discounted wholesale cost as a result of poor cane yields and high production costs in recent years. The subsidised petrol cost is currently around 15% below the parity import price.

The effects of capping petrol prices at the pump for the last six years, making it cheaper for the public to purchase than ethanol, have also hit hard.

An estimated 61% of the vehicles on Brazil's roads are able to run on 100% hydrous ethanol, petrol or a blend of 25% biofuel with petrol (E25). Only 24% of flex-fuel vehicles, as they are known, are now being filled with biofuel. This is down from 82% in 2009, when the price of hydrous ethanol was at around 54 to 56% of petrol

per gallon, and the country's vehicle fleet is increasing all the time the ethanol industry is paralysed by high prices and decreased consumption.

While Petrobras did announce a 4% increase in petrol prices towards the end of 2013, it is thought sugar mills will continue shutting across Brazil as this price hike will not be enough to lift demand for ethanol and debts are unmanageable. This could theoretically benefit the industry in the long-term, as only the most efficient facilities will survive the challenging climate.

The Brazilian sugarcane industry association UNICA says that, since 2007, an estimated 51 mills have closed – or 12% of the nation's total. The low profitability of the sugarcane industry has meant finding buyers for old mills is proving to be difficult and building new

ones unlikely. Processing capacity is still high – though not inexhaustible – and these 51 mills account for a combined crushing capacity of 48 million tonnes, according to market research firm Informa Economics.

From 2004 to 2008, Brazil saw a 100% increase in production, whereas from 2009 to now, it has increased by only 27%. Despite this, a record 594 million tonnes of sugarcane were processed last year, with mills using 54.6% of the cane crop for ethanol in the season that ended in December, up from just over 50% in the previous harvest. Total ethanol production hit 6.7 billion gallons, up 19% on the previous year.

Persistent dry weather in Brazil's southeast region, where most of the country's sugarcane grows, is said to be generating some concern for the next crop season beginning in April. The country therefore has been importing cheap corn ethanol from the US in order to satisfy demand while the industry is between crops.

Corn-based ethanol in Brazil is also facing issues caused by short-term concerns in the centre-western regions of Brazil – especially Mato Grosso state – where logistical costs of corn for major consuming and export regions have been high due to the current lack of infrastructure in the country. With sugarcane being the more competitive feedstock in the region, both economically and environmentally, this is not currently an overriding problem for the country's biofuels industry.

### Investment and 2G biofuel

The solution to this loss of momentum as a whole is not simple and involves many aspects, such as clear and transparent rules for fuel pricing in Brazil, a tax

policy that recognises the advantages of ethanol and larger investments in R&D to increase productivity.

'The Brazilian sugarcane sector is doing its homework to increase productivity,'

small increase of sugarcane production in the next couple of years, due to both productivity gains and a little land expansion. It is important to mention however that this increase is capped

logistics facilities like ethanol pipelines and terminals should amount to more than R\$5 billion in the next few years.

Investment through major corporations like BP, which runs three mills and has



UNICA cane fields

Mechanised harvesting is allowing farmers to harvest much greater yields

says Eduardo Leão de Sousa, executive director of UNICA, 'however this won't be enough to meet the 2020 projected energy demand in the transport sector. In the absence of an enabling public policy that will make the rules of petrol price formation transparent and predictable and therefore promote new investments in ethanol production capacity, Brazil will have to import 13 billion litres of petrol equivalent by 2020.'

'We can still expect a

by the current industrial capacity. Beyond 2015, the increase of sugar and ethanol production in Brazil will require new investments in order to expand industrial processing capacity,' De Sousa adds.

Nevertheless, all of this does not mean that investors have been completely swayed away from the sector. UNICA reports that R\$4.5 billion (€1.3 billion) has been invested in mechanised harvesting and sugarcane field renewal since 2006, while investments in

developed 400 square miles of farmland leased from local owners across the country, has allowed the development of mechanised harvesting to bring in much larger yields. As an alternative to the common practice of burning cane straw and leaves, mechanisation of sugarcane harvesting in Brazil has also been shown to decrease environmental impact and waste.

In São Paulo, one major initiative aiming to reduce environmental impact when harvesting cane crops is the Green Protocol, a private-public partnership between the sugarcane industry and the São Paulo state government. This was a voluntary agreement, established in 2007, in which the mills committed themselves to eliminating pre-harvest burning by 2017. As a result of this protocol, more than 90% of the state's cane is harvested mechanically,

avoiding the use of fire.

Government funding for advanced biofuel technology projects is a key factor in developing the industry, and the Brazilian government has injected R\$6.1 billion into research through 2011-2014.

An agreement was signed in 2011 by the Brazilian Development Bank (BNDES) and the Brazilian Innovation Agency (FINEP) to create the Joint Plan for Supporting Industrial Technological Innovation in the Sugar-based Energy and Chemical Sectors (PAISS). Its purpose is to back up projects that aim to develop, produce and commercialise new industrial technologies designed to process sugarcane biomass in order to produce cellulosic ethanol and other advanced biofuels.

Renewable energy firm Raízen began construction of its first production division for cellulosic ethanol in Piracicaba last year. Located adjacent to the company's Costa Pinto sugarcane mill, and with a capacity of 40 million litres per year, the project has benefited from BNDES funding of R\$230 million. It is scheduled to begin operations by the end of 2014.

Using enzymes provided exclusively by Danish technology firm Novozymes, the facility will process bagasse, leaves, bark and other sugarcane waste to produce its ethanol. These enzymes are responsible for converting cellulosic material into sugar.

Novozymes will at first import its raw materials, but plans are in the pipeline to build a unit for production of the enzymes in Brazil at a later date.

Raízen is among the top five ethanol companies in Brazil, producing over 2 billion litres a year and generating over 900MW of electricity from bagasse. It expects to be operating a total of eight cellulosic ethanol facilities by 2024, with all of them producing enough second generation biofuel to compete



Petrobras experimented with second generation ethanol on a fleet of minivans last year

with existing first generation units. At maximum capacity, the firm says it expects these facilities to produce one billion litres of ethanol.

With major producers like Raízen looking towards a future of large-scale cellulosic ethanol consumption, some companies are researching the possibilities of new feedstock varieties that can be efficiently processed into fuel.

One such company, GranBio (formerly Graal Bio Investments), is currently developing strains of a new 'energy cane', *cana vertex*, which is being obtained by genetically crossing ancestral types of cane with commercial hybrids.

'The cane is more robust, more resistant to pests and diseases, with greater longevity, higher fibre content and greater productivity than conventional plants,' says Alan Hiltner, GranBio's executive VP of operations and new business. 'It does not produce much sugar, but lots of biomass and CO<sub>2</sub>. If we have energy cane as a crop we can put standalone plants anywhere; it removes the complexity of processing bagasse and straw.'

GranBio says raw material is the key to making second generation ethanol competitive.

The company with the cheapest, most efficient cane will ultimately lead the way. Ideally, mills will be able to produce more ethanol without having to plant more cane.

With the first commercial harvest planned for 2015, Hiltner says GranBio's energy cane development 'is a small drop in Brazil's ethanol industry, but we believe we will be seen as pioneers in the future. Second generation ethanol is the best answer to this country's needs'.

In May 2013 the company opened a second generation experimental station in Alagoas, in the northeast region of the country, with an investment of R\$10 million. GranBio is also on track to have its first commercial-scale second generation ethanol plant in Brazil online by March 2014. BNDES provided R\$300 million financing to Bioflex Agroindustrial, a subsidiary of GranBio, for the project under the PAISS programme.

The Bioflex plant is expected to produce 82 million litres of biofuel from sugarcane and bagasse, boosting biofuels production in Alagoas by 20%.

Research and development into advanced biofuels is ongoing all the way up to state-owned energy giant Petrobras. The corporation

has so far produced 80,000 litres of second generation ethanol, some of which was used experimentally in a fleet of 40 minivans during last year's Rio+20 UN conference on sustainable development.

The company's biofuels subsidiary, Petrobras Biocombustível, will invest \$2.9 billion (€2 billion) to increase ethanol and biodiesel production through 2013-2017 and aims to implement a second generation ethanol unit in a first generation plant in 2015 to experiment with synergies that could help to produce fuel at a more competitive cost.

Petrobras is also working with state-owned company Embrapa to develop new technology for sugarcane production to eventually benefit the ethanol market in a project that will develop over the next four years.

The two companies signed a technical cooperation agreement in late November aimed towards sugarcane production in Rio Grande do Sul, the southernmost state of Brazil. The project is backed by an investment of R\$5.5 million and has been approved by the ANP, Brazil's oil, gas and biofuel regulator.

Rio Grande do Sul is a temperate region not well-

suited to growing sugarcane. With that, the study will evaluate varieties of sugarcane which are better adapted to the soil and climate in the state, taking into consideration the issues of productivity, pest resistance and tolerance to cold and drought.

'The state imports almost 100% of its sugarcane from other regions,' says a spokesperson for Petrobras, adding that the project's goals are to 'develop a production system model' and 'provide an agro-climatic zoning of sugarcane in a temperate climate'.

### Biodiesel

Speaking on behalf of producers in Brazil about the country's required biodiesel blends, Julio Minelli, executive director for the Brazilian Biodiesel Producers Association (APROBIO), says: 'The situation is not good. We expected to have a 7% blend in 2012, leading to 10% by 2015 and 20% in 2025. None of this has happened for various reasons including fear of inflation, which is insignificant when compared to the real benefits of price, economic growth, and to the environment.

'Right now the biodiesel industry is trying hard to increase the blend to 10% within the next couple of years, but so far it does not look likely.'

The Ministry of Energy and Mines has not said when the decision to boost the blend will be. Meanwhile up to 27 plants have closed down, says Minelli, representing 40% of the installed industry.

Despite Minelli's outlook, country officials including agriculture minister Antonio Andrade says Brazil's soyabean harvest – the most widely used source of biodiesel feedstock – could produce record amounts in 2014, with the potential to surpass US output and boost the blend mandate.

Brazil produced around 3 billion litres of biodiesel in 2013, making it the world's second-largest producer in total. Capacity in the country is around 7.5 billion litres and there are still around 65 plants operating across the country.

Similarly to ethanol, the biodiesel industry is looking towards second generation fuels and alternative feedstocks.

US company Amyris operates a well-documented commercial-scale plant in Brotas, using genetically-engineered microbes to convert sugar into hydrocarbons rather than produce oil directly. The plant sources its feedstock from local mills, but the use of sugarcane should not affect the ethanol industry in Brazil, according to UNICA's de Sousa:

'Biodiesel normally competes on the domestic diesel market,' he says. 'The current rules in the Renewable Fuels Standard in the US, that allow blenders to use biodiesel to fulfil their demand obligations for advanced biofuels, creates a competition between the biodiesel and the sugarcane-based ethanol in that specific market, as both are considered advanced biofuels.'

### Argentina and the EU

South America's biggest producer of soyabeans, Argentina, has been facing legislative troubles of its own over the past couple of years.

The country is currently embroiled in a battle before the World Trade Organisation after the EU's European Commission levied high anti-dumping duties on Argentinean biodiesel exports to the continent last year, which previously amounted to around 90% of Argentina's exports. The country is appealing against the duties with hopes to having them removed.

The negative impact for Argentine biodiesel is evident, says the country's non-profit

biofuels association, Carbio: 'Up until 2012, exports from Argentina averaged around 1.5 million tonnes per year,' comments Gustavo Idigoras, senior trade advisor, 'but there was a significant reduction in 2013.'

Idigoras says Argentina's exporting industry 'will collapse' if the appeal fails, and producers may be required to export the less lucrative soya oil, potentially causing an international oversupply that would resonate financially in Argentina. The surfeit of soybeans already in the country goes towards explaining why plans to grow other feedstock plants like jatropha have so far been inconclusive.

Soyabean-based biodiesel takes up around 30% of total national soyabean oil production (representing less than 20% of annual soyabean harvest), and most is produced around the central Pampa region. With producers currently working at just 40% capacity since production levels started to fall in 2012 and plants began closing, Carbio predicts this year to be the worst yet for biodiesel production – though heavy rain in January is expected to increase soyabean yields.

Domestic consumption of biodiesel is estimated to be around 800,000 tonnes, a figure the industry wants to increase by boosting the blend mandate. The 8% blend in 2013 is expected to be pushed to 10% this year.

Petrol in Argentina must currently contain 5% ethanol and production is government-controlled under a monthly quota system which assigns supply shares to the producers.

Ethanol is yet to really take off in Argentina, as sugarcane only grows well in the north of the country, but hopes to reach a 20% mandate by 2015 are still strong. Available land for corn production is over double that for cane.

With this in mind, Promaíz,

the result of a JV between General Deheza and US-based Bunge, last year opened Argentina's largest corn-based ethanol plant in Cordoba, with a nameplate capacity of 420,000 litres.

The plant utilises ethanol technology licensed by Vogelbusch of Austria and is expected to have revenues of \$200 million in 2014, according to the Industry Ministry, whilst contributing a significant proportion of the national quota.

### Peru

Unlike Argentina, there are no anti-dumping duties on Peruvian exports of ethanol to the EU, and the country has been accused of taking advantage of the free trade agreement by ramping up its exports into Europe and substituting its missing domestic supplies with cheap US imports.

According to the European Renewable Ethanol Association (ePURE), exports from Peru between January and October 2013 more than tripled to over 93 million litres compared to 27 million litres during the same period in 2012.

This surge, it says, occurred in the three months immediately following the removal of import duties in August 2013.

Peruvian terminal operator Penta Tanks Terminals reportedly loaded the largest ethanol cargo ever in Peru at the end of 2013.

Around 15,200m<sup>3</sup> of ethanol, owned by producer Maple Energy, was reportedly bound for Rotterdam.

A total amount of approximately 54,300m<sup>3</sup> of fuel-grade ethanol were produced by Maple Energy between January and October 2013, according to the company's December update. Maple's ethanol project, operated through its subsidiaries Maple Etanol and Maple Biocombustibles, has been operating since 2012.

Meanwhile, ePURE says Peru imported 84 million litres of ethanol from the US between January and October last year in order to replace the exported fuel.

'It does not appear that any law has been broken in this case. Nonetheless, trade agreements typically contain provisions that, under specific circumstances allow the EU to enact safeguard measures to counter unexpectedly sharp increases in trade volumes. We will continue to monitor the situation...and discuss with the European Commission what measures could possibly be taken in the future,' says Barry Magee, policy manager at ePURE.

### Uruguay

Away from international export issues, Uruguay operates a domestic biofuels policy for

its relatively small population of around 3 million.

Although production is fairly limited, the country processes a number of feedstocks for both ethanol and biodiesel that have shown potential, including sorghum, canola, and the South American staple, sugarcane.

Alcoholes de Uruguay (ALUR), the country's leading producer, operates three plants in Montevideo, Bella Union and Paysandú, producing around 16,000 tonnes of biodiesel and 24 million litres of ethanol annually.

The company is currently constructing another, larger plant in Paysandú – under a deal with Abengoa – that will produce 70 million litres of ethanol a year from dry milling and batch fermentation of sorghum, maize, barley and wheat.

Abengoa also operates in Chile, where it is currently in the process of adapting advanced biofuel technology for the South American market with plans to offer two products.

The first is for the conversion of organic municipal solid waste, while the second is for the conversion of sugarcane waste and bagasse from refining operations into ethanol.

### Cuba

Earlier this year authorities in the western Cuban province of Matanzas revealed a strategy to boost the use of renewable energy sources by 2016.

The programme includes construction of two biofuel plants with a total production capacity of 2,000 litres.

It is clear the giants of the

South American biofuels industry, Brazil and Argentina, are struggling to maintain the momentum that has brought them to the heights they have reached now. While it has been a story of massive success it is, as the saying goes, a long way down should this period of uncertainty continue.

Elsewhere, the technology and credibility the bigger countries have brought to South American biofuels development is still rippling through the smaller nations in the forms of international investment and governments pushing renewable fuels towards commercial use. This, plus the increasing focus on research into second generation technology and innovations in the harvesting process, makes the outlook for 2014 as exciting as it is testing. ●

## Gillian Harrison, CEO of Whitefox Technologies, discusses how ethanol producers in Brazil could help lower rising power prices

**Brazilian electricity** prices hit an historic high this January due to droughts in the south east and Midwest. The former record came in 2008 and was set at R\$569.59 (€175) per megawatt hour (MWh). In parallel, a new record in electricity demand was attained off the back of increasing consumption and that combination is causing a real concern in the wider economy. How can the ethanol industry help to redress the balance of supply and demand?

### Challenge

Dehydrating ethanol using azeotropic distillation with cyclohexane is energy intensive. The ethanol concentration in the feed to the cyclohexane tower must have no more than 7% water before it can be dehydrated. In addition, the cyclohexane must be recovered and recycled using a separate distillation step, which adds complexity and consumes energy. Azeotropic distillation therefore requires around 5kg of steam to dehydrate each litre of ethanol. Historically this has not been a concern as ethanol producers had

an abundance of bagasse for steam generation. However, as the middle classes have grown, the demand for electricity has increased, leading to prices reaching new highs. The ethanol industry has realised that there is an excellent opportunity to gain from this situation by converting surplus bagasse into electricity and securing additional revenue streams. However, in parallel, there is an increased demand for anhydrous ethanol production in Brazil. For a plant using cyclohexane dehydration, switching to anhydrous production can push producers into a 'bagasse deficit' scenario, meaning they not only have to buy bagasse to meet the anhydrous demand, but they are less able to take advantage of the opportunity to make revenue from electricity sales.

### Solution

One solution involves replacing the azeotropic distillation step with a membrane-based process. Membrane based dehydration can start with a water rich feed (up to 30 wt% water), reducing load on distillation which,

combined with other modifications, can cut steam consumption up to 50%. Whitefox recently carried out a feasibility study for a sugar-based ethanol facility in Brazil. Due to high steam consumption of the azeotropic distillation process, the client had to buy bagasse to run its boilers. The customer wanted to be able to produce and sell electricity from spare bagasse to the grid. By implementing membrane technology, the plant no longer needs to buy bagasse and it has a surplus. This solution gives the client a chance to increase annual revenue by R\$7 million a year.

### Impact on the wider economy

Greater efficiency in the Brazilian ethanol sector can be achieved by implementing readily available technologies. If a single plant can supply close to 40,000MWh to the national grid per annum then over 300 similar plants could make the difference required to alleviate the pressure caused by increasing demand for electricity and the uncertainty caused by low rain fall.