

Three commercial-scale second generation ethanol plants are due to start-up in the very near future. But how will the proposed RFS reduction impact the sector in the longer-term?

The final push

by **Nicholas Zeman**

If three cellulosic ethanol plants can start up and turn profits this year it will change not only the entire ethanol market, but the future of world energy consumption. Several companies are closer than ever, construction projects are booming and the time is now. But the US petroleum industry does not want to see ethanol's market share grow.

With three global construction and engineering companies in the throes of the final stages of construction for different cellulosic ethanol plants in the US Midwest, the situation suggests fierce angling to have the next commercial facility up and running.

DuPont Chemical, Abengoa Bioenergy and Poet-DSM are all driving hard to bring the final stages of their facilities home. Becoming the next 'first of its kind' plant on a new technological scene could mean gaining the lion's share of government backing and investor confidence.

The cellulosic industry has not been able to achieve the production targets that the Environmental Protection Agency (EPA) has set for it, with Mississippi-headquartered next generation renewable fuels company Kior – a company once thought to be a major player in cellulosic ethanol – recently announcing it may have to seek bankruptcy.

This 'lack of performance' gave the American Petroleum Institute (API), the largest trade association for the oil and gas industry, a chance to attack the volume requirements for cellulosic ethanol in the

Renewable Fuel Standard. API filed suit against the EPA in a US Court of Appeals over the agency's 2013 RFS, saying the rules mandate significantly more cellulosic ethanol than currently available in the marketplace.

With the production tax credit for cellulosic biofuels expired since the end of 2013, the Energy Information Administration predicts that production of cellulosic biofuels will remain below statutory targets through 2040. EPA requirements for cellulosic renewables were originally set at 1.75 billion gallons. The agency has instead proposed to set only 17 million gallons. The RFS requires oil companies to include a specified volume of biofuels in its reservoir – this drives the market.

What bothers cellulosic ethanol companies about the proposed RFS reduction is that it would likely cut into corn ethanol demand and reduce profits. This situation has had a dual effect on the ethanol market. Ethanol prices are high due to supply concerns and rail congestion, but investment in clean energy companies has been put in danger over the uncertainty of the regulatory environment. The ethanol industry needs investment to continue to innovate, especially to open up its feedstock sources. This is the primary issue for the ethanol market in 2014.

'Anything you do to hurt the profitability of grain ethanol producers is going to hinder their ability to invest in this new technology as well,' says Poet spokesman Matt Merrit.

Poet-DSM is ready to sell its new technology to other ethanol producers, but if those operations are not making money on its established businesses, the company risks capital being invested in an alternative technology.

Stiff competition

It is a time when competitive rivalries are being somewhat pushed aside. The presence of large serious companies who can combine to produce and present legitimate blending volumes to the market is needed to dispel any notions that cellulosic ethanol is a fictional fuel.

'We need each other,' says Steve Hartig, general manager of licensing for Poet-DSM. 'We're a company but we want an industry. DuPont, Abengoa, Poet and DSM being involved shows that the companies involved in cellulosic ethanol are big, serious ones.'

And there is a certain level of hypocrisy to API's case against cellulosic ethanol. 'For the oil companies to complain that there isn't enough cellulosic ethanol, it's a self-fulfilling prophecy. Look at all the deals and projects that they've walked away from,' says Mark Emelfarb, CEO of Dyadic International, a global biotechnology company based in Florida which has a license agreement in place with Abengoa. 'Shell abandoned Codexis and BP has backed off its biofuels investments. It's not to say they walked away from the table altogether but they're waiting for the last possible moment to step in. They have the money to do it.'

In Hartig's opinion, 'The cellulosic ethanol requirement is a drop in the bucket of the overall RFS. The API appears to be trying to get publicity. They don't want to give up their market share; they want to sell oil, not ethanol. They need ethanol for its octane properties, but they want to be totally in control of its distribution.'

Remaining faithful to the RFS, the EPA has continually declined to reduce the advanced and renewable targets from previous lawsuits and did not propose to do so for 2013. According to the Agency, non-cellulosic advanced biofuels, such as biodiesel, will be available in sufficient quantities to meet the statutory target and that the greenhouse gas and energy security benefits of using those fuels outweigh the benefits of lowering the target. Industry observers have said repeatedly that markets impose considerable pain on companies that are compromised by wavering public policy.

EPA's action comes after two Washington, DC circuit court decisions said oil refiners could not be penalised for non-compliance with the RFS if caused by lack of available product in the market; refiners cannot buy fuel that is not there. The API says the courts held that EPA cannot set mandates based on 'rosy projections', according to the Institute's spokesman Carlton Carrol.

'Some of these companies will release statements claiming they can produce 3 million gallons for the year,



The Poet-DSM plant under construction in Emmetsburg, Iowa

but then they only produce 100,000 gallons. We just want the mandate to be based on actual production,' he continues. 'The technology has not kept up with mandates, continues to fail to meet promises and refiners are stuck holding the bag.'

Tedious saga

Episodes like Kior can have a ripple effect. Backed by billionaire fund manager Vinod Khosla, Kior has been one of the most watched renewable fuel companies. When such a company fails it can hurt the entire market.

The road to Emmetsburg, Hugoton and Nevada, Iowa is littered with bankruptcies, broken dreams and a lot of money lost. Tearing cellulose apart to free the sugars needed to ferment biomass into ethanol has involved a Herculean effort. 'When you look at cellulose, nature designed it to stay together and we need to break it apart,' Hartig says. 'It's very rigid and you have all kinds of different materials. There are cobs, stalks, leaves – very different mixes.'

The synergies with and support of the existing ethanol producers is crucial to the success of new ethanol plants in a very concrete way. Kior's main plant is a standalone facility in Mississippi that uses Southern Yellow Pine as a feedstock. It also did not leverage existing ethanol plant infrastructure. This fact shows why the threat of volumetric reductions to renewable fuels standards is so dangerous. Abengoa, DuPont and Poet-DSM all utilise existing ethanol infrastructure and a residue from conventional corn production that farmers are familiar with. For now, Kior cannot make ethanol out of woodchips with the quality and yield needed to pay its debts.

Could the same thing happen to Abengoa, Poet-DSM or DuPont when they face production milestones? There are certain aspects of each's operation that still face tests using novel agricultural techniques, engineering plans and technologies. Even with corn stover, inventing new collection methods was necessary because no infrastructure has ever existed to move it.

It was discovered that the infrastructure built to support conventional ethanol production from corn held the answer. This means that DuPont, Poet-DSM and Abengoa are all relying on the ethanol industry's existing assets to make the next generation of biofuels technology commercial. This is no coincidence.

In a recent study, researchers from DuPont Cellulosic Ethanol and Iowa State University found they were able to reduce the cost of moving corn stover from \$91 (€65) to \$52 per tonne, a reduction of about 43%. The cost of \$91/tonne represented the equivalent of over \$1/ gallon of ethanol, just for the feedstock logistics cost.

'That's before you have to pay for the plant, actually run the plant, distribute the fuel and get it ultimately to an end user,' explains Matt Darr, Iowa State University associate professor in agricultural and biosystems engineering.

There were several areas where savings could be achieved: shrinking the production area with information technology

maximised collection; improving baling systems for higher density; and reducing the quantity of in-field machinery all cut costs. DuPont is building its facility next to Lincolnway Energy in Nebraska, another first generation facility that will support the production of cellulosic ethanol from corn stover.

On the ground

Fuel from waste has been the quest for so long, some wondered if it ever was going to happen. In Hugoton, Kansas, however, the pace of construction has picked up to complete Abengoa's new cellulosic ethanol plant.

Abengoa sees 2014 as culminating in a decade's worth of struggle and sweat. 'The commencement of our demonstration plant took place in 2003. That was followed by the pilot-scale facility in Nebraska, and the Hugoton site has been under construction since 2011,' Christopher Standlee, Abengoa Bioenergy's US CEO, says.

Abengoa chose Hugoton because weather in the southwest corner of Kansas is dry and predictable (moisture and humidity cause feedstock degradation), meaning it did not have to invest in additional storage infrastructure. 'That makes a difference,' Standlee says. 'We can store it out in the open.'

The Hugoton site can accommodate the sheer volumes of biomass required. 'We need 1,000 tonnes a day,' Standlee reveals. 'This isn't just a cellulosic ethanol plant, it's also a power facility. It's a self-contained environment, so we need a large amount of material.'

In addition, there is a convergence of feedstock sources in the southwest corner of Kansas. 'For multiple crops,' Standlee says, 'the corn in southwest Kansas is irrigated. That means there are more plants per square

foot, a lot of stover and more cellulose. There's grain sorghum, milo stalks, wheat straw, prairie grass. There's also a pilot switchgrass farm. Hugoton offers a multitude of dedicated, ideal feedstock, and as a result we are not dependent on one source – it's an ideal location.'

The uncertainty of the RFS has given new importance to Abengoa's business plan, with Standlee explaining: 'We've been on the ground with offices in Hugoton for some years. It's a new team, new feedstocks, a new deal altogether. We're not going to just make cellulosic ethanol, this facility gives us flexibility and diversity to be more productive and make a lot of different things – jet fuel, plastics and chemicals.'

One plus one

Abengoa and Dyadic's partnership is one similar to that of Poet-DSM – a construction and engineering company and an enzyme specialist.

What interested DSM in Poet was that, as a partnership, the companies fit together seamlessly. 'One of our key drivers as a company is sustainability, not only as a company policy but as a business driver. So for 10 years we've been working on applying our life sciences and enzyme expertise to ethanol,' Hartig says. 'There wasn't a lot of overlapping in our partnership with Poet, they know the process and the ethanol market and we know the biotechnology.'

The rise of the interest and involvement from the specialty chemical sector has been a bright spot for the ethanol industry, which needs big backing if it is going to keep fighting for market share from the oil majors – at the pump and in the courtroom.

BASF, DuPont and DSM have a combined market capitalisation of near \$170 billion. While these are some of the biggest companies with

integral biofuels departments in the world, considered to have deep financial, research and industrial power, consider that Exxon Mobil's market cap alone is over \$422 billion.

The commitment of big-cap companies will continue to influence the success of ethanol, and that is what makes the entrance of BASF so exciting, according to Dyadic's Emelfarb. BASF, a company 50 times the size of Novozymes, is now positioned to catch up to its rivals in the second generation biofuels space.

'By licensing Dyadic's technology and buying Verenium, which has spent 20 years compiling one of the best gene libraries out there, BASF is putting together the pieces without having to invent everything themselves,' he explains. 'You need distribution, licensing, market power. That's why we are working with some of the biggest companies out there. C1 has a better genetic makeup than trichoderma. We think we have found something superior to trichoderma and so do the Abengoa's and BASF's of the world.'

Enzymes are getting quicker, faster and cheaper, and ethanol companies are becoming increasingly educated about their synergistic effects.

Abengoa has been able to greatly reduce the cost of making cellulosic ethanol, Emelfarb says, but for the EPA the progress has probably been slower than expected.

That is no reason for EPA to change the RFS.

'They should leave the target if the product is available,' Emelfarb believes. 'By leaving it in, they force the oil companies to spend more on R&D. Abengoa's plant in Hugoton is costing \$400 million.'

Abengoa, whose stock price of €4.06 has been climbing steadily since construction on its Hugoton plant accelerated, is using Dyadic's C1 enzyme platform in its Hugoton process. In March, Dyadic was awarded two new patents for turning biomass into sugar, the building block of cellulosic ethanol.

Abengoa took a license of the C1 platform for \$5.5 million in 2006 and has since become Dyadic's largest single shareholder. Along with BASF, Codexis is another major licensee, who spent \$300 million to have access to Dyadic's C1 platform.

Here and now

But deals, new partnerships, R&D and cellulosic ethanol production cannot continue

without the support of corn ethanol producers. It is a theme that industry leaders are stating over and over again as the EPA prepares to act on its proposed rule.

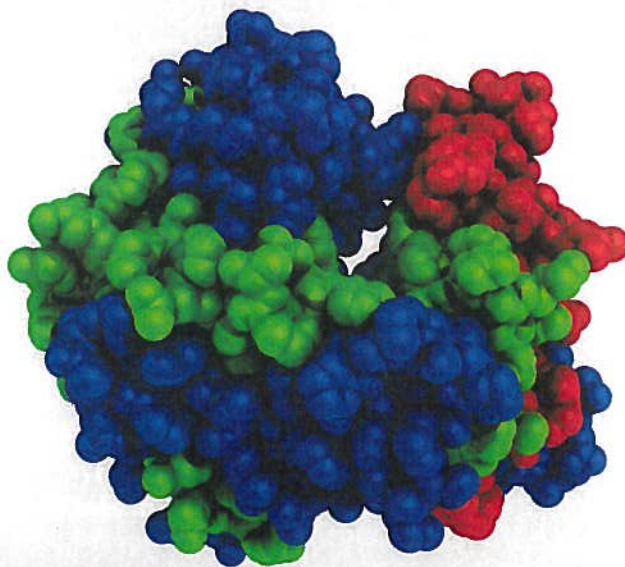
'Investments in first generation biofuels plants are not a priority,' says Standlee. 'First generation biofuels are inextricably tied to second generation biofuels and we expected investments for second generation plants to be done largely by those first generation producers.'

EPA's proposal asks first generation producers to strand millions of dollars of investment to advance second generation biofuels, according to Standlee, who notes that this puts a box around the ethanol market and pushes the first generation to compete with the second generation for market share.

'EPA has put into question the administration's support of this policy, which we're only five years into a 15-year plan,' Standlee says. 'This will significantly impact and make it almost impossible for existing biofuels producers and new investors to have the confidence that a market will be there in order to invest a large sum of money for a new facility.'

When his company helped complete the start-up of the world's only operating commercial ethanol plant in Crescentino, Italy, Novozymes CEO Peder Nielsen said: 'It is here, it is happening.'

It is this message that the ethanol industry needs to reinforce to Congress and the EPA. The ethanol market in 2014 will be defined by the start up of these major cellulosic ethanol plants that can produce a combined 75 million gallons per year. Their success will change the investment priorities of the entire ethanol industry and free the fuel from attacks against its impact on world food and feed supplies. It is here, it is happening. The EPA should take notice. ●



A cellulose enzyme that is being engineered by Dyadic and others to produce renewable fuels and chemicals