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Industry Brief

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Renewable Energy and Clean Technology - Fuels and Chemicals: Industry Tidbit

Hope Springs Eternal: Cellulosic Project Gets Underway in Canada - First Such Approval in Years

- We periodically get the question: What has been the number-one disappointment in renewables? The short answer is: wave power. Worldwide, nearly all of the efforts in that field have ended in failure. A close second, though, would have to be cellulosic biofuels. Much hyped as recently as three or four years ago, the scale-up of cellulosics has been drastically below expectations. This is not an issue of whether oil is $100/Bbl or $50/Bbl – in fact, among petroleum substitutes cellulosics were supposed to be the most insulated from commodity prices. Rather, it's been a series of mechanical and operational mishaps – put bluntly, plants that just don't work – that resulted in a nearly total absence of cellulosics from the present-day fuel market, even as conventional ethanol and biodiesel are being produced in record quantities. There is no denying that stark reality, but that does not mean that cellulosics are altogether hopeless. Today we profile a rare bit of good news from this space: namely, the decision by Canada-based Ensyn (which we originally profiled in 2014) and its partners to move forward with the construction of a commercial-scale cellulosic plant in Quebec. We take this opportunity to provide an update on the space.
- **Why do cellulosics have such trouble scaling?** In the U.S. market, the EPA is enforcing 230 million gallons of cellulosic biofuel blending for 2016, whereas the Renewable Fuels Standard statute nominally requires 4.25 billion gallons. Why is there a 95% haircut? Because the other 95% of the gallons simply do not exist. In fact, most of the 230 million gallons will probably come from landfill gas (e.g., produced by the likes of Clean Energy Fuels) rather than "textbook" cellulosic biomass. In the table on page 2, we show all of the currently operating cellulosic plants around the world: five in North America, two in South America, and one in Europe. Their aggregate capacity is 121 million gallons, essentially the size of one large corn ethanol plant. We use the word "operating" rather loosely: most of these plants are producing far below their nameplate capacity, if at all. Case in point: the INEOS Bio plant in Florida has not published an operational update since September 2014, surely not a good sign. (Abengoa's Kansas plant is not shown in the table because it has been officially shut down since December 2015.) As we noted at the beginning, the central problem for these facilities is not the backdrop of low oil prices. Of course they would all prefer higher oil prices, but the economic premise of cellulosics was to have an underlying cost structure that could compete with Gen1 biofuels even at low price points. For example, a common target for cellulosic ethanol was to produce at a cash cost of $1.00 to $1.50 per gallon. At the time of our Green Plains Partners comment from May, corn ethanol was trading at $1.50/gal, and it has since bounced further to $1.60/gal. Thus, in theory, cellulosic peers could be cost-competitive. In practice, though, scale-up difficulties with the underlying technologies have proven too onerous. Notably, mechanical and operational mishaps have materialized with both kinds of processes: bio-based (fermentation) as well as thermochemical/catalytic. Simply put, it is very difficult to name real winners to date in this space.
- **What gives Ensyn the confidence to move forward with expansion?** Ensyn's existing plant in Renfrew, Ontario is quite small (3 million gallons), but it has the distinction of operating on a steady-state basis, and selling actual product (biocrude) to actual customers in the U.S. and Canada. This plant was expanded in 2014, and Ensyn's technology has been in commercial use for over two decades. Thus, in contrast to peers, there is a long-standing operational track record. As such, Ensyn and its partners (Arbec Forest Products and Groupe Rémabec) today announced that they have made a final investment decision to approve construction of 10.5 million gallon plant in Port-Cartier, Quebec. Alongside the partners, financing for this project is also coming from Canada's federal government and Quebec's provincial government. Why is this project approval so notable? Because, to our knowledge, this is the only commercial-scale cellulosic biofuel project that has gained approval anywhere in the world over the past two years – in other words, since the time that many of the other plants' travails became clear. Needless to say, numerous other cellulosic projects are on the drawing board – but most of them have been unable to secure financing, given the obvious difficulty of convincing investors about technological viability. Thus, it is encouraging to see at least one company moving forward with capacity expansion – though we would caution readers that one positive datapoint does not a trend make. Ensyn's Quebec plant is targeted for completion by year-end 2017 – stay tuned.

Please read domestic and foreign disclosure/risk information beginning on page 3 and Analyst Certification on page 4.

Commercial-Scale Cellulosic Biofuel Production Facilities

Location	Company	Capacity (MMgy)	Production Type	Fuel Product
Crescentino, Italy	Beta Renewables	20	Enzymatic	Ethanol
Vero Beach, FL, U.S.	INEOS Bio / New Planet Energy	8	Gasification	Ethanol
Edmonton, AB, Canada	Enerkem	10	Gasification	Ethanol
Emmetsburg, IA, U.S.	POET / Royal DSM	20	Enzymatic	Ethanol
Alagoas, Brazil	GranBio	20	Enzymatic	Ethanol
Piracicaba, Brazil	Raizen / Iogen	10	Enzymatic	Ethanol
Nevada, IA, U.S.	DuPont	30	Enzymatic	Ethanol
Renfrew, ON, Canada	Ensyn	3	Non-catalytic thermal	Fuel oil

Source: Company reports

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Underperform (Sell)	5%	2%	0%	14%	2%	0%	0%	0%

* Columns may not add to 100% due to rounding.

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