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BIOFUELS: WHAT'S IN THE PIPELINE?

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THE BIOFUELS PIPELINE

BY SHAUN LESLIE TURRIFF

Canadian companies are laying the groundwork for a wood-based biofuels sector. This pipeline may never deliver ethanol for passenger cars but it can heat businesses, fuel fleets of trucks and airplanes, and power industrial processes.

Several commercial and near-commercial opportunities for liquid and gaseous wood-based fuels are being explored by pulp and paper companies. Cutting edge mills are diversifying from their core product into co-products that make novel use of wood fibres, exploit the chemical backbone of lignin, or capture the energy value of waste wood.

In Canada, Kruger, Domtar, Resolute Forest Products, Alberta-Pacific Forest Products, and AV Group have all taken steps to join the bio-products market. They are keeping Canada at the front of the pack in the global forest industry.

The list of avenues under exploration in Canada is impressive: gasification for process heat, pyrolysis for fuel oil, lignin extraction, crystalline nanocellulose, cellulose filaments, C5/C6 sugars, and biomethane.

Enlarging the vision of biofuels

The iconic imagery of a gasoline pump attached to a tree isn't likely. Warren Mabee, a biofuels expert from Queen's University, has concluded that ethanol cannot be competitively produced from trees in North America.

Nevertheless, Donald Smith, BioFuelNet Canada, suggests that in the new bio-economy, biofuel should be the focus, with other bioproducts as co-products of the biofuel production.

Mabee and Smith were among the experts speaking at PaperWeek Canada, which had several bio-economy presenta-

tions and was co-located with the International Forest Biorefinery Symposium.

DeWitt Patterson, AMEC, explained that investment in biofuels plays an important role in hedging against future oil price fluctuations, an important consideration for the airline industry. A movement away from oil has also prompted recent news that the U.S. Navy has successfully developed a means of producing a hydrocarbon fuel from seawater.

The development and profitability of biofuels are still closely tied to matters of policy, as shown by the recent debate in the U.S. over the upcoming renewal, and possible weakening, of renewable fuel standards (RFS2), and in comments by speakers at PaperWeek 2014 who criticized Canada's policies, including Sten Nilsson and Mabee. Nilsson also noted that political will towards a world bio-economy is eroding in Europe. Nilsson, a consultant with Forest Sector Insights AB, argued for the necessity of a fundamental change to our patterns of production and consumption.

However, several presentations by government offices suggest that Canadian policy is headed in the right direction, despite the dire warnings. The success and continued funding of the IFIT program is one such indication.

Two other presentations also spoke to the future potential of biofuels. Patrice Mangin, UQTR, reported on studies concerning mobile pyrolysis units, to produce easily transportable bio-oil at the site of harvest, saving substantial feedstock transportation cost. Julie Barrett, NRCan, discussed the potential for using dead fall in bioenergy production, after it has become unsuitable for pulping.

Commercial success in Ontario

Developments since PaperWeek wrapped up point to the growing importance of biofuels in the emerging bio-economy. Pyrolysis is emerging as a competitive means of producing so-called "drop-in", or advanced, biofuels. These fuels, unlike ethanol, can be used in existing transportation and refining infrastructures.

Ensyn is undertaking a \$4-million expansion to upgrade its existing production facility in Renfrew, Ont., to a dedicated biofuels facility with enhanced production capacity of 13 million litres/year of a liquid biofuel. Ensyn uses its Rapid Thermal Processing (RTP®) technology, a pyrolysis process, to produce RFO™ for sale as heating oil or as a refinery feedstock for production of gasoline and diesel in an application known as refinery coprocessing. CRIBE, a provincial research corporation, will invest

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up to \$1.5 million to the expansion project.

Ensyn's Renfrew plant has recently been qualified under the U.S. renewable fuel standard, RFS2, and the company has signed a five-year deal with Memorial Hospital of North Conway, New Hampshire, to supply heating oil, displacing 100% of Memorial's petroleum heating oil.

Renfrew's qualification under RFS2 has accelerated customer demand from U.S. clients. Ensyn expects that sales of RFO from Renfrew to U.S. customers will qualify for

Renewable Identification Numbers (RINs) under the RFS2 program, enhancing contract economics.

Ensyn's Renfrew facility has been in operation since 2006, applying Ensyn's RTP® thermal conversion process to convert cellulosic, non-food biomass to liquids. Commercial operations to date have focused on the production of specialty chemicals and heating fuels for certain applications.

"This project represents a critical step in our biofuels development process," said David Boulard, president of Ensyn Technologies. "Although Ensyn has had commercial operations for many years, and while the Renfrew facility has served us well as a commercial merchant facility for contract production and business development, Renfrew will now serve as our first commercial facility dedicated to biofuel production and will allow us to accelerate the development of market demand."

Ensyn is also developing additional projects in the US and in Brazil. Ensyn's



Ensyn's pyrolysis facility.

Photo: Ensyn

model is to partner with fiber owners in the development of their biofuel projects. In Brazil, Ensyn has partnered with Fibria Celulose SA, the world's leading market pulp producer. Fibria has announced the location of the first Brazilian project, at their 2.3 million ton/year mill in Aracruz.

In addition, Ensyn is developing its roll-out plans in a strategic alliance with UOP, a Honeywell company. UOP, through Envergent Technology, its joint venture with Ensyn, provides Ensyn's RTP conversion facilities to Ensyn's projects, with performance guarantees, and UOP also supports

Bioproducts a focus at PaperWeek

Many presentations at PaperWeek Canada and its affiliated International Forest Biorefinery Symposium covered potential options for the future bio-economy.

An interesting presentation by Mariana Royer, BioForXtra, introduced the possibility of forest product extractives. Extractives, which are chemical compounds such as terpenes and polyphenols, can easily be removed before other processing without affecting yields downstream. Used in the pharmaceutical, nutrition, and cosmetics industries, the potential combined market for these chemicals is very large, and is expected to grow. Royer emphasized the need to build bridges between the forest products industry and the chemical industry in exploiting these value-added chemicals.

Christina Rueda, University of Cantabria, estimates that the conversion of sugars obtained via membrane separation from a sulfite process into furfural could have a pay-back period of one to three years. Similarly, Sudip Rakshit, Lakehead University, examined the fermentation of poplar sugars into xylitol.

Charles Chunbao presented on using lignin to produce polyurethane biofoam, with promising results, although the quality of the biofoam is not yet high enough to make it a replacement product.

Fatma Mechmech, INSAT, examined the production

of butanol, a potential biofuel for jet engines, using wood hydrolyzate and alfalfa juice.

Pedram Fatehi, Lakehead University, looked at the NSSC process and the potential for integrating a biorefinery process using the spent liquor, currently a waste product.

Sourour Ben Cheikh examined the use of syngas in an integrated biorefinery, which remains a viable option for replacing fossil fuel use and for the production of co-products. Cedric Briens, Western University, looked at the production of biochar, a replacement for activated charcoal, using a new form of reactor, and Murray Thomson, University of Toronto, focused on the potential for using bio-oil directly in burners and engines.

Discussing high level market drivers and challenges, Roger Gaudreault of Cascades said during PaperWeek that the bio-economy is becoming increasingly relevant, addressing environmental concerns and a growing world population. Gaudreault stressed the need for an innovative mindset among industry and government leaders, as well as cooperation and partnership with the oil and gas industry, whose knowledge and infrastructure are vital to the future of the bioeconomy. Innovation and partnership with other industries, especially the oil and gas and chemical industries, was also a central message delivered by Sten Nilsson, Forest Sector Insights AB.

Ensyn in the commercial development of refinery coprocessing opportunities.

Another pyrolysis project was recently announced by a consortium in Finland. Valmet, UPM and Fortum have partnered to develop transportation and heating fuels, as well as high value bio-liquids, from woody biomass. The five-year development project will use a catalytic pyrolysis technology called LignoCat to upgrade bio-oil.

Valmet is also involved with the Gothenburg Biomass Gasification Project in Sweden. This pilot project aims to gasify forest product residue into high quality biomethane to be mixed with natural gas and supply gas-powered transportation vehicles. The combination of gasification and methanation is a world first. (See page 22 also).

But wood-based biofuels remain a risky business. Several advanced biofuels startups in the United States are nearing, or have just begun, commercial production. KiOR is one of these, making advanced biofuels via pyrolysis from various non-food feedstocks including woody biomass. In March, the company announced it may not be able to continue business as a going concern due to losses. It later secured financing from an investor for a few more months while the company works to secure further financing and keep its doors open.

Wood-based chemicals also secure investment

One of the bioproducts success stories at PaperWeek this year was an update by Bruno Marcoccia, Domtar, about its commercial scale demonstration plant that produces and sells lignin under the trade name Bio-Choice™. Using Valmet's LignoBoost™ system, Domtar's Plymouth, N.C., pulp mill is currently manufacturing commercial quantities of lignin on a continuous basis, with a goal of 30,000 tons/year. Marcoccia said that the lignin removal is the first stage of a multifaceted project. The next phase is the fermentation of C5/C6 sugars derived from low-cost available feedstocks into value-added products.

Marcoccia was careful to mention the importance of Domtar's partnerships in this venture, with roughly 20 sponsored sub-projects and a sizable grant from the USDA-DOE Biomass Research Development Initiative.

Domtar's careful integration at the

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Coal to biomass conversions – a materials handling challenge

As renewable energy continues to gain popularity among some power producers in the United States, several power plants are being converted to use biomass. Some municipalities, utilities, private developers, and coal-powered electrical generating plants are prioritizing a biomass conversion as their primary fuel source since they are able to make use of existing assets and a well-established means of distribution.

Bruks has supplied equipment to several converted plants now producing power in California and Virginia. These plants introduced more than 100 MW of biomass power over the past two years, requiring a substantial amount of woody biomass. DTE and Dominion Energy, where the conversions were implemented, opted for high-capacity, fully-automated designs in their wood yards.

There is a distinct difference between handling coal as compared to wood waste. A typical power plant can consume upwards of 500,000 tons of "green" wood chips on an annual basis. Receiving, processing and storing this volume of wood can be challenging, and requires a drastic change from typical coal yard operations.

The new, state-of-the-art wood yards include truck dumpers, conveyors, screens, hogs and stacker reclaimers. This equipment is not a novel idea, however, the installations capitalize on years of engineering practices for handling true "wood waste" materials. In most cases, material classified as "wood waste" is non-uniform in size and is quite often contaminated with non-desirable materials. The wood yard design must overcome these characteristics, providing uninterrupted material flow to the processing system.

The most significant impact of changing feedstock is the actual space required for a biomass system as compared to a coal system. The typical wood yard can consume upwards of five acres of real estate as compared to a coal yard that can often be as simple as a single silo and contained on one acre or less.

A biomass-fuelled facility also needs to receive biomass by truck, and then store and recover the bulky and wet material. The biomass is screened before sizing it to the boiler's requirements. The biomass must be delivered at consistent rates for base-load power generation. Modifications to the boiler, ash-handling system, exhaust gas processing, and many other changes are also required.

– Contributed by Bruks, www.bruks.com

Plymouth site (which had available black liquor due to a bottleneck and a change of pulp grade) and choice of LignoBoost as a pathway (robust and commercially available technology), along with the importance of partnerships, echoes many of the strategies that theorists and analysts have been discussing for the past few years with regard to developing bioproducts.

Kruger and FPInnovations spoke at PaperWeek Canada 2014 about a new bioproduct, cellulose filament (CF), and the construction of a demonstration plant at Kruger's Trois-Rivières location. Kruger sees CF as having potential both within the pulp and paper industry as a cost-saving strength additive, and in other industries, such as thermoplastics, thermosets, adhesives, non-wovens, and coatings.

A key point in FPInnovations' presentation was the very short time scale of this program, influenced by their funding partner, IFIT. The project has gone from lab to demo scale in only four years, a clear sign, according to Jean Hamel of FPInnovations, that innovation is key to the future of the bioeconomy. Kruger also highlighted the importance of a grant from NRCAN, under the IFIT (Investment in Forest Industry Transformation) Program. Speaking later, Jean-François Levasseur, NRCAN, discussed IFIT's successes, including 14 projects in Canada. The IFIT program was renewed in the most recent federal budget.

Clearly, the "forest biorefinery," which five years ago was an academic construct with a dizzying array of possibilities, is beginning to take shape in Canada. **PPC**

Biomass gasification plant serves transportation sector

A Valmet-supplied gasification plant at GoBiGas (Gothenburg Biomass Gasification Project) will produce biomethane gas by gasifying forest residues and wood pellets. The biomethane is similar to natural gas and will primarily be used in the transport sector. The new plant is first of its kind in the world.

Johanna Lindén, Valmet's director of Scandinavia, Energy, explains the advantages of the chosen technology: "The indirect gasification generates high-energy gas with high heating value that can be mixed with natural gas. This makes it possible to replace a lot of today's fossil transportation fuel by fossil-free fuel in gas-powered vehicles."

The biomass is gasified in a process called indirect gasification, developed by the Austrian company Repotec. Valmet is

handling the engineering work for the gasification plant in Gothenburg with a license from Repotec.

Gasification takes place in a separate reactor and heat is transferred from a combustion chamber by circulation of hot bed material, i.e. indirect gasification. Biomass is fed into the gasifier where, on contact with the hot bed material, it undergoes thermochemical decomposition. After the cleaning and methanation, the gas is imported to the natural gas supply and is used in Göteborg Energi's power plant.

Because of the high quality, the biomethane can be fed to the existing distribution grid, where it is mixed with natural gas. Valmet says combining a biomass gasification plant with a methanation plant is unique in the world.



Photo: Valmet

The GoBiGas gasification plant in Sweden is the first to combine a biomass gasification facility and methanation plant.

Lafarge cement operations will test torrefied biomass as substitute for coal

A commercial demonstration of the use of biomass-based solid fuels instead of coal at cement plants or coal-fired utilities in British Columbia has received funding of \$1 million from the BC Bioenergy Network.

BC Bioenergy Network, a provincially-funded organization supporting the bioenergy sector in British Columbia, will support Diacarbon Energy Inc.'s demonstration of its Torrefaction Bioreactor Technology. Diacarbon will produce a renewable and sustainable biocoal derived from wood residuals that will displace coal used by Lafarge Canada's cement operations in B.C.

The total project investment is \$9 million.

The project involves the establishment of a fully automated torrefaction facility which will process wood residuals. Torrefaction, the process of heating biomass materials at elevated temperatures in the absence of oxygen, results in transforming wood into a material possessing the energy value and processing characteristics of coal, with a significantly lower carbon footprint.

Jerry Ericsson, president of Diacarbon, announced that this new technology follows several years of technology and product development in B.C., where a trial demonstration plant has been in operation. "We are proud to be building the first Canadian

commercial biocoal facility in B.C. This is just the first step in deploying torrefaction technology in B.C."

AV Terrace Bay will test method to extract sugar from biomass

CRIBE is partnering with GreenField Specialty Alcohols to test and develop a biorefining technology that could be applicable to pulp mills.

The project will take GreenField's patent pending equipment – a modified twin screw extruder used to extract and recover clean sugars – and apply it in a pulp and paper mill demonstration project at two mills, one of which is AV Terrace Bay Inc., in Terrace Bay, Ont.

CRIBE is providing up to \$1.3 million in funding to this project to leverage a total project cost of almost \$2.7 million.

This project has two phases. Initial testing will be done at Greenfield's facility in Chatham, Ont., with "streams", i.e. wood chips and by-products of the pulping process such as sludge and white water, to be partially provided by AV Terrace Bay Inc. In phase two, a portable version of the modified twin screw extruder technology will be installed for testing in situ at the AV Terrace Bay mill.

"GreenField is most appreciative of CRIBE's support to advance and accelerate the development and commercial deployment of its extruder technology; and is

pleased and excited to partner with CRIBE to adapt this technology for applications that will benefit the pulp and paper industry," said Barry Wertzman, vice-president of business development, GreenField Specialty Alcohols Inc.

Ensyn planning commercial-scale production of biofuels in Ontario

Ensyn is undertaking a \$4-million expansion to upgrade its existing production facility in Renfrew to a dedicated biofuels facility with production capacity of 13 million litres/year. The site produces a liquid biofuel that can be used as a heating fuel and as a feedstock for the production of gasoline and diesel. CRIBE, a provincial research corporation, will invest up to \$1.5 million to the expansion project.

By enhancing its existing facility in Renfrew, Ensyn will have a fast-to-market option for delivery of its petroleum-replacement liquid biofuel produced from forest residues to heating oil customers in Quebec and Northeastern United States.

The capacity increase is being carried out in order to meet immediate demand for Ensyn's biofuel, RFO™, from clients in Canada and the US. On March 7, Ensyn announced that it had signed a five-year contract with Memorial Hospital of North Conway, New Hampshire, for the supply of RFO to be used as a heating fuel, replacing petroleum-based fuels. **PPC**