A Compelling Case for Integrated Biorefineries (Part I)

As the world fast runs out of oil and gas, U.S. renewable fuel needs outgrow the capability of corn-based ethanol and require the use of "second-generation" biofuels

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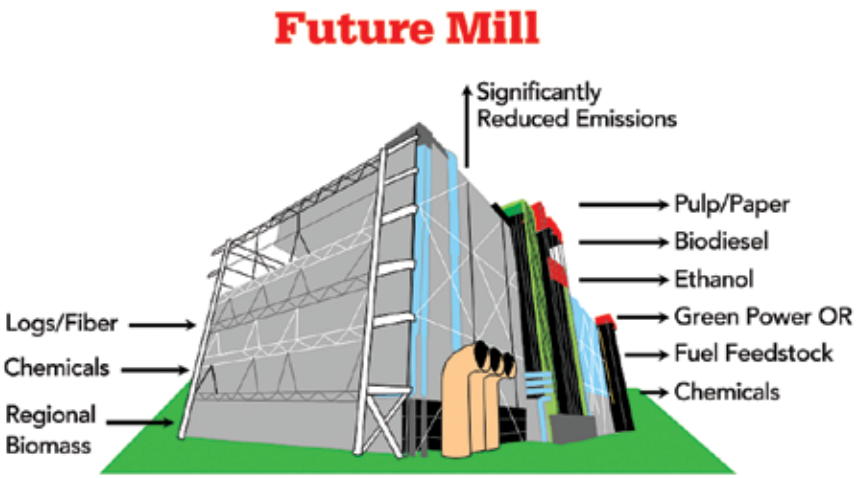
According to a report by Lee Raymond, former chairman of Exxon Mobil and head of the Federal Energy Council, if the world continues to increase its use of oil and natural gas at the current rate, supplies will eventually be inadequate. This will lead to a rise in prices until supply and demand balance, and the development of alternative fuels.

In the U.S., the most predominant "first-generation" biofuel is ethanol derived from corn, followed by ethanol derived from hemicellulose at sulfite pulp mills and biodiesel derived from vegetable oil or animal fat. "Second-generation" fuels include renewable gasoline and diesel, cellulosic ethanol and fuel feedstock made from catalytic reactions like the Fischer-Tropsch.

Liquid biofuel that can supplement transportation fuels is becoming one of the best options for energy independence and needs to become a national priority.

The forest products industry has the commercial skills and resources critical to this emerging industry, and is on the verge of awakening to the opportunities. What remains is to sort out real opportunity from volumes of information containing far too much hope and hype.



Forest Biorefinery

THE BIOREFINERY

The average U.S. integrated pulp and paper mill has a thermal demand of ~40% fossil fuel and ~60% biomass, which is largely met from combustion of black liquor. With a biorefinery, there is no longer an input for fossil fuel-based energy, since the pulp and paper facilities run on recovered heat. This "heat sink" aspect of integration is vital because it represents a critical revenue stream for the biorefinery. It also reduces capital investment and improves the environmental footprint by reducing the need for cooling towers. More importantly, it drastically cuts CO_2 emissions from the "steam host." The outputs include pulp and paper, plus one or more "green" fuels or chemicals. Power input will be an option determined by its cost versus the value of other output streams.

FAR-REACHING EFFECTS

One of the fascinating aspects of a forest products biorefinery is its potential life cycle and what it can do for the life cycle of potential steam hosts.

In the older industrial states, many mills are near the end of their life cycle. The same is true of older mills in the south like St. Francisville, LA, built in the late 1950s and early 1960s and now shut down. These mills can be abandoned, but this can have a devastating effect

on the mill town and supplier infrastructure, and a negative impact on the corporate balance sheet. Furthermore, operating permits are lost.

Adding a biomass-to-fuel facility can drastically reduce costs to the "host mill." Something in excess of 2 to 3 trillion BTUs of steam can be recovered from the gasifier, gas cleanup and Fischer-Tropsch unit and sold to the host mill at a lower cost than steam generated by fossil fuel (there are only four fossil fuel-free mills in North America).

Infrastructure—like accounting, HR, purchasing, logistics and effluent systems—can be shared. For example the process described used 1.56 gallons of water per gallon of fuel. (As a benchmark, the best corn ethanol produced requires more than 11 gallons of water per gallon of ethanol and 18 gallons of water per "equivalent gallon" [the amount required to hold the same BTUs as a gallon of Fischer-Tropsch liquid]).

It is expected that most mill systems can handle this within current permit limits. All of this can add more than a decade to a mill's life, without any disruption to the mill's main business—the fiberline. The production cost of Fischer-Tropsch liquid in a modest-sized unit with forest residuals at $50 per bone dry ton, is less than $1 per gallon.

After a decade or so, we will have learned how to extract hemicellulose from chips prior to processing in a way that reduces pulping energy at no loss in yield and strength. (I have seen lab results that achieve this and will be pleased to share the source of this development work.) We will also have the mill skills and perhaps even the corporate will to add a second biorefinery, which will add more decades to the life of the facility.

After several decades, we will have learned how to gasify black liquor and gain 10% to 20% more useful energy. Now the revenue stream from renewable energy streams equals or exceeds that from pulp and paper. More importantly, more decades have been added to the life of the facility.

At any point during this exciting transformation, we may need to curtail paper production. We are likely to have several choices. The easiest to visualize is that the steam that went to the paper machine now goes to a steam turbine and the facility sells green power to the grid, probably at a premium over conventional power. Other alternatives include converting pulp into market pulp or turning the cellulose into more ethanol (as Lignol will have been doing at its facility for a decade or so).

Next the facility can work on product development since fuel is one of the cheaper output steams and is currently a focus because of market demand and federal incentives. There are a host of products that can be made from the new process streams and they have selling prices of 3 to 10 times that of fuel. Exploiting this now adds even more decades to the facility life, and pulp and paper is now a minor revenue stream.

One of the best aspects of a properly managed biorefinery is that it is likely to have a lifetime that greatly exceeds that of a brand new tropical pulp mill that remains a pulp mill.

(This is the first of a 3-part series that will discuss the various "pathways" forward and how recent recipients of Department of Energy grants intend to proceed.)

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Learn more about the latest developments in biofuels

The spring meeting of the Biorefinery Deployment Collaborative (BDC) for members and invited guests is April 10-11, 2008, at the USDA Forest Products Lab (FPL) in Madison, WI. The main focus will be on the latest commercial biorefinery developments, a review of current federal policies and incentives, investor perspectives on biorefinery technologies and projects, and an update from NewPage on its recently Department of Energy-funded (US$30 million) integrated biorefinery project.

Speakers include Doug Cameron, Khosla Ventures, LLC; Bill Hancock, Verenium Corp.; Doug Freeman, NewPage; Eric Apfelbach, Virent Energy Systems; Gerson Santos-Leon, Abengoa Bioenergy; David Hogsett, Mascoma; Wes Bolsen, Coskata, Inc.; Ted Wegner, FPL; Neil P. Rossmeissl, DOE; John R. Regalbuto, NSF; Paul N. Argyropoulos, EPA; Bob Wallace, NREL; and Frank Frassetto, USDA.

The meeting will include commercial exhibits from BDC vendor members Boldt, Andritz, Metso, Earth Care Products, Inc., Crane Engineering and Michael Best & Friedrich. The meeting will conclude with a tour of Virent Energy's biofuels pilot plant in Madison, which uses solid-state catalysts to transform biomass feedstocks into hydrocarbon-based products.

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