

Converting Wood Waste to Ethanol – A Strong Case for Pulp and Paper Mills

Heightened unrest by the public that US gasoline prices are hovering around the \$4 per gallon mark has renewed political interest in biofuels and re-energized the debate over what should be done.

By Tim Sklar



Although the price of oil has backed-off slightly from its high point earlier this summer, it's likely to continue its upward journey in the future, putting pressure on government to develop alternate sources for energy, including biofuels.

The world's increased demand for biofuels has been driven by environmental concerns and related legislation. Specifically, there are legislative mandates in effect in several states that require a phase-out of MBTE (methyl butyl tertiary ether), a fuel additive used in motor gasoline, and demand for ethanol is increasing as ethanol is being used in its place. It is true that increased production of biofuels, such as corn ethanol and biodiesel in the US has contributed to inflated commodity prices and prices for fertilizer, animal feed and food.

On a worldwide basis, although the percentage of biofuels being used is small when compared to fossil fuels, the amount of biofuels used is significant. Biofuels now account for less than 2% of liquid transport fuels, but they contribute an equivalent of 1 million barrels per day to world supplies. And biofuels are now being used to supply 30% of increased transportation fuels demand. In the US, 99% of our biofuels needs are being met by corn ethanol.

ENERGY INDEPENDENCE AND SECURITIES ACT

In recognizing the need for increasing our nation's use of renewable fuels, in late 2007, Congress recently passed the Energy Independence and Securities Act (EISA). Among other provisions, EISA established "Renewable Fuels Standards" with a mandate for having 36 billion gallons per year of renewable fuels produced in the US in fifteen years.

But, US DOE's Energy Information Agency predicts that current corn ethanol production of 9 billion gallons per year cannot be increased above 15 billion gallons, and it will take 10 years to reach that level. The 21 billion gallon shortfall built into the mandate by Year 2022 is expected to be filled from 2nd generation cellulosic biofuels—16 billion gallons of which is expected to be in the form of cellulosic ethanol.

In a March 17, 2008 article appearing in the Oil and Gas Journal, it was argued that EISA's mandate would in all likelihood not be met as it presumes that the private sector will invest \$80 billion over the next 15 years to build an equivalent of 291 large ethanol plants that would be needed to meet the 16 billion gallon/year cellulosic ethanol mandate. It is at this juncture where a case can be made for having the pulp and paper industry participate in cellulosic ethanol plant projects, using untapped wood waste as the feedstock.

There are many reasons why the pulp and paper industry is in the best position to exploit the ethanol potential of wood waste. This article will discuss the findings from a study conducted by my firm, Sklar & Associates (S&A)—a study we undertook for a proposed cellulosic ethanol plant

where two such technology providers had processes that were being successfully built to commercial scale. These findings present a strong case for pulp and paper mills to consider participation in wood waste to ethanol projects.



Verenium's demonstration-scale cellulosic ethanol plant in Jennings, Louisiana. Verenium and BP recently partnered to accelerate the development and commercialization of cellulosic ethanol technologies.

OVERVIEW OF THE PRE-FEASIBILITY STUDY

Our firm had previously been engaged in evaluating biofuels project proposals and performing due diligence reviews of business plans being used to obtain funding. In almost every biofuels engagement in which we were involved, we found that these projects all had fatal flaws that could not easily be remedied in a timely way. As a consequence, we undertook an initiative to develop a

biofuels project that could prove to be technically and financially viable.

Our basic research indicated that we should concentrate our efforts in defining wood waste to ethanol projects and concentrate our efforts in the Southeast to attract participation from among the many pulp and paper mills that operate in this region.

The following arguments were presented to interest mill managers in this region and ultimately, the mill owners.

- Cellulosic ethanol plants are being built that are technically and economically viable;
- Cellulosic ethanol plant development in the Southeast should be a priority because such plants would be strategically located to best serve the fast emerging increases in ethanol demand in PADD 1 markets;
- Wood waste is readily available to most mills in the Southeast, and mills have the infrastructure for obtaining, pre-processing and storing such waste;
- Partial integration of cellulosic ethanol plants to pulp and paper mills offers synergies that would reduce ethanol production costs while providing a new value stream for many mills;

- Oil industry participation in these projects could reduce investment requirements of mill owners and spread the risk, while offering oil companies opportunities for obtaining stable ethanol supplies and price certainty in acquiring such supplies.

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The presentation of these arguments was instrumental in getting the go-ahead from one mill manager to conduct a pre-feasibility study. This study would provide sufficient information for determining whether participation in a cellulosic ethanol project could generate a high enough “value stream” to be of interest to mill owners. The study would also consider whether it would be financially feasible for the mill to obtain a sufficient share of project cash flows with little up-front investment.

It was then agreed that this pre-feasibility study provide information and analysis to demonstrate that:

1. There is a ready and growing market for fuel ethanol and prices paid will continue to rise, providing excellent margin opportunities for converting wood waste into ethanol.
2. There is a supply of wood waste being used in the mill as a boiler fuel that could be diverted to producing ethanol, and there are also abundant untapped sources of wood-waste in close proximity that could also be used for producing cellulosic ethanol.
3. There is a ready market for all of the cellulosic ethanol that the proposed plant could produce.
4. The proposed cellulosic ethanol technology to be used is on the cusp of achieving commercial viability and will be available under license.
5. Synergies associated with partial integration of the mill to the proposed cellulosic ethanol plant will offer significant financial benefits to the resident plant as well as the host mill.
6. New government programs could offer a source of low cost debt to mill owners and significant financial support to wood waste sub-contractors.

7. Wood waste to be obtained will be a cost effective feedstock.
8. Participation in this cellulosic ethanol project by the mill may be critical to its survival.
9. The mill can afford to participate in this project with a small investment and at little risk if they partner with affinity investors from the oil industry.
10. Many leading companies in the US paper industry are pursuing strategies for participating in biofuels and those that are not may become less competitive.

THE PRE-FEASIBILITY STUDY RESULTS

The major finding of this study was the indication that a new significant value stream could be generated for the host mill, if the proposed project were undertaken. Listed below are nine favorable prerequisites that justified considering this project.

- The mill was located near a port with rail access, close to abundant untapped supplies of wood waste and strategic to serving PADD 1 markets using economical modes of transportation.
- The mill site was big enough to accommodate an ethanol plant.
- Mill owners indicated that they could “guarantee” that any additional environmental permitting needed, could be obtained without undue delay.
- The mill had excess boiler capacity to supply steam requirements of the ethanol plant.
- The mill could provide the ethanol plant’s waste treatment, water, and power needs at little or no cost.
- The mill’s wood procurement department was willing and capable of obtaining wood waste for the ethanol plant, and could guarantee a waste stream of at least 1,000 dry tons/day.
- Mill owners were willing to consider making a \$1 million investment in infrastructure upgrades to support the “partial integration.”
- Mill owners were willing to provide partial integration support over a five-year period in return for approximately 25% equity in the ethanol plant.
- Mill owners would consider co-signing on ethanol plant debt or providing debt financing.

Viability of the proposed project was demonstrated by:

- Obtaining proprietary “metrics” and cost estimates from technology providers and consulting engineers and selecting a process best suited to converting wood waste into ethanol;
- Obtaining mill engineering estimates on how best to perform the partial integration, what such integration measures would cost, and what value should be placed on partial integration support that would be provided each year;
- Obtaining confirmation of past and current ethanol prices and developing projections of expected future prices;
- Developing fixed and variable operating costs for ethanol plant operations;
- Developing alternative financing schemes;
- Developing a financial model to project revenues, earnings, cash flows and return on equity for small, medium and large cellulosic ethanol plants, then using the financial model to run sensitivity tests reflecting sets of optimistic, most likely and pessimistic assumptions; and
- Summarizing results obtained and drawing conclusions with respect to project viability.

After reviewing the various technologies that offered promise for processing wood waste, a dialogue began with a technology provider who had successfully demonstrated this capability and was willing to license their process. A confidentiality agreement was entered into and proprietary data was obtained for use in the feasibility study. This data was based on metrics of a specific plant that was under construction. Included were plant construction costs and the construction time-line, plant-operating costs, staffing requirements, steam and power requirements, and estimated ethanol yields from cellulosic wastes having a specified cellulose content. The data obtained from the technology provider was then scaled to reflect three plant sizes (see Figure 1). Data was also developed for each plant size to reflect partial integration of the plant to the host mill. Mill engineers provided estimates of amounts of steam the mill could supply the plant. A plant site was identified on land available at the mill. Estimated infrastructure upgrades were identified and cost estimates made.

Capacities and Costs of Ethanol Plants of Three Sizes			
	Small	Mid-Sized	Large
Feedstock Capacity (dTPY)	500	1,000	2,500
Ethanol Output (mmGPY)	10.8	22.1	55.2
Capital Cost (\$mm)	85	142	275
Capital Cost/Gallon	7.88	6.41	4.99

Figure 1.

Lease values were then placed on acreage to be used by the plant. Cost estimates were made for process steam, electricity and water supplied to be supplied the plant. Fair value estimates were made for support services that the mill would provide including, waste treatment and disposal, wood waste procurement, and materials storage and handling.

FINANCIAL MODEL

Using these data, a financial model was developed and projections run for each plant size. Sensitivity tests were performed using a variety of expected ethanol prices, and costs and yields for various mixes of wood waste and wood chips.

In order to meet the mill manager’s requirement to minimize the mill’s investment, it was estimated that up-front capital outlays for infrastructure improvements to support the partial integration would cost approximately \$1 million. It was also estimated that the “value” of the partial integration support to be provided by the mill would run between \$1.1 million per year for a small plant, \$2.1 million for a medium-sized plant and \$5.1 million for a large plant. It was envisioned that the mill would forgo collection of partial integration support costs for five years in return for equity in the ethanol plant. In this way, the goal of minimizing up-front investment could be achieved.

The study of ethanol pricing indicated that in recent years, ethanol prices were highly correlated to gasoline prices staying in a range of +/- \$.35/gallon of observed gasoline prices. It was also found that over a three-year period, although ethanol prices had varied widely, they had been trending upward and that the upward trend is expected to continue, due to the MBTE phase-out and to increases in gasoline prices. Although a recent average rack price for ethanol was at \$2.33/gallon, a lower ethanol price of \$2.23 was used in evaluating the economies of scale for the three ethanol plant sizes.

With respect to evaluating economies of scale, the sensitivity tests performed indicated that partial integration to a mid-sized plant appeared to be most economic of the three alternative sizes being considered. Because the mid-sized plant requires only 1,000 dTPD of wood waste, no expensive woodchips would be needed, giving a mid-sized plant a \$.24 per gallon direct cost advantage over a large plant.

Further, because the large plant’s feedstock requirement is 1,500 dTPD higher than a mid-sized plant, the mill procurement department expressed the concern that to acquire this additional amount of feedstock, they would run the risk of driving up the cost of the mills 8,000 dTPD “wood basket.” It was also estimated that the mid-sized plant had a \$.15 per gallon direct cost advantage over a small plant, reflecting its operating economies of scale. And as can be expected, the mid-sized plant exhibited the highest income per gallon and a higher cash-on-cash return (see Figure 2).

Financial Summary for Resident Partially Integrated Cellulosic Ethanol Plants of Three Sizes			
	Small	Mid-Sized	Large
Direct Cost/gallon	1.01	0.86	1.10
Operating Income/gallon	1.32	1.47	1.23
Avg. Ann'l Revenue (\$mm)	25.1	50.3	128.7
Avg. Ann'l Cash Flows (\$mm)	8.9	24.7	53.1
Mill's Percentage Equity	26%	27%	32%
Value of Mill's Equity (\$mm)	6.7	11.5	26.7
Mill's Share of C'Flows (\$mm)	2.3	6.7	16.4 (a)
Ann'l Mill Subsidies (\$mm)	1.1	2.1	5.1 (b)
Mill's Cash-on-Cash Return	2.1:1	3.2:1	3.2:1 (a/b)

Figure 2.

The bottom line of all of this is that the pulp and paper mill could receive a significant value stream, with a minimum investment, if it participated in the partial integration with a resident cellulosic ethanol plant. Mill owners realized that these pre-feasibility findings would have to be validated through conduct of a comprehensive feasibility study and due diligence review. Such a study has recently been proposed.

OIL INDUSTRY PARTICIPATION

Clearly, petroleum products refiners have the attributes for becoming “affinity investors” in cellulosic ethanol plant joint

ventures. Refiners run continuous processes, they handle volatile fuels, they market and distribute motor fuels, and they have an increasing need for ethanol in making E10 and E 85.

Likewise, major distributors and marketers of motor fuel have the experience in handling volatile fuels, in blending and distributing E10 and E85, as well as a need for large quantities of ethanol. These companies often have the resources to provide much of the equity and co-guarantee much of the debt that will be required. They are all looking for reliable sources of ethanol at stable prices. They are always seeking investment opportunities that offer high rates of return and shared risk. Participating in cellulosic ethanol projects with the paper industry should satisfy these needs. In addition, these companies employ personnel with the skill sets that could be of value to mill owners who are embarking on cellulosic ethanol projects.

ETHANOL OPPORTUNITIES IN THE SOUTHEAST

The implication of extending a project of this type to 21 other pulp and paper mills in the Southeast region is significant. It is estimated that at least six of these mills have similar attributes to the mill that had been studied. If each of these mills could host a mid-sized resident cellulosic ethanol plant, 120 million gallons per year of ethanol could be produced in four years, enough to meet 24% of the EISA Renewable Fuels Standard cellulosic ethanol mandate for the year 2012.

And there may be enough wood waste in the Southeast region to supply mid-sized plants at the remaining 15 mills. In fact, there may be enough wood waste to support 24 large (55 million gal/year) stand-alone plants. A recent independent study conducted by Clemson University estimated the annual amount of untapped wood waste in South Carolina, a typical wood producing state in the Southeast. Using this data, South Carolina alone has enough wood waste to support 39 mid-sized plants. If extrapolated for all 22 mills in the Southeast, 3.432 billion gallons per year of ethanol could be produced from untapped wood waste. This is equivalent to the ethanol capacity of 62 large plants, and that is quite an untapped potential. ■

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