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Progress in Biofuels Commercialization

In a New York Times article that appeared last week the author, Clifford Krauss, began with the line, “There is an old joke in the energy business that advanced biofuels are the fuel of the future, and always will be.” The point, of course, is that the bright green promise of a renewable, carbon-neutral solution to many of our energy supply problems has been inexorably slow in coming to fruition. But later in the article he notes that “... this is the year biofuel production will finally lift off, industry executives say.”

Indeed, recent developments signal a turning point in efforts to commercialize the technologies. Beta Renewables started up the first commercial-scale plant in October 2013 outside the city of Crescentino in northern Italy. It can reportedly produce more than 13 million gallons per year (13 mgy) of cellulosic ethanol from wheat straw, rice straw and arundo donax, a high-yielding energy crop grown on marginal land.

Abengoa Bioenergy has built a plant in Hugoton, Kansas that is scheduled to go onstream early next month, producing ethanol from corn stover (stalks, leaves, husks and cobs) and wheat straw. It is reported to have a production capacity of 25 mgy and will generate energy from byproduct biomass. POET-DSM, a joint venture of US ethanol producer POET and Dutch food and chemicals company DSM, will begin producing ethanol from corn stover at a new facility in Emmetsburg, Iowa. Like the Abengoa plant, it will have a capacity of 25 mgy. A DuPont Cellulosic Ethanol facility, one of the largest commercial-scale cellulosic biorefineries in the world, is nearing completion in Nevada, Iowa, and will begin ethanol production later this year. It is expected to produce 30 million gallons of biofuel per year from corn stover.

It seems, then, that cellulosic ethanol production from wheat straw and corn stover is now a viable commercial operation. But does this have any relevance to the paper and forest products industries? What about using wood or wood waste as raw material? Wouldn't this fit into the oft-envisioned forest biorefinery concept, where a forest-based feedstock is converted not only to pulp and paper but also chemicals, energy and fuels? Unfortunately the answer is not clear-cut. (Pun not intended.)

The reason has to do with the structure of lignin, that component of the tree or plant that endows it with rigidity. Unfortunately for would-be producers of cellulosic ethanol, lignin also presents an obstacle to the breakdown of the plant or tree that is a necessary prerequisite to deconstructing its carbohydrate and fermenting the resulting sugars to make ethanol. In the case of herbaceous materials like wheat straw and corn stover, the lignin is of a type that is more readily degraded than the lignin found in trees, especially in softwoods such as pine, spruce or fir. Hardwoods, such as poplar, have lignin that is somewhat less problematic than softwoods, but nevertheless more difficult than that of straw and herbaceous plants.

Apparently undeterred by this obstacle, several producers have forged ahead with plans for commercial wood-to-biofuel facilities. One of the first, Ensyn, built a commercial heating fuel facility in Renfrew, Ontario. Ensyn recently announced it had signed a five-year contract with Memorial Hospital of North Conway, New Hampshire to supply renewable heating oil, replacing Memorial's petroleum-based heating fuel. Another wood-to-biofuel company, Kior, built a plant in Columbus, Mississippi, funded in part by a \$15 per share IPO in 2011. A few months later the share price had risen to about \$24. Subsequently, however, the plant failed to perform as predicted and the share price plummeted to less than \$1. Most recently, the company decided to idle production, pending process improvement and securing of

additional financing. It appears that the company is in danger of succumbing to the “valley of death,” the hazardous gap between pilot-scale and commercial-scale production. Another wood-to-biofuel company, Zechem, recently idled a demonstration facility in Boardman, Oregon when performance failed to meet expectations. It, too, is seeking additional financing to enable process improvement efforts to proceed.

The less-than-stellar performance of initial forays into the business of converting wood to ethanol or other fuels suggests that new approaches and/or more basic knowledge are needed. Responding to this need, a multi-institutional research team led by Michigan State University researchers, has found a way to modify the genetic makeup of poplar trees to make their lignin easier to remove, facilitating their conversion to fuel. The research is described in the April 4 issue of the journal, *Science*. Though not applicable in the short term, this research holds promise for commercialization in the not-too-distant-future, given the rapid growth characteristic of poplar.

Late-breaking news: As we were “going to press” Reuters announced that “The U.S. Environmental Protection Agency slashed its target for 2013 use of cellulosic biofuel to less than a million gallons on Tuesday after the industry failed to meet goals for production of the fuel last year.

The agency lowered the mandate to 810,185 gallons in a new rule, well below the 6 million gallons it had required in the plan it finalized last August.”

This does not augur well for the markets that will be supplied by the new capacity described above.

Trend Indicators from Industry Intelligence Inc.

[Industry Intelligence Inc.](http://www.industryintel.com) has provided market intelligence to more than 600 companies worldwide since it began as Forestweb in 1999. Industry Intelligence delivers a daily report featuring news of the paper and forest products industries. For your subscription visit: <http://www.industryintel.com>

Below is a small sampling of recent Industry Intelligence headlines, chosen to mirror significant trends in and around the paper and forest products industries.

Michigan State University researchers looking into ways to enhance poplar trees so they can be broken down more easily, improving their viability as a

biofuel; research result of a collaboration partially funded by Great Lakes Bioenergy Research Center

This multi-institution collaboration may open the door to a much more energy- and cost-efficient way to convert biomass into fuel.

IP inaugurates India's largest casuarina clonal propagation center in Andhra Pradesh; IP's fifth CPC in India, it has the technology to develop superior clonal saplings that can double productivity of pulpwood as compared to conventional seedling methods

The productivity through the clonal saplings will increase to 65 – 70 MT pulpwood per acre during 4 year plantation cycle from existing 30 – 35 MT per acre of the conventional seedling plantations.

E-book sales slow in US and UK, attributed to fewer new reading device launches, alternate uses of devices such as social media, games, videos; print book sales remain relatively stable

Despite all the hype about digital, sales of physical books remain surprisingly resilient. E-books are still only about 20 per cent of the UK market, though some analysts forecast that this figure will rise to 35 per cent by 2016.

Washington State DNR to sponsor demonstration of mobile pyrolysis technologies capable of converting woody biomass from forests into bio-oil, biochar and syngas in the field, increasing cost-efficiency

The technology uses high temperatures to convert woody debris from forest harvests into bio-fuel directly in the field, making this renewable energy source more cost effective.

Columbia Pulp seeking long-term supply contracts with area farmers to provide about 215,000 tons/year of wheat and alfalfa straw for its proposed US\$50M, 140,000-tons/year straw pulp mill near Starbuck, Washington; area has 'straw density advantage'

According to University of Washington Paper Science Laboratory Director Mark Lewis, a technical adviser to Columbia Pulp, straw pulp offers an attractive alternative to hardwood pulp, is cheaper to produce, has a similar fiber length, requires less water and fewer chemicals and doesn't use any odor-causing chemicals.

Town supervisor in New York state seeks Vermont public officials' support for natural gas pipeline that would cross Vermont for benefit of IP's paper mill in Ticonderoga, New York; IP is paying large portion of pipeline's cost in New York and Vermont

Countering resistance from within Vermont, the Ticonderoga official emphasized the benefits of the proposed pipeline project for both Vermont and New York. The issue exemplifies paper industry efforts to capitalize on natural gas price and availability trends.

Evergreen Packaging earmarks US\$1M to start engineering work on US\$50M natural gas conversion of coal-fired boilers at its Canton, North Carolina, paperboard mill, after receiving US\$2.1M state grant; company seeks additional state aid for project

The project will require upgrading a pipeline that will carry natural gas to the mill. It will allow the mill to meet the new standards imposed by the U.S. Environmental Protection Agency.

US Dept. of Energy's Catalysis Center for Energy Innovation and ExxonMobil to research converting lignocellulosic biomass to polymers, part of larger effort to create breakthrough technologies to produce biofuels, chemicals from non-food biomass

In a departure from previous strategies focusing on fossil fuel replacement chemicals that have the same function but new structure, the new research focuses on using thermochemical (non-biological) catalysts to yield chemicals that can be directly blended at any ratio with existing petrochemical products.

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US book sales remain steady in 2013, totaling US\$7.01B, down 1% from US\$7.08B in 2012, reports Association of American Publishers; e-book sales declined slightly, while young adult books remain more popular in print than in e-book form

E-book sales declined slightly after years of explosive growth.

Resolute Forest Products plans US\$105M upgrade at its Calhoun, Tennessee, pulp and paper mill, to be completed mid-2016; new continuous pulp digester, woodchip processing equipment will raise pulp capacity, cut costs, improve versatility

The Calhoun mill has been operating since 1954; it currently operates 3 machines and a pulp dryer. and

has a total mill capacity of approximately 609,000 metric tons of market pulp, specialty papers and newsprint.

CMPC to receive US\$340M credit bureau loan toward financing US\$2.1B, 1.3 million tonnes/year eucalyptus pulp mill project in Guaiba, Brazil

The 1.3 million tonnes/year bleached eucalyptus kraft pulp (BEKP) mill is expected to start up in the second quarter of 2015.

Paper sludge could lead to safer BPA

Bisphenol A (BPA) is used in plastic items, but has raised health concerns in recent years. University of Delaware researchers have found a way to create a safer alternative. Called bisguaiacol-F (BGF), it is derived from lignin and is designed not to interfere with hormones in the way that BPA might.

Paper Quotes

“Paper is light, absorbent, strong, plentiful and portable; you can fold it, mail it, coat it with wax and waterproof it, wrap gunpowder or tobacco in it, boil tea in it. We have used paper in abundance to record our history, make our laws, conduct our business, correspond with our loved ones, decorate our walls and establish our identities.... When it comes to pure utility, modern hygienic practice is unimaginable without paper ...” - Nicholas A. Basbanes, in “*On Paper. The Everything of its Two-Thousand-Year History*,” Alfred A. Knopf, New York, 2013

“At the present time it would be impossible for civilization to endure, even for a day, the total lack of paper – a material that is as little understood by the average consumer as it is indispensable.” – Dard Hunter, in “*Papermaking. The History and Technique of an Ancient Craft*,” Alfred A. Knopf, New York, 1947

AF&PA Statistics

Since our last reporting of American Forest and Paper Association statistics releases, the Association has issued its February 2014 Printing and Writing Report and its March 2014 Paperboard, Kraft Paper and Containerboard Reports.

Printing and Writing

Total shipments decreased 3 percent in February compared to February 2013, with total inventories decreasing 3 percent from January levels. Uncoated free sheet shipments decreased 5 percent compared to February 2013. YTD shipments are down 8 percent. Coated free sheet shipments were down 1 percent compared to the same period in 2013. Uncoated

mechanical (UM) shipments increased 7 percent in February, the fifth year-over-year increase in the past six months. Year-to-date shipments of UM are up 2 percent compared to 2013. Coated mechanical (CM) shipments decreased 6 percent compared to February 2013. Imports of CM in January were down 16 percent relative to the same period in 2013.

Paperboard

Total boxboard production increased 1.8 percent when compared to March 2013 and increased 9.3 percent from February. Unbleached kraft boxboard production increased over the same month last year and increased compared to February. Total solid bleached boxboard & liner production increased compared to March 2013 and increased compared to February. The production of recycled boxboard stayed flat compared to March 2013 but increased when compared to February.

Kraft Paper

Total shipments were 123,400 tons, 1.5 percent higher than in February. Bleached kraft paper shipments were 17.3 percent higher than February, while unbleached kraft paper shipments were essentially flat. Overall, shipments for the first three months of 2014 were 5.3 percent lower than the same period last year. Total month-end inventories were also essentially flat compared to February.

Containerboard

Production increased 8.7 percent from February and was 3.8 percent higher compared to the same month last year. The month-over-month average daily production decreased 1.8 percent. Shipments for March were 2,958,200 tons, representing 166.2 billions of square feet. The containerboard operating rate for March decreased 1.7 points from February, from 96.3 percent to 94.6 percent.

The reports can be purchased by contacting Caroline Nealon at Statistics_Publications@afandpa.org or 202-463-2448.

Technology for the Nontechnical: Pulp Washing

Pulp emerging from the kraft digester is suspended in spent pulping liquor (“black liquor”). This dark-colored liquid must be removed, for two reasons. One is that it contains valuable pulping chemicals that must be recovered, regenerated and re-used to make the overall process economically viable. The other is that it contains roughly half of the original wood substance, in the form of dissolved organic material. This

dissolved material is the fuel that is later burned to provide much of the energy needed to run the mill.

The most commonly used method uses a series of vacuum drum washers. Each washer consists of a rotating horizontal drum that is partially immersed in a vat containing a dilute suspension of the pulp to be washed. The surface of the drum is covered with a fabric that allows liquid, but not pulp fibers, to pass through to the interior of the drum. As the drum rotates into the pulp suspension, vacuum inside the drum causes a thick layer of pulp to be deposited on the surface of the fabric. As the pulp-covered surface rotates out of the vat, it is sprayed with wash water, which is drawn through the pulp by the vacuum inside the drum. The wash water displaces spent liquor, pushing it into the drum’s interior, from which it is collected. The pulp passes through a series of washers, each of which uses, instead of fresh water, the filtrate collected from the next washer in the series. This “countercurrent” arrangement minimizes dilution of the collected spent liquor. That’s important because the next step in the chemical recovery process is removal of water prior to burning the liquor’s organic material.

Statistics Corner: Employment by Pulp, Paper and Board Mills

As shown in Figure 1 below, the number of people employed by pulp mills and paper mills dropped sharply between January 1998 and May 2003, from 163,000 to 111,000. This was followed by a more gradual decrease to 93,000 in July 2008. At that point, the onset of the recession marked the beginning of another period of steeper job losses that lasted until the spring of 2010, when the mills employed a total of approximately 83,000. Since then the losses have continued, albeit at a more moderate rate. In February of this year, employment stood at approximately 76,000.

Employment losses at paperboard mills, though significant, have occurred at a lower rate than at pulp and paper mills. Between January 1998 and the beginning of the recession in July 2008 employment by paperboard mills fell from 48,000 to 34,000. By December 2010 it had fallen to 29,000, but since then it has remained at about that level. This presumably reflects the fact that board applications (mainly containers) are more tied to the general level of commerce and not as vulnerable to digital alternatives as paper is. ■

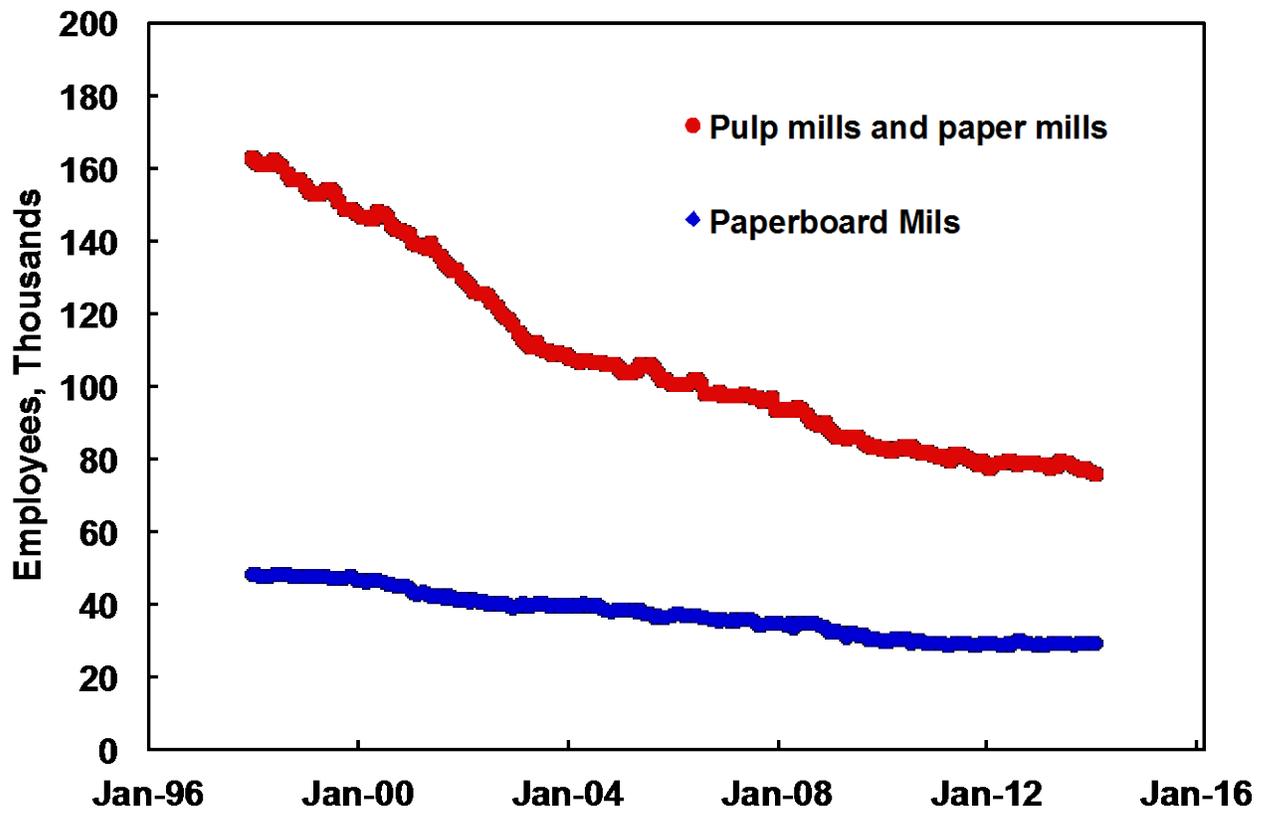


Figure 1. Paper Industry Employment, 1998 - 2014 (Source: Bureau of Labor Statistics)