The first part of this series in September issue of PaperAge examined the six platforms of Agenda 2020 and the goals and progress being achieved in each. The second half of this series in this issue looks specifically at the forest biorefinery platform and its promises and progress to date.

As shown in Figure 1, the forest biorefinery platform consists of three parts—sustainable forestry, extraction of value from wood prior to pulping, and creation of new value streams from residuals and spent pulping liquors. The discussion below looks specifically at the last two parts of the forest biorefinery platform, examining how today’s existing technologies can (and in many cases will) be modified and adapted for use in new and different ways to achieve the many benefits of forest biorefining.

**Value Prior to Pulping**

Figure 2 describes the process of extracting hemicellulose. This does not impact the cellulose or yield as we currently destroy this hemicellulose in pulping. Adding this step is predicted to lower the energy consumption in subsequent operations.

As will be seen later, this can add $3.3 billion in annual net cash flow increase. It is doable with technology that is already developed. In fact, selected mills have made alcohol for decades. The uniqueness is in applying this to the kraft process, removing the acetic acid, and using newly developed enzymes to accelerate fermentation. It is important to note that this process does not require gasification.

Basically, there are two choices for increasing the value from spent liquor - power and fuel/chemicals. For each choice, there is - An incremental capital analysis, and full capital analysis.

- Currently, both choices require gasification of black liquor. Black liquor gasification is becoming commercial. The Chemrec atmospheric gasifier has been running continuously for more than a year at Weyerhaeuser, New Bern. The TRI Steam Reformer is in startup at Georgia Pacific, Big Island. A third unit, the TRI Steam Reformer at NorAm Pac in Trenton, Ontario, is in the advanced stages of startup.
- Figure 3 shows the process for producing power from hydrogen rich “off gas.” This can be run through a gas turbine to generate power and the turbine exhaust gas run through a heat recovery cycle to produce steam for the mill.

![Figure 1. Forest biorefinery technologies will have a disruptive but potentially positive impact on the pulp and paper industry.](image1)

![Figure 2. Process of extracting additional value of wood raw materials prior to pulping.](image2)

![Figure 3. Producing power from off-gas using conventional technologies.](image3)
The processes after cleanup of the off gases is conventional technology. This figure shows consumption for the U.S. kraft industry.

Figure 6 is the same mill that has evolved to a forest biorefinery. Again, national consumption and production figures are shown. The estimated net cash flow from the ~50 million annual tons is estimated to be $5.5 billion or about $100 per ton. This is probably higher than most U.S. mills have experienced in the past five years.

The net cash flow from the 1.9 billion gallons of ethanol and 600 million gallons of acetic acid produced from fermenting hemi-cellulose is $3.3 billion. The annual net cash flow from sale of the RFTF can be as much as $5.5 billion. Together they total $8.8 billion or 160% of the historical net cash flow derived from pulp. Further, we know that more valuable chemicals can and will be produced. More importantly, this is just from one of the six technical platforms. This is why the agenda 2020 goal of doubling net cash flow may prove to be conservative.

Figure 7 lists some of the major hurdles. Again, the greatest challenge is not the development of technology, but rather the lack of technical entrepreneurship. The question is: can we develop this skill as rapidly as it will be needed?
Figure 8 shows major conclusions based on more than a decade of Agenda 2020 experience and many years in the pulp and paper industry as well as the academic side, the supplier side, the engineer/construction side, and the owners side. Three points need emphasis:

• First, we have unique opportunity at our doorstep
• Second, our fate is in our hands
• Third, the name of the game is deployment , not wait and watch.

There are several ways of getting involved and becoming part of the solution:

• Recognize your mill must change or be a candidate for overseas replacement
• Learn more about Agenda 2020 and its projects
  – Contact your company representative
  – Join a committee
  – Find out which programs will benefit your mill
  – Find out if state/federal funding is available
  – Learn how to successfully deploy new technology while minimizing risk to operations
  – Help create a plan to change your mill or your company both short and long range.

Figure 9 is a depiction of the historical business model that was developed at Agenda 2020’s second technical symposium held in March of this year. It depicts the forest products industry as growing trees and producing logs, chips, and fiber from them. These were converted into conventional products and sold largely through distributors. This industry was “distant” from its customers and from those who also used and loved the forests.

Figure 10 is a depiction of stewardship of resources, be they owned or purchased. Products now include bio-chemicals and energy. Trees are more important and effluents are considerably smaller. There is a greater focus on customers. Products are defined in terms of jobs that customers need doing. Many of these customers are those who use and love the forests. So this picture “wraps” in a very healthy way.

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