

From biomass to **biobusiness**

Many experts say that first-generation biofuels are doing our planet more harm than good. So, UPM of Finland is investing in second-generation technologies to turn biomass into liquid fuels. The creation of synthetic diesel and other biochemicals from forest residues represents a ground floor (or actually forest floor) opportunity. UPM's chosen partners in key technology development? Andritz and Carbona.

Editor's note: Since the biofuel business may be new to many readers, we have included a glossary of terms, "Talking the Biologing" on page 15 which you may find helpful.



"In addition to biofuels, we have identified what we call native wood chemicals – those chemicals found in trees that can be extracted or utilized without much processing. We see potential for biochemicals that are in demand by the pharmaceutical companies, for dietary/food products, and for cosmetics."

Petri Kukkonen, Director of Business Development of UPM-Kymmene Corporation.

"Developed nations are looking for alternatives to fossil fuels," says Petri Kukkonen, Director of Business Development for UPM-Kymmene Corporation. "Second-generation biofuels have the potential to be a big part of the solution. And, UPM has the potential to provide these biofuels while developing a profitable business in a fast-moving market."

The pace of development is exciting. UPM is leading a fast-track program to investigate the production of biofuels on a commercial scale, along with Carbona/Andritz and GTI. More about these partners in a minute.

It starts on the forest floor

According to Kukkonen, there are significant differences between first- and second-generation biofuels. Until now, the EU has mainly focused on first-generation. However, concerns are being raised that first-generation biofuels actually produce more greenhouse gases than conventional fuels if you include the emissions from agriculture, transport, and processing. In addition, diverting foodstuffs to biofuel production is triggering a record rise in the price of edible oils and other foods. Lastly, imports of ethanol vegetable oils or biodiesel from countries where rainforests are being cleared is causing some groups to label first-generation biofuels "deforestation diesel."

According to Kukkonen, second-generation biofuels do not compete with food crops, significantly reduce CO₂ production, and can offer better performance in vehicle engines. Used at 100% concentration, second-generation biofuels could reduce well-to-wheels CO₂ production by up to 95%.

"Second-generation biofuels will be based largely on wood residues," Kukkonen explains. "UPM knows how to cultivate, harvest, and process wood. We have the infrastructure in place to deliver the highest possible energy yield for society."

Log wood, pulp wood, energy wood

Typically, a tree is divided into three sections, Kukkonen explains. "One section is the log wood for the sawmill, one section is pulp wood, and the third section is energy wood." UPM's energy wood harvest equals about 3.5 TWh per year. It includes small diameters, branches, and stumps.

Stumps? "Stumps will be an important portion of the biomass feedstock," Kukkonen says. "UPM is the only company that collects and processes spruce stumps on a large scale. There is as much energy in the stumps as in the other forest residue combined. About 13-15% of the volume of roundwood entering the mill consists of bark."

The Carbona connection

The main path for second-generation bioenergy production is through gasification. This is where Carbona comes in.

Carbona was formed in 1996, when partners Kari Salo and Jim Patel bought the technology from a Finnish company and ventured out on their own.

Both Salo and Patel have spent virtually their entire adult lives around gasification technology. Their paths converged in the late 1980's when



Andritz and biomass

Andritz has become increasingly active in the promising liquid biofuel industry as the battle against climate change and high oil prices are initiating global developments.

The product portfolio includes systems for the front-end wood processing equipment, drying systems for biomass, pelletizing machinery, centrifuges for bioethanol production, gasifiers, and biomass power boilers.

Specifically, Andritz now offers Bubbling Fluidized Bed boilers for different biomass fuels to the pulp, paper, and power industries. Currently, four such boilers have been sold or are in the order process. Two units are destined for Spain (subsidiaries of the ENCE Group), one rated at 120 t/h of steam and the other at 195 t/h. Two units have been sold to Portucel in Portugal (58 t/h each).

▼ GTI's Flex-Fuel Test Facility in the USA is a state-of-the-art site for evaluating gasification processes. Pilot testing of the Carbona/Andritz technologies is currently underway here.



the Gas Technology Institute (where Patel was working) sold the license for its U-GAS® process to the company where Salo was Director of Technology. Working cooperatively, they built a coal gasification pilot plant in Tampere, Finland. The system was then converted for biomass gasification.

"We went to different vendors looking for gasification solutions," Kukkonen of UPM says. "We knew that we wanted fluidized bed technology, and were interested in Carbona's solutions. Carbona has the knowledge and Andritz has the muscle."

Patel explains, "Despite our experience, Carbona was too small to be a strong financial partner for the large pulp and paper companies." In August 2006, Andritz acquired a minority share position in Carbona, with an option for full ownership in the future.

In May 2007, UPM announced its cooperation with Carbona/Andritz on the development of technology for biomass

gasification and synthetic gas purification. The cooperation also covers the design and supply of a commercial-scale biomass gasification plant.

"The goal of our project is to develop a technology platform that we can duplicate for multiple sites," Kukkonen says. "First, we have to prove the gasifier concept and run it in a reliable manner. Of course there are challenges, but we have some experience feeding wood into pressurized vessels."

UPM has prepared the biomass feedstock in pellet form and is in the process of shipping 1000 tonnes to the Flex-Fuel Test Facility near Chicago, Illinois USA.

Shaving two years off the schedule?

Carbona's close relationship with the Gas Technology Institute (GTI) has helped UPM keep on its fast-track schedule. "If we didn't have access to

GTI's plant, we would have to build a pilot plant from scratch, which would take 18 to 30 months, and then begin a 6-month testing program," Kukkonen says.

According to Bruce Bryan, Director of Gasification at GTI, the test facility is unique in its capabilities for evaluating different systems and processes. "The facility is configurable to test a variety of gasification, gas clean-up, and processing schemes," Bryan says. "The instrumentation and control systems in the facility are unparalleled, offering online analyses of gas compositions for instant feedback about the performance of gasification and gas conditioning systems. We don't have to wait for lab tests as we can see what's happening online."

Modifications to the GTI test facility, which center around Carbona's technology for gas reforming/cleaning, are being completed. Salo explains, "A common problem with the F-T process is the sensitivity of the catalyst to

contamination. Most likely, the catalyst will be cobalt. This requires a very pure syngas, so gas cleaning becomes extremely critical."

"The pilot tests will verify the technologies for the feed system, gas cleaning, scrubbing, the syngas recycling compressor system, and the cooler," Kukkonen says. "We expect to have results by the end of the year. Based on these results, we'll move forward with the next step."

The next step: commercial-scale

"First-generation biofuel suppliers can be more entrepreneurial," Kukkonen says. "But, second-generation companies have to be well funded because of the capital investments required for the multi-stage process."

"Pulp and paper companies have a distinct advantage," Kukkonen says. "Biofuel production totally fits our infrastructure. We have access to biomass and much of the equipment, utilities, transportation, water treatment, and effluent treatment in place."

The commercial-scale plant that UPM has in mind will produce about 100,000



▲ The test facility at the Gas Technology Institute is configurable to test a variety of gasification and gas clean-up schemes.



◀ Modern instrumentation and control systems give testers instant feedback about gas analyses without having to wait for standard lab tests.

to 150,000 t/a of finished product – a synthetic diesel fuel much cleaner than conventional diesel. The feedstock required for this will be about 1,000,000 t/a of biomass, so the ratio is about 10:1.

"With Andritz and Carbona, we have completed the conceptual engineering for the plant," Kukkonen says. "Andritz has the technology, starting from wood handling equipment and dryers. We hope they will provide technical solutions for our integrated processes from wood processing to the balance of plant."

UPM has yet to select the site for its plant. "We have many good sites, 17 in Europe in fact," Kukkonen says. "Our decision criteria will be based on the mill having space available and the cost of the biomass feedstock."

►► find out more at www.fiberspectrum.andritz.com

Talking the Biologo

Biomass. A wide-ranging term meaning any source of organic carbon (plant materials) that is renewed rapidly as part of the carbon cycle.

Biomass-To-Liquid (BTL). Synthetic fuels made from biomass that are similar to current fossil-derived fuels so they can be used in existing fuel distribution systems and with standard engines.

First-generation biofuels. Biofuels made from foodstuffs with either a high starch content (e.g. sugar beets, sugar cane, potatoes) or oil content (rapeseed, soybean oil).

Ethanol. Ethanol is produced by fermenting plant sugars in a watery solution which is then separated by distillation. A typical 10% blend of corn ethanol in U.S. gasoline can reduce well-to-wheels CO₂ emissions by approximately 3%.

Fischer-Tropsch (F-T). Catalyzed chemical reaction in which carbon monoxide and hydrogen are converted into liquid hydrocarbons of various forms. The F-T process is an established technology that is applied on a large scale for coal and natural gas.

Gasification. A process that converts carbon-containing materials into carbon monoxide and hydrogen by reacting the materials at high temperatures (> 700°C) with a controlled amount of oxygen. The resulting gas mixture is called syngas. The gasification of biomass is carbon neutral.

Second-generation biofuels. Biofuels from ligno-cellulosic sources (e.g. forest residues). Second-generation materials will be converted into liquid biofuels via BTL technology.

Syngas. Synthesis gas created during the gasification process. The syngas is cleaned and the ratio of hydrogen and carbon monoxide is adjusted before being converted into synthetic fuel in the F-T process.

Well-to-wheels. Biofuels have the potential to cut greenhouse gas emissions because the plants they are made from absorb CO₂ as they grow. An assessment of the life cycle impact is called a well-to-wheels study – calculating the net CO₂ from the growing of the plant right through to the vehicle exhaust emissions.

▼ Bruce Bryan (left), Director of Gasification at GTI, and Jim Patel of Carbona show the pelletized biomass feedstock shipped from UPM to the GTI test facility. The blue vessel behind Patel is part of the biomass gasifier at GTI.

