Austro2007/FORMEC´07: Meeting the Needs of Tomorrows´ Forests – New Developments in Forest Engineering, October 7 – 11, 2007, Vienna and Heiligenkreuz – Austria

DEVELOPING BIOMASS UTILIZATION IN LOUISIANA, USA: EDUCATING POLICY-MAKERS, ASSESSING SUPPLY AND DEMAND, AND INTEGRATING WITH FOREST MANAGEMENT

Cornelis F. de Hoop; Sun J. Chang; Amith Hanumappa-Reddy; Anil Kizhakkepurakkal
Louisiana State University Agricultural Center; Baton Rouge; USA; cdehoop@lsu.edu; xp2610@lsu.edu

Keywords: biomass , wildfire fuel

Abstract: *To improve the utilization of biomass, particularly for energy, in the state of Louisiana, a multi-step approach is being attempted: Educate; assess the quantities; and integrate biomass utilization with other activities. A booklet to educate politicians and other policy-makers was developed and distributed. A web-based project has been started to evaluate the biomass quantities produced, used, sold, wasted and grown; this includes both woody, agronomic and animal waste feedstocks. Finally, a proposed economic evaluation of an in-woods chipping logging operation is described; this operation also harvests very small (sub-merchantable) trees and brush to reduce hazardous wildfire fuels.*

1. Introduction

The state of Louisiana is located on the southern edge of the United States where the Mississippi River empties into the Gulf of Mexico. It is at the same latitude as Cairo and Jerusalem, but its summers are hot and humid, encouraging high rates of plant growth (*Pinus taeda* and *Pinus ellioti* 50-year site index of 30 meters are common). Yet winters oscillate between cold/dry and warm/humid, so temperate climate plants are the norm and tropical plants are rare (a notable exception is sugar cane, which is a major agronomic crop in Florida, Hawaii and Louisiana).

Louisiana has the resources that could make it a leader in biomass energy. It has the warm climate, rainfall and fertile soils necessary for fast growth rates in agronomic and timber crops, it is a natural transportation hub with its ports, river traffic, oil & gas pipelines, and ground transportation. The petroleum, natural gas, chemical, forest products and agronomic industries are already well-established. However, because the petroleum and natural gas industries are well-established and traditional, there has been relatively little interest in developing a biomass-based industry. Thus, one of the first steps toward expanding a biomass industry in the state involves educating politicians and other policy makers in the potential of biomass for energy and other purposes. Other steps include assessing the supplies of potential biomass, encouraging the existing biomass energy industry to thrive, and encouraging the expansion of new markets for biomass through economic development and new product research.

1.1. Awareness and education

In the 1999, the Louisiana State University Agricultural Center, in cooperation with the state’s Department of Agriculture & Forestry (and sponsored by federal grants) published a 16 page booklet titled <u>Biomass Energy Resources in Louisiana</u> (de Hoop et al. 1999). This booklet was distributed to legislators and upper administrators in the state government to heighten awareness about the potential of biomass as an alternative source of industry to supplement traditional sources. At the time, the primary interest in biomass energy was from an environmental standpoint. Natural gas was so cheap, that some sawmills and even a pulp mill had only gas-fired boilers. This publication was substantially revised and reprinted in 2006 (de Hoop et al. 2006).

1.2. Status of biomass for energy in Louisiana

Louisiana's forest products industry includes some 100 sawmills, plywood mills, panel mills, veneer mills, and pulp/paper mills that are scattered throughout the state. Together they produce more than 7,000,000 tons of green wood residues annually, most of which are utilized by the industry for energy (de Hoop et al. 1994; de Hoop et al. 1997). Most mills utilize what they need for their own energy needs (such as lumber drying kilns or veneer driers) and sell the rest to other mills, usually to pulp and paper mills, which typically have combined heat and power systems that are 100% self-sufficient in their heat production and are 50% to 80% self-sufficient in their electricity generation. Only 54,000 tons annually go unutilized.

Louisiana's secondary forest products industry (cabinet shops, architectural millwork, furniture & pallet manufacturers, etc.) produces 80,000 tons of wood residues annually. This includes wood trimmings, sawdust, and sanderdust. Most of it is already dry. Still, nearly all of this material goes unutilized (Table 1 shows the combined total residual residues from the primary and secondary industry combined).

The major agronomic crops in Louisiana are sugarcane, rice, soybeans, corn and cotton. Rice generates three types of residue: straw, hulls, and bran. Rice straw is usually left in the fields during and after collection to prevent erosion of the topsoil. The straw is sometimes grazed by cattle or crawfish and then plowed back into the field for nutrients. Possible uses of rice hulls include compost, abrasives for polishing, additives in hand soap, conditioners for fertilizers, and energy. In winter, the bran is mixed with rice hulls to make cattle feed. About 96% of the bagasse produced by sugar mills is utilized, mostly as fuel to run the syrup mills (Chang 2006). Other uses include paper, ceiling tiles, industrial boards, and compost. Soybean straw (stems) is usually left in the fields to prevent erosion. It can also be used as livestock bedding or burned for fuel.

Table 1: Annual wood and agricultural residue production in Louisiana, USA.

This material is potentially available for biomass energy or other uses. Approximately 98% of the wood milling residues (bark, sawdust, etc.), 96% of the sugarcane bagasse and 54% of the rice hulls are already being utilized for energy in Louisiana and are NOT included in this table.

Residue	Wet Tons	Net Million BTU	Million kWh	Energy Equivalent
Wood				
Sawdust, trimmings, bark	134,323	1,244,665	73	supply 4,068 homes
Logging Slash	8,432,792	43,428,879	2,555	supply 141,924 homes
Soybeans				
Straw	1,501,071	8,916,364	524	supply 29,138 homes
Sugarcane				
Bagasse (dry wt.)	122,702	895,725	53	supply 2,927 homes
Rice				
Hulls (dry wt.)	85,100	766,751	45	supply 2,506 homes
Straw	2,180,694	11,928,397	702	supply 38,982 homes
Sweet Potatoes				
Vines	60,288	253,000	15	supply 827 homes
Corn				
Stalks, roots, husks	350,043	1,470,000	86	supply 4,804 homes
Wheat				
Straw	320,064	2,010,000	118	supply 6,569 homes
Grain sorghum (milo)				
Residue	52,544	221,000	13	supply 722 homes
Cotton				
Gin trash	57,553	327,000	19	supply 1,069 homes
Peanuts				
Vines	1,435	6,700	0.39	supply 22 homes
Oats				
Straw	267,670	1,670,000	98	supply 5,458 homes
Animal Waste				
Cattle manure/biogas	9,881,919,000cf	5,930,000	395	supply 21,963 homes
Poultry manure	944,150	4,437,505	261	supply 14,502 homes
Total		83,505,986	4,959	supply 275,479 homes

1 home = 18,000 kW-hours/year
1 kilowatt-hour = 3413 British thermal units (Btu) theoretically, but boilers commonly run on 20% efficiency or less.

There are 1,657,107 homes in Louisiana (2000 Census). The above potential energy is enough to power 17% of these homes.

1.3. Existing industry: Biomass energy without government subsidies

There are several notable facilities in Louisiana and elsewhere in the USA that have been producing energy from biomass for years with little or no government subsidies. A few interesting examples are highlighted below.

An example of a business that has utilized biomass residue to produce energy since 1984 is Agrilectric Power, a subsidiary of The Powell Group. The Powell Group realized the need to utilize the hulls removed from rice during milling at their Farmers Rice Mill, near Lake Charles, LA. Agrilectric successfully produced energy and rice hull ash from rice hulls since 1984 with an in-service rate of 94%. The 13-megawatt plant consumes about 300 tons of rice hulls per day. Agrilectric Power has done an excellent job of marketing the ash, which is used as an insulator in the steel manufacturing industry and as a filter in swimming pools and other applications.

The Temple-Inland. Inc., paper mill in Bogalusa, LA, purchases sawdust and other wood residues from neighboring sawmills and fuel chips from whole-tree logging operations. After the heat is used to make pulp and paper, the leftover steam from the boilers is used to co-generate about 75% of the 80 Megawatts of electricity it uses.

Sugarcane processing mills operate only half the year – during harvesting season (about November through March). In Lacassine, LA, there is a new syrup mill that co-generates electricity. Enough excess bagasse is produced during the processing season to generate and sell 6 Megawatts of electricity to the grid for the rest of the year. It is anticipated that an ethanol manufacturing facility will be added, making ethanol from the syrup squeezed from the cane. This is unique for the United States because the country currently has no commercial-scale plants that make ethanol from sugarcane (even though it is a mainstay in Brazil).

Current U.S. production of ethanol is from corn (maize) grain. In 2006, there were 101 producing ethanol plants (primarily in the Mid-West) and 65 biodiesel plants in the U.S., and over 44 plants were under construction. Several cellulosic ethanol plants were announced for construction in 2007. Ethanol and biodiesel fuels are subsidized by the U.S. government. It is generally believed that these industries depend on the subsidies for there existence.

In the 1980s and 1990s, the state of California subsidized the burning of wood and other biomass to generate electricity. As a result, some 20 power plants were built that burned both wood and agronomic wastes. These subsidies ended during the 1990s. As a result, most of these plants stopped operating. A survivor of this situation is Wheelabrator Shasta Energy Company's stand-alone power plant near Shasta, California. It produces 49 Megawatts of electricity, running exclusively from 2055 tons (80 truckloads) of biomass per day, including apricot pits, nut shells, used lumber and other urban wood waste, and trees thinned from forests. Its parent company owns or operates 17 waste-to-energy plants nationwide.

2. Fuel from the forest: a case study

Mr. James Fincher of Andalusia, AL, has a whole-tree in-woods chipping operation (de Hoop et al. 2003). The product output of his operation is chips for pulp/paper and boiler fuel (hog fuel). In August

2002, this operation was thinning an 11-year-old loblolly pine plantation near Leakeville, MS, with typical diameters breast height ranging from 10 to 14 inches. The equipment consists of two operational feller-bunchers (plus a spare), two skidders, an in-woods chipper (Morbark 2455 Flail Chiparvestor), a spare chipper, and a recycler (Bandit 2680 Beast Recycler). The Chiparvestor delimbs and debarks, producing fine quality chips suitable for paper pulp. The Chiparvestor has two chutes; the first chute produces delimbed and debarked material and the second chute produces wood chips. The reserve chipper is swapped out regularly to minimize down time for maintenance. The recycler is stationed next to the Chiparvestor; it further grinds down the limbs and the bark that came from the first chute of the Chiparvestor. Finally, two trucks are stationed at the chute of the recycler and the second chute of the Chiparvestor, where the ground material is blown into chip vans.

The crew consists of six operators plus truckers. The machines use about 350 gallons (c. 1200 liters) of fuel per day. The chip vans are hauled by three owned trucks and 2 or 3 contract trucks. Details of the operation were provided by the loggers and by the recycler sales representative in August 2002.

The Chiparvestor ($650,000 new) is powered by two diesel engines: a 6-cylinder 325 hp and an 8-cylinder 800 hp. Key maintenance points include:

- Flails chains can break with wear, causing severe damage downline to the chipper knives, so it is very important to check and replace them as needed.
- Bottom flail chains are checked twice a week, and worn chains are replaced.
- Top flail chains are checked weekly, and worn chains are replaced.
- Chipper knives are checked daily and typically replaced daily.
- The replaced knives are reconditioned at the machine shop and are used again.
- Greasing is performed daily.

According to the sales representative, the Recycler ($200,000 new) holds its resale value well. After three years, its resale value is reported to be roughly 80% of its purchase price, despite the recommended life of four years. It has a productivity rate of 25 tons/hour (22 metric tonnes/hour). The total power of the machine is 365 hp: 300 hp is used by the hammer mill and 65 hp is used to operate the discharge chute. The machine is operated manually. The designer plans to incorporate remote control to eliminate the need for a person operating near the machine (safety concerns). Key maintenance points include:

- Need to reharden cutter bodies (10/month out of 60 cutter bodies)
- Replace about 3 teeth per day (of 60 teeth).
- Belts last for 1500 to 2000 hours.
- Conveyer lasts for 1500 hours and up.
- Infeed chain lasts for 6000 hours.

The operation was producing 9 to 10 truckloads of pulp chips and 4 to 5 truckloads (29 tons or 26 tonnes/truck) of recycled material, which was being used as boiler fuel. In smaller timber, the ratio of chips to hog fuel is 1:1. The pulp/paper mill consumed about 100 truckloads of fuel per day.

2.1. Biomass energy pays for wildfire fuel reduction

Travis Taylor Logging & Chipping of Goldonna, LA, uses conventional logging equipment to conduct mechanical forest fuel reduction to reduce wildfire threats while enhancing forest health and improving habitat for the red-cockaded woodpecker (an endangered species). While no direct government subsidies are involved, the landowner pays a premium to have this operation cut and remove sub-merchantable trees while also conducting a conventional forest thinning. Some notable points about Mr. Taylor's fuel reduction operation are as follows (de Hoop et al. 2004):

- The process involved a general logging operation, where the feller-bunchers which is of the drive-to-tree type, were used to cut down the small diameter set trees.
- Skidders were used to skid the cut trees to a unloading point where the MORBARK 50/48 whole tree chipper and the Prentice 210 loader were stationed.
- The 50/48 chipper is capable of processing the cut trees, brush, slash, orchard removal and storm debris in to chips. Models are available with loader and with out loader. Here a Prentice 210 loader was stationed next to the chipper was used to load the severed trees in to the chipper. The chips were guided thro a chute and blown in to a trailer. Since the chipper does not debark or delimb the cut trees, the chips produced are called as fuel chips nad used for boiler fuel as hog fuel.
- A reserve chipper ,a Morbark Model 22 Total Chiparvestor was also stationed at the site, but is not used when there are space limitations in the woods. This model is capable of separating much of the limbs and leaves producing dirty chips for pulp/paper.
- Trucks transported these chips to their destination.
- A crew of six was present, plus truckers.
- Four company-owned trucks and 2 leased trucks were used.

Information on the Machines and their basic maintenance:

Mobark 50/48 Whole Tree Chipper.

- This portable in-woods system is capable of processing whole trees with diameter up to 24 inches.
- A single operator operates the entire machine. He controls the chipping operation.
- This particular model did not have the hydraulically operated boom with grapples. Instead it was fed with a Prentice 210 loader, which was stationed next to it. The butt end of the cut tree was fed first to process the chipping operation.
- This machine is just a whole tree chipper; it does not carry out any delimbing or debarking operation.
- A new model costs about $ 365,000.

Maintenance:

- Daily greasing.
- Chipper knives are checked and changed everyday.
- The knives need to be replaced after 10 to 15 truck-loads of chips were produced. Each load produced is about 28 tons (25 metric tonnes).
- The replaced knifes are re sharpened and reused.
- Hydraulic fluid is checked regularly.
- Air filters are blown out for dust regularly and they are replaced every 3 weeks.

Morbark Model 22 Total Chiparvestor.

- This portable in-woods system is capable of processing whole trees with diameter up to 30 inches.

- A single operator operates the entire machine. He controls the feed rate and the chipping operation.
- This particular model came with its own cab and hydraulically operated boom with grapples. The bottom part of the cut tree was fed first to process the chipping operation.
- This machine is just a whole tree chipper; it does not carry out any delimbing or debarking operation. However, it is capable of blowing much of the “trash”(leaves, twigs, etc…) out of the chip mix, allowing the production of “dirty chips” for paper making instead of just “fuel chips”.

Maintenance:

- The machine is greased at the required greasing points everyday in the morning before starting of the operation.
- Chipper knives are checked and changed everyday.
- The knives need to be replaced after 15 to 20 truck loads of chips were produced. Each load produced is about 28 tons.
- The replaced knifes are re-sharpened and reused.
- Hydraulic fluid is checked regularly.
- Air filters are blown out for dust regularly and they are replaced every 3 weeks.

Other Information:

- The production capacity of the operation is about 20 truck loads per week with each load weighing about 28 tons (25 tonnes).
- The target (goal) production of the operation is15 truck-loads per week.
- The operation was carried out for 5 days a week with 10 hours per day.
- Normally the contractor plans to work 48 weeks per year.
- The contractor operates with his own trucks and leased trucks for the shipment of chips to the destined location (Weyerhauser, Campti, LA).
- There are three types of chips: fuel chips (hog fuel or boiler fuel), dirty chips (a low value chip for paper)and clean chips (for paper). This operation is not capable of producing clean chips.
- Although the volume of brush and small tree tops going in to the chipper appears large, the actual volume of the solid biomass in this material is insufficient to support this operation economically. The pine stem volume is needed to maintain the marginal profitability of the operation

3. Conclusion

Although biomass as a major source of energy is still in its infancy, there are notable operations that exist with little or no direct government subsidies. In many cases, these operations were created to solve an environmental problem and learned that they can be profitable in their own right.

4. References

Chang, S.J. 2006. Unpublished report to selected sugar companies. Louisiana State University Agricultural Center, Baton Rouge, LA.

de Hoop, C.F., S.J. Chang, A. Kizhakkepurakkal, and B. Bullock. 2006. Biomass Energy Resources of Louisiana. Second edition. Research Information Sheet 102. Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center. Baton Rouge, La. 16 pp.

deHoop, C.F., W.R. Smith, A. Hanumappa-Reddy, J.N. Lee, R.Y. Vun, R.H. Dupré, M. White, and T. Dufour. 2004. Final Report, Reduction of Forest Fuel Loading in Louisiana. Louisiana Forest Products Development Center, LSU AgCenter. Baton Rouge, LA. 187pp.

de Hoop, C.F., W.R. Smith and A. Hanumappa Reddy. 2003. Reduction and Utilization of Forest Fuel Loading in Louisiana. Proceedings of the Annual Meeting of the Council on Forest Engineering held at Bar Harbor, Maine. Corvallis, OR. 5pp. www.cofe.org .

de Hoop, C.F., W.R. Smith and J.T. Houston, Jr. 1999. Biomass Energy Resources of Louisiana. Research Information Sheet 102. Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center. Baton Rouge, La. 16 pp.

de Hoop, C.F., S.R. Kleit, S.J. Chang, R. Gazo and M. Buchart. 1997. Survey and Mapping of Wood Residue Users and Producers in Louisiana. Forest Products Journal 47(3):31-37.

de Hoop, C.F., S.R. Kleit and S.J. Chang. 1994. The 1994 Directory of Biomass Sites in Louisiana. Tennessee Valley Authority, Southeastern Regional Biomass Energy Program, Muscle Shoals, AL. 205 pp.