What is Bioenergy?

Biomass energy, or bioenergy, refers to all forms of renewable energy that are derived from plant materials produced by photosynthesis. Biomass fuels can be derived from wood, agricultural crops and other organic residues. These fuels can be obtained from many sources in Canada, including sawmills, woodworking shops, forest operations and farms.

Case Study

Biomass Combustion Systems

Greenwood Forest Products Ltd.
Heating a Large Value-Added Production Facility

Biomass Combustion Systems
Summer 2002

Storage silo and rear view of building that houses biomass unit. The pipes leading from the main building in the background are conveying sanding dust from the baghouse. A fan is used to blow the dust through the pipes to the silo.

The recent upward trend in oil and gas prices has caused many Canadian business owners to reflect on the finite nature of fossil fuels and to take another look at renewable sources of energy such as solar, wind and biomass. Many are discovering that renewable energy technologies today are well developed and reliable.

Bioenergy is regarded as "green" energy for several reasons. Assuming that biomass resources, such as forests, are managed properly, biomass fuels are infinitely renewable. They have already proven to be economically stable sources of energy over time. Bioenergy is neutral in terms of carbon dioxide (CO_2) emissions. The burning of biomass fuels merely releases the CO_2 that the plants absorbed over their life spans. In contrast, the combustion of fossil fuels releases large quantities of long-stored CO_2, which contributes to climate change. Using bioenergy displaces fossil fuels and helps slow the rate of climate change.

Commercial wood heating is common in rural areas across Canada. Between 1980 and 1993, many businesses and institutions in the Atlantic provinces installed automated biomass heating plants to stem rising energy costs. Despite relatively low oil prices in the last decade, many businesses have continued to operate – and often expand – their biomass heating plants. They have achieved significant savings and other benefits from low-cost bioenergy.

This case study features one of several small businesses that have installed biomass combustion systems (BCS).

Introduction

Few companies are fortunate enough to take a problem and turn it into an advantage. In November 2000, Greenwood Forest Products Ltd. finished the final stage of a two-part solution to a problem. The latter had long passed the nuisance level and was becoming a threat to the company's profit margin.

Natural Resources Canada
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To control the sanding dust that had resulted from increased production, Greenwood installed a new vacuum system and a 1500-kWh biomass combustion unit to consume the dust and to heat its production plant. Although the cost of natural gas heating soared in the next few months, general manager Peter Beulah knew that the cost of keeping his workers warm was well under control.

Greenwood Forest Products is situated in Penticton, British Columbia. It remanufactures lumber purchased from select sawmills in British Columbia and Alberta and employs about 85 people. The plant produces tongue-and-groove flooring and wall coverings, wainscot and moulding wall systems, edge-glued laminated panels and components, and furniture-grade lumber stock. Most of its customers are U.S.-based, including The Home Depot and Lowe's Home Improvement Warehouse. A large sign on the mill, which proudly announces Greenwood's ISO 9001 certification, underscores the company's goal of high operating standards. Moreover, Greenwood is striving toward ISO 14001 certification.

Maintenance supervisor Dan Halverson and general manager Peter Beulah at the base of the baghouse where sanding dust is collected by the extraction or blower system.

Biomass combustion units burn material completely, at high temperatures, so that a minimal amount of ash is produced and an almost negligible level of particulate is released into the air. In addition to lower heating bills and a beneficial use of its wood waste, Greenwood has the comfort of working near a city and the recognition that it is a good environmental neighbour – thanks to the efficiency of its biomass unit.

Building housing biomass unit (front view) – Above the building a set of pipes carries sanding dust from the baghouse to the silo at the rear. The large pipe coming from the front of the building is the heat duct pipe carrying warm air to the production facility. The spill vent, which is used on hot days, can be found near the bend where the heating duct goes upward.

Technical Operation

Greenwood's biomass unit is fully automatic. The dust produced in the plant is collected and vented into a large cone-shaped baghouse that sits adjacent to the production plant. From here, the dust is blown through a 0.30-m (1-ft.) diameter duct to a cylindrical-shaped storage silo, which is next to the 6 × 12 m (20 × 40 ft.) building containing the combustion chamber. Maintenance supervisor Dan Halverson estimates that the storage silo is larger than 50 m^3 (1765 cu. ft.).

In the storage silo, a rotating horizontal auger moves the dust from the outside of the silo to the centre. From here, the dust drops into an agitator, which stirs the dust before it enters the rotary valve or air lock. The dust in the air lock then drops into another auger and is conveyed to the combustion chamber. The air lock prevents possible flashbacks from getting into the silo. It also prevents outside air from getting into the combustion chamber.

Inside the combustion chamber, the auger deposits the dust onto a steel bar grate, where it dries and burns. The grate is surrounded by high-temperature firebrick that gets red-hot. Through a system of divertors, a fan blows air *over*, *under* and *on* the burning dust for maximum burning efficiency. The combustion chamber is a rectangular box: 1.5 m wide × 7.3 m long × 3.1 m tall (5 ft. × 24 ft. × 10 ft.).

Baghouse – the baghouse collects the dust produced by the sanders in the production plant. The large pipe coming in from upper left and curving down and past the baghouse and into the building in the background is the heating duct carrying warm air from the biomass unit. The heating duct is approximately 1 m (3 ft.) in diameter.

The biomass system is designed to optimize the combustion process. Thus stack emissions controls are rarely needed. In addition, the unit is designed to integrate its combustion or furnace components with its heat exchange system, which makes the heating system cost-effective.

The passage of heat to the production plant starts with a simple fan system, which blows outside air through a duct into the heat exchanger. Here the air is quickly heated to over 50°C (120°F). There is no contact between the forced air and the hot combustion air in the heat exchange system.

A 0.95-m (3-ft.) diameter heating duct travels from the biomass system to the production plant for a distance of 20 m (65 ft.). Within the combustion unit, a hot-gas thermocouple regulates the level of heat. When the selected temperature is reached, the auger stops turning until the temperature drops again.

System Cost

Greenwood purchased a warm air system that has lower installation costs than comparable hot water boiler systems, which require additional pipe work and dissipaters. Peter Beulah estimates that the company paid $300,000 for the entire system, which includes equipment, housing, training and ductwork.

Operating Period

The biomass unit burns all year, six days a week, 24 hours a day. It heats the main production plant, which is approximately 45 × 90 m (150 × 300 ft.). In the summer, when temperatures in Penticton commonly reach 38°C, excess heat is released through a spill vent. The unit must work continually, as both the baghouse and storage silo would otherwise quickly run out of space.

Maintenance

The automatic feed system is shut off on the weekends. This gives maintenance crews the opportunity to perform a four-hour clean-up of the cooled biomass unit every other Monday. During scheduled clean-ups, the company's original gas heating system keeps production crews warm. Although Dan Halverson says that the ash build-up is minimal, amounting to "roughly a wheelbarrow full every two weeks," he believes that it is necessary to keep this cleaning schedule to ensure that the unit performs at its best.

In addition to keeping costs in line and disposing of sanding dust in a cost-efficient manner, the biomass unit has allowed the company to remain focused on its plans for expansion.

The production supervisor on each shift oversees the day-to-day operation of the biomass system. In addition, maintenance staff who are passing by the unit are expected to do a quick check. This happens usually every hour.

Biomass Fuel Supply

Greenwood burns only the sanding dust that is produced in its plant.

Safety

In addition to being a very difficult fuel to burn, sanding dust is extremely explosive. As a consequence, all lines have a GreCon® Spark Detection and Extinguishment System. Recalling the mounds of sanding dust that filled the production plant before the changes, Peter Beulah says, "The proper containment of the sanding dust has made my insurance company happier as well."

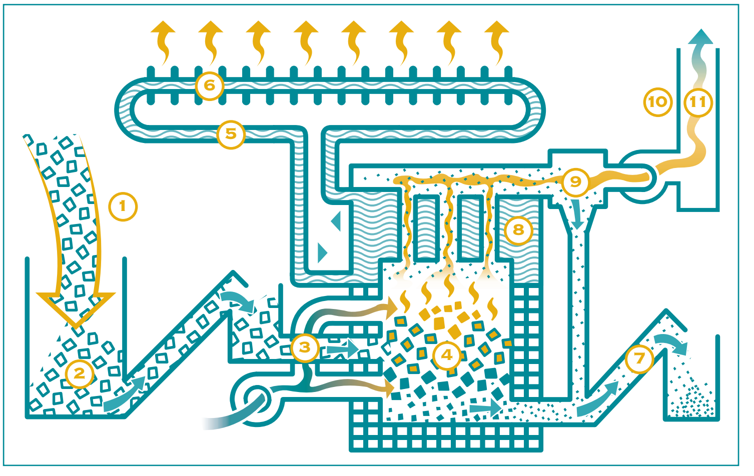
Set-Up

Greenwood purchased a Talbott C7 biomass combustion system. Talbott's Ltd sent three technicians from the U.K. to assist Dan Halverson and his maintenance crew during the installation, which took two weeks. "It was simple and straightforward," says Peter Beulah.

Annual Savings

Greenwood paid about $300,000 for its biomass unit, more money than it wanted to spend. But its investment in biomass combustion became easier with a grant from the Renewable Energy Deployment Initiative (REDI) of Natural Resources Canada.

Biomass Combustion System – General Layout
1. Fuel Delivery
2. Fuel Storage
3. Automatic Feed
4. Combustor Unit
5. Water Piping
6. Radiators
7. Ash Disposal
8. Heat Exchanger
9. Particulate Removal
10. Stack
11. Exhaust Gases



Accurate financial statements before and after installation are not available, as Greenwood has only one gas meter for both its factory and dry kiln. The company still relies on natural gas to heat its kilns, a situation it hopes to improve in succeeding years.

Nevertheless, despite the absence of hard figures, Peter Beulah is confident that his heating costs are significantly lower. Moreover, the company now has direct control over heating expenses and can almost ignore the fluctuating costs of natural gas.

Greenwood's prompt action allowed it to keep a long-time buyer of its wood shavings. The shavings were becoming contaminated with dust, and in all likelihood, if the dust problem had not been solved quickly, this customer might have gone elsewhere.

Finally, and perhaps most important, Greenwood was able to turn the cost of disposing its sanding dust into a substantial benefit.

System Performance

Peter Beulah has absolutely no doubts that purchasing a biomass unit was a good investment. In addition to keeping costs in line and disposing of sanding dust in a cost-efficient manner, the biomass unit has allowed the company to remain focused on its plans for expansion.

Dan Halverson adds, “It works well. I am very pleased. The system is very automatic. It is clean-burning, operates on a simple heat exchange system and produces practically no emissions. It is a very efficient way to turn wood waste into heat.”

Lessons Learned

As good as the combustion unit is, the installation itself was an occasion to learn several lessons. At first, the unit was consuming dust at a low level and staying just ahead of the dust produced. However, Dan Halverson persevered and, four weeks later, found the right combination of settings. The unit now burns twice as much dust.

Dan Halverson was pleased with the help he received over the phone, but he suggests that companies who purchase a biomass unit invite the manufacturing representative to stay for the first week of operation.

The burning of fuel in an automated biomass system occurs under ideal conditions – very high temperatures in the cell, with controlled under-fire and over-fire air.

Future Plans

At the time of purchase, general manager Peter Beulah and maintenance supervisor Dan Halverson made sure that the unit they chose would suit the mill’s plans to increase capacity the following year.

Now, more than one year later, Greenwood is replacing its production line for edge-glued panels. This will cost $3.2 million. The result will be more dust. But Peter Beulah and Dan Halverson are confident that the biomass unit will do just fine.

Developing the Canadian Market for Biomass Combustion Systems

Natural Resources Canada’s (NRCan’s) Renewable Energy Deployment Initiative (REDI) promotes investments in renewable energy technologies. These include biomass combustion systems that produce space heat and water heat for businesses. REDI for Business will refund 25 percent of the purchase and installation costs of a qualifying (i.e. high-efficiency with low emissions) biomass combustion system for a business, to a maximum of $80,000. The program is in effect until March 2004. REDI serves to stimulate market demand for renewable energy systems and ensure that industry infrastructures are developed to meet consumer demand.

A buyers' guide to small commercial biomass combustion systems is available from NRCan. For more information, contact the following:

Natural Resources Canada
Renewable Energy Deployment Initiative
580 Booth Street, 18th Floor
Ottawa ON K1A 0E4
Tel.: 1 877 722-6600 (toll-free)
Fax: (613) 943-1590
E-mail: redi.penser@nrcan.gc.ca
Web site: www.nrcan.gc.ca/redi

Find out more about how you can benefit from biomass combustion systems or other types of renewable energy technologies by visiting NRCan's Canadian Renewable Energy Network (CanREN) Web site at www.canren.gc.ca

Glossary

Aquastat – A temperature control mechanism that maintains the boiler temperature within a preset range by regulating the quantity of fuel fed to the combustion cell and hence the amount of heat produced. When the boiler temperature drops below the low-limit setting, the Aquastat signals the BCS to operate in the high fire mode. In this mode, the combustion air fan runs continuously, and the feed auger delivers large quantities of fuel to the combustion cell at frequent intervals (e.g. 10 out of every 20 seconds). When the boiler temperature rises to the upper-limit setting, the Aquastat signals the BCS to switch to the hold fire (or idle) mode. In the hold fire mode, the combustion air fan is shut off, and the feed auger delivers only small quantities of fuel to the combustion cell at relatively long intervals (e.g. 5 out of every 100 seconds). It provides only enough fuel to maintain the fire.

BCS – An abbreviation for biomass combustion system.

Bridging – Bridging refers to the tendency of some small-particle, biomass fuels to lock together in an arch configuration above a fuel feed mechanism (such as a screw auger or a day bin agitator). When this happens, the fuel above the bridging configuration ceases to flow, the BCS is starved for fuel and the production of heat is curtailed.

Cord – A traditional North American unit for measuring the volume of wood. A cord represents a pile of neatly stacked wood that measures 1.2 m high x 1.2 m wide x 2.4 m long (4 ft. x 4 ft. x 8 ft.). The pile volume, including air spaces, is 3.6 m^3 (128 cu. ft.), but the actual solid wood volume is about 2.3 m^3 (80 cu. ft.). A cord of softwood weighs about 1.6 t. A cord of green soft-wood (chipped) can displace about 340 L of heating oil.

Moisture content – The moisture content in wood or other biomass fuels is commonly expressed on a "wet basis." Moisture content on a wet basis (or MCWB) refers to the proportion of the total weight of a given quantity of wood that is actually water. For example, if green wood has a moisture content of 45 percent MCWB, then 45 percent of the total weight is water and 55 percent of the total weight is wood.

Units of measure – Wood chips and other particulate wood-waste materials are sold in a variety of measurement units. Wood fuels may be sold by weight (e.g., by the tonne) either with or without a calculation of the moisture content of the wood. Wood fuels may also be sold by volume (e.g., in cubic metres or cubic yards) or simply by a fixed amount for a truckload of a stated volume. The haul distance from the source (e.g., a sawmill) is also commonly factored into the delivered price of biomass fuels.

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