RENEWABLE ENERGY

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

Valley Truss & Metal Ltd.

Converting On-Site Wood Waste into Economic Space Heating

Biomass Combustion Systems
Spring 2001

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 directly 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.

Here are a few of the Valley Truss & Metal Ltd. buildings.

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

Introduction

Biomass fuel can be obtained from many sources, including sawmills, woodworking shops, forest operations and agriculture operations. One of the most appropriate uses for bioenergy is where a business can use its own wood waste to meet its own heating energy needs – and solve what could be a costly waste disposal problem. This situation applies to Valley Truss & Metal Ltd. of Kensington, Prince Edward Island.

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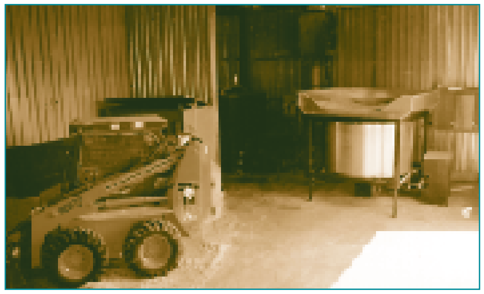
This group of companies includes a plant that produces steel roofing and siding, an adjacent building that manufactures laminated wallboard products and a plant across the street that makes roofing trusses. In 1994, owner Isaac Schurman installed a 160-kW BCS to heat his various manufacturing plants and to use the growing volumes of wood waste from the roof-truss plant. The biomass system heats about 1860 m^2 (20 000 sq. ft.) of working area in the three buildings.



A small skid-steer loader is used to fill the round day bin of Valley Truss and Metal's 160-kW dry-fuel BCS.

Using renewable energy resources runs in the Schurman family. Isaac used to live on a farm next door to his brother Lea, a pig farmer. Lea has used a straw burner and, since 1985, has used a sawdust-burning system to heat numerous buildings on the farm. Isaac also used a separate sawdust burner for many years to heat his home. Thus, the Schurmans are very familiar with the benefits of automated BCSs.

Technical Data

Isaac Schurman's BCS comprises four major components: a 3-m^3 round fuel (or day) bin; a 160-kW combustion cell (or chamber); a boiler; and a stack (or chimney). The day bin has an agitator made up of four horizontally rotating paddles. The paddles ensure that the fuel flows continuously to a small, 18-cm (7 in.) screw auger. The auger meters fuel into the second component of the system, the combustion cell.

The combustion cell has a steel bar grate upon which the fuel (fed by the auger) spreads out, dries and burns. The grate is surrounded by high-temperature firebrick that becomes red hot under heavy firing. A variable speed fan provides two separate streams of preheated primary (under-fire) and secondary (over-fire) combustion air to the fire. The combustion cell sends a jet of flame through a firebrick-lined tunnel into the third component of the system, a water tube boiler.

The boiler is a heat exchanger that extracts heat from the hot gases and transfers it to water, which is circulated through the boiler. The cooled gases then pass up the stack, which is the fourth major component in the system.

The hot water from the boiler is then distributed to three separate manufacturing plants via insulated underground piping. The temperature in each building is regulated by a thermostat, which turns the circulation pumps on and off to maintain the desired temperature.

The net heat output of the BCS is controlled by an Aquastat – a temperature-control mechanism in the boiler that regulates the quantities of fuel fed to the combustion cell. The BCS operates in either the high-fire mode, when the Aquastat calls for heat, or the hold-fire (idle) mode, when the boiler reaches the desired temperature.

For Isaac, the principal benefits of his biomass system are low-cost heat for his businesses and a practical way to dispose of the wood waste that would otherwise cost him money.

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. This results in high combustion efficiency and low emissions with very little smoke or airborne particulates being produced.

System Cost

Because Isaac Schurman's BCS has been built in several stages, he is not sure of its exact cost. He estimates, however, that the cost of the system he has today would be about $150,000. This includes the heat distribution systems and the wood grinder. The latter is used to process wood ends into usable feed stock for the BCS.

Biomass Fuel Supply

Isaac's initial objective when installing the biomass system was to provide low-cost heat for his shops. Later, he discovered that he could use the biomass heating plant as a cost-effective way to dispose of waste wood generated by the roof-truss plant. He did not want to incur major tippage costs in the future. Prince Edward Island plans to institute a province-wide waste management system, so disposing of wood waste is going to cost more than it has in the past.

Valley Truss and Metal's 160-kW BCS with the new prototype round day bin designed for dry fuel.

Isaac Schurman has tried many devices to produce fuel that can be used from the wood blocks (by-products of the roof-truss plant). But he found the results less than satisfactory. This ultimately led him to buy a new, slow-speed wood grinder in 1996 at a cost of about $42,000. "The wood grinder works well for all kinds of materials – wood blocks, even paper," says Isaac.

In the beginning, the truss plant generated limited volumes of wood. To complement this fuel supply, Isaac also bought three to four vanloads of green sawdust from Georgetown Timber Ltd., Prince Edward Island's largest sawmill. He mixed the wet sawdust with dry wood chips and sawdust from his truss plant to produce an acceptable fuel. Schurman also bought a few loads of whole-tree chips, fresh from the forest. "Fresh chips are the best fuel," said Isaac. "You get a really nice blue flame with them, but they are also quite expensive." With fresh chips, none of the volatile gases contained in the wood are lost (as they are with drier fuel).

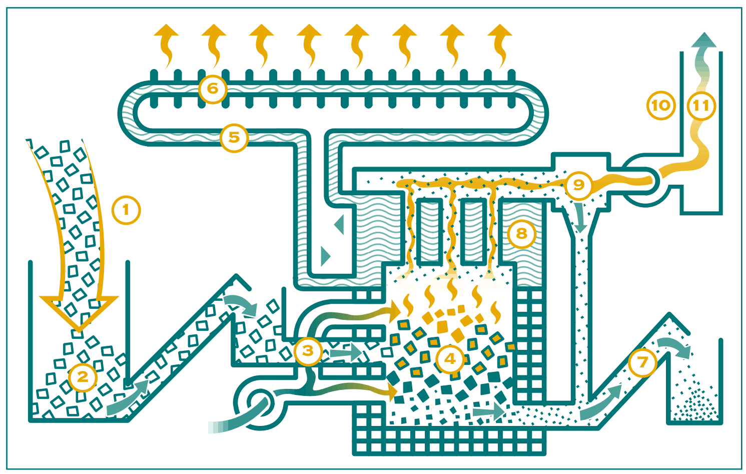
Over time, the volume of wood generated by the truss plant has increased to the point that it exceeds his own heating needs. Isaac no longer buys sawdust and is now selling surplus waste fuel to his brother for the farm's bioenergy heating plant. They mix this dry fuel with green sawdust to boost the output from their heating plant. In addition, Isaac has increased the size of the fuel storage area in his heating plant so that enough fuel for the entire heating season can be stored. The area now measures 8.5 m x 18 m x 4 m (28 ft. x 60 ft. x 14 ft.).

Using the 10-to 15-percent moisture content fuel produced by the wood grinder in his burner, however, created problems in the fuel feed system. The long fibre fuel would bridge over the agitator in the day bin and starve the burner for fuel. To address this problem, Isaac approached the burner manufacturer, which built a prototype round hopper that could feed the dry fuel. The new system was installed in January 2000 and has proven to be very effective and quite satisfactory.

Mode of Operation and Maintenance

Isaac or his helper fills the day bin twice a day. They also rake the grate at the same time and knock the ash into the ash pan below. Isaac has found that very little ash is produced since he switched to his own dry fuel. "I don't think that we would get two drums full of ash over the entire winter now," says Isaac. Fly ash buildup in the boiler is also significantly reduced. "Generally, we clean out the boiler only two or three times a year," he says.

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



Operating Period

Isaac runs his BCS as a heating system only. It usually starts in November and operates until April.

System Performance

Generally, Isaac is satisfied with his current heating system. "Considering the fact that we changed fuels, the system works fine," says Isaac. "The manufacturer has been very patient trying to adapt the system to handle our fuel."

Annual Savings

Isaac cannot estimate what his annual savings are from his biomass system, although he says, "I am sure that we have saved a good few dollars with the system over the years. Sometime I would like to be able to run the heating system on oil for a week so I would actually know how much it would cost with oil. Of course, I also don't know what the cost would be to get rid of the waste wood if I was not burning it." (The heating system does not have a back-up oil-fired boiler.)

Principal Benefits to Valley Truss & Metal

For Isaac, the principal benefits of his biomass system are low-cost heat for his businesses and a practical way to dispose of the wood waste that would otherwise cost him money.

Lessons Learned

Having made the change to burning very dry wood waste, Isaac has become more concerned about fire safety. He has mounted a heat sensor on the feed auger to detect any burn-backs that might occur. This sensor is connected to an automatic dial-alarm system that will call, in sequence, up to three people in the event of a potential burn-back. "The alarm has gone off several times, and we had to come down to check it out, but there have not actually been any serious burn-backs to date," says Isaac.

The heating plant was originally in a separate building, which is ideal from a fire-safety perspective. However, when the fuel storage area was expanded, the heating plant became attached to the adjacent wood lamination plant. This means that if a fire did occur, it could possibly spread into the lamination plant. In hindsight, Schurman believes that joining the buildings was a mistake, and he would not do it again.

Isaac limits the number of people who deal with the BCS to himself and one employee. He feels that it is important that the people who run the biomass heating plant are reliable and have a good understanding of how it works. He also learned an important lesson about processing waste-wood blocks from the truss operation. "We put a lot of dollars into various chippers," he says. "Don't play around with used chippers. Go out and buy a new, slow-speed grinder and get it over with."

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Future Plans

Isaac's combustion cell has a lid with a ceramic lining. Since 1998, the manufacturer has switched to a new type of water-filled lid. This change increases burner output by at least 20 percent and reduces radiant heat losses. It will also likely increase the longevity of the burners. Isaac plans to install one of these water-filled lids in the future when the plant is shut down for maintenance.

With the installation of the new dry-fuel feed system, Isaac's BCS is well adapted to handle the dry fuel produced from the truss plant. He also hopes to install a hood over the hopper to reduce the dust from the very dry fuel when it is dumped in the hopper. He foresees no other changes at this time.

Developing the Canadian Market for BCSs

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 BCS (i.e. one that is high-efficiency with low emissions) 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: http://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 http://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 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 this 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.

Burn back – Fire travelling back from the combustion area along the incoming fuel stream.

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 x 1.2 m x 2.4 m (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 softwood (chipped) can displace about 340 L of heating oil.

Moisture content – The moisture content in wood or other biomass fuels is most 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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