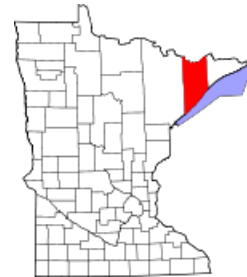


Using Biomass in Minnesota



Case Study

Highlights



Facility

- 6282 Cranberry Road, Finland, MN 55603
- 84,000 square feet

Biomass System

- Four GARN 3200 wood-fired boilers
- 480,000 Btu/hour per boiler
- Generates heat and hot water.
- 3,200 gallons of hot water storage
- Provides 100% of heat load

- 2 BioMax pellet boilers will be installed September 2011 to replace GARNs
- BM 650 2.2 million Btu/hour and BM 300 1.02 million Btu/hour.
- 3,200 gallons of hot water storage
- Manufactured by ABioNova

-Continued on last page

Case Study

Wolf Ridge Environmental Learning Center

Authored by **Adam Zoet** of Dovetail Partners, www.dovetailinc.org

Founded in 1971, Wolf Ridge Environmental Learning Center was the first such learning center in the nation to be accredited as a K-12 school. It is recognized nationally and internationally as a leader in environmental education.

Each year, more than fifteen thousand children, teachers, and parent chaperones travel to Wolf Ridge's two thousand acre campus. They serve an additional three thousand people annually through a broad spectrum of environmental and outdoor learning programs for children, families, seniors, and college students.

The Wolf Ridge facilities

include three classroom buildings, two dormitories, a dining hall, a raptor aviary, a library, two auditoriums, two rock-climbing walls, two outdoor ropes courses, and an administration building. The facility has 380 beds, sixteen for staff and 364 for program participants.

Since they moved into their current campus in 1987, Wolf Ridge has relied on four GARN cordwood boilers to produce heat and hot water for five of its main buildings totaling 84,000 square feet. Each boiler has 3,200 gallons of hot water storage which circulates through a closed-loop system.

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When they were first installed, the GARN system was cutting edge technology, and there were not a lot of other biomass boilers to choose from that could meet Wolf Ridge's heating needs.

The GARNs provide a flexible heating system. The individual boilers can be fired independently and also act as backups for one another. Generally, two or three of the boilers are operational at any given time. The system is designed for temperatures around thirty degrees F below zero, fitting for cold winters typical at Wolf Ridge's location. Heating is required nine months of the year. Because the system was manufactured and installed by a local company (Dectra Corporation) based in Saint Paul, Minnesota, an engineer can easily visit Wolf Ridge for any technical assistance that might be needed.

Northern Minnesota is heavily forested, making biomass a very secure source of energy for Wolf Ridge. The Center's cordwood fuel source has periodically been harvested from their two thousand acres. If Wolf Ridge were not located near such a rich fuel source, they would have to use propane, a very costly alternative for heating their large campus.

Any fuel that is not gathered onsite comes from within a forty-five mile radius of the facility. Birch costs around \$80.00 per cord at logging sales and then another \$75.00 per cord for processing. On average, about fourteen truckloads (160 cords) are needed per year for heating, at a cost of approximately \$25,000. Overall, Peter Smerud, Executive Director of Wolf Ridge, believes they are paying a fair price compared to other regions in the US.

Operating the GARN system is simple but a very hands-on experience that requires a lot of work. Chemicals occasionally have to be added to help prevent oxidation of the boilers.

Someone always has to be onsite attending the system. Before the cordwood can be burned, loggers cut and haul the birch so that it can be stored in eight-foot lengths to dry for up to a year. Wolf Ridge stores the entire annual fuel supply in open air for many months. Later on, the wood gets transported to a heating plant and cut, stacked, and conveyed to storage sheds where it remains under roof for several months. Workers are then able to access these sheds and fill wheelbarrows of fuel to load the boilers every three to four hours from September through June.

Annual operation and maintenance for the GARN boilers costs roughly \$20,000. The cost (all inclusive) to run the GARN boilers is \$47,000 per year, far below the cost of using propane.

As an environmental education facility, Wolf Ridge also uses the biomass system as a teaching tool. According to Smerud, "Parents and children who come to Wolf Ridge learn about the boilers. The boilers are incorporated into classes and serve as a model of renewable energy to others. We want to have facilities that model our educational efforts to promote renewable resources." The renewability, local supply, and impact on carbon output were all attractive features of using cordwood versus fossil fuel based heating systems: "Birch is a forty-year renewable resource that is considered carbon neutral, versus propane which takes thousands of years to renew," says Smerud. "Our wood supply comes from local sources, which means that it is transported very short distances compared to petrol products which are transported many miles to end users."

"We want to have facilities that model our educational efforts to promote renewable resources"

It is easy to become disconnected from the process of how our energy needs are met. Smerud has found that really connecting people to a fuel source and directly relating it to their energy demands has a great impact on their thinking. Unlike the complex process associated with the use of fossil fuels, people can easily envision the process of how biomass is used to meet heating needs.

Since 1987, Wolf Ridge has made improvements to the heating system. Four of their buildings originally had thin-wall fiberglass pipe connected to the heating system. Poor piping (and the fact that they could not bury it deep in the ground because of bedrock) led to heating loss. They would burn around two hundred cords of birch per year with the poor quality piping. In the last few years, they replaced old, inefficient piping with super-insulated material, and this has cut their annual fuel demand by twenty percent to 160 cords.

The GARNs are a great cordwood system, but despite continuous improvements, the GARN boilers have begun to show their age and currently only maintain fifty percent of their original output (480,000 Btu per hour each totaling two million Btu). It also has become very difficult to find a local vendor for firewood processing in the volume and manner needed. Running the system also requires attention to worker compensation issues (e.g. through injuries sustained from lifting the heavy fuel). The boilers also produce a large amount of ash that has to be frequently removed.

Wolf Ridge has been very happy with utilizing biomass for heating over twenty-four years, and they knew that they wanted to stick with it for their new system. During the initial stages of investigating options for a new system, the view was that they would stay with cordwood as a fuel source. However,



issues with processing made them change their mind. Smerud explained that twenty years ago it was easy to find people to process a tremendous amount of wood. In the last three to four years, however, it has been very difficult to find businesses in their rural location that would provide processing, and Wolf Ridge has also on occasion had to source contractors and equipment from more than one hundred miles away. They have struggled with reducing the moisture content of the cordwood fuel so that it will burn well. Given these problems, attention began to shift toward a wood pellet-based system.

To help inform their decision, members of Wolf Ridge's staff talked to numerous manufacturers (including GARN) and toured different facilities in Minnesota, Maine, and New Hampshire that utilize biomass for heating. They discovered that although there are improved techniques and considerably more system choices available now, it was difficult to find a biomass system with a heating output appropriate for the size of their facility. Many units on the market were either too large (e.g. meant for municipalities) or too small (e.g. for households). Nevertheless, they kept at it, continued to look around, put out bids, and found a system that best fit their needs in terms of cost, Btu output, system design, and that matched their educational objectives.

In September 2011, Wolf Ridge will begin installation of two new BioMax pellet boilers

to replace its four aging GARN boilers. The total cost (labor, boilers, water storage, piping, etc) for the pellet system will be \$456,000. To help fund the project, they applied for, and received, a DOE grant for \$300,000 that supports the installation of the new pellet boilers as well as educational modeling.

Ultimately, it was decided that wood pellets were the way to go because they are not prone to freezing like woodchips; they have a good Btu output per pound; and they are easy to move, manage, and store. Smerud believes that using pellets as a fuel source is a sound investment: “Pellets may be more expensive, but we believe they are worth it in the long-run.”

The new BioMax system offers numerous improvements. For example, the previous system required 24/7 supervision and maintenance. They needed to be checked for loading every three hours and it could take a person about an hour to load the system (six hours per day and forty-four hours per week on average including de-ashing). In contrast, the BioMax system will likely only require one person two to four hours a week to complete the necessary operations and maintenance work. Lastly, moisture content will not be a problem with pellets as it was with cordwood. Cordwood was delivered at about fifty percent moisture content and had to sit and dry until it reached thirty percent. Pellets, in contrast, have a five percent moisture content and do not require this processing.

While the pellet system is more automated, it comes with mechanical complexity and electronic controls that should be considered in comparison to the simplicity of loading logs into a boiler. Also, a potential problem is that, unlike cordwood, it will be harder to find a local wood pellet supply. The supplier that Smerud says they are currently considering makes pellets out of waste wood and is located

seventy miles away in Superior Wisconsin. If this source does not work out, Wolf Ridge will have to get its pellet supply within a two hundred mile radius. Plans to construct pellet mills are being proposed which would be very near Wolf Ridge, and Smerud hopes that five years from now pellets will come from no more than twenty-five miles away.

It is estimated that Wolf Ridge will need about nine truckloads or 180 tons of pellets per year. Pellets cost around \$133.00 per ton and delivery is about \$13.00 per ton on average. They anticipate having to store eighteen percent of annual needs onsite.

Smerud warned that there are challenges that people should take into consideration when deciding whether to convert to biomass. If using cordwood, it can be difficult to cut and dry quickly enough to have an adequate supply and challenging to get it processed. Staffing can also be an issue when the equipment needs 24/7 attention. Also, a labor supply can be hard to come by in rural areas. Smerud feels the biggest challenge with pellets will probably be simply trying to get the closest source that they can for fuel supply. He commented, “It would be great if our commitment to pellets could create an industry for the fuel and a local pellet mill was developed.” One of the most important considerations Smerud believes biomass adopters should think about is the increased demand it will require from staff and whether you have the resources (labor and fuel supply) to make it successful.

The best qualities of biomass as a fuel source, according to Smerud, are that it is renewable, it helps support the local economy, reduces transportation impact on the environment, and it can have a positive impact on people’s thinking about renewable energy. Overall, Smerud says, “we are extremely happy using biomass, as evidenced by the fact that we’re still committed to it after twenty-four years.”

Case Study

Highlights

Fuel

- GARNs use onsite cordwood supply
- Moisture content ~30% cordwood and <5% pellets.
- ~14 truckloads or ~160 cords per year
- Cordwood processing cost: \$75
- GARN total annual fuel cost: \$25,000
- BioMax system uses purchased pellets
- Pellets cost ~\$133 per ton
- Delivery costs ~\$13.00
- Will need ~9 truckloads or 180 tons of pellets per year.
- Each GARN boiler produces about 5-6 cubic feet of ash per week. Pellets will produce ~1/10 of that amount

Funding

- DOE grant for \$300,000

Costs and Savings

- Total cost for GARN system is \$47,000 per year
- Total cost for pellet system project: \$456,000
- Annual maintenance costs for the GARN boilers is \$20,000
- Pellet boiler labor costs about \$8,000

Operations

- GARN system required 24/7 supervision and maintenance. GARNs had to be checked for loading every 3 hours. Could take a person ~1 hour to load the system (on average, ~6 hours per day and 44 hours per week including de-ashing)
- The BioMax system will likely require 1 person 2-4 hours per week to complete operations and maintenance work