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Overview and Background

-Northern Land and Lumber Co.

Northern Land and Lumber Co., of Escanaba, Michigan, is a producer of quality timber and lumber products for the log home industry. The firm operates a wood fired boiler to provide process steam for dry kilns and heat for factory buildings. A $75,000 MECP grant was used to offset construction costs of a larger, upgraded wood energy system to increase their lumber drying capabilities. The completed system includes fuel storage and handling capabilities, burner/boiler, emission control system, and exhaust stack.

-MECP Wood Energy Demonstration Project

The Michigan Energy Conservation Program was established to help farmers and wood energy users reduce their energy costs by several different conservation methods. The program was funded by Michigan's legislature and is the result of two federal court decisions stemming from oil overcharges during the 1970s. The Wood Energy Demonstration Project was one of six areas within MECP and was designed to help wood fuel users establish energy systems, to serve as model demonstration sites for other organizations. The Wood Energy Demonstration Project was administered by Michigan State University Department of Forestry and by the Michigan Department of Agriculture.

As a grant recipient of MECP's Wood Energy Demonstration Project, Northern Land and Lumber hosted facility tours on a regular basis, which were free and open to the public. In addition, case study work and wood energy system evaluations were conducted. All Michigan businesses, governmental units, and not-for-profit organizations were eligible for the grant program. A total of $300,000 in funding was provided to 8 demonstration sites to either upgrade existing systems or develop new systems.

Wood Energy at Northern Land and Lumber

-Previous Wood Energy System

Northern Land and Lumber's original wood en-

Table 1

Comparison of original wood energy system vs. new wood energy system for Northern Land and Lumber Co.

	original wood energy system	new wood energy system
rated horsepower	105	250
tons wood/ month	270-290	135-145
fuel type	sawmill slabs	bark

ergy system had been in operation for more than 30 years and provided heat for dry kilns and factory space. The fuel source was sawmill slabs up to 8 ft. long and averaging 40-60 percent moisture content (total weight basis). Fuel consumption for the 105 horsepower (HP) system averaged about 8-10 tons per day, with somewhat higher fuel demands during winter months. Fuel was fed into the burner manually at least once per hour on a continual (24 hours per day) basis.

With hand-firing, the steam pressure to the dry kilns was difficult to control. Dry kiln efficiency was reduced, resulting in lengthened kiln cycles and high lumber degrade. Hand-firing also reduced air quality and combustion efficiency because combustion air ratios were difficult to control when the burner doors were opened for loading. Higher levels of opacity and particulate emissions resulted. High smoke content of exhaust gasses as well as unpredictable swings in steam pressure to the dry kilns were common problems with the original system.

-Advantages of New Wood Energy System

The new wood energy system is able to meet Northern Land and Lumber's energy needs with about 50 percent of the fuel as the previous system used. Fuel consumption has been reduced from 270-300 tons per month of sawmill slabs to less than 150 tons per month of bark and sawdust (Table 1). The new system results in more uniform drying conditions due to better steam pressure control. The low pressure boiler consistently delivers steam between 7 and 9 psi to the dry kilns; previously steam pressure was difficult to control. Lumber drying times are also reduced because drying conditions can be adjusted efficiently to conform to recommended kiln schedules.

Better control of air ratios results in less visible emissions from the exhaust stack, improving air quality. Total particulate emissions are expected to be reduced because of lower fuel consumption, more complete wood combustion, and improved emission control equipment.

-New System - Design and Operating Characteristics

Northern Land and Lumber's new wood energy system is a 250 HP boiler (maximum rated capacity), which utilizes sawmill residues as a fuel source. Only 50-70 HP is used for current energy needs of drying 50 thousand board ft. (MBF) of lumber and heating 18,000 square ft. of factory floor space. The turndown ratio, defined as the ratio of maximum output to minimum output, is close to 4:1. This indicates that the system can operate satisfactorily under a wide range of operating conditions and steam demands. Northern Land and Lumber plans to increase its energy production after installing an additional 150 MBF of dry kiln capacity.

The system has a low pressure steam boiler which operates between 7 and 9 psi. Combustion temperatures typically range from 1800-2000 degrees F. Overfire air and underfire air are used to provide turbulent mixing of gasses and fuel in the combustion chamber. A 7.5 HP induced draft fan is mounted on the exhaust stack and runs intermittently to provide additional airflow through the burner.

The new system is fueled entirely by green bark (primarily from pine species) but can also utilize chips or sawdust, which are both generally easier to handle than bark. Fuel demand is currently 4-5 tons per day, and is somewhat higher during winter months. The green material varies from 40-60 percent moisture content (total weight basis). Dry material such as planer shavings are not utilized as a fuel source.

Bottom ash is removed manually from the burner about once per week. The ash is high in clinkers, which result when sand and other inorganic compounds are included with the pine bark. About 100-150 lbs. of bottom ash is collected weekly and landfilled. A muticyclone collector is used to remove flyash and other uncombustible particles from the airstream. Considerably less flyash is generated than bottom ash.

-Lumber Drying at Northern Land and Lumber

Northern Land and Lumber's dry kilns were established in 1961 and include one 20 MBF track kiln and one 30 MBF batch kiln (total capacity of 50 MBF). Most of the drying is for log home components and includes pine cants and dimensional timbers up to 8 inches thick. Pine lumber is also dried for paneling (one inch thickness) and for roof decking (two inch thickness). About 25 percent of the total lumber drying is cedar, with the remainder being about 70 percent red pine and 30 percent white pine. Small amounts of cedar are also dried. Pine is kiln dried either from the green condition (winter months) or from the air-dry condition (warmer months). Lumber which is currently custom dried at another facility

will be dried on-site after the kiln capacity is increased.

System start-up

Several minor problems developed during the start-up phase of the wood energy system. Some bridging and compaction occurred as fuel was unloaded from the storage silo to the primary auger used to feed the burner. Fuel sometimes bridged just above the auger, or in some cases would overflow from the auger onto the floor. Increased labor was required to monitor the fuel flow. A moving chain device inside the silo was adjusted for more uniform flow to the auger. A larger diameter auger is being considered as a means of facilitating fuel flow and increasing capacity.

NLL operates a hog mill to reduce bark fuel to a usable size. Tramp metal and other contaminants included with the wood has damaged some of the moving parts of the hog. To reduce this risk, floor sweepings from the shop area are no longer utilized for fuel.

Ash production has been higher than expected because of sand contained in the pine bark. Addi-

Table 2

Production and uses of sawmill residues at Northern Land and Lumber Co. [1]

		tons of residue produced						
		week						
residue	destination/ use	1	2	3	4	5	6	avg.
bark fuel (green)	paper mill	33	78	72	38	88	76	64.2
bark-free chips (green)	paper mill	152	103	122	143	150	98	128.0
bark-free sawdust (green)	hardboard mill	51	24	44	18	21	17	29.2
planer shavings, sawdust [2] (dry)	animal bedding	11	11	11	11	11	11	11.0
bark fuel [2] (green)	NLL wood energy system	35	35	35	35	35	35	35.0
	total:	282	251	284	245	305	237	267.3

[1] weekly averages for 6-week period during spring 1991
[2] estimated use

Table 3

Characteristics and utilization of sawmill residues sold by Northern Land and Lumber Co. [1]

	residue type			
	bark fuel	bark-free chips	bark-free sawdust	dry planer shavings
volume (tons/week)	64.2	128.0	29.2	11.0
net price [2] ($/ton)	2.9	18	13	37.5
revenue ($/week)	186	2,304	380	413

[1] weekly averages for 6-week period during spring 1991
[2] net price after transportation

tional labor has been required to clean the burner and remove ash.

Sawmill Residue Management

Based on a sampling period of 6 weeks, Northern Land and Lumber generates approximately 270 tons of sawmill residue per week, including sawdust, bark, and chips from edging and trimming operations. Five different types of waste wood residue are generated, with different moisture contents, sizes, market values, and utilization (Table 2).

NLL currently sells about 64 tons per week of surplus bark for fuel to a local paper mill for a net price of $2.90 per ton (Table 3). The paper mill utilizes bark as part of its fuel mix, reducing its need for alternative fossil fuels for energy.

NLL also sells high quality bark-free chips to be used as a raw material for papermaking to the same mill for a net price of $18 per ton (average of 128 tons per week). Each week about 10-12 tons of dry residue (planer shavings and sawdust) are sold for turkey bedding for $35-40 per ton. Green sawdust is sold to a hardboard manufacturing facility for a net price of $13 per ton. Green bark, which is the lowest value residue, is used to fuel NLL's wood energy system.

If residues were not sold to outside sources or used on-site for fuel, alternative means of disposal would be needed. The nearest public landfill is located 5 miles from the mill and charges a tipping fee of $17.50 per ton.

Table 4

Energy savings from new wood energy system at Northern Land and Lumber Co.

component	estimated savings ($/year)
increased sale of mill residues	23,400
reduced drying times	50,400
labor savings	35,000
total:	108,800

Energy savings from new wood energy system

The new wood energy system at NLL is saving fuel and labor as well as increasing dry kiln efficiency. The new system uses about 150 tons per month less fuel than the original system, a reduction of about 50 percent. More fuel may now be sold for other purposes, including energy production at local facilities. During winter months when more bark fuel is needed at NLL, less will be sold to outside buyers.

Since the new wood energy system was installed, more bark-free chips have been sold to a local paper mill at a net price of $18 per ton. The expected revenue increase will be about $ 23,400 per year for sales of 1,300 tons of chips (Table 4). Previously, this material was used less profitably as an on-site fuel source.

Lumber drying times have been reduced considerably during the first 3 months of operation. Over the initial 4-5 drying cycles, 6-inch thick pine cants have been dried in about 15 days as compared to 21 days with the original system, a savings of more than 25 percent. More consistent steam production and delivery to the dry kilns has resulted in greater efficiency and shorter drying times.

Northern Land and Lumber has estimated that for pine lumber, the 15-day drying cycle will result in a savings of $42 per MBF compared to the 21-day cycle. This cost analysis considered labor, electrical energy for fans, and routine maintenance. Based on drying volumes of 100 MBF per month, energy savings of more than $50,000 per year are expected (Table 4).

The biggest direct savings is expected to be in labor. With the previous system, a boiler operator was needed continuously (24 hour per day basis) to feed fuel into the burner. Three shifts were required at a cost of about $45,000 per year. The new system is fed automatically, requiring little labor except for routine maintenance and ash removal. After the start-up phase, total labor savings are expected to be about $35,000 per year (Table 4).

Abbreviations

NLL:	Northern Land and Lumber Co.
MCGB:	moisture content green basis
F:	degrees Fahrenheit
MBF:	thousand board feet of lumber

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The Wood Energy Demonstration Project

The Michigan Energy Conservation Program for Agriculture and Forestry's Wood Energy Demonstration Project was designed to help businesses and organizations throughout the state realize cost and energy savings through the use of wood as an energy source. A $300,000 direct grant program provided competitive awards to facilities to offset the cost of installing and maintaining wood energy systems. The maximum individual grant award was $75,000.

Under terms of the grant, recipients documented all installation and operating costs. Information on operating conditions and energy savings is available to any organization interested in the economics of wood as an energy source for heat or manufacturing.

Twenty-nine applicants submitted grant proposals, including primary and secondary forest products manufacturers, schools, agricultural related businesses, and a medical care facility. Nine proposals were received from businesses that use kilns to dry lumber, representing the largest single project type.