Preliminary Wood Energy Economic Feasibility Analysis for the Clear Lake Organization Camp at Hiawatha National Forest
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A preliminary economic analysis was conducted for a proposed wood energy system for the Clear Lake Organization Camp of the Munising Ranger District, Hiawatha National Forest. The facility would have the potential for cost savings and would also serve as a demonstration site for wood energy systems in Michigan's Upper Peninsula. Based on expected operating conditions and energy needs, a wood energy analysis was used to determine the financial feasibility of installing and maintaining the wood energy system.

Results include expected cash flows over a 20-year planning horizon and a project payback period. A total of 54 computer runs were performed, allowing for a wide-range of expected operating conditions and wood fuel prices. Six scenarios were evaluated in greater detail, indicating 'most likely' operating conditions for the Clear Lake facility.

The study was a preliminary economic analysis designed to provide financial information on the overall operations of a wood energy system. Specific equipment recommendations, operating conditions, and system design criteria are not within its scope.

Background

The Clear Lake Organization Camp is currently a seasonal facility with minimal heating needs. Under a proposed expansion, the facility would be open year-round with wood fuel supplying energy for winter heating. Fifteen buildings, ranging from about 450 sq. ft. to more than 2200 sq. ft. of floor area will require space heat. In addition, a dining hall and 2 bath houses will require hot water. Two possible fuel sources include residues from a local sawmill and salvage residues from a recently burned forest tract.

Heating Requirements

The heating season was determined to be 24 hours per day from September 15 - May 15 (240 days per year). Heat loss calculations were based on methods from the Michigan Energy Code and from the American Society for Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). Facility blueprints for the Clear Lake facility were also evaluated. It was assumed that walls and ceilings would be insulated but floors and roofs would not. The inside design temperature throughout the heating season was 72 degrees F. Assumptions were also made for distribution and heat losses throughout the buildings.

It was estimated that the Clear Lake Camp would require a boiler system with a capacity of about 1.9 million British Thermal Units (BTUs) per

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hour. About 720 tons per year of wood fuel at 50 percent moisture content (total weight basis) would be needed to power the system. About 67,000 gallons of propane would produce an equivalent amount of heat.

Wood Energy Financial Analysis Model (WEFAM)

The Wood Energy Financial Analysis Model (WEFAM) determines the economic returns from establishing wood energy systems. The computer program (developed by the Office of Energy Programs, Public Service Commission, Michigan Department of Commerce), is used with the LOTUS 1-2-3 Spreadsheet Programming Package and requires estimates of the wood energy system parameters (Table 1). Inputs that cannot be measured accurately can be estimated at different levels for separate computer runs. Thus, any number of scenarios can be modelled by adjusting WEFAM inputs. A separate computer run can be performed for each set of estimates.

WEFAM Assumptions

Assumptions for the WEFAM computer runs included an alternative interest rate (discount rate) of 7 percent. Overall inflation rates were assumed to be 4 percent per year for years 1 through 10 and 7 percent per year for years 10 through 20. Price increases for wood fuel were assumed to be 4 percent per year for years 1 through 5 and 7 percent per year for years 5 through 20. The planning period for all WEFAM runs was 20 years.

Table 1

Wood energy system information used with the WEFAM1 computer program

	Input	Units
1.	Wood Energy System Size	(million BTUs per hour)
2.	Current Fuel Used	(fuel type)
3.	Current Fuel Usage	(appropriate units)
4.	Annual Current Fuel Cost	($)
5.	Moisture Content of Wood	(percent of total weight)
6.	Cost of Wood	($ per ton)
7.	System Operation	(hours per day)
8.	System Operation	(days per year)
9.	Employee Wage Rate	($ per hour)
10.	Capital Cost for Installing Wood Energy System	($)

Wood Energy Financial Analysis Model, Michigan Biomass Energy Program, Public Service Commission, Michigan Department of Commerce

WEFAM Analyses

A total of 54 WEFAM computer runs, covering a wide range of expected operating conditions, were made. Values used in the WEFAM analysis represented most likely conditions, based on information from personnel involved with the wood energy conversion project at Hiawatha National Forest. Six cases, ranging from relatively short to relatively long payback periods, were considered.

Review of WEFAM Variables

Moisture Content: Two different moisture content levels of the two most likely fuel sources were modeled in the computer program. The moisture content of manufacturing residues from forest product producers was estimated at 40 percent (total weight basis) or less. These residues could include trimmings from kiln-dried wood. Freshly cut wood from harvesting operations was estimated to have moisture contents somewhat higher (50 percent or more) than manufacturing residues.

Wood Fuel Cost: Wastes from forest products producers may be available at very low or no cost. Nearby industries are often willing to donate wood wastes because the alternative disposal methods are usually more costly.

Wastes from forest harvesting operations and burned-over lands are available nearby and also on Hiawatha National Forest lands. These wood sources were evaluated at higher costs than the manufacturing residues because labor and transportation costs to handle residues from forest lands must be accounted for. The present cost for commercial firewood in this part of Michigan is estimated to be $18 per ton. Woodfuel costs used in the WEFAM sensitivity analysis ranged from zero dollars per ton to $25 per ton.

Alternative Fuel Cost: Propane was indicated to be the most likely alternative fuel if wood was not used. Based on survey data from Michigan propane suppliers, the selling price to end

Table 2:

Variables Used for WEFAM Analysis

	moisture content (green basis)					
	40%			50%		
wood fuel cost ($/ton)	0	5	10	15	18	25
alternative fuel cost (propane; $/gallon)	low 0.80	medium 1.00	high 1.20	low 0.80	medium 1.00	high 1.20
capital cost for wood energy system (x 1,000 ($))	low 180	medium 200	high 220	low 180	medium 200	high 220

Total number of WEFAM runs = 54

users was 81.8 cents per gallon in December 1989, but rose to $1.11 per gallon in just one month (January 1990 prices).

This example illustrates the short term price fluctuations that can be expected with propane. As of October 15, 1990, Upper Peninsula propane suppliers reported prices ranging from $0.93 to $1.09 per gallon.

Wood Energy System Capital Cost: The capital cost for the wood energy system, including wood handling and storage equipment, was estimated to be about $200,000. This is based on a 2 million BTU per hour boiler system and associated equipment. Systems were also modeled at a lower cost ($180,000) and at a higher cost ($220,000).

Discussion of 6 Cases

The payback period represents the time necessary for a capital investment to accumulate savings or income equivalent to the original investment. Payback periods for the 6 cases in Table 4 ranged from three to seven years. Cases with the shortest payback periods were those having high alternative fuel costs combined with low capital costs. Cases 1 and 5, with payback periods of three years each, had the highest level of alternative fuel cost ($81,000/year) and the lowest level of capital cost for the wood energy system ($180,000).

Cases with longer payback periods generally had lower alternative fuel costs combined with higher wood energy capital costs. Cases 3 and 6, with payback periods of five and seven years respectively, had the lowest level of alternative fuel cost ($54,000/year) and the highest level of capital cost for the wood energy system ($220,000).

Cases 2 and 4 had intermediate payback periods of four years, and intermediate values for alternative fuel cost ($67,500/year) and capital cost for wood energy system ($200,000).

Wood fuel cost was related to payback period in most cases. However, it appears to be less influential than either alternative fuel cost or wood energy capital cost. Although Cases 1 and 5 had payback periods of three years, Case 1 had wood fuel cost of $15/ton, while Case 5 had wood fuel cost of $0/ton.

Conclusions

Based on this preliminary analysis for the Clear Lake Camp, a wood energy system is feasible and would be cost-effective under a broad range of expected operating conditions. Over a 20-year life-time for the camp facilities, the net present value of the wood energy project can be expected to be between $270,000 and $1.1 million, depending on operating variables such as the cost of wood and alternative fuel, and capital costs. Following the economic evaluation, a detailed engineering study would provide equipment specifications and design parameters.

Table 3

WEFAM Economic Analysis

Sensitivity Analysis for 6 Selected CasesConstant values for all cases:

- System size.. 2 million BTU/hour
- Expected fuel usage .... 6,164 million BTU/year
- System Operations .... 24 hours/day
- System Operations .... 240 days/year
- Wage Rate of Boiler Operator $8.00/hour

TABLE 4

Sensitivity analysis for 6 selected cases - variables and results:

Case 1:

Variables

- Alternative fuel cost — $81,000/year
- Fuel moisture content (green basis) — 50%
- Wood fuel cost — $15 /ton
- Capital cost for wood energy system — $180,000

Results

- Payback period — 3 years
- Total cash flow (20-year cumulative) — $2,216,274
- Net present value of cash flow — $919,151

Case 2:

Variables

- Alternative fuel cost — $67,500/year
- Fuel moisture content (green basis) — 40%
- Wood fuel cost — $5/ton
- Capital cost for wood energy system — $200,000

Results

- Payback period — 4 years
- Total cash flow (20-year cumulative) — $2,044,986
- Net present value of cash flow — $829,646

Case 3:

Variables

- Alternative fuel cost — $54,000/year
- Fuel moisture content (green basis) — 40%
- Wood fuel cost — $10/ton
- Capital cost for wood energy system — $220,000

Results

- Payback period — 5 years
- Total cash flow (20-year cumulative) — $1,399,177
- Net present value of cash flow — $522,265

Case 4:

Variables

- Alternative fuel cost — $67,500/year
- Fuel moisture content (green basis) — 50%
- Wood fuel cost — $18/ton
- Capital cost for wood energy system — $200,000

Results

- Payback period — 4 years
- Total cash flow (20-year cumulative) — $1,599,197
- Net present value of cash flow — $624,963

Case 5:

Variables

- Alternative fuel cost — $81,000/year
- Fuel moisture content (green basis) — 40%
- Wood fuel cost — $0/ton
- Capital cost for wood energy system — $180,000

Results

- Payback period — 3 years
- Total cash flow (20-year cumulative) — $2,690,795
- Net present value of cash flow — $1,137,027

Case 6:

Variables

- Alternative fuel cost — $54,000/year
- Fuel moisture content (green basis) — 50%
- Wood fuel cost — $25/ton
- Capital cost for wood energy system — $220,000

Results

- Payback period — 7 years
- Total cash flow (20-year cumulative) — $855,581
- Net present value of cash flow — $272,674

References

1) Office of Energy Programs, 1988. **Wood Energy Financial Analysis Model (WEFAM),** (computer program). Michigan Department of Commerce, Public Service Commission, Lansing, Mich.

2) Office of Energy Programs, 1988. **Wood Fuel User's Manual**. Michigan Department of Commerce, Public Service Commission, Michigan Biomass Energy Program, Lansing, Mich.

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