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Economics of Small Commercial Wood Chip Combustion Systems in Eastern Canada

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ABSTRACT

The purpose of this study is to investigate the economic viability of heating farms and small commercial buildings using wood chips/mill residues in eastern Ontario. The analysis suggests that wood fuel heating can be a viable energy option in eastern Ontario, especially in areas where natural gas is not available. The availability of a reliable source of low-cost wood fuel is the main factor influencing the economic viability of this type of system, followed by the availability of an existing infrastructure. Nonetheless, sawmill residues in eastern Ontario appear to be in limited supply in certain locations and it would be worthwhile to investigate the potential of using forest thinnings to supply wood heating systems.

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BTU British Thermal Unit = 1,054.8 joules

cm centimetre
cu.ft. cubic feet = 0.028 cubic metre
ha hectare - 2.47 acres
hp boiler horsepower = 33,480 BTU/h or 9.8095 kW
IRR internal rate of return
kg kilogram = 2.2 pounds
kW kilowatt = 3,413 BTU/h
L litre = 0.2199 Imperial gallons = 0.2642 American gallons
Ibs pounds = 0.455 kg
Mg Megagram - one metric tonne - 2,200 Ibs - 1.1 ton
m metre
mb millibars
mm millimetre
na not available
NPV net present value
od oven dry- 0% moisture content
odMg oven dry Megagram
odt oven dry tonne
rH relative humidity
ton one metric tonne - one Megagram - 1.1 ton
yr year
$ Canadian dollar

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Introduction

The sustainable development of the forest in eastern Ontario requires the implementation of many practices including the development of new markets for both end products and residues. An example of this new market development would be to add value to mill residues and forest thinnings. This would reduce land filling and provide an additional monetary incentive to woodlot owners to invest in sylviculture programs. A potential market for both materials exists in the production of space and process heat for farms and local small and medium size businesses.

The use of wood as a source of energy on farms is obviously not new, but recent advances in the technology used to design wood chip combustion systems is warranting a re-evaluation of its viability in eastern Ontario. Among the approximately one hundred systems installed so far in eastern Canada, most of them located in the Atlantic provinces, some have proven to be very successful while others have failed. Several variables, including the price of conventional energy sources, the availability and price of wood fuel sources (residues, thinnings), heat load demand, and system efficiencies have played key roles in determining the viability of each venture.

Since the majority of the wood chip systems installed so far are located in the Atlantic provinces, this study focuses on the potential existing in the area covered by the Eastern Ontario Model Forest (EOMF). More precisely, the purpose of this study is to investigate the economic viability of heating farms and small commercial buildings using wood chips/mill residues in eastern Ontario. This is achieved by reviewing the basics of wood chip heat, presenting the typical installation costs, and developing two case studies from an actual installation in the EOMF. General conclusions and recommendations for future work complete the report.

Methodology

The decision regarding the choice of one energy source versus another involves both monetary and non-monetary considerations. Monetary factors include such things as capital cost and its recovery over the useful life of the system, maintenance charges, fuel cost, as well as other factors such as subsidies, tax breaks etc. These can be fairly easily evaluated and then used to estimate the financial viability of each energy source under consideration. A purely financial decision can then be made. Non-monetary factors (noise, odors, dependence on one supplier, price stability, centralised versus decentralised systems, reliability, etc.) are also considered by the potential consumers/investors although their effects on the decision- making process are difficult to evaluate. Although the focus of this study is the evaluation of the financial aspect of wood chip heating, an effort is made to identify non-monetary factors influencing the decision-making process.

Net Present Value Criterion

A valuable tool to investigate the financial viability of a project of heating system is the net present value criterion (NPV), which is calculated via the following formula:

$$NPV = -I + \sum_{i=1}^{n} \frac{CF_i}{(1+r)^i}$$

where:

- I is the initial investment,
- CF_i is the expected net cash flow in year i,
- r is the discount rate
- n is the time horizon of the project.

A project is viable when for a given discount rate, the net present value is greater than zero[1].

In the development of the case studies, the capital investment required to purchase and site the wood chip heating system is first estimated. The net annual cash flow is then estimated for each year up to the end of the useful life of the system. There are no direct annual revenues associated with a heating system. Rather, a reduction in cash requirement is experienced from the savings achieved by using wood chips instead of conventionàl fuels - assuming that wood is a less expensive energy source than conventional fuels, which is usually the case.

Table 1: Energy Content and Approximate Price of Various Energy Sources in Ontario

Energy Source	Energy Content in Gigajoules (GJ)	Price ($/GJ)

Oil	0.0382 GJ/L	10.00
Electricity	0.0036 GJ/kWh	25.00
Natural Gas	0.0375 GJ/m^3	6.00
Propane	0.0253 GJ/L	9.90
Wood Chips (at 35% MC)	12.02 GJ/t	0.79-4.73

Sources: 1. Natural Resources Canada, 1996. Comparing Heating Costs. 2. Ontario Ministry of Environment and Energy, Economic Service Branch, 1996. 3. Statistics Canada/Natural Resources Canada, 1994.

Determining the value of the savings involves first an estimation of the consumption of fossil fuels and wood that would be necessary to meet the farm heat demand. These values are then multiplied by their respective fuel cost, and the savings achieved by using wood chips are computed by subtracting wood chip cost from each fossil fuel cost. Heating system efficiencies are usually needed for these computations and are summarized in Table 2.

[1]Expressed in words, the NPV is equal to the present value of future returns, discounted at the marginal cost of capital, minus the present value of the cost of investment. When a project returns more than the cost of capital, the NPV is positive, and the profitability of the farm is improved.

Table 2: Typical Efficiency of Different Heating Systems

Fuel Type	**Efficiency**
Light Fuel Oil	
Residential	65%
Commercial	80%
Industrial	80%
Propane	
Residential	75%
Commercial	78%
Industrial	85%
Natural Gas	
Residential	68%
Commercial	78%

Industrial	85%
Electricity	
Residential	100%
Commercial	100%
Industrial	100%
Wood Chips & Sawdust	50-72%

Sources: 1. L'Energie au Quebec. 1995. Government of Quebec. 2. McCallum et al., 1992.

In order to compute the net cash flow, the annual cost related to repairs and maintenance of the wood fuel system are estimated. The difference between the annual fuel cost savings and annual costs of maintenance and repairs provides the net cash flow value[2]. Labour required to fill the hopper (twice a day) is not considered in this report since the operation usually takes only a few minutes. The importance of this task in the decision-making process is probably better dealt with as non-monetary issue.

The NPV of each project is then computed, along with the IRR[3] and payback period[4].

The NPV analysis assumes an interest rate of 10%.

[2]Annual maintenance charges related to the fossil fuel heating system can be added to the annual net cash flow figure, if substantial.

[3]IRR: internal rate of return. The IRR is the rate of return on an asset investment, calculated by finding the discount rate that equates the present value of future cash flows to the cost of the investment.

[4]Payback period: the length of time required for the net revenues of an investment to return the cost of the investment.

Results

1.0 Basics of Wood Chip Heat

Every heating system is a little different depending on the physical lay-out of buildings and the heat load involved. However, a typical wood chip systems includes the following components:

- **Fuel Reserve**

  A fuel reserve is a bin or building where wood fuel is stored. Most fuel reserves in small commercial wood chip burning systems are simply pole teams or steel sheds.

- **Fuel Metering Bin**

The fuel metering bin is a bin or hopper that stores at least a day's worth of fuel. They range in size from 3 to 6 cubic metres.

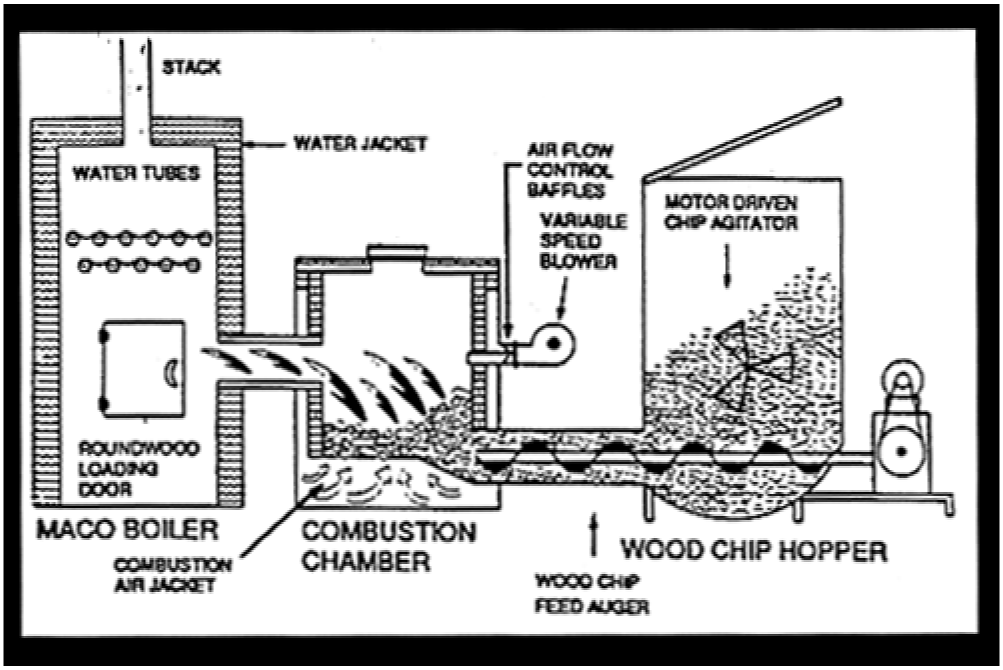

Figure 1: Wood Chip Combustion System.

- **Fuel Feed System**

  The fuel feed system automatically extracts fuel from the metering bin and feeds it into the combustion chamber.

- **Combustion Chamber**

  The combustion chamber is a small firebrick-lined chamber where the fuel is burned. Combustion takes place on a grate in the chamber and in a small firebrick tunnel that connects the bumer to the heat exchanger. Fuel is fed into the combustion chamber by an auger. A small fan directs pre-heated primary combustion air below the grate and a small amount of secondary combustion air above the grate.

- **Heat Exchanger**

  The heat exchanger is a hot water boiler that extracts heat from the spent combustion gases. Round wood can also be burned in most boilers.

- **Heat Distribution System**

  The heat distribution system transports heat from the boiler via pipes to radiation systems in the building where it is needed.

A more complete description of wood chip heating systems is currently available in other reports (e.g. McCallum, 1995) and thus will not be discussed further in this report.

2.0 Typical Installation Cost

The investment required to install a wood chip combustion system may vary considerably from one farmer to another, depending on the type of infrastructure already in place. Assuming no infrastructure in place implies, in addition to the cost of the system, the construction of a building to site the combustion unit and the installation of an underground hot water piping system.

The typical installation requirements were obtained from Vince Court of GroveWood Heat in Prince Edward Island, the manufacturer of the systems sold under the trademark Bioblast. The Bioblast™ systems are available in five different sizes: 75 kW, 100 kW, 130 kW, 160 kW, and 200 kW. The analyses performed in this report are all based on a 160 kW unit.

Simply to site the combustion unit, a building space of 12' x 16' is required. In addition, the building usually also holds sufficient space to store an 8' x 8'x 50' truck load of wood chips plus another half load so that the farmer never runs out before a new load comes in. Using these figures, a building of approximately 600-800 sq. ft. is required. Construction cost of a suitable building is reported to be $10/sq. ft., for a total between $6,000 and $8,000.

The total cost for the hopper, combuster, heat exchanger, expansion tank, water douser, aquastat and motor control for a 160 kW system ranges between $20,000 and $22,000. Piping between the combustion unit and the building to be heated costs $8-$12 a foot each way. The system uses a high quality plastic polyethylene pipe with 1.25" inside diameter, surrounded by insulation and put in a 4" sewer pipe. Digging the trench is estimated at $0.50 per foot. The cost incurred for a plumber to hook up the piping system coming from the combustion to the distribution heat network in the building to heat is approximately $325.

Assuming that (1) the heat distribution network is already in place and remains usable no matter the source of energy used, (2) that the building is 250 feet away from the combustion unit, and (3) that a farm tractor with a front-end loader is already available, the level of investment required by the farmer is $33,450 (see Table 3 and Figure 2)

Table 3: Typical Investment for the Installation of a Brand New 160 kW Wood Chip Combustion System

Building	6,000
Equipment (hopper, combustor, etc.)	22,000
Digging trench (250 ft.)	125
Piping	5,000
Plumber	325

Total	**$33,450**

This amount can be reduced substantially if an existing building can-be used to site the combustion system and the storage area and/or if one is only retrofitting an existing installation.

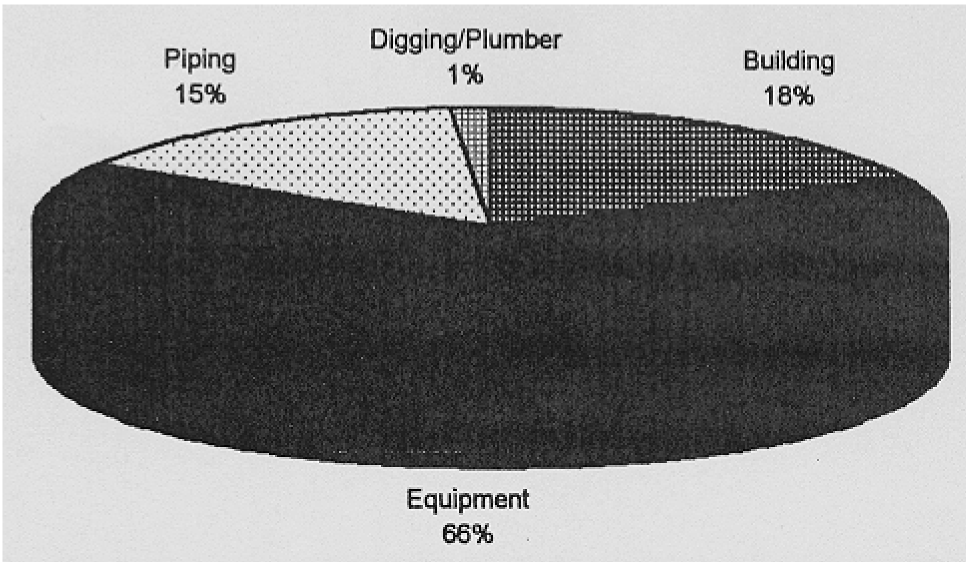

Figure 2: Typical Breakdown of an Investment in a Wood Combustion System.

3.0 Case Studies

3.1 Basics of Greenhouse Tomato Production

The two case studies developed in this report examine the economic viability of heating an hydroponic tomato facility using a wood chip system. The following paragraphs provide background information on greenhouse production.

One of the main expenses incurred in greenhouses is the cost of heating. Greenhouse operation requires very strict control over the environment. Temperature, humidity and vapour pressure must be strictly managed if high yields and high quality are to be achieved.

Tomatoes require a steady temperature of 19°C during the day and 17.5°C at night. Proper temperatures ensure that the plants remain balanced and productive. Relative humidities should be maintained between 75% and 85%, and vapour pressure deficits between 4 and 8 millibars (mb). Humidity control is important, as high humidities promote disease, and cause fruit cracking. Careful control of the relative humidity will pemmit fungicide-free growing, as well as promoting higher quality fruit.

Greenhouses are usually de-humidified by alternately heating and venting. Hot water heating with roof venting is especially well-suited to de-humidification. If heat is applied to the floor, very uniform heating in the greenhouse is achieved. When constructing a greenhouse and choosing a heating system, the climate must be given serious thought, as the farmers livelihood depends on high production.

There are two ways to heat greenhouses: hot air or hot water. Hot water is the method of choice, because it permits even heat throughout the greenhouse, and provides a more constant temperature. There are four ways to fire hot water boilers (or steam): natural gas, oil, propane and wood. Natural gas is not accessible in rural areas without very high penalties assessed by the gas company for pipeline construction. For this reason, natural gas is not considered in the case studies.

3.2 Case Study #1: Propane and Wood

The greenhouse operation used for this analysis is the property of Roy Pattemore. The family enterprise is located near Seely's Bay, eastern Ontario. Up until 1996, this 8,500 square foot hydroponic tomato operation relied entirely on propane to meet its heat requirement. With financial support from the EOMF, a 160 kW Bioblast™ wood heating system was installed in November 1996.

Existing Propane System:

The propane water boilers in this greenhouse are conceptually different from conventional oil fired boilers in that the propane boilers surround the water with hot air. The tubes in these boilers are filled with water, in contrast with conventional oil boilers which are tube fired, and have water surrounding the air-filled tubes. The propane boilers deliver heat much faster but drawbacks exist. In particular, propane is selling for more on a Gigajoule basis than oil, usually making propane heating more expensive in spite of the lower capital cost of the system.

The propane boilers on this site are state-of-the-art telydyne boilers (these boilers can also be fired on natural gas). The propane boilers on this site are 117 kW (400,000 BTU's) each and cost $2,400 each. The heating system in this facility cost approximately $25,800 to purchase and install: $4,800 for the boilers, $16,000 for the pipes, and $5,000 for welding and installation. The heat pipes were installed on the floor, providing uniform heat at the base of the crop. This propane system has been maintenance free, due to the simple and clean combustion system employed.

Propane costs $0.25/L in Seely's Bay, and this greenhouse spends between $15,000 and $18,000 per year on propane, which means an annual consumption of 60,000-70,000 L/year.

These costs reflect actual heating as these operators spent little in the way of dehumidification.

Propane boilers are much smaller than oil fired boilers, and as a result are often installed in the greenhouse, as is the case at this facility. This eliminates the need and expense of erecting a boiler shed that costs in the order of $10 per square foot to build. An alternative to this is to erect greenhouse framing at a cost of $7 per square foot when covered in polyethylene.

New Wood Fuel System:

A 160 kW Bioblast™ wood chip combustion system was installed in November 1996 at the Seely's Bay facility. This new installation was connected directly onto the existing heat pipes. The system is a standard wood set-up complete with hopper, combustion chamber, and boiler as outlined in a previous section. Because the boiler is located in a separate building (as opposed to the propane boilers), the effects of increased relative humidity (rH) are reduced[5]. Only dry heat is provided to the greenhouse.

The initial investment for the 160 kW system was $18,500, plus $6,000 for the boiler shed, and $1,500 for installation. The wood fuel, which is hardwood sawdust, is obtained from a sawmill near Perth, Ontario, which is approximately 80 kilometres from Seely's Bay. The sawdust is approximately 45% moisture and contains hard and soft maple, beech, and birch. The sawdust costs $220 per truck load (800 cu. ft.) or about $40/tonne[6].

[5]Propane boilers are sited in the greenhouse, which minimize capital cost, but creates environmental problems in the greenhouse because of the type of chimney used with propane, resulting in increased relative Humidity (rH), with all of the associated problems (diseases, fruit cracking, etc.)

[6]Assumes a bulk density of 15 Ibs/cu.ft.

No propane at all has been used since the installation of the biomass unit. The propane system is currently used only as a backup system. The operators of this facility estimate that the biomass system reduces heat costs by 60%. Propane heating cost average $15,000 per year in the past at this operation. Using these data, the annual fuel cost savings should be in the order of $9,000. However, since the system has not been operating for a full year, this analysis will use an estimate of $8,000.

Assuming that the wood fuel system has a useful life of 12 years, an annual maintenance cost of $350, and fuel cost savings of $8,000, the payback period of this system is 3.4 years. The NPV of the project is positive ($26,000) and the investment provides an internal rate of return of 28% (Table 4). Hence, for this particular greenhouse operation, the addition of the wood system unit is quite a profitable investment.

Table 4: Propane to Wood - Wood Fuel System as Incremental Unit

Capital Cost		Annual Cost			
		Year	**Maintenance**	**Savings**	**Net Cash Flow**
Building	6,000	1	350	8,000	7,650
Equipment	18,500	2	350	8,000	7,650
Installation	1,500	3	350	8,000	7,650
Total	**$26,000**	4	350	8,000	7,650
		5	350	8,000	7,650
		6	350	8,000	7,650
		7	350	8,000	7,650
		8	350	8,000	7,650
		9	350	8,000	7,650
		10	350	8,000	7,650
		11	350	8,000	7,650

		12	350	8,000	7,650
NVP	**$26,125**				
IRR	**28%**				
Payback Period	**3.4 years**				

The previous analysis dealt only with the capital required to purchase and install the Bioblast™ system and did not include the cost of piping, plumbing, etc., since the water system was already in place for the propane system.

If these costs are included in the analysis, along with the cost of one propane furnace necessary as a backup, the wood chip system is still a profitable investment with a NPV of $2,725, an IRR of 11%, and a payback period of 6.5 years.

Table 5: Propane to Wood Fuel - assuming both systems are put in place in a brand new facility					
Capital Cost		**Annual Cost**			
		Year	**Maintenance**	**Savings**	**Net Cash Flow**
Building	6,000	1	350	8,000	7,650
Equipment	21,900	2	350	8,000	7,650
Piping	16,000	3	350	8,000	7,650
Plumber	5,000	4	350	8,000	7,650
Installation (others)	1,500	5	350	8,000	7,650
Total	**$49,400**	6	350	8,000	7,650
		7	350	8,000	7,650
		8	350	8,000	7,650
		9	350	8,000	7,650
		10	350	8,000	7,650
		11	350	8,000	7,650
		12	350	8,000	7,650
NPV	**$2,725**				
IRR	**11%**				

Payback Period	**6.5 years**				

System Shortfalls:

From a technical standpoint, two main shortfalls have been identified with this system to date:

- Fuel quality delivered to the greenhouse is not consistent between loads, resulting in variable fuel use. The operator must tinker constantly with the system to try to improve the fuel combustion characteristics. Different fuels have different burning capacities, for example maple chip fires burn longer than poplar chips. Generally, wood chips burn hotter than sawdust because blower air can penetrate the fuel causing more complete combustion. Sawdust is denser, blower air does not penetrate as much and therefore the fire is restricted to the perimeter, reducing combustion and heat produced. The problem with fuel quality could probably be resolved by getting some sort of agreement with the supplier on the specifications on the wood fuel which is to be delivered.

- The hopper-burner functions on timers, and when fuel sources change the timers must be reset. Furthermore, these systems must be installed with a primary hot water loop combined with a four way mix valve to the greenhouse loop, otherwise there is no control of heat. This piece of equipment has not been installed yet at this greenhouse and this is causing problems - it becomes an "all or nothing" scenario. Standardizing fuel quality would solve the first problem, while investing at most $1,500 to install a four-way valve would solve the second.

Overall, the biomass system at this farm is definitely viable but still requires minor adjustments to provide constant temperature to the greenhouse.

3.3 Case Study #2: Oil and Wood

Using the same greenhouse, a scenario was developed to look at the profitability of the 160 kW wood chip unit but in the case where the initial system in place was oil-fired instead of propane-fired. The two 117 kW (400,000 Btu's) propane boilers were replaced by two 118 kW (12 hp) oil-fired boilers at a cost of $8,000 a unit. The same piping system as for the existing propane scenario was used. Annual fuel cost savings were estimated at $5,000.

The addition of the wood chip heating system to replace the oil-fired system, which would be used a backup only, is still profitable (Table 6) but not as much so as in the case of propane. This is because of the lower fuel cost savings achieved since oil is less expensive to purchase than propane. Again assuming a 12-year useful life for the wood system, the NPV of the investment is $5,684, with IRR of 14% and a payback period of 5.6 years.

Table 6: Oil to Wood – Wood Fuel System as Incremental Unit					
Capital Cost		**Annual Cost**			
		Year	**Maintenance**	**Savings**	**Net Cash Flow**

Building	6,000	1	350	5,000	4,650
Equipment	18,500	2	350	5,000	4,650
Installation	1,500	3	350	5,000	4,650
Total	**$26,000**	4	350	5,000	4,650
		5	350	5,000	4,650
		6	350	5,000	4,650
		7	350	5,000	4,650
		8	350	5,000	4,650
		9	350	5,000	4,650
		10	350	5,000	4,650
		11	350	5,000	4,650
		12	350	5,000	4,650
NPV	**$5,684**				
IRR	**14%**				
Payback Period	**5.6 years**				

In a scenario where it is assumed that, 1) there is no existing heating system in place (basically a brand new greenhouse), 2) only one oil furnace (12 hp) is installed as backup, and 3) the cost of piping is included, the overall heating system becomes non-viable: the NPV is -$29,000 and the IRR is -3% (Table 7). In this case then, a completely oil-fired heating system would more cost-effective than a wood-oil system.

The main conclusion arising out of the analysis of this scenario is that the installation of an oil fired system and a wood chip system simultaneously is not financially viable. However, if the oil furnaces are already in place and paid for, using them as backups would extend their life and installing a wood chip unit to act as the main source of heat would make economic sense as in the first scenario.

Table 7: Oil and Wood – assuming both systems are put in place in a brand new facility					
Capital Cost		**Annual Cost**			

		Year	Maintenance	Savings	Net Cash Flow
Building	12,000	1	350	5,000	4,650
Equipment	26,500	2	350	5,000	4,650
Piping	16,000	3	350	5,000	4,650
Plumber	5,000	4	350	5,000	4,650
Installation (others	1,500	5	350	5,000	4,650
Total	**$61,000**	6	350	5,000	4,650
		7	350	5,000	4,650
		8	350	5,000	4,650
		9	350	5,000	4,650
		10	350	5,000	4,650
		11	350	5,000	4,650
		12	350	5,000	4,650
NPV	**-29,316**				
IRR	**-1%**				
Payback Period	________				

Discussion and Guidelines for Eastern Ontario

The level of capital investment required to purchase and install a wood fuel heating system, as well as the access to a relatively low-cost wood fuel of constant quality, are key factors in the success of wood chip heating. The case of the greenhouse operation at Seely's Bay is a good example of a situation in which wood fuel heating makes economic sense. Fuel costs savings are substantial and the capital cost of the system was reduced since all the piping was already in place. Furthermore, at the current wood fuel cost, installing the same wood chip system along with the same two propane units in a brand new facility of the same size would still be a profitable investment, as shown in Table 5. This would provide a 100% backup as opposed to 50% with the initial propane system, which reduces the risk of crop failure.

One of the problems with wood chip heating in eastern Ontario appears to be the limited amount of sawmill residues available, at least in certain locations. The issue is not that there are no sawmill residues available in the region, but rather that it can sometimes become difficult to secure a year-round supply of residues in quantities required for a typical wood fuel unit (e.g. 160 kW). For instance, the greenhouse operation in Seely's Bay has to get its supply of sawdust from a sawmill located 80 kilometres away. The possibility that sawmill residues could be rather difficult to access for end uses such as farm heating was mentioned to the authors by a few industry people in the region. The potential of using forest thinnings as a fuel source thus deserves special attention in the future.

In areas of eastern Ontario where natural gas is available, the potential of wood chip heating is probably rather limited. Natural gas sells for nearly half of the cost of propane on an energy basis in eastern Ontario, which substantially reduces the potential fuel savings derived from using wood chips. The availability of a reliable source of low cost wood fuel becomes critical to the financial success of this type of substitution.

The greenhouse at Seely's Bay is approximately 8,500 sq. ft, which is a relatively small operation. One might question whether, in the case of a larger operation, wood heating would be as promising. An existing 47,000 sq. ft. greenhouse located in Alexandria, eastern Ontario, is used to explore this possibility. The operation is a state-of-the-art hydroponic tomato production facility, and uses two 1,000 kW oil boilers to produce its heat requirement. The heating system has a 100% backup, which means that one boiler is actually sufficient and the other is used as a backup. The installation of a 160 kW Bioblast™ unit would represent slightly more than 10% of the existing installed capacity. If low cost wood fuel is available in this area, the addition of a wood fuel unit could be attractive to provide heat for de-humidification during the summer and during winter shut down when the water temperature is maintained at freezing, which in both cases uses approximately 10% of the current oil boiler capacity. Hence, during these periods, the oil boilers could be completely shut down. Provided that the fuels savings achieved by using wood instead of oil are sufficiently large, the 160 kW could make economic sense. This type of possibilities should receive attention in the future.

Non-Monetary Considerations

At the beginning of this report, it was mentioned that non-monetary factors were also considered by consumers when deciding on the use of one form of energy versus another. Wood fuel systems require more daily labour than conventional fuel systems. How users value that time is difficult to assess but for some it is obviously a major concern. For instance, if the farmer works near the unit everyday, in the case of a greenhouse for example, then filling the hopper twice a day will take only few minutes and will not be very disturbing. On the other hand, if the user has to make a special trip to fill the units then wood fuel systems may be a lot less attractive. The costs related to labour were not included in the case studies analysis.

Year-round availability and quality of the wood fuel supply are also major issues considered. In the case of sawmill residues in eastern Ontario, there appears to be a problem with availability in some locations, which could reduce the attractiveness of wood fuel heating. Guidelines for Ontario From the analysis performed in this report and the experience developed in the Maritimes, it is a rather difficult task to specifically identify the type of farm operations or general rules where wood chip heating is a financial success. Rather, economic viability appears to be extremely farm-specific.

To provide some sort of guidelines for eastern Ontario, one approach is to compute the annual fuel savings required to break-even for different level of investment (Figure 3). For instance, if the initial investment required to install the combustion system is $20,000, then annual fuel savings must be at least $3,450 (this assumes a capital cost of 10%). This kind of chart is useful to identify quickly farmers for whom a more detailed analysis is worthwhile.

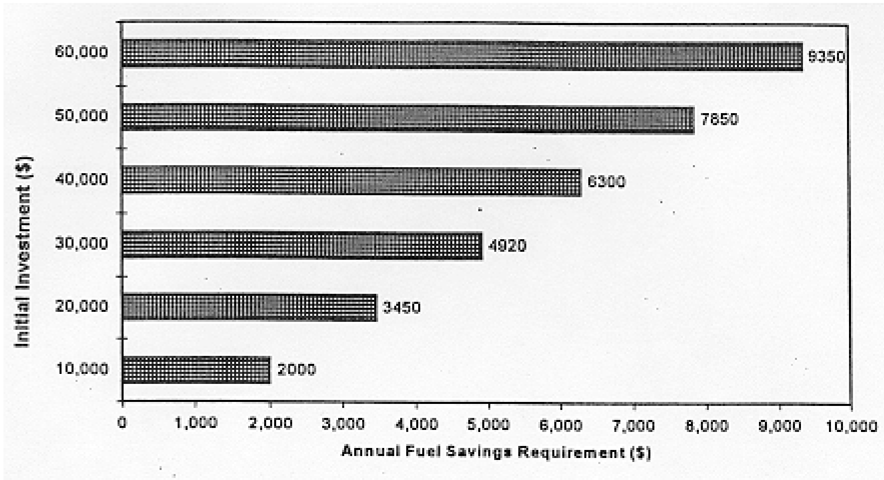

Figure 3: Minimum Annual Fuel Savings Required to Justify Investing in a Wood Combustion System. Assumptions: interest rate: 10 %; useful life of the wood fuel system: 12 years.

Conclusion

The analysis conducted in this report suggest that wood fuel heating can be a viable energy option in eastern Ontario, especially in areas where natural gas is not available. The availability of a reliable source of low-cost wood fuel is likely the main factor in the economic viability of this type of system, since the additional capital cost of these systems compared to conventional fuel systems has to be at least offset by the annual fuel savings achieved. The availability of an existing infrastructure (e.g. piping system, sheds, etc.) also plays an important role as it reduces the capital spending required for the wood fuel system and thus greatly enhances their economic viability.

Since the profitability of wood chip heating is very site-specific, it is difficult to identify exactly what type/size of enterprise should be targeted. Nonetheless, a chart has been developed so that farmers simply need to determine the level of capital investment required and the potential annual fuel cost savings to determine if the investment is viable. If so, a detailed financial analysis is worth performing in order to confirm profitability and resolve financing issues. Finally, sawmill residues in eastern Ontario appear to be in limited supply in certain locations and it would be worthwhile to investigate the potential of using forest thinnings to supply wood heating systems in the region.

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