

# ASSESSING REMOTE FIRST NATION COMMUNITIES FOR THEIR POTENTIAL TO UTILISE BIOMASS-FUELLED HEATING SYSTEMS

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## ABSTRACT

A study was initiated in 1997 to develop methods to assist remote First Nation communities in northern Canada to determine their potential to utilise small district heating systems based on wood chips from surrounding forests. A method to determine the ratio of biomass supply to biomass demand was developed to rank communities' potential to succeed based on the available forest resource and the communities' bioenergy needs. A framework for forest management planning consistent with First Nation culture and traditions is described. Two wood chip supply systems, one based on a farm tractor and one utilising conventional forest machines, are suggested as viable wood supply options. Preliminary results suggest wood chips can be supplied at prices competitive with fossil fuels in Canada's remote communities. Field testing of the systems developed in this study will take place during 1998–99.

**Keywords:** Biomass, bioenergy, remote communities, First Nations, pre-feasibility study, wood chip supply systems, forest management.

## INTRODUCTION

There are approximately 310 communities in Canada that could be considered remote in terms of accessibility to natural gas pipelines and the provincial power grids. About half of these communities are located in areas that support forest resources suitable for conventional commercial forest industry or for utilising forest biomass for bioenergy production. In addition, many more communities are connected to the power grid but do not have access to natural gas, which is a low-cost and preferred fuel for space heating. In general, these communities are located in the northern regions of Canada and often are inhabited solely by First Nation people.

First Nation people have a traditional lifestyle close to the land. Living in remote communities is a choice many First Nation people make because it gives them the opportunity to maintain their traditions. This choice often means they experience high unemployment and low incomes simply because the economic base in many remote communities is small and has little chance to expand. As a result, many First Nation communities are dependent on government programmes for their survival. Any opportunity to become self-sufficient or at least reduce the community's dependence is

well received by both community members and governments.

One way for a remote community to generate income and reduce unemployment among its members is for the community to become self-sufficient in their energy requirements, at least for their space heating needs. Many remote communities have access to forest resources, and the concept of utilising biomass from the surrounding forest is consistent with First Nation traditions. Current space heating practices involve a combination of fossil fuels, such as fuel oil, and roundwood. Fuel oils are trucked over winter roads or barged from larger centres. Roundwood is collected by individuals in small amounts and is generally not an efficient operation, particularly when harvesters must travel long distances on snow machines. The fossil fuels contribute to cash outflows from the community while income (or cost savings) resulting from roundwood harvest remains in the community.

In 1997, the Canadian Forest Service of Natural Resources Canada began a 2-year project to determine the potential to utilise forest biomass to heat public buildings in remote First Nation

communities. This paper will outline the activities undertaken in the study and provide a status report

of the first-year accomplishments and expectations for the second and future years.

## STUDY OUTLINE

The heating system that is considered most appropriate for remote communities is a small or mini district heating (MDH) system consisting of a small wood-chip burning furnace to heat water for subsequent space heating (McCallum 1997). The heated water is piped from the central boiler to other buildings or to a series of private homes. The challenge is to assess the potential of prospective remote communities to utilise such an MDH system, to manage the forest resource so as to supply the community's forest product needs (both timber and non-timber forest products) on a sustainable basis, and to design or configure a wood-chip supply system that is best suited for a particular community.

Before forest biomass can become a viable alternative fuel in remote communities, the technical, environmental, and social aspects must be accepted and understood by the community. These issues are considered in the study through a series of separate reports with the objective that the reports, while independent of each other, could be

included in a resource binder that would be a reference tool for communities considering investments in local bioenergy production. The following topics were specifically addressed in the study and are in varying degrees of completion:

- (1) ranking a community's potential to utilise forest biomass
- (2) development of a forest inventory and management plan framework suitable for small-scale biomass harvesting in remote First Nation communities
- (3) wood-chip supply system options
- (4) community level testing of the products from #1, 2, and 3 above.

The first three topics were addressed in Phase I of the project during 1997–98. The last topic will be addressed during Phase II to be completed during 1998–99. A third phase, which involves actual installation and monitoring of MDH systems in a selected remote community, might be implemented in future years.

## ASSESSING A COMMUNITY'S POTENTIAL TO UTILISE FOREST BIOMASS

The decision process a community can use to assess its potential to convert existing heating systems generally follows a sequence such as:

- (a) reconnaissance survey,
- (b) pre-feasibility study,
- (c) feasibility study, and
- (d) project engineering.

The reconnaissance survey will give a general indication of whether the community should pursue more detailed and more costly studies. The reconnaissance survey in this study was conducted by using a model developed to determine the relative ranking of communities in terms of their potential to succeed. This model yields an initial screening based on biological characteristics and heating requirements which could make a biomass facility feasible. Data requirements for the model include:

- annual heating degree days,
- community population,
- required MDH system capacity,

- biomass consumption based on required MDH system,
- land area,
- forested area, and
- average biomass productivity from lands available to the community.

These data are used to calculate a biomass supply to biomass demand ratio. The higher the ratio, the higher will be the community's potential to utilise biomass for bioenergy.

The output from this component of the study is a community's relative rank of high, medium, or low to describe the community's potential to succeed based primarily on biological factors. The reconnaissance survey provides a very basic level of decision making and is, in fact, a screening tool designed to identify those communities that clearly could not meet the minimum biological criteria. For example, communities with forest land resources inadequate to meet the MDH system biomass demand will fall in the low potential category and

could be flagged as communities that need to develop biomass supplies from areas other than their own lands.

Communities that rank medium or high can be further assessed for their capability in terms of political will and technical capacity at the community level as well as for logistical considerations. Once this categorisation is determined, the resulting list of communities can be considered for further screening through a pre-

feasibility study. The preliminary sort, therefore, indicates if investment in further study is warranted.

Communities with potential to utilise biomass will require a forest inventory and management plan to ensure a sustainable harvest of forest products. A framework was developed to assist communities with planning for sustainable management of their forest resources in the context of harvesting forest products, including biomass, to supply an MDH system.

## A FRAMEWORK FOR FOREST MANAGEMENT PLANNING FOR REMOTE COMMUNITIES

Many remote communities are surrounded by forest resources of varying quality and quantity. Careful planning is required if these forests are to be sustainably managed and utilised for the benefit of the community. First Nation people rely on many resources produced from the forest. For this reason, their values are often different from those a commercial forest industry might consider when developing a forest management plan. In addition, when the management plan includes harvesting forest biomass, different inventory methods and protocols might be required. Finally, when the forest resource is not considered of commercial quality in terms of marketability of the timber, a conventional forest management plan might be too costly compared to the value of the wood identified for extraction.

The proposed framework for remote communities is based on the planning requirements of non-industrial and small commercial operations where the land base is less than 10 000 ha. These approaches are flexible enough to accommodate First Nation people's relationship with the forest land and its values, have simple but effective data requirements, and can facilitate the community approach to decision making that is prevalent in remote First Nation communities.

The management plan should not be developed in isolation but be an integral part of the community's overall strategy. The proposed framework includes the plan period, forest land description and maps, history of the area, community objectives, forest resource inventory, 5-year management schedule, plan approval from community leaders, and monitoring and review. Annual work schedules can be developed to implement the plan, and where biomass is to be harvested, appropriate harvest and renewal plans can be formulated.

A description of the land will identify areas of specific interest to the First Nation community. For example, recently burned areas could provide ideal wildlife habitat because of the juvenile stands and lessor vegetation that have emerged. This information is particularly useful in the context of other development plans the community might be considering.

Maps provide records of the land base which will be the basis for management decisions. Where the community has adequate financial and/or technical capacity, geographic information systems (GIS) are recommended to facilitate map updates and the integration of other information for applications such as wildlife habitat mapping.

The community's objectives need to be identified through consultation with community leaders. Subsequent information sessions with the community at large may be necessary to ensure the community's objectives are recognised and addressed in the forest management plan. Traditional environmental knowledge may be imbedded in the community's objectives. This knowledge might be a sensitive topic, however, and communities might not wish to formalise this information in written documents.

The forest inventory will be consistent with the plan's objectives and the type of products to be produced from the forest. The purpose of the inventory is critical in determining how the inventory will be conducted and what data will be collected. For example, if biomass is an important product, then information on tree species groups rather than predominant species is adequate. If, however, more detailed inventories are conducted, then the information could have other applications such as mapping culturally significant plants or delineating areas important for wildlife habitat.

Throughout the development of the plan, the community should be consulted regularly following the protocols that prevail in each specific community. Different communities may have different leadership structures or may lead more traditional lifestyles. The consultation process must consider and be adaptable to these variations. When the plan is completed, the community and its leaders are better prepared to approve and accept the plan or recommend appropriate changes. Again the approval process must respect the traditions of each community.

Once the plan is approved, implementation can proceed. Throughout the implementation stage, forest management activities must be monitored and the plan reviewed. Again there is a need for communication with the community to ensure their involvement in the assessment of the plan's performance and, if necessary, its revision.

With a management plan in place, the community can now consider how to supply the required wood chips, i.e., what supply system in terms of equipment configuration, is best suited for the particular community.

## WOOD-CHIP SUPPLY SYSTEM OPTIONS

The range of practical equipment configurations applicable to a small bioenergy installation was assessed by visiting several remote communities in Northern Ontario, Northern Saskatchewan, and the Western Arctic near Inuvik. These visits provided information on the communities' infrastructure in terms of available equipment such as trucks and tractors to harvest, transport, and process the biomass, proximity, accessibility, and general quality of the surrounding forest biomass resource, and the occurrence and spatial distribution of public buildings and private homes. These visits were used to develop scenarios of generic remote communities and to design wood-supply systems that could effectively meet the needs of these communities. The resulting systems could then be used as guidelines for communities wanting to acquire the capability for supplying their own wood chips.

The field visits indicated that, in general, public buildings such as schools, hospitals, band offices, and other community buildings occur in clusters and are usually heated by oil furnaces. These buildings are ideal candidates for wood-chip fired central heating systems. The potential annual biomass fuel requirements for such buildings could range from 600–800 tonnes for a community of 500 people to 1500–2000 tonnes for a community of 1500 people.

Two general wood-supply approaches could address the needs of remote communities: a system utilising conventional forest machines, or a system based on a heavy duty four-wheel-drive farm tractor.

Systems based on forest machines have the highest capital cost and are usually practical only when a community is already engaged in other viable forest

harvest activity. Equipment costs are high and the utilisation rate, if used only to produce wood chips for the heating plant, is low. A typical system might consist of a skidder, a chipper, and a dump truck. Costs of such a system will vary considerably depending on the type, capacity, and age of the equipment. As an example, new skidder costs start at about \$80,000, small commercial-scale chippers start at \$50,000, and a good used log truck will start at \$25,000. This gives a minimum system cost of \$155,000.

The farm tractor-based system, on the other hand, starts at about \$90,000, based on a minimum of \$50,000 for a new 100 hp tractor, \$15,000 for a farm-scale chipper, and the same \$25,000 for a used log truck. Modification to the tractor for forestry use could add another \$15,000 to the system cost. Both systems utilise manual chainsaw felling. The utilisation of the equipment for other tasks around the community, however, might be a more important factor to consider than the initial capital costs. Machinery that can be utilised for more than one function (for example, a farm tractor can be fitted with a backhoe and increase its utility to the community) will have a higher utilisation rate and, therefore, a lower machine-hour cost.

A small community that typically requires 600–800 tonnes of wood chips can expect wood chip costs to range from \$50 to \$60 per tonne. At 45% moisture content one tonne of wood chips will displace about 210 litres of fuel oil. This makes the wood chip production cost equivalent to paying \$0.24–\$0.28 per litre for fuel oil—much less than the reported rates of \$0.80 to \$1.20 per litre some remote communities pay for their fuel oil. A larger community will have more and perhaps larger public buildings to heat; therefore, their wood-chip requirements might justify a larger supply system.

Depending on utilisation rates, larger systems that produce larger volumes will have lower production costs. The conventional forest machine configuration described above can produce 2000 tonnes in the \$40–\$50 per tonne range (all amounts are in Canadian dollars).

With this information the community can begin to examine its existing supply of equipment and determine its suitability for a biomass harvesting operation, and make further decisions on required equipment purchases.

## PHASE II : EXPECTED ACTIVITIES FOR 1998–99

Phase II of the study will be implemented during 1998–99. One or more communities will be selected using the screening method developed in Phase I. The pilot community will be visited to validate the screening/selection mechanism and to determine if the community has the political will and technical capacity to undertake a biomass conversion project. In addition, the site visits will identify any logistical details, such as accessing the biomass resource, which need to be considered. If the reconnaissance level survey indicates the community has a high potential for success, preliminary work toward a management plan following the framework developed in Phase I will be initiated. Results from the test communities will be presented in a workshop format to First Nation leaders from remote communities to promote the findings of this

study and the use of decision-making tools such as the systems developed in this study and the RETScreen™ (Leng *et al.* 1998). RETScreen™ is a computer-based spreadsheet system developed by the Canada Centre for Mineral and Energy Technology to help energy project proponents prepare preliminary evaluations of annual energy, performance, costs, and financial viability of potential renewable energy projects located throughout the world.

A third phase to this study is the actual installation of an MDH system in a remote community and the monitoring of this system's performance in terms of socio-economic and biological impacts. Funding partners and implementation date for the third phase are to be determined.

## DISCUSSION AND CONCLUSIONS

Many remote communities are known to have abundant forest biomass resources that are suitable for bioenergy applications. However, the perceived convenience of fossil fuel systems is a barrier to conversion. The current practice of using fossil fuels to heat public buildings is largely driven by a lack of information on alternative technology, and a lack of documented costs and benefits of existing and alternative systems. While this study has developed methods of assessing a community's potential to successfully implement a biomass system using biological and engineering criteria, the study did not address the costs and benefits associated with both systems (i.e., a fossil-fueled v. a biomass-fueled system). Biomass-fueled MDH systems might address economic and social concerns faced by many remote communities; however, these issues need to be investigated and the results transferred to community leaders. Current price structures would seem to favour a shift to bioenergy.

Phase II of the study will be implemented during 1998–99. During this year, one or more pilot communities will be selected for detailed analysis in the form of case studies. Socio-economic criteria will also be measured to strengthen decisions

regarding installation of MDH systems. Procedures established during the first year will be applied to the pilot communities. Results from the first-year activities and detailed pre-feasibility analysis from the pilot communities will be presented at a workshop. The workshop will target members from remote communities that could benefit from applying the information from this study to their communities. This workshop will promote the use of decision-making tools such as the model developed from this study and the RETScreen tool developed by CANMET (Leng *et al.* 1998).

A third phase to this study will install an MDH system in a remote community and monitor its performance in terms of socio-economic and biological impacts.

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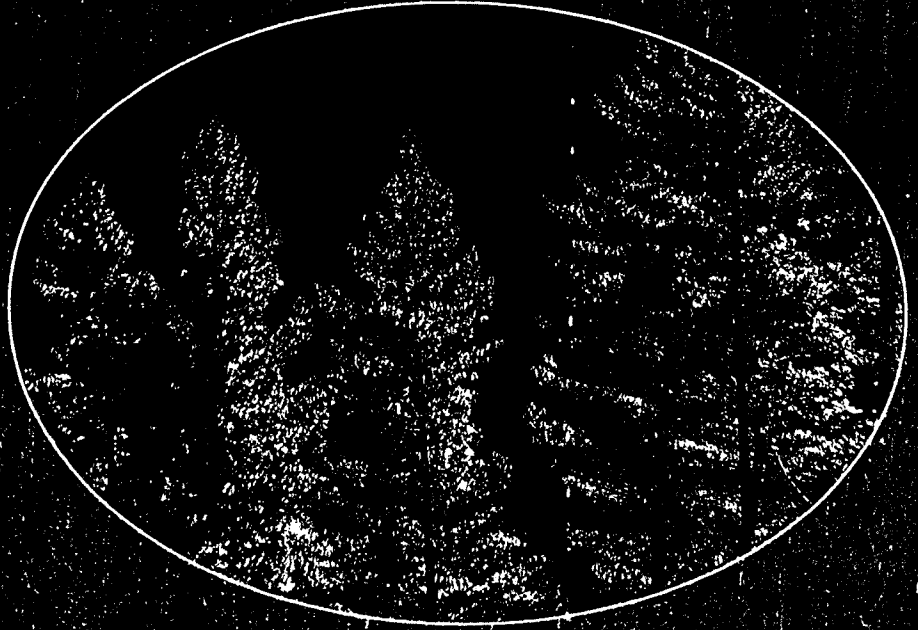
was conducted in three separate sections by consultants John Marion of Marion and Associates, David Puttock of Silv-Econ Ltd, and Bruce McCallum of Ensign Consulting. This paper is based on reports prepared by the three consulting firms on behalf of the Canadian

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**Conventional Forestry Systems for Bioenergy**



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