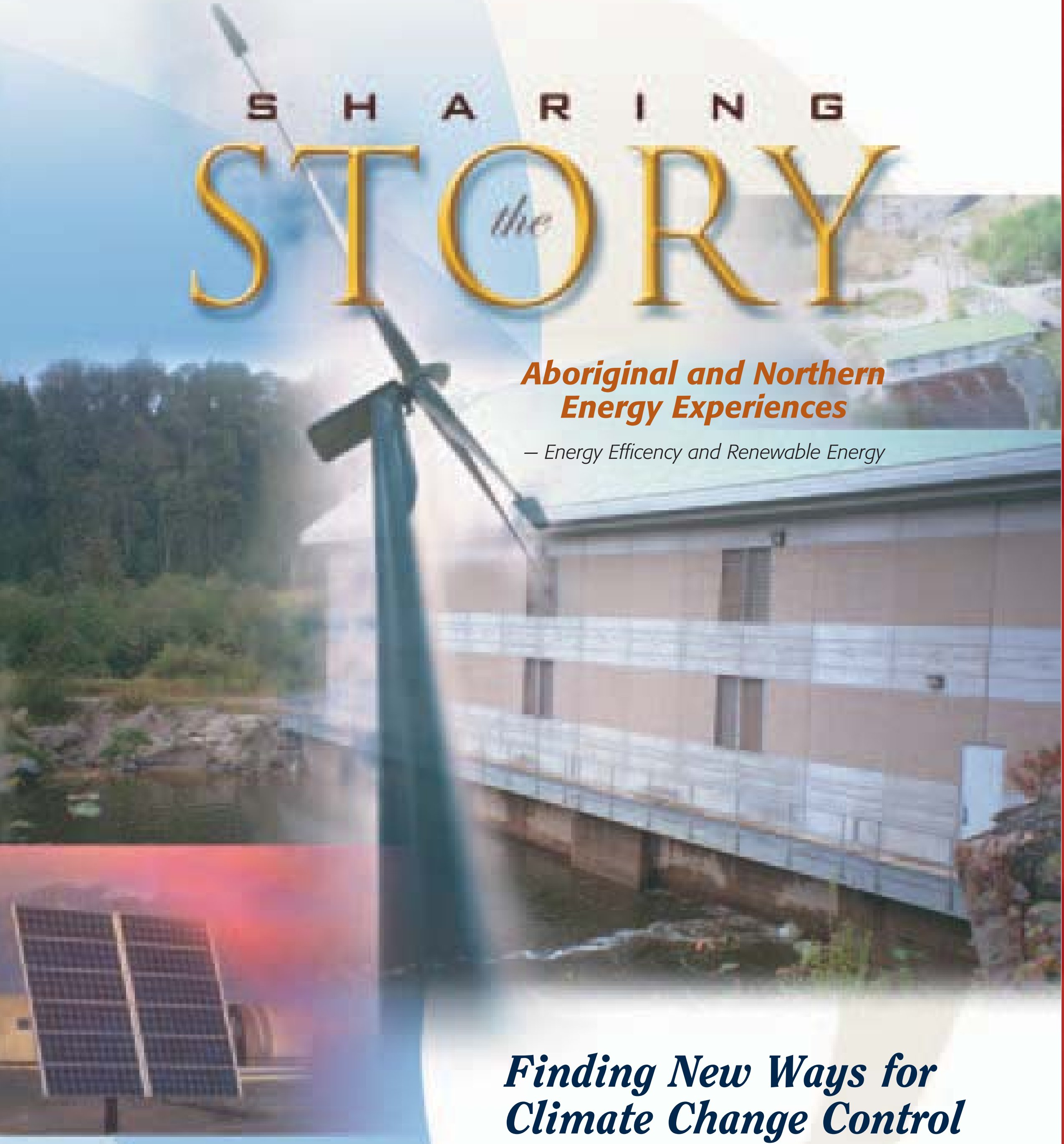
SHARING *the* STORY

Aboriginal and Northern Energy Experiences

— Energy Efficency and Renewable Energy



Finding New Ways for Climate Change Control

Deer Lake First Nation • Fort McPherson • Fort Severn First Nation
Fort Smith • Iqaluit • Grassy Narrows First Nation • Kahnawake Mohawk Territory
Kluane First Nation • Mohawks of the Bay of Quinte
Ojibways of the Pic River First Nation • Oujé-Bougoumou Cree Nation
Piikani Nation • Rankin Inlet

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Cette publication peut aussi être obtenue en français sous le titre :
Anecdotes de réussites : Expériences énergétiques des collectivités autochtones et nordiques.

This document has been prepared by:
Neegan Burnside Ltd.
in collaboration with and for
INAC, PWGSC and NRCan

Published under the authority of the
Minister of Indian Affairs and
Northern Development
Ottawa, 2004

QS-6177-060-EE-A1
Catalogue No. R2-259/2003E
ISBN 0-662-34658-0

FOREWORD

On behalf of the Aboriginal and Northern Climate Change Program, expressions of gratitude are extended to the Aboriginal and Northern communities highlighted in this publication, *Sharing the Story – Aboriginal and Northern Energy Experiences – Energy Efficiency and Renewable Energy.*

Each community has a unique and enriching experience in the development and management of their energy efficiency or alternative energy projects. The participants in this publication are acclaimed as role models in self-reliance, not just to Aboriginal and Northern communities, but to all Canadians. These energy initiatives, led by community people, create local solutions to local challenges and improve on the quality of life in their communities.

Sharing the Story – Aboriginal and Northern Energy Experiences is a joint publication of the departments of Indian and Northern Affairs Canada, Public Works and Government Services Canada and Natural Resources Canada. The collaborative efforts by all three departments has been instrumental in the realisation of this publication. It clearly demonstrates how Aboriginal peoples and Northerners and the Government of Canada can work in partnership to build a stronger heritage for future generations.

It is the intention that the experiences of the communities profiled in this document will inspire and assist other communities as they develop and apply energy efficiency and renewable energy technologies.

EXECUTIVE SUMMARY

Reducing the effects of climate change is one of society's top priorities at many levels. Scientists and lobbyists debate the type and magnitude of change. Governments and industry grapple with the meaning of carbon credits. Innovators race to be the first to develop new technologies. At the same time, progress is being made at the community level.

Aboriginal and Northern communities in particular stand to gain much from improving energy efficiency, taking advantage of renewable energy and contributing to the control of climate change. Not only are energy costs typically very high in these communities, but the effects of climate change are likely to be more pronounced in their localities.

Aboriginal and Northern communities across Canada have, in recent years, undertaken numerous projects involving energy efficiency and renewable energy. In 2002-2003, Public Works and Government Services Canada, Indian and Northern Affairs Canada and Natural Resources Canada undertook to profile some of these community-driven projects. The project was funded by the Aboriginal and Northern Climate Change Program.

This document presents the profiles of projects in the following areas:

Renewable Energy

Small Hydro

Ojibways of the Pic River First Nation (ON)
Deer Lake First Nation (ON)

Wind Power

Piikani Nation (AB)
Rankin Inlet (NU)

Solar Energy

Alaittuq High School, Rankin Inlet (NU)
Recreation Centre, Fort Smith (NT)
Nunavut Arctic College, Iqaluit (NU)

District Heating – Wood

Kluane First Nation (YT)
Grassy Narrows First Nation (ON)
Oujé-Bougoumou Cree Nation (QC)

Energy Efficiency

Housing

Mohawks of the Bay of Quinte (ON)
Kahnawake Mohawk Territory (QC)

Waste Heat Recovery

Fort McPherson (NT)
Fort Severn First Nation (ON)

The profiles demonstrate through various project examples the ways in which Aboriginal and Northern communities are developing innovative approaches to energy efficiency and renewable energy. These initiatives are consistent with Aboriginal values of environmental stewardship and society's goal of creating a sustainable way of life.

The experience gained by those undertaking the profiled projects indicates that there are many ways in which energy efficiency and renewable energy projects can contribute to self-sufficiency at the local level. This self-sufficiency has benefits of reduced fuel transportation and energy transmission costs, local employment, capacity building opportunities and reduced greenhouse gas emissions. In some cases, the revenues generated by such projects can be directed to other community purposes.

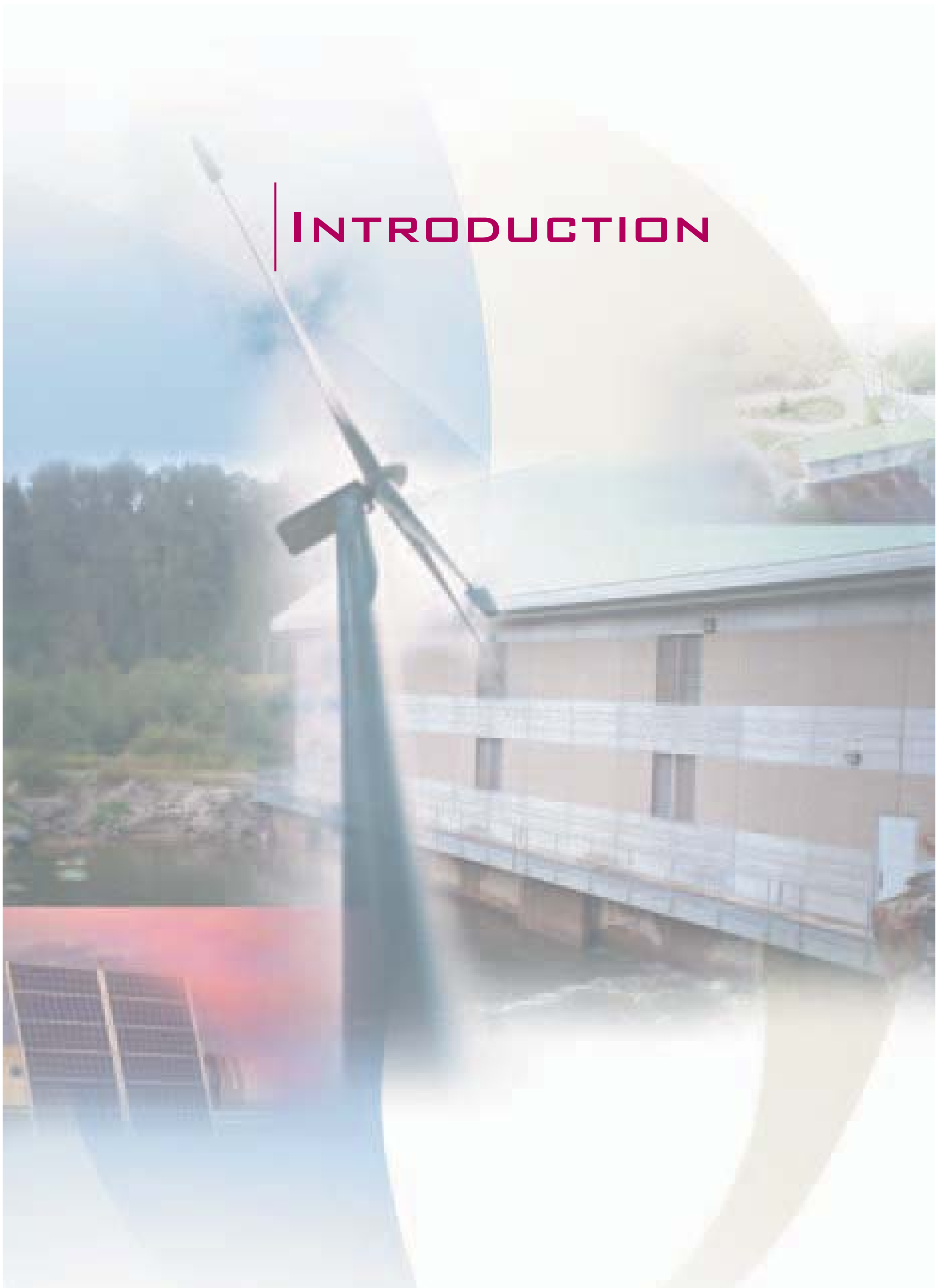
In undertaking energy efficiency and renewable energy projects in Aboriginal and Northern communities, great care must be taken to select the technical applications most suited to the community's situation in terms of physical setting, availability of resources and energy requirements. Often, the most simple and robust technologies are most applicable. Technical advancements in innovative areas are typically gradual, requiring patience and persistence, so realistic expectations and committed community support are critical.

Aboriginal and Northern communities have built a positive track record through these projects and have gained valuable experience in the managerial aspects of project development. As energy demands and costs increase, innovative technologies will become more cost-effective. It will, however, be critical that the true cost of energy be recognized and integrated in policy and decision-making processes.

Issues such as global warming, climate change control, and sustainable living are top priorities for society. Aboriginal and Northern communities have a vested interest in addressing these issues and have made significant progress through innovative projects such as those profiled in this document.

CONTENTS

Introduction



1.0 INTRODUCTION

The profiling of energy efficiency and renewable energy projects presented in this document is an undertaking of Indian and Northern Affairs Canada (INAC), Public Works and Government Services Canada (PWGSC), Natural Resources Canada (NRCan) and funded by the Aboriginal and Northern Climate Change Program (ANCCP). The profiles are based on interviews conducted in 2002-2003 with a number of individuals, usually at the community level, who were instrumental in seeing their projects completed. The resulting stories of these challenging and innovative projects are presented in various subject areas. They are provided as resource and learning tools.

INAC, PWGSC and NRCan would like to thank the following groups for their participation in this project and their willingness to share their experiences and knowledge for the benefit of other Aboriginal and Northern communities:

- Deer Lake First Nation (ON)
- Fort McPherson (NT)
- Fort Severn First Nation (ON)
- Fort Smith (NT)
- Grassy Narrows First Nation (ON)
- Gwich'in Development Corporation (NT)
- Iqaluit (NU)
- Kahnawake Mohawk Terrirory (QC)
- Kluane First Nation (YT)
- Mohawks of the Bay of Quinte (ON)
- Northwest Territories Power Corporation (NT)
- Nunavut Power Corporation (NU)
- Nunavut Arctic College in Iqaluit (NU)
- Oujé-Bougoumou Cree Nation (QC)
- Ojibways of the Pic River First Nation (ON)
- Piikani Nation (AB)
- Rankin Inlet (NU)

1.1 Purpose of Portfolio

For many years, Aboriginal and Northern communities have undertaken innovative energy efficiency and renewable energy projects. Much can be learned from these projects, not only from a technical viewpoint but also in terms of various aspects of project development. Taking an innovative project from the conceptual stages through to implementation presents many challenges. Support at organizational, strategic and community levels is critical.

The experiences of those who have been working through these challenges can be useful to those in other communities with similar interests in contributing to the control of climate change. Perhaps most importantly, these stories can be used to increase awareness of community members and leaders alike, to show that progress towards climate change control is indeed achievable.

1.2 Climate Change

Upsetting the Natural Atmospheric Balance

Life on earth thrives because the atmosphere traps the sun's heat and reflects it back to the earth's surface. Without the atmosphere the temperature on the earth would be too cold to support life as we know it. It is the greenhouse gases in the atmosphere that reflect the sun's rays. However, as the amount of greenhouse gases increases, a warming trend is observed on the earth.

There is strong evidence that the concentration of greenhouse gases in the atmosphere is increasing and that the world is getting warmer. This change is not seen as a steady increase in temperature, but rather as a series of warming and cooling cycles. The long-term trend, however, is one of net global warming. Alpine glaciers have been retreating, sea levels have risen, and climatic zones are shifting.

Cause for Concern

Climate change can have unpredictable and far-reaching environmental, social and economic consequences. The changes in temperature can impact climate patterns such as wind, rain, snow and storm intensity. Impacts can include flooding and erosion to coastal regions, harsh weather conditions, increased risk of pests and disease, increased risk of forest fires, receding glacial areas, water shortages and drought. Many plant and animal species may be at risk if they are unable to adapt to the changes.

Many Contributing Factors

Activities that contribute to greenhouse gas emissions include:

- energy generation, particularly coal-based generation;
- heating and cooling;
- transportation; and
- high energy use in manufacturing.

The six main greenhouse gases, those covered under the *Kyoto Protocol*, are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. Carbon dioxide is of primary concern because its release is closely associated with human activities and is thought to be the main contributor to climate change, especially through the burning of fossil fuels.

Measurable Change

Although climate change has occurred naturally over the history of the earth, the changes observed in the last century have been rapid. As a result of human activities since the industrial revolution, concentrations of carbon dioxide in the atmosphere have increased by 30 percent and concentrations of methane and nitrous oxide have increased by 145 percent and 17 percent respectively. In Canada, greenhouse gas emissions in 2000 were 15 percent greater than they were in 1990. Canada is the third largest per capita emitter of these gases, after the United States and Australia.

Change Required

Action to control climate change will take time and significant change on the part of individuals and society. Some of the ways that people are contributing to this change include:

- conserving energy, reducing usage;
- supporting the use of alternative energy sources that are efficient and/or do not emit greenhouse gases;
- improving the energy efficiency of buildings, homes, appliances, businesses and vehicles;
- reducing, reusing and recycling products that take energy to produce and transport to their point of use;
- minimizing travel distances and times; and
- walking, cycling, car pooling, public transportation.

1.3 Aboriginal and Northern Perspective

Improving energy efficiency and taking advantage of renewable energy forms are of particular importance to Aboriginal and Northern communities.

Northern Impacts

The impact of climate change is likely to be more severe in the polar regions than nearer the equator. This has serious implications for sensitive polar ecosystems. Increasing temperatures are melting glaciers and decreasing ice cover, affecting the way of life for Northern inhabitants.

Many Northern communities rely on ice roads during a brief window of time during the winter season in which sustained cold temperatures permit the safe transport of people and materials. Should climate change progress significantly, the reliability of these routes may be threatened. Furthermore, ecosystems and wildlife are also affected by climate change, which has an impact on habitat and migratory patterns. Fragile permafrost conditions are very susceptible to even minor changes in climate patterns.

In cold Northern locations, energy costs can be significant due to the high cost of transporting fuel to sites and also due to the long, cold winters and short hours of daylight.

Cultural Values

The earth and its environment play a strong and direct role in the spiritual and cultural values of many Aboriginal peoples. There is also a strong dependence on the land, water and atmosphere and the natural resources they sustain. Many Aboriginal cultures hold that one should not take more from the earth than one needs and that when one does take from the earth, an offering should be made in return. The concept of planning with the best interests of future generations is also quite prevalent.

These values are consistent with the goals of energy efficiency, renewable energy and sustainability. It is perhaps for this reason that many Aboriginal communities have pursued innovative projects of this nature.

1.4 Adaptive and Mitigative Measures

Reversing the tide of climate change will require a multifaceted approach, with many contributing factors.

Technical Applications

Technical applications play an obvious and significant role in the approach to controlling climate change. Although the pursuit and development of these applications will require the investment of human and financial resources, technology can be used to:

- improve energy efficiency and the use of renewable energy sources;
- reduce energy costs to consumers;
- reduce greenhouse gas emissions; and
- assist in the scientific understanding of the relationship between energy and climatic conditions.

In some cases, existing technologies will find new applications as increasing energy costs and demands make them more feasible as time passes. In other cases, new technologies will have to be developed and introduced progressively.

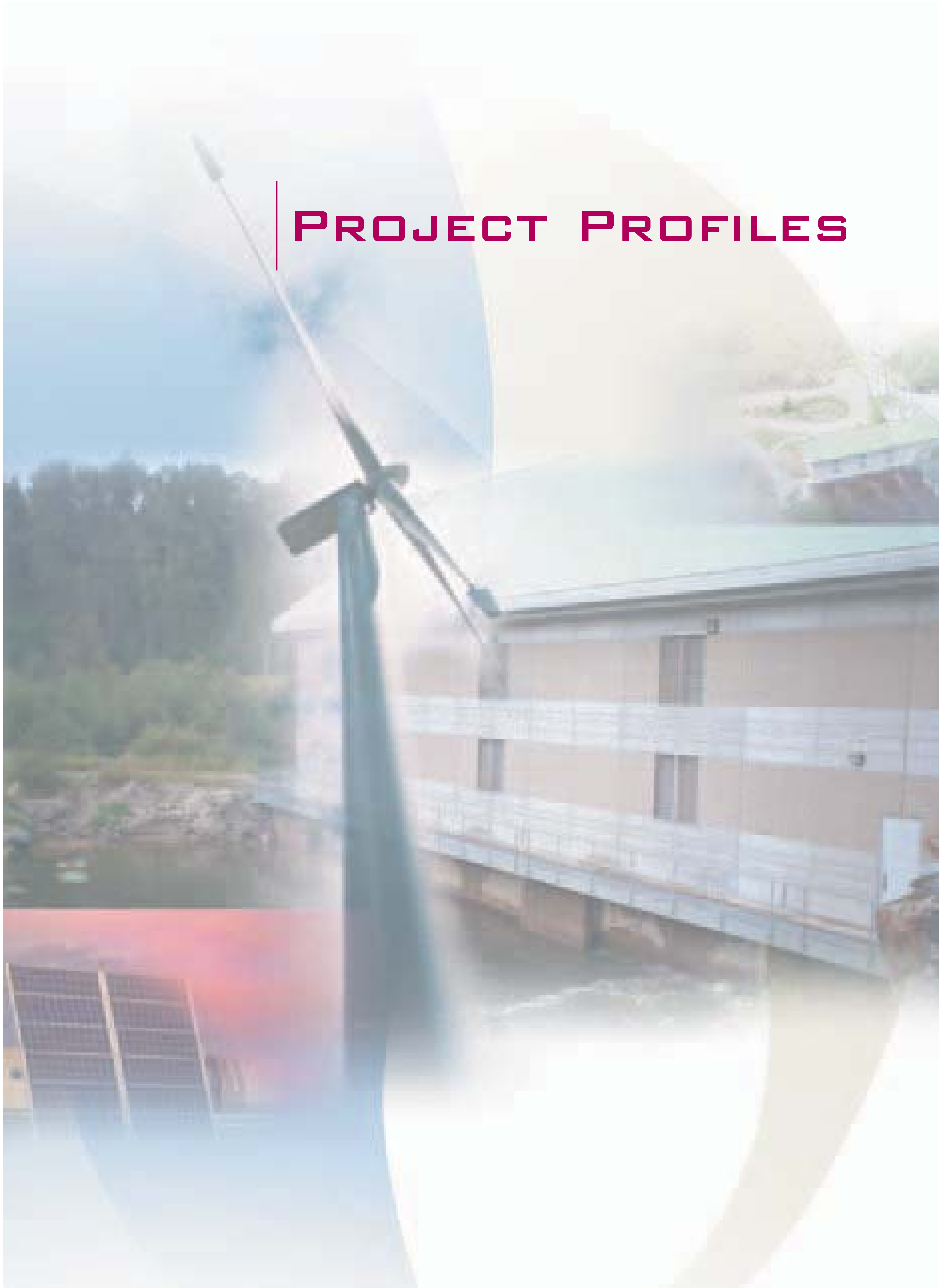
Awareness and Attitude

Whether the technology is cutting-edge or existing, the application can only be effective if taken to heart by those producing and consuming energy. For Aboriginal and Northern communities, as anywhere, that essentially involves everyone, including community members, service providers, governments and leaders. Project initiatives, such as those profiled in this document, lead to a better understanding and awareness of the types of change that can occur.

Organization and Planning

The development and implementation of energy efficiency and renewable energy projects require strong organizational support and diligent planning. Technical feasibility assessments must be matched with social, economic and environmental analyses. Administrative and managerial systems are necessary and the community must ensure that appropriate financial and human resources are available to ensure the long-term viability of the project. Most importantly, projects involving energy efficiency and renewable energy must be compatible with a community's strategy for energy, environmental protection, economic development and community planning. This way, the project can be truly community-based.

Project Profiles



2.0 PROJECT PROFILES

2.1 Renewable Energy

2.1.1 Small Hydro

Small hydro generally refers to hydroelectric projects of less than 30 megawatts (MW) in size. Though water power was originally harnessed to produce mechanical power to drive machinery in flour mills, sawmills and textile plants, today most small hydro facilities in Canada generate electricity either for remote communities or to sell to a regional, provincial, or territorial grid. Hydro power is a mature and cost-competitive technology, and although many of the best and largest sites in this country have already been developed, many potential small hydro sites remain, especially in remote areas. There are also many existing small hydro facilities no longer in use that could be refurbished with new technology.

The energy potential of a hydro site depends on three factors: the *flow*, the *head*, and the *efficiency* of the generator. The flow is the quantity and speed of the water. The head is the vertical distance over which the water drops. To generate electricity, a site must have adequate river flow and a sufficient head, with the best locations being waterfalls, rapids, canyons, deep valleys and river bends. Careful on-site measurements are required to calculate a site's flow and head that, in combination with the generator's efficiency, determine how much power a site will produce.

Many small hydro projects require a small dam or weir (a submerged dam) to create a headpond or reservoir to ensure an adequate year-round flow. Water in the headpond is directed into an open channel or through a penstock (closed intake pipe), which carries the water downhill to an intake in the powerhouse where the turbine is located. Inside the powerhouse, the turbine blades rotate as they are struck by the falling water, turning a shaft that drives an electric generator.

Run-of-the-river projects use the power in the river water as it passes through the plants and may not require the construction of a dam. These projects generally do not cause alterations in the natural flow of the river.

Small hydro projects are generally classified into the following categories:

Category	Size	Purpose
Micro hydro	Less than 100 kW	typical supply for one or two houses
Mini hydro	100 kW to 1 MW	typical supply for an isolated community or small factory
Small hydro	1 MW to 30 MW	supply to a regional or provincial electricity grid

The primary benefits of small hydro are as follows:

Clean, Renewable Energy Source with Low Environmental Impact

Hydroelectric developments do not cause greenhouse gas emissions or local air contaminants. The negative environmental impacts often associated with large-scale hydroelectric projects can usually be minimized during the development of small hydro projects through the use of good design and appropriate construction and operating practices. Run-of-the-river projects, in particular, have little environmental impact. Mitigative measures may be required to ensure the protection of wildlife habitat and fish migration routes.

Cost-Competitive

Small hydro developments can provide a competitive source of reliable energy whose cost is not subject to fluctuations in the international oil market. Electricity produced from small hydro projects is particularly competitive when compared to diesel generation that currently supplies electricity in many remote communities. Small hydro can often qualify for certification under green electricity programs that pay a premium price for electricity from an emission-free, environmentally-friendly source.

Socio-Economic Benefits

Small hydro projects can bring economic benefits to a region through construction jobs and use of local services.

Ojibways of the Pic River First Nation

Small Hydro – Selling to the Grid

The Pic River First Nation is a small Ojibway community located between Thunder Bay and Sault Ste. Marie, along the north shore of Lake Superior. The First Nation has part ownership in two operational hydro stations and majority ownership in a third hydro station in the planning stages. Income generated by the sale of power to the provincial grid has been re-invested in the community and used to support additional ventures. The decision was governed by opportunity, economic development and environmental stewardship. Experience gained in the first hydro development has allowed the First Nation to gradually build capacity and play an increasing role in the development and management of subsequent hydro ventures.

Deer Lake First Nation

Mini Hydro – Supplementing Power to the Community

Deer Lake First Nation is a small community of approximately 800 people located in remote northwestern Ontario. Power generation in the community is provided by a diesel-powered generating station with diesel fuel flown in by air. In 1998, a small 490-kilowatt (kW) run-of-the-river hydro generating station was constructed on the Severn River, approximately six kilometres from the community. There is a joint agreement for ownership between Hydro One and the First Nation, however, the First Nation has an option to take over ownership after 10 years of operation.

2.1.2 Wind Power

Wind energy is the world's fastest growing electricity source and is among the cheapest of the renewable energy sources. Good wind sites are fully cost-competitive with traditional fossil fuel generation, and in remote sites, where fuel has to be transported long distances, it is often more cost-effective than fossil fuel generation. Wind is one of the world's cleanest sources of energy – it produces no air or water emissions, no toxic wastes, and does not present any significant hazard to birds or other wildlife.

Wind energy has been in use for thousands of years for pumping water and grinding grain. As early as the 1920s, over a million wind turbines pumped water and provided electricity to farms in rural North America. The current interest by many countries in wind energy was triggered by the need to develop clean, sustainable energy systems that do not rely on fossil fuels. Modern aerodynamics and engineering have significantly improved the efficiency of wind turbines, providing reliable, cost-effective, pollution-free energy for individual, community, and regional applications.

The greatest use of wind energy today occurs in Europe. Canadian use of wind energy has been slower because of relatively low electricity rates and because Canada generates a surplus of electricity. Nevertheless, the wind energy industry is growing and several wind turbine manufacturers now have representatives in Canada.

Wind energy can be used in a variety of applications – from small 50-watt battery chargers in cabins and lighthouses to industrial scale turbines of 2 MW capable of supplying electricity for 500 families. The most common application is to have one or more wind turbines connected to the area grid with the electricity sold to a local utility as a source of income. Wind turbine generators can also be used to offset diesel-generated electricity in remote communities through wind and diesel combinations.

Wind speed is a critical element for the success of a wind generation project. The power and energy output increases dramatically as the wind speed increases. An annual average wind speed greater than 4 metres per second (m/s) is required for small turbines. Utility scale wind power plants require minimum average wind speeds of 6 m/s.

Wind speed is affected by local terrain and generally increases with height above the ground, which is why wind turbines are usually mounted on high towers. Although wind conditions near coastal areas tend to be ideal for wind projects, there are many inland areas suitable for wind turbines, particularly in hilly terrain. As the wind passes over a hill, or through a mountain pass, it becomes compressed with a resultant increase in speed. Rounded hilltops with a wide view in the direction of the prevailing wind make good wind turbine sites. Rough terrain or obstacles, however, may affect local wind speed and/or create turbulence that may decrease energy production and increase wear and tear on the turbines. Location of the wind turbine, therefore, is critical in order to maximize the amount of available wind. Calculating the potential energy production from a wind turbine requires detailed topographical maps of the area and accurate meteorological wind measurements at the proposed site.

Wind turbines work well with agricultural land use and cause little disturbance to farm stock, wildlife and bird life. Restrictions on location, however, include migratory bird paths and airstrip locations.

The major drawback of wind power is variability – wind speeds vary throughout the day and the year, and therefore the amount of electricity generated will also vary. With smaller grids, diesel generators can be used to balance variations in wind-generated electricity. Modern electronic controls permit operation of wind-diesel hybrid systems with a higher proportion of the energy being supplied from the wind.

The cost of wind energy is determined by:

- initial cost of the wind turbine installation;
- wind resources available;
- interest rate on the money invested; and
- availability of renewable energy incentives.

Depending on local wind conditions, typical costs for wind generation can range from $0.05 to $0.15 per kilowatt-hour (kWh), which tends to be slightly higher than that associated with the average fossil fuel plant. In remote areas relying on diesel plants and imported fuel, energy costs can be as high as $0.70 per kWh. Wind generation can be cost-effective in comparison. Economies of scale will continue to decrease wind energy costs, while most conventional generation costs continue to increase. It is important to note that these costs do not account for the environmental and health benefits of using a non-polluting source of energy.

Special consideration must be given to the design of wind turbine installations in harsh, Northern climates. Though the location of remote Northern communities means wind energy can be very cost-effective, most wind turbines are not designed for the severe climatic conditions they may be exposed to. Adaptation to harsh conditions is required for most wind turbines on the market today.

Wind generation is an attractive renewable energy option for Aboriginal and Northern communities with good wind resources and high fuel costs. Successful prospects require a careful feasibility assessment, a local champion to get the project on its feet and ongoing operational attention by dedicated staff.

Piikani Nation

Weather Dancer Performs

In windswept southern Alberta, Piikani Nation is harnessing the power of the wind to generate clean emission-free electricity. A 900 kW wind turbine, known as Weather Dancer 1, generates an average of 3 000 MW hours of emission-free electricity each year, sufficient to meet the needs of 450 homes. By displacing coal and gas-based grid electricity, the Weather Dancer reduces annual carbon dioxide emissions by approximately 2 500 tonnes per year. The project has been undertaken as a joint venture with EPCOR, an Alberta-based utility company. The partnership has a long-term contract to supply power to the grid. Eighty percent of the power is sold at a fixed price which is then sold to customers as “green power” at a premium rate. The remaining 20 percent is sold to the regional power pool at market prices.

Rankin Inlet

Wind Power in the North

Of the five wind turbines purchased by the Nunavut Power Corporation (NPC) in 1995 for installation at various locations across the North, only the one at Rankin Inlet is still in operation. The harsh Northern climate has proved to be a challenging environment for wind turbines. The 50 kW unit is connected to the local grid supplied by diesel generators. Following adaptation of the equipment for local conditions and ongoing maintenance, the Rankin Inlet unit has been operating successfully since 2000, displacing approximately 40 000 litres of diesel fuel per year.

2.1.3 Solar Energy

The sun's energy has long been used for common activities such as preserving foods for long-term storage and for drying clothing. Today's technologies allow us to use solar energy for new and diverse applications:

- *Photovoltaics (PV)* converts the sun's energy into electricity for use in homes, buildings or remote applications. The efficiency of solar PV increases in colder temperatures and is particularly well-suited to Canada's climate. Although the price of PV modules is decreasing as new, more efficient technologies are developed, PV applications are still relatively expensive. PV systems are most cost-effective in small load applications in remote areas;
- *Solar Air Heating Systems* convert the sun's energy to heat to be used for space-heating, usually in large buildings such as schools, community centres or manufacturing facilities. One application is the Solarwall, developed by Conserval, a Canadian company. A Solarwall requires a large south-facing wall and consists of a perforated dark metal cladding that covers the wall, leaving an air cavity between the metal and the wall. When sunlight hits the dark metal, it is absorbed, heating the air space thus preheating the air drawn into the building's main heating system. Use of the Solarwall is most cost-effective in Northern locations where the sunlight reflects off the snow to improve the solar gain, and high fuel prices and cold temperatures combine to increase the fuel savings;
- *Solar Water Heaters* collect the sun's energy to heat water for use either providing hot water or for space heating. Water is circulated through a collector panel and the heated water is then pumped into a water tank for domestic use. In Canada, glycol, or a similar fluid to prevent freezing, is used to circulate through the solar collectors, and its heat is then transferred via a heat exchanger to the hot water tank. In cold climates, solar heaters are often used on a seasonal basis;
- *Passive Solar* is a method of building design that takes advantage of the sun's energy through placement of windows, and the use of colours and materials that absorb, reflect and store solar energy as needed to help regulate indoor temperatures.

It is not necessary to live in a hot climate to take advantage of solar energy. In fact, some solar technologies operate most efficiently in cold climates. Relevant factors in evaluating the feasibility of solar technologies include the number of hours of sunshine on a daily and annual basis and the intensity of the solar radiation. In Canada, the regions with the most solar radiation are in parts of southern Alberta and Saskatchewan, but there are many other regions where solar technologies can be cost-effective.

Alaittuq High School – Rankin Inlet

Solar Energy Heats High School

In the community of Rankin Inlet on the northwestern shore of Hudson Bay, the sun's energy is being used to help heat the local high school. As in most Northern communities, the combination of low temperatures and high fuel prices mean heating costs can be exceptionally high. The use of solar energy captured by a solar heating system known as a Solarwall is expected to reduce fuel use at the school by about 2 600 litres per year. Taking into account rebates available for renewable energy, the system is expected to be cost-effective after five to six years.

Fort Smith Recreation Centre

Combining Solarwall and Heat Recovery Ventilation

A Solarwall has been installed at a community recreation centre in Fort Smith, NWT, a community of 2 500 inhabitants about 300 kilometres south of Yellowknife. The Fort Smith Recreational and Community Centre is a multi-purpose facility that provides a range of recreational programs and services to the community. The 120 m^2 Solarwall provides over 75 percent of the total energy for space heating, resulting in a total savings of 6 370 litres of fuel oil.

Nunavut Arctic College, Iqaluit

Photovoltaic System Performs in Harsh Climate

In July 1995, a 3.2 kW photovoltaic (PV) system was installed on the south wall of the Nunavut Arctic College in Iqaluit, NU, feeding into the local grid. Electricity produced from the PV array displaces the use of diesel fuel, reducing greenhouse gases and local air contaminants. The project was designed to monitor and document the long-term performance of a grid-tied PV system in Nunavut, and to promote PV as a viable power source in the Arctic.

2.1.4 District Heating – Wood

District heating (DH) systems use central energy plants to meet the space heating needs of residential, institutional, and commercial buildings. In some cases, domestic hot water and cooling needs are also filled. The central plants replace individual, building-based furnaces and boilers.

Advantages to DH include the ability to achieve more efficient use of local energy sources and thereby create a more flexible energy supply. DH allows diversification of fuel supply, encouraging economic development by including fuels that are not readily adaptable to building specific heating systems, such as garbage incineration, industrial waste heat, and biomass energy. The typical fuel source for many Aboriginal district heating systems is wood chips or wood waste, referred to as biomass. The fuel is either harvested directly or obtained as a byproduct from local sawmill operations.

DH systems also facilitate the use of more sophisticated energy-efficient technology and provide greater economic incentive to improve efficiency. Focusing energy generation at fewer but larger central plants makes it easier to maintain equipment, and to integrate technology upgrades such as emission controls. DH systems can adapt to different fuels in response to changes in availability, costs or evolving environmental concerns.

DH systems offer a range of potential social and economic benefits. The improved energy efficiency of DH systems and the use of available energy sources can significantly reduce community and individual energy expenditures. By increasing flexibility of energy supply, DH also offers communities improved energy security and price stability.

Kluane First Nation

Self-Sufficiency Through Use of Local Fuel Source

Burwash Landing is the home of the Kluane First Nation, people of the southern Tutchone. A small community on the west shore of Kluane Lake adjacent to Kluane National Park, Burwash Landing is on the Alaska Highway about 285 kilometres northwest of Whitehorse. In order to reduce dependence on outside fuel sources, the First Nation installed a DH system. A central boiler provides hot water heat to four community buildings. Fuel is provided by wood chips, harvested from Aboriginal lands. A recent forest fire in the area left many of the trees dead, but still standing, providing a good source of fuel. Benefits to the community include savings in operating budget along with non-tangible benefits including reduced reliance on outside fuel suppliers and fluctuating prices, keeping the money within the community, and creating local employment.

Grassy Narrows First Nation

District Heating as an Alternative to Transmission Line Upgrade

Grassy Narrows First Nation, located in northwestern Ontario, 90 kilometres from the town of Kenora, installed a DH system in 1997. The system services the commercial core including the school, day care centre, administration building and community hall, and approximately 30 percent of the residences in the core area. The system was first installed to delay construction of a 90-kilometre electrical transmission line upgrade that otherwise would have been required to heat the school. After an initial slow start, the system is now working well. Once capital repayment is complete, the system is expected to provide a return to the community. Meanwhile, advantages include stability of heating costs, reduced risk in transportation and storage of fuel, and a dramatic decrease in house fires.

Oujé-Bougoumou Cree Nation

District Heating – Turning Waste into Energy

Oujé-Bougoumou Cree Nation is located in Quebec, approximately 960 kilometres north of Montreal. After years of relocation from traditional villages and settlements, the Oujé-bougoumou Eenou reached an agreement with the federal and provincial governments to build a permanent community. As part of the traditional philosophy of sustainable development featured throughout the planning and construction of the new community, a biomass district heating system was installed to provide space heating and domestic hot water to the entire village. The Oujé-Bougoumou system represents the first village-wide application of a district heating system in North America using biomass as the fuel source.

2.2 Energy Efficiency

2.2.1 Housing

The energy efficiency of houses can be improved through a wide range of design measures and materials. One of the most widely-referenced programs for energy-efficient houses is entitled R-2000, a commercial program. Its certified builders construct houses to meet its high standards of energy efficiency, ventilation, low-emission, resource-efficient materials selection, and water efficiency. R-2000 homes consume about two-thirds the energy of conventional homes.

The operating energy consumed in cold climate housing is dominated by space heating, and the key factor affecting this is the design of envelope, glazing and mechanical systems. Energy-efficient homes typically consume half the energy of similar conventional homes for heating, and advanced home technologies are available to reduce this load by a further 50 percent.

The elements of advanced housing include:

- efficient framing to reduce the amount of timber used;
- blown-in cellulose insulation;
- advanced air barrier systems;
- improved basement insulation;
- energy-efficient windows using advanced technologies such as low-e coatings, argon fills and insulative spacers;
- combined space and water heating systems;
- heat recovery ventilators (HRV);
- energy-efficient lighting; and
- water-efficient fixtures.

There is a cost associated with these measures, however, and cost-effectiveness needs to be carefully considered.

When considering the energy issues related to housing, there are opportunities for improved efficiencies in three main areas:

- *embodied energy* – the energy required to produce the building materials, transport them to the building site, and erect the building;
- *operating energy* – the energy associated with the normal operation of the building for space heating, domestic water heating, and operating lights and appliances serving the dwelling; and
- *attached energy* – the energy associated with servicing the dwelling and its occupants within the community, for example, to transport goods and people from and to the dwelling.

All three of these qualities are significant in new housing development decisions, whereas only operating energy is likely to be impacted by retrofit measures. The development of new housing in cold climates should take into account a number of critical energy-related considerations, including:

- *Location* (Relative to places of work and supply of goods and services) – This factor bears directly on the attached energy component and the sustainability of the community as a whole.
- *Occupant Density / Type of Dwelling* – Smaller attached homes require less material for construction, have lower operating energy consumption, and usually consume less attached energy than their detached counterparts.
- *Dwelling Orientation* – The orientation of a dwelling relative to sun and wind is also of importance. In a cold climate, southerly exposures can be used to admit sunlight into areas and surfaces that have the capacity to absorb and slowly emit absorbed heat. Materials such as heavy masonry walls and floors, or overlaid ceramic tiles can be effective in this regard. Protection against heat loss associated with prevailing winds can be achieved with proper wall and roof designs and the judicious use of insulation and external wind breaks.
- *Occupant Behaviour* – Some types of human behaviour can defeat even the most sophisticated, energy-efficient technologies.
- *Building Technology* – The technology of buildings including materials of construction, envelope and glazing design, domestic water and space heating and ventilation systems are all important factors contributing to the overall energy efficiency of a structure.

Retrofits to improve the operational energy efficiency of dwellings generally relate to:

- building envelope and insulation improvements;
- new glazing and door technologies;
- higher efficiency space and water heating systems; and
- appliance upgrades.

Mohawks of the Bay of Quinte

Energy Efficiency – New and Retrofit Housing

Mohawks of the Bay of Quinte is located in Tyendinaga, on the north shore of Lake Ontario, approximately 95 kilometres west of Kingston. The innovation and creativity of this First Nation's housing program has been recognized nationally through numerous awards. Best available practices in energy-efficient construction have been applied to housing projects, which are not only practical, but also highly effective in meeting the social needs of the community members. After years of developing and promoting energy-efficient housing, the community is now seeing the benefits in its overall housing situation. The current standard in Tyendinaga is for all rental homes to be constructed according to R-2000 standards or better.

Kahnawake Mohawk Territory

Kanata Healthy Housing Project – Creating New Perceptions of Sustainable Housing

The Kahnawake Mohawk Territory is located on the south shore of the St. Lawrence River, 10 kilometres southwest of Montreal. Of the many projects under way to take on climate change and energy efficiency, the Kanata Healthy Housing Project incorporates several innovative technologies designed to maximize occupant health and comfort, while minimizing environmental impact. Part of the challenge of the project has been to go beyond technology to effect a change in perception and a lasting change in lifestyle.

2.2.2 Waste Heat Recovery

Many remote communities throughout the country are not connected to the mainline electrical grid and rely on individual diesel generating stations for electricity generation. As a byproduct of generation, the engines produce large quantities of waste heat. Using heat exchangers at the generating plant, waste heat can be collected and distributed through insulated hot water pipes to heat community buildings. Waste heat recovery, therefore, is a type of district heating system where the energy source is waste heat recovered from diesel generating equipment.

The amount of heat available varies according to the amount of energy generated. Fortunately, peak electrical loads coincide with peak heating loads in the winter months. Sufficient community size and electrical demand is required in order to allow the thermal output to generate revenue savings required to cover the cost of development.

Community buildings with larger heating loads work well to provide sufficient return on investment for distribution piping, particularly for retrofit systems. The connection of new residential subdivisions can also be cost-effective if the system is integrated as part of the original construction.

An important factor in the success of a district heating system relying on waste heat recovery is the location of the diesel generating plant relative to the buildings to be connected to the system. In many remote communities, the generating plant is located close to the airport, some distance from the community core. In addition to keeping the noise at a distance from the residential area, the advantage to being located near the airport, is minimized fuel transportation. The waste heat is then handy for heating the airport terminals and the work buildings located at the airport, but it is often too far for economical use in community buildings. The length of distribution piping required can greatly impact the capital cost of construction as well as the efficiency of heat delivered.

The cost of fuel can also impact the system viability. Remote communities see more savings using waste heat recovery systems because of higher imported fuel costs.

For retrofit systems, the physical size of the existing power plant building must be sufficient to allow installation of the necessary heat exchangers, pumps and other equipment.

Benefits of waste heat recovery system include:

- reduced reliance on imported fuel;
- reduced money flowing out of the community;
- reduced emissions; and
- enhanced operation of generators.

Fort McPherson

Partnership: An Investment in the Environment

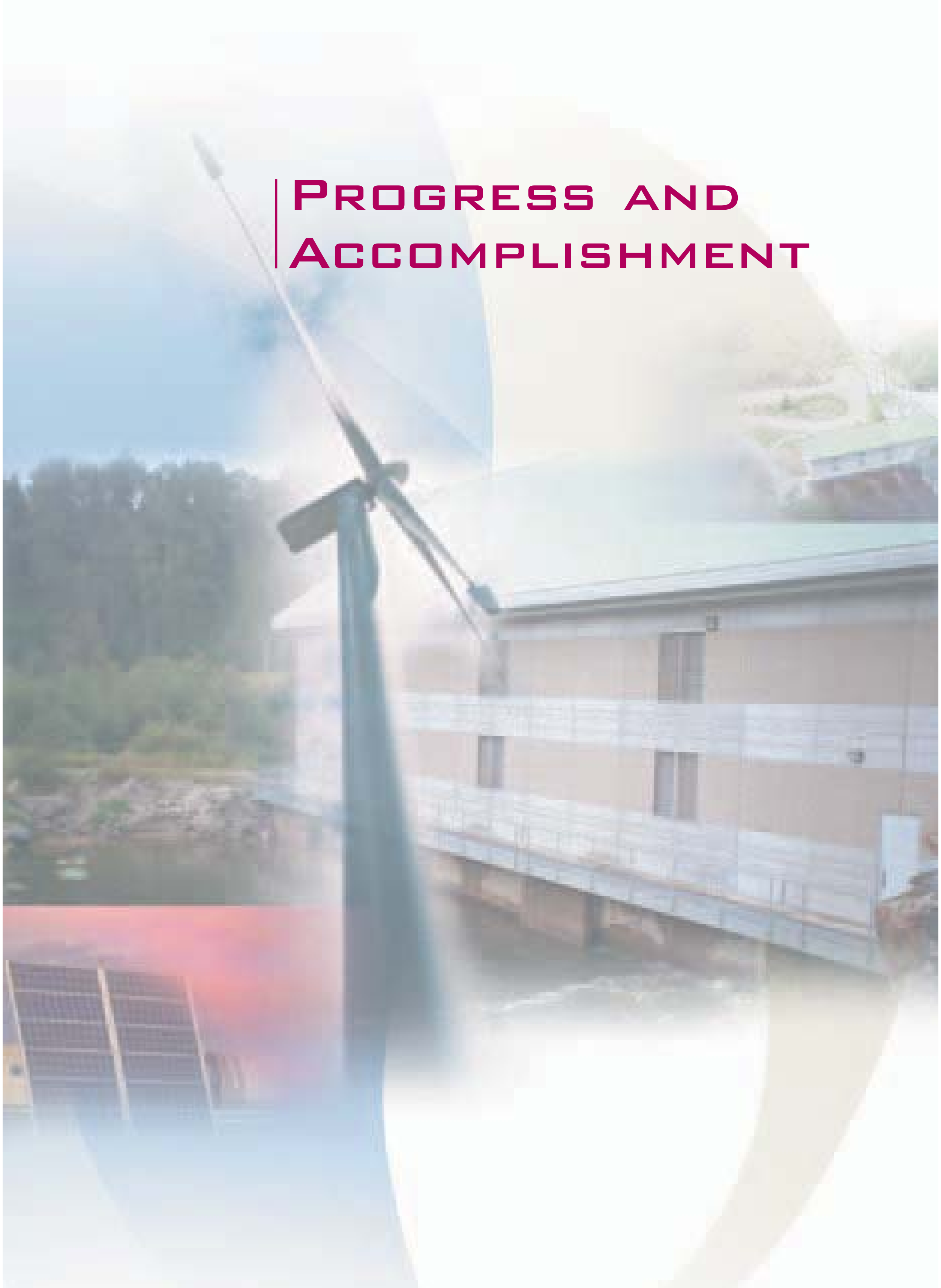
Fort McPherson is a community of 700 people located on the east shore of the Peel River about 100 kilometres (Km) north of the Arctic Circle and 110 km south of Inuvik. Through a joint venture of the Gwich'in Development Corporation and the Northwest Territories Power Corporation, a central heating system was installed using the water jacket coolant of the diesel generators at the power plant as a source of supplemental heat to community buildings. The system displaced approximately 164 000 litres of fuel oil in 1998, corresponding to a savings of $98 000.

Fort Severn First Nation

Waste Heat Provides Freeze Protection for Water Supply

Fort Severn First Nation, a remote community with fly-in-only access located on Hudson Bay in northern Ontario, uses a waste heat recovery system. The system is operated in conjunction with the Hydro One, Remote Communities diesel generating station located in the community. Waste heat from the diesel-generating engines is transferred across the road to the First Nation's water treatment plant to heat the building and provide heat to the community water supply as a primary method of freeze protection.

Progress and Accomplishment



3.0 PROGRESS AND ACCOMPLISHMENT

3.1 Project Highlights

Technology	Community	Highlights
Renewable Energy – Small Hydro	Ojibways of Pic River First Nation	• power sold to the provincial grid, hydro plants located off reserve lands • income re-invested in community and to finance additional power projects • active participation in approvals and management has built capacity for future endeavours
	Deer Lake First Nation	• partnership with provincial utility with option for future ownership
Wind Power	Piikani Nation	• First Nation driven, perseverance in obtaining partnerships and backing • power sold to provincial grid under contract • future plans for expansion
	Rankin Inlet	• operation under harsh Northern environment • displaces use of diesel fuel
Solar Energy	Alaittuq High School, Rankin Inlet	• pre-heated ventilation air saves on heating fuel • Solarwall provides short payback period for low capital outlay • low maintenance
	Recreation Centre, Fort Smith	• Solarwall combined with heat recovery ventilation
	Nunavut Arctic College, Iqaluit	• Photovoltaic system performs reliably for over seven years
District Heating – Wood	Kluane First Nation	• central boiler heats four community buildings • local fuel source – wood chips from waste trees left by local forest fire • step towards self-sufficiency • retains money in community, provides local employment
	Grassy Narrows First Nation	• district heating system installed to reduce electrical load associated with new school and delay transmission line upgrade • geographically compact area of heat loads • cost-effective strategy for obtaining biomass • lowered environmental risk of fuel oil spills connected with transportation and storage • dramatic decrease in house fires

Technology	Community	Highlights
District Heating – Wood (continued)	Oujé-Bougoumou Cree Nation	• use of sawmill waste material consistent with sustainable practices • local employment, trucking and system operation • savings in heating costs for residents
Energy Efficiency – Housing	Mohawks of the Bay of Quinte	• begin at grassroots level, listen to the people, build community support • seek opportunity for improvement, develop high standards • training of work crews • use of R-2000 standards and other resources
	Kahnawake Mohawk Territory	• broad definition of sustainability, includes materials of construction • need to raise awareness, change perceptions • sweat equity, training and knowledge transfer • sharing the knowledge, First Nations as leaders in the areas of sustainable development and renewable energy
Waste Heat Recovery	Fort McPherson	• cooling jacket water from diesel generator heats five community buildings • commitment to environment • partnership of an Aboriginal company with territorial utility • customer sees guaranteed savings
	Fort Severn First Nation	• waste heat from generators provide freeze protection for water distribution system • First Nation sees 50 percent cost savings • reduces wear and tear on radiator and cooling fan • implementing community-wide energy efficiency program

3.2 Common Elements

Much can be learned from the experience gained through the profiles of energy efficiency and renewable energy projects. Some of the common elements of the projects are discussed below.

Local Self-Sufficiency

One of the evident driving forces of the profiled projects is a move towards local self-sufficiency. This makes practical sense and offers multiple benefits for Aboriginal and Northern communities such as:

- reduced reliance on outside energy sources and suppliers of energy;
- increased control over the delivery of energy and the associated costs;
- opportunities for local capacity building and employment;
- revenue can be directed to energy system enhancement or other community development;
- optimal use of local waste products (energy, heat, materials);
- reduced transportation and transmission costs; and
- reduced greenhouse gas emissions.

Selective Application of Technology

The profiled projects emphasize the importance of being selective in matching energy efficiency and renewable energy projects to a community's situation and needs. The selection of an energy source and the technology or technologies used to harness it depends upon community-specific factors. The following questions should be considered:

- What is the current form of energy supply? Are there any issues related to the cost, control, efficiency or environmental implications of this supply? How might those issues be improved?
- What is the geographic and physical setting of the community? Does this setting offer opportunity for a particular type of energy efficiency or renewable energy?
- What is the proximity of the energy source to the location of consumption?
- What technology or technologies would be most effective given the scale of energy requirements?
- Is the project intended to create energy for purposes of supply to a grid or directly and specifically for community use?
- What human and financial resources are required for the project, and is the community capable of providing those resources, either directly or through partnerships?
- Is the technology under consideration capable of providing a consistently stable and reliable energy supply to its consumers? This is essential for gaining the confidence of community members, partners and financers.

Some technologies, such as hydro plants, and to a lesser extent, wind generation, involve significant capital costs, and in order to be cost-effective, are best applied at a relatively large scale in order to take advantage of economies of scale. Pic River First Nation took advantage of the hydro resources found in the area, and was able to overcome the high capital cost of the construction of a hydro generating station. The location on the provincial grid allowed the construction of a big enough plant to make it worthwhile. Piikani Nation is another example of a First Nation taking advantage of its location and wind resources. Once again, by connecting to the provincial grid, the First Nation entered into a joint venture and was able to negotiate a long-term contract in order to finance the construction of the wind turbine.

Benefits of Simplicity

The prominent forms of renewable energy used in Aboriginal and Northern communities are, in themselves, basic: wind, sun, water and wood. However, the technologies used to effectively and efficiently harness those energy forms can become somewhat complex. This can become problematic, particularly in remote locations where climatic conditions can be harsh and access to technical expertise may be limited. Therefore, the best technical applications in Aboriginal and Northern communities are often the most simple and robust ones. The Solarwall is a good example of a simple reliable technology, with few moving parts. The modest capital cost makes it achievable for most communities considering the construction of a school or recreation building.

Reasonable Expectations of Progress

The shift of society away from its present level of reliance on fossil fuels will be a gradual one. While the percentage of alternative fuel vehicles on our roads is minimal, and the number of solar panels and wind turbines on our landscape is few, evidence of these new technologies is an initial sign that change is on the way.

Aboriginal and Northern communities offer an excellent opportunity for energy efficiency and renewable energy projects to be developed at a reasonable scale. While the profiled projects may not represent a full-scale shift of entire communities to alternative approaches, they do represent fiscally responsible undertakings that are advancing the use of energy-efficient processes and renewable energy forms. This is a significant contribution to the control of climate change and shift to a sustainable way of life.

Although some of the projects profiled experienced a slightly longer pay-back period than first projected, all of the projects have experienced significant benefits, some of which are:

- reduced greenhouse gas emissions;
- reduced risk of transportation and storage of diesel fuel;
- recycling of waste products;
- increased local employment, training and capacity building;
- reduced house fires; and
- smaller heating bills for residents.

Importance of Community Support

By nature, some individuals are most comfortable with tried-and-true methods of approaching things, while others are interested in adopting innovative approaches. As with any technological advancements, it is inevitable that the development of innovative energy efficiency and renewable energies will be accompanied with challenges and the ongoing need for refinement. It is therefore essential that those pursuing and managing projects in this area gain the support of community members to ensure long-term commitment.

Those interviewed for the profiled projects emphasized the importance of community support. The Mohawks of the Bay of Quinte started by involving the community members and listening to their concerns in designing its housing program. The Kahnawake Kanata Healthy House Program also emphasizes the need to change perceptions and effect lasting changes in lifestyles.

Looking Ahead

4.0 LOOKING AHEAD

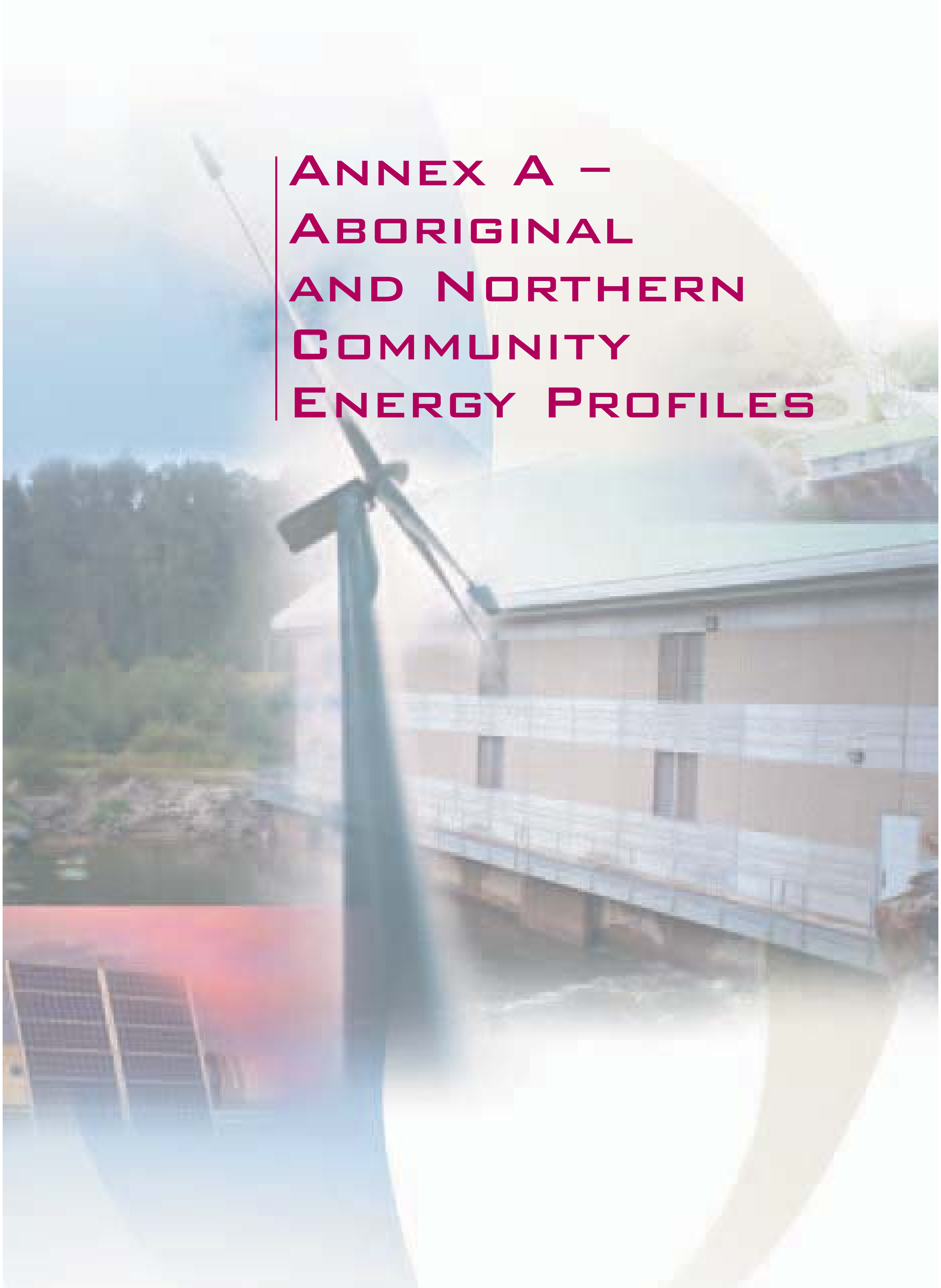
The outlook for continued innovation in energy efficiency and renewable energy in Aboriginal and Northern communities is good. These communities have built a positive track record and gained valuable experience in the managerial aspects of project development.

As the demand for energy increases, along with corresponding increases in energy costs, new technologies and technical applications will become more cost-effective. It will, however, be critical that the true cost of energy be recognized and integrated in policy and decision-making processes.

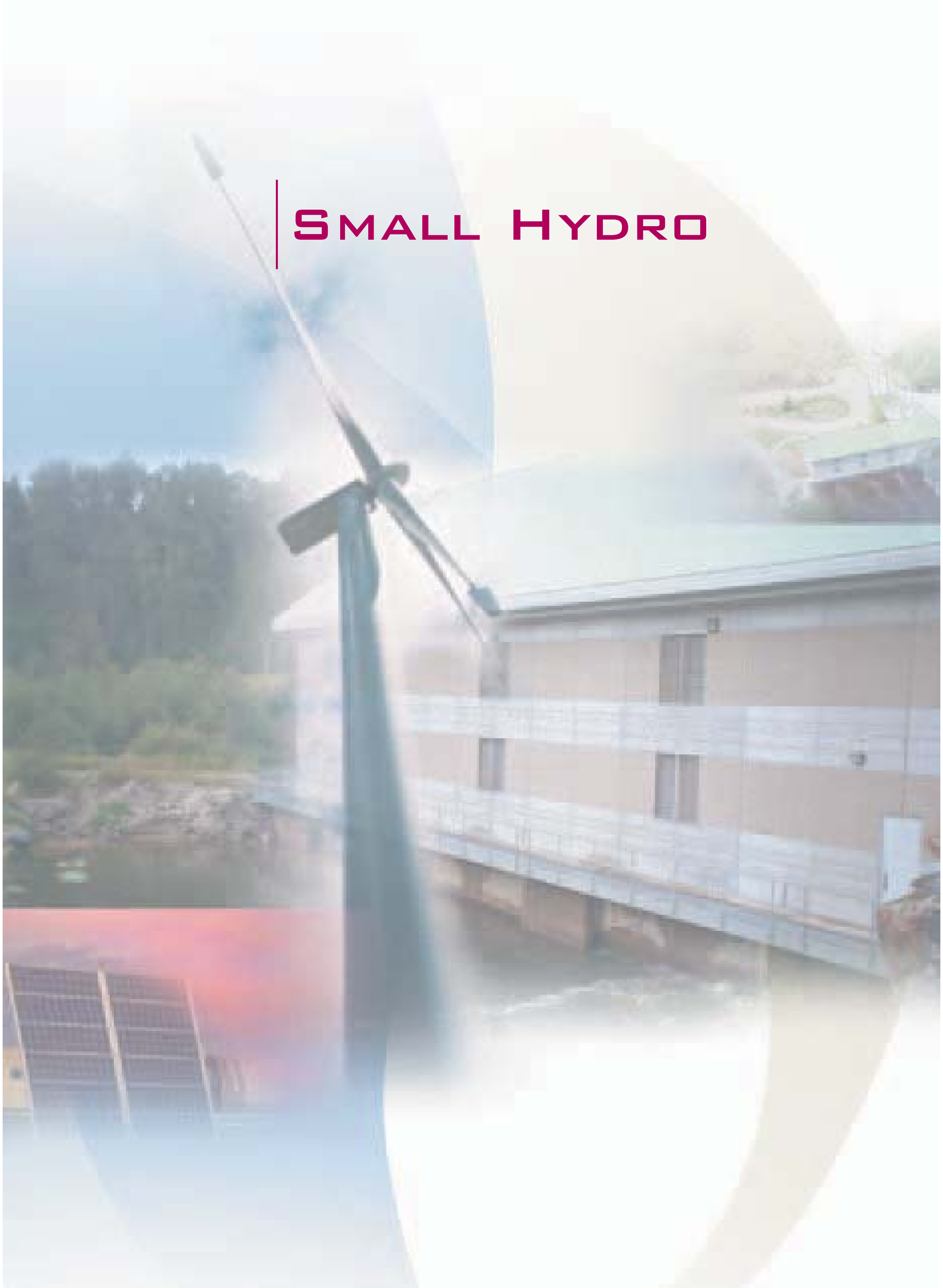
It will also be critical that communities and the public continue to be supportive of new and innovative approaches to energy efficiency and renewable energy. This support must acknowledge that progress is likely to be made in a modest fashion and that while economic practicality is essential, long-term societal and environmental benefits must be taken into account as well.

Issues such as global warming, climate change control, and sustainable living are top priorities for society. Aboriginal and Northern communities have a vested interest in addressing these issues and have made significant progress through innovative projects such as those profiled in this document.

Annex A – Aboriginal and Northern Community Energy Profiles



SMALL HYDRO



SMALL HYDRO

Hydroelectric power refers to electricity generated by the force of moving water. Small hydro generally refers to hydroelectric projects of less than 30 megawatts (MW) in size. Although water power was originally harnessed to produce mechanical power to drive machinery in flour mills, sawmills and textile plants, today most small hydro facilities in Canada generate electricity either for remote communities or to sell to a regional, provincial or territorial grid. Hydropower is a mature and cost-competitive technology, and although many of the best and largest sites in this country have already been developed, many potential small hydro sites are yet to be developed, especially in remote areas. There are also many existing small hydro facilities no longer in use that could be refurbished with new technology.

Small Hydro Basics

The energy potential of a hydro site depends on three factors: the *flow*, the *head*, and the *efficiency* of the generator. The flow is the quantity and speed of the water. The head is the vertical distance over which the water drops. To generate electricity, a site must have adequate river flow and a sufficient head, with the best locations being waterfalls, rapids, canyons, deep valleys and river bends. Careful on-site measurements are required to calculate a site's flow and head that, in combination with the generator's efficiency, determine how much power a site will produce.

Many small hydro projects require that a small dam or weir (a submerged dam) be built to create a headpond or reservoir to ensure adequate year-round flow. Water in the headpond is directed into an open channel or through a *penstock* (closed intake pipe) which carries the water downhill to an intake in the powerhouse where the turbine is located. Inside the powerhouse, the turbine blades rotate as they are struck by the falling water, turning a shaft that drives an electric generator.

Run-of-the-river projects use the power in the river water as it passes through the plant, and may not require the construction of a dam. These projects generally do not cause alterations to the natural flow of the river.

Some small hydro projects have multiple purposes, in addition to electricity generation. For example, irrigation, flood control, recreational use, or as part of a wildlife reserve. Such multi-purpose projects must strive for an optimal balance among the competing uses of water.

Categories of Small Hydro Developments

Small hydro projects are generally classified into the following categories:

Category	Size	Purpose
Micro hydro	Less than 100 kW	typical supply for one or two houses
Mini hydro	100 kW to 1 MW	typical supply for an isolated community or small factory
Small hydro	1 MW to 30 MW	supply to a regional or provincial electricity grid

Primary Benefits of Small Hydro

Clean, Renewable Energy Source with Low Environmental Impact

Hydroelectric developments do not cause greenhouse gas emissions or local air contaminants. The negative environmental impacts often associated with large-scale hydroelectric projects can usually be minimized during the development of small hydro projects through the use of good design and appropriate construction and operating practices. Run-of-the-river projects, in particular, have little environmental impact. Mitigative measures may be required to ensure the protection of wildlife habitat and fish migration routes.

Cost-Competitive

Small hydro developments can provide a competitive source of reliable energy, the cost of which is not subject to fluctuations in the international oil market. Electricity produced from small hydro projects is particularly competitive when compared to diesel generation that currently supplies electricity in many remote communities. Small hydro can often qualify for certification under green electricity programs that pay a premium price for electricity from an emission-free, environmentally-friendly source. In order to minimize construction costs, the project site should ideally be located close to the electricity demand (or a transmission line) and in a location that has relatively easy access for construction activities.

Socio-Economic Benefits

Small hydro projects can bring economic benefits to a region through construction jobs, use of local services, and revenue through selling energy to a grid.

Quick Facts

Profile	Small Hydro
Community	Ojibways of the Pic River First Nation
Pop. (approx.)	470
Area (ha)	316
Region	Ontario
Geog. Zone	2
Env. Index	B

Contact

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OJIBWAYS OF THE PIC RIVER FIRST NATION

Small Hydro – Selling to the Grid

The Pic River First Nation is a small Ojibway community located between Thunder Bay and Sault Ste. Marie, along the north shore of Lake Superior. The First Nation has part ownership in two operational hydro stations and majority ownership in a third hydro station in the planning stages. Income generated by the sale of power to the provincial grid has been re-invested in the community and used to support additional ventures. The decision was governed by opportunity, economic development and environmental stewardship. Experience gained with the first hydro development has allowed the First Nation to gradually build capacity and play an increasing role in the development and management of subsequent hydro ventures.

Initial Opportunity – Black River

Pic River First Nation first became involved in small hydro development when Chief Roy Michano was invited to sit on a review committee for a proposed hydro development located on Black River, five kilometres east of the First Nation. The Ontario Ministry of Natural Resources (MNR) had identified the site as one with potential for small hydro and was entertaining proposals for development. Rather than take a passive role on the review committee, Chief Michano opted for a more assertive role, choosing to bid for the right to develop the station.

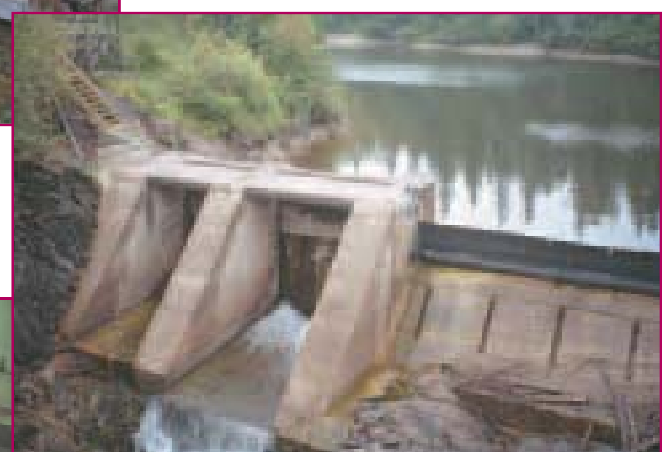
The decision to involve the community in hydro development was based on the First Nation's desire to benefit from this significant economic opportunity located so close to home. A second factor that influenced the decision was that the nature of small hydro development is consistent with the First Nation's view on environmental stewardship.

Black River Gorge

Pic River entered into a partnership with ConWest, a Canadian firm involved with mining and energy projects across the country. Initially, Pic River had 50 percent ownership in the venture; however, due to financial limitations, the First Nation was not able to maintain its equity position. Nevertheless, under the partnership the First Nation does receive a percentage of the net profit on the operation of the station.

The Black River generating station, referred to as Wawatay, became operational in 1992. The station is a 13.5 megawatt run-of-the-river-design, which minimizes the impact on the environment. The power is sold back to Ontario Hydro through a Power Purchasing Agreement (PPA). The PPA was a fixed-price 50-year contract at 6.3 cents per kilowatt-hour (kWh). The PPA gave the partnership the needed level of certainty in order to approach banking institutions to finance the $30 million capital project.

Black River Hydro Station



Black River Hydro Station

Black River – Penstock

The original business case projected a return on the capital invested after the first 11 years. Now in the 12th year of operation, the break-even point has been pushed off another few years. The Pic River First Nation, however, has received a total of just over $1 million in profits from the operation. This income has been reinvested back into the community. The First Nation has financed a women's crisis centre, a youth centre, a recreation centre, cable television, and high-speed Internet services. In addition, the funds available from the first hydro development project have allowed the First Nation to develop additional small hydro projects.

Building on Experience – Twin Falls Hydro Development

Following successful construction of the Black River generating station, Pic River was approached by Rapid-Eau Technologies Inc., a hydro-development company based in Cambridge, Ontario, to partner on the development of a 4.9 megawatt station on the Kagiano River at Twin Falls, just north of Pic River. Rapid-Eau first made application to the Ontario Ministry of Natural Resources in 1998 for authorization for development.

The original version involved damming the Kagiano River. In 1992, this approach was revised to a run-of-the-river operation in order to mitigate impacts on fishery habitat and spawning grounds. Pic River entered into a partnership with Rapid-Eau, holding 40 percent of the general partnership and 25 percent of the limited partnership, forming the Kagiano Power Corporation. Twelve additional limited partners were brought in, including the Union of Ontario Indians Development Corporation.

The total construction cost was in the range of $10 million, with $7.3 million raised in institutional financing, $900 000 contributed as equity by the general partnership and the remaining capital was raised by selling limited partnership units at $50 000 per unit.

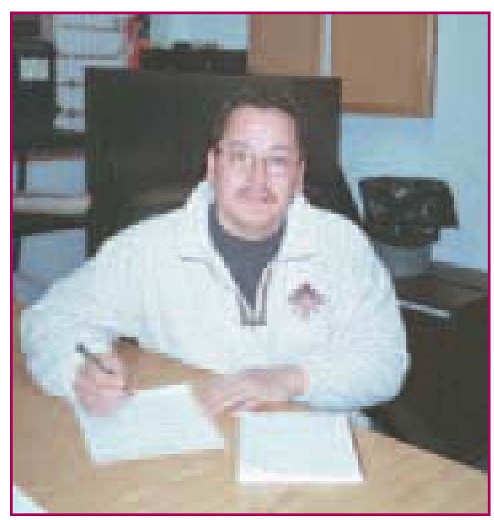
One of the important considerations for Pic River was the financing of its own interests in the project. The First Nation was able to pay its equity requirements from its central consolidated revenue account. Further funding of $300 000 was provided by Indian and Northern Affairs Canada (INAC) through the National Opportunity Fund Program.

Environmental Challenges

The site of the generating station, Twin Falls, consists of a series of chutes, falls, pools and islands approximately 575 metres in length with an overall drop in elevation of 55 metres. The development process was long and involved and before the station began operation in 2002, Pic River First Nation and the Kagiano Power Corporation, along with the Federal Ministers of the Environment, Fisheries and Oceans, and Indian and Northern Affairs, found themselves involved in a court action brought by a local trapper and environmental activist. The action alleged that the project involved clear cutting forested areas and destroying waterfalls and fish habitat. According to Councillor Byron Leclair, the area was previously altered significantly due to forestry operations and mining.

Specifically, the action alleged that the environmental assessment process was not followed adequately, that incorrect or incomplete data was being used to evaluate fishery impacts, that the assessment did not take into account cumulative impacts with control of upstream lake levels, and that convenient access was not provided to public registry documents. In July of 2000, the Federal Court Justice rejected each challenge and ordered court costs to be paid by the applicant.

"The cost issue is very sensitive for Pic River," Leclair explains. "There is no pool of money to defend these types of challenges to our activities. Such actions affect the cash flow of community programs such as the First Nation school, the seniors' residence and community healing centre."



Councillor Byron Leclair

New Ventures – Umbata Falls

The First Nation is currently leading the development of a 20.6 megawatt development on the White River, 15 kilometres to the east of Pic River at Umbata Falls. The First Nation's partner in this latest venture, Innergex, a Quebec firm, was selected through a Request for Proposal process initiated by the First Nation. The partnership has formed the Begetekong Power Corporation which is 51 percent owned by the First Nation.

Capacity Building

The experience that the Pic River First Nation has gained through the implementation of the first two projects, including the controversy over the Twin Falls development, has significantly increased management capacity at the First Nation level. The First Nation plays an active role on management committees, responsible for reviewing regular operational reports.

Although day-to-day responsibilities are handled by a managing director who is not a First Nation member, there are plans to mentor a Pic River youth to eventually fill this role.

The First Nation is taking the lead in the approvals process on behalf of its partnership in the Umbata Falls development. In addition, Innergex, the First Nation's partner on the Umbata Falls project, intends to relocate two Pic River members to facilities in its other operations for on-the-job training. Over the course of the next few years, these individuals will gain the experience and training to return to the community and operate the Umbata Falls station.

John Cress, a community member, operates the Black River site. The Twin Falls station is currently operated remotely from Rapid-Eau's office in southern Ontario.

Community Consultation

Through community meetings, hydroelectric development has been identified as a priority to promote environmental stewardship and economic self-sufficiency.

Accountability of the corporate entities to Chief and Council is addressed by ensuring adequate representation on boards of directors, direct involvement on the various management committees, and regular information reports back to Council as a whole.

Accountability to the community at large is accomplished through newsletters and regular community meetings. Job opportunities are also extended to members of the First Nation on a priority basis.

In addition to community involvement, the environmental assessment and approvals required for the development of small hydro involves significant public and agency consultation outside of the community. Leclair notes that the First Nation is held up as a lead proponent in public consultation forums.

The Economics of Small Hydro Development

For both the Black River and Twin Falls facilities, the power is sold through a PPA to Ontario Hydro. The initial agreement for the Black River station was for 6.3 cents per kWh; however, the more recent agreement negotiated for Twin Falls was much lower. Leclair indicates that Ontario Hydro maintains that its cost of production is 2.2 cents per kWh. Leclair counters that "We have lived a subsidized existence in terms of electrical power. The price of power should be going up. We are not going to get investment for new energy alternatives until true costs are reflected." The bright side of the picture is that "investment in the energy market now serves as a hedge against future price increases." Leclair says that society "has got to recognize the value of green power and be willing to pay a premium for it."

The new partnership will be looking for purchasers other than Ontario Hydro. Leclair says that they are looking for purchasers who are stable with good credit worthiness. Ideally, the number of purchasers would be limited. Contenders include local mines and large industry. According to Leclair, they are also looking into the federal procurement strategy for power.

Transformer

Sharing the Expertise

The First Nation has had its share of challenges in its hydro development initiatives. Answering to environmental charges and the subsequent court case presented a significant setback during construction of the Twin Falls station. Equity calls, which is the requirement for the First Nation to contribute its share of cash towards the capital cost, can place a financial strain on the community. Leclair notes that it is important to have community support behind the initiatives.

Leclair identifies two key components that led to success. Throughout the project, the team maintained a keen focus on the cost and worked hard to ensure that the project came in on budget. Also important was the First Nation's internal capacity to do its own work, essentially to hold up its side of the table. The focus on cost and the ability of the First Nation to undertake and complete its own work went far toward building a trusting relationship with the private sector partners in the project.

Leclair says that Pic River First Nation has gone out of its way to share experiences and expertise with other interested First Nations, offering many communities an opportunity to look over its operations. "We had hoped to be able to provide a working model to make this happen for other communities," he says.

Looking Forward

The First Nation will continue to look for opportunities to expand on its success to date. Leclair observes, "All the easy sites have been developed. All the remaining sites are second-tier sites. They require ingenuity to develop or solve access issues. Had they been easy, Ontario Hydro would have already claimed them."

To date, all three of the hydro development sites are located close to the community within Pic River traditional territory, although none is on reserve lands. "That's not to say that we won't look at opportunities on the outside. We are a power company," says Leclair.

Quick Facts

Profile |	Small Hydro
Community |	Deer Lake First Nation
Pop. (approx.) |	800
Area (ha) |	1 654
Region |	Ontario
Geog. Zone |	4 (4)
Env. Index |	C

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DEER LAKE FIRST NATION

Mini Hydro – Supplementing Power to the Community

Deer Lake First Nation is a small community of approximately 800 people located in remote northwestern Ontario. Power generation in the community is provided by a diesel-powered generating station with diesel fuel flown in by air. In 1998, a small 490 kilowatt run-of-the-river hydro generating station was constructed on the Severn River, approximately 6 kilometres from the community. There is a joint agreement for ownership between Hydro One and the First Nation; however, the First Nation has an option to take over ownership after 10 years of operation.

Power generation in the community is provided by a diesel-powered generating station operated by Hydro One, the provincial crown corporation. As in the majority of the northern Ontario communities, diesel fuel for the generation plant is flown in by air. This pushes the average cost of power generation to close to $0.70 per kilowatt-hour.

In November 1998, Hydro One completed construction of a small 490-kilowatt run-of-the-river hydro generating station located on the Severn River, approximately 6 kilometres from the community. The initial construction of the hydro station was funded by Hydro One and Indian and Northern Affairs Canada (INAC). The existing operating agreement is funded to December 31, 2009, and thereafter subject to further negotiation and formal ratification. The station is currently managed by Hydro One. A community member is employed as the on-site operator.

Hydro One estimates that hydro power displaces 39 percent of the community's power requirements. The station itself is operating at a capacity factor of 32 percent. Currently the hydro plant is providing a base load to the community with the diesel plant picking up the difference during peak demands. Communications and control software are currently being installed to co-ordinate the operation of the two power plants and enable greater use of the hydro power.

The Hydro Generating Station on the Severn River

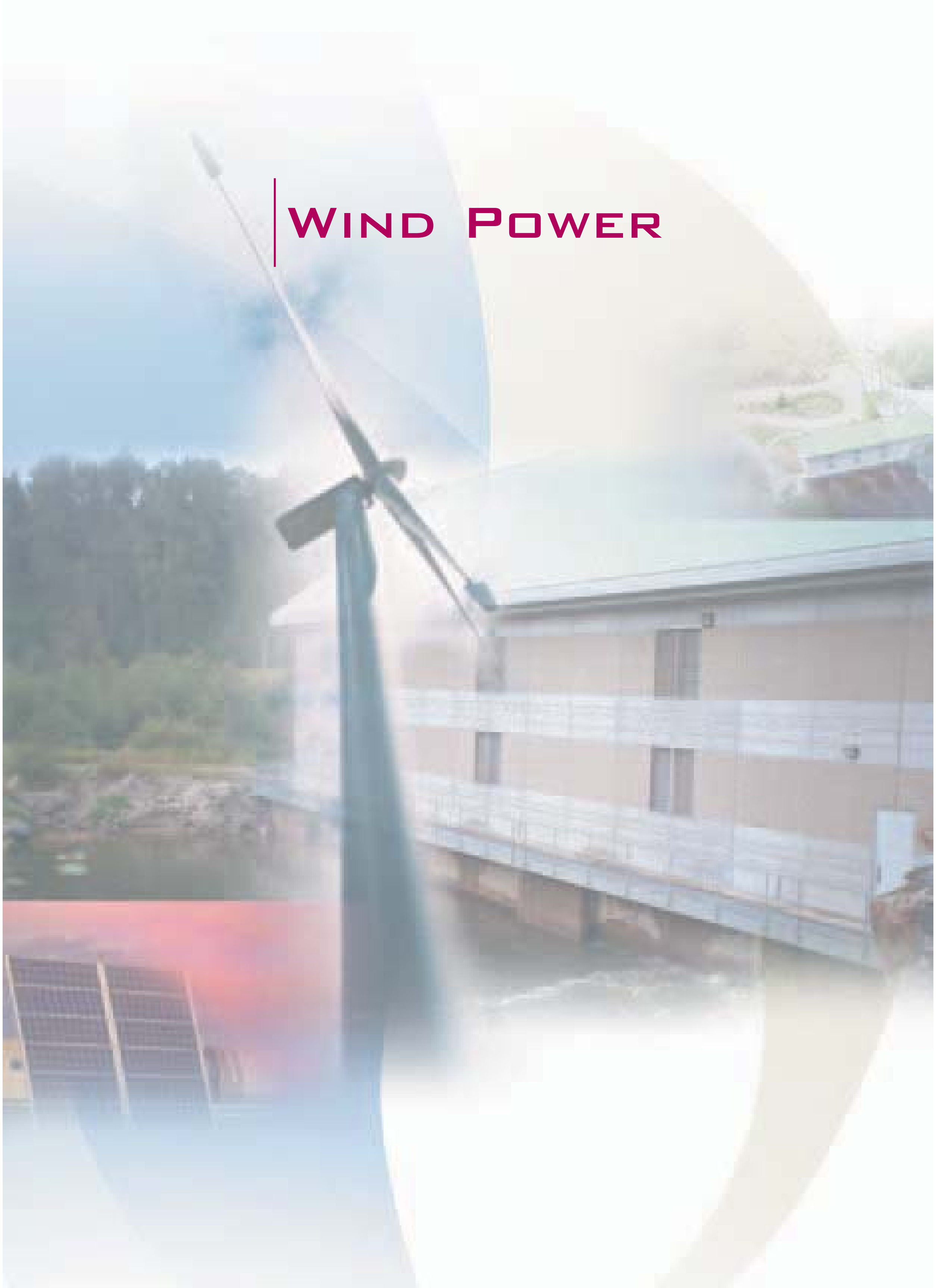
The Hydro Station undergoing repair and maintenance

There have been ongoing challenges including a bearing failure on one of the turbines and issues with the ability to dewater in order to complete repairs. The economic performance of the plant has been less than projected, due to cost overruns during construction and some problems with low water resources during mid-summer and mid-winter periods.

INAC has commissioned a study, presently underway, to evaluate the performance of the plant and applications for implementation in other communities. Barry Strachan of Northern Chiefs Tribal Council, says that making a business case for hydro development is more challenging for remote communities not connected to the grid, as there is no option to sell the surplus power to the regional utility or other purchaser.

Diver getting ready for underwater inspection

Wind Power



WIND POWER

Wind energy is the world's fastest growing electricity source and is among the cheapest of the renewable energy sources. Good wind sites are fully cost competitive with traditional fossil fuel generation, and in remote sites, where fuel has to be transported long distances, it is often more cost-effective than fossil fuel generation. Wind is one of the world's cleanest sources of energy – it produces no air or water emissions, no toxic wastes, and does not present any significant hazard to birds or other wildlife.

History of Wind Energy

Wind energy has been in use for thousands of years for pumping water and grinding grain. As early as the 1920s, over a million wind turbines pumped water and provided electricity to farms in rural North America. The current interest by many countries in wind energy was triggered by the need to develop clean, sustainable energy systems that do not rely on fossil fuels. Modern aerodynamics and engineering have significantly improved the efficiency of wind turbines, providing reliable, cost-effective, pollution-free energy for individual, community, and regional applications.

The greatest use of wind energy today occurs in Europe. Canadian use of wind energy has been slower because of relatively low electricity rates and because Canada generates a surplus of electricity. Nevertheless, the wind energy industry is growing and several wind turbine manufacturers now have representatives in Canada.

Wind Energy Applications and Location Considerations

Wind energy can be used in a variety of applications, from small 50-watt battery chargers in cabins and lighthouses to industrial-scale turbines of 2 megawatts capable of supplying electricity for 500 families. The most common application is to have one or more wind turbines connected to the area grid with the electricity sold to a local utility as a source of income. Wind turbine generators can also be used to offset diesel-generated electricity in remote communities.

Wind energy is the kinetic energy present in moving air. The amount of potential energy depends mainly on wind speed, but is also affected by the density of air which is determined by air temperature, moisture content, barometric pressure, and altitude.

Wind speed is a critical element for the success of a wind generation project. The power and energy output increases dramatically as the wind speed increases. An annual average wind speed greater than four metres per second (m/s) is required for small turbines. Utility scale wind power plants require minimum average wind speeds of six m/s. In low wind areas, turbines can be designed with large rotors compared to the size of the electrical generator. Such machines will reach peak production at relatively low wind speeds, although they will be less efficient in high winds. Manufacturers are increasingly optimizing their machines to suit a variety of wind conditions.

Wind speed is affected by local terrain and generally increases with height above the ground, which is why wind turbines are usually mounted on towers. Although wind conditions near coastal areas tend to be ideal for wind projects, there are many inland areas suitable for wind turbines, particularly in hilly terrain. As the wind passes over a hill, or through a mountain pass, it becomes compressed with a resultant increase in speed. Rounded hilltops with a wide view in the direction of the prevailing wind make good wind turbine sites.

Wind turbines work well in conjunction with agricultural land use and cause little disturbance to farm stock, wildlife, and birds. Restrictions on location, however, include migratory bird paths and airstrip locations.

The major drawback of wind power is variability – wind speeds vary throughout the day and the year, and therefore the amount of electricity generated will also vary. With smaller grids, diesel generators can be used to balance out variations in wind-generated electricity. Modern electronic controls permit operation of wind-diesel hybrid systems with a higher proportion of the energy being supplied by the wind.

Costs of Wind Energy

The cost of wind energy is determined by:

- initial cost of the wind turbine installation;
- wind resources available;
- interest rate on the money invested; and
- availability of renewable energy incentives.

Depending on local wind conditions, typical costs for wind generation can range from $0.05 to $0.15 per kilowatt-hour (kWh), which tends to be slightly higher than that associated with the average fossil fuel plant. In remote areas relying on diesel plants and imported fuel, energy costs can be as high as $0.70 per kWh. Wind generation can be cost effective in comparison. Economies of scale will continue to push down wind energy costs, while most conventional generation costs continue to increase. It is important to note that these costs do not account for the environmental and health benefits of using a non-polluting source of energy.

Special consideration needs to be given to the design of wind turbine installations in harsh, Northern climates. Though the location of remote Northern communities means wind energy can be very cost effective, most wind turbines are not designed for the severe climatic conditions to which they may be exposed. Adaptation to harsh conditions is required for most wind turbines on the market today.

Wind generation is an attractive renewable energy option for Aboriginal and Northern communities with good wind resources and high fuel costs. Successful projects require a careful feasibility assessment, a local champion to get the project on its feet, and ongoing operational attention by dedicated staff.

Quick Facts

Profile |	Wind
Community |	Piikani Nation
Pop. (approx.) |	3 308
Area (ha) |	45 590
Region |	Alberta
Geog. Zone |	1
Env. Index |	B

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PIIKANI NATION

Weather Dancer Performs

In windswept southern Alberta, Piikani Nation is harnessing the power of the wind to generate clean emission-free electricity. A 900-kilowatt (kW) wind turbine, known as Weather Dancer 1, generates an average of 3 000 megawatt (MW) hours of emission-free electricity each year, sufficient to meet the needs of 450 homes. By displacing coal and gas-based grid electricity, the Weather Dancer reduces annual carbon dioxide (CO_2) emissions by approximately 2 500 tonnes per year. The project has been undertaken as a joint venture with EPCOR, an Alberta-based utility company. The partnership has a long-term contract to supply power to the grid. Eighty percent of the power is sold at a fixed price, which is then sold to customers as "green power" at a premium rate. The remaining 20 percent is sold to the regional power pool at market prices.

The Piikani people, part of the Blackfoot Nation, were traditionally dependent on the buffalo, while today, much of their land is used for cattle ranching. The name Weather Dancer refers to a ceremony performed on the last day of the Sundance (Okaan), which renews the relationship with the natural world. On the final day of the ceremony, the Weather Dancer fulfills his sacred obligations by dancing for the natural elements, the life source. The name seems appropriate for the slim tower with its three majestic blades that turn gracefully through the air against the backdrop of the southern Alberta foothills. Cattle graze peacefully near the base of the tower and appear to be oblivious to the turning of the silent silver blades.

"Weather Dancer 1 ties the traditional elements of our culture with the goal of developing new opportunities for the Piikani people," said Peter Strikes with a Gun, Chief of the Piikani Nation. "Our success with Weather Dancer 1 is allowing us to look ahead to a larger wind power project, and a future where it may be possible for us to meet the energy needs of our own community. This will also bring new opportunities for the coming generations of the Piikani people."

Weather Dancer 1

Project Beginnings – Initial Vision

The idea for a wind energy project started with William Big Bull, the prime force behind the project. The idea surfaced during a time when Big Bull was taking young people of the community into the foothills to learn survival skills and Native ways. He liked the idea of having a permanent camp in the hills, a camp that would be self-sufficient and independent of the mainstream world. Big Bull started to look into a variety of options for tapping into the earth's renewable energy sources and was introduced to wind power while visiting other Aboriginal communities.

Developing the Project – First Attempt

In the 1980s, Shinook Projects Inc., approached the First Nation with an opportunity to develop a 9.9 MW wind power project under *Alberta's Small Power Producers Act*. Shinook Projects was looking for a partner to develop a wind farm, as well as a location in which to construct it, and the Piikani Nation appeared to have ideal wind conditions. Piikani Chief and Council were supportive of the project and decided to proceed.

As a first step, the Piikani Nation and Shinook Projects carried out an environmental assessment of the proposed project. Local utilities were then approached to invest in the project. Several turned down the request, citing as a reason the fact that wind does not generate a constant power supply. Although a total of five different business cases were put together, Big Bull had difficulty justifying the economics of the project. The available purchase rate for electricity was 5.2 cents per kilowatt-hour (kWh), while calculations showed that the cost to produce it would be closer to 7 cents per kWh. Although the First Nation had the land resources, it did not have the capital resources to finance the project.

In the early 1990s, changes in the power industry, such as deregulation and the establishment of a power pool to set the market price, helped improve the economics of the project. At the same time a number of utilities in the United States were looking for generating options located close to the border, in order to take advantage of the Canadian dollar. Unfortunately, the timing of these more favourable conditions corresponded to a change in approach of the Piikani Chief and Council who had withdrawn their support for the project. As a result, Vision Quest took its electricity allocation down the road to the neighbouring municipality of Pincher Creek. There they built an 18 MW wind farm with the first one commissioned in November 1995.

Developing the Project – Second Attempt

With the construction of the Pincher Creek wind farm clearly visible from the reserve, the people of Piikani began to ask their leaders what had happened to their own wind power project, and so Big Bull was asked to try once more to get a project up and running. He hit the pavement once again, looking for partners, searching for the best approach, and developing an excellent network of contacts in the fields of renewable energy and wind generation.

Weather Dancer 1

EPCOR, a Joint Venture Partner

EPCOR representative Ken Warren indicated that EPCOR is pleased with its partnership with the Piikani Utilities Corporation. "The project has met expectations and is operating well", said Warren. "The goal was to reach 37 percent capacity, and we are on target so far". Warren indicated that the advantages of working with the First Nation include the use of the land and the desirable location. EPCOR is anxious to get into environmentally friendly "green power" in order to balance its reliance on coal and gas plants. Although presently there is approximately a two cent premium paid on wind power generated, EPCOR indicates that customers are willing to pay a premium for power generated by renewable sources. When asked about the future, Warren indicates that they would like some additional operating data for evaluation, however, EPCOR is cautiously optimistic about expanding operations in conjunction with Piikani Utilities Corporation.

Mentored by Maurice Strong, a prominent promoter of renewable energy, Big Bull had the opportunity to meet and exchange ideas with some of Canada's foremost renewable energy experts. Big Bull also acknowledges the assistance of staff from Natural Resources Canada under the Renewable Energy Strategy. Looking back at this point in his quest, he comments, "Here is when the world started to turn. Up to then we were at a standstill." He was finally able to convince others to speak on behalf of the First Nation.

The initial vision was to construct a 100 MW wind farm. Big Bull began discussions with a number of companies, including Advanced Thermo Dynamics, a small power company, affiliated with Batchewana First Nation in Ontario that was licensed to market Nordex turbines, and NEG MICON, a Danish turbine manufacturer with some manufacturing facilities in the United States. NEG MICON has sold more than 7 000 wind turbines worldwide.

Choosing a Site

Although regional wind data was available from the nearby Pincher Creek wind farm, local site-specific data was needed in order to choose an optimum site. Several anemometers were installed to collect data on wind speeds at various locations under consideration. The preferred location for the project was on a hill with access to good winds, close to the main transmission line. Unfortunately this site was located on land that was held by an individual band member, which was not an ideal arrangement. A second site was selected, this one on community-owned land. This site provides good wind exposure, but is located further from the highway and the transmission main. The location has proven to have very good wind resources with average wind speeds ranging from 12 to 18 metres per second.

Finding a Partner

At the time, 50 percent of development costs of a renewable energy project were tax deductible. However, as a First Nation, Piikani was not in a position to capitalize on tax incentives and needed a partner in order to take advantage of this incentive. After looking at various options, Piikani eventually entered into a joint venture partnership with EPCOR, a utility company owned by the City of Edmonton. The First Nation provided the land and the location; EPCOR provided the financial backing. Although EPCOR is currently the majority owner, the agreement stipulates that Piikani can increase their ownership up to a maximum of 50 percent, which the First Nation is currently arranging to do. Returns are shared in proportion to ownership.

The First Nation initially had a reluctance to form a corporation, because it was considered "un-Indian" by community members. However, in order to move ahead with the project and set up the joint venture, Piikani eventually formed a utilities corporation called Peigan Indian Utility Corporation, later changed to Piikani Utilities Corporation. Before going ahead with the project, a presentation was made at an administration-wide open house to involve community members in the decision. Over 280 members filled out the opinion survey and questionnaire in support of the project. Subsequent to the initial public meeting, there has been an ongoing public consultation process.

Other Power Interests

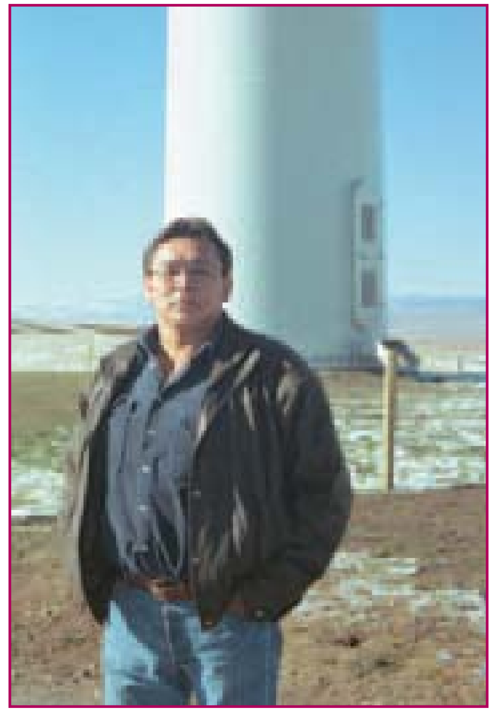
Weather Dancer is not the only power generation project that Piikani has on the go. The First Nation has a 25 percent interest in the Old Man River Dam, a hydro-electric dam with a 25 MW generator. Because the dam is operated primarily to meet irrigation needs, electricity generation from the dam is limited to the months between April and October to correspond with crop season. This balances nicely with wind power generation in the area, given that the strongest winds in this region occur in the winter and the early spring.

Local Distribution

The Piikani Nation owns their own local distribution system. The First Nation formed its own Rural Electric Association (REA) to operate the local grid in 1962. When INAC divested ownership in the system in 1975, the REA was saddled with significant pre-existing debt. This debt has been paid down over the years, allowing the REA to concentrate on building a reserve account to cover maintenance and refurbishment costs as required.

Technology

A 900 kW MICON wind turbine manufactured in Denmark was selected for the initial demonstration project. The tower stands at a height of 72 metres. The installation has a total footprint of only 24 square metres.



William Big Bull and Weather Dancer 1

Project Costs

The joint venture has entered into a 20-year contract with EPCOR, who will purchase at a fixed rate 80 percent of the power produced. The electricity, which is certified as green power, is then sold to EPCOR customers at a premium rate through its Green Power Program. The remaining electricity (20 percent) is sold to the regional power pool at market prices.

Success Factors

Both Piikani and EPCOR see the project as a success. Good wind resources are naturally an important factor in the success of such a project, but just as important have been the support and cooperation from those involved in the project, particularly the Piikani, whose Chief, council and people have given their support to the project. Without the vision and stamina of William Big Bull, the project's primary supporter, the project would likely never have happened. Support from Indian and Northern Affairs Canada (INAC) and the Federal Justice Department, and the provincial agencies regarding permits and hookups, were also factors in the project's success.

Future Directions

The current project is considered a pilot project. Now that it has been shown to be a success, Piikani has plans to gradually build a wind farm of its own and is now waiting for the right market conditions. Three additional turbines similar to Weather Dancer 1 can be installed using the existing 25-kilovolt distribution line.

One of the first goals of the Piikani Utilities Corporation is to buy back the transmission line. This will serve to improve the asset base, Big Bull explains, and will allow the corporation to charge a distribution tariff on the use of the main. The joint venture is also looking into selling a portion of the electricity directly to homes in the community instead of it going to the provincial grid.

Quick Facts

Profile |	Wind
Community |	Rankin Inlet
Pop. (approx.) |	2 177
Area (ha) |	5 234
Region |	Nunavut
Geog. Zone |	n/a
Env. Index |	E

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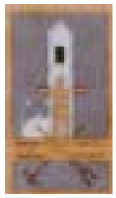
RANKIN INLET

Wind Power in the North



Of the five wind turbines purchased by the Nunavut Power Corporation (NPC) in 1955 for installation at various locations across the North, only the one at Rankin Inlet is still in operation. The harsh Northern climate of coastal Hudson Bay has proved to be a challenging environment for wind turbines. The 50-kilowatt (kW) unit is connected to the local grid supplied by diesel generators. Following adaptation of the equipment for local conditions and ongoing maintenance, the Rankin Inlet unit has been operating successfully since 2000, displacing approximately 40 000 litres of diesel fuel per year.

The other four generators have failed for various reasons – one was hit by lightning, and another was toppled by high winds. The wind generator installed at Rankin Inlet, however, has operated successfully under the watchful eye of NPC electrician, Philip Owens, since it began generating electricity in November 2000. Good community support and a local champion have contributed to the success of the wind turbine installed in this community of 2 177 on the shores of Hudson Bay.

Background

The Rankin Inlet wind turbine is a 50 kW unit with 7.3 meters (m) blades mounted on a 24 m shaft. The turbine is located on the outskirts of town, a short distance from Hudson Bay and is connected to a local grid for which the balance of electricity is supplied by diesel generators. The wind turbine generates an average of 189 000 kilowatt-hour (kWh) a year, displacing 40 000 litres of diesel fuel and reducing greenhouse gas by approximately 185 tonnes of carbon dioxide per year. At an average cost of diesel fuel at $0.55 per litre, this results in a fuel savings of $22 000 per year. Capital costs for the turbine were about $300 000 and maintenance costs are about $10 000 per year.

Wind speeds at this location vary greatly, with average speeds of around 10 metres per second (m/s). The manufacturer's specifications identify a shut down speed of 22 m/s and a peak survival wind speed of 58 m/s. The highest wind speed recorded has been 59 m/s.

Rankin Inlet Wind Turbine

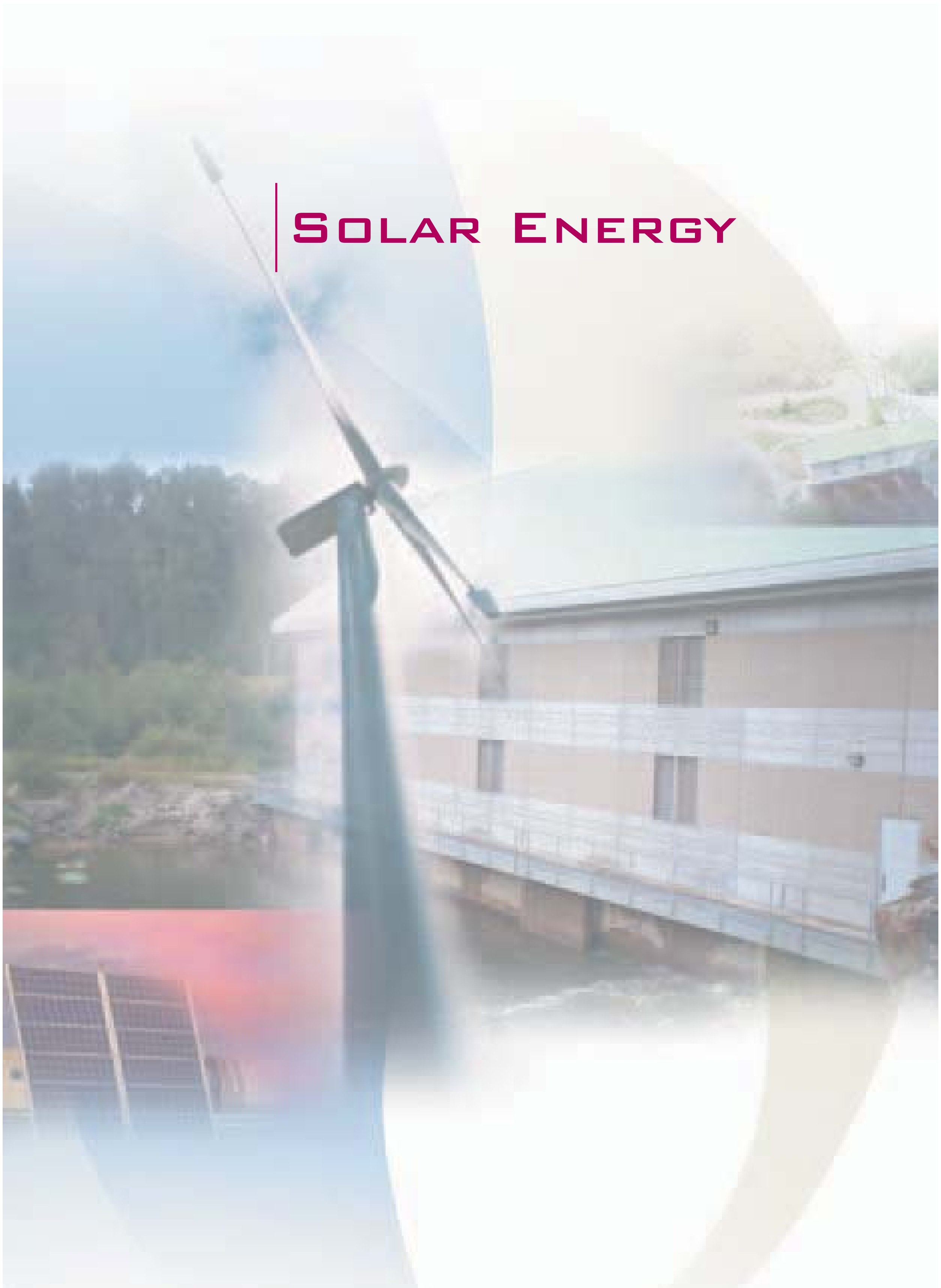
Challenges and Key Success Factors

According to Philip Owens, having dedicated operations staff with a real interest in making it work is essential to successfully operating a wind generator in the Northern environment. The turbine has to be constantly monitored and regularly adjusted to ensure a smooth and optimum operation. Before installation, the Rankin Inlet equipment was adapted for local conditions, since the generator was not originally designed for operation in such a harsh climate. A good portion of the wiring and controls was replaced with more durable materials so that they could withstand the high winds and low temperatures and the generic programming code was rewritten to suit local weather conditions. Difficulties were initially encountered with shipping and location of the unit, and replacement blades need to be on hand in case of damage or malfunction.

Owens expects that the turbine's operation will eventually become more efficient as the down time will decrease now that some of the wrinkles have been ironed out. His advice to communities investigating wind power is that the concept will work and has potential, especially in areas with good winds and high diesel costs. However, dedicated operations staff is required for ongoing success. He cautions that the type of unit should be appropriate to the particular installation and that the installation should be kept as simple as possible. He also stresses the need for flexibility and contingency when planning the budget for a wind project.

Owens cautions that in small communities, grid penetration or the amount of wind power relative to that supplied by diesel generators or another power source can be of concern. He indicates that if wind generation exceeds 5 to 10 percent of the total power demand, line instability can occur due to the power fluctuations. "Wind power generation is still in the early stages in the North and it is important not to proceed too quickly while these challenges are still being worked out." Controls are being developed that allow operation of wind-diesel hybrid systems with a higher proportion of the energy supplied by wind generation.

Solar Energy



SOLAR ENERGY

The sun's energy has long been used for common activities such as preserving foods for long-term storage and for drying clothing. Today's technologies allow us to use solar energy for new and diverse applications.

Photovoltaics (PV) converts the sun's energy into electricity for use in homes, buildings or remote applications. The efficiency of solar PV increases in colder temperatures and is particularly well-suited to Canada's climate. Although the price of PV modules is decreasing as new, more efficient technologies are developed, PV applications are still relatively expensive. PV systems are most cost effective in small load applications in remote areas. One promising new PV application is known as *Building-Integrated Photovoltaics (BIPV),* which offsets some of the costs of PV technology by incorporating PV modules directly into building components such as roofing tiles, windows and wall components. In Canada, sales of PV systems have been increasing by more than 20 percent per year over the past decade. In 2000, 1.5 megawatts (MW) of modules were sold in Canada, with 98 percent used in off-grid or remote applications, and 2 percent tied to the grid.

Solar Air Heating Systems convert the sun's energy to heat to be used for space heating, usually in large buildings such as schools, community centres or manufacturing facilities. One application is the Solarwall, developed by Conserval. A Solarwall requires a large south-facing wall and consists of a perforated dark metal cladding that covers the wall, leaving an air cavity between the metal and the wall. When sunlight hits the dark metal, it is absorbed, heating the air space – thus pre-heating the air drawn into the building's main heating system. Use of solar air heating is most cost effective in Northern locations where the sunlight reflects off the snow to improve the solar gain, and high fuel prices and cold temperatures combine to increase the fuel savings.

Solar Water Heaters collect the sun's energy to heat water for use, either providing hot water or for space heating. Water is circulated through a collector panel, and the heated water is then pumped into a water tank for domestic use. In Canada, glycol, or a similar fluid to prevent freezing, is used to circulate through the solar collectors, and its heat is then transferred via a heat exchanger to the hot water tank. In cold climates, solar heaters are often used on a seasonal basis.

Passive Solar is a method of building design that takes advantage of the sun's energy through placement of windows, and the use of colours and materials that absorb, reflect and store solar energy as needed to help regulate indoor temperatures.

It is not necessary to live in a hot climate to take advantage of solar energy. In fact, some solar technologies operate most efficiently in cold climates. Relevant factors in evaluating the feasibility of solar technologies include the number of hours of sunshine on a daily and annual basis and the intensity of the solar radiation. In Canada, the regions with the most solar radiation are in certain parts of southern Alberta and Saskatchewan, but there are many other regions where solar technologies can be cost effective. Natural Resources Canada (NRCan) has developed a free software program, called RETScreen, that can assess the feasibility of solar energy installations in any region of Canada. It is available on the Internet at **www.RETScreen.net**.

Quick Facts

Profile |	Solar
Community |	Rankin Inlet
Pop. (approx.) |	2 300
Area (ha) |	5 234
Region |	Nunavut
Geog. Zone |	n/a
Env. Index |	E

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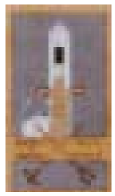
Alaittuq High School – Rankin Inlet

Solarwall Heats High School



In the community of Rankin Inlet, on the northwestern shore of Hudson Bay, the sun's energy is being used to help heat the local high school. As in most Northern communities, the combination of low temperatures and high fuel prices means heating costs can be exceptionally high. The use of solar energy, captured by a solar heating system known as a Solarwall, is expected to reduce fuel use at the school by about 2 600 litres per year. Taking into account rebates available for renewable energy, the system is anticipated to be cost effective in five to six years.

Rankin Inlet is a community of 2 300 on the shores of Hudson Bay in Nunavut. Heating costs for the community's Alaittuq High School are paid by the Nunavut Department of Education. The department, in its search to save on fuel costs, joined forces with the Department of Sustainability and the Department of Public Works and Services, which were looking for ways to reduce the territory's reliance on fossil fuels and increase its use of renewable energy. The high school gymnasium already had a large, south-facing wall, ideal for taking advantage of solar radiation, so the two departments investigated the possibility of maximizing the solar potential of this wall to lower heating costs.

In 2001, the two government departments contacted Conserval Engineering of Downsview, Ontario, and asked the company to design and build a solar heating system for the school gym. Construction of the Rankin Inlet Solarwall began in February 2002 and in early March it began operation.

Design and Operation of the Solarwall

The Solarwall installed at Alaittuq High School is 66 square metres and is painted a dark green to match the school's green trim. It sits four to six inches off the school's exterior wall, thus creating an air space behind the Solarwall. The dark colour of the perforated Solarwall results in the sun's rays being converted into heat. This heat is drawn into the air space and is fed into the building's main heating system.

Alaittuq High School Solarwall

The Solarwall

A Solarwall consists of a dark metal cladding installed on a south-facing wall that creates an air space between it and the building surface. The Solarwall acts as a pre-heating system for fresh air flowing into a building's ventilation system. Because of the dark colour of the cladding, when sunlight hits the metal, it is absorbed and converted into heat, creating a layer of warm air across the entire surface area of the wall. Fresh outdoor air is drawn through small holes in the surface of the wall and is warmed up by the metal before entering the building's ductwork.

A Solarwall can pre-heat air by between 17°C to 30°C, the actual increase depending on factors such as the outside temperature, the solar radiation, the prevailing winds, and the colour of the wall. A Solarwall reduces heating requirements because the preheated ventilation air requires less energy to bring it to room temperature than would have been needed for cold, outdoor air.

The Solarwall works especially well in cold and Northern climates because the low angle of the sun causes the sunlight to be reflected off the snow. This enhances the performance of the system by 50 to 70 percent, thus compensating for the shorter hours of sunlight. The economics of the Solarwall are also improved in the North because of the high cost of heating fuel and the high proportion of days in the spring, summer, and fall that are extremely sunny, yet very cold. This means that heated indoor air is required during virtually every month of the year. The Solarwall works well in any building requiring ventilation and positive air circulation such as hospitals, schools and large office buildings.

The Solarwall can increase the temperature of the incoming air by between 17°C and 30°C. For example, on a sunny day when the outside air temperature is -30°C, the Solarwall may increase its temperature to -5°C. The Solarwall ties into the existing ventilation system, upstream from the heating coils, so that it pre-heats ventilation air before the air is drawn into the main heating system.

The operation of the wall is fairly simple. A louver opens and closes to control the air flow, and electronic thermostatic controls regulate the indoor air temperature. During the summer the system is bypassed.

Costs and Benefits of the Solarwall Installation

The total capital cost of the system was $77 000, but because the Solarwall is eligible under the Renewable Energy Deployment Initiative (REDI), a 40 percent rebate was received on capital costs. The payback period for the system was estimated to be 5 or 6 years, based on projected savings of 2 650 litres of heating oil per year. By reducing the consumption of fossil fuels, the solarwall will reduce greenhouse gases by about 10 tonnes of carbon dioxide per year. It will also reduce air contaminants such as sulphur dioxide, particulate matter and carbon monoxide, thus improving local air quality. The pre-feasibility analysis of the installation was carried out using RETScreen, a renewable energy software tool designed by Natural Resources Canada which is available free over the Internet at **www.RETScreen.net**. RETScreen contains a module that is specifically used for analysing Solarwall applications.

Monitoring the Results

An additional $15 000 is being spent on monitoring the operation of the Solarwall installation over a 1 year period. The monitoring equipment measures the temperature of the outside air and the temperature of the air after it has passed through the Solarwall, as well as the volume of incoming air. With this data it then calculates the increase in air temperature brought about by the Solarwall, as well as the amount of solar energy delivered. Monitoring results will assist in the design of future Solarwalls in Northern communities and will be used for teaching local students about environmental technologies.

Quick Facts

Profile	Solar
Community	Fort Smith
Pop. (approx.)	2 500
Area (ha)	9 275
Region	NWT
Geog. Zone	n/a
Env. Index	E

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RECREATION CENTRE – FORT SMITH

Combining Solarwall and Heat Recovery Ventilation

A Solarwall has been installed at a community recreation centre in Fort Smith, Northwest Territories (NWT), a community of 2 500 inhabitants about 300 kilometres south of Yellowknife. The Fort Smith Recreational and Community Centre is a multi-purpose facility that provides a range of recreational programs and services to the community. The 120 square metre (m^2) Solarwall provides over 75 percent of the total energy for space heating, resulting in a total savings of 6 370 litres of fuel oil.

The 120 m^2 Solarwall at Fort Smith is combined with a heat recovery ventilator (HRV) that recovers a portion of the heat contained in outgoing air which it uses to warm up incoming ventilation air. Installed in 1998 for a capital cost of $53 000, the Solarwall/HRV system was designed to provide 75 percent of the building's heating load, yielding an expected payback period of 5 to 6 years through the savings in heating oil. The system began as a demonstration project involving the participation of the Town of Fort Smith, the NWT Government, and Natural Resources Canada.

How the System Operates

Outdoor air is drawn in through small perforations in the Solarwall cladding. When the sun shines on the cladding, solar energy is absorbed by the metal and warms the air as it flows through the perforations. The solar-heated outdoor air then moves toward the supply side of an HRV. The heat exchanger in the HRV further warms the solar-heated outdoor air with heat recovered from the building's exhaust air. A heating coil provides any additional heating (i.e., makeup heating) that is required to bring the mixed air up to the desired temperature before delivering it to the interior of the building.

To maintain acceptable indoor air quality, the system is designed to supply a minimum of 50 percent outdoor air. The outdoor air is mixed with re-circulated indoor air to maintain an indoor air temperature of 20°C. However, if carbon dioxide levels inside the building rise to unacceptable levels (for example, during periods of high occupancy), a carbon dioxide sensor in the gymnasium overrides the temperature control, and ventilation air is then supplied by 100 percent fresh outdoor air. The system is equipped with a summer shut-off control, so that on hot, summer days, the building doesn't overheat.

Monitoring Results

The installation at Fort Smith was closely monitored from May 2000 to March 2002, providing information on the amount of energy that can be delivered by the Solarwall/HRV system, and the associated savings in fuel oil.

Over the monitoring period, the Fort Smith Solarwall (not including the HRV) delivered approximately 0.2 gigajoule per square meter of energy per year, yielding a savings in fuel oil of 1 542 litres. Together, the Solarwall/HRV combination contributed 78 percent of the total energy needed for ventilation air heating over the monitoring period and resulted in a total saving of 6 369 litres of fuel oil. At a fuel price of 50 cents per litre, this represents a saving of over $3 000.

The monitoring results also indicate that the combined Solarwall/HRV system provided a greater reduction in fuel oil usage than either could provide alone and that the Solarwall/HRV system is particularly effective when three conditions occur simultaneously:

- long operating hours;
- low outdoor temperatures; and
- clear, sunny weather (i.e., significant solar resource available).

Quick Facts

Profile |	Solar
Community |	Iqaluit
Pop. (approx.) |	6 000
Area (ha) |	2 024
Region |	Nunavut
Geog. Zone |	n/a
Env. Index |	E

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NUNAVUT ARCTIC COLLEGE – IQALUIT

Photovoltaic System Performs in Harsh Climate

In July 1995, a 3.2 kilowatt (kW) photovoltaic (PV) system was installed on the south wall of the Nunavut Arctic College in Iqaluit, NU, feeding into the local grid. Electricity produced from the PV array displaces the use of diesel fuel, reducing greenhouse gases and local air contaminants. The project was designed to monitor and document the long-term performance of a grid-tied PV system in Nunavut, and to promote PV as a viable power source in the Arctic.

The system consists of 60 PV modules mounted vertically on the front wall of the college, which faces 30 degrees west of south. Since its installation, the following data has been monitored continuously: solar insolation (available solar energy in watt per square meter), ambient temperature, array temperature, array current and voltage, direct current power generated and alternating current power delivered to the grid. This data is then averaged on an hourly basis and stored on the computer database.

Since 1995, the system has been very reliable and has required little maintenance. The array generated a total output of 1.98 megawatt-hour (MWh) during 1995/96 and 2.13 MWh during 1996/97. On an annual basis, the recorded amount of solar energy falling on the PV array was, respectively, 25.3 and 26.8 MWh for these time periods. The efficiency for the array (ratio of generated power to available power) has been calculated at approximately 11.2 percent under optimal conditions and about 8.6 percent during the winter months.

Solar panels mounted on the south wall of the Nunavut Arctic College

The Nunatta Campus PV array was installed as a demonstration project under the PV for the North Initiative: a five-year undertaking by the Nunavut Research Institute and Natural Resources Canada's Energy Diversification Research Laboratory (EDRL) aimed at increasing the penetration of PV technologies in Canada's North.

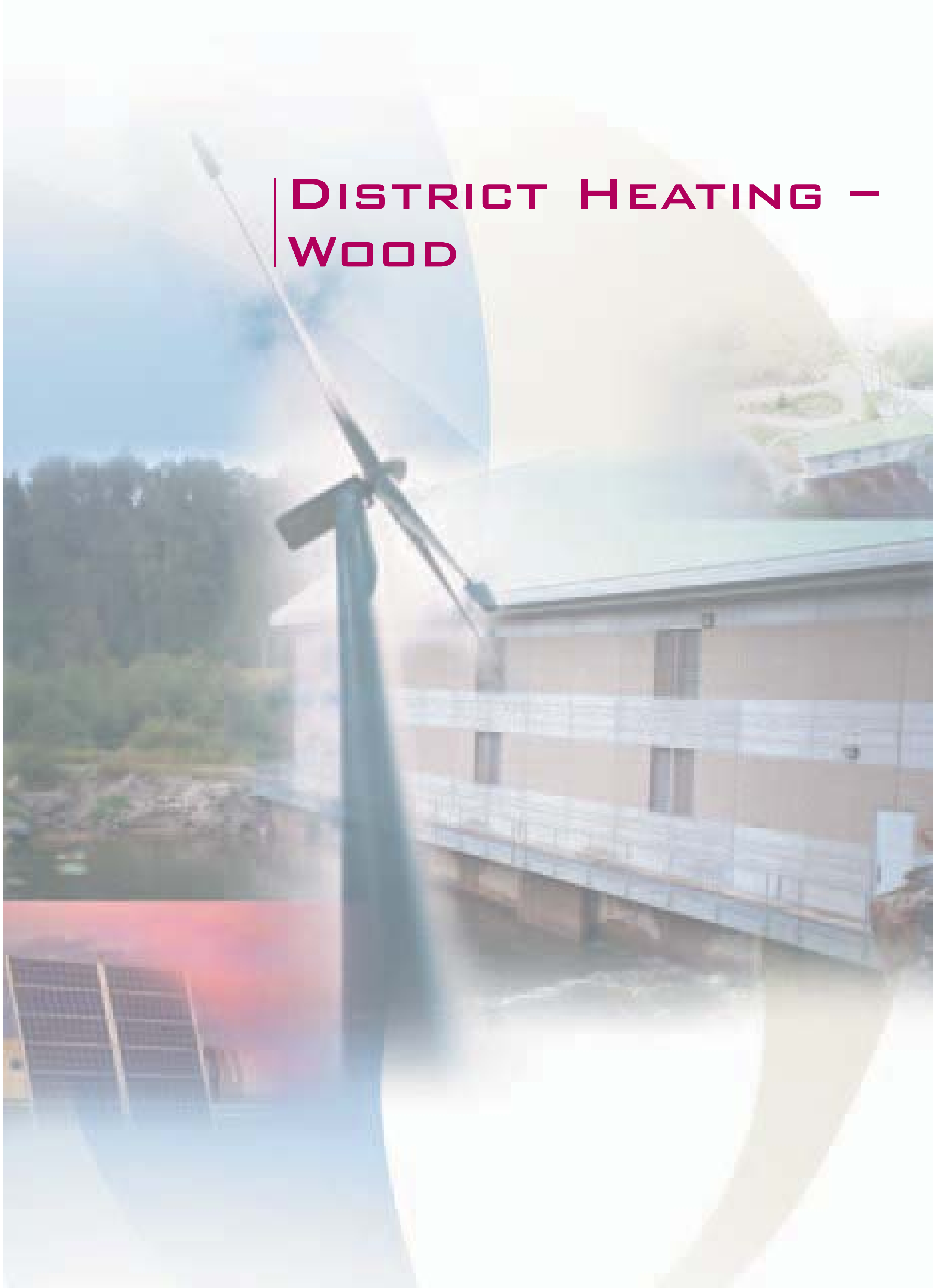
Part of the Nunatta Campus PV array system

During the first full year of operation, the Nunatta Campus PV system produced 1 785 kilowatt-hour (kWh) of electricity, roughly enough to power the lights in one large classroom for 78 days continuously. At an annual production rate of 1 785 kWh, the system is producing approximately $625 worth of electricity per year (assuming a government customer energy charge of approximately $0.35/kWh).

Nunatta Campus PV array's monitoring station

The Iqaluit system has demonstrated that PV systems are a viable alternative in a harsh, Northern climate. Although the efficiency of modules is low under the weak sunlight conditions prevalent for most of the year, the system has operated reliably with little maintenance for over seven years and continues to generate electricity for the local community and reduce the need for expensive diesel fuel.

District Heating – Wood



DISTRICT HEATING – WOOD

District heating (DH) systems use central energy plants to meet the space heating needs of residential, institutional, and commercial buildings. In some cases, domestic hot water and cooling needs are also provided. The central plants replace individual, building-based furnaces and boilers. This approach to heating is similar to centralized generation and distribution of electricity and water in municipalities.

In DH systems, thermal energy in the form of hot water is distributed from central production plants to the individual buildings and customers. A DH system consists of three parts:

- the generation of the thermal energy for district heating;
- the distribution to the network of energy users; and
- transfer of the thermal energy at the user's building.

Advantages of DH systems include the ability to achieve more efficient use of local energy sources and thereby create a more flexible energy supply. DH allows diversification of fuel supply, encouraging economic development by including those that are not readily adaptable to building specific heating systems, such as garbage incineration, industrial waste heat, and biomass energy. The typical fuel source for many Aboriginal DH systems has been wood chips or wood waste, referred to as biomass. The fuel is either harvested directly or obtained as a byproduct from local sawmill operations.

DH systems also facilitate the use of more sophisticated energy-efficient technology and provide greater economic incentive to improve efficiency. Focusing energy generation at fewer but larger central plants makes it easier to maintain equipment and to integrate technology upgrades such as emission controls. DH systems can adapt to different fuels in response to changes in availability, costs or evolving environmental concerns.

When energy is generated on a building-specific basis, the energy production equipment in each building must be sized to meet its peak seasonal and daily energy demand. Its ownership and operation is the responsibility of the building owner. In a district system the peak loads diversify, resulting in a lower energy generation rate. With multiple energy profiles, aggregated into one system, equipment can be sized and operated more efficiently to meet a more steady demand. Energy can also be stored during periods of excess production for use in the system during periods of peak demand.

DH systems are used extensively in Europe. In Canada, DH systems have been used primarily to serve university, hospital and government complexes.

A range of potential social and economic benefits are offered by DH systems. The improved energy efficiency and the use of available energy sources can significantly reduce community and individual energy expenditures. By increasing flexibility of energy supply, DH also offers communities improved energy security and price stability.

Quick Facts

Profile	District Heating – Wood
Community	Kluane First Nation
Pop. (approx.)	80
Area (ha)	46 550
Region	Yukon
Geog. Zone	2
Env. Index	E

Contact

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KLUANE FIRST NATION

Self-Sufficiency Through use of Local Fuel Source

Burwash Landing is the home of the Kluane First Nation, people of the southern Tutchone. A small community on the west shore of Kluane Lake adjacent to Kluane National Park, Burwash Landing is on the Alaska Highway about 285 kilometres northwest of Whitehorse. In order to reduce dependence on outside fuel sources, the First Nation installed a district heating (DH) system. A central boiler provides hot water heat to four community buildings. Fuel is provided by wood chips, harvested from First Nation lands. A recent forest fire in the area left many of the trees dead, but still standing, which provides a good source of fuel. Benefits to the community include savings in operating budget along with such non-tangible benefits as reducing reliance on outside fuel suppliers and fluctuating prices, keeping the money within the community, and creating local employment.

Although there are approximately 135 members of the Kluane First Nation, the population of Burwash Landing is only about 80. Many families with school-aged children have relocated to Haines Junction or to Whitehorse for employment opportunities and access to schooling. Employment in the Burwash Landing area consists of First Nation administration, health services, and limited tourism opportunities. People also live off the land.

Central Boiler System

Many residents have installed their own wood stoves in order to minimize dependence on expensive imported fuel oil. In 1998, to further reduce dependence on outside fuel sources, the First Nation installed a district energy system. A central boiler provides hot water heat to four community buildings – the administration building, the health services building, the laundromat, and the carpenter shop.

The boiler is located central to the community. Fuel is provided by wood chips, harvested from First Nation lands. A recent forest fire in the area left many of the trees dead, but still standing, which provides a good source of fuel. Band members supply the wood based on 10-cord contracts for wood to be cut and hauled to the boiler building. The band typically purchases 100 cords of wood per year. Because of the readily available dead wood supply adjacent to the community, the price paid for the wood has dropped to $90 per cord, from the previous $150 per cord.

Members of the maintenance staff chip the wood three times per week using the First Nation chipper. The wood chips are stored in a covered area adjacent to the boiler building. An automatic auger feeds wood chips to the boiler as required.

Supplementary Heat from Log Boilers

The water treatment plant and water and sewage delivery truck garages are heated with separate log boilers. Mr. Johnson indicates that the community is quite satisfied with their performance. There is some concern, however, that these log boilers do not burn as hot as the wood chip boiler, with the incomplete combustion resulting in pollutants in the local environment. This is of particular concern if the unit is oversized, causing a low-grade fire that smoulders for the majority of the time.

Log Boiler

Wood Heating Boiler

The administration office has been retrofitted for the district heating system with the addition of hot water radiators in each room. The existing oil furnace and forced-air heating remains as a backup system. The health centre and laundromat were added after the startup of the district energy system. Heating in these buildings is provided by a combination of hot-water radiators and ceiling-mounted space heaters. The laundromat system also includes waste heat recovery from the dryer units.

In addition to the backup oil furnaces located in most of the buildings, the central heating system also has a backup oil-fired boiler. According to Keith Johnson, Capital Projects Director, in the past year the backup oil-fired boiler has seldom been used.

Kluane First Nation Administration Building

Returns to the Community

The community is considering extending the wood heating system to service 16 residences and a youth centre. The CANMET Energy Technology Centre in Ottawa was retained to do an analysis of the system and evaluate the feasibility of expanding the system. Depending on the cost per cord of wood chips used and the cost of fuel oil assumed, the CANMET calculations conclude that the savings in fuel oil will just balance the additional operational costs of servicing these additional buildings. There would appear to be a fairly long pay-back period in order to recover the capital costs for the minor upgrades to the boiler system and the piping required to connect the additional buildings.

The community saves money on its operating budget with the use of the wood heating system rather than outside fuel oil. Non-tangible benefits to the district heating system include reducing reliance on outside fuel suppliers and fluctuating prices, keeping the money within the community, and creating local employment.

Quick Facts

Profile |	District Heating – Wood
Community |	Grassy Narrows First Nation
Pop. (approx.) |	738
Area (ha) |	4 145
Region |	Ontario
Geog. Zone |	2
Env. Index |	C

Contact

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GRASSY NARROWS FIRST NATION

District Heating as an Alternative to Transmission Line Upgrade

Grassy Narrows First Nation, located in northwestern Ontario, 90 kilometres from the town of Kenora, installed a district heating (DH) system in 1997. The system services the commercial core including the school, day care centre, administration building and community hall, and approximately 30 percent of the residences in the core area. The system was first installed to delay construction of a 90-kilometre electrical transmission line upgrade that otherwise would have been required to heat the school. After an initial slow start, the system is now working well. Once capital repayment is complete, the system is expected to provide a return to the community. Meanwhile, advantages include stability of heating costs, reduced risk in transportation and storage of fuel, and a dramatic decrease in house fires.

Grassy Narrows First Nation

Transmission Line Limitations Drive Innovation in Heating

The driving factor in the decision to install DH in the community was the construction of the new school. Indian and Northern Affairs Canada (INAC) policy in the construction of new schools is to move away from fuel oil for a variety of reasons including concerns with transport, storage and greenhouse gas emissions. As natural gas is not available in the community, electric heat was the obvious alternative. Service to Grassy Narrows, however, is provided by a 90-kilometre transmission line from the nearest town of Kenora. The existing single phase transmission line did not have sufficient capacity to supply the load required by the new school. In order to avoid the estimated $6 million upgrade to the transmission line, the First Nation and INAC began to look at other alternatives.

Community Wood Boiler Building

The final cost of the system came in at approximately $3.7 million. At the time of construction, the capital dollars came from a combination of provincial funding, federal funding and from the First Nation itself.

Sawmill Waste Products Used as Fuel Source

Initially, the First Nation ran its own wood chipping operation to supply the wood boiler. Although the wood chips provided a better quality fuel source, this approach was not cost competitive. A waste product is now obtained from a local sawmill operation in Kenora, approximately 90 kilometres away, available for the cost of trucking and loading. The First Nation puts out a competitive tender for the trucking contract. Robert Williamson, Councillor, with a housing and infrastructure portfolio, anticipates that as demand for the sawmill waste is growing, it may not continue to be available for such a low cost. The First Nation is currently investigating options for alternative sources to ensure security of supply.

Learning Experiences

The Grassy Narrows system encountered problems in the first few years following startup. During the first four years of operation, mechanical problems with the boiler forced the First Nation to run the oil-fired backup boiler a significant portion of the time, incurring considerable fuel costs. Some of the problems were traced back to the limitation of operating equipment using single-phase power. Problems were also encountered with the distribution lines breaking and/or separating at the joints. The lack of reliability during the first years of operation led many of the residential customers to disconnect or not maintain the heat exchanger in their house and return to using individual heating systems. Out of the 84 residential units originally connected, only 18 remain connected at this time.

Williamson's advice to other communities considering wood heating systems is that proper time and care be taken in the design of the system and selection of the components. The boiler should be a simple, robust design with limited mechanical devices. It is best not to oversize the boiler, as a smaller unit is more efficient. Mechanized feeders and rake systems should be robust with few moving parts. Plastic distribution lines should also be sized and selected appropriately.

Keys to Viability

Carl Chaboyer, technical advisor for the First Nation and acting General Manager of the Utility Corporation, says that the key components to a viable district heating system include a reliable cost-effective strategy for obtaining biomass and a geographically compact area of existing heat loads. Chaboyer says that following a slow start, the system is now working well to the First Nation's advantage. Loans for the First Nation's component of the capital are now being paid off, and he anticipates that within 12 years the system will begin to generate a return to the First Nation community.

Those connected to the system receive lower cost heat and there is now significant demand for reconnection among those houses in the core area. Reconnections are being made as budget and resources allow. Other advantages include stability of heating costs and lowered environmental risk in transportation and storage of fuel oil. Chaboyer quotes former Chief Bill Fobister, saying, "One of the biggest benefits of the district heating system has been a dramatic decrease in house fires."

Quick Facts

Profile |	District Heating – Wood
Community |	Oujé-Bougoumou Cree Nation
Pop. (approx.) |	700
Area (ha) |	16 200
Region |	Quebec
Geog. Zone |	2
Env. Index |	B

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OUJÉ-BOUGOUMOU CREE NATION

District Heating – Turning Waste into Energy

Oujé-Bougoumou Cree Nation is located in Quebec, approximately 960 kilometres north of Montreal. After years of relocation from traditional villages and settlements, the Oujé-Bougoumou Eenou reached an agreement with the federal and provincial governments to build a permanent community. As part of the traditional philosophy of sustainable development featured throughout the planning and construction of the new community, a biomass district heating system (DH) was installed to provide space and hot water heating to the entire village. The Oujé-Bougoumou system represents the first village-wide application of a DH system in North America using biomass as the fuel source.

Hot water from a central plant circulates in buried pipes throughout the community. A small heat exchange unit is located in each house and building. Sawdust and wood chips obtained from a nearby sawmill are used as an inexpensive fuel source. The Oujé-Bougoumou Public Works department is responsible for trucking the wood waste using community-owned trucks.

Community District Heating Plant

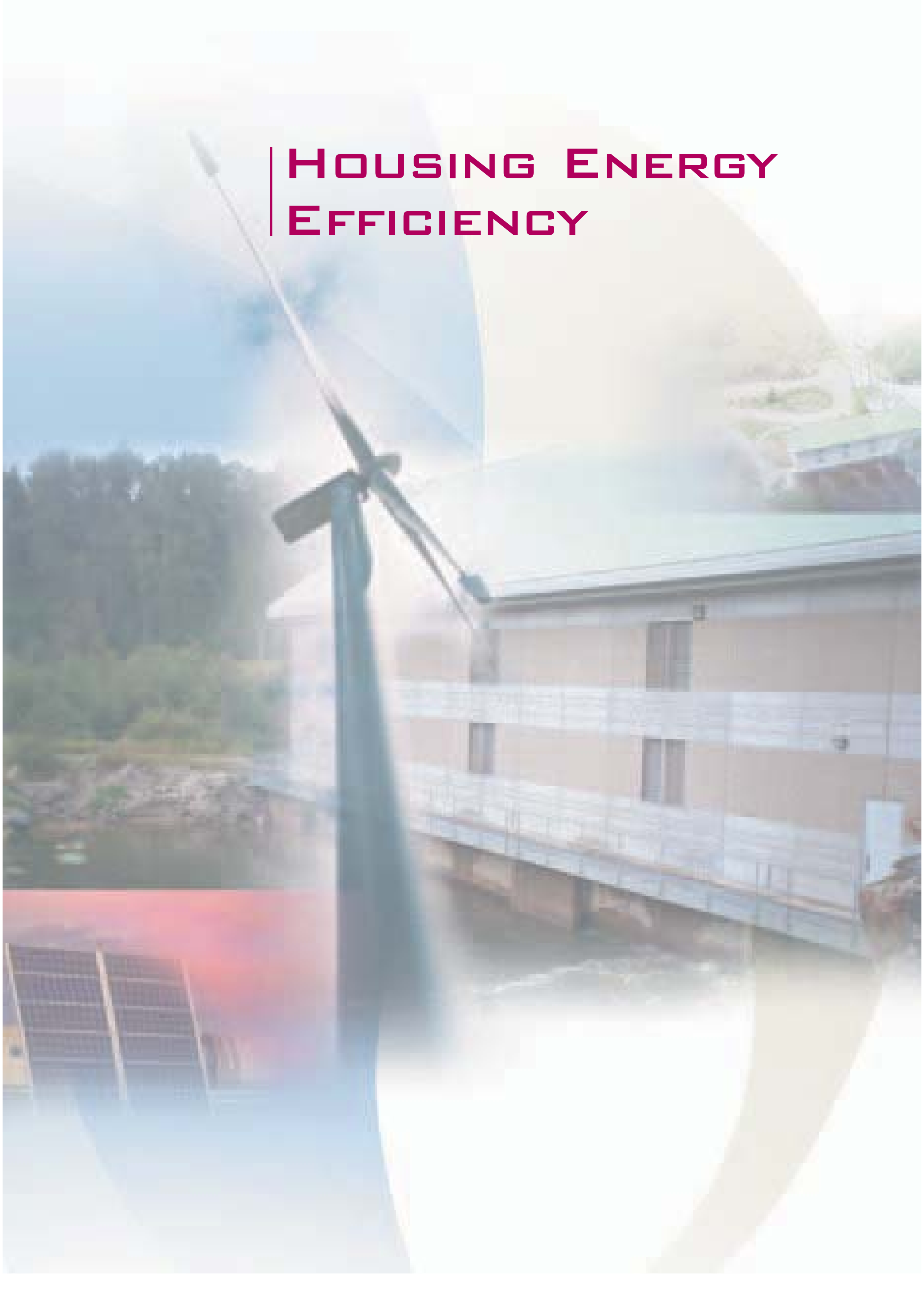
When Oujé-Bougoumou constructed its DH system, initial capital costs for the biomass boiler plant and distribution piping were relatively high. Due to the relatively low fuel and operational costs, however, the lifecycle costs are remarkably low. Equally important are the associated benefits of employment generation, reduced environmental impact and the retention of energy dollars in the community.

Fuel oil is used for peak loads and as a backup fuel source. Generally, 75 percent of the energy used to fuel the DH system comes from biomass; the remaining comes from fuel oil. The operation of the boiler is automatically controlled, including water temperature control, load matching, stoking, combustion and ash collection.

Each building is individually metered for billing purposes. In general, the cost to residents is less than half what it would be using conventional alternatives.

This productive use of waste wood is consistent with the Aboriginal approach of drawing no more from the environment than is necessary and using whatever waste is produced for useful purposes. This cost-effective and innovative technology is proving to be one that is practical and consistent with Oujé-Bougoumou's philosophy of sustainable development.

Housing Energy Efficiency



HOUSING ENERGY EFFICIENCY

The energy efficiency of houses can be improved through a wide range of design measures and materials. One of the most widely-referenced programs for energy-efficient houses, entitled R-2000, is a commercial program. Its certified builders construct houses to meet its high standards of energy efficiency, ventilation, low-emission, resource-efficient materials selection, and water efficiency. R-2000 homes consume about two-thirds the energy of conventional homes.

The operating energy consumed in cold climate housing is dominated by space heating and the key factor affecting this is the design of envelope, glazing and mechanical systems. Energy-efficient homes typically consume half the energy of similar conventional homes for heating, and advanced home technologies are available to reduce this load by a further 50 percent.

The elements of advanced housing include:

- efficient framing to reduce the amount of timber used;
- blown-in cellulose insulation;
- advanced air barrier systems;
- improved basement insulation;
- energy-efficient windows using advanced technologies such as low-e coatings, argon fills and insulative spacers;
- combined space and water heating systems;
- heat recovery ventilators;
- energy-efficient lighting; and
- water-efficient fixtures.

There is a cost to these measures, however, and cost-effectiveness needs to be carefully considered.

When considering the energy issues related to housing, there are opportunities for improved efficiencies in three main areas:

- *embodied energy* – the energy required to produce the building materials, transport them to the building site, and erect the building;
- *operating energy* – the energy associated with the normal operation of the building for space heating, domestic water heating, and operating lights and appliances servicing the dwelling; and
- *attached energy* – the energy associated with servicing the dwelling and its occupants within the community – for example, to transport goods and people from and to the dwelling.

All three of these qualities are significant in new housing development decisions, whereas only operating energy is likely to be affected by retrofit measures. The development of new housing in cold climates should take into account a number of critical energy-related considerations, including:

- *Location (Relative to places of work and supply of goods and services.)* – This factor bears directly on the attached energy component and the sustainability of the community as a whole;
- *Occupant Density / Type of Dwelling* – Smaller, attached homes require less material for construction, have lower operating energy consumption, and usually consume less attached energy than their detached counterparts;
- *Dwelling Orientation* – The orientation of a dwelling relative to sun and wind is also of importance. In a cold climate, southerly exposures can be used to admit sunlight into areas and surfaces that have the capacity to absorb and slowly emit absorbed heat. Materials such as heavy masonry walls and floors, or overlaid ceramic tiles can be effective in this regard. Protection against heat loss associated with prevailing winds can be achieved with proper wall and roof designs and the judicious use of insulation and external wind breaks;
- *Occupant Behaviour* – Some types of human behaviour can defeat even the most sophisticated, energy-efficient technologies;
- *Building Technology* – The technology of buildings including materials of construction, envelope and glazing design, domestic water and space heating and ventilation systems are all important factors contributing to the overall energy efficiency of a structure.

Retrofits to improve the operational energy efficiency of dwellings generally relate to:

- building envelope and insulation improvements;
- new glazing and door technologies;
- higher efficiency space and water heating systems; and
- appliance upgrades.

Quick Facts

Profile |	Energy Efficiency – Housing
Community |	Mohawks of the Bay of Quinte
Pop. (approx.) |	1 930
Area (ha) |	7 362
Region |	Ontario
Geog. Zone |	1
Env. Index |	A

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MOHAWKS OF THE BAY OF QUINTE

Energy Efficiency – New and Retrofit Housing

Mohawks of the Bay of Quinte (MBQ) is located in Tyendinaga, on the north shore of Lake Ontario, approximately 95 kilometres west of Kingston. The innovation and creativity of this First Nation's housing program has been recognized nationally through numerous awards. Best available practices in energy-efficient construction have been applied to housing projects, which are not only practical, but also highly effective in meeting the social needs of the community members. After years of developing and promoting energy-efficient housing, the community is now seeing the benefits in its overall housing situation. The current standard in Tyendinaga is for all rental homes to be constructed according to R-2000 standards or better.

Learning From Residents

When Chris Maracle, Director of Housing, Parks, and Band Property Maintenance for the MBQ, started out as an apprentice carpenter in 1987, the community did not have a formal housing department. The housing co-ordinator worked with an on-site contractor, who also acted as the construction instructor. Over the past 15 years, Maracle has overseen the development of a housing department that is now responsible for constructing approximately 6 to 12 housing units per year. He recalls that the first step for the community was to get more units up and running, not only to fulfill the need for housing, but also to begin the process of learning from the residents. "We constructed 25 rental units that were air-tight, electrically heated and had unfinished basements with poured concrete walls. During the initial years of occupancy we began receiving complaints from the residents. Some people complained of symptoms of asthma due to moist and mouldy conditions. Others had problems with locks freezing due to excessive moisture. In many cases condensation was evident, so we realized that long-term structural and maintenance problems were bound to arise. Residents were also having difficulty accepting the high monthly heating bills due to the cost of electrical heating. Chief and Council took these complaints very seriously and set out to resolve them."

Chris Maracle, Director of Housing, Parks and Band Property Maintenance

Moving Towards Energy Efficiency – Gaining Confidence Through Retrofits

In 1990, the MBQ undertook a housing retrofit program. Basements were finished and high-efficiency gas furnaces were installed. Heat recovery ventilation (HRV) systems were also implemented. As a result of these measures, energy bills were reduced by 30 to 40 percent and the amount of living space available to community members increased dramatically.

About the same time that the retrofit program was initiated, the Ontario Hydro incentive for R-2000 construction was made available. The benefits far outweighed the incremental costs of implementing R-2000 construction. Building designs were reviewed for energy efficiency, high-efficiency equipment was used, and upgrades to windows, doors and other building envelope components were implemented.

Community owned, award winning Granny Homes

Chris Maracle recalls: "At that time, we realized that we needed to design the house as a system. Once we got onto the R-2000 concept, we never looked back. We established a core crew of five trainees and began to cross train to ensure they were certified for HRV and mechanical systems. All crew members took the R-2000 building certification course and became certified for insulation, concrete formwork and indoor air quality. After the retrofits, we gained the confidence of Chief and Council, and we began setting goals for establishing more rental units. It's very important to have the political support to make the initial investments, otherwise it's just not going to happen. Every year we have many First Nation people from across Canada come to our community to find out more about our housing program. In some cases, the housing managers are well-intentioned and knowledgeable, but have a lack of support from their leadership."

Training and Certification

Over a decade ago, MBQ undertook a carpenter apprenticeship program. In addition to formal classroom training, all apprentices received hands-on training during the construction of 20 rental homes for the community. Upon completion of the apprenticeships, some participants found employment with contractors or initiated their own business. Five went on to form the nucleus of the MBQ housing department construction crew. The crew has received training, experience and certification in:

- healthy housing;
- project management;
- cost estimating;
- R-2000 certification;
- HRV design and installation;

A Formal Housing Department

The Housing Department is one of the largest departments at MBQ. Part of its function is to review band buildings on a regular basis and assess retrofit requirements. The department consists of the following:

- Director of Housing, Parks and Band Property Management;
- Administrative Assistant;
- Purchasing Order Clerk;
- Band Property Managers/Building Inspectors/Apprentice Instructors – two people;
- carpentry crew – three people;
- apprentices – four people;
- full-time painters – two people; and
- full-time electrician.

- insulated foundation block design and installation;
- Hot-2000 computer training (design and analysis of energy efficiency building practices);
- indoor air quality certification; and
- all aspects of residential construction.

Use of Outside Technical Resources

The Housing Department gains its primary technical support from the Canada Mortgage and Housing Corporation (CMHC), Policy and Research Division. Other sources of technical information include Indian and Northern Affairs Canada (INAC), the Ontario First Nations Technical Services Corporation, and the Assembly of First Nations Housing Conference. Chris Maracle has found the CMHC workshop series entitled "The Builders' Series" to be most beneficial. "If First Nation builders and managers could attend this workshop, they could learn directly what took us years to gather on our own," he says.

R-2000 Home

Strategic Alliances

The MBQ vision for strategic alliances supporting housing development is very specific and focused:

> "The core of our long-term strategic alliance plan is premised on the idea to partner with every and all possible funding, training, administrative and technical support bodies. Our vision is to attempt to piggyback or combine numerous opportunities to complete specific projects or enhance existing programs. We have developed an infrastructure of highly-skilled and knowledgeable housing administrators, builders and tradespeople, resulting in a high level of professionalism of all involved. With the commitment and support of the community, who are the largest and most important stakeholders in the alliance, we control our own destiny" says Mr. Maracle.

A partial list of the various partners who provide either funding, training services or other forms of assistance is:

- Tyendinaga (community members, Council, administration);
- community youth;
- INAC;
- CMHC;
- Human Resources Development Corporation (Kagita Mikam Area Management Board);
- financial institutions (banks);
- Health Canada;
- Ontario First Nations Technical Services Corporation;
- Home Builders' Association;
- R-2000 program membership;
- manufacturing and building industry affiliation;
- Loyalist College First Nations Technical Institute;
- Ontario Native Affairs Secretariat; and
- industry (Centra Gas, Ontario Hydro).

Evidence Of Success

After 10 years of ongoing training, workshops and housing developments, Chris Maracle is beginning to see the positive impacts on the community as a whole. "After all these years of preaching the benefits of healthy and energy-efficient housing, it's good to see the outcome in the community. The number and quality of our houses is much improved and people's appreciation is evident by the way they use and maintain their homes. It shows that our message is getting across," he says.

Some of the individual housing projects that the community is particularly proud of include the following:

R-2000 Subdivsion

The community is particularly proud of some of the individual housing projects. In the R-2000 subdivision, there are 51 units, including triplex, 4-plex, slab-on-grade barrier free, and 3-bedroom bungalows. Units have:

- radiant in-floor heating in the basement;
- hydronic baseboard heating on main level;
- insulated concrete form from the footings to the roof; and
- HRV that gives continuous ventilation to every room.

Granny Flats

In 1996-1997, five houses were built on the banks of the Salmon River for community Elders. These small, accessible granny flats were designed according to R-2000 standards. Some of their features include:

- shared well and septic systems;
- in-slab radiant heating – is efficient and provides a comfortable and consistent heat (multiple zone controls, 94 percent efficient, propane or natural gas fuel, hot water heating loop); and
- heat recovery ventilation.

Recognition of Excellence

- 2003 National Energy Efficiency Award (NRCan)
- 2002 CMHC Housing Awards Program's Affordable Housing Innovations
- Ontario R-2000 Technical Award for Excellence in Housing for the best tract or production homes in the province
- Ontario R-2000 Technical Award for Excellence in Housing for the best single detached under 1 500 square feet home in the province
- Ontario "Healthy Housing" Award
- Ontario First Nations Technical Services Corporation award for Technology and Innovation in housing
- Nomination: National Best Single Detached Home Under 1 500 square feet, Canadian Home Builders Association
- Three Assembly of First Nations Awards
- Canada Energy Efficiency Award – Housing Section, NRCan (Granny Flats – runner up)
- Canada Energy Efficiency Award Applicant – Tract Built, NRCan (R-2000 Subdivision)

Award of Excellence

Granny Flat

The feedback from seniors has been very positive. The flats provide safe, healthy and affordable houses for community Elders.

Reaching Out

Chris Maracle considers it essential to get the next generation thinking about the housing challenges of the future. Periodically, a workshop will be held for approximately 100 students from the elementary school. During the sessions, the children are asked things like, "What does housing mean to you? What does housing look like now and how might it look in the future? What are some of the options that we might incorporate to improve our housing?" As a next step in the development of community relations, Maracle plans to consult with Elders in the community.

Getting Community to "Buy In"

Of the approximately 800 homes in Tyendinaga, approximately 375 are mortgaged, 120 are rental units, and 305 are funded independently or owned outright. In the past 10 years, the Housing Department has been involved in the construction of approximately 150 of the mortgaged units and 100 of the rental units. Mortgage and rental income assist in providing revenue which the Housing Department can direct toward the construction of new homes. All new mortgage holders must attend a mandatory workshop which focuses on healthy housing and energy efficiency. Chris Maracle observes:

> "People are adopting new ways of thinking. We're seeing that rather than putting money into the aesthetic features of their homes, they're often choosing to spend on the upgrade of its efficiency. This is really encouraging because we realize that this is not always easy for those with fixed incomes and limited financial capacity. People are realizing the importance of having a home that will be healthy for their children, won't be drafty and will provide a better living environment."

Moving Towards Sustainability

After achieving success in creating functional energy efficiency housing, the MBQ are now looking to move one step further, toward a vision of sustainable neighbourhoods. The First Nation is partnering with CMHC, INAC, NRCan and the Ontario First Nations Technical Services Corporation to develop a demonstration house that will showcase leading edge technologies, possibly including wind and solar energy, district heating, and alternative water and wastewater systems. The demonstration centre will be part of a broader concept that involves sustainable neighbourhoods consisting of 25 to 30 mixed housing units designed in clusters which might include single family units, group housing, townhouses and special need units. The project is being undertaken as part of CMHC's Healthy Housing Initiative.

Looking Ahead

Chris Maracle has specific thoughts about the future of Aboriginal housing:

> "First Nations should be pushing the envelope as far as possible toward energy efficiency, not just for cost savings but for health. It's also important from the point of view of global warming. Even though we might not see the direct effects of global warming as much as Northern First Nations might, it doesn't mean we're not committed to dealing with the problem. Greater awareness is required and we all have to contribute to the solution. As Aboriginal people, we have an obligation to protect the environment. I realize that it may be difficult for some First Nations communities to even start thinking about energy efficiency when the reality is that they are over-crowded in their homes and are just battling to obtain a basic level of acceptable housing. So for them, that is the starting point. In general, more commitment to community planning at a grass roots level is required. Agencies like INAC and CMHC have to do more to increase the awareness of available funding and technical programs."

Maracle sees a lack of infrastructure as being a main stumbling block to the development of adequate housing in First Nations. He also sees a lack of support for alternative approaches, such as cluster housing, as a barrier to improvement. "We've got to get away from the idea of spreading out within our communities. There once was a time when we lived closer together and if we're to be practical and efficient in the future, we should be doing it now," he says.

If First Nations houses and ultimately neighbourhoods and communities of the future are going to be energy efficient and sustainable, the momentum will have to come from community members themselves.

Quick Facts

Profile		Energy Efficiency – Housing
Community		Kahnawake
Pop. (approx.)		7 000
Area (ha)		5 059
Region		Quebec
Geog. Zone		1
Env. Index		B

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KAHNAWAKE MOHAWK TERRITORY

Kanata Healthy Housing Project

Creating New Perceptions of Sustainable Housing

The Kahnawake Mohawk Territory is located on the south shore of the St. Lawrence River, 10 kilometres southwest of Montreal. Of the many projects under way to take on climate change and energy efficiency, the Kanata Healthy Housing Project incorporates several innovative technologies designed to maximize occupant health and comfort, while minimizing environmental impact. Part of the challenge of the project has been to go beyond technology to effect a change in perception and a lasting change in lifestyle.

After several years in development, the concept of the Kanata Healthy Housing Project became reality in 2000-2001.

Defining Innovation

Kanata Healthy House Under Construction

Lynn Katsitsaronkwas Jacobs is the coordinator of the Kanata Healthy Housing Project, a collaborative effort between the Kahnawake Environment Office and the Kahnawake Housing Department. Jacobs is from Kahnawake, has her degree in Environmental Science and is presently working towards obtaining her Master's degree in Environment and Management. As Environmental Advisor to her community, she works within the Kahnawake Environment Office. Jacobs explains that launching the healthy house project required patience and perseverance, cooperation and changing perceptions about conventional housing practices:

> "The need for this project was originally identified by Eva Johnson of the Kahnawake Environment Office. After the Housing Department obtained seed funding in 1997 from Indian and Northern Affairs Canada (INAC) under the Gathering Strength Program for a project in Innovations in Aboriginal Housing, we realized that we needed to define what innovation means, according to our community. A planning team was established and the process was under way."

Features of the Kanata Healthy House:

- straw bale insulation
- slab-on-grade construction
- passive solar design
- healthy materials with no off-gassing
- dual solar hot water and radiant floor heating
- near tertiary level sewage treatment using the Waterloo Biofilter

"Kanata" means "village" or "dwelling place."

Researching the Possibilities

Jacobs makes it clear that for an undertaking like the Kanata Healthy Housing Project to proceed, strong community convictions must be in place to back it up:

Grand Chief Joe Norton, Lynn Jacobs, Iris Jacobs and Eva Johnson at a ribbon cutting ceremony for the Kanata Healthy House Project

"Following the ice storm in 1998, people were very interested in developing something that didn't rely on outside services and resources. We also wanted to become more aware of the impacts of our activities and lifestyle. Although large-scale energy projects are often promoted as producers of clean energy, this is not always the case. Projects in Northern areas have devastated the environment and severely impacted the way of life of our indigenous brothers and sisters. One of our goals in Kahnawake is to reduce our dependence on outside resources and to become increasingly conscious of the broad impact that our use of materials and energy has on others and our future generations."

In order to position themselves to take full advantage of the INAC seed money, Kahnawake obtained funding from other sources. Canada Mortgage and Housing Corporation (CMHC) provided pre-design research funding and many other related small project dollars, and Natural Resources Canada (NRCan) funded the solar panels for the dual solar hot water and radiant floor heating system used in the house.

Sweat Equity

Design and construction of the healthy house was accomplished through a combination of outside and community resources. In all cases, when an outside resource such as an architect was used, training and knowledge transfer also took place. Local contractors were used for many of the trade construction activities, but the sweat equity of volunteers from inside and outside the community was also put to good use. For the straw bale installation, training sessions were held in the morning with work sessions following in the afternoon.

Next Steps – the Kanata Healthy Housing Neighbourhood

The Kanata Healthy House is presently being monitored for parameters such as temperature, relative humidity, water use, and utility bills in order to evaluate the efficiency of the building envelope and systems. Tracking is in place to determine the percentage of time the solar system is being used, in comparison with the electrical back-up system. As with many pilot projects, some troubleshooting is required to improve the house and add to the learning for future projects. One of the main challenges for the solar heating aspect of the house has been to balance the seasonal requirement of the in-floor radiant heating system with the year-round hot water heating requirements.

While various individual aspects of the healthy house are being implemented in other buildings within the community, the Kanata Healthy House is the only example that combines these concepts. However, there are plans to create a neighbourhood that adopts these and other complementary principles. It is recognized that certain lifestyle changes will be required, so focus group sessions are being held to define what it would mean to live in such a neighbourhood. Jacobs explains, "People will be sharing space and taking care of the land in a different way. It will, in some respects, be a return to our customs and traditional way of living."

The Kanata Healthy House with solar panels installed

Changing Perceptions

Jacobs says that the two greatest barriers to advancing sustainable housing are lack of funding and a requirement for changed perceptions:

> "Funding can be difficult for stages following the initial seed funding. We can create a very progressive product, but without the appropriate follow-up funding, it won't likely be reproduced. Perceptions must also be changed. People have become accustomed to a turnkey way of thinking, relying on a contractor for everything it takes to create a new home, without thinking through where all the materials come from and what the broad impacts of that might be. It's not just the people living in the homes, but also our organizations. Some of our departments do not deal with sustainability on a regular basis."

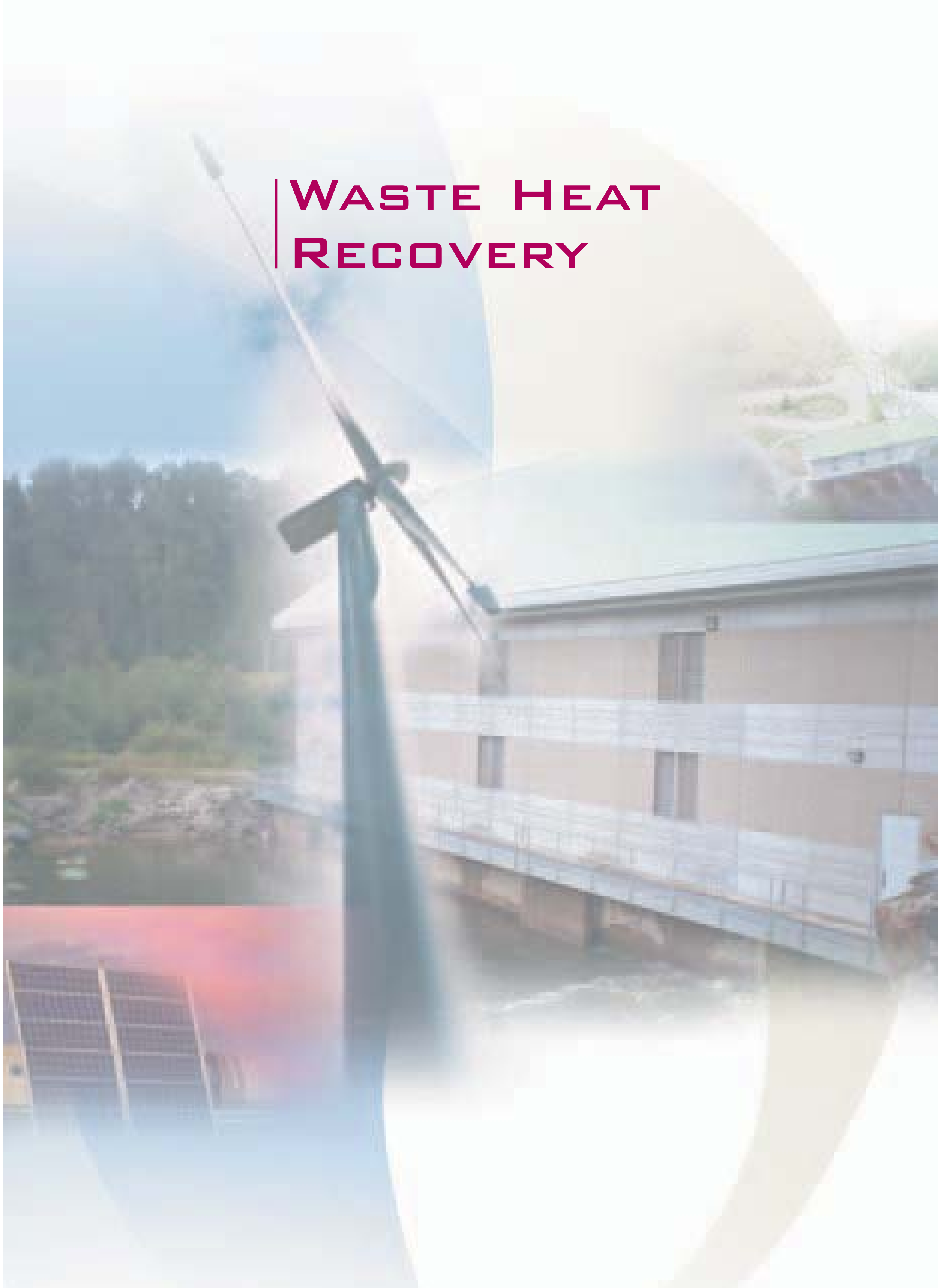
Sharing the Knowledge

Jacobs also emphasizes the importance of sharing knowledge. "One of our goals was to undertake this project so that we could share it with other First Nations. It is very time consuming and arduous for research and development, so we want to pass on all the knowledge that we have gained so that other First Nations do not have to re-invent the wheel."

Future Directions

Jacobs sees an opportunity for First Nations to become leaders in the area of energy efficiency and renewable energy, but sees a need for broad national support. "There are a lot of First Nation communities interested in renewable energy. This is presently challenging due to the low level of implementation in Canada. New and innovative technologies are not yet affordable or user friendly and are somewhat difficult to obtain." Building on the success and experience gained from the Kanata Healthy House project, a study is being undertaken to test the feasibility of using wind energy to provide a sustainable source of energy for the community. The wind energy feasibility study will be concluded and recommendations made in the fall of 2004.

Waste Heat Recovery



WASTE HEAT RECOVERY

Many remote communities throughout the country are not connected to the mainline electrical grid and rely on individual diesel generating stations for electricity generation. As a byproduct of generation, the engines produce large quantities of waste heat. Using heat exchangers at the generating plant, waste heat can be collected and distributed to heat nearby community buildings through insulated hot water pipes. Waste heat recovery, therefore, is a type of district energy system where the energy source is waste heat recovered from diesel generating equipment.

The amount of heat available varies according to the amount of energy generated. Fortunately, peak electrical loads coincide with peak heating loads in the winter months. Sufficient community size and electrical demand are required in order to allow the thermal output to generate revenue savings required to cover the cost of development.

Community buildings with larger heating loads work well to provide sufficient return on investment for distribution piping, particularly for retrofit systems. The connection of new residential subdivisions can also be cost-effective if the system is integrated as part of the original construction.

Location of Diesel Generating Plant

An important factor in the success of a district energy system relying on waste heat recovery is the location of the diesel generating plant relative to the buildings to be connected to the system. In many remote communities, the generating plant is located close to the airport, some distance from the community core. In addition to keeping the noise at a distance from the residential area, the advantage to being located at the airport includes minimizing fuel transportation. The waste heat is then handy for heating the airport terminals and the works buildings located at the airport, but it is often too far away for economical use in community buildings. The length of distribution piping required can greatly affect the capital cost of construction as well as the efficiency of heat delivered.

The cost of fuel can also affect the system viability. Remote communities realize more savings using waste heat recovery systems because of higher imported fuel costs.

For retrofit systems, the physical size of the existing power plant must be sufficient to allow installation of the necessary heat exchangers, pumps and other equipment.

Benefits of Waste Heat Recovery System

- reduces reliance on imported fuel;
- reduces money flowing out of the community;
- reduces emissions; and
- enhances efficient operation of generators.

Quick Facts

Profile |	Waste Heat Recovery
Community |	Fort McPherson
Pop. (approx.) |	700
Area (ha) |	5 306
Region |	NWT
Geog. Zone |	n/a
Env. Index |	E

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FORT MCPHERSON

Partnership an Investment in the Environment

Fort McPherson is a community of 700 people located in the Northwest Territories on the east shore of the Peel River about 100 kilometres north of the Arctic Circle and 110 kilometres south of Inuvik. Through a joint venture of the Gwich'in Development Corporation and the Northwest Territories Power Corporation, a central heating system was installed using the water jacket coolant of the diesel generators at the power plant as a source of supplemental heat to community buildings. The system displaced approximately 164 000 litres of fuel oil in 1998, corresponding to a savings of $98 000.

Central Heating System Serves Community Buildings

The heating system in Fort McPherson uses the water jacket coolant of the diesel generators at the power plant as a source of supplemental heat to customer buildings thereby assisting building owners in reducing the cost of heating. The majority of the existing heating systems in commercial buildings in Fort McPherson are hydronic (hot water heat), powered by oil-fired boilers. The central heating system does not eliminate the need for customers' individual heating systems as peak demands continue to be provided by these existing systems.

Aerial view of buildings serviced by district heating system

The central heating system supplies heat to five commercial and institutional buildings in Fort McPherson, including the school, municipal office building, small manufacturing facility, water treatment plant where the water is pre-heated before treatment, and the community swimming pool (seasonal load only). Because of permafrost conditions, distribution piping is provided by a two-pipe above ground system using pre-insulated steel pipe supported on piles and protected by a galvanized steel outer jacket. Road crossings are buried, with the piping encased in a steel culvert.

Partnership

The system is owned by Aadrii Ltd., a joint venture company of the Gwich'in Development Corporation and the Northwest Territories Power Corporation (NTPC). The Gwich'in Development Corporation is the business arm of the Gwich'in Tribal Council, beneficiaries of a comprehensive land claim in the MacKenzie Delta region encompassing the community of Fort McPherson.

Above ground piping

The distribution system and connection to the customer's building is supplied by Aadrii Ltd. The word "Aadrii" translates to "the light" in the Gwich'in language. Energy provided to each customer is monitored and the customer is billed based on 90 percent of the cost for an equivalent amount of heating fuel. In this way, the customer sees some benefit from the system and the supplier can recover capital and operating costs.

The system was connected in February 1997. The original projections estimated that 200 000 litres of heating oil would be displaced, representing 12.5 percent of the annual consumption of heating oil in the community. In 1998, the system displaced 164 000 litres of fuel oil. At $0.60 per litre, this corresponds to a savings of $98 000. The original capital cost for the system was in the range of $1.2 million. Subsequent to 1998, an exhaust gas recovery unit was installed on the largest generating unit, which has increased the thermal output available.

Fort McPherson Selected as Pilot for Waste Heat Recovery Concept

NTPC supplies electricity to many small communities across the Northwest Territories. The majority of the generating facilities are stand-alone diesel generation plants feeding isolated grids. NTPC uses residual heat from the generation process in most locations to heat the plant and attached offices. Some effort had been made in the past to make use of the excess waste heat to heat external community buildings, but with limited success. As technology improved and more experience was gained, NTPC decided, once again, to pursue the concept of an economic design for distribution of the residual heat to community buildings.

Fort McPherson was selected as the location for the development of the first system. Once preliminary studies and financial projections had been completed, the Gwich'in Development Corporation was approached with the proposal and agreed to become joint venture partners in the development and construction of the system.


Main jacket water heat exchanger

Since its installation, several other waste heat recovery systems have been installed in other communities in the Northwest Territories. As the pilot system, there was a learning curve in its installation and early years of operation. Tim Farrell, of NTPC, indicates that newer systems are more efficient. Heat exchangers and equipment installed may have a slightly higher capital cost, but are more economical in the long run.

Farrell indicates that the system in Fort McPherson is running well. It is now operating in the black, although it did take a few years to iron out the wrinkles. He estimates that the return is not as large as first estimated and that the return period may be closer to 20 to 25 years rather than the 5 to 8 years first anticipated.

An Investment in the Environment

Willard Haagen, a past member of the Aadrii Board, indicates that the system has held its own with respect to profitability. Although he does not recommend installing such a system with the idea of making a large profit, he indicates that there are other benefits, including the reduction of greenhouse gasses and the educational value. "It opens your eyes in terms of how much waste goes up the chimney," he says. The decision was made as a commitment to a cleaner atmosphere rather than the profit available and he considers it an investment in the environment. "A larger community would improve returns. The economics become questionable in smaller communities."

Quick Facts

Profile |	Waste Heat Recovery
Community |	Fort Severn First Nation
Pop. (approx.) |	436
Area (ha) |	3 959
Region |	Ontario
Geog. Zone |	4 (6)
Env. Index |	D

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FORT SEVERN FIRST NATION

Waste Heat Provides Freeze Protection for Water Supply

Fort Severn First Nation, a remote community with fly-in-only access located on Hudson Bay in northern Ontario, makes use of a waste heat recovery system. The system is operated in conjunction with the Hydro One, Remote Communities diesel generating station located in the community. Waste heat from the diesel-generating engines is transferred across the road to the First Nation's water treatment plant to heat the building and provide heat to the community water supply as a primary method of freeze protection.

The First Nation pays $4 000 a year for the use of the heat. This amount is calculated as 50 percent of the cost of the fuel oil that was used to heat the water prior to the waste heat recovery system being installed.

Aerial view of Fort Severn

Looking to the future, the First Nation would like to investigate the use of additional waste heat for space heating in the school, the band office and the nursing station. "It's one of those 'how can you lose' propositions," says Mel Orecklin, co-manager on contract to the First Nation.

Hydro One residence

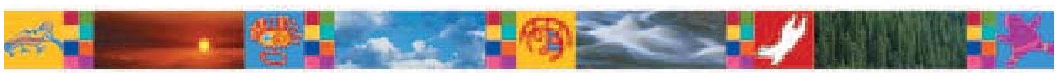
Community Energy Planning Program

Fort Severn is undertaking a community energy program, investigating any and all reasonable energy saving measures. The program involves having a local champion for energy conservation and alternative sources of energy. Initiatives under consideration range from delamping (replacing incandescent with fluorescent fixtures), low-cost housing upgrades (calking windows, weather stripping, jackets around hot water heaters), and waste oil recycling, to alternative energy generation methods such as mini hydro and wind generators. With all fuel flown or barged into the community at present, small initiatives can have a significant impact.

Michael Wesa, of Hydro One, Remote Communities, confirms that the waste heat recovery system works well. "It operates independent of our operation and has not caused any problem. In fact, it effectively reduces the wear and tear on the radiator and cooling fan associated with the generator engine." Wesa cautions that the water treatment plant is currently using close to 60 percent of the available heat and there may be a limit to the number of community buildings that could be heated using waste heat from the generators.

Transformer

NOTES



Fire *Wind* *Water* *Earth*

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