Community Energy Planning

A Guide for Northern Communities

ARCTIC ENERGY ALLIANCE

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PREFACE

The Arctic Energy Alliance has published this report to encourage communities to better manage their energy usage and supply.

The report has been written to assist communities in starting their own community energy planning process. Communities are free to use this report as a guide in getting organized and developing their own community energy plans.

The report is organized as follows:

Section 1: Provides an introduction to the concept of community energy planning.

Section 2: Outlines five basic steps to develop a community energy plan.

Section 3: Addresses specific energy management and energy supply strategies that Northern communities can consider for inclusion in their community energy plan.

Section 4: Provides examples of different energy management and energy supply projects that have been successfully implemented in various Northern communities.

Communities interested in starting a community energy plan or in obtaining additional information can contact the Arctic Energy Alliance as follows:

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1.0 INTRODUCTION TO COMMUNITY ENERGY PLANNING

1.1 Introduction

Communities in the Northwest Territories (NWT) and Nunavut (NV) (formerly part of the NWT) have some of the highest energy costs in Canada. As a result of recent program transfers from the territorial government to the municipal level, community governments are becoming more aware of the need to reduce costs where possible. One way in which communities can reduce costs is to more effectively manage their energy and utility expenditures.

Community Energy Planning (CEP) is a planning process that helps a community identify and address its energy needs. The purpose of CEP is to provide benefits to the community such as lower-cost energy, improved energy efficiency, cleaner air and economic development opportunities.

Using principles such as sustainability, affordability and environmental preservation, communities engage in a multi-step planning process to identify and evaluate how energy is used in the community (energy demand) and how that energy is supplied to the community (energy supply).

1.1.1 Energy Demand

Energy consumption can be reduced significantly by implementing an energy management strategy. Reducing energy consumption provides immediate benefits to the community in the form of lower annual energy costs and reduced environmental emissions.

In a typical community, most of the energy use occurs in buildings, municipal infrastructure and transportation. Buildings require energy for heating, ventilation, lighting and to operate equipment and machinery. Municipal infrastructure such as water service consumes significant amounts of energy due to the need to heat and treat the water. Transportation of people and goods within a community also consumes large amounts of energy.

1.1.2 Energy Supply

Once an energy management plan has been established to reduce energy demand as much as possible, the community can then focus its attention on how energy is supplied to the community. In most NWT communities, electrical, heating and transportation services are provided by burning refined petroleum products such as diesel fuel, heating oil and gasoline.

With the exception of water, communities are usually not involved in the planning and delivery of municipal energy and utility systems. Typically, energy supply and other municipal infrastructure is planned and delivered by a number of government departments or agencies. Decisions by these departments and agencies are often made without reference to a community's values and objectives. As a result, opportunities to implement cost-saving measures and innovative ideas may be missed or overlooked.

To improve the way in which energy is provided to the community, it is necessary to identify and assess alternative energy supply options. In the NWT, the most promising alternative supply options include the use of residual heat from diesel-electric generating plants and renewable energy technologies such as wind turbines and photovoltaic (solar) systems.

1.1.3 Energy Planning

It is important to note that CEP will not eliminate the need for government departments and agencies to be involved in planning and delivering energy systems. Government departments and agencies need to participate in the CEP process in co-operation with the community.

It is also important to note that community energy planning is a community owned and driven process. To be successful, community energy planning requires commitment and involvement on the part of local government leaders, officials and consumers.

Community energy planning can provide local leaders and residents with a much greater role in the decision-making process, particularly with respect to energy management initiatives. It also offers local leaders an opportunity to help plan and manage the community's energy and utility systems in accordance with the community's goals and objectives.

1.2 Benefits of Community Energy Planning

Some of the potential benefits of community energy planning include:

- Keeping money in the communities and in the Northern economy. Money saved on energy expenditures in a community can be used for other programs and services in the community.
- Educating consumers to be aware of the costs of energy usage and the benefits of reducing energy expenditures.
- Providing training and employment for local residents.

- Improving the local and global environment by reducing emissions of greenhouse gases related to the consumption of fossil fuels.
- Reducing dependence on imported petroleum products by increasing the use of renewable energy technologies, where cost-effective.

1.3 Community Energy Planning Pilot Projects

During 1997/98, two CEP pilot projects were initiated in Fort Simpson and Cape Dorset. In Fort Simpson, the process yielded a community energy plan that the community is now implementing. Details of the Fort Simpson community energy plan are contained in Section 4.0. In Cape Dorset, the planning and community consultation process was started, but not completed due to staff turnover in the territorial government and other organizations.

Based on the results obtained in Fort Simpson and in other jurisdictions, community energy planning has the potential to yield significant benefits to a community by reducing energy expenditures and by ensuring that community goals and objectives are reflected in the design and delivery of energy and utility systems.

1.4 Role of the Arctic Energy Alliance in Community Energy Planning

The Arctic Energy Alliance's mandate is to help consumers and producers work together to reduce the costs and environmental impacts associated with the production and consumption of energy and utility services in the NWT.

Historical experience with energy management and energy supply projects indicates that communities are often confronted with some or all of the following difficulties when considering energy projects:

1. Limited knowledge of energy management practices and potential energy supply opportunities.
2. Community leaders and officials often do not know where to get information and advice on energy and utility related issues.
3. Communities need assistance in identifying, evaluating and implementing cost-effective energy management and alternative energy supply projects.
4. Communities need assistance in securing funds for energy projects.
5. Communities need assistance in locating qualified contractors.
6. Communities need training in cost-effective operation and maintenance procedures for their facilities.

1.5 Purpose of this Document

One of the Alliance's main goals is to help communities manage their energy and utility costs. To help achieve this goal, the Alliance has now assumed the lead role in the promotion and implementation of community energy planning in the NWT.

The purpose of this document is to provide communities with information to help overcome some of the barriers listed above and to enable local governments to begin managing their energy and utility costs.

2.0 GETTING STARTED

There are several steps in the Community Energy Planning process. They are described below.

2.1 Get Organized

Successful community energy planning requires a high level of local involvement and participation. In many cases, the key players needed to identify, evaluate and implement energy projects already live and work in the community. These include local leaders, administrative officials, financial officers, facilities managers and operations and maintenance staff.

To begin community energy planning, it is important to establish a local group to oversee and drive the process. Ideally, this group should include a variety of people from the community such as decision-makers, technical people, financial people, business people and consumers. Representation from these different groups will help ensure that the community energy plan reflects the goals and objectives of the community.

Getting Organized:

- *Establish a Local Steering Committee*
- *Appoint a Champion*
- *Identify Community Goals and Objectives*

One of the first tasks of the local group is to collect information regarding the community's goals, objectives and areas of concern. This will help shape the community's vision with respect to the type of energy projects to implement.

Another important aspect of getting organized involves the appointment of a local champion. This does not have to be someone with a lot of expertise in energy matters. The main role of the champion is to provide the motivation and drive necessary to ensure that a community energy plan is developed and then implemented. As such, the champion should be someone who is well respected in the community and believes in the importance of increasing the community's independence and self-reliance.

If a community is interested in developing and implementing a community energy plan, the Arctic Energy Alliance is available to help set up a community energy planning process suited to the needs and circumstances of the community. The Alliance can also help communities deal with technical issues and provide answers to energy-related questions.

2.2 Monitoring and Tracking

Before a community can decide where it wants to go in terms of its energy future, it must first determine where it is. To obtain a snapshot of the community's current energy situation, a profile of the community's energy usage and expenditures must be assembled. The energy or utility services to be considered include electricity, water/sewage and heating.

An energy profile illustrates the community's current energy situation.

A community energy profile provides baseline data on current energy consumption, prices, annual energy expenditures, the number and type of buildings in the community, technology used in the community and capital spending plans. Also included in the profile is an energy audit which identifies potential ways to reduce energy consumption, increase efficiencies and may even consider the potential for using alternative energy supply technologies.

The Alliance can help a community begin monitoring and tracking its energy use by providing appropriate forms or a computer spreadsheet that can be used to record the community's energy consumption and expenditures. Examples of these forms are provided in Appendix A.

An Energy Assesment provides suggestions for reducing energy consumption.

2.3 Basic Energy Assessment or Audit

To identify energy management or energy supply opportunities that may exist in a community, it is necessary to evaluate the major buildings, facilities and infrastructure in the community. A preliminary evaluation is known as an energy assessment. A more detailed evaluation is known as an energy audit.

The purpose of an energy assessment or audit is to obtain a written description of the different ways in which energy consumption may be reduced or the energy supply systems could be improved.

It is important to note that the results of the energy audit provide a starting point for the community consultation process. An energy assessment or audit will provide different options on how a community's energy situation can be improved, but it is up to the community to decide which of the options should be implemented.

2.4 Community Consultation

Residents of the community must participate in community energy planning for it to be successful. There are several reasons for this:

Successful community energy planning requires the participation and support of the people living in the community.

- Residents need to be consulted to determine the community's goals and objectives.
- Residents may have concerns or doubts regarding particular energy projects. For example, residents may not be comfortable with a particular technology. If these concerns cannot be overcome, the use of that technology should not be considered in the community's energy plan.
- Many energy management initiatives require the participation and co-operation of community residents to be successful. For example, if a community wants to reduce its electricity consumption by 20% over three years, everyone in the community should be aware of this goal and help to achieve the goal.

- Community residents need to be involved in setting priorities for the community. The energy audit report may identify many opportunities for reducing energy demand and consumption and/or alternative methods for supplying energy to the community. However, these opportunities must be reviewed carefully as budget limitations and other priorities may mean that the community cannot implement all of the suggestions at once.

Although there are no fixed rules regarding the community consultation process, it is preferable to have regular meetings with community members throughout the energy planning process to obtain their input and to keep them informed.

Meet with community members on a regular basis.

2.5 Community Energy Plan

Once local leaders have reviewed the potential energy management and supply initiatives described in the energy audit report and consulted with community residents, the community energy plan can be formalized.

The community energy plan should start with a description of the current energy situation. The next task is to choose among the energy management and energy supply opportunities identified in the audit report to determine which projects are consistent with the community's goals and objectives. The final task is to prepare a written plan for implementing those projects that the community has agreed upon.

The community energy plan should describe:

- *the current energy situation*
- *the projects or activities to be completed*
- *funding and scheduling details*

The written plan should include the following information:

- A list of the different projects or initiatives to be implemented.
- The order in which the projects will proceed.
- The time required to implement each initiative and the expected results.
- The amount of funding required and the sources of these funds.
- A schedule of the major steps necessary to complete each project.

The community energy plan is intended to guide the community's energy-related activities for the next few years and to provide a framework for future energy-related decisions. Therefore, the community should revisit its energy plan every few years to keep it current and to ensure that it continues to reflect the community's goals and objectives.

3.0 ENERGY MANAGEMENT AND ENERGY SUPPLY STRATEGIES

Many different energy management strategies and energy supply technologies may be considered during the community energy planning process. To determine the strategies and technologies that are appropriate for a particular community, several different factors must be considered:

- The goals and objectives of the community.
- The community's current energy profile and consumption patterns.
- The relative costs of the energy and utility services currently being provided.
- The extent to which the community can influence capital planning decisions.
- The availability and suitability of alternative supply options such as wind, solar, hydro, wood and natural gas.

For many communities, the main objectives will be to reduce energy consumption and expenditures. For other communities, there may be an opportunity to harness the energy of the sun or wind to improve the way in which energy is provided in the community.

An overview of different energy management strategies and energy supply technologies is provided below as an example of the different energy options that may be available to a community.

Energy management can eliminate wasteful use of energy and improve energy efficiency.

3.1 Energy Management Opportunities

The objective of energy management is to reduce or control the community's consumption of energy and utility services. By reducing energy consumption, it is possible for a community to reduce its energy expenditures by as much as 10% to 20%.

The potential for savings is considerable if one considers the amount of money spent each year on energy and utility services. The following table illustrates the estimated expenditures each year for energy and utility services in several Northern communities:

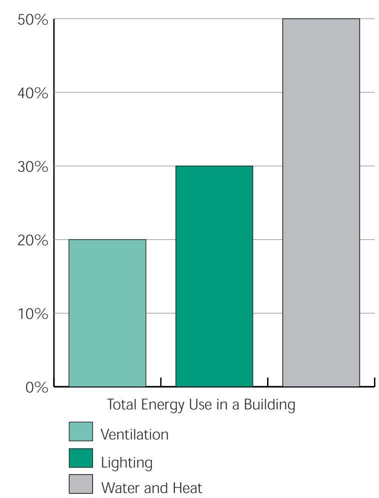
Community	Electricity	Water	Petroleum Products	Total Cost
Yellowknife	$19,400,000	$6,400,000	$20,000,000 est.	$45,800,000
Norman Wells	$1,750,000	$960,000	$900,000 est.	$3,610,000
Wha Ti	$825,000	$540,000	$450,000	$1,815,000
Iqaluit	$8,850,000	$4,220,000	$7,000,000 est.	$20,070,000
Cambridge Bay	$2,560,000	$1,575,000	$3,125,000	$7,260,000
Baker Lake	$1,930,000	$1,480,000	$2,940,000	$6,350,000

For communities such as Yellowknife or Iqaluit, a 20% reduction in energy expenditures could result in millions of dollars being available to be spent in other, more meaningful ways. Even for smaller communities, it may be possible to save many thousands of dollars annually. An added benefit of reducing energy consumption is the reduction of environmental emissions associated with the use of refined petroleum products like diesel fuel and heating oil.

Energy management can save money and reduce harmful environmental emissions.

Excluding transportation activities, the majority of energy use in smaller communities occurs in municipal infrastructure, buildings and houses. Typically, the buildings and infrastructure that consume most of the energy include:

- office buildings
- health centres
- schools
- recreation centres and community halls
- water pumping and treatment facilities
- maintenance garages
- hotels
- community freezers
- houses



Energy for space and water heating may account for as much as 50% of a building's total energy use. Lighting often accounts for 20% to 30% of total energy use while the energy used by ventilation systems typically accounts for 5% to 20% of a building's total energy use. Other machinery and equipment normally accounts for the balance of the energy usage in a building.

To illustrate some of the many ways that energy demand and consumption can be reduced, a brief overview of building systems and examples of energy efficient technologies and practices is provided below. These examples are broken down into two categories: (1) low or no cost opportunities; and, (2) opportunities requiring an investment in new equipment or operating procedures.

3.1.1 Building Envelope

The building envelope is made up of the various components that separate the interior of the building from the outdoors. This includes the walls, windows, doors, ceilings and floors of the building. The purpose of the building envelope is to provide the occupants with a suitable environment for the activities they are engaged in.

Methods of reducing energy losses through the building envelope include reducing air leakage and increasing the amount of thermal insulation in some or all of the envelope components.

Help prevent heat loss by adding insulation and reducing air leaks.

Some of the typical low cost or no cost suggestions for improving the building envelope include:

- Seal, caulk and weatherstrip to reduce air leakage around windows and doors and through penetrations of the walls, ceilings and floors.
- Adjust window and door hardware to ensure that they seal tightly when they are closed.

Some of the opportunities for improving the building envelope require a capital investment to be made. These include:

- Increase the amount of thermal insulation in the walls, ceilings and floors. This is usually only cost-effective when done in conjunction with other upgrades such as roof replacements or the installation of new siding.
- Replace inefficient windows and doors. This is usually only cost-effective when the windows or doors have to be replaced due to wear and tear.
- Provide a porch for the main entrance of the building to reduce the amount of air moving between the inside of the building and the outdoors when people enter or leave the building.

An example of an improvement made to a building envelope is described in Section 4.2.1.

3.1.2 Lighting and Electrical Systems

Lighting systems are provided so that the occupants of a building can perform their tasks safely and effectively. Lighting systems may also be provided for security or for decorative purposes.

The efficiencies of lighting systems vary widely. Incandescent lamps are the least efficient lighting system, but they are still commonly used in houses and for outdoor lighting.

Fluorescent lighting systems are three to four times as efficient as incandescent systems and are commonly used in offices and commercial and institutional buildings. Because they operate poorly at low temperatures, fluorescent lighting systems are not suitable for outdoor lighting.

Reduce energy costs by replacing inefficient lighting systems and eliminating excess lighting.

The most efficient lighting systems are high intensity discharge (HID) systems such as high pressure sodium and metal halide systems. These systems are typically used in industrial buildings, recreational facilities, garages and for outdoor lighting.

As noted previously, lighting systems account for up to 30% of the energy used in a building. Therefore, it is not surprising that they offer some of the best opportunities for reducing energy consumption. Methods for reducing the amount of energy used by lighting systems generally fall into one of three categories:

1. Replacing inefficient lighting systems with more efficient systems.
2. Reducing the amount of light provided.
3. Reducing the amount of time that the lighting systems are used.

Other major electrical loads that may present opportunities for reducing energy usage include electric motors and block heater outlets for vehicles. Energy usage for electric motors can be reduced by reducing the operating hours of the motors and by using more efficient motors. Energy usage for block heater outlets can be reduced by reducing the number of hours that the receptacles are energized.

Low or no cost suggestions for reducing electric consumption include:

- Switch off lights when they are not required.
- Replace incandescent lamps with compact fluorescent lamps.
- Replace inefficient fluorescent lamps and ballasts with more efficient lamps and ballasts.
- Replace incandescent exit sign lamps with LED lamps.
- Remove unnecessary lamps and ballasts.
- Manually shut down fans, pumps and other electrical equipment when it is not required.
- Manually switch off the power to block heater outlets when they are not required.

Suggestions requiring some capital investment include:

- Install timers and/or photocells to control outdoor lighting.
- Replace inefficient lighting systems with more efficient systems.
- Install motion sensors to automatically turn off the lights when occupants leave the area.
- Install photocells to control indoor lighting near windows and skylights.
- Install controls to automatically shut down electrical equipment when it is not required.
- Install controls to automatically operate block heater outlets according to time and temperature.

Examples of successful Northern lighting retrofits are described in Section 4.2.2.

Reduce heating when spaces are not occupied.

3.1.3 Heating Systems

Heating systems are used to maintain the temperature within the building at a comfortable level for the occupants. Heating systems are also used to heat outdoor air that is brought into the building by the ventilation systems.

Methods for reducing the amount of energy used by heating systems generally fall into four categories:

1. Reducing the amount of heat required by reducing the temperature in the building.
2. Reducing stand-by losses by reducing the operating temperature and the operating hours of the heating equipment.

3. Improving the combustion efficiency of the fuel burning equipment.
4. Improving the distribution of heat by eliminating leaks in ductwork and piping and by keeping radiators and grilles clean and free of obstructions.

The following are low or no cost suggestions for reducing heating bills:

- Manually reduce thermostat settings when the building is not occupied.
- Test and adjust fuel-burning equipment annually to ensure optimum performance.
- Manually shut down heating systems when outdoor temperatures permit.
- Seal leaks in heating system ductwork and piping.
- Regularly remove dust, debris and obstructions from radiators and grilles.
- Reduce ventilation system supply air temperature settings.

Retrofit opportunities requiring a capital investment include:

- Replace inefficient heating equipment.
- Install controls to automatically reduce space temperatures during unoccupied periods.
- Install controls to automatically adjust the operating temperature of the heating systems in response to changes in the outdoor temperature.
- Install controls to automatically shut down heating systems when outdoor temperatures permit.

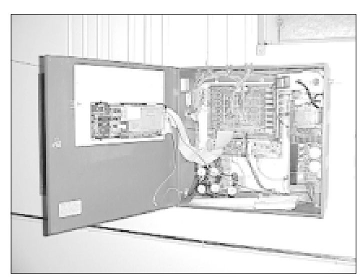
Automatic controls help eliminate unnecessary heating loads.

Some examples of successful improvements to heating systems in the North are described in Section 4.2.3.

3.1.4 Ventilation and Air Conditioning Systems

Ventilation systems are provided to maintain a healthy environment for the occupants of the building by replacing stale indoor air with fresh outdoor air. In some parts of the North, ventilation systems may be equipped with air conditioners to remove excess heat during warm summer weather.

Methods to reduce the amount of energy used by ventilation and air conditioning systems include reducing the amount of cooling required by the building, reducing the amount of outdoor air that has to be heated or cooled and reducing the amount of time that the ventilation systems operate.



Direct Digital Control system (DDC) – acts as a timer for the air handling system.

Excessive ventilation or poorly maintained systems result in unnecessary heating bills.

Some low cost or no cost ways to reduce energy use for ventilation and air conditioning systems include:

- Regularly inspect, clean and/or replace air filters.
- Manually shut down ventilation systems and exhaust fans during unoccupied periods.
- Increase space temperature thermostat settings during summer months.

Suggestions for improving energy efficiency that will require a capital investment include:

- Install controls to automatically shut down ventilation systems and exhaust fans during unoccupied periods.
- Install controls to permit the use of outdoor air for cooling when temperatures permit.
- Install occupancy sensors to control exhaust fans in intermittently used areas.
- Install controls to allow the amount of outdoor air to be varied according to the number of occupants in the building.
- Install heat exchangers to recover heat from exhaust air and preheat incoming air.

To reduce the amount of water consumed consider using the following:

- *low flow toilets*
- *low flow showerheads*
- *flow restricters on faucets*

3.1.5 Service and Domestic Hot Water Systems

Service water systems and domestic hot water systems provide potable water for drinking, cooking and various sanitary purposes such as washrooms, showers and janitorial operations. Water may also be used in various processes such as food processing and beverage making.

Methods for reducing energy usage in service water and domestic hot water systems generally fall into three categories:

1. Reducing the amount of water used.
2. Reducing pumping requirements.
3. Reducing heating requirements.

Low or no cost opportunities for reducing water consumption and/or reducing energy use include:

- Eliminate leaks in piping, fittings and fixtures.
- Test and adjust fuel burning equipment annually to ensure optimum performance.
- Reduce the temperature setting for domestic hot water.
- Manually shut down circulating pumps during unoccupied periods.

Opportunities for reducing water consumption and/or energy use that require a capital outlay include:

- Insulate hot water piping and storage tanks.
- Install controls to automatically shut down circulating pumps during unoccupied periods.
- Replace standard toilets, faucets and showerheads with low volume fixtures.
- Replace electrical heating equipment with fuel burning equipment.

Several examples of ways in which water consumption and/or energy costs may be managed are described in Section 4.2.4.

3.1.6 References for Further Information

Readers interested in learning more about energy management are encouraged to attend the Arctic Energy Alliance's Energy Management workshop series. This series was developed by the Alliance to focus strictly on energy management in the North. For further information on the workshops, please refer to the information contained in Appendix B.

See Appendix B to learn more about energy management.

The Alliance will also be publishing a more detailed report on energy management in the near future. For additional information regarding the publication of this upcoming report, please refer to the Preface for information on how to contact the Alliance's office in Yellowknife.

For additional information on energy management, readers are also encouraged to check out the publications and web sites contained in Appendix C.

3.2 Energy Supply Opportunities

From a planning perspective, communities are strongly encouraged to develop and implement an energy management plan before considering energy supply options.

The reason for this suggestion is the fact that communities can, through their own actions, directly influence their consumption of energy. There is usually no other outside group or organization that must be consulted to begin implementing changes.

Assuming a community has begun to reduce energy consumption and become more efficient, a community may also decide to address the ways in which energy services are provided to it.

Energy supply options depend on available natural resources and technology choices.

Communities should approach the question of energy supply options carefully, however. The energy supply options available to a community depend very much on the presence of natural resources (such as a good wind resource, sufficient solar energy, an economic hydro site or natural gas) and whether these resources can be developed economically.

With the exception of water and sewer systems, communities in the North have not typically become involved in how their energy needs are being supplied. Communities are usually aware of the high cost of energy and utility services, but often do not have much information on why the services cost so much or what new technologies may be available to lower the costs or improve the service.

Historically, responsibility for planning and delivering energy services to communities has resided with GNWT departments and agencies such as Municipal and Community Affairs (MACA), the Petroleum Products Division (PPD) and the NWT Power Corporation (NWTPC).

Due to several factors such as division of the NWT, community empowerment initiatives and user pay policies, local governments and residents in Northern communities are beginning to pay more of their actual energy costs. As communities assume more responsibility for paying their energy costs, they will also need to have more input into energy supply decisions as they will end up paying for them.

To assist community leaders and residents to understand some of the energy supply technologies that may be suitable for use in Northern communities, a brief overview of several energy supply options is provided below.

Waste-oil can be burned instead of heating oil.

3.2.1 Waste-Oil Furnaces and Boilers

Waste-oil furnaces and boilers are similar to conventional furnaces or boilers except that their burners are designed to burn heavier fuels such as motor oil and gear oil. In addition to reducing heating costs, using a waste-oil furnace or boiler eliminates the problem of disposing of used motor oils and other lubricants.

In most of the communities in the North, the NWT Power Corporation generates significant amounts of waste-oil at its diesel plants. If there is no waste-oil boiler or furnace installed in the community, the waste-oil from the diesel engines accumulates in the community and must eventually be shipped to larger centres for burning or shipped down south for disposal. Disposing of the waste-oil is a cost to NWTPC that they must eventually recover in the electric rates that they charge.

An alternate solution is to burn the waste-oil in a waste-oil boiler or furnace installed in the community. This avoids the expense of shipping the waste-oil out of the community and also permits the community to reduce its consumption of heating fuel. Further information on the use of waste-oil boilers or furnaces is contained in Section 4.3.1.

3.2.2 Residual Heat Recovery and District Heating Systems

Heat from the diesel power plant can be used to heat surrounding buildings.

In most Northern communities, electricity is produced using diesel-electric generators. This method is quite inefficient as only one-third of the energy content of the fuel is actually transformed into electricity. The other two-thirds of the energy content is lost as heat in the exhaust gases and through the water jackets on the engine.

Residual heat recovery involves capturing some of the wasted heat from the diesel engines and using it for space heating in buildings. In a typical system, a heat exchanger is used to recover heat from the diesel engines and transfer it to a delivery medium such as glycol. The heated glycol is then pumped through a piped distribution system to one or more buildings located near the diesel generating plant. Space heating is achieved by distributing the hot glycol through a series of radiators located throughout the building. As the glycol circulates, it loses heat and is then pumped back to the heat exchanger in the diesel plant where the cycle starts all over.

The primary advantage of using residual heat is that it greatly increases the efficiency of the diesel engines. For every kilowatt-hour of electricity produced, another one to two kilowatt-hours of heat can be captured and used for space heating. This reduces the amount of heating fuel needed to provide space heating in buildings and reduces emissions of harmful pollutants into the atmosphere.

One disadvantage of residual heat recovery and district heating systems is the need to have the heat loads (i.e. the buildings) located within a kilometer or so of the diesel plant. For distances greater than a kilometer, it is usually not cost-effective as too much heat is lost between the diesel plant and the buildings.

Further information on residual heat recovery and district heating systems is provided in Section 4.3.2.

3.2.3 Renewable Energy Technologies

In the North, most of our annual energy requirements are met by importing and burning refined petroleum products such as diesel fuel, heating oil and transportation fuels.

There are several renewable energy technologies that may be suitable for use in Northern communities, but is important to note that they will never completely replace petroleum products. However, increased use of renewable energy technologies would help to significantly reduce our reliance on imported fuel for electricity and heating.

Solar Energy

From a practical viewpoint, solar energy is a limitless resource. The amount of energy that falls on the earth in the form of sunlight each year is hundreds of times greater than the amount of energy mankind uses each year in the form of petroleum products.

Solar energy can:

- *heat water*
- *heat buildings, and*
- *produce electricity*

Three different types of solar energy systems are commercially available: passive solar, active solar and photovoltaics.

Passive and active solar building systems make use of the sun to provide heat and lighting thus reducing the requirements for conventional heating and lighting systems.

The passive approach involves orienting a building to face south and then capturing as much sunlight as possible using large windows and other materials that will absorb and store heat from the sun. An example of a passive solar technology currently being tested in the North is Solarwall. Details on the Solarwall pilot project are provided in Section 4.3.4.

Active solar technologies collect, store and distribute solar energy for water heating and space heating. In typical water or space heating applications, heat from the solar collector is transferred to an insulated storage medium, such as a water tank and then distributed as needed. Due to our long, dark winters, active solar technologies may not be economic in the North except for remote, seasonal applications such as hunting lodges and research facilities that are used only during the summer.

An example of a Photovoltaic cell.

Photovoltaic (PV) cells are the best known of the solar energy technologies. A PV cell converts sunlight into electricity. When sunlight falls on the PV cell, a flow of electrons is created within the cell due to the presence of a magnetic field and the nature of the semi-conductor materials that make up the cell. An individual cell can generate between 0.6 and 1.2 volts. Connecting PV cells together in a panel allows for greater voltage or current output.

The largest use of PV cells currently is to provide electricity in remote applications that are not connected to an electrical supply grid. Worldwide, there are thousands of PV systems powering remote communications stations, navigational aids, water-pumping equipment and warning systems. PV cells have been installed in Inuvik, Iqaluit and numerous remote, off-grid locations in the North. Further details are provided in Section 4.3.4.

Wind Energy

Winds are created by the uneven solar heating of the earth's surface. The air above warmer surfaces rises, creating low pressure areas into which air from higher pressure areas flows. Winds are affected by bodies of water, altitude, local terrain, buildings, and other factors. Wind speeds increase with the height above the ground and vary over time: through the day, from day to day, and seasonally. The amount of wind for a particular location is measured by the annual average wind speed and is expressed in metres per second (m/s).

Wind turbines convert the power of the wind into electricity.

Wind turbines use the kinetic energy in the wind to produce electricity. The key components of a wind turbine are:

- A rotor or blade that converts the kinetic power in the wind into mechanical power at the rotor shaft.
- A tower to support the rotor high above the ground.
- A gearbox to link the rotor shaft to the electric generator.
- A control system to start and stop the turbine and to monitor its operation.

Most wind turbines operate automatically, starting up when wind speeds reach a cut-in speed of four to five m/s. The turbines then produce power until wind speeds either reach the cut-out speed, above which damage to the turbine might occur, or fall below the cut-in level.

The amount of electric power that a wind turbine produces depends on its size and the average wind speed where it is located. The mathematical relationship between the wind speed and the energy produced is such that a small increase in the average wind speed will produce a large increase in the amount of electric power generated.

From a cost perspective, wind turbines are expensive to buy and install, but inexpensive to maintain and operate. The actual cost per kilowatt-hour will depend on the fixed cost to install the turbine and the amount of energy that is produced. Therefore, the greater the average wind speed, the more wind energy that will be produced and the lower the cost per kilowatt-hour. This is why it is imperative that the site for a wind turbine be chosen very carefully based on reliable wind data for that location.

The reliability of wind turbines has improved in recent years. Some early wind turbines developed unexpected problems including mechanical breakdown, excessive vibration, and material fatigue. Now, with better materials and designs and improved maintenance some wind turbines have reliability rates greater than 95%.

Wind turbines have been operating or are being installed in several locations in the North. For more information, please refer to Section 4.3.3.

Wood

Wood stoves and heaters are commonly used for space heating in residential buildings in the Western Arctic. Wood is a renewable resource if forests are properly managed. Significant advances in wood heating technologies in recent years have led to improvements in the efficiencies of wood heating systems and reductions in the amounts of particulates and other byproducts of combustion that are emitted to the atmosphere.

A side benefit of wood heating technologies is the potential for secondary employment in managing, harvesting and processing wood resources.

4.0 NWT CASE STUDIES

Virtually all of the ideas and technologies discussed in this report have already been successfully used in the North. To help illustrate this fact, the following are some specific case studies which illustrate community energy planning, energy management strategies and energy supply projects.

4.1 Community Energy Planning

The Village of Fort Simpson initiated a community energy plan process in 1996 to identify different ways to reduce its energy consumption and utility costs.

4.1.1 Fort Simpson

Following the completion of an energy audit and several community consultations, the Village prepared an action plan which outlined the various goals of the community and strategies and time frames to be followed in implementing and completing the plan.

Several of the key community goals identified in the Fort Simpson Community Energy Plan are as follows:

- *Reduce* the electrical power peak from 1.8 megawatts to 1.0 megawatts by 1999.
- *Promote* energy awareness through school presentations, public meetings, displays and high visibility energy audits to educate community members on potential ways of reducing energy usage.
- *Promote* Reducing, Reusing and Recycling to reduce the volume of material delivered to the landfill site. This would lower operating costs and adverse environmental impacts.
- *Investigate* alternate energy sources to identify sources that are more cost effective and environmentally friendly than the existing diesel generators.
- *Promote* the use of gray water systems to reduce water/sewage production and delivery costs.
- *Investigate* the establishment of a district heating system using radiant and exhaust heat recovered from the NWTPC diesel generators.
- *Install* a waste-oil furnace or boiler to use the waste-oil from internal combustion engines. The waste-oil (80 drums or more each year) that is presently trucked out of the community for disposal could produce heat at a lower cost than refined heating oil and repay the capital cost in less than one year.

4.2 Energy Management Projects

The following are examples of some successful energy management initiatives undertaken over the last several years in Northern communities.

4.2.1 Building Envelope

The Milton building in Fort Simpson is a good example of how an improvement in the building envelope can help save energy dollars. In the 1995/96 fiscal year, the insulation in the building was upgraded at a cost of $41,700. The savings in heating costs achieved as a result of the improved insulation was estimated to be $14,500 per year. The total time required to recover the original investment was 2.9 years.

4.2.2 Lighting

As previously noted, lighting systems can account for up to 30% of the energy used in a building. Switching lights off, installing timers and motion sensors and replacing inefficient fluorescent lighting systems are several of the easiest ways to reduce energy consumption and save money.

Over the last eight years, the GNWT's Energy Conservation Capital Program (ECCP) has funded approximately 65 lighting retrofit projects. The money saved each year on energy bills as a result of these projects is estimated to be approximately $830,000 per year, which on a cumulative basis, is many times more than the original investment of approximately $1.7 million.

For more information on the Energy Conservation Capital Fund, readers are encouraged to contact the Arctic Energy Alliance's office in Yellowknife or contact the Environmental Protection Service, Department of Resources, Wildlife and Economic Development (RWED) at (867) 873-7654.

4.2.3 Heating and Ventilation Systems

One way to reduce the energy consumed in a heating system is to ensure that the system is as energy efficient as possible. If a boiler or furnace is inefficient, it may pay to replace the unit even before it reaches the end of its useful life. An example of a heating retrofit is the Chief T'Selihye School in Fort Good Hope. During the 1991/92 fiscal year, a boiler was installed to replace seven furnaces at a cost of $54,000. Due to the increased efficiency of the new boiler, this replacement resulted in savings of approximately $11,000 in the annual heating bill for the school. Based on these savings, the cost of the new boiler would have been recovered in about five years.

Heat recovery ventilation (HRV) systems represent another way to save money on heating costs. The purpose of an HRV system is to recover some of the heat that is lost as warm, stale air is exhausted from a building and replaced by cold, outside air. The HRV captures the heat in the warm exhaust air and uses it to help warm the cold intake air. Pre-heating intake air in this fashion helps reduce the amount of heating fuel required to heat fresh intake air. The use of HRV systems is not common in the North, but this technology is now being examined more carefully for possible use in commercial and institutional buildings.

A third way to reduce heating costs involves the installation of controls and timers to reduce space temperatures when buildings are not occupied or to automatically shut down heating systems when outdoor temperatures permit. One example is the Inuvik Hospital. In the 1993/94 fiscal year, as part of a larger retrofit effort, time clocks were installed on the heating and ventilation system to control the operation of the system. The estimated payback of the capital investment for the timers was 0.5 years.

4.2.4 Service and Domestic Hot Water Systems

Energy costs associated with the heating and usage of water can be reduced by lowering hot water temperature settings, replacing inefficient electric hot water heaters with higher efficiency oil-fired hot water heaters and installing devices such as low-flow shower heads and toilets.

Another technology being tested in the North involves the recycling of waste-water. Using grey-water recycling technology, it is possible to treat waste-water and reuse it to flush toilets and wash clothes. This helps to significantly lower annual water bills by reducing the amount of water that must be delivered to the residence. The NWT Housing Corporation is conducting demonstration tests of this technology in Detah and Ndilo and will be installing additional units in Cape Dorset in early 1999.

4.2.5 Cambridge Bay Freezer Modification

Large refrigeration units are often powered by electricity and must operate year round to ensure that the contents of the freezer remain frozen. During the winter months, it is possible to use cold outside air to help keep the freezer unit at the correct temperature. Introducing cold outside air into the freezer reduces the amount of electricity required to run the refrigeration equipment, thereby reducing the amount of money spent on electricity.

Kitikmeot Foods in Cambridge Bay tested this idea by installing an Ambient Temperature Refrigeration Support System (ATRSS) on a 12m by 6m by 2.3m freezer that had to be maintained at -18°C. The ATRSS consisted of a supply and exhaust duct system, with a fan to move air in and through the freezer box when the freezer box temperature required cooling.

The cost of the modification was approximately $7,000 and it resulted in reduced annual refrigeration costs of $8,900 or approximately 30%.

4.3 Energy Supply Projects

The following are examples of successful energy supply projects that have been implemented in the North in the last several years.

4.3.1 Waste-Oil Boilers/Furnaces

As part of its Community Energy Plan, the Village of Fort Simpson recently installed a waste-oil boiler in a four-bay community garage. Waste-oil for the boiler is being supplied free from the local NWT Power Corporation (NWTPC) plant plus other NWTPC plants in the region. NWTPC estimates there may be 16,000 litres or 80 drums of waste-oil available for the boiler, or approximately 65% of the garage's average yearly heating oil requirements of 25,000 litres. At a capital cost of $30,000 for the boiler (partially cost-shared with the NWTPC), the pay back period could be less than two years depending upon the price of the heating oil.

Approximately 50 waste-oil boilers or furnaces have been installed throughout the North. Examples of communities with waste-oil boilers or furnaces include:

Northwest Territories

- Yellowknife
- Inuvik
- Fort Simpson
- Hay River
- Fort Smith
- Norman Wells
- Fort Providence
- Fort Good Hope
- Wrigley

Nunavut

- Iqaluit
- Rankin Inlet
- Baker Lake
- Coral Harbour
- Arviat

Communities interested in installing a waste-oil boiler or furnace should first contact the NWT Power Corporation or government and private sector garages as potential sources of waste-oil in the community. If waste-oil is available, then the Environmental Protection Service of the Department of Resources, Wildlife and Economic Development (RWED) should also be contacted to obtain information regarding their current regulations on the handling and storage of used oil and waste fuels.

4.3.2 Residual Heat Recovery and District Heating System

Prior to 1990, the GNWT utilized residual heat from local diesel plants, at no charge, for small scale district heating systems in public buildings such as schools and water treatment plants. From 1990 to 1997, additional district heating projects were completed in Holman Island (1995), Fort McPherson (1997) and in Taloyoak (1997).

The Fort McPherson project was noteworthy in that it was developed as a joint venture between NWTPC and the Gwich'in Development Corporation (GDC). This $1,000,000 project provides heat to five buildings including a school, swimming pool, hamlet office and water treatment plant. The annual heat output is approximately 1,700 MW.h, resulting in displacement of approximately 250,000 litres of heating oil annually.

NWTPC is now pursuing residual heat sales/district heating systems as a business opportunity. Based on a Memorandum of Understanding (MOU) signed in March 1998 between NWTPC and the GNWT, NWTPC is preparing an inventory of potential residual heat recovery projects. While the inventory is not yet complete, there may be as many as thirty communities where residual heat recovery projects may be economically beneficial to both parties.

The first project initiated under the MOU is the supply of residual heat to two schools in Pangnirtung. It is estimated that the district heating system will be capable of supplying up to 85% of the heating requirements of the two schools, thereby displacing an estimated 185,000 litres of heating oil per year.

4.3.3 Wind Turbines

Wind turbines may represent one of the most promising new technologies for use in communities with a good wind resource. Over the last few years, the NWT Power Corporation has undertaken wind turbine demonstration projects in Cambridge Bay, Kugluktuk, Sachs Harbour and Rankin Inlet.

Cambridge Bay

Since September 1994, Dutch Industries, a Saskatchewan company, has owned and operated a Lagerwey 80 kW wind turbine in Cambridge Bay and sold the wind energy to the NWT Power Corporation under the terms of a power purchase agreement. Total production for the Cambridge Bay unit from September 1994 to November 1998 was approximately 665,000 kW.h which has resulted in the displacement of approximately 190,000 litres of diesel fuel.

Kugluktuk

In late 1996, NWTPC installed two of Dutch Industries' Lagerwey 80 kW wind turbines in Kugluktuk. Due to several difficulties, the turbines did not begin operating until the spring of 1997. Since then, both turbines have been off line at various times due to component failure and breakdown. During 1998, the two turbines were much more reliable and produced an estimated 165,000 kW.h of electricity which represents approximately 48,000 litres of displaced diesel fuel consumption.

Energy supply options depend on available natural resources and technology choices.

Sachs Harbour and Rankin Inlet

Also in 1996, NWTPC purchased two 50 kW wind turbines from Atlantic Orient Canada. One turbine was installed in Sachs Harbour in September 1998 and will be commissioned in the spring of 1999. The annual energy production of this machine is expected to be approximately 140,000 kW.h, resulting in the displacement of an estimated 45,700 litres of diesel fuel per year.

The second Atlantic Orient wind turbine will be erected in Rankin Inlet in May 1999. This turbine was originally planned for Iqaluit, but the project was relocated to take advantage of the better wind regime in Rankin Inlet. Annual energy production from this turbine is expected to be approximately 150,000 kW.h which, based on estimated diesel engine efficiencies, should result in the displacement of approximately 44,000 litres of diesel fuel.

4.3.4 Solar and Photovoltaics

Passive and active solar systems use the energy of the sun to provide heat and lighting thus reducing the need for conventional fossil fuel heating and lighting systems.

Solarwall

The Solarwall system is a passive solar technology that uses solar energy to pre-heat fresh intake air for the ventilation system of a building. Solarwall consists of an exterior metal cladding that is mounted on the south face of a building and a fan and air distribution system installed inside the building. When the sun shines on the building, the exterior cladding serves as a solar collector. Cold outside air drawn in through small holes in the metal cladding is heated as it passes into the ventilation system. Using the sun to pre-heat cold intake air reduces the need to burn heating oil in the building.

An example of a Solarwall system.

This technology is currently being tested on the Recreation Centre in Fort Smith. The technology was installed in April 1998 and will be monitored over the winter of 1998/99 to determine how much heating fuel can be saved. The total cost of the project is approximately $53,000 and it is estimated that it may result in annual fuel cost savings of $12,300. Given the limited amount of solar radiation available in most northern communities during the winter months, it is not yet known whether the Solarwall system is cost-effective for use in other Northern communities.

Photovoltaics

Photovoltaic (PV) cells have been installed in dozens of locations in the North. By converting solar energy directly into electricity, PV cells are ideal for use in remote applications where there is no electricity grid.

The following examples of successful PV installations in the North were taken from a list of solar and wind energy projects published by the Aurora Research Institute in 1996:

1. Alert and Eureka on Ellesmere Island

   In 1993, the Department of National Defence installed PV systems to power six microwave repeater stations.

2. Bay Chimo

   In 1995, a PV/wind/diesel hybrid system was installed in Bay Chimo to supply power to community freezers, a nursing station, office space and communications systems. Diesel generated power is used only when there is insufficient wind and/or solar energy available to meet the load.

PV systems have also been installed in Fort McPherson, Inuvik, Iqaluit, Norman Wells, Sachs Harbour and Tuktoyaktuk.

Readers interested in learning more about photovoltaics are encouraged to consult the web sites and references listed in Appendix C.

APPENDIX A: ENERGY MONITORING FORMS

Electricity Consumption Record

Building: ____________________

Date	Meter Reading	Use (kW.h)	Demand (kW)	kW.h/Day Since Last Reading	12 Month Running Total

Heating Oil Consumption Record

Building: ______________________________

Date	Meter Reading	Use (Litres)	Litres/Day Since Last Reading	12 Month Running Total

Water Consumption Record

Building: ____________________

Date	Meter Reading	Use (Litres)	Litres/Day Since Last Reading	12 Month Running Total

APPENDIX B: ENERGY MANAGEMENT WORKSHOP SERIES

Workshop #1: Introduction To Energy Management

This workshop is intended to help Northern organizations and businesses learn more about how to manage their energy and utility use and save money. Our intended audience includes Senior Administrative Officers, Financial Officers, Local Government Officials, General Managers, Facilities Managers, Maintenance Supervisors or any other person in a decision-making capacity interested in learning how to save money by saving energy.

The information presented is non-technical in nature and has been designed for an audience with a wide range of backgrounds and experience.

By attending this workshop, participants will learn how their organizations can:

- Understand energy use and energy management.
- Set up a successful energy management program.
- Identify immediate energy savings opportunities.
- Finance and implement energy savings opportunities.

Workshop #2: Building Operator Training Course

Our second workshop is intended to help persons in technical positions learn more about the operation and maintenance of building systems and how such systems consume energy in providing lighting, heating, ventilation and water services. Our intended audience includes maintenance and operations personnel, facilities managers or any person responsible for equipment and buildings.

The information is technical in nature and is appropriate for persons wanting to learn about specific energy management concepts and implementation techniques.

By attending this workshop, participants will learn about:

- electrical systems
- interior and exterior lighting
- heating and ventilation systems
- domestic hot and cold water systems
- building envelope (walls, windows, roofs and doors)
- identifying opportunities to save energy and money

APPENDIX C: REFERENCE MATERIAL

Publications

The Department of Natural Resources Canada (NRCan) has dozens of energy-related publications. Readers interested in obtaining a copy of their publications list and an order form can contact the Department's Energy Publications group at 1-800-387-2000, by fax at (819) 994-1498 or by Internet: http://www.nrcan.gc.ca

The following publications are available from the International Council for Local Environmental Issues (ICLEI). ICLEI can be reached in Toronto at (416) 392-1462, Fax: (416) 392-1478, Internet: http://www.iclei.org

ICLEI. *Profiting from Energy Efficiency! A Financing Handbook for Municipalities.* By Dan Goldberger and Phillip Jessup, Editors. Toronto, 1993. 48 pages

ICLEI. *Economic Instruments to Improve Environmental Performance: A Guide for Local Governments.* By Nancy Skinner and James Liljenwall with Jeb Brugmann (draft). 1996. 50 pages

ICLEI. *A Survey of Municipal Measures to Reduce Energy Use in Buildings*. By Phillip S. Jessup. Toronto, 1992. 49 pages

As a final suggestion, Fact Sheets and publications on a wide variety of energy issues can also be obtained by checking out the publications links on the web sites provided below.

Web Sites

Arctic Energy Alliance
http://www.aea.nt.ca

Aurora Research Institute
http://www.aurresint.nt.ca

Resources, Wildlife & Economic Development (RWED)
http://www.rwed.gov.nt.ca

Federation of Canadian Municipalities
http://www.fcm.ca

Natural Resources Canada (NRCan) Office of Energy Efficiency
http://oee.nrcan.gc.ca

Government of Canada Global Climate Change
http://www.climatechange.gc.ca

Association of Energy Services Professionals
http://www.aesp.org

American Society of Heating, Refrigeration,
and Air-conditioning Engineers (ASHRAE)
http://www.ashrae.org

Building Owners Managers Association International
http://www.boma.org

Canadian Association of Energy Services Companies
http://www.web.apc.org/sustenergy/caesco.html

Canadian Gas Association
http://wwwcga.ca

Canadian Home Builders' Association
http://www.chba.ca

Industry Canada Strategis
http://strategis.ic.gc.ca

Canadian Energy Research Institute
http://www.ceri.ca

Centre for the Analysis and Dissemination
of Demonstrated Energy Technologies (CADDET)
http://www.caddet-ee.org

The Canadian Technology Network (CTN)
http://ctn.nrc.ca/ctn

Electric Power Research Institute
http://www.epri.com

Greenhouse Gas Technology
Information Exchange (Greentie)
http://www.greentie.org

Netherlands Energy Research Foundation
(a searchable site containing over 650 energy related links)
http://www.ecn.nl/eii/main.html

Office of Industrial Technologies
http://www.oit.doe.gov

Rocky Mountain Institute
http://www.rmi.org

The Alliance to Save Energy
http://www.ase.org

U.S. Department of Energy
Energy Efficiency and Renewable Energy Clearinghouse
http://erecbbs.nciinc.com

U.S. Department of Energy
Energy Efficiency and Renewable Energy Network (EREN)
http://www.eren.doe.gov

Associations

Association of Energy Services Professionals
http://www.aesp.org http://www.aesp.org

American Society of Heating, Refrigeration,
and Air-conditioning Engineers (ASHRAE)
http://www.ashrae.org http://www.ashrae.org

Building Owners Managers Association International
http://www.boma.org http://www.boma.org

Canadian Association of Energy Services Companies
http://www.web.apc.org/sustenergy/caesco.html

Canadian Gas Association
http://wwwcga.ca http://wwwcga.ca

Canadian Home Builders' Association
http://www.chba.ca http://www.chba.ca

Training

Arctic Energy Alliance
Energy Management Workshop Series
Suite 205, 5102 - 50th Ave
Yellowknife, NT X1A 3S8
Phone:(867) 920-3333
Fax: (867) 873-0303
E-mail: info@aea.nt.ca

Seneca College
Building Environmental Systems
Energy Training Centre
Seneca College, Newmarket Campus
16775 Yonge Street
Newmarket, ON L3Y 8J4
Toll-free: 1-800-572-0712
Fax: (905) 898-7014
http://www.senecac.on.ca

Canadian Institute for Energy Training (CIET)
P.O. Box 21007, 150 First Street
Orangeville, Ontario, L9W 4S7
Phone: 1-800-461-7618
Fax: (519) 942-3555