A Plan to End Diesel Dependency on Three Manitoba First Nations

Barren Lands First Nation on Reindeer Lake

Our three communities—Barren Lands First Nation (in Brochet, on Reindeer Lake), Northlands Dënesųłiné First Nation (on Lac Brochet) and Sayisi Dene First Nation (on Tadoule Lake)—have developed Community Energy Plans (CEPs) which, if implemented, will end our dependency on diesel fuel. We will create own local, renewable energy, and make our communities the first near-zero emission communities in Canada.

These Community Energy Plans were developed using Aki Energy's multi-disciplinary consulting team, with financial support from the Indigenous Services Canada (ISC).

THE CURRENT CHALLENGE

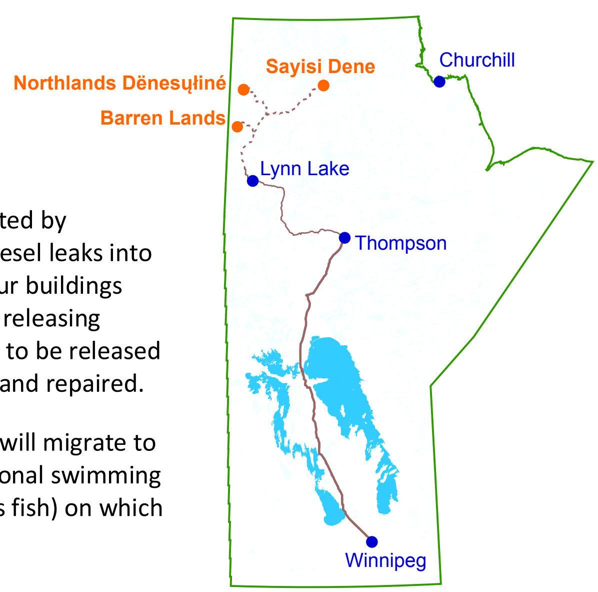
Kids Playing Shinny on Lac Brochet

Currently, all three of our communities need to have diesel fuel trucked in over winter roads, which are open less than two months a year. Each community requires between 1 million and 2 million litres of diesel a year—about half to generate electricity and half for heat.

Sayisi Dene First Nation on Tadoule Lake

Electricity is generated in each of our communities in a diesel-electric generating station owned and operated by Manitoba Hydro. Heat is generated using individual diesel furnaces located in each of our houses and community buildings. Both the electricity and heat generated using diesel are extremely expensive. Even worse, they create almost no jobs for our members.

Our houses and buildings all have diesel day-tanks beside them, with the tanks connected to the furnaces by piping. In some cases, these pipes run underground; in every case, they run under our homes and buildings. There are more than 400 of these day-tank/piping/furnace heating systems between our three communities. Every one of these 400+ heating systems are prone to leaking. They are, on average, more than 25 years old. As they come to the end of their life, they will all need to be replaced.



In addition to the GHG (Green House Gas) pollution generated by extracting, refining, transporting, and burning diesel, the diesel leaks into the soil in our communities. It spreads around and under our buildings and homes, contaminating both soil and groundwater, and releasing fumes into our buildings and homes. These fumes continue to be released for years, even after the sources of the leaks are identified and repaired.

There is also a danger that the contaminated groundwater will migrate to the lakes beside our communities, threatening our recreational swimming areas, drinking water, and traditional food supplies (such as fish) on which our communities depend.

A PRACTICAL, COMPREHENSIVE PLAN FOR A SUSTAINABLE FUTURE

Current Reality: A Day-Tank Beside Each Building

To end our dependency on diesel, we need to meet our current and future energy needs using clean, sustainable energy.

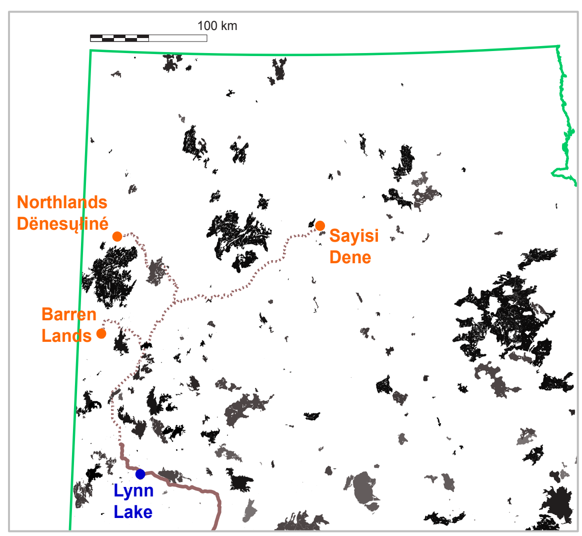
The work being done now in Northlands Dënesųłiné (the Environmental Remediation And Alternative Energy Systems—ERAAES—project[1]) shows that alternative energy systems can be installed in our communities.

As part of our Community Energy Planning, micro-grid optimization analyses (using Homer Pro[2]) were conducted for each community to determine the best mix of energy systems to meet our electricity and heat needs for, at least, the next 20 years. The results, in combination with the experience to date in Northlands Dënesųłiné's ERAAES project, indicate that six principles need to guide our planning and implementation:

- *generate base load electricity and heat using local, renewable energy sources*
- *build energy systems that can by operated and maintained by local community members*
- *use only proven technologies suitable for remote and northern communities*
- *ensure system redundancy*
- *decrease and shift peak loads*
- *improve energy use efficiency*
- *allow for future expansion*

Achieving these principles requires an integrated and comprehensive approach:

1. **Harvest local biomass for district heat and power**
2. **Provide supplemental electricity and heat through solar PV (Photo Voltaic) , battery storage, in-lake geothermal, and emergency diesel backup generators**
3. **Improve efficiency through demand-side management and smart energy controls**
4. **Research and demonstrate use of electric vehicles and motors, and micro-hydro for extreme climates**
5. **Establish and build management capacity of community-owned utility cooperatives**
6. **Integrate energy initiatives with other community-development initiatives**



Burn Areas in Northwest Manitoba – 2004 to 2015

[1]"ERAAES" is an abbreviation of "Environmental Remediation And Alternative Energy Systems". The ERAAES project was designed, in part, to serve as a demonstration and pilot project for the more comprehensive multi-community initiative being proposed here. See http://bokeconsulting.com/northlands-denesuline-first-nation/ for overview.

[2] More on the Homer Pro at https://www.homerenergy.com/homer-pro.html.

1. Harvest local biomass for district heat and power

We will use the dead standing timber left after forest fires in our region as a renewable source of biomass. Careful analysis has gone into this resource to determine if the amount of harvesting we would need to do is sustainable, and what effect the harvesting will have on our environment.

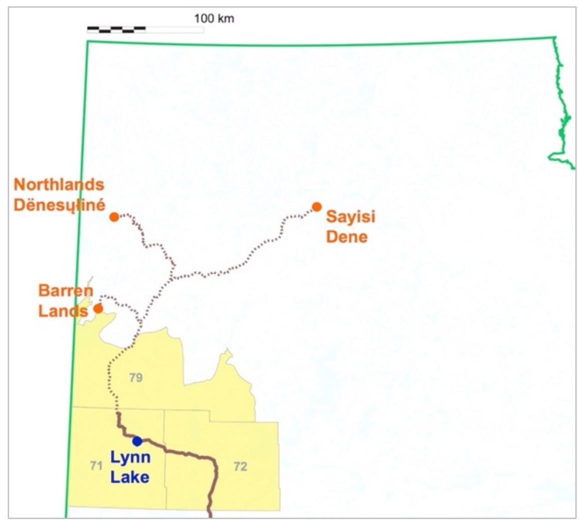
Multiple sources—including a series of masters-level theses conducted by the University of Manitoba's Natural Resources Institute and research by the Government of Manitoba's Forestry Branch—tell us that the rate of fire-kill in our area is significantly greater than the resource we will require.

If this estimate turns out to be inaccurate, or if there are a number of years with below-average forest-fire activity, the Forestry Branch indicates we will also be able to negotiate access to Forest Management Units (FMUs) immediately to the south of our three communities.

We have carefully designed our harvesting process to ensure there is no harm to the environment. That's why we're waiting at least one season after a burn (to allow needles, bark and branches to fall off), harvesting using chainsaws and sleds (rather than heavy equipment) and taking only the central pole of each tree and leaving branches on the land. It is also why we are only transporting the wood to our communities when the ground is frozen (to prevent soil damage). Working with the Forestry Branch, we will closely monitor regrowth rates and, if appropriate, reseed the burn areas we have harvested.

Wood Required When Systems Fully Implemented

	tonnes	*cords*	*m³*
Barren Lands	2,100	1,400	5,100
Northlands Dënesųłiné	2,900	2,000	7,200
Sayisi Dene	1,600	1,100	4,000
totals:	*6,600*	*4,500*	*16,300*



Forest Management Units in Northwest Manitoba

1.1. *Equipment and training to harvest dead standing wood from fire-kill areas accessible from our three communities*

- As part of the ERAAES project, using chainsaws and sleds, a team of local harvesters are currently doing this work in Northlands Dënesųłiné.
- Similar teams of local harvesters will be needed in Barren Lands and Sayisi Dene.
- The trainers used for the Northlands Dënesųłiné ERAAES project can be used for Barren Lands and Sayisi Dene as well.
- In addition to training on the safe operation and maintenance of chainsaws and sleds, participants will be trained in estimating harvesting volumes of burnt areas, and in sustainable forestry practices.

Fire-Kill Harvesting – Nov 2017

1.2. Biomass-based district heating community loops

- Biomass boilers (without an Organic Rankine Cycle system) and the initial stages of a district loop are being installed now in Northlands Dënesųłiné as part of the ERAAES project.
- Similar systems are needed in Barren Lands and Sayisi Dene.
- Once these systems are operating, the district loops can be expanded to include more buildings.

Harvested Fire-Kill in the Log Yard – Dec 2017

1.3. Combined Heat and Power (CHP) systems

- Given the fuel supply, and the heating needs in our communities, Organic Rankine Cycle (ORC) engines are the most appropriate CHP systems. They can be added to the biomass heating system.
- Systems sized to produce 600 kW of electricity, with 2 times redundancy, would be required in each community—a total of 1.2 mW of electricity.

1.4. Modern wood stoves

- It has been a long-standing practice in our communities to have wood stoves in homes. Modern, efficient wood stoves are needed.
- The heat from these wood stoves would supplement the district-loop biomass and geothermal systems and provide back-up heat, should the district energy heating loops ever fail.

2. Provide supplemental electricity and heat through Solar PV, battery storage, in-lake geothermal, and emergency diesel backup generators

These clean energy systems will supplement the biomass energy system, ensuring that the systems are resilient.

2.1. Solar PV arrays

- Each of our communities will need a solar array of 350 kW.
- A 282 kW array is being installed now in Northlands Dënesųłiné. This will need a small addition to boost it to 350 kW.
- Similar ones will be needed in Barren Lands and Sayisi Dene.

Installing Solar Panels in the Snow – Oct 2017

2.2. Battery storage

The HomerPro optimization analysis (conducted as part of the CEP) indicates that:

- A minimum of 210 kWh of storage will be needed in both Sayisi Dene and Barren Lands—approximately one 10-foot shipping container of storage.
- A minimum of 420 kWh of storage would be needed in Northlands Dënesųłiné— approximately one 20-foot shipping container of storage.

To allow for more load shifting and prepare for future demand growth, we believe 500 kWh of storage in each community is appropriate.

2.3. In-lake geothermal

Assembling Lake Geothermal Loops – Aug 2017

- 12 buildings in Northlands Dënesųłiné are currently being retrofitted with in-lake geothermal as part of the ERAAES project.
- Because the near-shore waters in the lakes beside Barren Lands and Sayisi Dene are deeper than beside Northlands Dënesųłiné, a higher percentage of houses and other buildings may be retrofitted with in-lake geothermal in these two communities. Bathymetric measurements for both communities will be conducted this summer.

2.4. Backup diesel generation for emergencies

- As these new renewable energy systems are implemented, the current diesel-electric plants could be repurposed to provide tertiary back-up emergency electrical supply.
- They could eventually be eliminated, over time, as they reach the end of their design life, and confidence in the integrated renewable-fuel systems grow.

3. Demand-Side Management and Smart Energy Controls

3.1. Retrofitting existing housing and building stock

- The CEP research indicated that, with moderate retrofits, electricity and heat savings in excess of 20% could be achieved in our buildings. Specific requirements include:
    - Energy-efficient lighting and appliances
    - Insulation, door and window retrofits
    - Aerated faucets and showerheads
    - HRV (Heat Recovery Ventilation) systems for make-up air in schools, community buildings, and homes

3.2. Smart-metering and demand management systems

- Hot water tanks currently contribute approximately 40% to the electric peak load in our homes. As the biomass-based district loops are added, our current all-electric hot water tanks can be replaced with dual-system hot water tanks. These would each have a primary district-loop-connected heating element, with a back-up electrical element.

- Smart metering of these tanks and other electrical-system draws would reduce peak electrical loads.

3.3. An integrated micro-grid to maximize the efficiency of the energy subsystems

4. Research

4.1. Research and demonstrate use of electric vehicles and motors

- Research
    - duty cycles for all vehicles types
    - electric vehicle functioning in extreme cold conditions
    - adaptation of chassis and suspensions of electric vehicles to remote community conditions
- Demonstrate use of
    - electric off-road vehicles for community infrastructure operations (including recycling initiatives)
    - electric or hybrid pick-up trucks (for general purpose transportation)
    - electric boat motors (for commercial and private fishing)
    - charging stations in extreme cold conditions

4.2. Research the feasibility of run-of-the-river-hydro

- Previous studies and current data indicate that run-of-the-river hydro may be viable in each community.
- A feasibility study is required to accurately determine:
    - Community acceptability and interest
    - The best one or two locations near each community
    - Flow characteristics at each location
    - The run-of-the-river technology most appropriate for each location
    - Ecological impacts
    - The potential dispatchable power that each installation could provide
    - Costs and benefits (both capital and operating)
    - A life-cycle cost and benefits comparison to dispatchable power from the ORC

5. Establish and build management capacity of community-owned utility cooperatives

- These entities would be responsible for hiring harvesters, and for operating and maintaining these energy systems.
- One is currently being formed in Northlands Dënesųłiné as part of the ERAAES project. Similar entities will be needed in Barren Lands and Sayisi Dene.

6. Integrate energy initiatives with other community-development initiatives

This Community Energy Plan is a significant part—but only one part—of broader community initiatives. These include:

- Waste and recycling, including the decommissioning, crushing and removal of derelict vehicles.
- Growing local, healthy food.
- Improving building standards.
- Increasing community recreation opportunities.
- Increasing community development opportunities.

Each of these initiatives requires a reliable supply of affordable, clean energy.

COSTS

- *The research undertaken for our Community Energy Plans (conducted at a prefeasibility level) indicates that the total capital cost for all these components will be between $25 and $30 million per community.*
- *Prefeasibility estimates, and the initial results of the Northlands ERAAES project, indicate that fuel, operating and maintenance costs—including hiring and paying local wood harvesters in each community—can be covered by the money* ***currently being spent*** *on imported diesel fuel.*
  - Using the results of the ERAAES project, a full business plan is being developed for the operation and maintenance of these energy systems for all three communities.
- *The diesel-electric generating stations are due for costly replacements.*
  - The replacement capital cost of the existing diesel-electric systems is more than the combined capital costs of all the systems outlined in our Community Energy Plans (CEPs).
  - The systems proposed in our CEPs would provide both electricity and heat, while replacing the diesel-electric systems would address only electricity needs.

BENEFITS

If these Community Energy Plans are implemented, Barren Lands, Northlands Denesuline, and Sayisi Dene would be amongst the leading renewable-energy communities in Canada.

Specific benefits for our communities include:

- *Reduce the cost of replacing the current diesel-electric systems*
  - Each of our communities trucks in between 1 and 2 million litres of diesel each year over winter roads—half for heat and half for electricity.
  - If capital, operating and maintenance are included, it costs approximately $1.00/kWh to produce electricity with the current diesel-electric systems.
  - Prefeasibility estimates are the ORC can produce electricity for $0.70/kWh, while also generating the heat needed for the biomass-based district heating loops.
- *Create 50 permanent seasonal and full-time local jobs amongst the three communities*
  - These 50 jobs are in addition to construction jobs created to install the energy systems, and in addition to the jobs created to retrofit the existing housing and building stock to improve their energy efficiency.
  - The majority of these 50 jobs would be created to harvest and transport fire-kill wood. The remainder would be created to operate and maintain the energy systems.
  - Because current unemployment rates in our three communities are approximately 80%, the jobs created will result in an equivalent reduction in social assistance.
- *Improve health*
  - Eliminating diesel contamination in homes and community buildings will reduce health risks. This is a significant externality not priced into the charged cost of electricity or heat.
  - Chainsaw-and-sled based harvesting will significantly improve the physical fitness of our people doing the harvesting.
- *Avoid diesel contamination*
  - Millions of dollars are spent each year cleaning up diesel contamination in diesel-dependent communities.
  - For our three communities, it costs approximately $0.30 to $0.50/litre to decontaminate the soil and groundwater for every litre of diesel trucked in. Recently, in Northlands, cleaning up one home contaminated by a diesel spill cost $50,000. These are significant externalities not priced into the charged cost of electricity or heat.
- *Eliminate contamination risk to our water and food supplies*
  - All three of our communities are dependent on our adjacent lakes for drinking water and fish.
  - Diesel contamination in the soil and groundwater risks contaminating those lakes.

BENEFITS (CONTINUED)

- *Cut GHG emissions by more than 90%*
    - 2.7 kg CO_2e[3] emissions are generated per litre of diesel consumed (not including extraction, refining and transportation emissions).
    - Implementing the energy systems proposed here would reduce GHG emissions by 10,000 tonnes CO_2e/year.
- *Build community ownership & control of energy systems*

In addition to the Community Energy Plans outlined here, our three communities are in the process of enhancing local food production and redeveloping our waste management systems. These initiatives, taken together, put us on track to become near-zero emissions communities.

NEXT STEPS

The immediate next steps are:

- *Provide training and begin to harvest local burnt wood in Barren Lands and Sayisi Dene to parallel the work already underway in Northlands Dënesųłiné*
- *Provide training and begin to retrofit houses and buildings*
    - Equipment and materials could be brought in to train and begin blow-in-insulation retrofitting
    - Local shops could be set up to train and begin building and installing high-efficiency doors, using local labour and primarily local materials
    - High efficiency lighting could be installed
    - Old, inefficient appliances could be swapped out for new, efficient ones.
- *Establish utility cooperatives in Barren Lands and Sayisi Dene to parallel the one being established in Northlands Dënesųłiné*
- *Conduct feasibility, design, and engineering studies for all components of these CEPs*
- *Demonstrate the feasibility of any required equipment—such as ORCs—not yet in use in remote First Nations communities in Canada*
- *Buy equipment*
    - Some materials (e.g. piping for geothermal and district loops) are easily available and have short supply timelines.
    - Other equipment (such as biomass boilers) are built-to-order and have longer timelines. These need to be ordered this year to be ready for next year's winter road.
    - Barren Lands has a locally-owned tugboat and barge that operates six months a year. Equipment for Barren Lands can be shipped before the winter road opens.

[3] "CO_2e" the abbreviation for "CO_2 equivalent", the standard measure used to estimate Green House Gas (GHG) emissions. This measure factors in the effects of other greenhouse gases, in addition to CO_2, when comparing fuels.