NORTHERN RECONCILIATION
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Energy Can be Innovating

Nation Rebuilding Series, Volume 8

By: Mateo Orrantia and Mercedes Labelle

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NPI – Who We Are

Land Acknowledgement

NPI would like to acknowledge the First Peoples on whose traditional territories we live and work. NPI is grateful for the opportunity to have our offices located on these lands and thank all the generations of people who have taken care of this land.

Our main offices:

- Thunder Bay on Robinson-Superior Treaty territory and the land is the traditional territory of the Anishnaabeg and Fort William First Nation.
- Sudbury is on the Robinson-Huron Treaty territory and the land is the traditional territory of the Atikameksheng Anishnaabeg as well as Wahnapitae First Nation.
- Kirkland Lake is on the Robison-Huron Treaty territory and the land is the traditional territory of Cree, Ojibway, and Algonquin Peoples, as well as Beaverhouse First Nation.
- Each community is home to many diverse First Nations, Inuit, and Métis Peoples.

We recognize and appreciate the historic connection that Indigenous peoples have to these territories. We support their efforts to sustain and grow their nations. We also recognize the contributions that they have made in shaping and strengthening local communities, the province and the country as a whole.

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Partners

Animbiigoo Zaagi'igan Anishinaabek

Our people have been present in these lands for time immemorial. Our ancestors were strong, independent people, as we are today, who moved with the seasons throughout a large area of land around Lake Nipigon. We governed ourselves using the traditional teachings we still teach our children today. Now, our community members widely scattered throughout many communities, the majority of which are located in northwestern Ontario in and around the shores of Lake Superior. We are unified by our connection to the environment, our commitment to our traditional values, and our respect for each other.

Bingwi Neyaashi Anishinaabek

The people of Bingwi Neyaashi Anishinaabek – formerly known as Sand Point First Nation – have been occupying the southeast shores of Lake Nipigon since time immemorial. Our community is dedicated to fostering a strong cultural identify, protecting Mother Earth, and to providing equal opportunities for all. Furthermore, our community vision is to grow Bingwi Neyaashi Anishinaabek's economy and become recognized as a sustainable and supportive community where businesses succeed, members thrive, and culture is celebrated.

Lac des Mille Lacs First Nation

The community of Lac des Mille Lacs First Nation is located in Northwestern Ontario, 135 km West of Thunder Bay, and encompasses roughly 5,000 HA of Mother Nature's most spectacular beauty. Our people have held and cared for our Lands and Traditional Territories since time immemorial. To fulfill our purpose and in our journey towards our vision, we, the Lac Des Mille Lacs First Nation are committed to rebuilding a strong sense of community following a holistic approach and inclusive processes for healthy community development.

Partners

Northern Policy Analytics

Northern Policy Analytics (NPA) is a community-inspired applied policy and research consulting firm based in the Yukon and Saskatchewan. Founded by Drs. Ken Coates and Greg Finnegan in response to rapidly changing conditions and opportunities in the Canadian North, NPA recognizes that Northern and Indigenous communities often experience poorer educational outcomes, higher unemployment rates, receive fewer public goods and services, and lack the economic stability needed to optimize community well-being and quality of life. Yet these communities are often located in direct proximity to some of Canada's most valuable natural resources, resulting in both opportunity and conflict.

We address both policy and economic development issues and strive to effectively bridge the gap between Indigenous communities and settler government agencies by supporting community and economic development planning, grant writing, facilitating meetings, and by supporting entrepreneurship and the development of businesses in the region. NPA also helps communities marshal the information and resources they require to improve community and economic outcomes, while mitigating the impacts of colonialism and the over-arching resource extraction sector that dominates the regional economy.

Northern Policy Institute

Northern Policy Institute is Northern Ontario's independent, evidence-driven think tank. We perform research, analyze data, and disseminate ideas. Our mission is to enhance Northern Ontario's capacity to take the lead position on socio-economic policy that impacts our communities, our province, our country, and our world.

We believe in partnership, collaboration, communication, and cooperation. Our team seeks to do inclusive research that involves broad engagement and delivers recommendations for specific, measurable action. Our success depends on our partnerships with other entities based in or passionate about Northern Ontario.

Our permanent offices are in Thunder Bay, Sudbury, and Kirkland Lake. During the summer months we have satellite offices in other regions of Northern Ontario staffed by teams of Experience North placements. These placements are university and college students working in your community on issues important to you and your neighbours.

About the Authors

Mateo Orrantia

Born and raised in Marathon, ON, Mateo is proud to call Northern Ontario home. Currently in his first year of medical school at NOSM U, Mateo tries to bring an interdisciplinary approach to problem-solving. A firm believer in a self-directed and diverse North, he wants to apply his experiences in research and grassroots activism to help foster stronger and more sustainable communities across Northern Ontario. After spending his last few summers working at Pukaskwa National Park, Mateo has become passionate about protecting the region's unparalleled natural resources. Unsure of where his future will take him - other than back to the North - Mateo has gotten involved with initiatives across disciplines, from Strength & Conditioning coaching, to literary research and student governance. When he's not working, Mateo enjoys strength training, reading, and exploring the outdoors (which usually results in a little too much bushwhacking).

Mercedes Labelle

Mercedes Labelle graduated from McGill University in 2020 with an Honours Bachelor of Political Science and Urban Systems. During her studies, she focused on Canadian politics and public policy processes, specifically researching the uneven distribution of benefits and services between urban and rural communities. Having grown up in Canada, the United States, and Spain, Mercedes is eager to return to Northern Ontario, where her family now resides. In her free time, Mercedes enjoys listening to podcasts, cooking, and reading.

Contributions by Larissa Yantha, Charles Cirtwill, and Rachel Rizzuto.

Table of Contents

Executive Summary

This paper examines energy infrastructure design. The communities studied – T'Sou Ke, Gull Bay, Ouje-Bougoumou, Peguis, Fisher River, and North Bay - all had the goal of greater energy autonomy and incorporation of green technologies where possible. Some communities were previously reliant on basic build energy infrastructure, like diesel generators. Others had grid connection but felt there were more environmentally friendly and efficient ways of producing energy for their communities. Through innovative energy infrastructure designs, created through community engagement and education, and with local capacity building at the forefront, these goals were able to be met.

This paper illustrates examples of successful and best practices in the Canadian-Indigenous and non-Indigenous context. By doing so, First Nations communities, and beyond, will have more tools to reference when looking to undertake new infrastructure projects.

The **best practices** identified in this case study analysis include:

- Designs that are specific to the selected community's needs and take advantage of local opportunities, as identified through extensive community conversations;
- Full, but delayed, community ownership over the energy infrastructure project;
- Construction of the infrastructure by local community members, in turn building capacity; and,
- Community education initiatives to establish an understanding and sense of ownership over the new technologies and their proper uses and benefits.

The case studies also revealed what, when possible, the following practices should be **avoided:**

- Timelines that do not account for the innovative nature of the technologies, and/or a community's northern and/or remote location; and,
- Reluctance to switch from the basic build status quo infrastructure due to the high upfront costs of making the change
- Projects that are not "driven by, and for", the community

Introduction

Successful infrastructure development goes hand-in-hand with economic and social success and will be of utmost importance for Indigenous and non-Indigenous communities across Canada as they set their sights on recovery and prosperity in a post-COVID world. However, conversations around Indigenous energy infrastructure development in Canada take place against a backdrop of failures largely fostered by the "basic build" approach to infrastructure funding and construction. Basic build infrastructure often follows a "blanket approach" to funding, design, and construction, without accounting for a community's unique needs and circumstances, which will be demonstrated by looking at cases from Pikangikum and NunatuKavut.

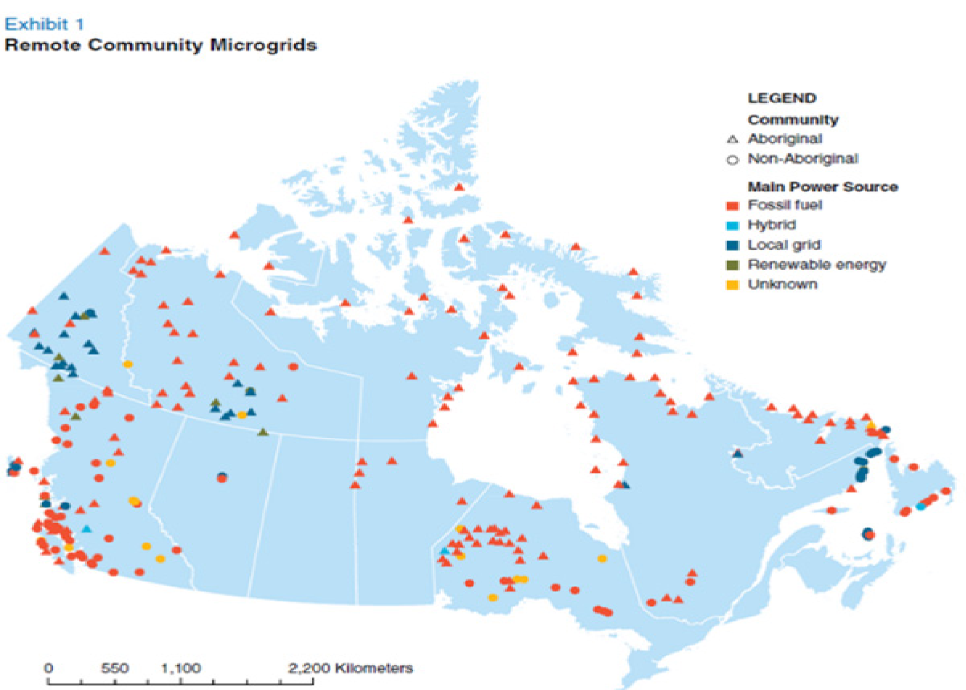
Although the basic build approach can sometimes allow for quicker infrastructure development with lower up-front costs, it often leads to negative project outcomes. The significant benefits associated with more innovative methods of design, on the other hand, far outweigh the obstacles—emphasizing the importance to shift away from the historically-used basic build approach towards more innovative methods.

The Basic Build Approach

First Nations communities are often incentivized to pursue minimally acceptable infrastructure projects in order to meet funding requirements. While arguably acceptable at the time, these projects are often not financially sustainable in the long-term.

Diesel energy systems have been widely implemented in remote communities due to their “technical simplicity and general reliability in normal operating circumstances” (McRobert, 2016, 3). Primary concerns surrounding basic build diesel generators relate to heat insecurity, and energy systems dependent on external control, support, and imports (Mercer et al, 2020). Basic build energy infrastructure, like diesel generators, can have long-reaching effects on communities, impacting day-to-day operations, such as schools, hospitals, and overall health. Not only does diesel have to be transported en masse to remote communities throughout all seasons, but a disruption in the supply can leave communities without power, or rationing it via strategic blackouts, for days on end. Though some communities attempt to supplement heating needs through alternative energy sources, such as wood burning, many still heavily rely on diesel due to continued dependence, familiarity, and high switchover costs.

Figure 1: Remote Community Microgrids and their main power source, August 2018



Source: Natural Resources Canada, 2018

Pikangikum First Nation, ON

Pikangikum First Nation is an Ojibwe First Nation located in the Kenora District in Northwestern Ontario, 500 kilometers northwest of Thunder Bay with a self-reported population of about 3,000 residents (Whitefeather, n.d.). In the case of this First Nation, the basic build energy infrastructure – diesel generators – have become more costly to operate and maintain than their innovative, green energy counterparts. In addition to the adverse effects on health and current infrastructure interruption, insufficient basic build energy systems – with no room for expansion or updating - can hinder communities from further infrastructure advancements, such as adding wastewater systems or running water to the existing on-reserve homes, due to the insufficient capacity of existing energy systems (Pikangikum v. Nault, 2010, para. 28).

Prior to 2018, Pikangikum operated a costly, fuel-intensive diesel generating system despite more economic options available, due to lack of financial and other resources necessary to make the transition. The diesel generator system used was approximately 40 years old and had undergone several major upgrades to extend its lifespan (Wataynikaneyap Power, n.d.). In fact, it was estimated that "power that was being created by diesel generator at a cost of $3,580,650 per year would be available at a cost of $358,429 per year for a saving of $3,222,221 per year [with connection to the power grid]" (Pikangikum v. Nault, 2010, para. 28). The high costs of diesel generation do not only negatively affect the community, but also various levels of government. Due to the high costs, various levels of government are required to provide significant subsidies to keep rates affordable for consumers (Mercer et al, 2020, 3).

Using diesel generators is not only costly, but also inconsistent. As noted in a response to the proposed amendments to Ontario Regulation 442/01, "During the coldest days in winter, First Nations in northwestern Ontario are sometimes forced to close their schools and public buildings, due to diesel shortages, equipment breakdowns or other problems" (McRobert, 2016, 3). For example, in 2016, the reserve's main diesel generator broke down, requiring the community to operate on a system of rolling blackouts for several days. When the generators are running, diesel fuel must be transported to the remote community by plane or truck, further increasing heating costs while increasing external reliance on fuel, thus reducing reliability (Bombicino, 2016). Additionally, unreliable generators interrupt educational infrastructure such as WiFi routers, internet serves and laptop computers. Prior to connection to the power grid, Pikangikum's reliance on diesel generators resulted in as much as 20 per cent of the educational year being lost to school closures due to power outages (Brooke & Moore, 2017, 44).

Use of diesel fuel is also a risk to human health. Diesel-based power generation and furnace emissions contributes to poor indoor air quality, which can exacerbate respiratory, health and other ailments (Golder Associates Ltd., 2017). Climate-wise, diesel generator use is destructive to the environment as it is responsible for emitting large amounts of carbon dioxide, among other pollutants, into the atmosphere (Kennedy, 2017, 1). When cleaner, greener options are available, and less costly in the long run, alternate energy sources will reduce many negative impacts on human and environmental health.

Basic build diesel generators can also hinder further development. Indigenous peoples, on average, have higher birth rates than non-Indigenous Canadians. Pikangikum is no exception – the community is growing rapidly, and the diesel generation system is not sufficient to meet increasing demands. For example, new water and sewer projects would be dependent on additional reliable electrical capacity to run pumps for the distribution of fresh water and pumps to lift sewage up to the sewage lagoon (Pikangikum v. Nault, 2010, para. 28). For these infrastructure advancements to occur, a more reliable source of power, such as connection to a grid, is needed as diesel has been shown to be unreliable. Thus, these updates have been stalled as a result of insufficient funding to transition to more reliable systems (ibid).

Watay Power stated: "The need for clean, reliable, and sufficient power is crucial to the community and cannot be satisfied without a wholesale replacement/upgrade of the diesel generating station" (Wataynikaneyap Power, n.d.). The connection to grid power was essential for the community's continued advancement. Basic build diesel generators have hindered the community's progress up until 2018 – when the transition began to connect the community to the power grid. Pikangikum First Nations fought for grid connections for two decades prior to receiving it (Pikangikum v. Nault, 2010, para. 177). As noted by Doug Keshen, the Band's former lawyer, "Had the grid been connected back in the early 2000s, these annual savings could have been funnelled back into the community or used to pay for the project itself" (Bombicino, 2016). The transition will aid in further development of Pikangikum.

NunatuKavut Inuit, Labrador

The Southern Inuit of NunatuKavut, Labrador, rely on diesel-generator and home-heating sources, such as wood, as energy sources in their communities (Mercer et al, 2018). The specific communities of Black Tickle, Norman Bay, and St. Lewis will be analyzed as cases of basic build energy infrastructure used for heating. Currently, all three communities are exclusively dependent on diesel-fuel for electricity generation, though some alternative sources are used for household heating.

Figure 2: Primary Household Heating Source by Number of Community Respondents

Primary Heat Source	Black Tickle	St. Lewis	Norman Bay	Percentage of Total
Oil	11	2	0	17%
Wood	11	30	6	63%
Electric	8	1	0	12%
Wood/Oil Mix	3	3	0	8%

Source: Mercer et al, 2018, 15, n = 75

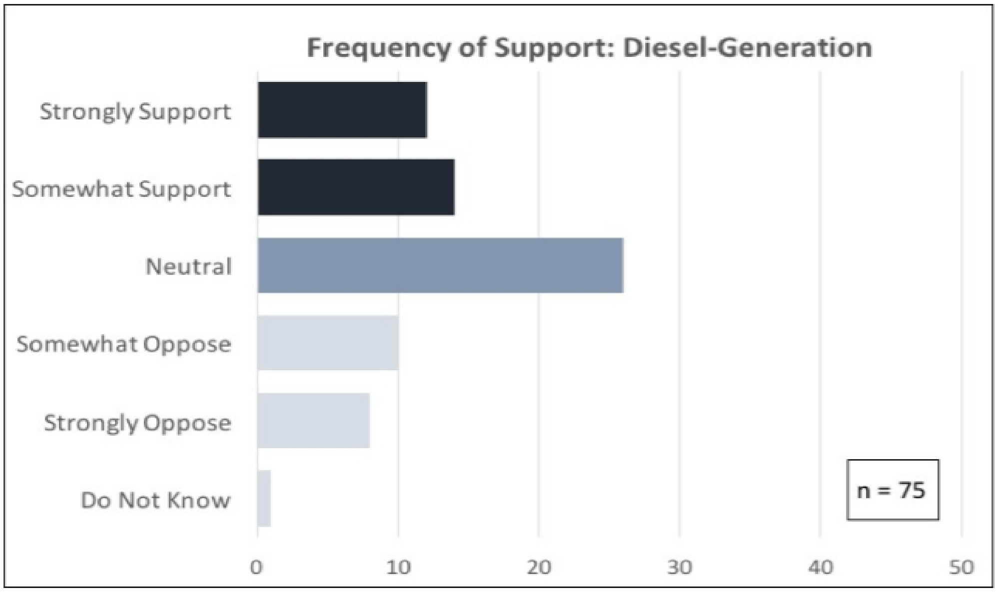
In the community of Black Tickle, the greatest energy-system concern was related to heat insecurity, both in terms of secure supply of a heating source, as well as price volatility of fuel sources (Mercer et al, 2018, 14). Heating fuel in the community – wood, furnace oil, and electricity – are noted as being restricted across all sources. Additionally, the location of the community results in added difficulty in obtaining energy sources; Black Tickle is located on a tundra island with no locally available wood source. As such, the 42 percent who rely on wood (or a wood and oil mix) must travel approximately 60 to 80 kilometers (round trip) via snowmobile to harvest firewood. These trips, though recognized as an important cultural tradition, can be expensive, time-consuming, and emissions intensive (ibid, 15). The difficulty in obtaining wood contributes to the relatively high reliance on oil in Black Tickle, compared to the other two communities. Due to a 2015 discontinuation of fuel storage and sales of furnace oil and gasoline to the community, Black Tickle Local Service District has been forced to import the fuel sources into the community, adding to the vulnerability of supply disruptions. Limitations are felt year-round, as supplies can only be brought in via freight ships in ice-free months (Mid-July – Mid-December) (ibid, 16).

The top energy-related concerns in St. Lewis are interdependent; they surround the themes of utility dependence and desire for energy autonomy; the community fears escalating energy costs and outside control of energy (Mercer et al, 2018, 16). 92 per cent of respondents in St. Lewis rely on wood-heat (or a wood and oil mix). Those using wood expressed satisfaction with hydro costs, with some paying approximately $30 to $35 per month. On the other hand, respondents with electric heaters pay approximately $350 to $700 per month, depending on the season (ibid, 18). As the population ages, it becomes more difficult to access wood for heating, pushing older community members towards electric (diesel-powered) heat.

The six interview respondents in Norman Bay identified the affordability and continuance of energy subsidies as the highest individual concerns (Mercer et al, 2018, 21). All respondents rely on wood-heat as a means to minimize their electricity bills. Though wood is used to heat buildings, the community relies on diesel energy to pump water from a local source, since there is no municipal-supplied water source in the community.

It is important to note, while respondents are interested in improving environmental aspects of their energy system, they wish to maintain the socio-economic benefits associated with diesel-generation as well (Mercer et al, 2018, 28). The community is comfortable and familiar with diesel generation and might be hesitant to convert to a lesser known, new form of generation. The majority of respondents are neutral on the "social acceptance" of diesel generation or are strongly or somewhat supportive of diesel-generation (see Figure 3).

Figure 3: Frequency of Support – Diesel Generation – Black Tickle, St. Lewis, Norman Bay, 2018



Source: Mercer et al, 2018, 28

Outcomes

Basic build energy infrastructure can hinder economic and social developments within the communities it is implemented. Alternative generation technology options exist, such as wind, solar, tidal, biomass, or connection to the electrical grid. Pikangikum First Nation, who previously relied on diesel generation, established a connection to the provincial power grid through Wataynikaneyap Power. Having a stable, less costly energy supply allowed the community to carry out multiple upgrades and builds to existing infrastructure, such as installing sewage systems in houses and not having to revert to strategic blackouts to conserve their short supply of diesel.

In addition, diesel generation often goes against Indigenous peoples' environmental sustainability beliefs. The Southern Inuit cited fossil fuel consumption and pollution as another concern throughout the community. Not only were environmental concerns a factor, but also the long-term availability and possible future scarcity of fossil fuels (Mercer et al, 2018, 29). But, since these systems are already in place, there is often a desire - either by funders, government, or communities themselves - to follow the path of least resistance, which means maintaining the status quo of diesel generation. The tendency to uphold whatever infrastructure system is currently in place contributes to failing basic build infrastructure projects throughout Indigenous communities. While, in the short term, this option seems sufficient, diesel generation can impede further community development by creating reliance on government subsidies and outside sources for supply of diesel (ibid, 29).

For the Southern Inuit of NunatuKavut, wind and solar generation had the highest levels of support throughout the communities surveyed – far surpassing support for the status quo (Mercer et al, 2018, 23-24). There is awareness in the communities of what is, and is not, working. With this, not all Indigenous peoples are adamant about replacing diesel generators with newer, less familiar energy sources. Indigenous communities across Canada are not a homogenous group, meaning a one-size-fits-all approach to infrastructure development is not adequate in addressing communities' unique needs. Location, resources, skills, and preferences must be taken into account when formulating and implementing infrastructure projects.

A common theme throughout the communities was needing more information about clean, alternative energy sources. As it stands, diesel is familiar and jobs in the community exist because of it. The willingness to learn more about alternative energy sources again emphasizes the importance of community engagement and input during the formative stages of infrastructure developments. To start, energy efficiency and innovation can come from more than just generation; it can also tie into what was talked about in the housing infrastructure paper (see Volume 7) – whereas passive improvements, such as selecting environmentally friendly insulation and LED lightbulb, reduces household electricity consumption (Mercer et al, 2018, 36).

Case Studies: Innovation in Practice

T'Sou Ke First Nation, British Columbia – Solar Project

Project Overview

Community Specifics: T'Sou Ke has a population of 290. The community is connected to the power grid.

Challenges: The community wanted to find a way to live according to the Seven Generations' teachings - the principle that each decision a community makes should benefit members approximately 100 years into the future, meaning an environmentally friendly energy system was a priority.

Solution: A three-part solar project: the installation of solar panels and solar water systems, and a community energy conservation program

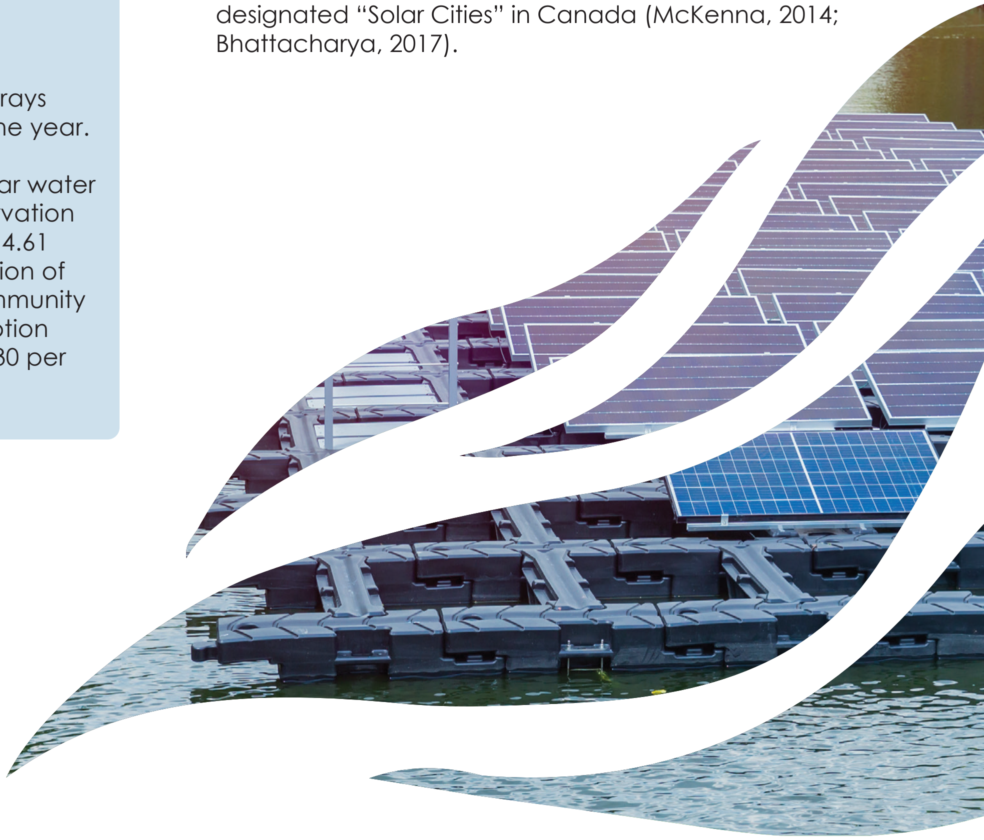
Funding sources: There were 16 different funding sources for the project, both public and private. Initial funding was provided by Natural Resources Canada's Innovative Clean Energy Fund.

Cost: $1.25 million for all three elements

Project length: The installation of the solar arrays and hot water systems were completed in one year.

Outcomes: Solar panels were paired with solar water heaters in homes and the community conservation plan, reducing greenhouse gas emissions by 4.61 tonnes of CO_2 per year. Through a combination of technical and behavioral measures, the community has succeeded in reducing energy consumption in community homes and buildings by 20 to 30 per cent.

T'Sou Ke First Nation is a small First Nation of approximately 290 members, located near Victoria in British Columbia (INAC, 2020). Despite being connected to the power grid, the community has taken a revolutionary approach to energy autonomy. In 2007, they began their journey towards renewable energy development by undertaking the development of a Comprehensive Community Plan, and eventually installed what would become the second-ever Indigenous solar project in B.C., and (as of 2017) the second largest in the province (Bhattacharya, 2017). Solar panel installations were paired with solar water heaters in individual's homes, and a community-wide energy program—an innovative holistic approach to energy and environmental stewardship. Since the project's completion, they have come to be regarded as a national leader in Indigenous energy and renewable development, becoming one of only four designated "Solar Cities" in Canada (McKenna, 2014; Bhattacharya, 2017).



Initial Stages

The seeds for the solar project were sown in 2007, when project manager Andrew Moore introduced Community Comprehensive Planning (CCP) to the community. The first planning phase was to create elder and leader groups that met every three weeks for a year to establish a vision for the community. Then, the community developed ideas based on that visioning process and refined them with the community at large through meetings and workshops (Bhattacharya, 2017). A principal idea that came from the CCP process was finding a way to live according the Seven Generations' teachings—the principle that each decision a community makes should benefit members approximately 100 years into the future (Schmucker & Lorimer, 2018). In accordance with the Seven Generations' teaching, one of the main goals arising from the CCP was achieving community energy autonomy, which can be achieved by becoming net energy neutral. Generating more power than they consume (Bhattacharya, 2017). To this end, the solar project was decided on by the community because the reserve receives great exposure to sunlight. Additionally, one of the band members had previously worked with solar technology, and had some expertise in the area (Bhattacharya, 2017).

To fund the project, which would come in at $1.25 million[1] for all three elements, the First Nation had to look to multiple avenues—a total of 16 different funding sources, both public and private, were necessary to complete this project (Bhattacharya, 2017). The First Nation had to leverage the money they had initially received from Natural Resources Canada's Innovative Clean Energy Fund to secure funding from most of the other sources (Bhattacharya, 2017). Despite being the only option, the large number of different funding sources would present significant difficulties in having to fulfill conflicting funding requirements and meet the different timelines of each funding body, which significantly delayed the project (Bhattacharya, 2017).

The First Nation also remarks financial related challenges in starting the project due to an initial lack of buy-in from B.C. Hydro, who the First Nation had to convince to get on board. It is hypothesized that this may be because the project would lessen the First Nation's dependency on their services and reduce the fees they were paying to the company (Bhattacharya, 2017).

Design and Construction Process

The main design elements of the T'Sou Ke solar project arose from the CCP process, wherein the community was able to establish the main parameters for the project. From there, project design involved significant dialogue between project champion Andrew Moore, the community, and the private partners working on the project (T'Sou-ke First Nation, 2009). In this way, the project remained community-directed throughout.

In deciding on its private partners, the First Nation was adamant about only partnering with someone who would be willing to train and employ community members throughout the project. As a result, they partnered with First Power and Home Energy Solutions, which gave 11 community members in nine communities certifications to become solar installers (Carr-Wilson & Pai, 2018). To do so, the partners developed custom training programs that were sensitive to the learning styles of the community members (INAC, 2011, 19).

[1] Of note: a similar system was estimated to be 65 percent cheaper in 2014, and is likely even cheaper now, due to a reduction in the cost of materials (Bhattacharya, 2017)

Design Elements

The solar panel aspect of the project is comprised of solar arrays on three buildings in the community, as well as one array mounted near the community administration building. The largest array is a 39.9kW system on the Band's canoe shed, which exports power directly to the grid, generating revenue for the community (Bhattacharya, 2017). There is a 24.4kW ground-mounted solar system that generates some power to be used by the administration building and exports the rest to the grid. On the administration building itself, there is a 7kW array that charges a battery bank that will power the building in case of power outage—it has enough power to maintain communications, heating, appliances, and power medical equipment. Finally, there is a 6.3kW system attached to the roof of the community fisheries building that simulates an off-grid system. This array provides 57.2 per cent of the power for the building, while the rest is provided by the grid (Bhattacharya, 2017).

The second element of this project is the solar hot water systems, of which there are 40 individual units mounted on homes in the community. These systems consist of a solar collector mounted on the roof, a pump for circulating the heat transfer fluid, and two storage tanks for storing the hot water when there is no sun (Bhattacharya, 2017). These systems, by using the sun to heat water for the homes, can result in significant energy savings (Ozog, 2012).

The energy conservation program is the third element of the project and has two main goals: the reduction of energy consumption through behavioral change, and the reduction of energy consumption through small technical changes to existing buildings' energy systems and structural components (Bhattacharya, 2017). To help achieve the goals of this part of the project, the Band formed the T'Sou-Ke Smart Energy Group, which was comprised of four young adults from the community and a mentor (Bhattacharya, 2017). This group advocated for energy saving measures across the community, designing, and holding energy conservation workshops for all ages, including arts and crafts activities for children aged three-to-five and Eco Bingo and crafts for Elders (Bhattacharya, 2017).

As it pertains to the technical aspects of energy conservation, home energy audits were performed across 86 on-reserve homes by City Green Solutions. They tested for air leakages in the houses through doors, outlets, and windows—among other things. Using this information, the group also helped implement B.C. Hydro's energy conservation program, which is available for free on reserves. This included installing energy saving products for lighting, heating, insulation and draft proofing, and personalized energy education (Bhattacharya, 2017).

Project Completion and Outcomes

The installation of both the solar arrays and solar hot water systems was completed in 2009, just one year after the CCP process was completed by the community (Schmucker & Lorimer, 2018). Initially, there were some issues with the wiring of the energy system, which were resolved in just under a year (Bhattacharya, 2017). The Band experienced significant difficulties in getting Hydro officials to come and investigate the issue. It was not until the 2010 Olympics that the community was able to get someone to come investigate (Bhattacharya, 2017). Since then, the project has had a massive longstanding impact on the community while contributing both financial and non-financial benefits.

In terms of energy production, the solar panels produce approximately 87,900kWh of electricity annually, of which 23 per cent is consumed by the Administration and Fisheries buildings. (According to BC Hydro, a typical home generates 4 kWh capacity and generates 4400 kWh per year. This is the equivalent of 20 homes supplying about 40 per cent of home electricity needs.) The remaining 67,267kWh is purchased by the B.C. Hydro grid at a rate of 9.99 cents per kWh, which generates revenue for the community. The panels can provide 92 per cent of the power for the Administration building annually, with the remainder being purchased from B.C. Hydro (Bhattacharya, 2017). The buildings are fully supplied by solar power in the summer but need to purchase B.C. Hydro power in the winter (Bhattacharya, 2017).

Over the first year, the systems were able to generate $5,389 in revenue for the community. At the time of their completion in 2009, payback times for the systems ranged from 19.6 years to 7.8 years, making their economic feasibility questionable. However, using figures from 2014, their payback times ranged from 4.1 to 6.8 years making them easily economically viable, and quickly profitable (Bhattacharya, 2017).

The solar water heaters have shown mixed results. Technical difficulties and operational barriers have made it such that only around 20 of the 40 systems installed are still functional. Where functional, these systems have succeeded in reducing water heating diesel energy demands by up to 20 per cent per home (Bhattacharya, 2017).

On the other hand, the community energy saving measures have been a resounding success. Through a combination of technical and behavioral measures, they have succeeded in reducing energy consumption in community homes and buildings by 20 to 30 per cent (Bhattacharya, 2017). They have been able to use this program to foster a community identity of sustainability and leverage the mentorship aspect of the initiative to generate capacity and community engagement in local youth (Bhattacharya, 2017). Looking back, community project champions have identified this part of the project as both the most cost-effective and important to achieving positive environmental outcomes "[without a conservation program] all of that great renewable energy you produce goes right out the leaky windows" (Ozog, 2012).

Altogether, the community was able to reduce their greenhouse gas emissions by 4.61 tonnes of CO_2 per year. Interestingly, because 90 per cent of B.C. Hydro's energy is produced through hydroelectricity, the installation of solar panels resulted in a slight increase in emissions. It was only when coupled with the community conservation measures that emission reductions were made possible (Bhattacharya, 2017).

T'Sou-Ke First Nation experienced economic benefits from the project as well. In employing community members during the project construction and helping them obtain valuable training, the community helped generate significant capacity in its workforce (Bhattacharya, 2017). After the project, eleven community members went on to become CANSIA certified solar installers (Bhattacharya, 2017). This provided an opportunity for the community to diversify its economic base and lessen its dependence on resource extraction industries (Bhattacharya, 2017). Four Band members went to work on solar installment projects in neighbouring communities, while the other members feel as though they have gained a diverse set of skills that will help them in search of future employment (Bhattacharya, 2017).

The Band has been able to use the solar project as a way to showcase themselves as an innovative community and as a leader in renewable energy (Bhattacharya, 2017). The Band now provide solar tours and energy conservation workshops to around 2,000 visitors each year from other First Nations, schools, institutions, and municipalities—which help bring in additional funds for the community (Schmucker & Lorimer, 2018). Further, they have been able to form renewable energy partnerships with other local First Nations, helping them develop their own projects (Ozog, 2012). Their success has also helped them become more prominent political figures, forming the District of Sooke-Climate Change Action Committee, and being selected by the government to mentor other communities on CCP (Bhattacharya, 2017).

Finally, the Band has been able to use their success with the solar project and the increased visibility it brought them to motivate further sustainable development on their lands. Since completion, they were able to start a commercial wasabi project, an 82-hectare oyster farm with Chinese partners, a community garden, and a wind power project on Vancouver Island (McKenna, 2014). Clearly, the solar initiative helped create a community identity based on both sustainability, innovation, and economic entrepreneurship.

Kiashke Zaaging Anishinaabek (Gull Bay First Nation), Ontario[2] - Solar Project

Project Overview

Community Specifics: Gull Bay First Nation has approximately 1,459 members, 374 of which live on-reserve. The community is located along the shore of Lake Nipigon. The community is not connected to the power grid and so there is not an opportunity to raise revenue directly from generation

Challenges: Previously, the community solely relied on diesel generation, resulting in unreliable electricity as well as serious environmental consequences. The generators were also impeding the growth of the community due to the extremely limited capacity of the generators.

Solution: The creation of a solar micro grid. The solar array is made up of 1020 solar panels rated at 360-kW/DC, along with 81 lithium-ion battery modules rated at 300Kw/555kWh, which store excess energy produced by the panels.

Funding sources: Ontario Power Generation, Hydro One, the Independent Electricity Systems Operator, and both the federal and provincial governments provided funding. Specifically, much of the funding came through the Northern Ontario Heritage Fund (NOHFC), Ontario's Smart Grid Fund, and the LDC Tomorrow Fund.

Cost: 8 million of funding was acquired through sources external to the community. It is not specified if, and what, the Band contributed to the project. The total project cost was between $8-$9 million.

Project length: Construction began in 2018 and lasted until August 2019. The testing and commissioning phase started in the summer of 2019 and was still ongoing as of June 2020.

Outcomes: The community now has a solar-diesel hybrid model which has contributed to a reduction in diesel usage and CO_2 emissions. As of June 2020, the community had offset 60,650L of diesel through the array's production, equivalent to around 200 square tonnes of CO_2.

KZA, commonly referred to as Gull Bay First Nation, is a First Nation located roughly 175 kilometres north of Thunder Bay, along the shore of Lake Nipigon. It counts a total registered population of 1,459 members, approximately 374 of which live on the Gull Bay reserve (AANDC, 2020). For years, the reserve has been completely powered by a diesel generator, resulting in unreliable electricity as well as serious environmental consequences. Water from Lake Nipigon, on which Gull Bay First Nation resides, is used to supply power up to 290,000 homes, but the reserve was never connected to the grid (CTV News, 2019). Wanting a power supply that was more reliable and in line with Indigenous ways of life, Gull Bay First Nation entered into a partnership with Ontario Power Generation (OPG) in 2014 to create a first-of-its-kind solar micro grid to power the community.

[2] Unless otherwise indicated, information about this case study was provided via interview with AJ Esquega, Gull Bay First Nation, ON, June 26, 2020.

Initial Stages

In the 1920s and 1940s, OPG built a series of dams along the Nipigon and Okogi Rivers, which led to the flooding of traditional Gull Bay First Nation lands and the destruction of the First Nation's burial grounds, homes, and buildings (CTV News, 2019). In the 2000s, the First Nation filed a suit against OPG for those injustices. In 2014, the suit was settled for $12.5 million. After the settlement, Gull Bay First Nation approached OPG with the idea of collaborating on a project as an opportunity for OPG to work towards reconciliation with the community. During this time, the community was undergoing both a comprehensive community planning and energy planning process and had determined that they wanted to pursue renewable energy development. The current generators, in addition to being extremely harmful to the environment, were impeding the growth of the community due to their extremely limited capacity (CTV News, 2019).

It was agreed that OPG would take on the administrative aspects of the project, like pursuing funding and permits at the government level, so that Gull Bay First Nation administrators and council members would be able to both learn throughout the process and not become more burdened than they already were. In 2017, the $8 million in funding required was secured from sources external to the community—OPG, Hydro One, the Independent Electricity Systems Operator (IESO), and both the federal and provincial governments all contributed to the project (Charlebois, 2020). Specifically, much of the funding came through the Northern Ontario Heritage Fund (NOHFC), Ontario's Smart Grid Fund, and the LDC Tomorrow Fund[3] (APPrO, 2018). Help on the project also came from a variety of sources: Hydro One Remotes, MaRS, Lumos Energy, and ABB collaborated on the project (APPrO, 2018).

It was also established from the start that Gull Bay First Nation would assume 100 percent ownership of the project once it was completed, which would be the first time that OPG did not have ownership over a project they worked on (CTV News, 2019). The ownership agreement had a built-in clause that the First Nation would not assume ownership until all assessments are complete, to make sure that the system was fully functional before taking on responsibility for it. This was an innovative step in-and-of itself, protecting the First Nation against being left with a piece of infrastructure that did not work which has historically been an issue for First Nations infrastructure projects.

[3] LDC Tomorrow Fund did provide some private funding, but it was not comparable to the level of funding provided by NOHFC and Ontario's Smart Grid Fund. As an example, LDC Tomorrow Fund provided about one-third the amount of funding as IESO.

Design and Construction Process

To develop the community's energy plan, extensive community consulting was done, both in large public and small private forums. Together, the community decided to pursue solar development because there was a greater understanding of it among community members, it had a much smaller footprint than alternatives such as wind, and the environmental assessment processes were also easier to compete.

In terms of the technical design aspects, significant collaboration from multiple actors helped bring the innovative design to fruition: DNG VL, ABB, Hydro One Remotes, ALLTRADE, Stantec, and MaRS all helped work with OPG to help design the system according to the community's needs. OPG handled many of the meetings with these collaborators, given that no one at KZA had experience working on this sort of project. This helped build capacity in the First Nation and helped ensure that their needs were being communicated effectively, by those that had experience in the sector.

Significant efforts were made to involve Gull Bay First Nation community members at all stages of the project. KZA residents helped work on the project through the construction phase, while two young interns from the community were placed on the project to gain experience in project coordination and working on the administrative side of such endeavors. The community Energy Projects coordinator, AJ Esquega, held educational workshops, site tours, and sent out seasonal newsletters to help build understanding of the project, and foster acceptance among community members. Special attention was paid to involving all demographics. For example, clean energy bingo was hosted for the community's elders. These events included information on how to reduce personal energy use and encouraged demand-side energy reduction.

There were also visits to regional schools to mentor youth in renewable energy. Efforts were even made to involve the local police force in the project in the pursuit of full community integration in the project. The community was given ample opportunity to provide input (and say no) throughout the project, but overall, it was very well-accepted. This is additionally evidenced by the fact that, although trespassing and theft had been an issue for previous projects, the solar project was left completely undisturbed throughout the process. Looking back, community members involved in the project describe the newsletters and community education as integral, as they were able to keep the community engaged and help build community support. Combined, these initiatives helped to generate a sense of pride and a feeling of project ownership in the community (Henriquez & Paquette, 2020).

Before construction could begin, permits had to be obtained from the federal government, which proved to be very difficult. The First Nation wanted an exemption from the full environmental assessment process, because the community had already decided that the area was acceptable to build on, based on intimate knowledge of the area. However, it wound up taking a significant amount of advocacy on the part of the involved parties to obtain the relevant permits, which were not sent until two days before construction was set to begin. Construction began in 2018, and lasted into 2019, which proved to be slightly longer than what was expected. Gull Bay First Nation's remote location proved challenging for construction, as supplies and backup tools would take about a day to arrive from Thunder Bay, should they be needed.

Design Elements

The solar array is made up of 1020 solar panels rated at 360-kW/DC, along with 81 lithium-ion battery modules rated at 300Kw/555kWh (Burger, 2019) which store excess energy produced by the panels. The panels are installed on helical piles above the ground, covering an area approximately equal to one soccer field. The entirety of the system is managed by a computerized controller (built in collaboration with ABB and Hydro One Remote) that functions with minimal overview, resulting in low operation burden for the community (Burger, 2019). The controller will also collect data on the system that OPG will use as proof-of-concept for future microgrid projects. The community employs a systems operator to do daily checks and monitor the system, reporting to technicians or service providers when problems arise. The entirety of the battery bank, controller system, breakers, and inverters are contained in two small, prefabricated units that were shipped to the reserve.

The solar array is directly tied into the community microgrid along with the diesel generators. When the batteries are 80 percent charged, the controller system turns off the diesel generators and switches the community power supply over to solar. When charge falls below 20 percent, power is shifted back to diesel. The transitioning process is entirely automated and takes approximately 15 minutes, though there is no service interruption or energy flicker for those in the community (Burger, 2019).

Project Completion & Outcomes

The project was completed in August of 2019, and a large ceremony was held in the community to mark the occasion, bringing all project collaborators together. The emphasis of the celebration was on instilling pride in the community and changing the perception of energy from a colonial one to a community-based reality (Henriquez & Paquette, 2020). At this ceremony, the community had its first experience of the power shifting to solar and the generator shutting off. This was the first time in years that the generator had shut off of its own volition, and the moment became powerful symbol marking a transition for the community towards a renewable future (Burger, 2019).

Since then, the solar panel has produced energy as expected, though there have been issues with the system, due to the innovative nature of the project. The testing and commissioning phase, which was expected to take a few weeks at the end of the summer in 2019, was still ongoing as of June 2020. This is in large part due to the fact that OPG has never designed a system like this, so there have been various issues with the computerized elements of the projects like the controller and data collection. These issues have had the unexpected positive consequence of allowing the community operators to become more comfortable with the system while knowledgeable technicians are on-site. This issue has also highlighted the importance of the ownership agreement that Gull Bay First Nation brokered at the beginning of the project—because the project is not 100 percent complete, Gull Bay First Nation has not yet assumed ownership, and OPG must carry responsibility for solving the issues. This has saved the community from the significant financial commitments and administrative burdens that it would incur if they had to resolve the issues themselves.

These issues have not stopped the panel from providing energy for the community at levels predicted during the start of the project. The solar array generally supplies the community's power from an hour after sunrise to an hour after sunset, allowing the diesel generator to stay off for most of the day—significantly reducing environmental and noise pollution while also extending the life of the generator. As of June 2020, the community had offset 60 650L of diesel through the array's production, equivalent to around 200 square tonnes of CO_2. The community is confident that they will surpass their goal of offsetting 117,000L of diesel annually.

The project has significantly impacted the community outside of energy production. By working hand-in-hand with OPG, the administrative body of the community was able to build significant capacity and gain skills in the development of energy projects. The success of the project has motivated the community to continue pursuing development in innovative renewable energy technologies and has led to a feeling of increased confidence in being able to take on such projects. Initiatives to build youth and community interest in renewables throughout the project, combined with the rousing success of the initiative has generated significant pride in the community and optimism for the future (Henriquez & Paquette, 2020). The new energy system will facilitate further economic development, better health outcomes, and further infrastructure development, according to Chief Wilfred King (Burger, 2019).

Significant steps towards reconciliation and decolonization were taken through the project. Energy in Gull Bay First Nation has a long, painful, colonial history for the community, from the flooding of sacred sites through energy projects to being deemed "not economic" to be connected to the provincial energy grid, the community has found itself repeatedly harmed by the province's energy institutions. With this project, however, steps are being taken to wrest the community's energy reality from the province's hands and create a community reality of energy (Henriquez & Paquette, 2020). Moreover, it has facilitated reconciliation between OPG and the community, who now speak highly of one another—despite their past (Charlebois, 2020). The opportunities the system creates for the community will be important steps towards reconciliation, as Chief Wilfred King says: "Economic reconciliation is a key to reconciliation" (CTV News, 2019).

Ouje-Bougoumou Cree, Quebec – Biomass Heating

Project Overview

Community Specifics: Ouje-Bougoumou Cree has a community of approximately 900 people, with 760 living on-reserve.

Challenges: The community was continuously removed from their land by the government in favour of mining and forestry operations. Wood was an abundant resource in the area, and there was active harvesting in the region. In 1990, the Canadian government and the Quebecois provincial government agreed to fund the construction of a new community for the Ouje-Bougoumou people, providing up to $75 million for creation of the community from the ground-up.

Solution: Their energy project involved building a district mass heating system that uses waste wood from a nearby pulp mill to heat community homes. The district system is fueled by biomass.

Funding sources: Funding was provided by the federal and provincial governments through the Community Construction Fund.

Cost: The initial 1991 construction would cost $1.74 million, including the energy system, district heating pipes, and energy transfer stations. To help meet the demand of a growing community, a 1.7-megawatt biomass boiler and another backup were added to the system in 1998, for a combined cost of approximately $525,000.

Project length: The heating system construction lasted one year (1991-1992). Overall, the ground-up community construction lasted four years.

Outcomes: The biomass heating system helped reduce the community's greenhouse gas emissions, helping cut CO_2 emissions by 200 tonnes over the first year of its use and nitrous oxide emissions by 35 per cent. The price of heating using biomass is approximately $11 per MWh for the Cree community. Energy bills for homes are $150 less than they would have been annually if oil heating was pursued. This is the equivalent of 74,000L of diesel, or a cost savings of $100,000.

The Ouje-Bougoumou Cree community in Quebec is widely regarded as one of the most innovative and groundbreaking community-building initiatives in the world, let alone among First Nations. In 1995, after the completion of its community, it received the prestigious "Best Practices for Human Settlements" designation from the United Nations Centre for Human Settlements, and the "Global Citizen" award from the United Nations for its environmentally and human-friendly design (Biomass Energy Resource Center, 2009). Part of their innovative community design is a district mass heating system that uses waste wood from a nearby pulp mill to heat community homes, the first of its kind in North America.

Initial Stages

Through the 1970s and 1980s, the Ouje-Bougoumou Cree found themselves living in conditions comparable to a refugee camp, the government having removed them from their land (Williamson, 2013). All the while, billions of dollars in forest products and mining profits were being extracted from their lands, with nothing being yielded to the community (Williamson, 2013). In 1990, after a series of political protests, the Canadian national government and the Quebecois provincial government agreed to fund the construction of a new community for the Ouje-Bougoumou people, providing up to $75 million for creation of the community from the ground-up (Williamson, 2013).

Even before this agreement, the Ouje-Bougoumou community had begun discussing heating their future community using a district system fueled by biomass. The first feasibility study the community had done found that the idea would be too expensive. However, community leaders sought a second opinion, asking the federal government to help with a second study. This study urged the community to move forward with the project, projecting that it would help them save money, create new jobs, and gain control over its energy (Biomass Energy Resource Center, 2009). The initial 1991 construction would cost $1.74 million, including the energy system, district heating pipes, and energy transfer stations (CES Rural Development Wood Energy, 2008). Funding was provided by the federal and provincial governments through the Community Construction Fund.

Design and Construction Process

The choice of biomass was influenced by multiple factors. First, wood was an abundant resource in the area, and there was active harvesting in the region (Laundreville, 2009). Local leaders had also been interested in the success of Scandinavian communities that were already using this method. Finally, there was a sawmill near the proposed community site that burned their waste wood 24 hours a day for all to see. To the Ouje-Bougoumou, this stood in stark contrast to the traditional Indigenous approach of harvesting only what is required and finding a use for all parts of the items that were harvested. Further, it stood as a reminder of how natural resources were being used by outsiders, as the Cree were further and further isolated and marginalized economically (Biomass Energy Resource Center, 2009).

As previously mentioned, at this time the Ouje-Bougoumou were going through the process of constructing a new community from the ground up, and so the design of the biomass plant would need to go hand-in-hand with the community's design as a whole. This process would be led by renowned architect Douglas Cardinal, who was known for his Indigenous-inspired designs and incorporation of community input into his designs. Cardinal and his firm would hold multiple sessions with the community to help decide on community layout and infrastructure placement and design, among other things (Laundreville, 2009). This helped inform the broad strokes of the heating system design, while the more technical aspects of the design were decided on by CANMET and KMW Energy systems, located in Ontario (Laundreville, 2009).

Construction of the community involved many Ouje-Bougoumou members and lasted over four years. The district heating system itself would begin construction in 1991 and be completed in 1992. Although there is no information on the construction of the actual system, it can be assumed that community members played a significant role in the process, as they did in the community build as a whole (Laundreville, 2009).

Design Elements

The original heating system was comprised of a one-megawatt biomass boiler, with a one-megawatt oil boiler as a backup (CES Rural Development Wood Energy, 2008). To help meet the demand of a growing community, a 1.7-megawatt biomass boiler and another backup were added to the system in 1998, for a combined cost of approximately $525,000 (CES Rural Development Wood Energy, 2008). The biomass boilers are fueled by milling residuals obtained from the nearby Barrette-Chapais sawmill, located with a thirty-minute drive from the community, and can burn a wide range of waste wood (Laundreville, 2009). The system is fully automated, from fuel feed to ash removal—leading to lower operational demands. A built-in telecommunications system allows for operators to receive remote supervision and assistance, should they encounter issues (Biomass Energy Resource Center, 2009).

The boilers are connected to the community's homes by approximately 2,300 metres of polyethylene piping and 600 metres of steel pipes that run underground and into each individual home (Biomass Energy Resource Center, 2009). These pipes carry water that is heated to approximately 85°C by the boilers. Once used by the homes, the remaining water is carried back towards the boilers—if more is needed, then it is pumped in from a nearby lake (BIOCAP & EnergyNet, 2006). Each home is equipped with two heat exchangers, one for heating the building and one for hot water. Today, the system is used to heat approximately 15 commercial units and 200 homes in the community, consuming approximately 3,800 tonnes of sawmill waste a year (Church, 2019).

In 2019, the community replaced one of their boilers with a new unit, the largest containerized wood biomass boiler in the country (Church, 2019). This was done because the original boilers are beginning to approach 30 years old and is a part of a larger $2.7 million initiative to upgrade the system with new pipes and upgraded control panels (Church, 2019).

Project Completion Outcomes

The heating system has been able to help the community significantly reduce its greenhouse gas emissions, helping cut CO_2 emissions by 200 tonnes over the first year of its use and nitrous oxide emissions by 35 per cent (CES Rural Development Wood Energy, 2008). Additionally, it helps make use of what would be an otherwise wasted product—even the ash remaining after sawdust combustion is used for fertilizer—thereby helping to exemplify the value of an Indigenous lifestyle that is in harmony with the environment. The project has also allowed the Ouje-Bougoumou community to save considerable money. The price of heating using biomass is approximately $11 per MWh for the Cree community, only 11.5 per cent of what it would be had they used their other option of oil heating (BIOCAP & EnergyNet, 2006). This has resulted in energy bills for homes that are $150 less than they would have been annually (Laundreville, 2009).

Three community members are employed to run the heating system, helping keep the economic benefits of the system in the community (Laundreville, 2009). These employees have also received training and engaged in skill development to help develop their capacity to work on the system (Guerguieva et al, 2013). There is a high emphasis on maintenance of the facility, as the parts are highly specialized and may take an extended period to ship to the community should there be a malfunction (Landreville, 2009). Reduced energy costs, combined with keeping economic benefits within the community have resulted in significant savings for Ouje-Bougoumou (BIOCAP & EnergyNet, 2006). This money has been put into the housing fund, allowing for additional houses to be built in the community (BIOCAP & EnergyNet, 2006).

The biomass system has had an undeniable impact on the identity of the community. Taking control of their heating and hot water supply has helped the community move towards self-sufficiency and become more independent, in the eyes of their members (Guerguieva et al, 2013). It has also become a symbol for the Ouje-Bougoumou on the world stage, representing not only their innovative and forward-thinking mindset, but the value and applicability of First Nations principles to modern issues (Church, 2019). In 2000, the community earned the opportunity to exhibit at the World's Fair Expo2000 in Germany for exemplifying "the balancing of mankind, nature, and technology" (in addition to the awards mentioned at the beginning of this case study) (CES Rural Development Wood Energy, 2008).

Peguis First Nation and Fisher River Cree Nation, Manitoba – Geothermal Energy

Project Overview

Community Specifics: Peguis is the largest First Nation community in Manitoba with approximately 10,246 members of Ojibway and Cree descent. Fisher River is composed of two reserves. The reserve population is 1,945, while the off-reserve population is 1,934, totalling 3,879 band members. The communities are located about 200km north of Winnipeg.

Challenges: Reliant on burning wood to heat homes, high monthly electricity and propane costs.

Solution: Over 850 homes were retrofitted with closed loop geothermal energy systems.

Funding sources: Government of Manitoba's new Energy Savings Act, Manitoba Hydro, and band members themselves.

Cost: The initial costs of installation, covered by Manitoba Hydro, can be as high as $17,500 per home. But, customers use a portion of their monthly energy bill savings to pay the money back over time. Alternatively, some communities have been able to gain access to funding to assist with this particular home and wellness necessity.

Project length: Five years.

Outcomes: Half of the on-reserve homes are now powered by geothermal energy, along with the school, laundromat, and fitness centre. Geothermal energy systems save the ratepayer about 65 per cent of costs. The life of geothermal systems is estimated to be up to 24 years for the inside components and over 50 years for the ground loop.

In partnership with the Manitoba government, Manitoba Hydro, and AKI Energy, the First Nations communities signed a memorandum of understanding that will see the retrofit of over 850 homes with geothermal energy over five years (Manitoba, 2015). AKI Energy works with Manitoba First Nations to reduce energy costs through smart, cost effective investments in renewable energy (AKI Energy, n.d.). The Assembly of Manitoba Chiefs (AMC) Housing Department worked with industry partners, including Manitoba Hydro, to discuss and test alternative energy sources for First Nations housing (Peguis, 2012).

Geothermal heat pumps have been in use since the late 1940s, and were selected as the best alternative, innovative energy source for these communities. Geothermal energy used for heating and cooling relies on heat from the ground, instead of the outside air, to regulate temperatures inside the home. This innovation works because, no matter where you live, underground temperatures remain largely consistent throughout the year (Canada, 2017). In the summer months, the ground is cooler than the air. In the winter months, the opposite is true.

Initial Stages

AKI Energy, a project partner, is a non-profit, social enterprise governed and operated by First Nations. The enterprise works with First Nations communities, in this case Fisher River and Peguis, to provide technical expertise, financing development, and project management to make sure the project stays on track (AKI Energy, n.d.). The partnership between communities and AKI Energy is not single-stage but is maintained from the conception of the project and continues beyond the final rollout. In fact, Indigenous principles and beliefs are incorporated into their business management models. For example, leaders in the communities are asked to sit on the project boards to continuously provide feedback on all project stages (ibid).

Figure 4: How to Work with AKI (the AKI process)

Source: AKI Energy, n.d.

Design and Construction Process

The geothermal pilot program involved Manitoba Hydro covering the upfront costs of retrofitting a home. Through the Government of Manitoba's new Energy Savings Act, Manitoba Hydro can finance energy efficiency and ground source heat pump projects that have acceptable paybacks (Peguis, 2012). The initial costs of installation, covered by Manitoba Hydro, can be as high as $17,500. Customers use a portion of their monthly energy bill savings to pay the money back over time (Purdy, 2015). Though Manitoba Hydro is fronting the costs, workers from the First Nations communities will be installing the systems. In fact, 40 First Nations people in the two communities were employed during the initial rollout to install the energy systems (CBC News, 2014).

During the initial stages of the project, the Geothermal Trades Training Program was formed. Local band members were invited to participate to learn how to install and maintain geothermal units in Peguis and Fisher River (Peguis, 2013). The successful completion of the training program could lead to long-term employment opportunities for the individuals – creating both capacity and employment opportunities in the communities.

Design Elements

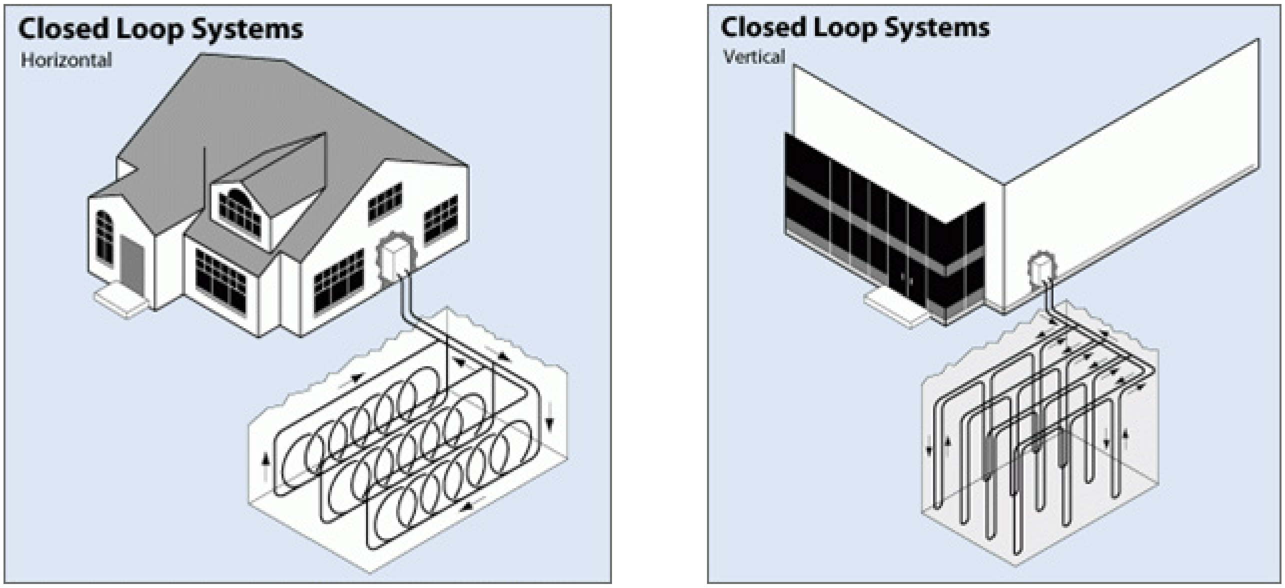
Geothermal heating and cooling has a number of names, such as ground-source heating or earth-energy systems. These names represent the function of the design, whereas heat is removed from the earth using a liquid, usually groundwater or antifreeze solution. The liquid's temperature is raised by the heat pump from the ground, then is transferred to indoor air via the refrigerant, to provide heat.[4] During summer months, the opposite occurs. Indoor hot air is transferred to the ground through liquid, creating a heat sink (Canada, 2017)[5]. The heat pump component is located inside the home, while the piping is outside and underground. Both Peguis and Fisher River used closed loop systems.

Closed loop systems circulate an antifreeze liquid, usually water mixed with antifreeze, through a closed loop tube system that is buried underneath the frost line in the ground (United States, n.d.). The liquid solution that runs through the pipes absorbs heat from the ground surrounding it.

The closed loops in Peguis and Fisher River are in either horizontal or vertical orientations, though there is also the possibility of aligning the system through a pond/lake configuration. Horizontal installations are typically more cost-effective due to the method of looping the pipes, thus allowing for shorter trenches. Horizontal systems are most common in residential areas (ibid). Vertical installations are common with large commercial buildings and schools due to the limited land available surrounding them.

There is also an open loop variation of a geothermal heat pump system where water returns to the ground via a well. For an open loop system, there must be an adequate supply of relatively clean water.

Figure 5 and 6: Closed-Loop Geothermal Systems: Vertical and Horizontal



Source: United States, n.d.

[4] See Appendix 1 - "The Heating Cycle"
[5] See Appendix 2 - "The Cooling Cycle"

Despite high initial installation costs, communities and/or individuals choose to pursue geothermal systems due to their many benefits, such as efficiency and energy savings. Geothermal energy systems, though expensive in the short-term, pay themselves off in the long term through money saved compared to conventional energy systems. In fact, compared to electric furnaces which is common to that of Peguis First Nation, geothermal energy saves the ratepayer about 65 percent of costs (Canada, 2017).

The following geothermal system benefits are taken from a WaterFurnace (geothermal) Owner's Manual distributed to users in Fisher River Cree Nation (2017, 6).

1. **Energy savings:** WaterFurnace units deliver three to four units of energy for every one unit of energy consumed. Many homeowners experience energy savings from 30 percent to 70 percent over other ordinary heating and cooling systems.

2. **Cost effective:** Because of the extraordinary efficiency of a WaterFurnace system, any added investment related to installing a geothermal unit is usually more than offset by your energy savings.

3. **Comfort:** You will experience consistent, precise temperature control without the hot blasts of air associated with gas furnaces or the cold blow of an air source heat pump.

4. **Reliable:** The WaterFurnace reputation for reliability has been earned by using only the highest quality components, design, and workmanship. Your geothermal unit will provide many years of steadfast operations.

5. **Quiet:** Unlike ordinary air conditioners or heat pumps, there are no noisy outdoor units. Our units are designed and constructed for extremely quiet operation.

6. **Safe and clean:** WaterFurnace units do not burn fossil fuels, so there is no flame, fumes, combustion or concerns about carbon monoxide poisoning.

7. **Environmentally friendly:** Your geothermal system does not release harmful greenhouse gases into the air, unlike a fossil fuel burning furnace. The reduced energy consumption of a geothermal system further reduces the need for more coal-fired or nuclear power generating plants and places less demand on our current capacity to produce electricity. Geothermal units use far less refrigerant than ordinary heat pumps or air conditioners and are factory seals to prevent leakage.

Project Completion and Outcomes

Fisher River Cree Nation now has more homes powered by geothermal energy than any other community in Manitoba, winning them the Sustainable Community Award in 2018 (Fisher River, 2020). Half of the on-reserve homes are powered by geothermal energy, along with the school, laundromat, and fitness centre. The innovative energy systems, "all but eliminated" Fisher River's reliance on burning wood to heat homes (ibid, 2020).

The life of geothermal systems are estimated to be up to 24 years for the inside components and over 50 years for the ground loop (United States, n.d.). Thus, despite the higher upfront costs, the system will pay itself off through energy savings well before it reaches the end of its life.

The projects in Fisher River and Peguis were such large successes that now, the pilot program is being rolled out to multiple communities. Not only does geothermal energy lower monthly energy bills, it also provides training opportunities for residents and creates good jobs in communities.

North Bay, Ontario – Community Energy Park Microgrid

Project Overview

Community Specifics: North Bay is a city located in Northeastern Ontario with a population of around 52,000 residents.

Challenges: Energy insecurity in the face of natural, and other, disasters, notably previous ice storms and province-wide blackouts.

Solution: A community micro-grid including solar panels, co-generation, and a battery.

Funding sources: Federation of Canadian Municipalities (FCM), the Independent Electricity System Operator, the Government of Ontario, the Government of Canada, and the City of North Bay.

Cost: $4.5 million.

Project length: November 2017 to July 2019.

Outcomes: The Community Energy Park micro-grid supplies electricity and heat to the YMCA Aquatic Centre, Thomson Park, and Memorial Gardens. It makes the facilities more efficient and resilient.

Initial Stages

North Bay, a city in Northeastern Ontario with a population of approximately 52,662 residents, identified the need for stable and reliable power and heat for key centres in the community. The solution: a micro-grid with capabilities to operate independent of grid connection if need be. The North Bay Community Energy Park micro-grid was developed in response to the energy insecurity faced during the 2003 Ontario-wide blackout leaving the province without power, and the 2017 ice storm that resulted in a Toronto blackout (Nhede, 2019). The Community Energy Park website also cites an "aging, inefficient power grid" and "increasingly unpredictable weather" as factors in their choice to pursue a micro-grid (n.d.). Among the benefits, power resiliency and efficiency are crucial byproducts of its creation (ibid). The North Bay community micro-grid is set to reduce dependence on large, centralized power plants in favour of more resilient, local power generation, thus increasing energy autonomy.

The community public access centres intend to have access to the power and heat - YMCA, Memorial Gardens, and Thomson Park - were identified as important community assets that are used by many people, daily. The facilities also double as emergency shelters in the city, making them ideal infrastructure to direct the self-sustained power and heat capabilities of the Community Energy Park (CBC News, 2017).

Construction of the micro-grid began on November 24th, 2017. Though initially expected to be complete by September 2018, the project was officially finished and running in July 2019. For six months prior to the official launch, including in three winter months, the micro-grid was being tested (Wilson, 2019).

Of the total $4.5 million project cost, the City of North Bay contributed $261,000, the Government of Ontario $1 million, and the federal government $750,000, with the Federation of Canadian Municipalities and the Independent Electricity System Operator also contributing (Frangione, 2019).

Design and Construction Process

North Bay Hydro Services led the micro-grid project in partnership with local engineering and construction companies. The use of local talent is crucial to this innovation, as has been demonstrated in previous case studies: community installation and maintenance knowledge helps further self-sufficiency and reliability. Along with employing local tradespeople, North Bay Hydro also runs educational outreach programs in local schools (Capkun, 2017).

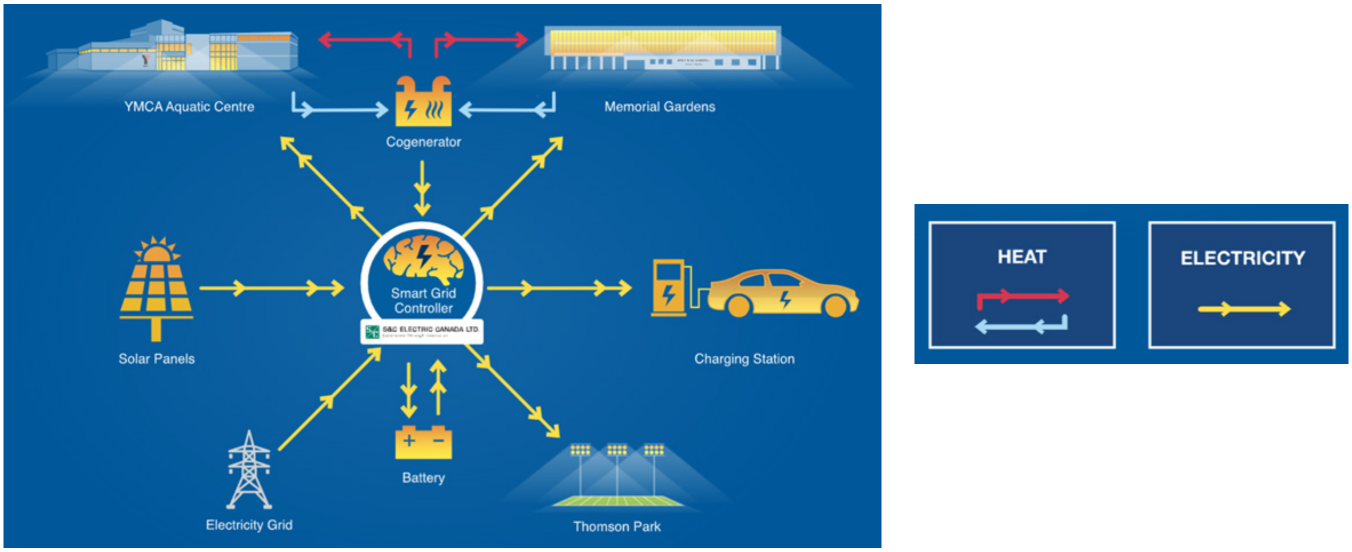
Design Elements

The Community Energy Park has multiple components, including the micro-grid, a co-generator, a smart grid controller, a battery, and electric vehicle charging stations. To start, the microgrid is powered by two 265-kilowatt natural gas generators, nine kilowatts of solar, seven kilowatts of rooftop panels, and a two-kilowatt solar flower (CEP, n.d.). The solar flower operates like flowers in nature, where it opens to accept sun during the day, then nests at night. The solar flower provides reliability to the grid, whereas it can create self-sustaining power during a major power outage or catastrophe. The flower does this automatically, eliminating the need for human intervention.

The co-generator produces both electricity and heat using engines that run on natural gas. Without a co-generator, heat produced when creating electricity would just escape into the surrounding air (CEP, n.d.). Co-generators are able to extract the heat and channel it to warmer water, which in turn is transferred via underground pipes to Memorial Gardens and the YMCA Aquatic Centre (Figure 7). Once it reaches the destination, it goes through another heat exchanger, then warming the water used in the radiators, swimming pool, and hot water taps. After, the cool water travels back to the co-generator and the process is then repeated (CEP, n.d.). The battery component of the microgrid helps the system operate more efficiently by storing energy that is produced either by the co-generator or solar panels but might not be needed right away.

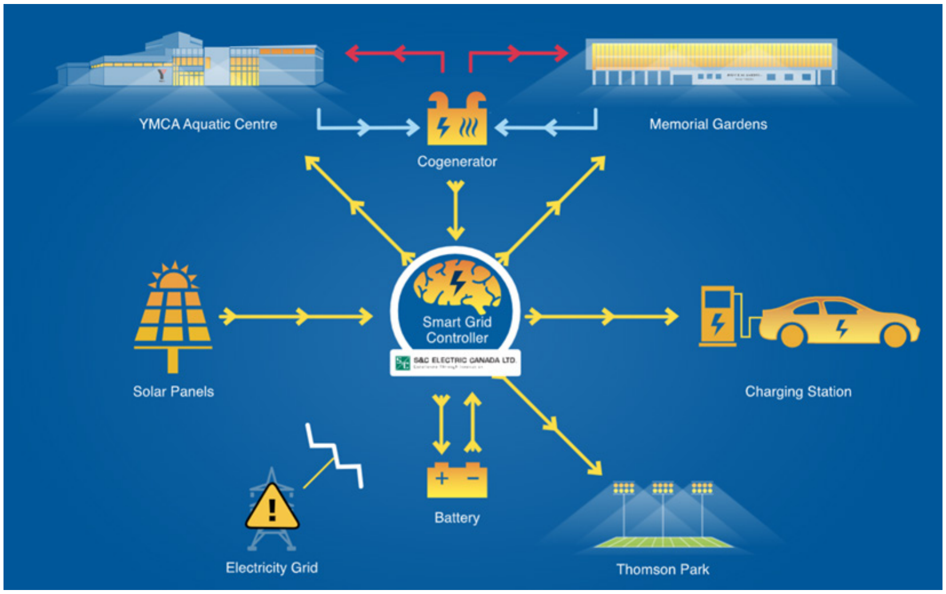
The most important aspect to achieving the goal of reliability and durability is the microgrid's ability to go into "Island Mode," which occurs when access to the electrical grid is not possible or is shut off; for example, during a severe ice storm (see Figure 8). The Energy Park can operate and provide heat and electricity indefinitely without grid connection, as long as natural gas is available. The benefit of island mode is that it provides the community with a heated and powered shelter, centrally located in the city.

Figure 7: Community Energy Park Microgrid Elements, North Bay, Ontario



Source: Community Energy Park, n.d.

Figure 8: Island Mode – Community Energy Park, North Bay, Ontario



Source: Community Energy Park, n.d.

In total, the Community Energy Park provides:

- ***YMCA:*** 86 percent of electricity requirements; 55 percent of heating and hot water requirements;
- **Thompson Park:** 84 percent of electricity requirements; and,
- **Memorial Gardens Sports Arena:** 87 percent of electricity requirements; 55 percent of heating and hot water requirements (CEP, n.d.).

The remaining energy is imported from the grid.

Project Completion and Outcomes

As mentioned, the microgrid officially began operating in July 2019. Since then, it is projected to have saved the City of North Bay over $200,000 a year in heating costs (CTV News, 2017). In addition, the energy generated via the microgrid is equivalent to that needed to power 300 to 400 homes (CBC News, 2017). Also, the microgrid's use of green technologies, such as solar, helps reduce reliance on the current hydro system (Wilson, 2019). Along with reducing energy and heating costs, the new Energy Park provides the community with energy resilience. The power created in the community allows for less reliance on centralized sources and brings energy and heat security closer to the consumer.

The facility is also of interest to other operators across the province, looking to implement similar community microgrids in their communities (Wilson, 2019), and is garnering broader global attention. There is also room for expansion of the microgrid offerings – with a senior living home being looked at as the next target to channel microgrid energy to (Wilson, 2019).

Benefits of Pursuing Innovative Energy Infrastructure Design

This section, and the subsequent one, intends to assess the benefits and obstacles of pursuing innovative energy infrastructure design. Each will be summarized and discussed along with whether they are considered to be a financial benefit or obstacle, or whether they are classified as a non-financial benefit or obstacle.

Financial Benefits

Direct Financial Benefits. Diesel generation is expensive, and the costs of transporting diesel to remote communities exacerbates these costs. Pikangikum's former lawyer, Doug Keshen, noted the band spent $7 million on diesel alone in 2015 (Bombicino, 2016). Court documents also show that Pikangikum paid over $3.5 million for diesel power in one year, which would have cost about a tenth of that if supplied from the provincial power grid (Pikangikum v. Nault, 2010, para 177). When taking into account the community's population of approximately 3,000 people, these costs are extensive. For Peguis and Fisher River, the geothermal system installations were projected to cut space heating costs by up to 40 percent. Ouje-Bougoumou's use of biomass only cost 11.5 percent of what it would have costed if they pursued an oil heating option, a savings of $150 per home, annually (Landreville, 2009). T'Sou Ke has an addition economic advantage by being able to sell their power by exporting it to the grid. As mentioned above, their solar power produces approximately 87,900KwH of electricity annual, of with 67,267kWh is exported to the B.C. Hydro grid. Basic build infrastructure, though arguably a cost affordable option at the time of installation, can result in long-term high costs for the communities in which it is implemented. Even more, the City of North Bay has reduced heating costs now that partial heat for community buildings is supplied through their micro grid.

Indirect Financial Benefits. The economic benefits of innovative infrastructure extend beyond the communities it is implemented in. The federal government currently shares costs with Ontario's electricity ratepayers for electricity service in remote First Nation communities (McRobert, 2016, 5). Thus, cost savings due to innovative infrastructure, such as grid connection, solar usage, or geothermal heating, will also benefit those currently subsidizing costs. In most projects, the community is undertaking most of the costs, while the household takes on less of a financial responsibility. The energy user would then see a reduction of costs but the community may actually see a rise in costs.

Tying into economic benefits stemming from new innovations is the topic of jobs and capacity built throughout the project rollout, and beyond. The five communities discussed above, having innovative energy infrastructure, all had training programs in place to educate community members in upkeep of the new energy systems. Jobs created in the community as a result of these energy projects significantly boost the communities' capacity for self-determination in the long run.

In addition, as seen in Gull Bay and Pikangikum First Nations, diesel generators were limiting the First Nations' capacity to expand and grow. The basic build diesel generators did not have the capacity to support more houses or infrastructure needed to accommodate the growing communities.

Nonfinancial Benefits

Environmental. The standard basic build energy systems for on-reserve communities tend to be diesel generators. Diesel generators emit large amounts of carbon dioxide and other pollutants. Continued reliance on diesel often goes against Indigenous peoples' cultural belief to live in harmony with the environment. With innovative, green energy infrastructure, such as biomass, solar energy, or geothermal heating, communities can begin phasing out diesel, thus lessening their environmental impacts. For example, Ouje-Bougoumou uses biomass to heat homes and water in their community. The biomass was otherwise being discarded by a nearby sawmill. This green alternative reduced the communities' greenhouse gas emissions significantly and aligned with the First Nations lifestyle in producing as little waste as possible. The North Bay Community Energy Park relies partially on solar power and can save excess produced power to a battery for later use, thus increasing efficiency. Green energy technologies come in many forms, and communities have options to choose from when selecting projects that align with their specific needs.

Community Benefits. As seen in Pikangikum and NunatuKavut First Nations, a large concern of diesel reliance was diesel insecurity, especially as these communities are remote. Price volatility and continuous energy security are top of mind. On the other hand, innovative energy infrastructure relies on resources already in or around the community as energy sources, such as ground heat in geothermal systems or biomass-reliant heating systems.

Self-Direction. Through community visits and meetings, partners were able to identify community-specific opportunities that would help reduce external energy dependence; even financial dependence by way of reliance on government energy subsidies was reduced with cost-saving innovative infrastructure.

Also, communities with innovative energy infrastructure have trained members in their communities on how to maintain and repair the systems, reducing reliance on external actors while also building capacity. Innovative energy infrastructure is a step towards energy autonomy for many First Nations communities. For the City of North Bay, they increased their power independence and were able to move away from the centralized grid, which they cited was unpredictable. The added reliability of energy and heat produced in the community itself lends peace of mind to residents and decision-makers in the city.

As is evident when reviewing and assessing the benefits of pursuing innovative energy design options, there are many financial and non-financial benefits. However, both sets of benefits contribute to sustainability in a broad sense, which includes economic, social, and ecological elements. So while a dichotomous framework is used to assess the benefits, it is important to note that sustainability is what ties the benefits, and the below obstacles, together.

Obstacles to Innovative Energy Infrastructure Design

Initial Rollout Difficulty and Delay

Not all infrastructure projects, innovative or not, are seamlessly built and implemented. As these designs are new, builders and communities likely have no prior experience installing or operating the systems. Thus, there is a learning curve to be expected. As exemplified with T'Sou Ke First Nations' solar project, not all installations go seamlessly. The first year after the implementation of the solar arrays and solar hot water systems were plagued with wiring issues, but these issues were resolved within the year. But, not without difficulty. Hydro officials were reluctant to come investigate the issue, adding increased importance to community training and capacity building surrounding new infrastructure projects. Technical barriers with the solar water systems resulted in only half of the systems – 20 of 40 – still functioning. This example demonstrates how delayed ownership, as undertaken by Gull Bay First Nation, could have mitigated the problem stress on T'Sou Ke. Delayed full ownership allows for the learning curve to run its course, and for the eventual owning community to establish a baseline understanding of upkeep and maintenance. The delayed ownership sets a solid groundwork of understanding of the systems and allows for greater success moving forward. Thus, projects are not perpetually stuck in their formative stages, and can be of use to the community.

Though Gull Bay First Nation is noted as a "best practice" in delayed ownership, the community did have issues of their own, mostly in terms of timelines being drawn out. The first challenge was in obtaining construction permits from the federal government, which required a significant amount of advocacy by the community. Once obtained, Gull Bay's remote status proved challenging if and when supplies and backup tools were required. Finally, new innovations are likely to experience a few hiccups on the onset of the project, which were in fact experienced by Gull Bay First Nation. Specifically, the testing and commission phase ran more than a year when it was projected to only last a few weeks. But, as the project is not 100 percent complete, the First Nation has not taken full ownership over from OPG, meaning this is not the community's problem alone.

Similar to rollout difficulties, community educaton and input timelines for innovative projects can also be longer than their basic build alternatives. For example, construction of the North Bay Community Energy Park was planned to finish in September 2018 but was ultimately only completed in July 2019. Again, since these projects are largely new to everyone involved, there is more background required and communication needed before breaking ground. Thus, innovative infrastructure projects, in an attempt to be thorough, can experience longer timelines than initially laid out. Additional difficulties may arise throughout the projects as unexpected complications arise that are not experienced in "tried-and-true" basic build systems.

Cost

Similar to innovative housing infrastructure designs, innovative energy systems will likely have higher upfront costs than simply maintaining the pre-existing basic build infrastructure. In the case of Fisher River and Peguis, Manitoba Hydro covered the upfront costs of retrofitting their homes and other buildings with geothermal heating systems. In addition, the Manitoba government has a "Pay as You Save" program which defers upfront costs to be paid later through energy savings cash. This is not the reality everywhere, and not all communities can afford $17,500 per unit to initially make the switch. As seen in T'Sou Ke's solar project, the $1.25 million project relied on a total of 16 different funding sources, delaying and complicating the process. Plus, over the first year, the systems were only generating $5,389 for the community. Revenue levels did steadily increase, making payback times more feasible – approximately 4.1 to 6.8 years.

Though these innovative infrastructure systems are often more expensive in the short-term, they often pay for themselves in eventual energy-cost savings. Payback times vary and can act as a disincentive for making the switch.

Successful Practices

Concurrent Community Education Initiatives

A common successful practice when rolling out new, innovative infrastructure is educating members of the community to its benefits and function. Not only does this teach the owners/users of the infrastructure how to use it, but also alerts the community to its overall benefits, perhaps further fostering community acceptance of the projects. A common theme in this practice is educating youth and other members of the community about the benefits of innovative energy infrastructure.

For example, the T'Sou Ke First Nations' community savings measures are deemed a large success; it was formulated based on fostering a community identity of sustainability. Through different measures, including mentorship to local youth, they reduced energy consumption in community homes and buildings by 20 to 30 per cent. Also, the band has used the solar project to showcase themselves to visitors from other First Nations, schools, institutions, and municipalities as leaders in renewable energy and sustainability. The First Nations additionally held educational workshops, site tours, and sent out monthly newsletters to help the community understand the project and foster their acceptance. The incorporation of the community in these projects via the education initiatives benefits all generations; many seek to know what is happening in their community and taking the time to educate them on new infrastructure projects develops a sense of understanding and pride.

Gull Bay First Nation's educational campaign, which heavily focused on youth engagement and community acceptance, was also deemed a large success. For example, while previous projects were plagued with trespassing and theft, the solar project was left completely undisturbed. This revelation ties into the overall theme of understanding contributing to acceptance. A project that, at the onset, is perhaps over-technical and foreign can become a source of pride in the community. This is especially true when the education goes beyond discussing economic benefits and exemplifies its contribution to self-sufficiency and Indigenous ways of life. For example, training and job creation in the community, as well as harmony with nature, as many innovative projects are more environmentally friendly than their basic build counterparts.

Identifying Local Opportunities through Community-Directed Design

There is not a one-size-fits-all approach to innovative energy infrastructure; every community, and its available skills and resources, is different. This fact makes community participation all the more crucial.

In fact, even basic build diesel generators were arguably not the proper choice for these remote communities, even if it represented the standard at the time. Transporting diesel is expensive in the first place, which is further exacerbated by the remoteness of many communities that rely on it to fuel their generators (Kennedy, 2017, 1). Though it was likely less costly than other alternatives, community characteristics were not indicative of successful diesel usage, despite ultimately needing to rely on it. Again, this exemplifies the counter productivity of basic build infrastructure – the "good on paper" downfall that could have been avoided, at the least mitigated, by talking to partners on the ground in these communities.

An example of a successful practice is T'Sou Ke First Nation's Comprehensive Community Plan. Through their plan, T'Sou Ke residents identified a solar project as the best choice for their community because the reserve receives great levels of solar insolation, plus, one of the band members had previously worked with solar technology. Additionally, solar development had a much smaller footprint than alternatives like wind and the environmental assessment process was easier to get through. The community-specific plan identified the best path forward based on community capacity and physical location/resources (Bhattacharya, 2017). Another example of identifying local opportunities is Ouje-Bougoumou's choice to build a biomass processing plant. The decision stemmed from wood already being an abundant resource in the area with active harvesting occurring. Plus, there was a sawmill present near the community site that burned waste wood. The identification of community resources, either a plethora of sun or wood, led to community-specific infrastructure projects that highlight naturally occurring resources. Whereas on the other hand, basic build diesel generators rely on exporting the heating material – diesel – hundreds of kilometers to fuel communities. Capitalizing on resources already abundant in the community is making the best use of local opportunities; the importance of community-directed design cannot be overstated.

Identifying local opportunities can only be done through community engagement. To promote community independence and advance self-direction in Indigenous communities, researchers suggest that "truly sustainable renewable energy development requires a project design that reflects community values, incorporates community control, and incentivizes Indigenous ownership" (Mercer et al, 2020, 62). The community control aspects of innovative infrastructure projects give the community a stake in its continued success.

As seen with the above examples, such as community leaders sitting on AKI Energy project boards, self-direction is necessary for successful innovative infrastructure design. Community members must have a say in what directly impacts their First Nations, especially long-term infrastructure designs. T'Sou Ke First Nation also created elder and leader groups that met frequently to develop a vision for their community established around the seven generations teachings. Two youth interns from the community were also placed on the project to gain experience. In addition, T'Sou-Ke and Gull Bay First Nations both have community project champions separate from the band that championed the project, both to the community and in general. Fisher River and Peguis First Nations had community leaders on the AKI Energy project boards to provide feedback. Innovative infrastructure projects rely on community directions to identify local opportunities that are crucial for long-term project success.

Self-Construction

Another practice that has proved successful is communities constructing the innovative infrastructure using their own resources and people. Using community resources keeps money and cost-savings in the community. Additionally, training community members throughout all steps of the project creates good jobs in the community, as well as increasing capacity. Through different training programs, residents have the newfound ability to install, update, maintain, and repair infrastructure for years to come. This capacity reduces reliance on outside actors to maintain infrastructure, adding to the community's energy autonomy and self-sufficiency, in turn reducing service charges on repairs and maintenance. Also, the available of stable jobs in the community reduces the number of people leaving reserves in search for this type of work. People remain in the community because there are good jobs available.

AKI Energy is a good example of self-construction and training best practices. The organization provided hands-on training to community members in Peguis and Fisher River, ensuring their geothermal system installation projects created local employment and long-term economic development opportunities (AKI Energy, n.d.). As stated above, self-construction and maintenance of systems gives the community self-sufficiency – they do not have to rely on outside help for upkeep and further expansion of the systems. In addition, the creation of more jobs in the First Nations was found to retain those that would otherwise leave looking for work.

In the T'Sou Ke project, the community and its partners, First Power and Home Energy Solutions, also trained 11 community members to become certified solar installers through custom training programs. After the project, nine of which went on to become CANSIA certified solar installers. The programs were designed to account for the specific learning style of community members. In total, 25 individuals worked on installing the panels and solar water heaters, many of whom might have otherwise been unemployed[6]. North Bay's project also employed local labourers, keeping installation and maintenance knowledge nearby, in the community, for future convenience and use.

Indigenous-led and designed training programs are not only beneficial for building capacity and creating jobs but are also an example of successfully tailoring programs to what the community needs. For example, relationships with private contributors, like Gull Bay First Nation's relationship with Ontario Power Generation (OPG), was mutually beneficial and allowed innovation to occur. OPG undertook administrative responsibilities for the project while Gull Bay First Nation administrators and council members learned from the process, contributing to long-term capacity and eventual self-sufficiency. Self-construction allows community members to learn about administrative duties, construction processes, and maintaining the infrastructure – creating jobs throughout the project duration and beyond.

Lessening the Administrative and Financial Burdens

Two best practices employed by First Nations in their innovative energy projects and external coverage, and eventual payback, of upfront costs. Firstly, First Nations, specifically Gull Bay, benefited immensely due to obtaining full ownership of the finished innovative infrastructure project. The community was poised, from the start, to take full ownership over the solar project they worked on in partnership with Ontario Power Generation (OPG). This would be the first time OPG did not have ownership over a project they worked on. However, the transfer of ownership was to not be transferred to the First Nation until all the technical issues were resolved, and the project was 100 percent completed. As mentioned above, this proved to be a highly beneficial clause for Gull Bay First Nation, as problems with the solar system did emerge in the first year of the project's targeted completion date. But, as the community did not yet have full ownership, OPG spearheaded the repairs and maintenance while the First Nation was able to learn from the process. In addition, Gull Bay did not have to redirect financial and human resources towards the fixes.

Another best practice was undertaken by Fisher River and Peguis First Nations who pursued geothermal retrofits. The geothermal installation is a costly, upfront upgrade, which was not feasible for many First Nations communities. But, under the Manitoba government's "Pay As You Save" program, Manitoba Hydro covered the upfront costs of the project. In return, a portion of the energy-savings money was used to repay the hydro company for the initial costs. The retrofit ended up saving families, on average, more than $1,000 a year on their energy bills (Fisher River, 2020). Also, the money paid back each month, as a share of money saved on home heating bills, was less than the total amount saved monthly. This meant community members had a more reliable, energy efficient home heating system, and more money in their pockets each month.

[6] INAC, "Sharing Knowledge for a Better Future: Adaptation and Clean Energy Experiences in a Changing Climate," Aboriginal Policy Research Consortium International, 2011, 19.

Conclusion

New, innovative energy infrastructure designs can result in longer timelines for input and discussions. Thus, extending the design, and the construction processes. The above case studies show that factors increasing project timelines and cost, like self-construction, green technologies, local materials, and new designs, provide substantial financial and non-financial benefits to the communities in the long-term, including that of self-reliance and energy autonomy. Basic build infrastructure projects, on the other hand, are not conducive to long-term growth or success; specifically tailored designs must be sought through community consultation, and when possible, built through community-led construction. As demonstrated above, durable, culturally appropriate, environmentally conscious energy infrastructure is a possibility for communities. Though the process may result in initial delays and/or higher upfront costs, the long-term benefits of innovative infrastructure, if done correctly, should far outweigh initial setbacks.

Appendix A: The Heating Cycle

Natural Resources Canada. "Ground-Source Heat Pumps (Earth-Energy Systems)" Government of Canada, March 2017. Accessed on January 12, 2021. Available online at https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/ground-source-heat-pumps-earth-energy-systems/6833.

The Heating Cycle

In the heating cycle, the ground water, the antifreeze mixture or the refrigerant (which has circulated through the underground piping system and picked up heat from the soil) is brought back to the heat pump unit inside the house. In ground water or antifreeze mixture systems, it then passes through the refrigerant-filled primary heat exchanger. In DX systems, the refrigerant enters the compressor directly, with no intermediate heat exchanger.

The heat is transferred to the refrigerant, which boils to become a low-temperature vapour. In an open system, the ground water is then pumped back out and discharged into a pond or down a well. In a closed-loop system, the antifreeze mixture or refrigerant is pumped back out to the underground piping system to be heated again.

The reversing valve directs the refrigerant vapour to the compressor. The vapour is then compressed, which reduces its volume and causes it to heat up.

Finally, the reversing valve directs the now-hot gas to the condenser coil, where it gives up its heat to the air that is blowing across the coil and through the duct system to heat the home. Having given up its heat, the refrigerant passes through the expansion device, where its temperature and pressure are dropped further before it returns to the first heat exchanger, or to the ground in a DX system, to begin the cycle again.

Appendix B: Membrane Filtration Modes of Operation

Natural Resources Canada. "Ground-Source Heat Pumps (Earth-Energy Systems)" Government of Canada, March 2017. Accessed on January 12, 2021. Available online at https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/ground-source-heat-pumps-earth-energy-systems/6833.

The Cooling Cycle

The cooling cycle is basically the reverse of the heating cycle. The direction of the refrigerant flow is changed by the reversing valve. The refrigerant picks up heat from the house air and transfers it directly, in DX systems, or to the ground water or antifreeze mixture. The heat is then pumped outside, into a water body or return well (in an open system) or into the underground piping (in a closed-loop system). Once again, some of this excess heat can be used to preheat domestic hot water.

Unlike air-source heat pumps, EESs do not require a defrost cycle. Temperatures underground are much more stable than air temperatures, and the heat pump unit itself is located inside; therefore, the problems with frost do not arise.

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