2013 Canadian Consulting Engineering Awards
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Off-Grid Generating Station Renewal and Solar PV Retrofit for Wawakapewin First Nation

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Wawakapewin First Nation is a small and very remote community in northern Ontario. Located 580 km north of Thunder Bay, Wawakapewin is only accessible by float or ski plane or a seasonably available, unreliable ice road. During freeze up and spring thaw there is no access other than helicopter. Combined with long, harsh winters, this isolated location means there is no reliable access to fuel for the generating plant, and energy efficiency is paramount in order to conserve fuel for community power and financial resources.

Until recently, the town was supplied by a diesel electric generating plant consisting of two, 125-kW generators. The generators are not connected to the Ontario electricity grid. When operating at part load – particularly throughout the summer, the plant becomes quite inefficient, and reliability is an issue since low load conditions cause the generators to shut down.

Consultant Enermodal Engineering, a member of MMM Group, was hired by the community to create a solution to the challenge of providing a year-round, reliable, and energy-efficient power solution. Enermodal designed an 18-kW PV array to offset diesel consumption, and a smaller 50-kW generator to be used instead of the large plant during the summer. The existing plant was significantly recommissioned and was also connected to the new graphics-based, easy-to-use control system. Savings are significant given that flown-in diesel can cost $4/L resulting in electricity generation costs of $1/kWh). The project is innovative since a large percentage of the peak load can be offset (80% or more during the day). The control system is designed to steadily reduce PV input at low-grid loads in order to maintain grid stability and prevent plant shut down. This is a ground-breaking solution for an off-grid situation, maintaining 24/7 grid operation due to the high offset percentage and the controls in place.

Innovation

The system designed for Wawakapewin's energy needs and goals was an innovative one, using out-of-the-box thinking and providing a solution that was highly customized to the unique climate, location, and capacity challenges.

Through careful design, experienced consultants, and innovative design controls strategies this project was able to offset a high percentage of daytime power consumption with renewable energy.

Another innovative aspect of the project is that the custom-designed, ground-mount PV installation is ideal for adapting to challenging ground conditions of peat and loam on top of bedrock. The frame base was placed into buried gabian rock baskets which would be adapted in shape and orientation to accommodate the varying soil depth and rock elevation. Many portions of the steel frame were fabricated onsite to suit conditions and the solar modules were installed with a larger than normal gap to allow for some movement / flexing of the structure without putting undue stress on the modules. The winter biased power production with steeply slopped (60 degrees from horizontal) solar system design is perfect for this difficult climate.

A beneficial and best practices step taken by the design team early in the project was to create a detailed energy model to account for actual community loads to ensure all community needs would be met today and tomorrow as well as to identify potential energy waste.

In addition to the 18-kW PV array and new, efficient summer generator, the existing plant was significantly re-commissioned and repaired, rewired, and reprogrammed to improve their efficiency and reliability. The existing generator running commands and diagnostic information was incorporated into the new system Programmable Logic Controller and touchscreen interface providing much needed information to the operation staff charged with the 24/7 operation of the system.

Complexity

This project involved significant complexity due to the numerous "players" and stakeholders as well as the atypical environment, lack of local technical capacity, remote location, and the challenges creating renewable energy systems as a significant source of community power.

Until recently, the town was supplied solely by a diesel electric generating plant consisting of two 125 kW generators as the community is not connected to the Ontario electricity grid. When operating at part load – particularly throughout the summer, the plant becomes quite inefficient and reliability is an issue due to low load conditions causing the generators to shut down.

The difficulty in accessing the site proved challenging from a project administration perspective and material supply perspective (there are no local materials) as well as in determining a reliable, easy-to-maintain design solution. The need for a cost-effective, energy-efficient solution in a harsh environment was also a complexity in the project. The project owner did not want to utilize local storage batteries to store excess solar generation since the cost of transportation makes it difficult to send equipment to the south for repair / recycling.

The remote nature of the site provided some of the toughest engineering and capital cost challenges. While it was preferable to transport most of the project materials via the winter ice road there was no guarantee of its viability for the upcoming winter. This meant ensuring that all products could, if needed, be fit into a large float plane for transport to the work site. Simple things that we take for granted in typical construction, such as the sourcing of a small amount of gravel to make concrete for the floor slab, required careful thought and planning. The heaviest items like the new generator arrived in an adjacent community and airlifted to the site by helicopter.

The project team had to deliver significant project management challenges due to the location, lack of local capacity, and complex relationships with government, First Nations, tribal council, and testing authorities, etc.

The new, easy-to-use system helps the community's operations staff easily manage the community's energy systems and builds internal capacity.

Social and Economic Benefits

For the Wawakapewin First Nations (WFN), this project has revolutionized their relationship to power generation and enabled them to become energy producers, rather than just consumers of expensive non-local fuel. This project has increased the community's energy independence, increased the expertise of its operations and maintenance staff, and improved the emergency-readiness and quality of life for the entire population.

This project demonstrates First Nations willingness to be innovative, government's desire to support technical firsts, and designer / consultant's innovation, professionalism and ability to design within a context entirely different to everyday projects. The project will serve as a case study and source of inspiration for other First Nations and remote communities with similar challenges and goals.

At the community level, two staff members are now trained in the use of the new system and control plant. The new, easy-to-use control system was an important part of this benefit. This increased local expertise will serve the community and future generations well.

From a financial perspective, Wawakapewin First Nations has significantly reduced energy costs and a more reliable energy supply. This increases the quality of life for the population as well as for their children.

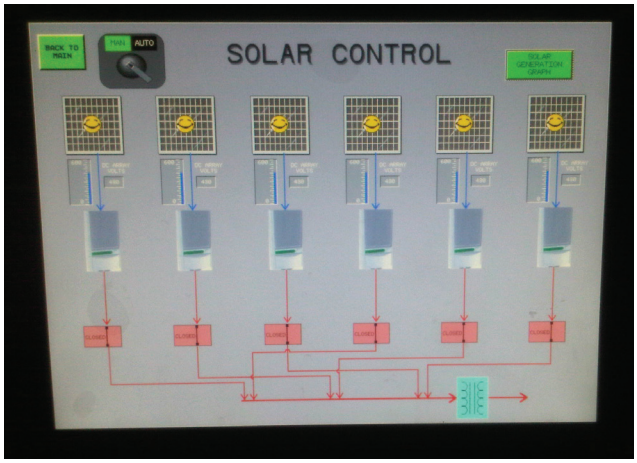
Objective	Solution	Achievement
Reduce fuel costs; diesel often had to be flown into the community at a cost of $4/L	• Increase plant efficiency	• Improve controls and add new generator to increase efficiency
Lower electricity costs (which were more than $1/kWh)	• Install solar PV to offset diesel-generated electricity	• Solar electricity now reduces generator loads and saves diesel
Improve reliability of power generation and the ability of the community to maintain and troubleshoot their own systems (technical expertise and parts are a helicopter or float plane ride away)	• Recommission plant and install new controls	• New touch screen, graphics-based control system in place to improve operations; generators now work as designed
Increase human capacity	• Involved Wawakapewin staff on the project to teach them about the new system, and relay knowledge of plant operations. • Document periodic maintenance	• Two staff now trained in the use of the new system and control plant
Create an energy solution that promotes the traditional environmental stewardship values of the First Nations	• New system means less reliance on outside resources to run the community and shows other First Nations Communities that renewable energy can be incorporated into their communities, despite remote location	• The solar panels will generate 21,000 kWh of electricity per year; the more efficient generator will offset 14,300 L of diesel per year, or 5,100 barrels of diesel.
Provide an educational case study for Wawakapewin, the tribal council, and Aboriginal Affairs and Northern Development Canada (federal government) and show other First Nations communities how to decrease their reliance on fossil fuels and become more independent	• Provide energy awareness training to residents, produce materials to help them understand how expensive energy is and how they can save	• Wawakapewin is optimistic other First Nations communities will learn from the project and that the federal government will recognize that these types of solutions will work for other remote communities.

Environmental Impact

The use of solar electricity now reduces generator load and diesel use, providing significant environmental benefit.

The solar panels will generate 21,000 kWh of electricity per year. This, plus the more efficient generator, will offset 14,300 L of diesel per year, or 5,100 barrels of diesel.

Meeting Client's Needs



The client's goals were to:

- Reduce fuel costs diesel often must be flown into the community at $4/L
- Lower electricity generation costs (over $1/kWh)
- Improve reliability of power generation and the ability of the community maintain and troubleshoot their own systems (technical help and parts are a helicopter or float plane ride away)
- Encourage capacity-building for operators in the community
- Create an energy solution that promotes the traditional environmental stewardship values of the First Nation
- Provide an educational case study for Wawakapewin, the tribal council and AANDC (The federal government) to show other First Nations communities how to decrease their reliance on fossil fuels and become more independent

In addition to the 18-kW PV array and new, efficient summer generator, the existing plant was significantly recommissioned and was also connected to the new graphics-based, easy-to-use control system. This is a ground-breaking solution for an off-grid situation, maintaining 24/7 grid operation due to the high offset percentage and the controls in place.

The Client's needs were met through the solution developed and implemented by Enermodal. The client was pleased with the result:

"As a remote Independent Power Authority community, our First Nation faces many challenges with producing affordable power for our community. The idea of this project was developed based on the knowledge that in the summer months when the community's energy loads are low, the generators were running inefficiently. Through funding from AANDC First Nations Infrastructure Fund and ecoENERGY program, our community was able to use an alternative green energy source and an appropriately sized generator for summer energy loads, thereby saving fuel costs and running our DGS more efficiently. Our community is proud to pilot this technology and promote the positive impacts it will have on our community and environment."

— Wawakapewin First Nation