PEMBINA institute

Solar PV Case Study
Colville Lake, Northwest Territories

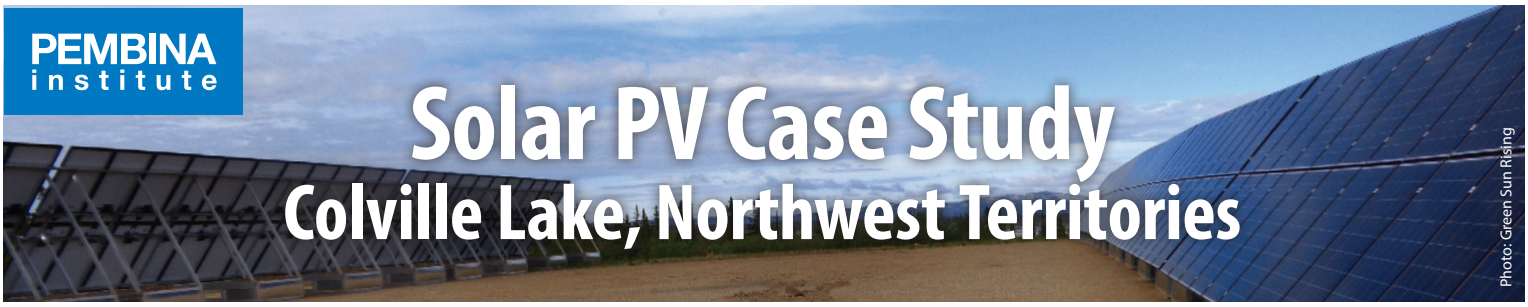
Photo: Green Sun Rising

Hybrid solar PV–diesel power plant with energy storage

136.5 kW of solar, 200kWh of battery storage and new diesel generators meet Colville Lake's electrical demands while demonstrating how to supply cleaner and more secure electricity to a remote community.

Community

Colville Lake is a First Nation community with approximately 160 residents, located 50 km north of the Arctic Circle (745 km north of Yellowknife), in the Northwest Territories (NWT) of Canada. The airport is not adequate for large cargo delivery and a winter ice road is open only a few weeks each year to bring in the annual diesel supply.

Motivation for the project

Colville Lake's diesel powered generators, owned and operated by Northwest Territories Power Corporation (NTPC) — NWT's government-owned utility — were at the end of their economic life. NTPC was looking for innovative alternatives to integrate renewable energy technologies, improve generator efficiency by sharing peak loads, and reliably meet the community's growing demand for electricity (which increased from a peak demand of 40 kW in 1990 to 160 kW in 2014). In addition, the new system presented an opportunity to meet the Government of the Northwest Territories' (GNWT) goal of expanding renewable energy generation in the north as outlined in its 2012 *Solar Energy Strategy* and 2013 *Energy Action Plan*. The project has also allowed the NTPC to relocate the generating plant to reduce noise and exhaust in the town.

Solar PV system

The Colville Lake system of renewable electrical generation plus energy storage is the first in NWT. The 136.5 kW solar PV system is expected to generate around 112 MWh of energy per year and should exceed the average electricity load of the community — a significant milestone in renewable technologies in remote communities. The system is ground-mounted and includes solar panels, lithium-ion batteries and new diesel generators, all integrated and remotely monitored through an internet-based system.

The system in Colville Lake was installed in two phases.

Phase 1

Solar PV: Ground-mount, 54 kW manually adjustable tilt

- Eclipsall NRG 60 - 265SE (265 W, mono-crystalline, 4 mm thick tempered glass)
- Two rows of nine racks, with 12 panels per rack (216 panels total)
- Galvanized steel racking with center balance pivot plate for tilt adjustment. Pressure treated lumber ballast boxes filled with local sand and gravel
- Enphase M250 inverters

Phase 2

Solar PV: Ground-mount – 82.5 kW 52° fixed angle

- Canadian Solar CS6P 260 W
- Three rows of five sections, 22 panels per section (330 panels total)
- Aluminum and stainless steel framed ground mounts filled with local soil as ballast. Floats on permafrost.
- Enphase M250 inverters
- Enphase Envoy communication gateway

200kWh battery storage

- SAFT Intensium® Max 20M batteries with winterized containers
- Four battery modules, 58kW each

Control system

- ABB PCS100 inverter
- ABB AC800M local unit controller
- Multi-unit controller

Diesel generators

- 350 kW total (2 x 100 kW, 1 x 150 kW)

Other details

- Both the solar and diesel generators can be shut off when the batteries are fully charged.
- The diesel generators will be shut down for extended periods during the summer and used less during the shoulder season.
- The batteries will enhance the electricity generated by the solar PV system, minimize the impacts of system maintenance and smooth out the load delivery required by the generators. This will result in lower maintenance and overall extend the useful life of the generators.
- Anticipated annual electricity generation from the solar PV system is 112 MWh; renewable electricity is expected to meet close to 20% of the overall electricity demand in the community
- Annual diesel fuel use will be reduced by 31,600 liters.
- The new hybrid solar PV-diesel-battery plant is located on a section of the community's old airport runway.


Photo: Green Sun Rising

Project life cycle

Extensive community engagement and consultation was carried out in February 2013 and continuing through to 2015.

2013
Phase 1, the 54 kW solar PV system, was tendered in the fall and the contract was awarded to Azgard in December.

February/ March 2014
Materials transported during the winter ice road season

October 2014
Phase 1 solar PV system installed and commissioned

Fall 2014
Phase 2, the system of 82.5 kW solar PV, batteries, new diesel generators and hybrid controller, was tendered

December 2014
Phase 2 contracts awarded:
- Solar: Green Sun Rising
- Diesel generator supply: Westquip Diesel Sales of Edmonton
- Diesel generator install: Adco Power Ltd.
- Battery, inverter and control supply: ABB and SAFT
- Switch gear: JenSo Controls of Edmonton

Early 2015
Diesel plant built, commissioned and tested in Edmonton

February/ March 2015
Solar materials and completed diesel plant transported to Colville Lake during the winter ice road season

June 2015
Solar PV system installed and commissioned

September 2015
Diesel plant to be installed and commissioned. The new system needs to be up and running and integrated before the old diesel generators can be shut down and removed

Financial model

The entire project is estimated to be $7.9 million (project still under construction as of this writing but cost details available at www.nwtpublicutilitiesboard.ca/documents.htm).

The small scale of renewable electricity generation made the economics of this project challenging; however, it represented a lower-risk opportunity to study both the integration of large renewable loads and battery storage in remote communities.

The solar PV system, batteries, controllers and system installation cost an estimated $3.2 million, while the replacement and relocation of the diesel generators is estimated at $4.7 million. Funding support was provided by:

- Government of the Northwest Territories, which provided $1.15 million for both solar phases
- EcoENERGY for Aboriginal and Northern Communities, which supplied $150,000 for a feasibility assessment on the battery/solar system integration

The combination of new solar, improved energy efficiency and reduced operating and maintenance costs is expected to add up to $107,000 in annual cost savings.

Project highlights

The GNWT committed under its 2012 *Solar Energy Strategy* to advance solar-diesel hybrid systems and promote the use of battery-based solar charging systems in remote off grid locations. GNWT support for this project greatly facilitated the implementation of this innovative system.

This project offered several key learning opportunities:

- Validate the technical and economic feasibility of integrating solar PV with significant battery storage.
- Benchmark the amount of renewables that can be integrated successfully into a microgrid for a remote application.
- Help clarify the long-term impact of an integrated system on diesel generators.

Colville Lake is a very remote community with challenging accessibility; project logistics had to be very carefully planned and executed with staggered construction and close communication with the community. Colville Lake had won an award for an earlier project to construct a new airport; skills and equipment from that project were invaluable in the execution of this energy project.