Residential Solar Power Systems

for Affordable Housing in B.C.

BC HOUSING
RESEARCH CENTRE

Acknowledgements

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Introduction

In 2009 a solar photovoltaic (PV) system was installed at the Greenbrook public housing site in Surrey, B.C., as part of a project that aimed to create a zero-emissions building complex. This research report looks back at the project details and lessons learned, in order to educate the construction industry about PV systems as they have now become more affordable and thus are in higher demand.

Project Overview

Greenbrook is a 127-unit public housing site in Surrey, B.C. Built in 1974. The site consists of 28 row-style townhouse blocks and an amenity building. In 2009, the complex underwent a major renovation project that included:

- New roofing
- Exterior siding
- Windows
- Doors
- Exterior insulation
- Air-source heat pumps
- Heat-recovery ventilation systems
- Energy-efficient lighting
- Water-efficient shower heads and toilets

The objective of the renovation project was to reduce the greenhouse gas (GHG) emissions of the complex by 90%. To offset the remaining 10%, the project implemented the largest solar photovoltaic (PV) installation in western Canada at the time. This resulted in the site being almost carbon neutral.

Technical Specifications

The solar PV system consists of almost 700 Sanyo HIP 195-watt PV modules for a total generating capacity of approximately 139 kW. The system was projected to generate roughly 130 MWh per year.

The PV installation is spread throughout 11 buildings in the complex. The site was a viable candidate for PV because many of the buildings had south-facing roofs.

In total, nine PV installations face south, one south-west, and one west. The PV modules are connected in different sub-arrays, which are then connected to three varied sizes of inverters (5 kW, 6 kW, and 7 kW).

The modules are mounted 10 cm (4 in.) above the roofs, using a UniRac mounting system. The project's structural engineer evaluated the attachment details between the UniRac systems and the roofs.

Figure 1: PV system installed at Greenbrook.

The system was installed under a net-metering agreement with BC Hydro. The PV-generated electricity is fed into each building (approximately five suites per building.) When electricity is being generated, it first meets all the electrical loads of that building. If there is more electricity generated than the building consumes, the excess is fed back into the grid via the building's electricity meter, which generates a credit for future consumption.

Figure 2: Electrical meters at Greenbrook.

Implementation Considerations

Roof Details

The first step is to determine if a building is suitable for a PV system. This includes assessing the roof's condition and ensuring there is a functional, unshaded solar surface.

The Greenbrook complex has many buildings with large south-facing roofs. Since the buildings had recently installed new roofs, they were in good condition.

PV modules typically come with a 25-year warranty and may last over 30 years. Therefore, new roofing (or any plans to replace or renew roofing) should be considered, because it is not economically feasible to remove the PV system a few years after it is installed.

The large trees at Greenbrook were a factor in choosing where to locate the PV installations, as shading may impact the performance of the whole array. Fortunately, there are south-facing roofs with unshaded roof surfaces. One system was mounted on an unshaded south-west roof and another on a west-facing roof.

Figure 3: Large trees at Greenbrook.

The housing complex's annual GHG emissions reduced by 422 tons of CO2e per year, or a 96% decrease compared with pre-retrofit emissions.

Cost Implications

This project was part of a demonstration on how net-zero carbon emissions could be achieved in existing buildings through extensive retrofits. Since it was a demonstration, the individual measures were not intended to be cost-effective at the time. The PV system was valued at approximately $1.34 million.

Because PV systems have become significantly less expensive since this project was completed, the cost today would be quarter of the original value. PV module prices have become so affordable, social housing projects that have access to long-term, low-interest loans could install PV systems and generate net annual savings.

System Maintenance

PV systems have no moving parts and generally require little maintenance. Carmanah Technologies, which designed and installed the system, provided BC Housing with an operation and maintenance manual, which includes monthly, bi-annual, and annual tasks:

Monthly

- Check inverter vents and fan for dirt or dust build-up. Clean if present.
- Visually check PV modules and the array support structure for signs of cracks or other damage.
- Check for dirt, dust or bird droppings on the array and clean as necessary. A uniform, light layer of dust doesn't significantly degrade performance.
- Use water and a soft brush to clean modules. Do not use a dry mop, which can scratch the glass surface.
- Clean modules in the morning or evening, before they become hot. Do not clean if the modules are cracked or damaged.
- Wear high-voltage gloves when washing the PV modules.

Every Six Months

- Check for broken glass, damage, or signs of electrical faults on both sides of the PV modules.
- Replace any damaged modules.
- Open each inverter connection box and check for blown fuses and torque the connection screws to manufacturers' specifications.
- Open each sub-array junction box and check electrical terminals for tightness.
- Inspect for short circuits or burning.
- Open each PV system AC/DC disconnect enclosure. Check electrical terminals for burning, corrosion, or blown fuses.
- Torque all wire terminations to manufacturers' specifications.

Annual

- Check that multi-contact module connectors are plugged tightly together (sample 10% of the connectors).
- Check that array wiring is neatly clipped to module frames, not hanging loosely beneath.
- Inspect module array for shading from vegetation, new construction, paint overspray, or other sources.
- Take photos to document any causes of reduced array performance, and remedy if possible.

Lessons Learned

The installer provided an extensive operating and maintenance schedule. One element that required more attention was to establish how tasks would be done safely by service personnel. With staff turnover and many other duties, not all the recommended maintenance tasks have been followed.

PV systems are fairly robust, and these have continued to operate without issue. However, since all the recommended inspections were not followed, an operations program is required to monitor the electricity production and the need to respond if production starts to decline.

Unfortunately, the electricity generated by the PV system at Greenbrook is not being monitored. The only monitoring available is the net-electrical usage of the building. This does not provide an accurate indicator to performance of the system, as deviations in electricity consumption can be due to many factors, such as occupant behaviour and changes to other electrical equipment.

Electricity production could be read in-person from individual inverters. The inverters can connect to the internet, and production could be tracked online. However, because the systems are distributed throughout 11 buildings, this would be costly if the access and reporting cannot be unified into a single account.

Final Thoughts

All retrofit measures combined (including the insulation measures and window replacements) led to a 50% energy reduction for the Greenbrook housing complex. The housing complex's annual GHG reductions targets have been achieved, and amount to 422 tonnes of CO2e per year, thanks to the low-carbon electricity in B.C. This represents a 96% decrease compared with pre-retrofit emissions.

More Information

1. *Best Practices in Photovoltaic System Operations and Maintenance*, available at www.nrel.gov/
2. *Canada's Go Solar Guide and Directory*, available at www.cansia.ca
3. *Case Study – Greenbrook Sustainability Project*, available at www.bchousing.org
4. *Integrating Photovoltaic Systems into Low-Income Housing Developments: A Case Study on the Creation of a New Residential Financing Model and Low-Income Resident Job Training Program*, available at www.nrel.gov/
5. *Residential Consumer Guide to Solar Power*, available at www.seia.org

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Contact Information

BC Housing Research Centre, 1701-4555 Kingsway, Burnaby, BC V5H 4V8

Phone: 778-452-6454

Toll-free: 1-866-465-6873

Email: research@bchousing.org

www.bchousing.org