CASE STUDY

CANADIAN ROCKIES PUBLIC SCHOOLS

March 2020

Since 2009, the Municipal Climate Change Action Centre has empowered Alberta's municipalities, school authorities and community related organizations to be leaders in climate change solutions through partnerships and innovation. This case study highlights how Canadian Rockies Public Schools has participated in the Solar for Schools Progam.

Municipal Climate Change Action Centre

The Municipal Climate Change Action Centre provides funding, technical assistance, and education to support Alberta municipalities, school authorities, and community related organizations in addressing climate change.

The Municipal Climate Change Action Centre is a partnership between the Alberta Urban Municipalities Association, Rural Municipalities of Alberta and the Government of Alberta.

Special thanks to the participants

Canadian Rockies Public Schools serves elementary, middle, and high schools in the Bow Valley and is a leader in Alberta's energy transition.

Statistics for projects completed through the Solar for Schools Program.

611
SOLAR PV MODULES WITH 263 MORE TO BE INSTALLED IN 2020

2
SCHOOL SOLAR SITES COMPLETED

137 tCO_2e
GREENHOUSE GAS EMISSIONS REDUCED EACH YEAR

20%
OF ELECTRICITY USE OFFSET BY SOLAR PV

2 SOURCES
OF FUNDING TO COVER COSTS OF THE PROJECTS

8 YEARS
SIMPLE PAYBACK

239,433 kWh
SOLAR ELECTRICITY PRODUCED PER YEAR

$23,923
IN ANNUAL ENERGY SAVINGS FOR THE SCHOOL AUTHORITY

EMISSIONS REDUCTIONS ARE EQUIVALENT TO TAKING

42 CARS
OFF THE ROAD EACH YEAR

$201,860
IN REBATES FROM THE ACTION CENTRE

REAL SAVINGS. REAL CHANGE.

Students, teachers, and administrators at schools across Canadian Rockies Public Schools are experiencing the Alberta solar advantage firsthand as they save money and greenhouse gas emissions, thanks to solar photovoltaic systems on school roofs.

With the Bow Valley's world-renowned landscapes and sensitive ecology, it should be no surprise the area has a history of environmental conservation and taking action on climate change. As a member of the Bow Valley community, Canadian Rockies Public Schools is committed to doing their part to reduce their greenhouse gas (GHG) emissions.

Since 2009, they have worked to install solar PV on schools in their school authority (Canadian Rockies Public Schools, n.d.). Their most recent projects saw 611 solar PV modules installed on two schools, resulting in 230 kilowatts (kW) of direct current (DC) capacity. These projects bring the total solar PV capacity across the Canadian Rockies Public Schools district to 515 kW. With plans for an additional 105.2 kW system in 2020, the School Authority is on track to have solar PV installed on 5 schools, representing over 60% of the institutions in their division.

This case study examines the Lawrence Grassi Middle School (LGMS) and Canmore Collegiate High School (CCHS) projects that were partially funded by the Municipal Climate Change Action Centre (Action Centre) through the Solar for Schools (SFS) Program. Combined, these projects received a rebate of $201,860. The total capital cost of the two projects was $403,720 and they are expected to reduce the School Authority's annual GHG emissions by 137 tonnes CO_2e. Together they are expected to generate 239,433 kilowatt-hours (kWh) of electricity each year, saving the School Authority an estimated $23,943 in avoided energy costs.

Solar PV array at Canmore Collegiate High School.

SOLAR PV SYSTEMS

The Canmore Collegiate High School project was completed in August 2019, and the Lawrence Grassi Middle School project completed in November 2019.

CCHS already had 23 kW of roof-mounted solar PV installed through a 2016 student-driven initiative, and three inverters in that array had unused capacity. To capitalize on this inverter space, the new CCHS array was designed using two different types of modules, 168 Hanwha Q.PEAK DUO L-G5.2 385 modules, and 90 LG360S2W-A5-72CELL modules. All modules were flush-mounted to the sloped asphalt school roof surfaces with Fast-Rack rails and fasteners. Due to the variety of angles and directions on the facility roof, installed azimuths are between 100° and 210° with tilt angles of around 40°. Four SolarEdge SE 14.4K-US string inverters were added as part of the new array. The DC capacity added by the new array was 97.08 kW, for a total system capacity of 120.08 kW DC.

The CCHS project also went through a few design iterations, as an assessment of the roof condition identified a number of areas that would need to be repaired or replaced in the near future. To avoid the removal and re-installation of sections of the solar PV array to accommodate this deferred maintenance, the final design only incorporated recently replaced roof surfaces. This means that there is additional unused roof space capable of receiving a future PV system expansion after the old roof is replaced.

The three LGMS roof surfaces used for solar PV are flat. To accommodate for this roofing style, this array was installed using ballasted TerraGen TGR2 racking that does not penetrate the roof. Instead, it sits on the roof surface and is held in place with concrete blocks, or ballast. This array used 65 LG360S2W-A5 modules and 288 Canadian Solar CS3U-380MS modules, making for a total DC capacity of 132.84 kW. The system uses three SolarEdge SE33.3KUS 3-phase string inverters, to convert the electricity produced from direct current (DC) to alternating current (AC), which is usable in standard residential and commercial electrical installations.

Initially a third project was also planned for 2019, on Banff Community High School (BCHS). Through the design phase, however, it was discovered that a number of sections of the roof, where solar PV was planned, needed repair. To allow ample time for these repairs to occur, the solar PV project was put on hold and the budgeted funds shifted to an array on Elizabeth Rummel Elementary School in Canmore, planned for 2020.

Installers working on the solar PV array at Canmore Collegiate High School.

"As one of the smaller school divisions within the province, funding is always an issue in pursuing our goals. The funding provided by the Municipal Climate Change Action Centre through its Solar for Schools Program is an important catalyst in Canadian Rockies Public Schools reaching it's goal of having all schools within our division solar power equipped."

Ken Riordon, Project Manager,
Canadian Rockies Public Schools

Fifty percent of the $403,720 in combined project expenses for the CCHS and LGMS projects were off-set by a $201,860 rebate contributed by the Action Centre. The remaining project expenses were covered by the School Authority's annual infrastructure budget.

The School Authority plans to use the annual savings to help offset other operational costs, reducing the annual financial burden and allowing dollars to be spent on other priorities.

An estimated electricity rate of $0.10/kWh was used in all savings and payback calculations for this case study. This rate is based on the historical average electricity rate in Alberta and factors in an estimated increase in electricity rates across a 25-year period. This rate is a conservative estimate and does not include any savings from reduced energy-related distribution and transmission charges that result when solar electricity is used onsite and not purchased from the grid.

Using this rate and the estimated annual electricity production from the solar systems, the projects are estimated to yield $23,943 per year in savings.

REAL SAVINGS

THE ECONOMICS

$403,720
PROJECT COST

$23,943
IN ANNUAL ENERGY SAVINGS

$0.00
ANNUAL MAINTENANCE COST

8 YEARS
SIMPLE PAYBACK

25 YEARS
EXPECTED SYSTEM LIFETIME

$201,860
IN REBATES FROM THE ACTION CENTRE

The $0.10/kWh rate was used because all the Canadian Rockies solar systems fit within the 'small micro-generator' category. This means they are credited for electricity sent back to the grid on a monthly basis at the retail electricity rate. This rate does not factor in that the School Authority may have a lower than average electricity rate due to power purchase agreements that they have with their retailer.

As school authorities are big purchasers of electricity, to supply large and multiple facilities, they often enter into fixed rate contracts at a rate lower than the typical residential or commercial electricity rate. For this reason, actual savings may be lower than what has been estimated in this case study.

One of the most common questions asked when assessing whether a project is worth pursuing is, "how long will it take for it to pay back?" This calculation is called the simple payback and is defined as the length of time it will take before the money seen from energy savings equals the amount that was initially paid for the system. To calculate this number, the total system costs are divided by the estimated total energy savings per year. When factoring in the Action Centre rebate, and using the $0.10/kWh estimated electricity rate, the Canadian Rockies systems will see their simple payback of 16 years reduced to 8 years.

As the systems have not yet been operational for a full year, there is not enough data to fully calculate the amount of energy they have produced or the actual savings the School Authority has seen from the project. The Project Manager for the School Authority reports that the systems appear to be producing as expected. The Action Centre will continue to monitor their progress and provide an update to this case study using real values for system operations and savings in the years to come.

"Actions speak louder than words. This project is the future we are dreaming of."

Phil Kimbley-Nicolair, Student, Canmore Collegiate High School

Ballasted solar PV array at Lawrence Grassi Middle School.

"Schools located in the Bow Valley have 1,319 solar panels in total and have the capacity of generating 486,679 kWh of electricity per year. Thanks to the Action Centre, we hope to add 263 solar panels (108,472 kWh) to one of our elementary schools this spring, bringing our totals up to 1,582 panels producing 595,151 kWh."

Ken Riordon, Project Manager,
Canadian Rockies Public Schools

Both solar PV arrays are expected to produce a combined 239 MWh (239,433 kWh) of electricity per year. This will offset about 20% of the 1,217 MWh of electricity historically used by Lawrence Grassi Middle School and Canmore Collegiate High School.

As is the case with all grid-connected micro-generation solar PV systems, all electricity produced will be used first by building operations. Excess power will then be exported to the Alberta electricity grid, with the facilities receiving a credit on their electricity bills for the amount exported.

When electrical demand cannot be met by the solar PV system (i.e. at night, during shorter days, or on a cloudy or stormy day), electricity from the grid will be imported and charged to the school electricity bills as usual. The facilities will typically export excess solar electricity during the day in the summer months and import grid electricity at night and in the darker winter months.

As of March 2019, electricity available from the Alberta grid was generated by coal-fired power plants (36%), natural gas co-generation, combined and simple cycle power plants (48%), wind turbine power generators (9%), hydroelectric facilities (5%), and other sources (3%) (Alberta Electric Systems Operator, 2019).

REAL CHANGE
ENERGY AND EMISSIONS

20%
OF ELECTRICTY IS GENERATED FROM RENEWABLE RESOURCES

137 TONNES
OF GREENHOUSE GAS EMISSIONS AVOIDED OVER 25 YEARS

239,433 MWh
OF ELECTRICITY GENERATED PER YEAR

The heavy reliance on fossil fuels to generate electricity makes the Alberta grid one of the most emissions-intensive electricity grids in Canada. Figure 1 illustrates the emissions, by fuel type, for electricity production. Figure 2 provides a comparison of the emissions intensity of electricity generation across Canada.

The Lawrence Grassi and Canmore Collegiate PV systems replace 20% of the schools' electricity supply with a renewable generation source. As a result, Canadian Rockies Public Schools will avoid producing the equivalent of 137 tonnes of CO_2e per year.

This will reduce greenhouse gas (GHG) emissions by 3,413 tonnes CO_2e over the course of systems' minimum 25-year lifetime. For each year the systems are operating, this is equivalent to taking 42 cars off the road (Government of Canada, Natural Resources Canada, n.d.).

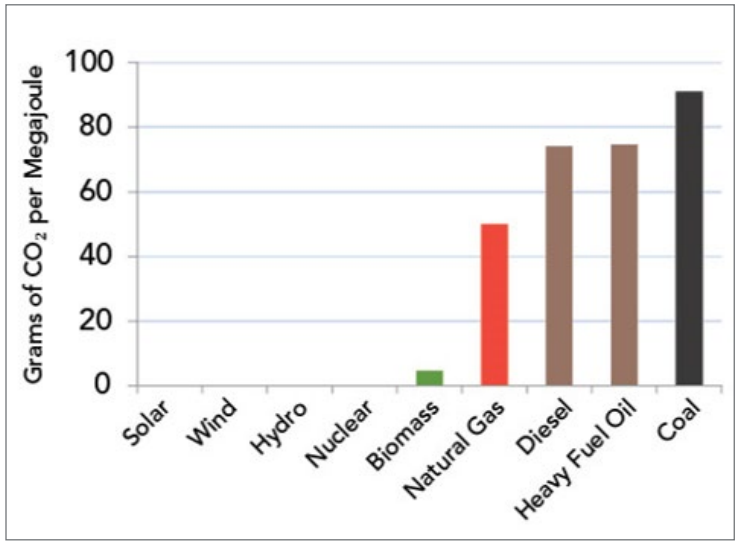


Figure 1. Emissions by fuel type for electricity generation in Canada (Government of Canada, 2017).

"We are so thankful that through the Action Centre, we were able to respond to the student's desire to use renewable energy to power part of our school building. It helps students and the community see the positive future ahead of us as we move away from fossil fuels."

Ruth Suffield, Teacher, Canmore Collegiate High School

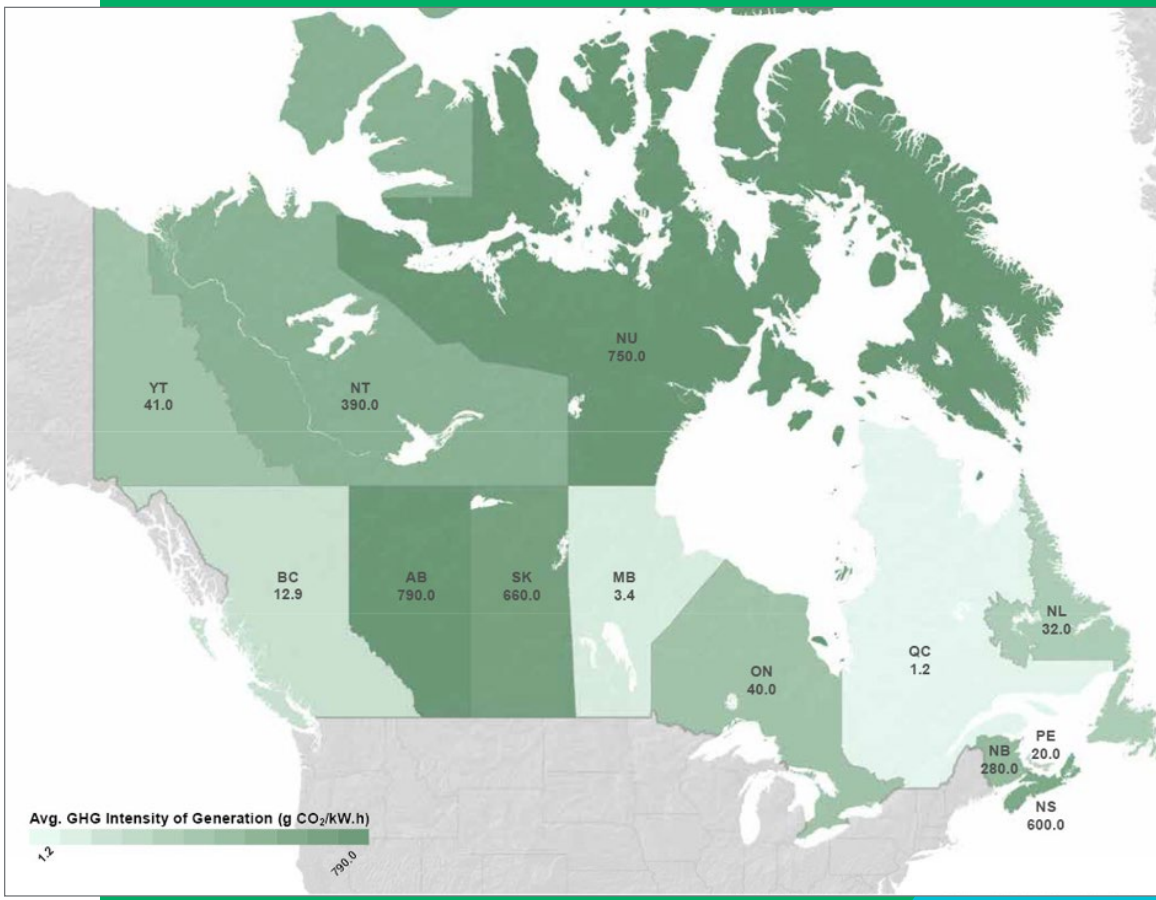


Figure 2. Greenhouse gas intensity of electricity generation by Canadian province and territory (Government of Canada, 2017).

From conception to completion, the Lawrence Grassi and Canmore Collegiate solar projects took just over two years and approximately 40 hours of staff time.

The annual hours budgeted for operation and maintenance of the systems are less than 10 hours per year, and the systems are expected to operate with minimal effort from School Authority staff. Aside from a basic annual inspection to check connections, and clearing the modules of debris, fixed-mount solar PV arrays typically have very few operational or maintenance requirements.

Given their previous experience with solar PV systems in operation on other schools, the value of installing solar PV was clear to Canadian Rockies Public Schools officials. They included funding for solar PV systems in their 2019 operating budget, at Ken's request, as they knew the systems would produce both financial and emissions savings.

CCHS and LGMS had some of the highest electrical loads in the district, so they were selected as the first candidates for new solar installations. A third, smaller system is under development in Canmore at the Elizabeth Rummel Elementary School. This project is expected to add another 105.2 kW of solar PV capacity to the Canadian Rockies solar roster early in 2020.

According to Ken Riordon, one of the biggest keys to a successful solar project is having a solar advocate within a school or school authority. This person identifies solar opportunities and advocates to ensure projects happen.

PROCESS
IMPLEMENTATION AND OPERATION

"Canadian Rockies Public Schools could not have achieved these totals or goals without the support from the Municipal Climate Change Action Centre grants, help and expertise of the Action Centre's staff to whom we are extremely grateful."

Ken Riordon, Project Manager, Canadian Rockies Public Schools

40 HOURS
OF STAFF TIME SPENT ON THE PROJECT

2 YEARS
TO COMPLETE THE PROJECTS FROM START TO FINISH

For Canadian Rockies, that solar advocate is Ken Riordon. Since the first array was installed on Banff Community High School in 2009, he has been championing the value of solar PV systems.

With more than a decade of solar project experience under his belt, and data from previous installations to support him, Ken Riordon convinced the School Authority that moving forward with these two new projects, and taking advantage of Action Centre funding, was a good decision. As with any capital project, solar PV installations are not without their challenges. Across the many solar PV projects he has worked on, Ken outlined the following challenges that he has encountered:

- Procuring engineering reports that accurately reflect the added load of the solar PV system on the schools.
- Deciding on the type of racking solutions that best fit each location.
- Identifying the best inverter locations for the electrical configuration, regulatory, and maintenance requirements of the system.
- Addressing potential upgrades needed on the main electrical panel.
- Establishing connection between the solar systems and the monitoring systems that are spread across several roofs. These complications can add time to a solar PV system project, and result in a monitoring system that does not accurately reflect production.

If he had it to do all over again, Ken would have involved teachers and students earlier on in the project. He recognizes the value of having the school community on board with the project from the very early stages, so they can ask questions throughout the process, and are more aware of the opportunities presented by this new learning tool.

PROCESS
LESSONS LEARNED

A portion of the solar PV array at Lawrence Grassi Middle School.

As part of the Solar for Schools Program, participating school authorities must also complete an educational component integrating the installed solar PV array into learning opportunities for students.

For both schools, curriculum support from The Critical Thinking Consortium (*Shining a Light on Solar Energy: Teaching and learning about sustainable energy*) was used, in conjunction with real-time data from the onsite monitoring system, to include solar PV content in existing classes.

Lawrence Grassi Middle School incorporated solar PV learning into their junior high science classrooms, in the Heat & Temperature and Interactions & Ecosystems units. Grade 7 students will learn about how solar energy can be used as an alternative and renewable energy source, how it can offset the unintended consequences of human action in an ecosystem, and the effect that using solar PV has on an individual's ecological footprint.

Canmore Collegiate High School will deliver solar PV content within grade 9, 10, and 11 science classes. In Biology 20, students will learn about sustainable solar-powered housing. In Physics 20, students will investigate the optimal position for a school rooftop solar PV array. Students in Science 10 will learn how solar PV cells convert photons into electric energy, and Science 9 students will consider whether micro or utility-scale solar generation is the best fit for Alberta.

Having a solar array physically present at each school, with the ability to see and track the electricity being produced by the system, is an excellent addition to the existing STEAM curriculum, providing a hands-on example that the students will interact with directly.

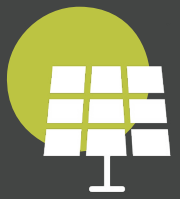
PROCESS
CONCLUSION

STEAM learning is a common, "approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking," in North America.

Institute for Arts Integration and STEAM, n.d.

Along with the previously installed projects, the arrays at Lawrence Grassi and Canmore Collegiate have solidified the value of solar PV for the School Authority. They plan to install solar PV on more schools . They will also promote solar power to other school authorities as a technological solution for reducing costs and emissions and creating innovative teaching opportunities.

4 GRADES
TO LEARN ABOUT SOLAR ENERGY IN SCIENCE CLASSES



SOLAR ARRAY CREATES
STEAM LEARNING OPPORTUNITIES

TEACHERS CAN USE
REAL-TIME DATA

REFERENCES

Alberta Electric Systems Operator. 2018. AESO 2018 Annual Market Statistics. Retrieved from: https://www.aeso.ca/market/market-and-system-reporting/annual-market-statistic-reports/

Alberta Electric Systems Operator. 2019. Electricity in Alberta. Retrieved from: https://www.aeso.ca/aeso/electricity-in-alberta/

Canadian Rockies Public Schools. CRPS Solar Panel Projects. Retrieved from: https://www.crps.ca/Solar%20Panel%20Initiatives.php

Government of Canada, Canada Energy Regulator. 2017. Canada's Renewable Power Landscape 2017 – Energy Market Analysis. Retrieved from: https://www.cer-rec.gc.ca/nrg/sttstc/lctrct/rprt/2017cndrnwblpwr/ghgmssn-eng.html?=undefined&wbdisable=true

Government of Canada, Natural Resources Canada. (n.d.) Greenhouse Gas Equivalencies Calculator. Retrieved from: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/calculator/ghg-calculator.cfm#results

Institute for Arts Integration and STEAM. (n.d.) What is STEAM Education? Retrieved from: https://educationcloset.com/what-is-steam-education-in-k-12-schools/

VISIT THE LEARNING CENTRE

A one-stop-hub of information, resources, and data to help Alberta municipalities and schools start climate change mitigation and adaptation. Access information on energy efficiency, renewable energy, community generation and more at mccac.ca.

Alberta Solar Calculator

This calculator helps project planners evaluate the cost implications of proposed grid-connected solar PV projects when compared to purchasing electricity.

View

Alberta Funding Guide

This guide provides information about funding programs for renewable energy and energy efficiency projects available to municipalities in Alberta.

View

Environmental Education for the Classroom

Free environmental, curriculum-connected, and classroom-ready environmental resources with fun exercises that support different learning styles provided by Inside Education.

View

Founding partners of the Municipal Climate Change Action Centre

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