SCHOOL DISTRICT 78
FRASER-CASCADE
EVERYONE PULLING TOGETHER

BOARD OF EDUCATION

OPERATIONS & FACILITIES COMMITTEE MEETING

October 12, 2021
4:30 p.m.
Via Zoom Conference Call

AGENDA

1. Call to Order/Acknowledgement of Indigenous Territory ………..		Mackie
2. Election of Chair …………………………………………………………………		Mackie
3. Approval of the Agenda ……………………………………………………….		Chair
4. Approval of the Minutes – May 25, 2021 ………………………………	Page 1	Chair
5. Custodial review …………………………………………………………………		Templeton
6. Seat belt bus update		Templeton
7. 21/22 CNCP progress report a) HHES b) BBES c) Kent Elem……..	Page 5	Templeton
8. 20/21 SEP progress report a) Kent roofing b) BBES building sprinkler c) dust collector AESS ………………………………………………………..		Templeton
9. AFG 21/22 work schedule a) BBES b)HHSE …………………………..		Templeton
10. AFG 22/23 planning schedule a) Kent Elem b) Coq Elm …………	Page 8	Templeton
11. Minor Capital requests 22/23………………………………………………..		Templeton
12. SD78/BC HYDRO joint project - energy storage/solar charging HHES …………………………..	Page 11	Templeton
13. Questions		

Adjournment

Next Meeting: **December 7, 2021**
4:30 p.m.

BOARD OF EDUCATION
SCHOOL DISTRICT NO. 78 (FRASER-CASCADE)

DRAFT MINUTES OF THE OPERATIONS & FACILITIES COMMITTEE MEETING
May 25, 2021
Via Zoom Video Conference

PRESENT:

Board Representatives:		
Ron Johnstone	Trustee	
Marilyn Warren	Trustee	
Committee Representatives:		
Lynne Marvell	President	FCTA
Karl Koslowsky	FCPVPA	
Gord Kearns	President	CMAWBC
Diana Stromquist	IEC	
District Staff:		
Balan Moorthy	Superintendent	
Renge Bailie	Assistant Superintendent	
Doug Templeton	Director of Facilities & Transportation	
Laurie Bjorge	Recording Secretary	
Regrets:		
Wendy Colman-Lawley	Trustee	Trustee
Heather Stewin	Trustee	Trustee
Natalie Lowe	Secretary-Treasurer	
Jenny Veenbaas	Assistant Secretary-Treasurer	
Anders Lunde	Teacher	FCTA
Crystal Hatzidimitriou	DPAC	
Leanne Bowcott	IEC	
Vacant	CMAW	
Vacant	FCPVPA	
Vacant	Parent Rep	
Vacant	Student Rep	

1. Call to Order and Acknowledgement of Indigenous Territory

The meeting was called to order by Trustee Johnstone at 4:30 p.m. via Zoom video conference. Superintendent Moorthy opened by acknowledging that the meeting was being held on the shared territory of the Cheam, Sts'ailes, Sq'éwlets, Seabird Island, Nlaka'pamux and Chawathil people.

2. Election of Chair

Election of Chair was bypassed, considering this is the last meeting until the fall.

3. Approval of Agenda

WARREN/MARVELL

THAT the agenda of the Operations and Facilities Committee meeting for May 25, 2021, be approved.

CARRIED

4. Approval of Previous Minutes – February 23, 2021

KEARNS/WARREN

THAT the minutes of the Operations and Facilities Committee meeting held on February 23, 2021 be approved as presented.

CARRIED

5. Custodial Review

The Director of Facilities & Transportation reported that the department is looking at continuing day custodians in schools beginning in the fall. Currently there is a custodian in the school during the day provided by supplemental Covid funding. Another custodian then comes in later in the day for deep cleaning. It is anticipated that the funding will not continue, so the department is trying to come up with a plan to maintain the current level of staffing.

6. Seat Belt Bus Update

Our district has been the only one that is participating in this pilot project up until now. Nanaimo district has just received their busses last week. The program has been very beneficial for the drivers and students. Aside from the seatbelts, the busses have new technology that has been a great benefit, such as lane assist, automatic breaking system, and 360 vision cameras. This district has decided to install the 360 vision cameras on every bus in the district.

7. 20/21 CNCP Progress Report a) SCE b) CES c) HSS

All projects have been completed. Additionally, the department was able to replace all the pneumatic air compressors in the Hope Secondary shops. All inefficient boiler systems were replaced with on-demand hot water systems. As well, a back up stand-by generator for Hope Secondary was purchased.

8. 20/21 SEP Progress Report a) roofing SCE b) flooring SCE c) dust collector AESS

Projects have been completed except the dust collector at AESS. Due to supply issues because of Covid, the equipment was delayed. The equipment has arrived now and should be installed by the end of June.

9. AFG 21/22 Planning Schedule a) BBES b)HHSE

The Ministry has redone the Capital request system, and as a result access to the program has been delayed. Once that has been fixed and we are able to enter the data, approval and funding should be coming shortly. The district is moving ahead with the planning schedule, but won't initiate until the funds have been received.

Boston Bar Elementary Secondary, has submitted their wish list. Some painting, electrical, and an upgrade to the front entrance was requested. The solar panel system will be installed on the roof to offset heating costs. The anticipated purchase cost of $150,000 - $200,000 for the system should be offset by running the boiler 75% of the time at no cost to the operating budget. The second stage of the project will create a micro-generating plant to sell power back to BC Hydro.

Harrison Hot Springs Elementary provided a small request list. As this school is on the list for replacement, minor changes will be made in the short term, such as making the school fully handicap accessible, some painting, office renovation, and adding more security cameras.

Additionally, the district received two free portables from New Westminster school district. Work is being done to remodel the two units and should be finished and installed at Kent Elementary in July.

10. Minor Capital Approvals 21/22

The Director of Facilities & Transportation reviewed the projects approved by Ministry

Facility Name	Program Project Description	Amount Funded by Ministry	Next Steps & Timing
Harrison Hot Springs Elementary	SEP - Electrical Upgrades	$250,000	Proceed to design, tender and construction. Project is to be completed by March 31, 2022.
Boston Bar Elem-Secondary	SEP - Plumbing Upgrades	$250,000	Proceed to design, tender and construction. Project is to be completed by March 31, 2022.
Kent Elementary	SEP - Roofing Upgrades	$350,000	Proceed to design, tender and construction. Project is to be completed by March 31, 2022.
Boston Bar Elem-Secondary	CNCP - Electrical Upgrades	$70,000	Proceed to design, tender and construction. Project is to be completed by March 31, 2022.
Harrison Hot Springs Elementary	CNCP - Energy Systems Upgrade	$100,000	Proceed to design, tender and construction. Project is to be completed by March 31, 2022.
Kent Elementary	CNCP - Electrical Upgrades	$120,000	Proceed to design, tender and construction. Project is to be completed by March 31, 2022.
Harrison Hot Springs Elementary	CNCP - Electrical Upgrades	$50,000	Proceed to design, tender and construction. Project is to be completed by March 31, 2022.

11. SD78/BC HYDRO Joint Project - energy storage/solar charging HHES

The topic was reviewed as per information from previous meetings.

12. Questions

No questions.

Next Meeting

Date: Fall, 2021
Location: District Education Office

Adjournment

/JOHNSTONE
THAT the meeting be adjourned.

CARRIED

The meeting adjourned at 5:40 p.m.

BACKGROUNDER

Provincial Funding Programs in support of B.C. public schools for 2020/21

EDUC receives annual Five-Year Capital Plan submissions from public school districts requesting approval and funding for a variety of Minor Capital projects. EDUC evaluates the merits of these submissions against the eligibility criteria of the various capital programs offered and the available program budgets, and provides project approvals and funding for school districts accordingly, to be completed by school districts within the upcoming fiscal year. The following is a brief description of the Minor Capital programs offered by EDUC.

School Enhancement Program (SEP)

SEP funding supports repair and maintenance projects that contribute to the function of the school and extend the life of the existing asset. Eligible projects include:

- electrical upgrades (ex: power supply, distribution system, etc)
- energy upgrades (ex: LED lighting, high-efficiency boilers, etc)
- health and safety upgrades (ex: fire systems, indoor air quality, etc)
- mechanical upgrades (ex: heating, ventilation, plumbing, etc)
- building enclosure upgrades (ex: roofing, exterior walls, windows, etc)
- washroom upgrades (ex: boys/girls changerooms, SOGI washroom spaces, etc)
- flooring upgrades (ex: gymnasiums, hallways, etc)

Carbon Neutral Capital Program (CNCP)

CNCP funding supports carbon neutral projects that have the greatest impact on reducing GHG emissions and providing energy cost savings.

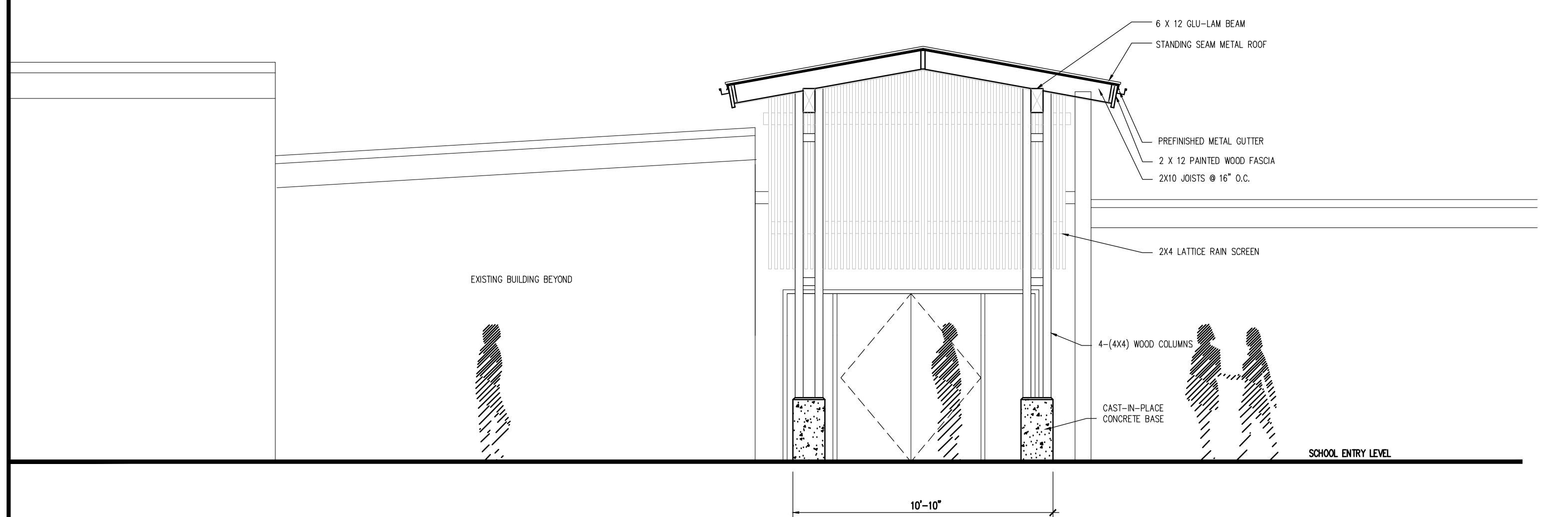
Building Envelope Program (BEP)

BEP funding supports the remediation of schools suffering damage from water ingress due to premature building envelope failure. School facilities eligible for BEP funding were built between 1985 and 2000, and have a Building Envelope Condition Assessment (BECA) completed by B.C. Housing.

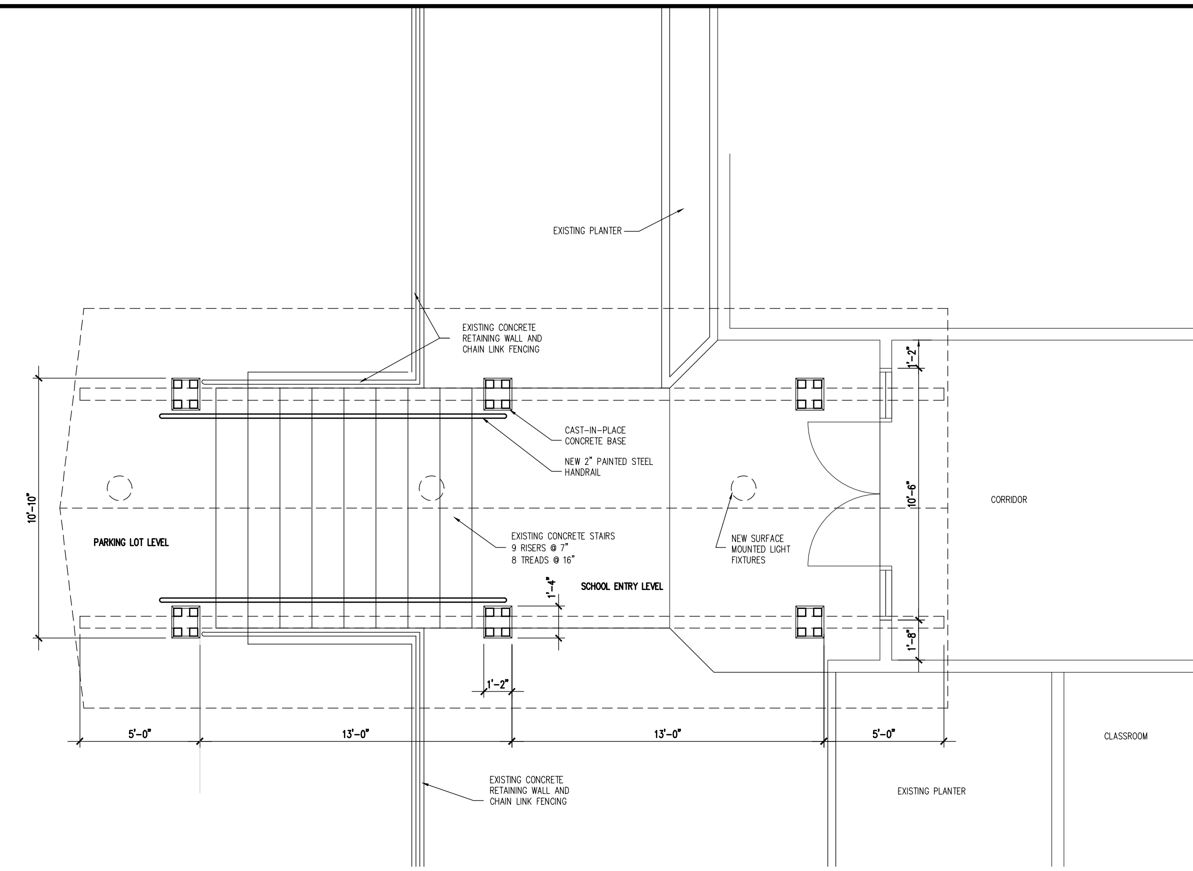
Bus Acquisition Program (BUS)

BUS funding supports the acquisition of new buses for those that have surpassed established thresholds for school bus age and/or mileage, demonstrate significant safety and/or mechanical issues, or that are required to support new routes in a school district without current student transportation service.

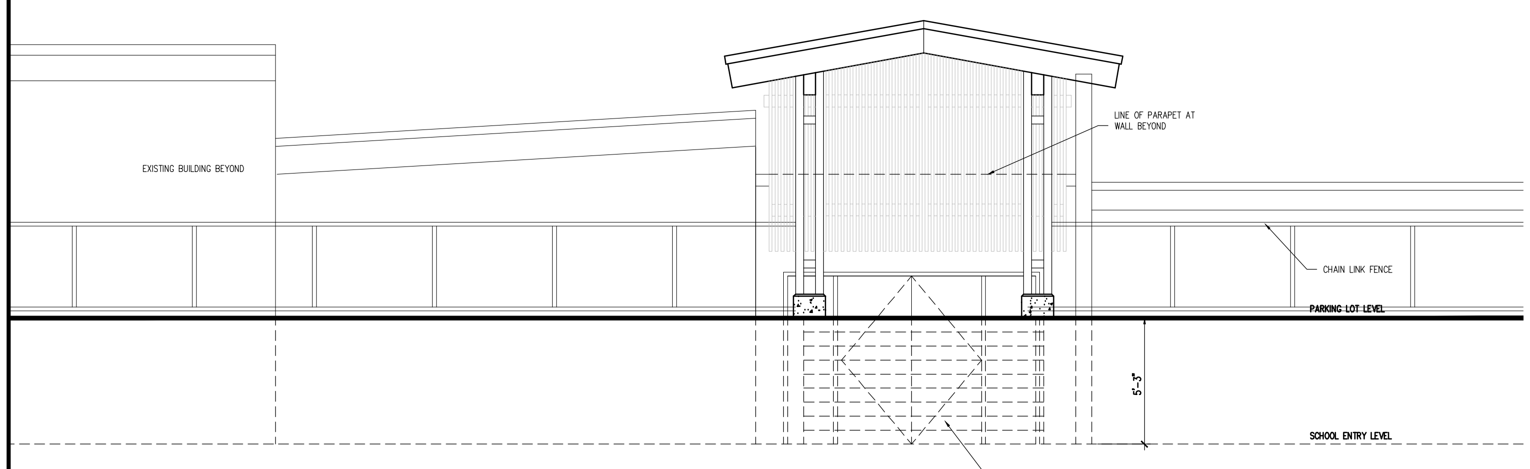
Name	Submission Categor	Funding Requestec	Project Type	Project year	Project Description	Project Req	Submission	Facility	Publish
151448 - Boston Bar Elem-Secondary	CNCP	70000	Electrical (CNCP)	2021/2022	LED lighting upgrade	Approved	Minor 2021/.	Boston Bar Elem-Secondary	Yes
151449 - Various	CNCP	70000	Energy	2021/2022	Electric car charging stations (10)	Draft			Yes
151450 - Harrison Hot Springs Elementa	CNCP	100000	Energy	2021/2022	solar charging and battery backup system	Approved	Minor 2021/.	Harrison Hot Springs Elemer	Yes
151451 - Kent Elementary	CNCP	120000	Electrical (CNCP)	2021/2022	LED lighting upgrade	Approved	Minor 2021/.	Kent Elementary	Yes
151452 - Yale Elementary	CNCP	100000	HVAC (CNCP)	2021/2022	Boiler upgrade	Approved	Minor 2021/.	Yale Elementary	Yes
151453 - Harrison Hot Springs Elementa	CNCP	50000	Electrical (CNCP)	2021/2022	LED lighting upgrade	Draft		Harrison Hot Springs Elemer	Yes
151754 - Harrison Hot Springs Elementa	SEP	250000	Electrical (SEP)	2021/2022	solar power system	Approved	Minor 2021/.	Harrison Hot Springs Elemer	Yes
151755 - Boston Bar Elem-Secondary	SEP	250000	Plumbing (SEP)	2021/2022	fire sprinklers	Approved	Minor 2021/.	Boston Bar Elem-Secondary	Yes
151756 - Kent Elementary	SEP	350000	Roofing (SEP)	2021/2022	partial replacement	Approved	Minor 2021/.	Kent Elementary	Yes
151757 - Kent Elementary	SEP	275000	Interior Construc	2022/2023	Flooring Replacement	Draft		Kent Elementary	Yes
151758 - Kent Elementary	SEP	400000	Plumbing (SEP)	2022/2023	Building fire sprinklers and upgraded municipal wat	Draft		Kent Elementary	Yes
152062 - Coquihalla Elementary	PEP	165000	Replacement (PE	2021/2022	Replace one wooden structure	Approved	Minor 2021/.	Coquihalla Elementary	Yes
152063 - Silver Creek Elementary	PEP	165000	Replacement (PE	2022/2023	Replace older playground	Draft		Silver Creek Elementary	Yes
152064 - Boston Bar Elem-Secondary	PEP	165000	Replacement (PE	2022/2023	Replace older playground	Draft		Boston Bar Elem-Secondary	Yes
154968 - Kent Elementary	SEP	200000	Interior Construc	2022/2023	Flooring replacement	Draft		Kent Elementary	No
154969 - Boston Bar Elem-Secondary	CNCP	250000	Electrical (CNCP)	2022/2023	solar power generation for electric lead boilers	Draft		Boston Bar Elem-Secondary	No
154970 - Kent Elementary	CNCP	300000	Electrical (CNCP)	2022/2023	solar installation for lead electric boiler and reducti	Draft		Kent Elementary	No
155222 - Coquihalla Elementary	SEP	200000	Interior Construc	2022/2023	complete flooring replacement of original school	Draft	Minor 2022/.	Coquihalla Elementary	No



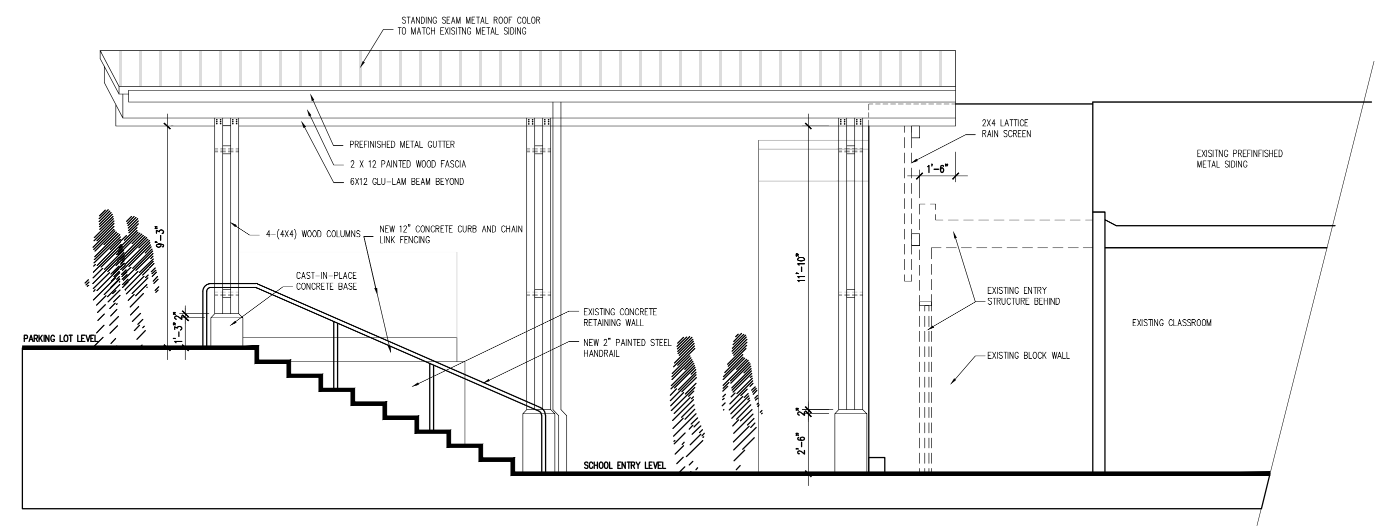
1 / A5 SECTION AT ENTRY LEVEL
SCALE- 1/4" = 1'-0"



1 / A5 PLAN – NEW CANOPY
SCALE- 1/4" = 1'-0"



1 / A5 FRONT ELEVATION
SCALE- 1/4" = 1'-0"



1 / A5 SIDE ELEVATION
SCALE- 1/4" = 1'-0"

M3a

NEW ENTRY CANOPY
BOSTON BAR ELEMENTARY SCHOOL - SD#78

PLANS - SECTION + ELEVATIONS

MAY 2017 A1

Fraser-Cascade School District
5 Year Minor Renovation
Program November 2020

Background:

In June 2002, the Ministry of Education announced a change in capital funding. Funding for school facilities that was previously allocated through the 5 year capital plan has now been separated into operating and capital budgets. Expenditures required for **"school renewal"** which are to maintain facilities through their life expectancy are now being funded through the Ministry's operating Budget in the form of an "**Annual Facility Grant (AFG)"**.

School Districts are expected to develop a long-term maintenance plan, expend the renewal funds annually within the context of the plan and report annually on the actual expenditures. In developing the maintenance plan, school districts should be able to manage the available funds according to their local needs and priorities, which should include the establishment of a reserve for any emergent health or safety expenditures.

School renewal funding is based on enrolment and square metres per student plus age and replacement cost of infrastructure and geographic factors. The grant will be recalculated annually in recognition of changes in enrolment.

The renewal funding (AFG) is **not** permitted for the following:

- Site acquisitions.
- Building acquisitions.
- Expansion of facilities resulting in increases in gross facility areas or nominal capacity.
- Acquisition of equipment, furnishing, personnel computers, servers, local area network connection or vehicles and their accessories.

Concept:

A 5 year program will be developed. Each year, one fifth of the facilities will receive an upgrade project using school renewal funds, District operating funds or Ministry Capital Plan funds. At the end of the five years, the program will be reviewed to determine whether the cycle will be repeated.

The key points in the concept are as follows:

- The amount of funds allocated to a school will be based on the needs at that school.

- Schools which have major capital projects funded by the Ministry may not receive upgrade funding if the work can be included in the Ministry project.

- A portion of the renewal funding will be retained for District priorities such as roofing, civil work, mechanical system installations or upgrades, contingency for emergent requirements or large projects which cannot be funded in one year.

- A portion of the renewal funding will be allocated to special education / accessibility issues at schools which are not included in the current year. The Director of Instruction will determine the priorities for the requests.

- The plan will insure those spaces worked on will be completely renovated; piecemeal work will be discouraged which may result in some sections of the facility not getting any work done in the first cycle.

- The following work may be carried out at each school as required as part of the upgrade:
  - Refinish exterior and interior surfaces.
  - Roofing repairs/replacement.
  - Lighting, electrical services, PA & telephone system and computer cabling upgrades.
  - Reconfiguration of interior partitions to meet changing space and functional requirements.
  - Heating and ventilating system upgrades.
  - Washroom upgrades.
  - Installation of new millwork such as computer tables, shelving and storage units.
  - Fencing, sidewalk maintenance/replacement, parking improvements, drainage upgrades.
  - Asbestos abatement
  - Health & Safety Upgrades
  - Loss Prevention

Annual Timetable for Schools Being Upgraded:

The following is the general timetable; the specific dates will be confirmed each year for the schools involved.

Mid January

- Each school must submit their proposal for facilities upgrade to the Director of Facilities
- The Manager of Maintenance will present his recommendation on facilities upgrades for the schools

Early February

- All proposals will be evaluated by a review committee consisting of the Secretary Treasurer, Assistant Superintendent, and the Director of Facilities
- A preliminary scope of work will be identified for the schools with input from the Principals
- Maintenance will complete a preliminary cost estimate for each school

Mid February

- The review committee, with input from the Principals, will adjust the scope of work in the schools to fit the funds available
- Final scope of work will be confirmed

Early March

- Maintenance will complete the detailed designs for the each school

Mid April

- Each Principal and Director of Facilities will be required to review the detailed design and sign the plans confirming acceptance. Changes in the scope of work will not be accepted after this time.
- Maintenance will complete a schedule for the work in the schools. The custodial requirements will be included. Maintenance will hire the crews and arrange the contracts to complete the work according to the schedule. Maximum effort will be applied to ensure most of the classroom work is completed during the summer break
- Maintenance will submit the appropriate requests for development permits (6 to 8 weeks required.

PROPOSED FIVE-YEAR SCHEDULE

SCHOOL	AREA OF SCHOOL	WORK SCHEDULE
BBESS		April 2021 - March 2022
HHSES		April 2021 - March 2022
Total		

Kent Elm		April 2022 - March 2023
Coquihalla Elm		April 2022 - March 2023
Total		

AESS		April 2023 - March 2024
TREC		April 2023 - March 2024
Total		

HESS		April 2024 - March 2025
SBO		April 2024 - March 2025
Total		

Silver Creek Elm		April 2025 - March 2026
Main/Trans		April 2025 - March 2026
Total		

19-036 School District No. 78

BATTERY STORAGE AND SOLAR FEASIBILITY STUDY

Submitted To:
School District 78 & BC Hydro
Attention: Cory Farquharson,
Doug Templeton, Christy Intihar

Prepared By:
Hedgehog Technologies Inc.
Unit 206 – 2250 Boundary Road,
Burnaby, B.C. V5M 3Z3

Submitted: 2020-04-06
Revision: 1.0

Document Revisions

Rev	Date	Description	Prepared By	Reviewed By	Approved By
1.0	2020-04-06	Issued for Review	AG/MK	MK/YR	YR

Executive Summary

School District 78 (Fraser-Cascade) is working with BC Hydro to understand the requirements of supplying back up power during blackouts to one of their schools at 501 Hot Spring Rd. Additionally, green initiatives are of high value to both stakeholders, motivating them to investigate battery storage integrated with solar PV power solution in the regards. Hedgehog Technologies was engaged to perform the feasibility study and recommend battery storage and/or solar PV power solution.

Being able to continue school for the day is identified as the most important metric so that children are not sent home prematurely disrupting both their learning and the ability for their families to pick them up. Since the blackouts can be random and the effectiveness of solar is weather dependent, the battery must be sized to the worst-case energy demand with solar being used for non-essential loads or charging the battery during off-hours. However, the cost-effectiveness of the solution is an important factor for both School District 78 and BC Hydro.

With the above-mentioned criteria in mind, a typical school day was identified to be Monday to Friday, from 8:30 AM to 3:30 PM. The school's utility bills, including 5-minute interval demand records for the last year, were analyzed to determine the daily demand and energy usage on a typical school day. This analysis identified that the maximum daily energy usage and peak demand in 2019 are 286 kWh and 57 kW, respectively.

A battery storage sized to the peak daily energy usage of 286 kWh will provide adequate backup power during a blackout on any given school day. The estimated EPC costs for a 286 kWh lithium-ion battery storage will be around $286,000. However, with the low likelihood of a blackout occurring for the entire 7 hours during peak energy school time, a 286 kWh battery storage for this application seems excessive.

In order to present more options for battery storage size while keeping in mind financial feasibility, several scenarios are considered in the report. These scenarios are based on elimination of unnecessary loads during a blackout, hence minimizing the required battery storage. Due to the absence of a detailed energy audit, these scenarios are presented in the form of potential reduction from maximum daily energy usage. By analyzing the school utility bills for the 5-minute interval demand in 2019, the average daily energy usage is found to be 188 kWh. This is equivalent to a 34% reduction from the maximum daily energy usage. The average daily energy usage is presented as one of the options for the size of battery storage in this report. The table below shows multiple scenarios between daily peak energy up to 60% reduction in peak.

Maximum Daily Energy For Sizing Battery Storage	Peak	Peak Less 10%	Peak Less 20%	Average	Peak Less 40%	Peak Less 50%	Peak Less 60%
Energy (kWh)	286	257.4	228.8	188	171.6	143	114.4
Power (kW)	57	57	57	57	57	57	57
Number of Weekdays/Year with Lower Energy Demand	260	236	205	133	98	50	10
% Weekdays/Year with Lower Energy Demand	100%	91%	79%	51%	38%	19%	4%
Battery Size (kWh)	286	260	230	188	170	143	115
Battery Storage EPC Costs	$286,000	$260,000	$230,000	$188,000	$170,000	$143,000	$115,000
5 kW Solar EPC Costs	$17,500	$17,500	$17,500	$17,500	$17,500	$17,500	$17,500
Total System EPC Costs	**$303,500**	**$277,500**	**$247,500**	**$205,500**	**$187,500**	**$160,500**	**$132,500**

To meet the objective of green initiatives intended by the stakeholders, solar PV power is proposed with battery storage. Since the battery storage system is designed to be the primary source of energy during a blackout, the PV system is kept fixed at 5 kW with the costs shown in the above table. The primary purpose of the solar panel installation at this site is to offset the load during school hours as well as charge the battery storage backup system if needed. The PV system is expected to generate 4,671 kWh of energy per year. Using the net metering program, excess PV generated on days with no school or during summer break can be delivered to the grid.

An AC-coupled configuration is recommended to interconnect the proposed PV plus grid storage system. The bi-directional inverter used in this interconnection allows the battery storage to directly respond to the demand requested by BC Hydro. Considering the battery storage system is used for small amount of peak shaving during the day, it is expected over 95% of full battery capacity is available to BC Hydro for a period of four hours from 5 PM to 9 PM to feed electricity back to the grid.

The cost savings options considered for this report are reducing the demand charge, energy fee savings from the solar system including net metering, and potential savings through the demand response agreement. The overall savings are estimated to be $1143/yr with savings of $400, $470, $273 for the demand savings, net metering and demand response, respectively.

The recommendation for the next steps is to establish a detailed budget for the project. Once obtained, it will dictate the size of the battery storage system that can be installed. The secondary recommendation is to perform an energy audit to pinpoint non-essential loads. This will further help reduce the required battery size and meet budgetary requirements.

Table of Contents

Document Revisions 2

Executive Summary 3

Table of Contents 5

Tables and Figures 6
- List of Tables 6
- List of Figures 6
- Definitions & Abbreviations 6

References 7

1 Scope 8

2 Introduction 8
- 2.1 Background 8
- 2.2 School District No. 78 Objective 8
- 2.3 BC Hydro Objective 8

3 System Assessment 9
- 3.1 Overview 9
- 3.2 Electrical Infrastructure Review 9
- 3.3 Load Budget 11

4 Demand Characteristics and Battery Storage Sizing 12
- 4.1 Overview 12
- 4.2 Battery Sizing Methodology 12
- 4.3 Demand Characteristics Analysis 12
  - 4.3.1 Historical Demand Data 12
- 4.4 Battery Storage System 13
  - 4.4.1 Battery Technology Options 13
  - 4.4.2 Fire and Safety Regulations 13

5 Solar Panel Modeling with Estimated Performance 15
- 5.1 Overview 15
- 5.2 Methodology 15
- 5.3 Solar Model 15

6 System Interconnection 18
- 6.1 Grid Interconnection Options 18
- 6.2 BC Hydro Interconnection Requirements 19

7 Operation Costs and Yearly Savings 21

8 Conclusion 22

9 Recommended Next Steps 23

Appendix A 24

Appendix B 25

Tables and Figures

List of Tables

Table 1: Typical Battery Storage Technology Installed Total Cost [1] 13
Table 2: Fire and Safety Requirements 14
Table 3: PV System specification 16
Table 4: PV System Expected Yield 16
Table 5: Comparison of DC-coupled vs AC-coupled system 19
Table 6: Yearly Cost Savings 21
Table 7: Battery Storage System Analysis 22

List of Figures

Figure 1: Main Distribution Panel 9
Figure 2: Electrical Room 10
Figure 3: Site for Rooftop Solar Installation 10
Figure 4: The School Monthly Peak Demand (2009-2019) 11
Figure 5: The School Yearly Energy Usage (2009-2019) 11
Figure 6: Typical Weekly Demand (Sunday to Saturday) 12
Figure 7: Peak Energy Demand (Feb 4, 2019) 13
Figure 8: Aerial View (501 Hot Spring Rd) 15
Figure 9: Solar Energy Generation 16
Figure 10: 3D Model of Solar PV Panels (501 Hot Spring Rd) 17
Figure 11: DC-Coupled System 18
Figure 12: AC-Coupled System 18

Definitions & Abbreviations

Item	Definition
DC	Direct Current
EPC	Engineering Procurement Construction
HVAC	Heating Ventilation & Air Conditioning System
Kilo (k)	1,000 (One thousand)
Kilowatt-hour	Measure of total energy used to measure quantity of electricity consumed.
Mega (M)	1,000,000 (One Million)
Power (Watt)	A measure of energy output per second
PV	Photovoltaic
V / kV– Volt/ kilovolt (1000 Volts)	Volt/ kilovolt (1000 Volts)
Wh / kWh / MWh	Wh / kWh / MWh – Watt-hour, kilowatt-hour

References

[1] Pacific Northwest National Laboratory, "Energy Storage Technology and Cost Characterization Report," U.S Department of Energy, 2019.

[2] R. Franks, "Safety of Stationary Grid-Connected Energy Storage Systems," CSA Group, November 2017. [Online]. Available: https://www.csagroup.org/documents/resources-insights/gcmp-special-tech/CSA_Group_Safety_ESS_White_Paper_NA_PrV.pdf. [Accessed 22 March 2020].

[3] J. Green, "New Developments in North American Energy Storage System Compliance," CSA Group, [Online]. Available: https://www.csagroup.org/article/new-developments-north-american-energy-storage-system-compliance/. [Accessed 22 March 2020].

[4] BC Hydro, "Distribution Generation Technical Interconnection Requirements 100kW and Below," BC Hydro, 17 October 2014. [Online]. Available: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/dgtir100.pdf. [Accessed 01 April 2020].

1 Scope

The scope of this document is to specify optimal storage size, operational requirements and order of magnitude installation cost for a battery and/or solar system at an elementary school located in School District No. 78. The analysis is based on the electricity records for the school provided by BC Hydro. The single line and load profile are provided by School District No. 78. This report also outlines performance expected and possible design of a solar panel installation at the same elementary school.

2 Introduction

2.1 Background

School District No. 78 (Fraser-Cascade) incapsulates ten schools including Hope, Agassiz, Harrison Hot Springs, Boston Bar, in the Fraser Canyon and Fraser Valley. Working with BC Hydro, the school district has engaged Hedgehog Technologies to perform a feasibility study to understand the requirements of supplying battery and/or solar back up power to one of their schools in the Harrison location, 501 Hot Spring Dr. Green initiatives are of high value to both stakeholders, and consideration for solar panels is important.

2.2 School District No. 78 Objective

The most important metric for School District No. 78 is being able to continue school for the day so that children are not sent home prematurely disrupting both their learning and the ability for their families to pick them up. The school district wishes to understand considerations, impact, and the cost of installing and operating battery storage and/or solar back up power.

2.3 BC Hydro Objective

BC Hydro is interested in supporting the school district for delivering power during blackouts and for peak load management using demand response triggers. The feasibility study is the first step in providing battery and/or solar backup power to School District No. 78. The cost-effectiveness of the solution, as well as the dynamics of the operational requirements, are of interest to other schools and districts.

3 System Assessment

3.1 Overview

The elementary school at 501 Hot Spring Rd under the jurisdiction of School District No. 78 is the subject of this feasibility study. Two members of the Hedgehog Technologies team travelled to the school and conducted a site assessment to determine the facility's baseline and infrastructure requirements.

Due to lack of proper electrical drawings, a hand sketch single line diagram was provided by the school's electrician (See Appendix A).

3.2 Electrical Infrastructure Review

Hedgehog team confirmed the following during the site visit:

a) Main distribution panel in the electrical room with eight (8) branch circuits (Figure 1):
   i. Sub A – 100 A
   ii. Sub E (Portable Building) – 100 A
   iii. Gym Furnace – 30 A (Not in Service)
   iv. Sub B (Library) – 70 A
   v. Sub D (Room 34) – 125 A
   vi. Electric Heater – 30 A
   vii. Spare – 50 A
   viii. HVAC – (Overcurrent protection not in the main distribution panel). See the subpanel single line diagram (Appendix A).

Figure 1: Main Distribution Panel

b) The size of the main electrical room is sufficient for installing the battery provided the floor space is cleared, and access to wall for wiring is provided (Figure 2)

Figure 2: Electrical Room

c) Hedgehog team also investigated rooftop for solar installation and identified the flat roof section on the school gym facing south ideal for the application (Figure 3).

Figure 3: Site for Rooftop Solar Installation

3.3 Load Budget

Utility bills from the past ten years were analyzed to establish a baseline load for the facility. As evident from Figure 4, the peak load has dropped and stayed consistently low from 2013 onwards. The peak load before 2013 was 92 kW and post 2013 is 57 kW. Some part of the reduction in peak load is attributed to the school district successfully transitioning to 100% LED lighting.

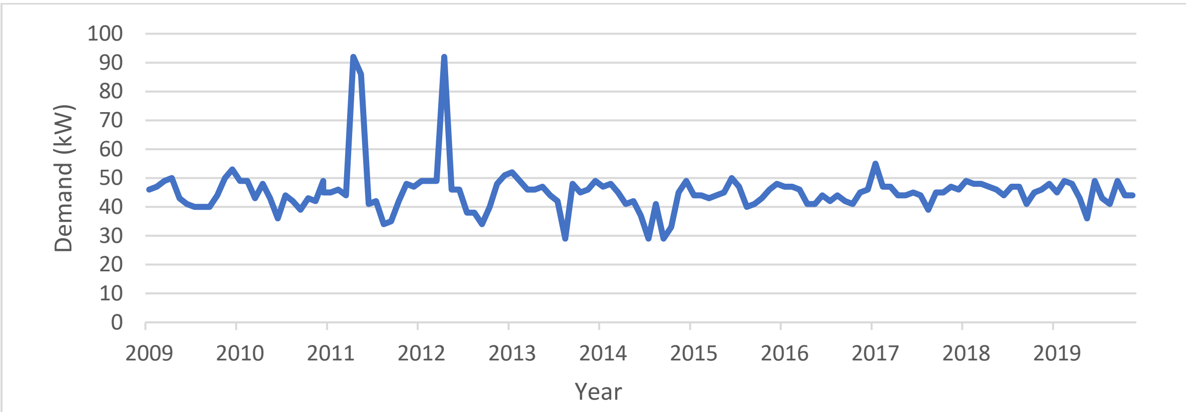


Figure 4: The School Monthly Peak Demand (2009-2019)

Even though the maximum peak demand has dropped in the past ten years, the yearly energy demand has not. As shown in Figure 5, the highest total energy used was in 2018 at 139 MWh.

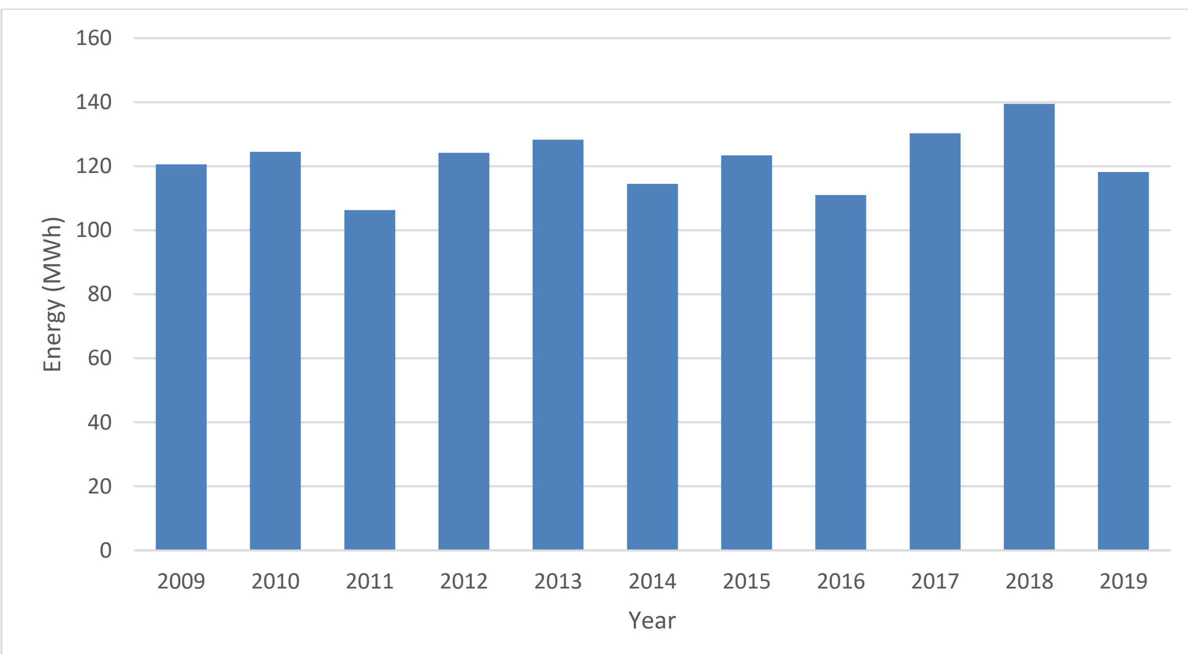


Figure 5: The School Yearly Energy Usage (2009-2019)

Since the school was not able to provide complete electrical drawings, the single line diagram (Appendix A) along with utility bills from the most recent year (2019) are used to provide a load budget baseline for the purpose of this report. A detailed energy audit of the facility is recommended to further identify individual loads.

4 Demand Characteristics and Battery Storage Sizing

4.1 Overview

This section of the report highlights the energy usage and power profile based on operating conditions. The demand characteristics are used to size the battery storage system accordingly.

4.2 Battery Sizing Methodology

The battery sizing methodology is a process of determining an optimal size for the proposed storage battery system. Since being able to continue school for a day is defined as the most important metric, the optimal battery size is determined using the highest daily demand curve over seven hours between 8:30 AM to 3:30 PM.

The following steps are taken as part of the battery sizing methodology:

1. Review the historical demand curves using 5-minute and hourly intervals from 2019 utility bills.
2. Determine electrical energy needs based on the historical demand curves.
3. Compare battery storage technology options and recommend a suitable type for this application
4. Present battery size options based on multiple budget estimates.

Assumptions made for this application consider a full day of school to be Monday to Friday, 8:30 AM to 3:30 PM. For the option in which battery is used to respond to the demand requested by BC Hydro, 95% of full battery capacity is considered for four hours from 5 PM to 9 PM to feed electricity back to the grid.

4.3 Demand Characteristics Analysis

4.3.1 Historical Demand Data

As shown in Figure 4, the monthly demand since 2013 has stayed consistent. To perform a more detailed analysis of daily peak demand 5-minute and hourly data from 2019 was used to calculate the school's current peak demand (kW) and energy usage (kWh). As expected, the energy demand during weekdays is higher than the weekend (Figure 6). From the available 2019 data, the peak demand day was June 14 at 57 kW.

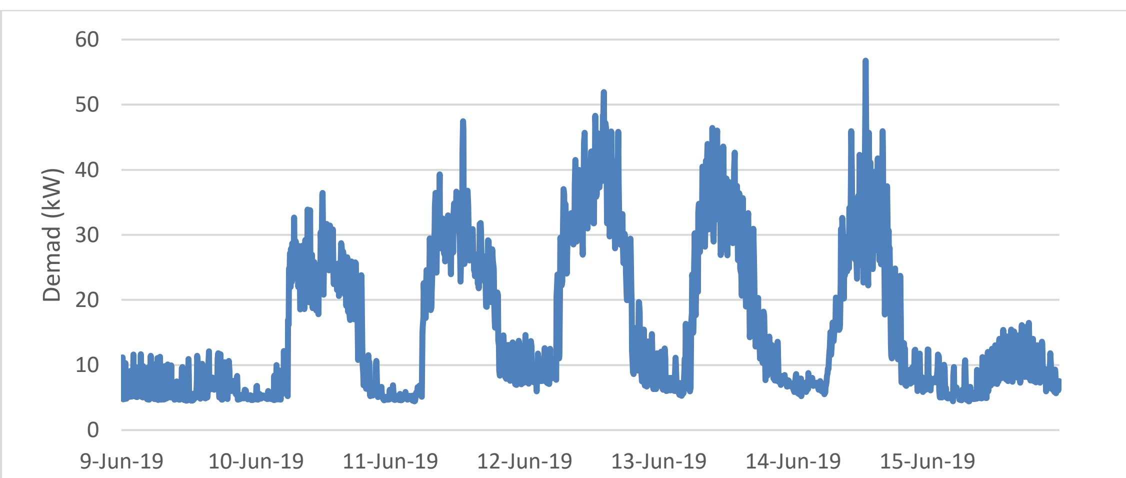


Figure 6: Typical Weekly Demand (Sunday to Saturday)

Since the most important metric for battery size is the continuation of a full day of school, the battery is sized according to the highest energy demand for a day in a year. Although the highest peak (kW) was recorded on June 14, the maximum energy (kWh) demand over 24 hours was February 4 at 720 kWh.

Figure 7 shows the energy demand on February 4, 2019 and has clearly shaded areas for typical school hours. The energy demand between the hours of 8:30 AM and 3:30 PM is 286 kWh.

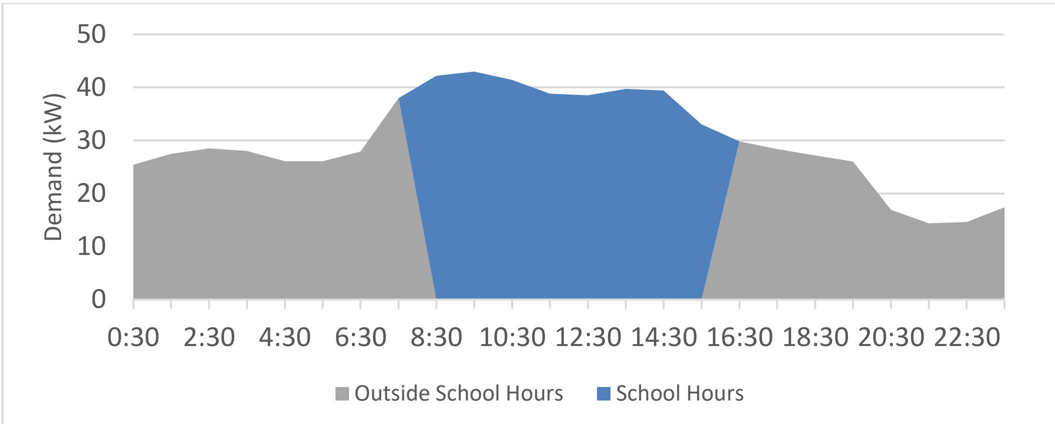


Figure 7: Peak Energy Demand (Feb 4, 2019)

4.4 Battery Storage System

4.4.1 Battery Technology Options

Many battery technologies exist in the market today, which can be used to meet the objectives of this study. Technologies such as lead-acid batteries, flow batteries and lithium-Ion were considered for this application.

Table 1: Typical Battery Storage Technology Installed Total Cost [1]

Storage Technology	Maturity	Cycles @ 80%	Power ($/kW)	Energy ($/kWh)
Lead-Acid Batteries	Mature	900	2,194	549
Flow Redox Batteries	Emerging Tech	10,000	3,430	469
Lithium-Ion	Mature	3,500	1,876	858

After a review of the storage technologies considered (Table 1), lead-acid batteries were rejected for their limited cycles and flow redox batteries for being an emerging technology. Lithium-ion batteries are commonly used for commercial and utility-scale energy storage and are currently the most suitable option available on the market.

4.4.2 Fire and Safety Regulations

Battery energy storage systems offer an effective way to manage electricity supply and use. The application here is used to store and release electricity on-demand, provide backup power and integrate with renewable energy sources (solar). Due to the custom application of the system, there are a variety of compliance requirements from component to system level. Risks include fire, explosion, and burns, as well as the potential for electrical shock and arc flash. Toxic or hazardous substances are sources of risks related to chemical exposure and unsafe chemical concentrations can represent inhalation or explosion and fire hazards [2].

Ultimately, the safety of energy storage systems is a shared responsibility and requires project owners and manufacturers to meet a broad array of requirements. A summary of some of the essential requirements in North America is shown in Table 2 [3].

Table 2: Fire and Safety Requirements

Category	Standard
Component Standards	
Battery System	UL/CSA 1973
Enclosure	CSA-C22.2 No. 60529
Inverter	C22.2 No. 107.1
Relevant Codes and Installation Standards	
National Electric Code	CSA C22.1
Special Inspection/Field Evaluation	SPE-1000

The battery energy storage system safety process is divided into four main steps [2]:

1. Identification of System Requirements: A preliminary review of the project should be conducted to formulate a plan for formal safety evaluation – including any component approvals or additional inspections and certification needs. This step should be performed after the battery and inverter manufacturers are picked and install location finalized.
2. Information Collection and Analysis: An in-depth review of the formal system design is conducted in this stage. The functional safety of the final system is addressed through hazard analysis and appropriate automated safety systems are identified. A failure mode and effect analysis (FMEA) is recommended to be performed to identify critical safety components in the system.
3. Equipment Safety Testing: Batteries, inverters or certain other system components must be individually tested and certified to meet applicable product safety requirements. For this application, it is recommended to purchase a commercially available product with all required certifications.
4. Field Evaluation and Inspection. Field evaluation is conducted by the testing organization at the installation location to confirm that the final system conforms to the applicable safety requirements. Included are national and international safety standards, as well as state and local installation codes.

Since this application is considered a commercial or industrial system, it must follow requirements dictated by local Authorities having Jurisdictions (AHJs) and ensure components being installed are certified by a Nationally Recognized Testing Laboratory (NRTL) such as CSA Group.

A field evaluation is required when the final system integration takes place. The field evaluation process provides additional review of a unique application system and results in a special label for the specific installation.

5 Solar Panel Modeling with Estimated Performance

5.1 Overview

Green initiatives are of high value to both BC Hydro and School District 78. The primary purpose of the solar panel installation at this site is to offset the load during school hours as well as charging the battery storage backup system if needed. Additionally, with the net metering program, BC Hydro provides a way for customers to connect a small energy source to the BC Hydro distribution system to offset their loads or sell excess power back to the grid.

5.2 Methodology

The methodology used in developing the rooftop solar solution includes:

1. Analysis of the potential solar locations and roof structures, angles and materials.
2. Modelling a rooftop solar system using 3D modelling software.
3. Analyzing school power data to determine a size for the solar system.

5.3 Solar Model

For the application at 501 Hot Spring Rd, a 5 kW solar is considered due to limiting factors like budget, size of rooftop and high shading from the hill in the west.

As shown in Figure 8, the hill in the west casts a significant shadow on most of the school's buildings. The gym roof highlighted in red is selected as the rooftop with the least shading to maximize energy generated.

Figure 8: Aerial View (501 Hot Spring Rd)

Climate data from Agassiz, B.C. is used to design a PV system with the following specifications and expected yield (Appendix B).

Table 3: PV System specification

Grid-Connected PV System	
Climate Data	Agassiz Cda BC, CAN (1991 – 2010)
PV Generator Output	4.88 kWp
PV Generator Surface	29.2 m^2
Number of PV Modules	15
Number of Inverters	1

Table 4: PV System Expected Yield

The Yield	
PV Generator Energy (AC grid)	4,671 kWh
Spec. annual yield	958.08 kWh/kWp
Performance Ration (PR)	87.8%
CO_2 Emissions avoided	2,802 kg/year

The PV system is expected to generate 4,671 kWh of energy per year.

Figure 9 shows the monthly distribution of energy with the highest generation during the month of July. Since the school is expected to be closed for summer during July and August, an estimated 1,251 kWh of energy can be put on the grid.

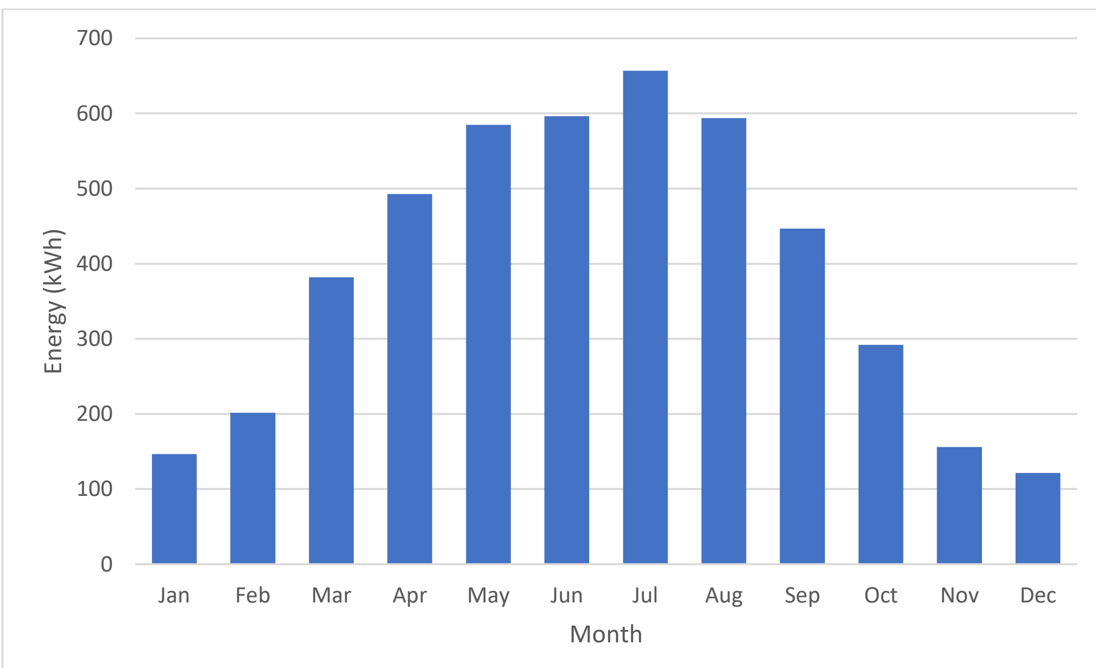


Figure 9: Solar Energy Generation

Figure 10 shows a 3D rendition of the solar panels installed on the gym rooftop.

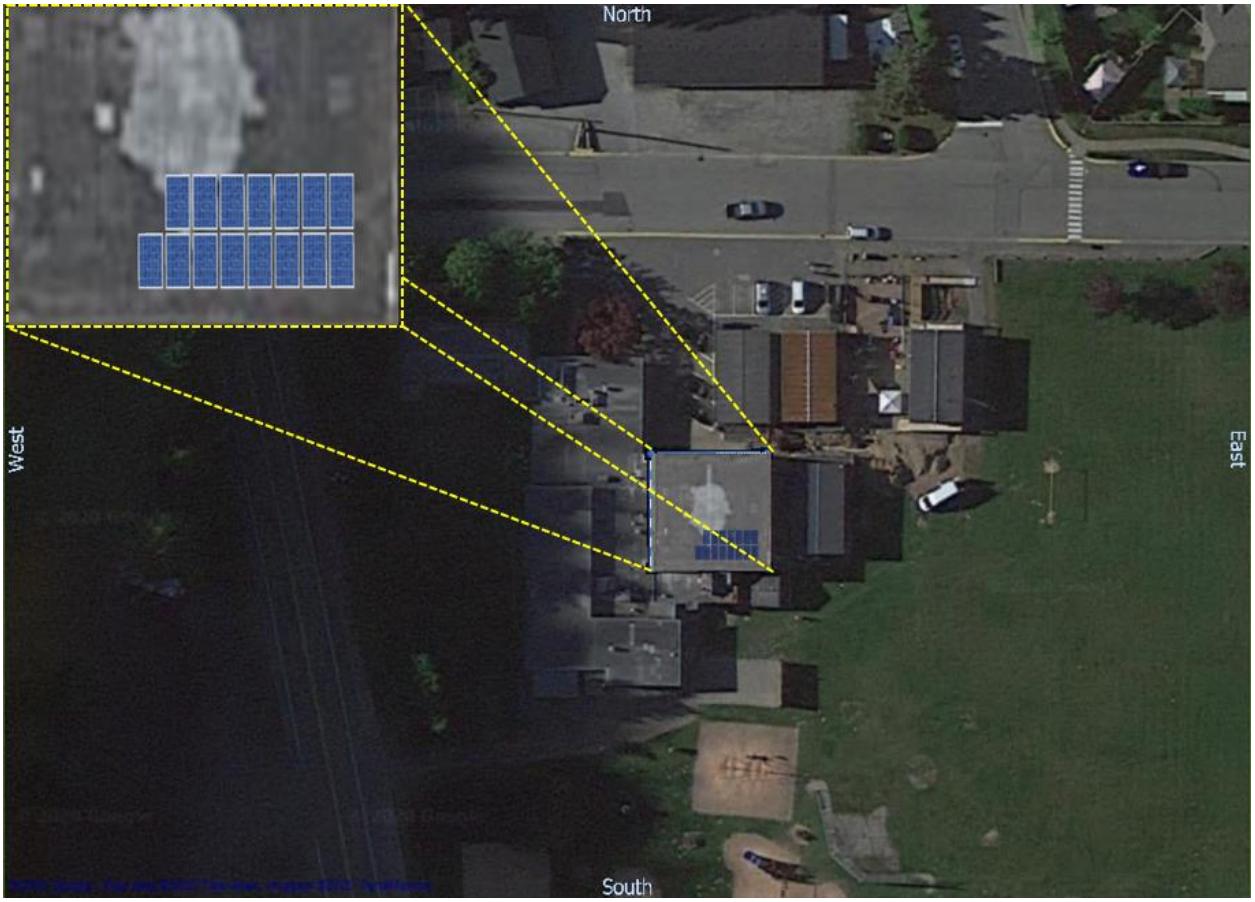


Figure 10: 3D Model of Solar PV Panels (501 Hot Spring Rd)

6 System Interconnection

6.1 Grid Interconnection Options

There are two main interconnection models for PV and battery storage systems. When combining PV and battery storage systems, the subsystem can be connected by a DC-coupled or AC-coupled configuration.

Figure 11 shows a DC-coupled system. A DC-coupled system needs only one bi-directional inverter, connects battery storage directly to the PV array, and enables the battery to charge and discharge from the grid.

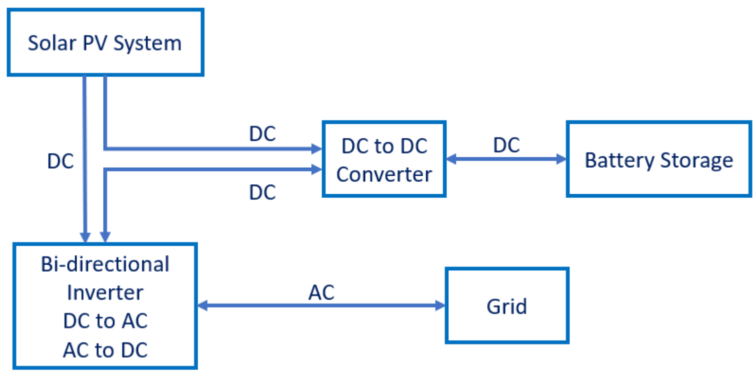


Figure 11: DC-Coupled System

On the other hand, an AC-coupled system needs both a PV inverter and a bi-directional inverter. As shown in Figure 12, there are multiple conversion steps between DC and AC to charge or discharge the battery.

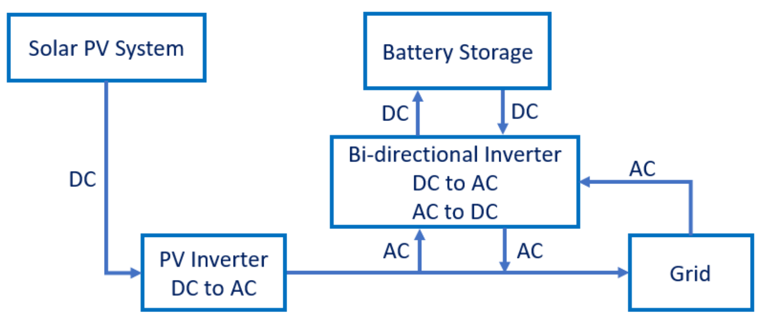


Figure 12: AC-Coupled System

Table 5 shows the comparison of DC and AC coupling systems for a PV plus grid storage system. The clear advantage of a DC-coupled system is that it uses a single bi-directional inverter instead of 2 inverters required for an AC-coupled system, thus reducing cost for the inverter, inverter wiring and housing. Since in DC-Coupled system, the battery is connected directly to the solar array, excess PV generation can be sent directly to charge the battery. An AC-coupled system is more advantageous where the system owner needs the flexibility to upgrade PV and battery separately or where the two systems cannot be placed in close proximity. Since AC-coupled systems can have batteries located outside the PV field, maintenance work is quicker and more comfortable.

Table 5: Comparison of DC-coupled vs AC-coupled system

Component	DC-Coupled Configuration	AC-Coupled Configuration
Number of inverters	1 (bi-directional inverter for battery)	2 (bi-directional inverter for battery plus grid-tied inverter for PV, resulting in higher costs for the inverter, inverter wiring, and inverter housing)
Battery rack size	Smaller (because the battery is directly connected to PV), resulting in more heating, ventilating, and air conditioning (HVAC) and fire-suppression systems required	Larger
Structural Balance of System (BOS)	More due to smaller battery rack size	Less
Electrical Balance of System (BOS)	Less but needs additional DC-to-DC converters	More due to additional wiring for inverters
Installation (labour cost)	More (due to smaller battery rack size, and more skilled labour and labour hours required for DC work)	Less
EPC Overhead	More (due to higher installation labour cost)	Less

The limiting factor for this application is the size of the electrical room. If DC coupled configuration is chosen, the smaller battery rack size results in more heating and requires additional fire-suppression systems (ventilation and HVAC). From Table 5 above, the biggest disadvantage for AC coupling configuration is the cost for an extra inverter and additional wiring. For the battery-solar system designed in this application here, the cost of an extra inverter and wiring will be minimal compared to requirements for a different installation site with more ventilation. Hence, the AC-coupling configuration is recommended for interconnection.

6.2 BC Hydro Interconnection Requirements

With the net metering program, BC Hydro provides a way for customers to connect a small energy source to the BC Hydro distribution system to offset their loads. As per BC Hydro guidelines [4], the system here is classified as a Complex Distribution Generator since the aggregate inverter rating is greater than 27 kW.

The system owner should work with a qualified personnel to address all technical design requirements listed in section 4.2 of BC Hydro interconnection requirements guideline [4] during the detailed design phase.

Once the system is designed, an application for technical review must be submitted to BC Hydro. In order to participate in the net metering program, the system must meet the following interconnection requirements [4]:

1. All equipment shall comply with the following standards (as applicable):
    a. CEC Part I (See sections 50, 64 and 84)
    b. CAN/CSA-C22.2 No. 257-06

    c. CAN/CSA-C22.3 No. 9-08
    d. CSA C22.2 No. 107.1-01
2. The system design owner is responsible for all design, construction, inspection, maintenance and operation of all facilities on their side of the point of common coupling (PCC).
3. Means of safe disconnection must be provided for all generators interconnected with the distribution system in accordance with CEC Part I. A warning label must be installed at the revenue meter location and at the disconnect means. A single line, legible diagram of interconnected system shall also be installed at the disconnecting means.
4. Prior to completion of system commissioning, a verification test shall be performed as recommended by the manufacturer and required by CAN/CSA-C22.2 No. 257-06.

The system owner must ensure that all requirements of the manufacturer and Local Regulatory Authority are met. The system owner must retain a complete set of manuals, installation drawings, permits, inspections and verification test reports.

The system owner shall verify the generator's interconnection protective functions according to the manufacturer's recommended schedule, or at least once a year as required by CAN/CSA-C22.2 No. 257

7 Operation Costs and Yearly Savings

This section of the report evaluates the variable costs related to the operation and maintenance of the battery-solar system as well as yearly cost savings from three main areas: demand charge, net metering and demand response.

The usable life of lithium-ion battery systems depends on cycles of usage. Since the battery is primarily sized for backup power, the actual usage of battery is very low. For this application, the operation and maintenance cost is estimated at $150/yr. The expected variable cost of the recommended system is negligible.

The cost savings options considered for this report are reducing the demand charge, energy fee savings from the solar system including net metering, and potential savings through the demand response agreement. The overall savings are estimated to be $1143/yr as seen in Table 7 with savings of $400, $470, $273 for the demand savings, net metering and demand response, respectively.

Table 6: Yearly Cost Savings

Cost Saving Area	Estimated Savings/Year
Demand Charge	$ 400
Net Metering*	$ 470
Demand Response	$ 273 (48 hrs/year @ 57 kW @ $0.0999/kWh)
Total	$ 1143

*Combined savings of net metering (energy sold to grid $0.0999/kWh) and cost saved by solar usage.

The demand charge is a monthly fee based on the maximum demand from the client in the month. School District No. 78 is considered a medium general service provider with a monthly fee of $5.37/kW (maximum monthly power). The battery and solar system can be used to reduce this daily peak demand. A proprietary software owned by Hedgehog Technologies is used to calculate optimized peak demand shaving at 19%. For a 170 kWh battery and 5 kW solar system, a 19% reduction results in a yearly saving of $400.

Net metering agreements allow BC Hydro clients to sell excess energy back to the grid. While the total yearly energy of a 5 kW solar install is around 4.7 MWh, the majority is used to offset site energy. The offset site energy is billed at the medium general service rate of $0.0958. Any excess energy is sold back to the grid at a net metering price of $0.0999/kWh. The total return and savings is $470.

Demand response agreements are used by BC Hydro to request clients to actively offset their own demand to a higher level or actively return energy to the grid. Assuming 48 hrs/year are requested and a fee structure (assuming the net metering price) of $0.0999/kWh, a total demand response savings would be $273.

8 Conclusion

School District 78 working with BC Hydro wishes to install a battery and/or solar system to provide back up power during blackouts. The main objective for the school district is to continue school for the day, so children are not sent home prematurely. BC Hydro supports the above objective and is also interested in peak load management using demand response triggers.

From three different battery storage technologies discussed in this report, lithium-ion is recommended considering the readiness of technology, the number of cycles at 80% and cost per kWh. For battery size between 100 kWh to 400 kWh, the total installed cost is around $1,000/kWh.

With the above-mentioned criteria in mind, a typical school day was identified to be Monday to Friday, from 8:30 AM to 3:30 PM. The school's utility bills, including 5-minute interval demand records for the last year, were analyzed to determine the daily demand and energy usage on a typical school day. The maximum daily energy usage in 2019 was 286 kWh. This is referred to as peak energy day in Table 7.

With a battery storage sized to 286 kWh, the school will have minimum of 7 hours of backup power during a blackout on any given school day in a year. The estimate EPC costs for 286 kWh lithium-ion battery storage will be around $286,000. This is considered the most expensive scenario. However, with the low likelihood of a blackout occurring for the entire 7 hours during peak energy school time, a 286 kWh battery storage for this application seems excessive. A more reasonable expectation of the required battery size is the average daily energy usage instead of the peak.

The average daily energy in 2019 for Monday-Friday [8:30 AM - 3:30 PM] was calculated to be 188 kWh. Even considering the day with highest daily energy usage (Feb 4, 2019), at 188 kWh the school can function with full loads from 8:30 AM to 1:00 PM. This gives the school enough time to reduce non-essential loads or inform parents.

Table 7 presents more options for battery storage size while keeping in mind financial feasibility. These scenarios are based on the elimination of unnecessary loads during a blackout, hence minimizing the required battery storage. Due to the absence of a detailed energy audit, these scenarios are presented in the form of potential reduction from maximum daily energy usage.

Table 7: Battery Storage System Analysis

Maximum Daily Energy For Sizing Battery Storage	Peak	Peak Less 10%	Peak Less 20%	Average	Peak Less 40%	Peak Less 50%	Peak Less 60%
Energy (kWh)	286	257.4	228.8	188	171.6	143	114.4
Power (kW)	57	57	57	57	57	57	57
Number of Weekdays/Year with Lower Energy Demand	260	236	205	133	98	50	10
% Weekdays/Year with Lower Energy Demand	100%	91%	79%	51%	38%	19%	4%
Battery Size (kWh)	286	260	230	188	170	143	115
Battery Storage EPC Costs	$286,000	$260,000	$230,000	$188,000	$170,000	$143,000	$115,000
5 kW Solar EPC Costs	$17,500	$17,500	$17,500	$17,500	$17,500	$17,500	$17,500
Total System EPC Costs	$303,500	$277,500	$247,500	$205,500	$187,500	$160,500	$132,500

For the application at 501 Hot Spring Rd, a 5 kW solar is considered due to limiting factors like budget, size of rooftop and high shading from the hill in the west. The battery storage system is designed to be the primary source of energy during a blackout. The primary purpose of the solar panel installation at this site is to offset the load during school hours as well as charge the battery storage backup system if needed. This PV system is expected to generate 4,671 kWh of energy per year. Using the net metering program, excess PV generated on days with no school can be delivered to the grid.

An AC-coupled configuration is recommended to interconnect the proposed PV plus grid storage system. The bi-directional inverter used in this interconnection allows the battery storage to directly respond to the demand requested by BC Hydro. For the battery-solar system designed in this application here, the cost of an extra inverter and wiring will be minimal compared to requirements for a different installation site with more ventilation. Considering the battery storage system is used for a small amount of peak shaving during the day, it is expected over 95% of full battery capacity is available to BC Hydro for a period of four hours from 5 PM to 9 PM to feed electricity back to the grid.

The cost savings options considered for this report are reducing the demand charge, energy fee savings from the solar system including net metering, and potential savings through the demand response agreement. The overall savings are estimated to be $1143/yr with savings of $400, $470, $273 for the demand savings, net metering and demand response, respectively.

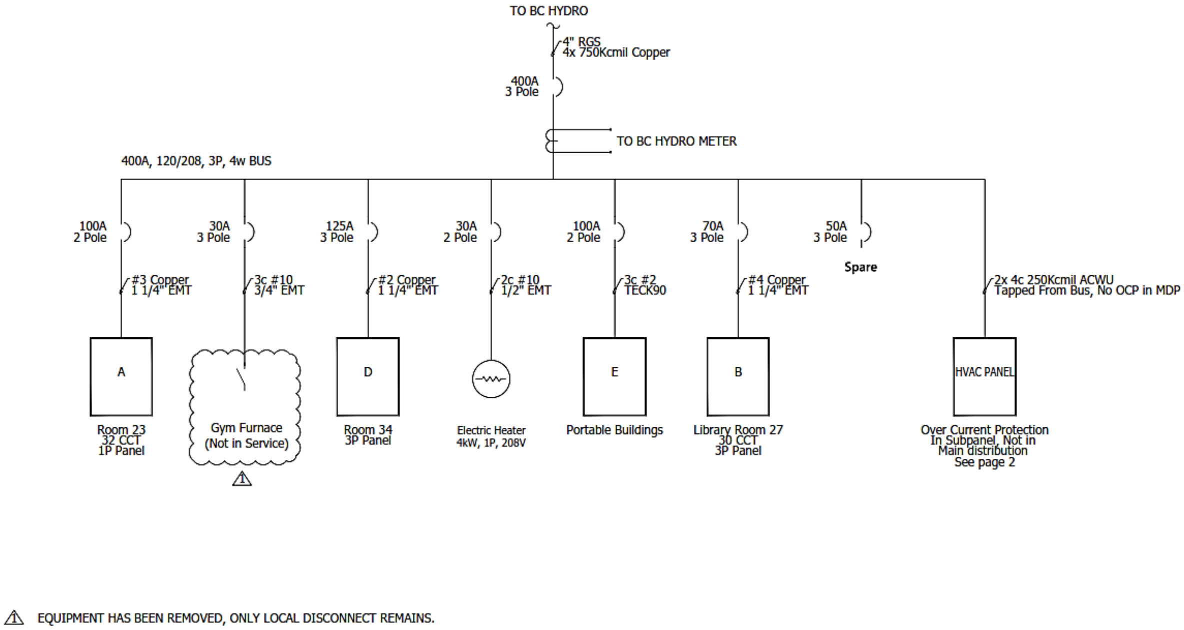
9 Recommended Next Steps

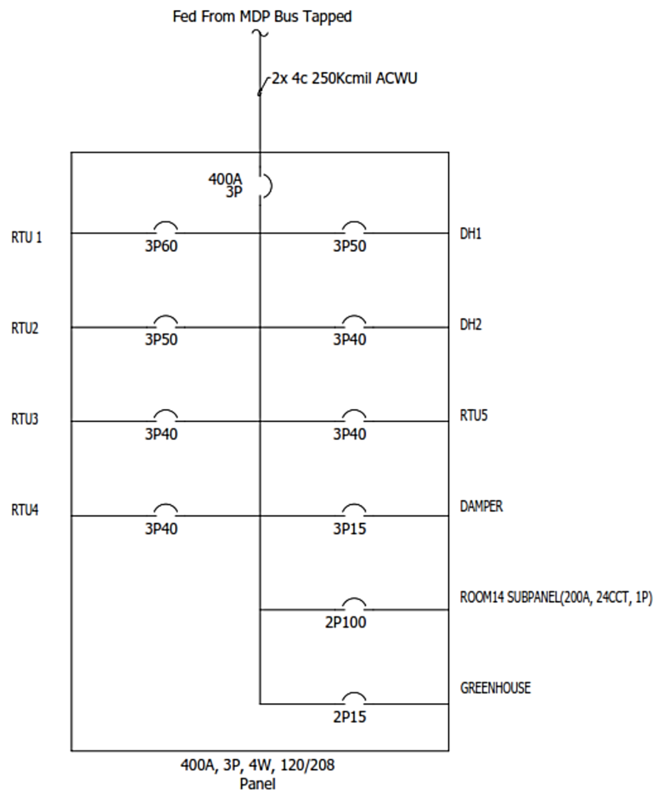
The main recommendation for next steps is to establish a detailed budget for the project. Once obtained, it will dictate the size of the battery storage system that can be installed. Additional work should also be done to confirm battery footprint and ventilation requirements in the electrical room. This is possible once the battery size is confirmed.

The secondary recommendation is to perform an energy audit to pinpoint non-essential loads. This will further help reduce the required battery size and meet budgetary requirements.

Appendix A

Note: The information below is copied directly from a hand-drawn singe line diagram provided by SD78.





Appendix B

Detailed system overview and simulations of the PV system.

System Overview

System Data

Type of System	Grid-connected PV System
Start of Operation	3/30/2020

Climate Data

Location	Agassiz Cda BC, CAN (1991 - 2010)
Resolution of the data	1 h
Simulation model used:	
- Diffuse Irradiation onto Horizontal Plane	Hofmann
- Irradiance onto tilted surface	Hay & Davies

Module Area 1

PV Generator, Module Area 1

Name	Module Area 1
PV Modules	15 x CS6U-325P
Manufacturer	Canadian Solar Inc.
Inclination	20 °
Orientation	South 180 °
Installation Type	Mounted - Roof
PV Generator Surface	29.2 m²

Inverter configuration

Configuration 1

Module Area	Module Area 1
Inverter 1	
Manufacturer	Fronius USA
Model	Fronius Primo 5.0-1 / 208V
Quantity	1
Sizing Factor	97.5 %
Configuration	MPP 1: 1 x 8
	MPP 2: 1 x 7

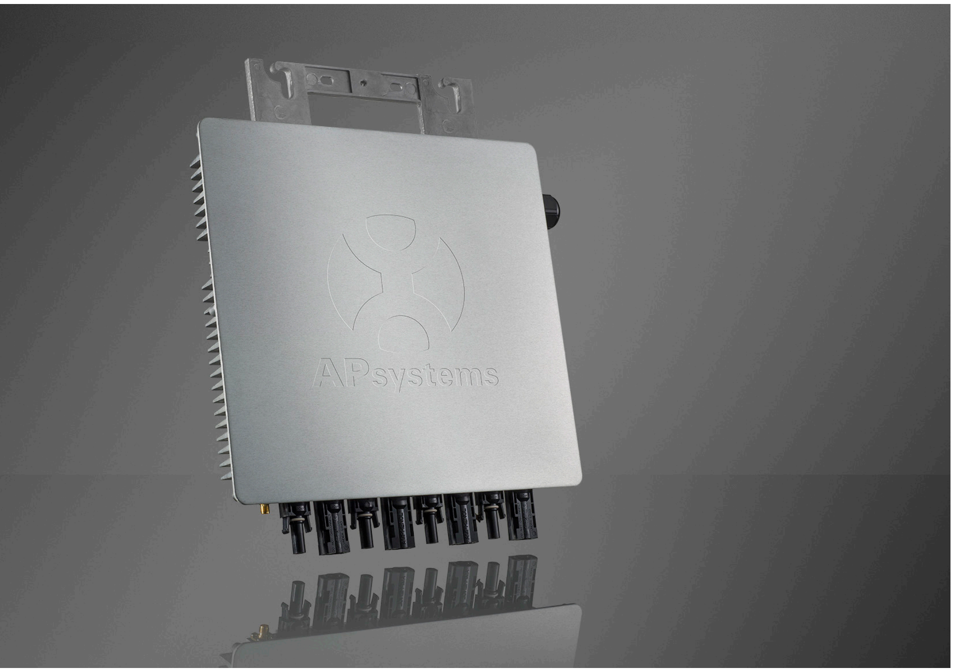
Simulation Results Total System

PV System

PV Generator Output	4.9 kWp	
Spec. Annual Yield	958.08 kWh/kWp	
Performance Ratio (PR)	87.8 %	
Grid Feed-in	4,671	kWh/year
Grid Feed-in in the first year (incl. module degradation)	4,671	kWh/year
Standby Consumption (Inverter)	13	kWh/year
CO_2 Emissions avoided	2,802	kg / year

APsystems
ALTENERGY POWER

Leading the Industry in
Solar Microinverter Technology



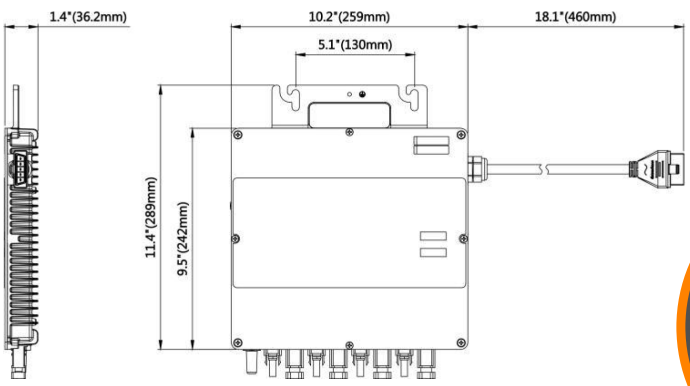
YC1000-3

Commercial Microinverter

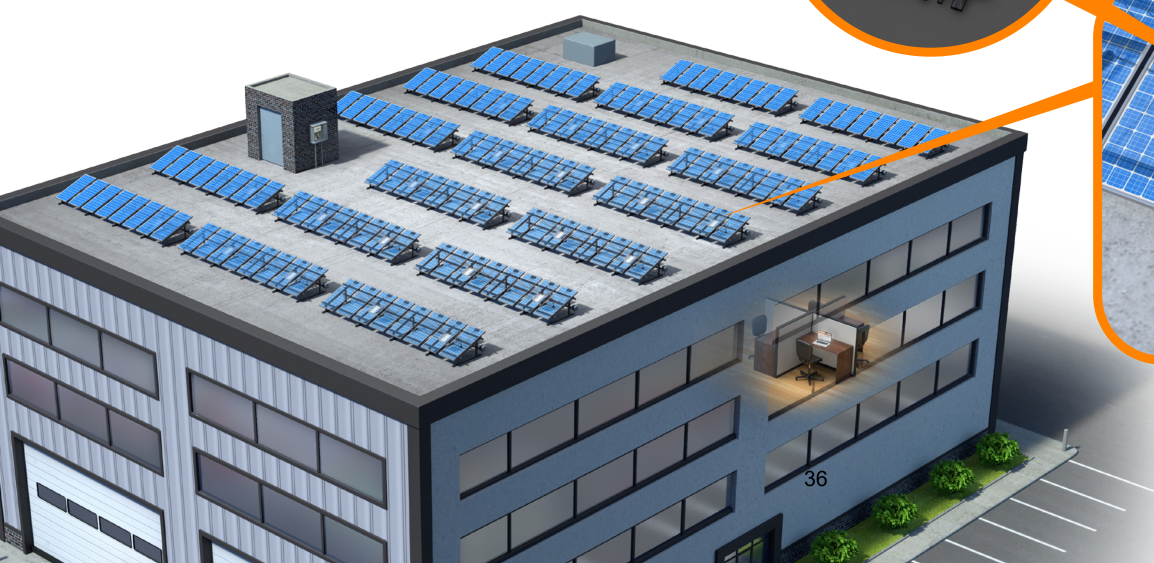
- Single unit connects up to four PV modules
- 1,130W AC output
- True 3-phase output (phase-balanced & phase-monitored)
- 120Y/208V or 277Y/480V
- ZigBee wireless communication and monitoring
- Up to 32 solar modules (60 or 72-cell) can be linked on a three-pole 15A breaker*

*Max # of modules is based on inverter voltage - see reverse side for more info.

DIMENSIONS



The YC1000-3 is the industry's first true 3-phase (phase balanced & phase monitored) solar microinverter, handling commercial grid voltages of 120Y/208V or 277Y/480V with 1,130 watts AC maximum output, ZigBee communication and an integrated ground. Each YC1000-3 supports up to 4 PV modules.



Four-module configuration shown

APsystems YC1000-3 Microinverter Datasheet

INPUT DATA (DC) PER CHANNEL	Accommodates 3 modules up to 450W+ or 4 modules up to 355W	
MPPT Voltage Range	16-55V	
Maximum Input Voltage	60V	
Maximum Input Current	14.8A	
Startup Voltage	22V	

OUTPUT DATA (AC)	**277Y/480V**	**120Y/208V**
Maximum Output Power	1,130W	1,130W
3-Phase Grid Type	277Y/480V	120Y/208V
Nominal Output Current	1.35Ax3	3.14Ax3
Nominal Output Voltage	277Yx3	120Yx3
Nominal Output Frequency	60Hz /59.3-60.5Hz*	60Hz /59.3-60.5Hz*
Power Factor	>0.99	>0.99
Total Harmonic Distortion	<3%	<3%
Maximum Units per Branch	8 per 15Ax3-pole Breaker	3 per 15Ax3-pole Breaker

EFFICIENCY	
Peak efficiency	95%
CEC Weighted Efficiency	94.5%
Nominal MPPT efficiency	99.9%
Night Power Consumption	300mW

MECHANICAL DATA	
Operating Ambient temperature range	-40°F to +149°F (-40°C to +65°C)
Storage Temperature Range	-40°F to +185°F (-40°C to +85°C)
Dimensions (W x H x D)	10.2” X 9.5” X 1.4” (259mm X 242mm X 36mm)
Weight	7.7lbs (3.5kg)
Enclosure rating	NEMA 6
Cooling	Natural Convection - No Fans
AC Cable	14 AWG

FEATURES	
Communication	ZigBee (wireless)
Integrated Ground Fault Protection (GFP)	The DC circuit meets the requirements for ungrounded PV arrays in NEC690.35. No additional ground is required. Ground fault protection (GFP) is integrated into microinverter.
Emissions & Immunity (EMC) Compliance	FCC Part 15; ANSI C63.4; ICES-003
Safety & Grid Connection Compliance	IEEE1547, CSA C22.2 No. 107.1-01, NEC 2017 690.12 ***
Warranty	10 years standard, extendable to 25 years

* Programmable per customer and utility requirements.
***Meets the standard requirements for Distributed Energy Resources (UL 1741) and identified with the ETL Listed Mark.

C ETL LISTED US Intertek

Specifications subject to change without notice – please ensure you are using the most recent update found at www.APsystems.com

APsystems ALTENERGY POWER


DYNAPOWER


KORE POWER
DYNAPOWER
EXIT


KOREPOWER
NOT AN
EXIT


SunGrid


Nimbus
Battery
Management
Solution (NBMS)™
hedgehog


PLEASE


PLEASE
RESPECT
PHYSICAL
DISTANCING


DIFFERENT
VALUABLE