IDS Énergie and PVavenue Inc. proudly present

15 kW solar PV + battery storage

for the Eastmain (Baie-James) project

Weather conditions in Eastmain, Baie-James

Case study: Eastmain

✓ **Location**: 52°14’ N, 78°30’ W

✓**Climate Zone**: **Sub-Arctic**

✓ **Average air temperature**: –2.5 °C

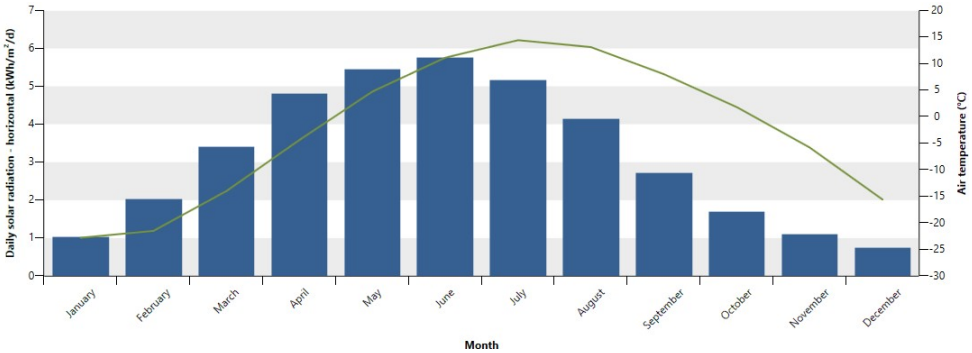
✓ **Rel. humidity** : 72.5 %

✓ **Precipitation**: 795 mm

✓ **Wind speed**: 4.1 m/s (14.8 km/h)

Solar PV (photovoltaic) potential in Eastmain

✓ Solar irradiation and air temperature

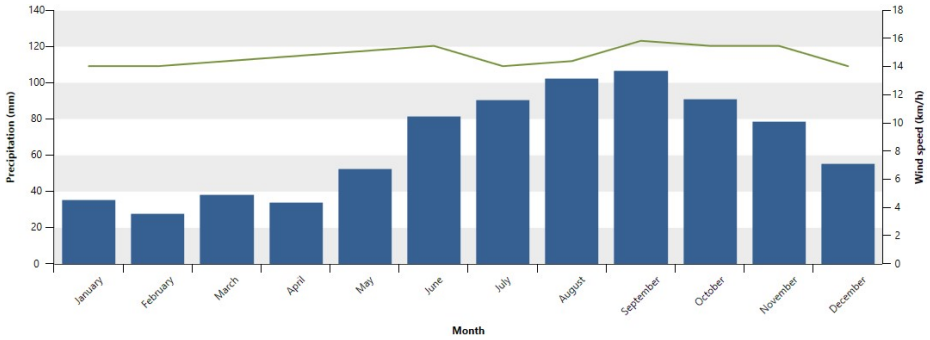


✓Daily solar irradiation (horizontal) : 3.18 kWh/m^2/day → 3.2 Sun hours/day

✓Air temperature in summer (< 15°C) and in winter (< –22.8° C)

✓ Very good PV generation in summer, However, not good in winter (Oct to Jan)

✓ Precipitation and wind speed



✓Precipitation in the second half of the year

✓Snow mitigation solution needed for winter season (optimal tilt angle required)

✓Medium wind speed (<16 km/hr)

Voices of customer (VOC)

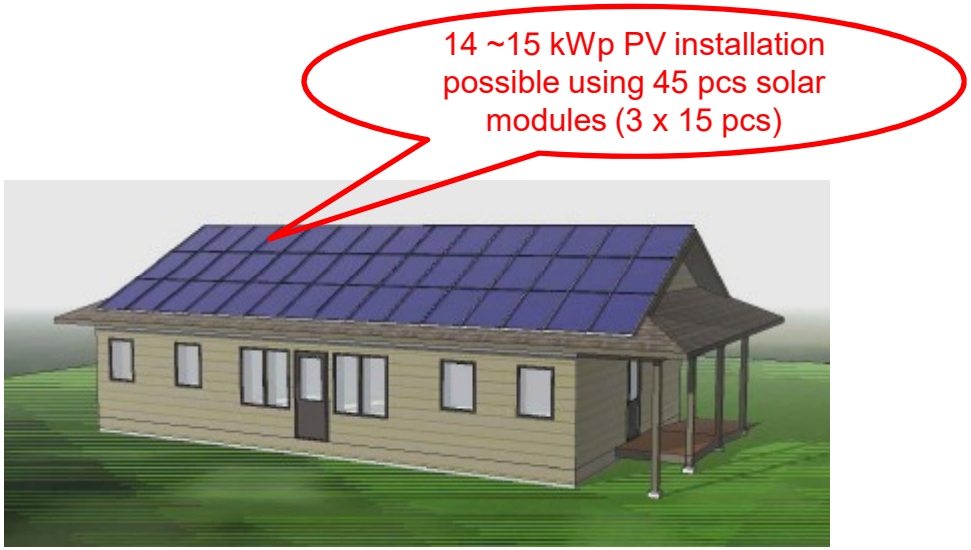
✓ Independance from the Hydro-Québec grid
→ off-grid (= stand-alone) energy net-zero house system

✓Renewable and environmentally-friendly energy source
→ Solar PV (photovoltaic) system, no-diesel generator

✓Reliable and durable energy source, operation and maintenance (O&M)
→ESS (Energy Storage System) based on battery storage
→backed-up by a gas generator in case of continuous low-illumination days (especially during the winter time from October to January)

✓Long-term economy
→ Low levelized cost of electricity (LCOE)

Analysis of the site for a feasibility study



Feasibility for a PV installation

✓ **PV installation capacity : 14~15 kWp possible (45 pcs x 60c 320 Wp solar module)**

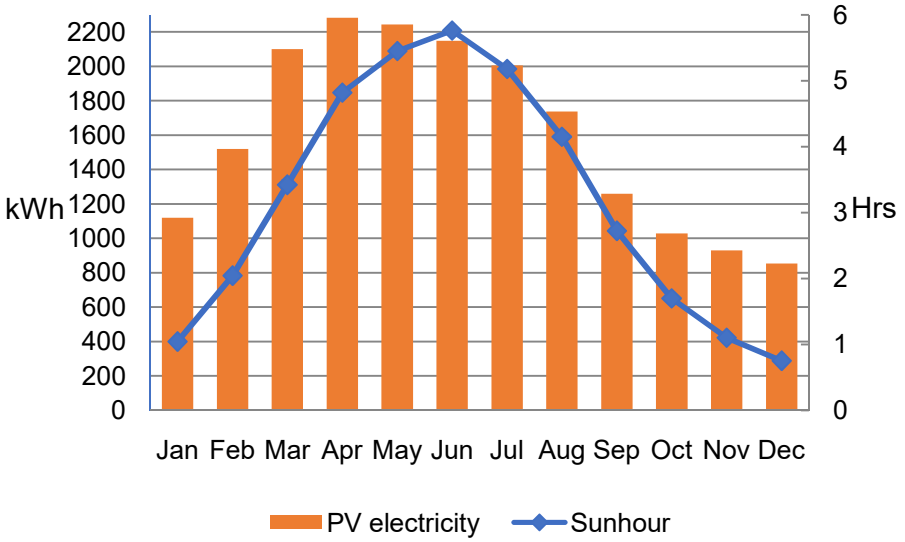
✓ **Installation type: fixed on roof-top (pitched roof)**

✓ **Roof tilt-angle : 29.4° fixed according to the architectural plan**

→ **Not quite ideal considering the latitude (52°14' N) of the location**
→ **Not steep enough for snow sliding in winter season**
→ **Should be higher than at least 45°, if possible.**

Prediction of electricity production for 15 kWp solar PV

✓ **Simulated PV electricity production** for 15 kWp PV system at 29.4° tilt and 0° azimuth (south) angle (PV installation on the pitched roof-top and inverter efficiency of 95%)



Annual production of 19 237 kWh for a 15 kWp solar PV system in Eastmain, Baie-James.

→ Monthly average of 1 603 kWh PV electricity production

→ Much lower production than average in winter season, below 1 000 kWh/month from October to December

→ Mitigation solution needed: @ 45° tilt angle, production of monthly electricity higher than 1000 kWh in these winter months

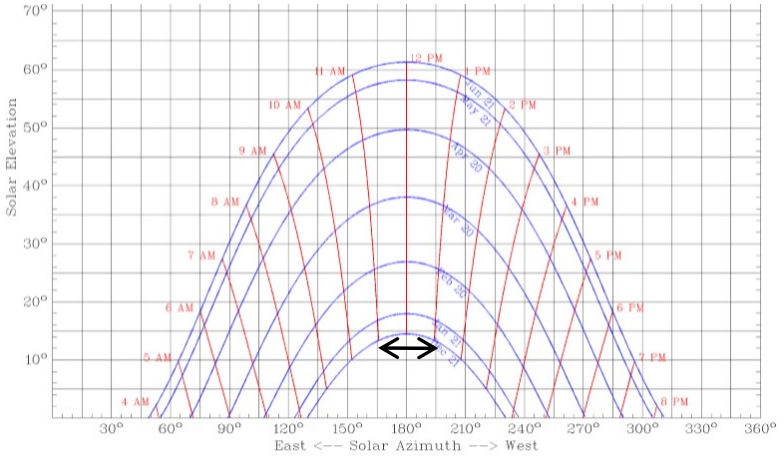
Checking of the planned PV system

Calculation of the electricity consumption limit for a given PV system size in Eastmain

Determination of the solar PV array size (kWp)	
Total daily consumption of electricity (kWH/day)	18
Number of sun hours equivalent to 1000 W/m^2 in winter	1.92
Efficiency loss factor of Battery banks	0.85
PV module loss factor due to heat	0.88
Various losses factor including shading, wiring loss, etc.	0.85
PV power (kWp) required = Total daily consumption (KWH) / number of sun hours equivalent to 1000 W/m2 (h) /efficiency of battery / PV module loss factor due to heat / various other loss factors	14.75

Consumption limit of electricity per day at 15kWp solar PV in winter

The equivalent Sunhour in winter in Eastmain



~1.92 hrs

✓**For a given 15 kWp PV system size, the total consumption of electricity per day should be limited to 18 kWH → For a higher consumption, a larger PV system size is needed.**

Ref: http://solardat.uoregon.edu/SunChartProgram.html

Design of system size (for off-grid Solar PV + ESS)

Summary for **ESS (Energy Storage System) battery capacity (kWh) needed**

*DoD \ # of days of autonomy	1	2	3	5
50% (Lead-acid)	44	89	133	222
70% (nano-carbon AGM)	32	63	95	159
90% (Li-ion)	23	46	69	116

*DoD: Depth of Discharge (of the battery)

Summary for **PV capacity (kWp) needed**

PV capacity (kWp)	15	Given by the architectural plan
Daily electricity consumption limit (kWh)	**18**	**This is the maximum consumption per day in winter at a given PV capacity of 15 kWp**

15 kWp solar PV + ESS(Energy Storage System)

✓Components

- Solar Module: **SHINSUNG** mono 60c, 320W x 45 pc
- Supporting structure: **TBD**, rust-free racking system (sustainable up to 45 m/sec wind speed)
- battery bank : **TBD** (depending on the customer's desired preference and # of days of autonomy)

- off-grid DC-coupled system: **SCHNEIDER** inverter/charger, MPPT charge controller, etc…
- off-grid (grid interactive) DC-coupled system: **OUTBACK** inverter/charger, MPPT charge controller, etc…
- Hybrid (off-grid/on-grid) All-in-One system: **HANSOL** All-in-One ESS system etc…

✓Design & Construction

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Components – Solar Module (SHINSUNG)

PID-free!

Lowest LID!

Tier-1 Quality!

Salt-mist corrosion tested & proven!

Wind resistance up to 205 mph!

1. POWER
- 320-340W with positive power tolerance (0 ~ +5W)
- up to 20% module efficiency

2. RELIABILITY
- Elimination of ribbon and soldering

3. AESTHETICS
- Ribbon-less design
- True black module

4. SHADE TOLERANCE
- Parallel string connection

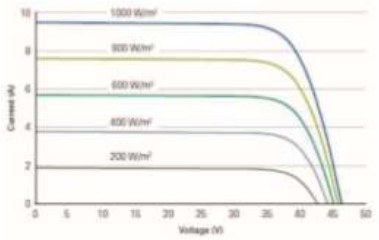
5. CERTIFIED
- IEC 61215/61730: VDE
- UL 1703: CSA

6. QUALITY
- ISO 9001, ISO 14001
- 100% Final Inspection

Shingle-type high aesthetics!

Reliability due to ribbon-less interconnection!

Representative I-V Curves (325W)



Electrical Data (STC)

Maximum Power (Pmax) Power	320W Black	325W Black	330W Black	335W Black	340W Black
Tolerance	0 ~ +5W	0 ~ +5W	0 ~ +5W	0 ~ +5W	0 ~ +5W
Module Efficiency	18.4%	18.7%	19.0%	19.3%	19.6%
Maximum Power Current (Imp)	8.77 A	8.86 A	8.95 A	9.03 A	9.12 A
Maximum Power Voltage (Vmp)	36.5 V	36.7 V	36.9 V	37.1 V	37.3 V
Short Circuit Current (Isc)	9.36 A	9.40 A	9.47 A	9.53 A	9.59 A
Open Circuit Voltage (Voc)	44.3 V	44.5 V	44.8 V	45.0 V	[illegible] V

High-efficiency PERC module up to 19.6%

Made in Korea Quality!

c UL us LISTED

25 years warranty!

Certified high output under -40 and 85°C

TIER 1 Bloomberg NEW ENERGY FINANCE

IEC 61215

High strength test passed (550kg/m²)

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Components – battery banks

Rolls FLA, DoD = 50%

Total: USD $22k
for 133 kWh @ 48V

GS nano-carbon
AGM, DoD = 70%

Total: USD $44k
for 95 kWh @ 48V

Discover LFP (Li-ion-phosphate), DoD = 90%

Total: USD $73k
for 69 kWh @ 48V

Note that the prices are here suggested as only for comparison purpose. These may not represent the reality of the current and local market values.

✓ **Different technologies, costs and operation & maintenance (OM) !**
✓ **Cost-effectiveness (up-front cost vs. long-term cost) → nano-carbon battery is one of the best options.**

Components – SCHNEIDER inverter/charger, *mppt charge controller

Tier-1 Quality!

1 or 3 phase hybrid inverter

Monitoring, generator control, further adaptability

Residential, commercial power solution

c UL us LISTED

Flexible

Designed for reliability

Schneider off-grid solution!

✓Conext XW+ 6848 inverter/charger

✓Reliable and scalable off-grid solution up to 76 kW (IEC) / 61 kW (UL)

Schneider off-grid solution!

✓Conext mppt 80 600 charge controller

✓Mppt range: 195-550 V

✓ 2 strings

*mppt: maximum power point tracking

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Components – OUTBACK inverter/charger, *mppt charge controller

Tier-1 Quality!

Grid-interactive/
Stand-alone

8000W of continuous power

Unsurpassed surge capacity

c UL us LISTED

Engineered for reliability

Easy to install,
Monitor & control

OUTBACK Grid/Hybrid solution!

✓Radian GS8048A grid-interactive off-grid inverter/charger

✓ modular and scalable up to ten inverters delivering 80kW

OUTBACK Grid/Hybrid solution!

✓FLEXmax 100 300V charge controller

✓Mppt range: 30-295 V

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*mppt: maximum power point tracking

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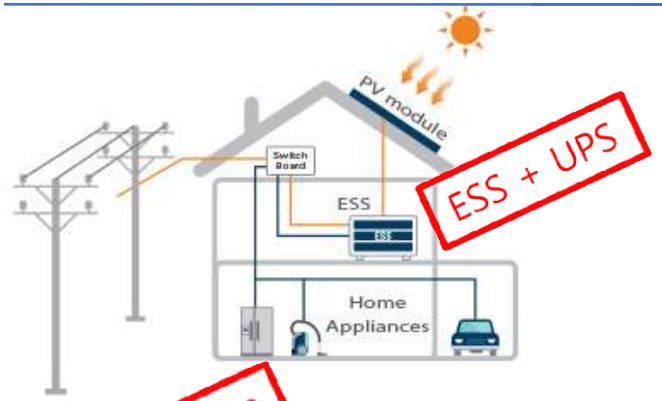
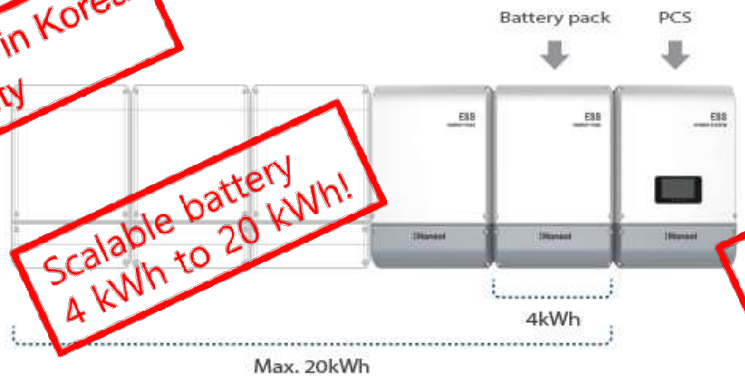
Components – Hybrid All-in-One ESS (HANSOL, ex-SAMSUNG)



ESS + UPS

Made in Korea quality

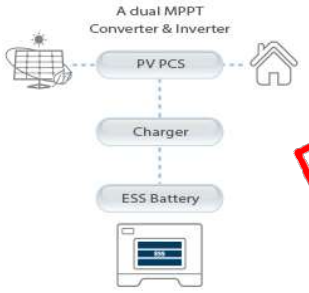


Scalable battery 4 kWh to 20 kWh!

SAMSUNG Premium Battery!

6000 cycles, 15 years lifetime!

Item		Hybrid AIO
DC Input (PV)	Max Power	6.6kWp
	Max Voltage	550V
	MPPT Range	125V ~ 500V
	Min / Initial Input Volage	125V / 150V
	No. of Strings(MPPT)	2 (2)
AC Output	Power	4.6kVA (DE)
	Noiminal voltage / Frequency	230V / 50Hz
	Feed-in Phase / Connection	1/1
Efficiency	PV to Grid(European)	95.5%
Lithuim-ion Battery	Power	2kVA (1 Enclosure) / 3kVA (2~5 Enclosures)
	Nominal Capacity	4 / 8 / 12 / 16 / 20kWh
	Usable Capacity	3.68 / 7.36 / 11.04 / 14.72 / 18.4kWh
Product	Dimension(L x W x H)	468 x 722 x 213 mm
	Weight	31.5kg
	IP grade	54
EMS	Remote Monitoring	Touch TFT LCD 5" / Web / Mobile
	Software update	Internet update
	Prevent Malfunction	Yes



All-in-One!

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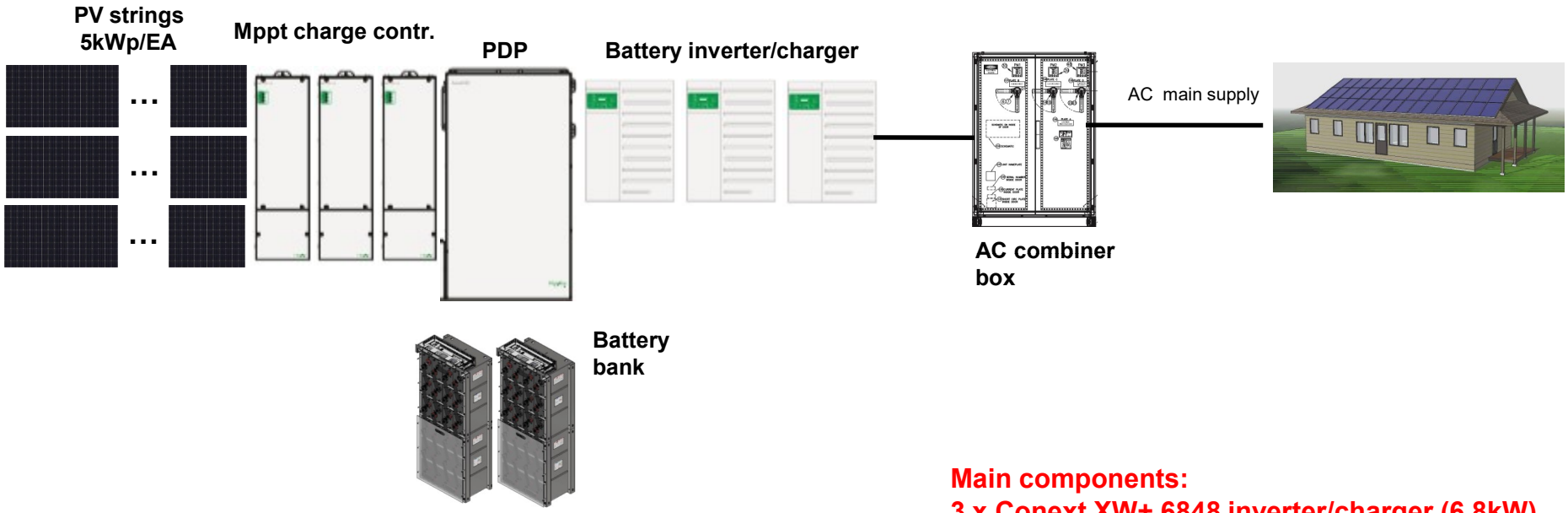
Options for PV production & consumption for Eastmain project

	Recommended #2		Recommended #1
	Option1 (Schneider)	**Option2 (Outback)**	**Option3 (Hansol Korea)**
Type	Grid-tied with back-up	Hybrid (grid interactive)	Hybrid (off-grid/on-grid)
PV Capacity	15 kWp	15 kWp	15 kWp
Storage capacity (kWh)	**96 kWh nano-carbon AGM (GS battery)**	**96 kWh nano-carbon AGM (GS battery)**	**60 kWp Li-ion battery (Samsung)**
Components	Battery inverter (3 pcs), mppt charge contr. (3 pcs), PDP (1 pcs)	Battery inverter (2 pcs), mppt charge contr. (4 pcs), Load center (2 pcs)	All-in-one (*PCS/BMS/EMS)
Cost	$$$	$$$	$$$

Calculation based on 18 kWh/day consumption

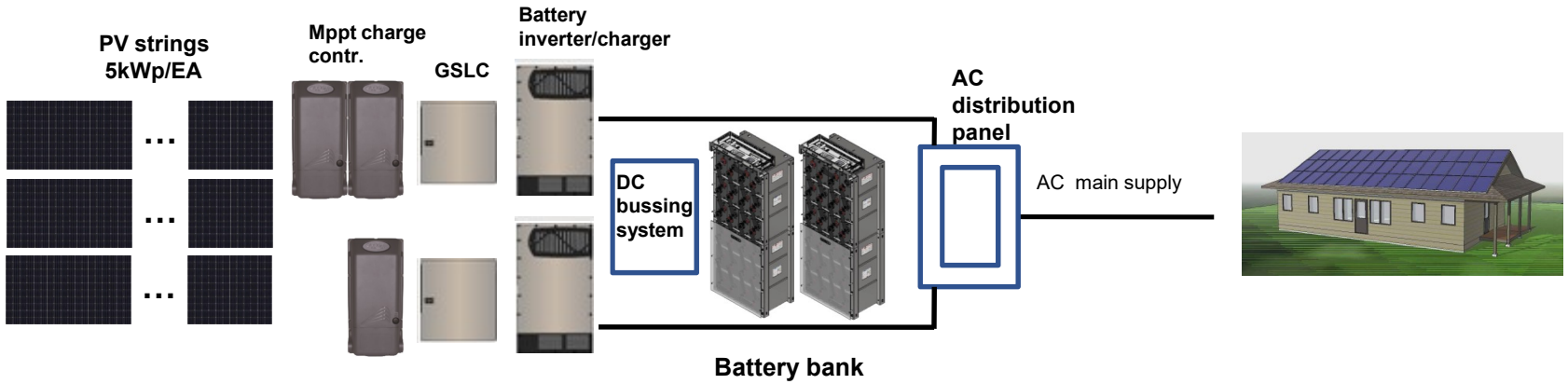
*PCS: Power Conditioning System
BMS: Battery Management System
EMS: Energy Management System

Option #1 – Schneider solution (off-grid 15 kWp solar PV + 96 kWh storage)



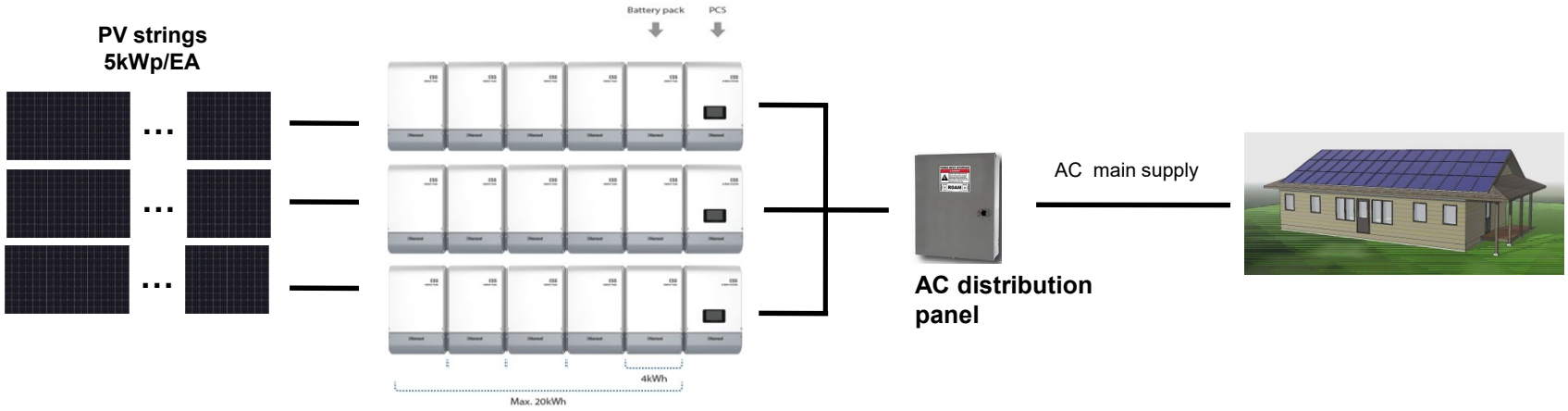
Main components:
3 x Conext XW+ 6848 inverter/charger (6.8kW)
3 x Conext 80 600 mppt charge controller (5kW)
1 x power distribution panel (PDP)
2 x nano carbon GS battery bank (48 kWh)

Option #2 – Outback solution (hybrid 15 kWp solar PV + 96 kWh storage)



Main components:
2 x Radian GS8048A inverter (8kW)
4 x FM100 mppt charge controller (5kW)
2 x GSLC Load Center
2 x nano carbon GS battery bank (48 kWh)

Option #3 – HANSOL solution (15 kWp solar PV + 60 kWh Li-ion storage)



All-in-One ESS
Li-ion 60kWh/20kW

Main components:
3 x All-in-One ESS/PCS (6.6kW)
15 x Li-ion Battery (SAMSUNG) pack (4kW)

Conclusions

✓ The house planned in Eastmain (52°14 N latitude) can accommodate up to 15 kWp Solar PV system on the rooftop.

✓ This PV system can generate about 19 237 kWH/year in this SUB-ARCTIC area. However, during winter season (especially, October to January), the PV electricity production may drastically decrease below 1 000 kWH/month under the current tilt angle of the roof (29.4 degree) according to the architectural plan.

✓ A steeper adjustment of the roof tilt angle (higher than 45 degree) can increase the PV electricity generation, especially during the winter months and facilitate a natural snow sliding removal on the solar arrays.

✓ For off-grid system, the 15kWp solar PV system physically limits the use of daily electricity consumption to 18 kWh/day in winter. For a higher consumption, a larger PV system size (> 15 kWp) is needed.

✓ For off-grid system, under the conditions of daily 18 kWh electricity consumption and 3 days of autonomy, the different capacity of the battery bank can be planned. Much less capacity (as well as weight and volume) is needed for Li-ion battery than for Lead-acid battery due to its higher energy storage density.

✓ We suggested three options with different combination of battery technologies (conventional lead-acid, nano-carbon AGM, and Li-ion battery). We recommend the option #1 (OUTBACK solution with nano-carbon GS battery bank) and the option #3 (HANSOL All-in-One ESS with SAMSUNG Li-ion battery pack).

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IDS Énergie and PVavenue Inc. proudly presented
“15 kW solar PV + battery storage” for the Eastmain (Baie-James) project

Thank you very much!

For more information, please contact
Mr. Denis St-Yves @ IDS énergie, +1 819 373 5978, info@ids-energie.com
Dr. Junegie Hong @ PVavenue Inc, +1 514 708 4536, info@pvavenue.com