Our Solar Grid -Tie with Battery Backup

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Solar Electricity Options

1) Off grid.
   - Need a battery to store excess power production and use at night.

2) Grid tie with no battery. (very efficient > 95%)
   - Use the grid as a very efficient storage battery to store your excess.
   - Not able to produce any power when the grid goes down.

3) Grid tie with battery.
   - You still have power when the electricity grid is down.
   - Efficiency converting the solar energy from panels to 220/120 VAC:
     -original lead acid batteries 68% in summer, 45% in winter. Could not utilize sunlight after batteries fully charged due to overheating. Fan required to exhaust H_2 gas outside. Top up with distilled water.
     -replaced by Lithium Iron Phosphate batteries in 2024, 98% efficient and able to utilize all sunlight received with no overheating. Very low maintenance and low space requirement.

Our 3.9 kW system provides 20% of our electrical power

Phil Gregory's Solar Power

Feb. 2015

Solar Modules

↓

DC to DC converter

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24 V Battery

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4 kW Inverter/charger

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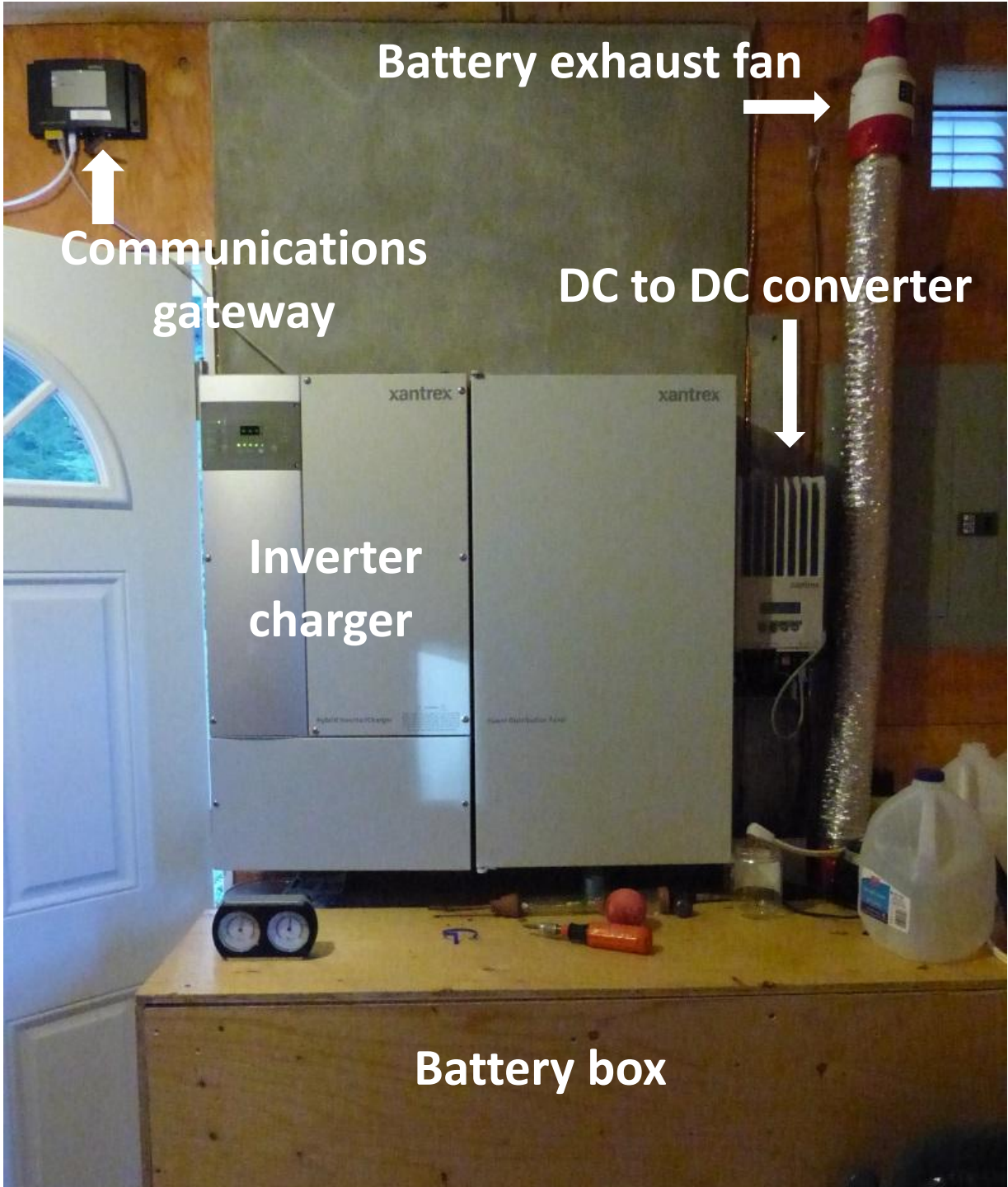
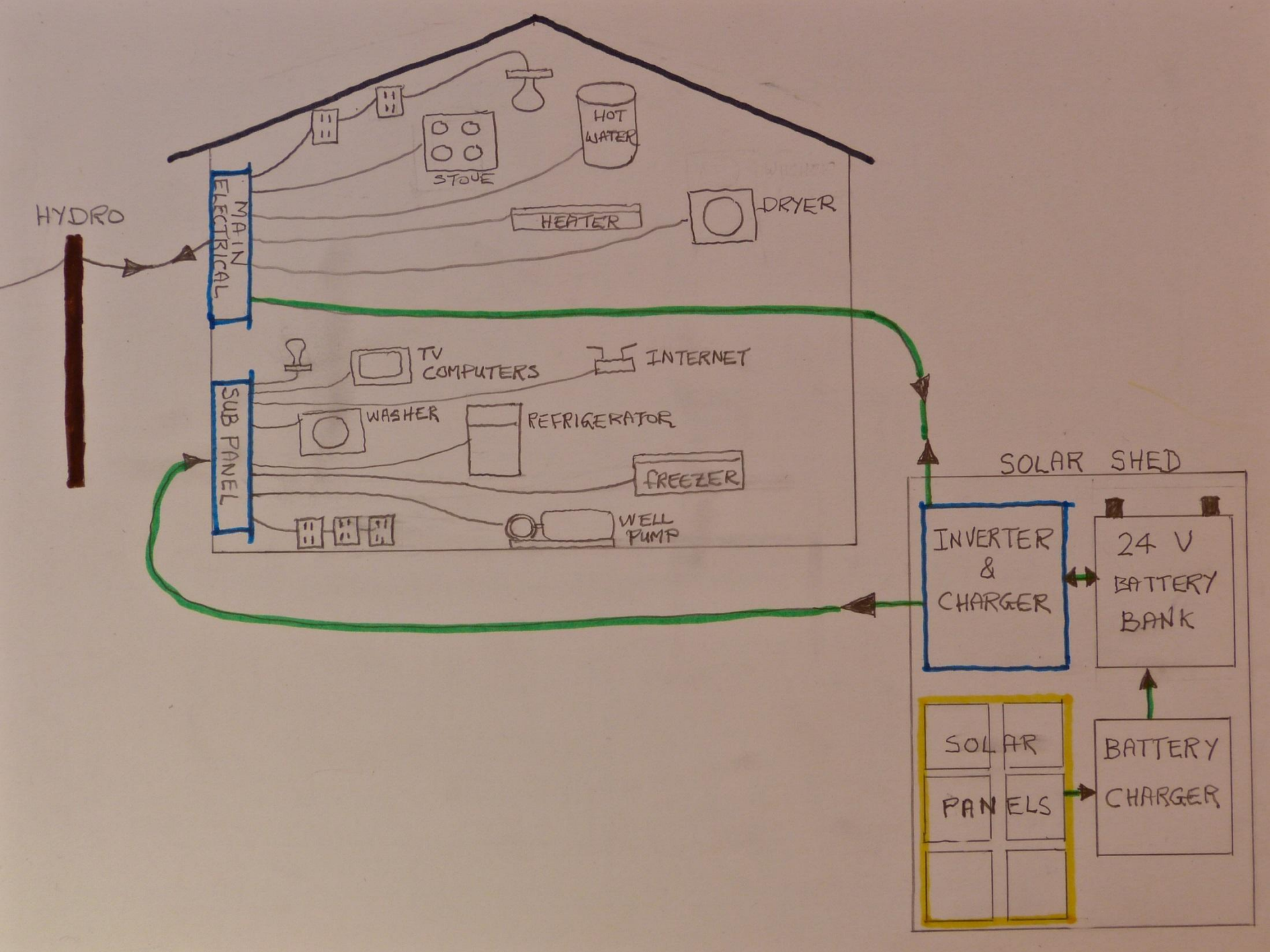
220 V AC Electrical & Intranet connection to house



Original lead acid batteries

DIRECTORY / DIRECTOIRE
HOT WATER
HOUSE EXTENSION SUB PANEL


HYDRO
MAIN ELECTRICAL
SUB PANEL
STOVE
HOT WATER
HEATER
DRYER
TV
COMPUTERS
INTERNET
WASHER
REFRIGERATOR
FREEZER
WELL PUMP
SOLAR SHED
INVERTER & CHARGER
24 V BATTERY BANK
SOLAR PANELS
BATTERY CHARGER

Costs

First phase 2008 (8 x 200 W panels = 1600 W)

8 Sanyo panels ($5.85 per W)	=	$9368
Xantrex 4 kW 120/240 W Inverter/Charge	=	$4873
Control panel + charge controller + gateway	=	$2086
Mounting rails	=	$ 980
Batteries (24 V, 24 kWh capacity) + shipping	=	$5343 ($6555 in 2016)
Labour + electrical supplies + safety permit +GST	=	$8205
Phase 1 total ----------	=	$30,855

Second phase 2015 (9 x 260 W panels = 2340 W)

9+1 spare Canadian Solar panels ($0.94 per W)	=	$2440
Mounting rails	=	$ 615
2 charge controllers	=	$1502
Electrical supplies + safety permit ($239)	=	$ 912
Labour + travel	=	$1373
GST	=	$ 263
Phase 1 total ----------	=	$ 7,105

Total ---------- = $37,960

Estimated cost of my system today

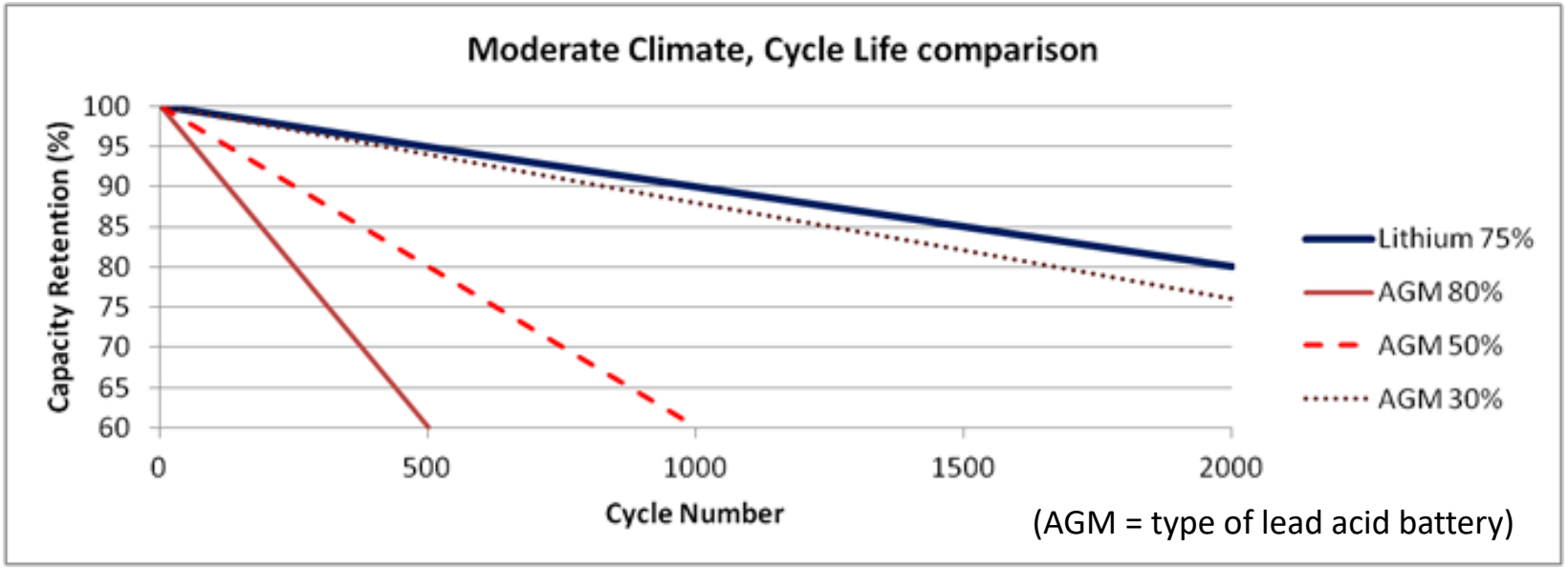
3900 W grid tie with battery

15 x 260 W panels = 3900 W ($1 per W) = $3900
4 kW 120/240 W Inverter/Charge = $3500
Control panel + 3 charge controllers + gateway = $3600
Mounting rails = $1200
Batteries (24 V, 24 kWh capacity) + shipping = $6555
Labour + electrical supplies + safety permit +GST = $10000
Total ---------- = $25,155
Cost per W = $6.45

3900 W grid tie NO battery

15 x 260 W panels = 3900 W ($1 per W) = $3900
8 micro-inverters = $2300
Monitoring unit = $ 600
Mounting rails = $1200
Labour + electrical supplies + safety permit +GST = $5000
Total ---------- = $13,000
Cost per W = $3.34

Battery life issues



A Comparison of Lead Acid and Lithium-ion in Stationary Storage Application, Greg Albright, Jake Edie, Said Al-Hallaj , AltEnergyMag , 2012, http://www.altenergymag.com/content.php?post_type=1884

Bowen Island power outages

Typical significant power outage duration = 8 hr
Average load during outage = 0.4 kW
Battery discharge = 8 x 0.4 = 3.2 kWh
My battery rated at 24 kWh

Battery discharge for an 8 hr outage = 24 %

Tesla Powerwall Li-ion batteries

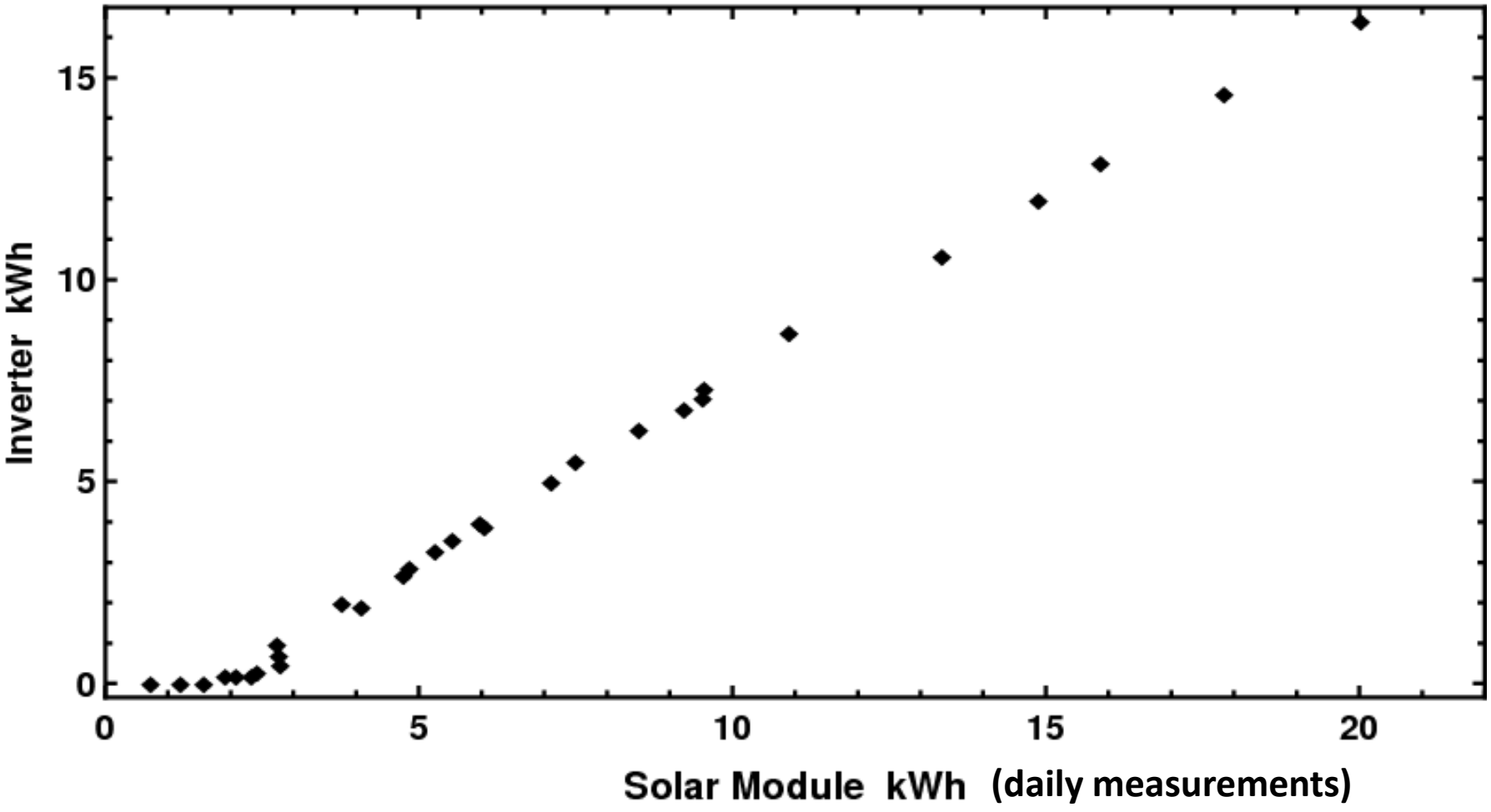
Advertise 6.4 kWh units for $3500 US or $4500 CAD

$16900 CAD to replace my 24 kWh battery capacity. That's 2.6 times the cost of lead acid but because Li-ion can be more deeply cycled for a similar or longer lifetime, one could probably get by with a smaller battery capacity.

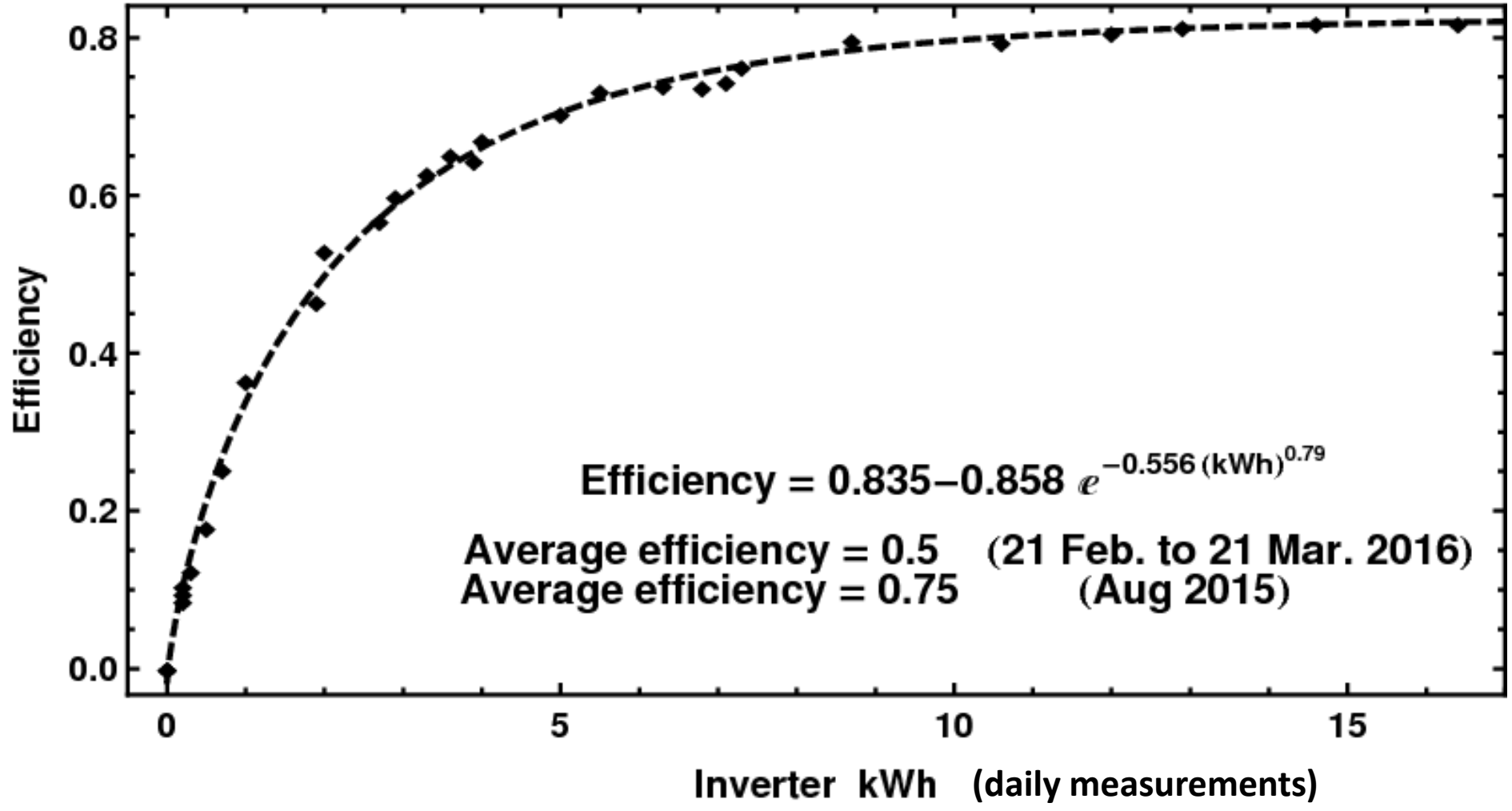
Advantages: 92% efficiency, no maintenance, more environmentally friendly to produce

Disadvantage: The likelihood and consequences of a thermal runaway event are higher for lithium-ion. It has a higher amount of energy in a smaller volume. On the other hand a flooded lead acid batteries produce hydrogen gas which needs to be vented for safe operation.

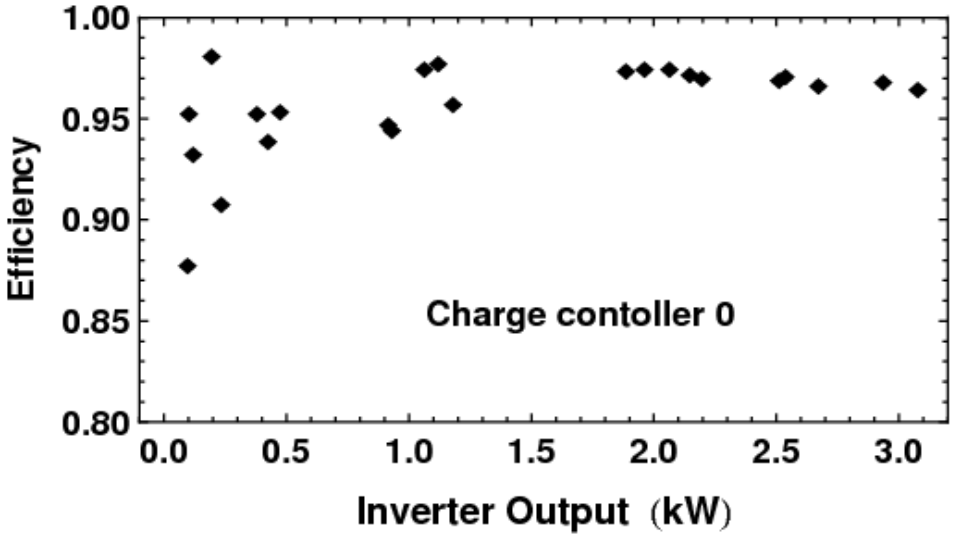
Comparison of daily energy produced by the solar modules (at output of DC to DC converters) compared to AC energy emerging from the inverter

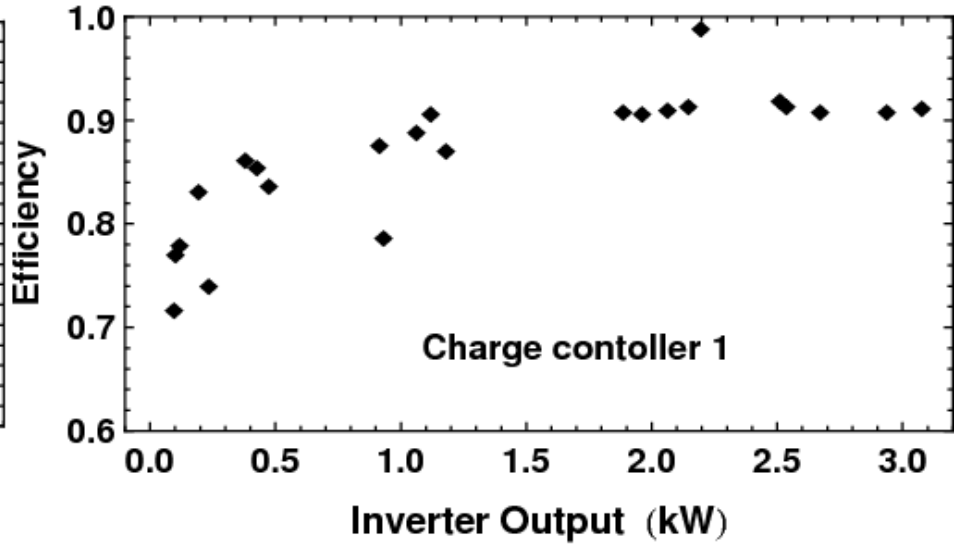


Efficiency of solar energy conversion measured from the output of the DC to DC converters through to the inverter AC output for my grid tie battery system

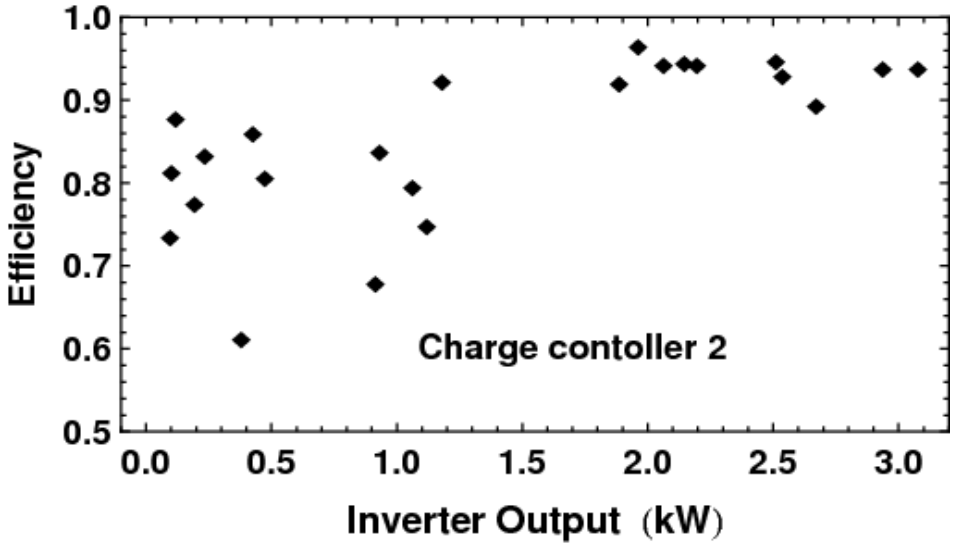


Charge Controller (DC to DC converter) Efficiencies





A charge controller, also known as a DC to DC converter, transforms the solar module output voltage to the voltage required to charge the battery.



My system of mounting the panels on wooden T beams provides good airflow below the panels, leading to lower panel temperature operation for greater energy output.