Rambler

Newsletter of the
Ottawa Valley Mobile
Radio Club
Incorporated

Nov 2013 Edition 58 Page: 1

President's Ramblings

VE3TWO Issue: In September, OVMRC wrote to Public Works and Government Services Canada to advise them of our concern that VE3TWO could no longer be available under the fees proposed by the building manager for hosting the repeater at 580 Booth Street.

In early October, the Club received a reply from Public Works confirming the terms of the contract signed in 1979 between the Club and the Crown for the installation and operation of VE3TWO. The following is a partial quote from that reply:

"On the question regarding the proposed $2,500 license fee, we have reviewed the license agreement and concur that the fee was a one-time administrative fee of $50 to be paid prior to the commencement date of the license. Furthermore, we are currently looking into your request with our service provider SNC Lavalin O&M and will advise it to work with you to resolve any perceived issues relative to the access rights to your equipment."

Under the guidance of our technical chairperson, Paul Labbé VE3NJS, we will now proceed to assess the condition of the repeater equipment after which the Club will be in a position to decide what should be done.

We want to thank all those who have contributed to the satisfactory resolution of the issues of proposed new fees and access to the repeater site.

RAC Insurance: We have submitted the required forms and cheque to RAC for our OVMRC insurance coverage for 2014. This means that all OVMRC activities have coverage and is in line with the museum's requirement for rental of their facilities.

OVMRC Membership: Membership is the fundamental asset required for a successful and meaningful enterprise. I personally think it is up to each and every one of us to contribute something and right now it's an answer to a basic question. What would you like OVMRC to be within the realm of amateur radio information, knowledge and/or radio experiences? Please let anyone on the executive know what we can do to make the club more interesting for you.

73
Sandy Haggart/VE3HAZ

INSIDE

Meeting Date

Club Meeting:

November 21st

Darin Cowan, VE3OU

VE3JW
Top to Bottom

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For information about the duties and responsibilities about all Executive and Chair positions, please visit the OVMRC forums, Member section or contact any member of the Executive.

Sponsors

The OVMRC acknowledges the following organizations for their support of our activities:

- **Acceptable Storage,** Ottawa, ON
- **Bytown Marine,** Ottawa, ON
- **Elkel Ltee.,** Trois-Riviéres, QC
- **Kenwood Electronics Canada Inc.,** Mississauga, ON
- **Travel-Mor Trailer Sales,** Ottawa, ON

The club's web site is hosted by:

Primus Telecommunications Canada Inc..

www.ovmrc.on.ca

Visit the OVMRC Store at

http://www.cafepress.ca/ovmrc

OVMRC Life Members

Maurice-André Vigneault, VE3VIG

Ralph Cameron, VE3BBM

Doug Carswell, VE3ATY

Doreen Morgan, VE3CGO

Ed Morgan, VE3GX

Bill Wilson, VE3NR (SK)

OVMRC Repeaters

147.300 MHz(+)

444.200 MHZ(+)

Amateur Radio Exhibit VE3JW

Web site:

ovmrc.on.ca/ve3jw.htm

Canada Science & Technology Museum

The Rambler is the official newsletter of the Ottawa Valley Mobile Radio Club Incorporated and is published 11 times a year (monthly, except for July).

Submit articles to the editor or by e-mail to:

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MEETING MINUTES, October 17, 2013

Call to order – The meeting was called to order by the Past President Michel (VE3EMB) at approximately 19:40 hrs.

Visitors and New Members – Norman (VE2NHN)

Speaker for the Evening – Paul (Technical – VE3NJS)

Paul presented an in-depth look at solar power generation and storage, specifically as to how the VE3RAM power system on the trailer was designed, purchased and installed.

Solar is the only available technology at this time that converts solar power directly into energy. All other technologies involve additional steps between the initial energy source and the electrical power. The present usage of power worldwide is approximately 16 Tw per year, whereas the solar energy falling on the surface of the earth is 23,000 Tw per year.

Paul presented a graph of the efficiencies of solar panels over time, from the initial units with efficiencies of 1-2%, to the present where some lab panels are rated at 44%. Many panels now commercially available are rated at >20% efficiency.

To harvest the maximum power from a solar panel, the load resistance must match the panel resistance. Unfortunately the characteristics of the panel changes with the amount of solar radiation falling on it, so a fixed resistance load will be efficient only for a single curve. Thus a smart charge controller is needed in which the maximum quantity of power is extracted from the panel.

Paul then proceeded to provide the basis for the panel selection and battery capacity for the club system. Ultimately 3 panels (3 x 240 watts) were ordered generating a maximum of 720 watts, along with a total battery storage capacity of 408 Ah. An appropriate smart charger was also ordered. The 408 Ah battery capacity would allow 2 days of operation with no solar energy. The batteries were of the deep-discharge type allowing more energy to be used without destroying the battery.

The 3 solar panels were installed on the trailer roof horizontally. This is not optimal but provides a significant amount of energy in the summer months when the sun is directly overhead. This configuration will be less efficient in winter when the sun is much closer to the horizon.

The system operated well after installation and allowed for the station to operate without a fossil fuel generator.

Many thanks to Paul for his in-depth presentation on solar power generation and storage.

Business Portion of the Meeting

Membership – Joe – VE3EUS

The club now has 25 members signed up, and a reminder that all interested in joining should do so quickly as the RAC insurance is quickly coming due.

Treasurer – Joe – VE3EUS

Everything is on track – no outstanding issues.

Radio Operations – James – VE3MYZ

The participation in the WM net on Wednesday evenings has been low, and James suggested ceasing operation of this net.

Training – Ernie – VE3EJJ

The course has 9 attendees with the possibility of 1 additional person. One student is interested in Morse code.

50/50 Draw

This was won by yours truly (Brian VE3KNE), and was donated to the club.

Door Prizes

A large number of prizes were given out to many of the people attending the meeting.

The meeting was then adjourned.

Utilizing solar energy
VE3RAM off grid power system

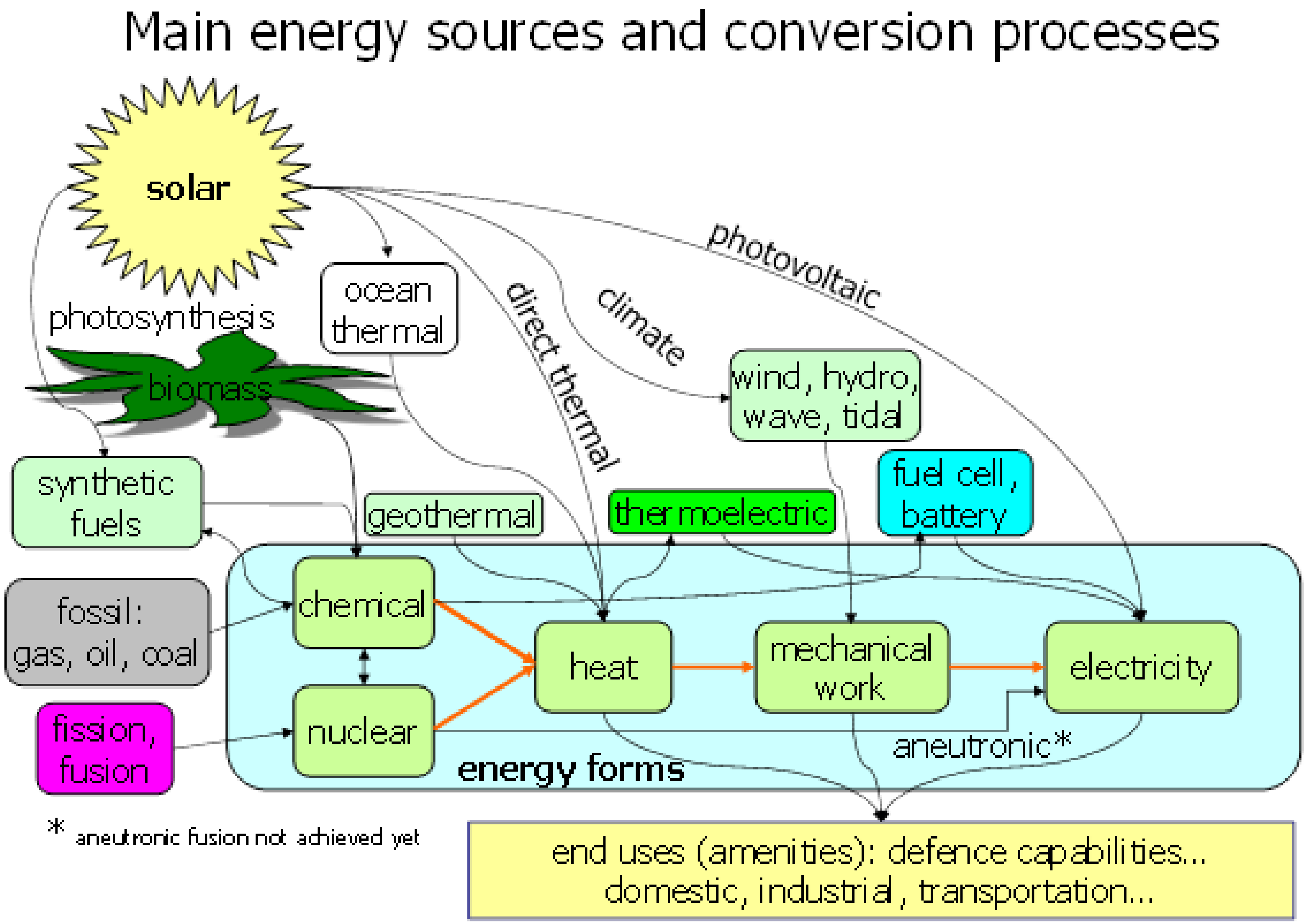
By Paul Labbé
VE3 NJS

OVMRC 17 October 2013

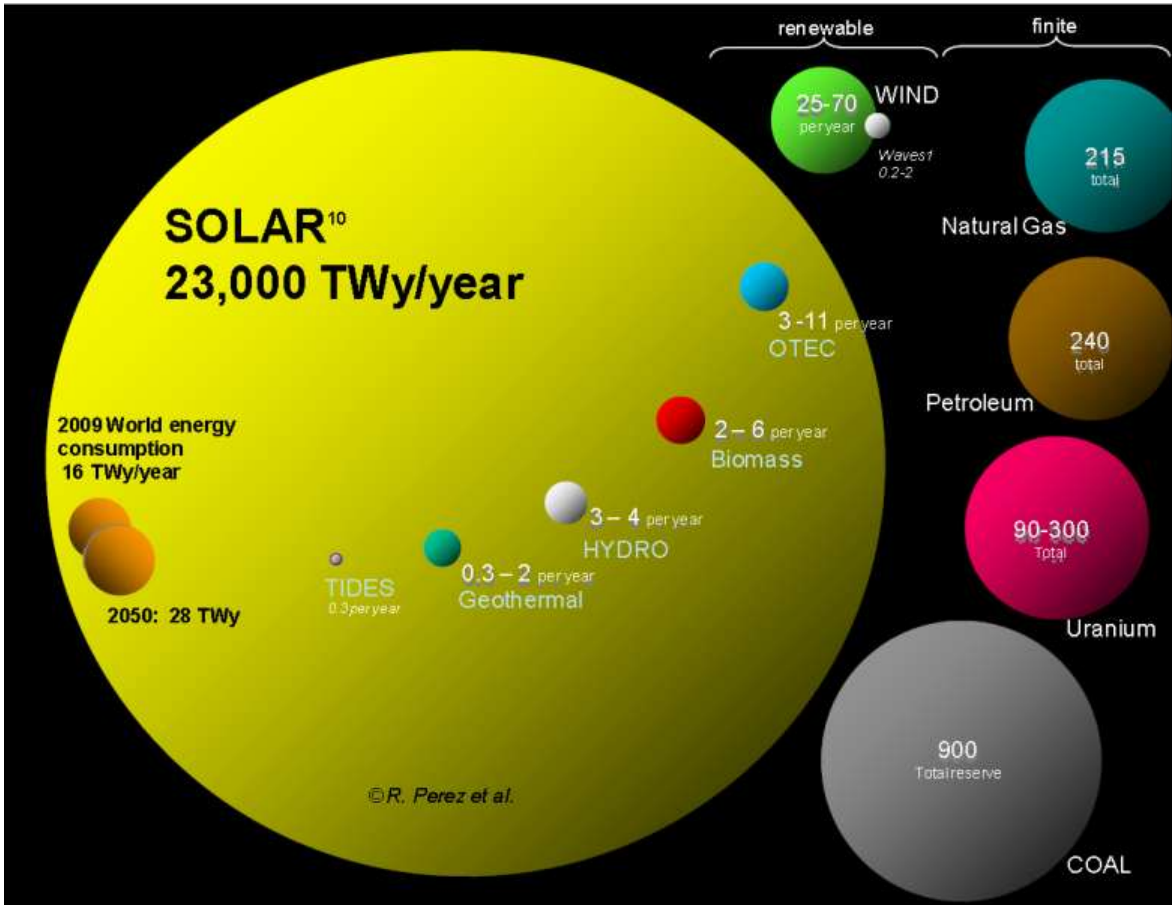
Itinerary

- Energy resources
- Solar energy and technologies
- Technology trends
- Solar system parameters, Ottawa…
- Evolution of the intent (2012-2013)
- Energy demand
- Finding a kit within budget
  - Panels + controller + hardware
  - Batteries + hardware + wiring + led lights
- Team installation
- Next, wireless monitoring?

Why using solar energy?



Earth resources



Annual world energy consumption, annual renewable and finite Earth resources[1].

[1] SOLAR10: Solar energy received by emerged continents only, assuming 65% losses by atmosphere and clouds.
More indications on the source of data for Figure 23 is available at Perez., R. and Perez, M. (2009), A fundamental look at energy reserves for the planet., *The IEA SHC Solar Update* (electronic journal) 50. http://www.iea-shc.org/data/sites/1/publications/2009-04-SolarUpdate.pdf

Basic solar cell

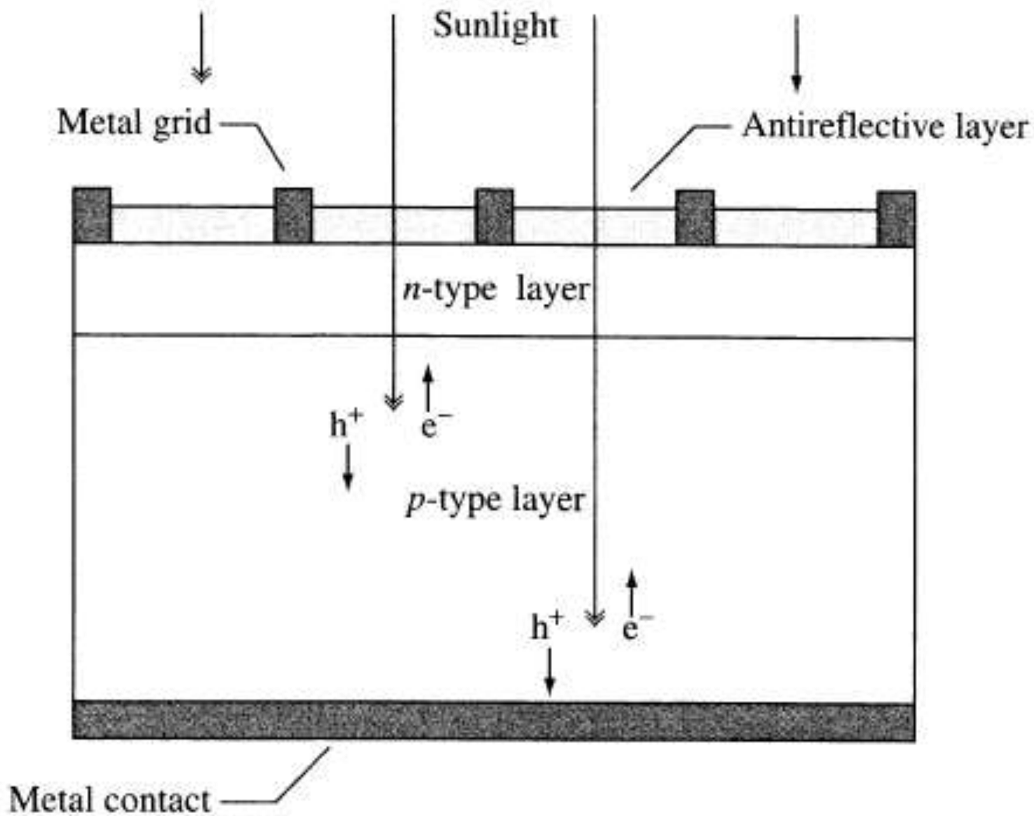
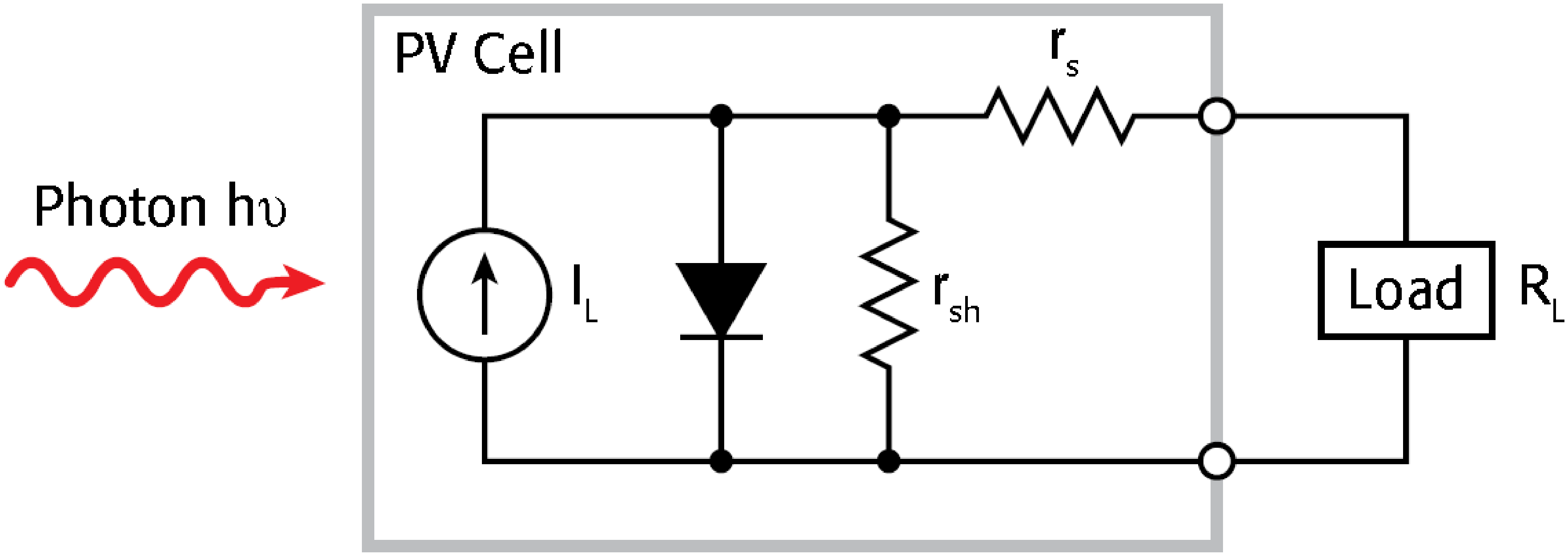


Figure 3.1 A schematic of a simple conventional solar cell. Creation of electron–hole pairs, e^- and h^+, respectively, is depicted

http://engphys.mcmaster.ca/undergraduate/outlines/4x03/Lecture%205,%20pn%20junction%20review.pdf

Idealized equivalent circuit of a photovoltaic cell



www.keithley.com/data?asset=57628

https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC4QFjAA&url=http%3A%2F%2Fwww.keithley.com%2Fdata%3Fasset%3D57628&ei=PZteUpP6A4nSqQHYxYD4CQ&usg=AFQjCNGxSelXTL3DIqi8u9y5ALC5msTkNg&sig2=ePP1SzEYQdYlv19UjYB6tA&bvm=bv.54176721,d.aWM

Solar cell/module parameters

When configured and applied properly, loads can be used to make all power-related measurements on the output of the solar cell or solar module.

Several key parameters are typically measured on solar cells. These parameters are:

- V_{OC} — Open-circuit voltage. The cell voltage at which point there is zero current flow.
- I_{SC} — Short-circuit current. The current flowing out of the cell when the load resistance is zero.
- P_{max} or P_{mp} — Maximum power output of the cell. The voltage and current point where the cell is generating its maximum power. The P_{max} point on an I-V curve is often referred to as the maximum power point (MPP).
- V_{max} or V_{mp} — The cell's voltage level at P_{max}.
- I_{max} or I_{mp} — The cell's current level at P_{max}.
- η — Conversion efficiency of the device. The percentage of power converted (from absorbed light P_{inc} to electrical energy P_{mp}) and collected when a solar cell is connected to an electrical circuit. This term is calculated by dividing P_{max} by the input light irradiance (*E*, in W/m², measured under standard test conditions) multiplied by the surface area of the solar cell (AC, in m²).
- Fill factor (FF) — P_{max} divided by the V_{OC} times I_{SC}.
- Cell diode properties.
- Cell series resistance.
- Cell shunt resistance (or parallel resistance).

http://www.electronicproducts.com/Test_and_Measurement/Choices_for_measuring_solar-cell_output_power.aspx?terms=Choices%20for%20measuring%20solar-cell%20output%20power

Power is maximized at V_{mp}, I_{mp}

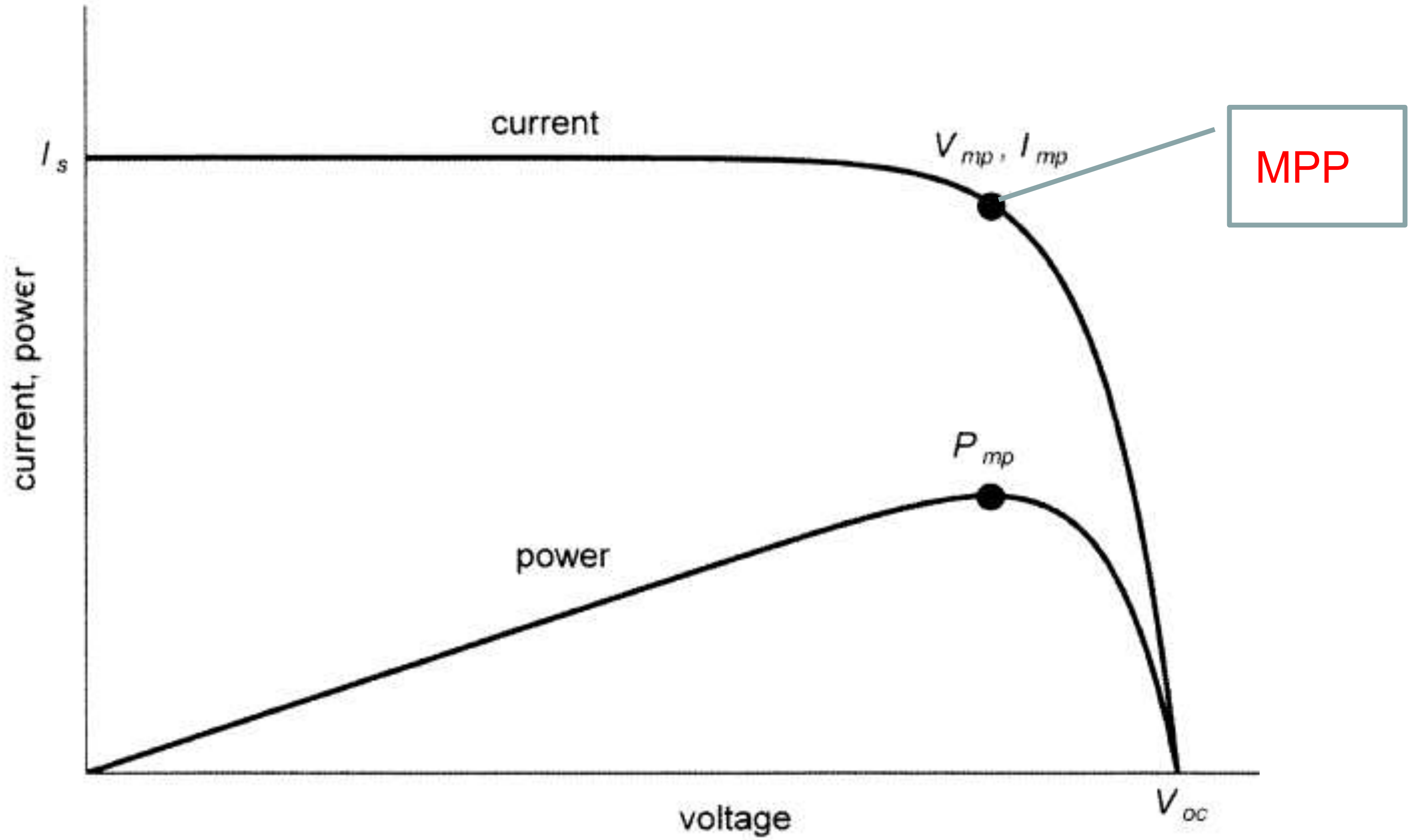
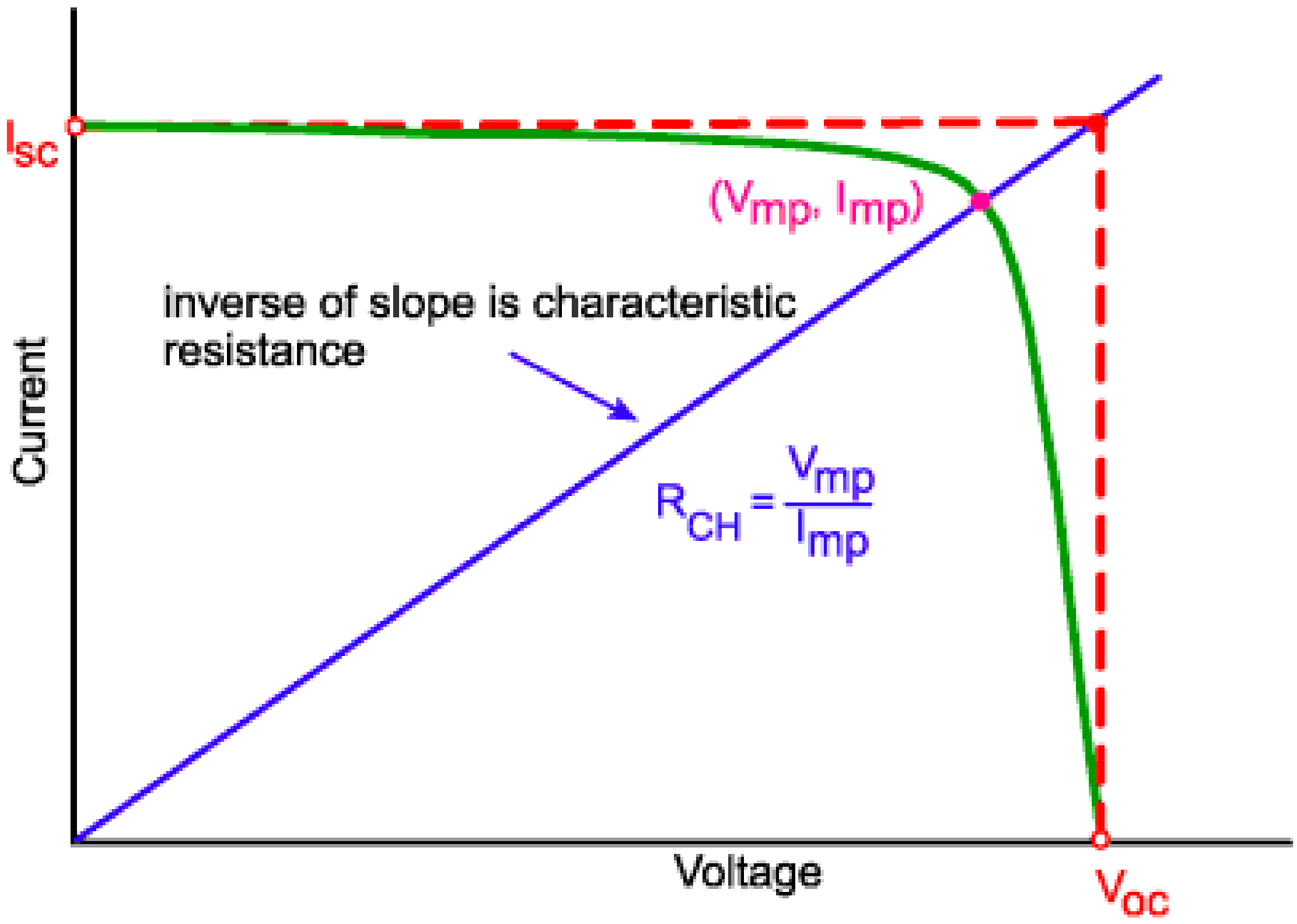


Figure 3.5. Typical representation of an I-V curve, showing short-circuit current (I_{sc} and open-circuit voltage (V_{oc}) points, as well as the maximum power point (V_{mp}, I_{mp}).

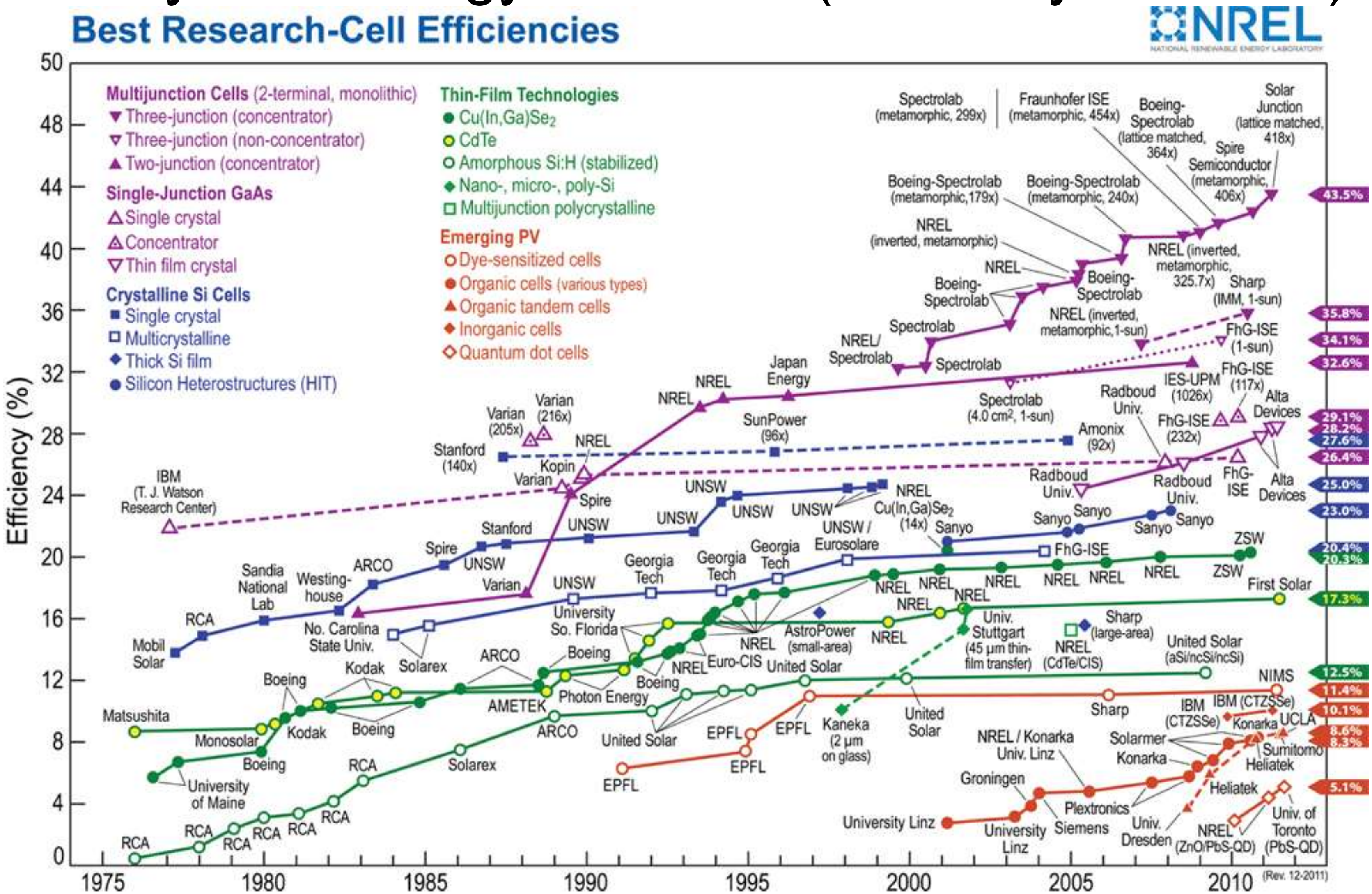
http://engphys.mcmaster.ca/undergraduate/outlines/4x03/Lecture%205,%20pn%20junction%20review.pdf

Power is maximized at V_{mp}, I_{mp}



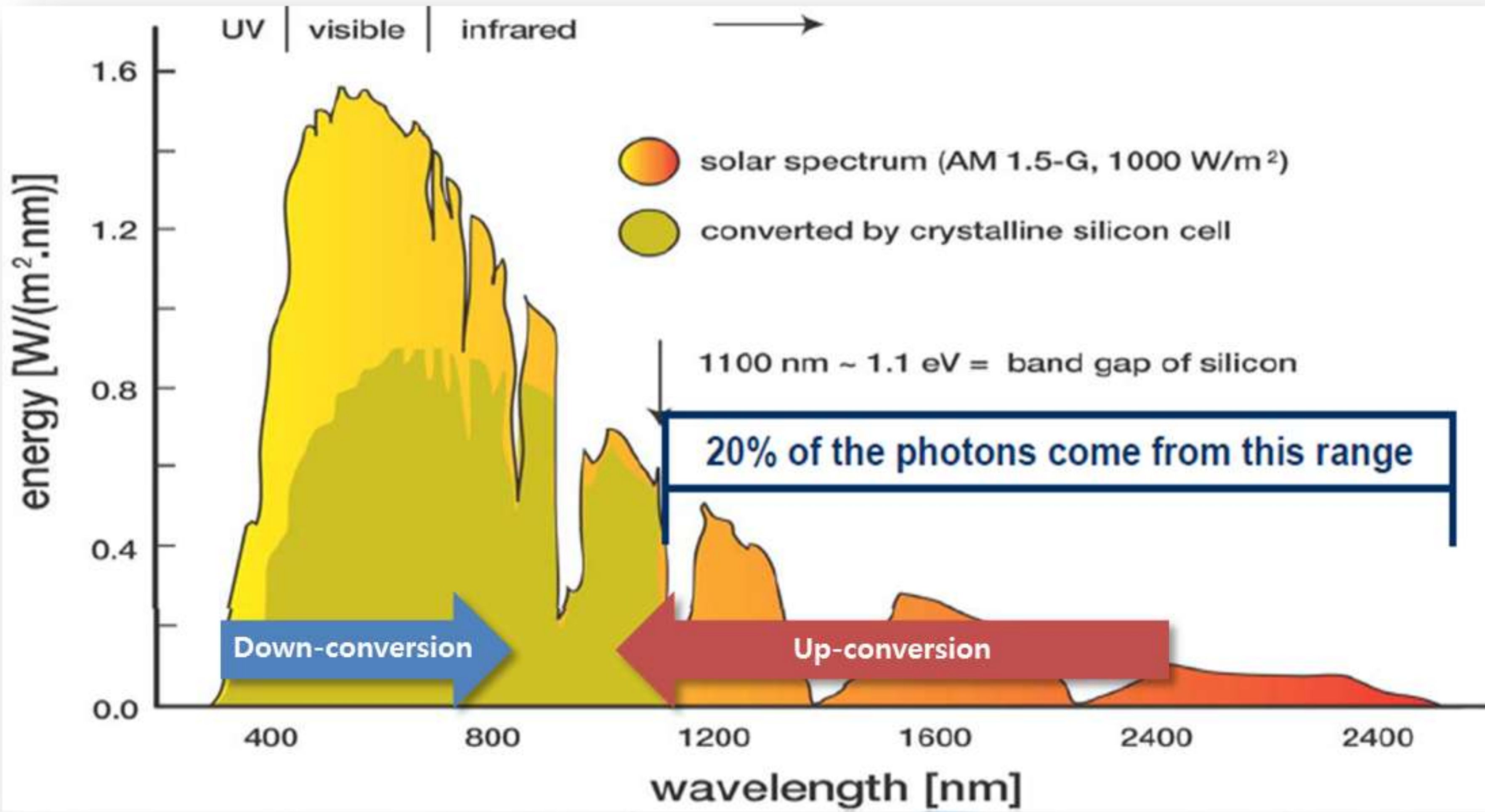
Trends in solar cell efficiencies

by Technology and Year (Courtesy of NREL)



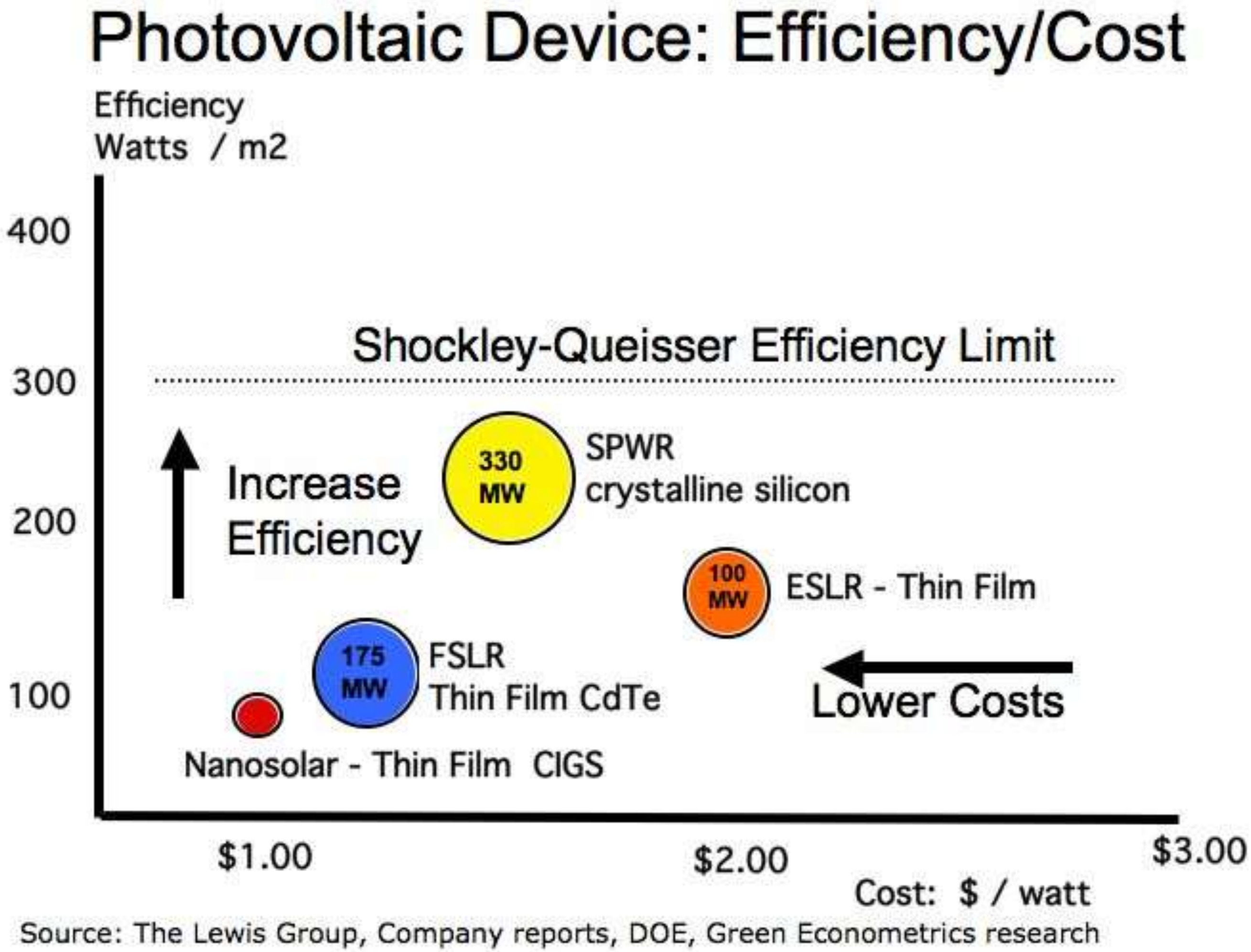
http://www.digikey.com/Web%20Export/techzone/energy-harvesting/article-2012march-emerging-photovoltaic-technology-fig2_fullsize.jpg

Solar cell efficiency enhancement



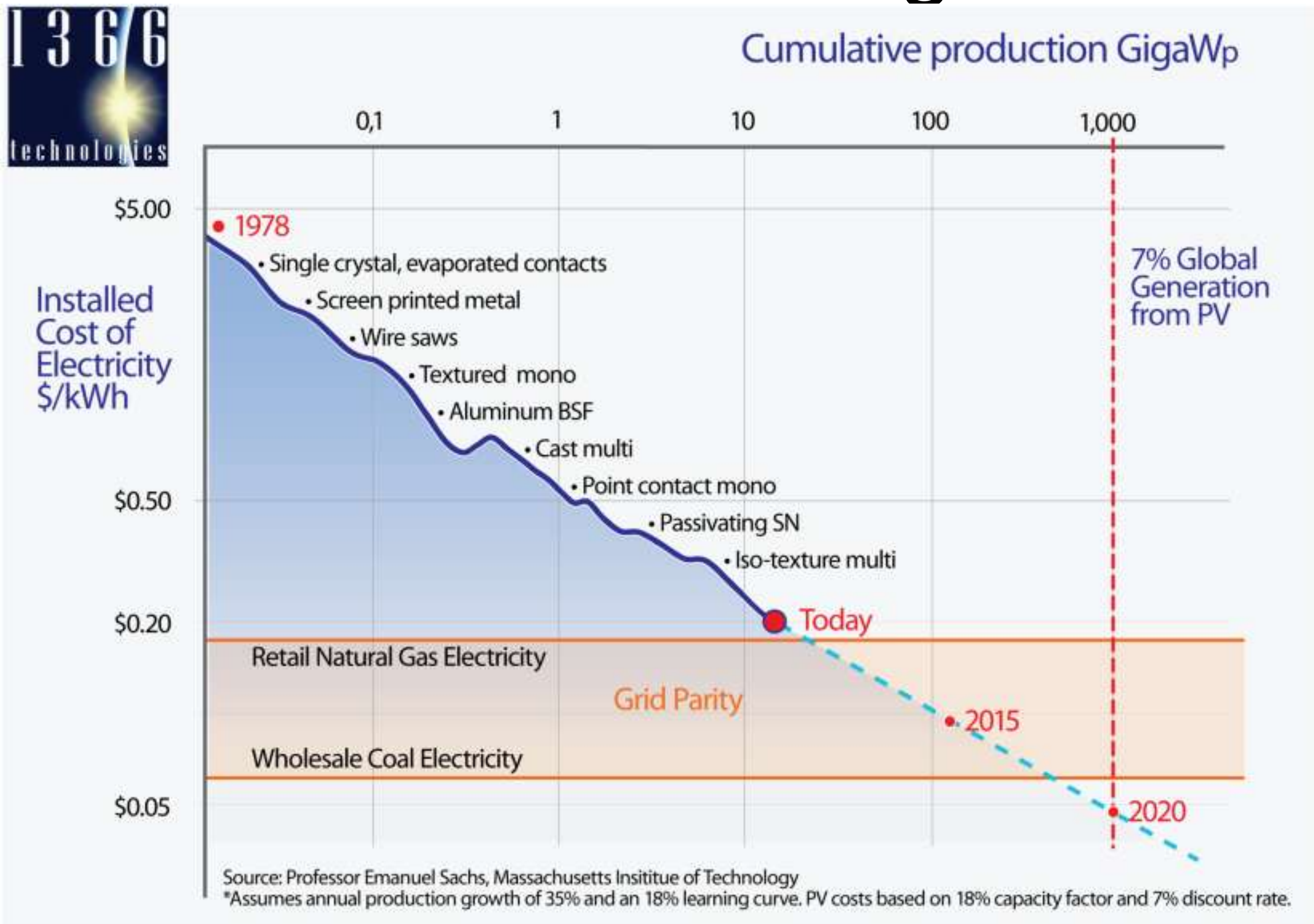
http://pglab.nolda.co.kr/research/field_02_e.php

Efficiency/cost



http://greenecon.net/research-at-caltech-may-provide-clues-to-improving-solar-cell-efficiency/energy_economics.html

Solar on the grid



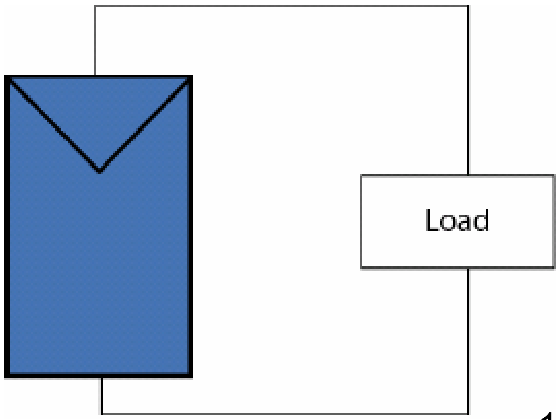
http://www.renewableenergyworld.com/rea/news/article/2010/08/test10

Factors to be considered-1

System configurations

Direct coupled DC system:

- Simplest type of system.
- Low cost, due fewer additional components required.
- Reliability can be very high.
- Ability to use direct coupled system depends on:
  - Match between load and solar resource or ability to tolerate low availability
  - Tolerance of load to range of input voltage and currents.
  - Load must have DC as input
- Examples: some home power systems, direct drive application including water pumping and ventilation systems.



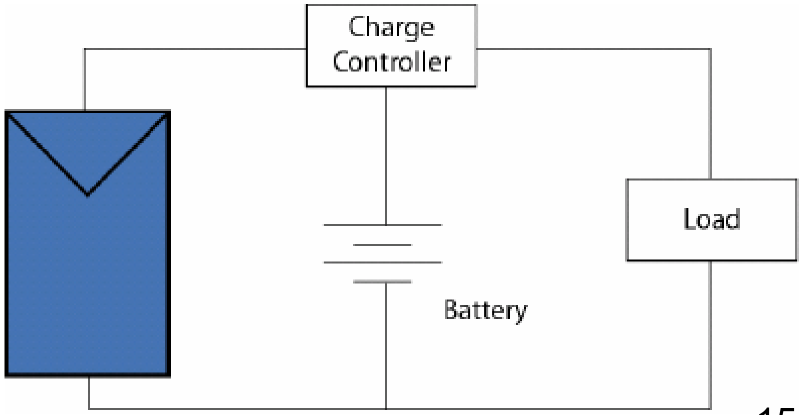
Source: http://www.eecis.udel.edu/~honsberg/Eleg620/06-PV_systems%2008.pdf

Factors to be considered-2

System configurations

DC Photovoltaic System:

- Traditionally most common type of system, still extensively used in smaller systems or specific purpose systems.
- Requires all DC appliances, but efficiency of DC appliances may be higher than that of conventional appliances.
- Requires different wiring, connector, fuses, and built to different set of standard.
- In most cases, charge controller (which may be parallel or series) as well as battery included. Use of a power point tracker depends on load and system.
- High voltage DC connections and wiring requires caution.
- Examples: specific use industrial systems, small home power systems.

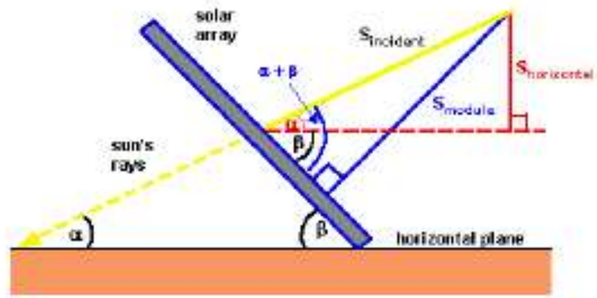


Source:
http://www.eecis.udel.edu/~honsberg/Eleg620/06-PV_systems%2008.pdf

Factors to be considered-3

Losses in the system compared to generated.

- Losses in system:
  - Losses in incident radiation due to optical losses and angular losses.

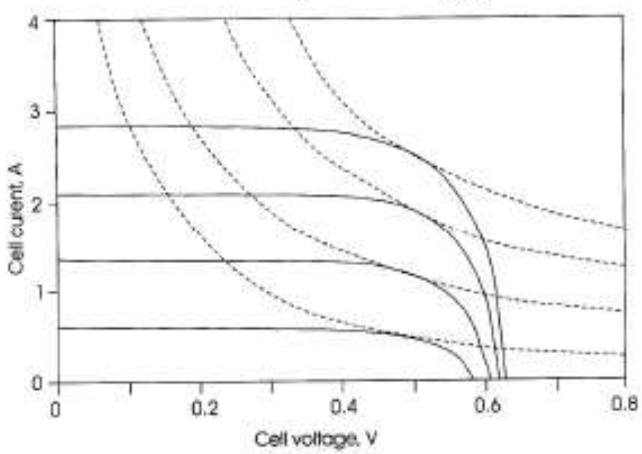


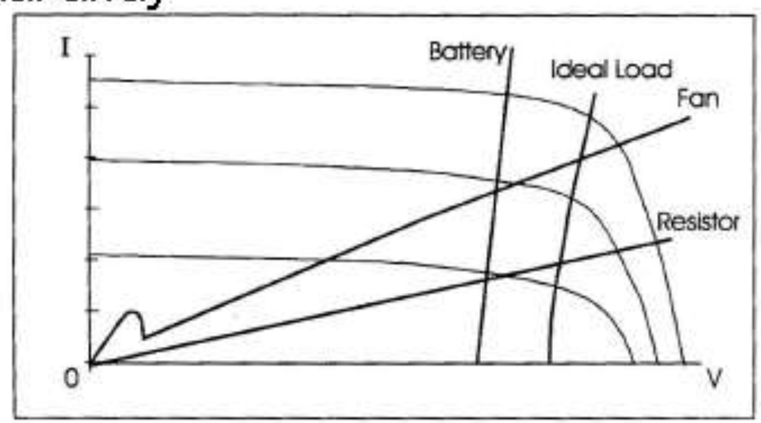
$$S_{horizontal} = S_{incident}\sin(\alpha)$$

$$S_{module} = \frac{S_{horizontal}\sin(\alpha+\beta)}{\sin(\alpha)}$$

$$S_{module} = S_{incident}\sin(\alpha+\beta)$$

- Losses due to operating point of solar array





Source: http://www.eecis.udel.edu/~honsberg/Eleg620/06-PV_systems%2008.pdf

Factors to be considered-4

No battery sizing or tilt angle calculations and just calculate rough estimate of array size.

1. Calculate average load, L in Watts, or the total daily load, D, in Wh

- For a continuous running load, the load is the average load.
- Calculate D from appliances ratings or by comparing to similar situations, and then L = D/24

2. Calculate average power need from array.

- Average load is used for 24 hrs
- Increase load to account for electrical losses in inverter, batteries, power controller, wiring losses, etc.

$$\text{Power needed (Wh)} = \frac{24\text{L (Wh)}}{\eta_{batt}\,\eta_{inverter}\,\eta_{other}}$$

$$\eta_{batt} \approx 0.85,\ \eta_{inverter} \approx 0.9,\ \eta_{other} \approx 0.95$$

Source: http://www.eecis.udel.edu/~honsberg/Eleg620/06-PV_systems%2008.pdf

Solar Power for Amateur Radio-1

http://www.ctsolar.com/solarpowerforamateurradiofaq.aspx

Powering radio communications equipment using solar energy.

1. Are there any special considerations when using amateur radio gear on solar power?

- Yes, there are some issues. Many solar charger controllers actually will generate RF noise when charging. This is most common with pulse width modulated (microprocessor controlled) charge controllers. Sometimes this can be controlled with wire shielding and/or good grounding/DC filtering. RF noise output may vary depending upon battery state of charge (usually less when batteries are near full, depending upon the charger PWM protocol).

2. What are the advantages of solar power for radio communications?

- Solar power is ideal for radio communications as the DC power does not introduce line noise or 60 cycle hum. Isolation from the grid (in most installations) also will assure relative immunity from grid power surges. Using solar energy as a power source actually fulfills a prime mission of amateur radio: reliable emergency communications. Solar powered communications will function when everything else is off-line. Solar power can also keep a standby battery bank constantly topped-off and ready to use in the event of a power failure. UPS inverters are also available that switch power over to solar power upon a quarter-cycle failure of the 120 VAC grid.

Power supply design: Pulse Width Modulation (PWM)

Solar Power for Amateur Radio-2

http://www.ctsolar.com/solarpowerforamateurradiofaq.aspx

Powering radio communications equipment using solar energy.

3. What kind of solar panels will be necessary for backpacking, handheld and QRP radios?

- A CTSolar 10.4W Backpack solar panel is ideal for this purpose. You will get 750 mA in full sun. Use a charge controller and a small 8 AH (amp-hour) or so sealed lead acid battery. Using this setup you're good for many hours of operation. You can also charge consumer electronic devices as well. CTSolar produces just such a powerpack that will run your amateur radio as well as consumer electronics needs. This unit features low-voltage disconnect to protect your battery as well as state-of-charge indicators to help you judge battery capacity. We also market a 3A lithium battery pack in 6AH and 12AH capacity. This unit is incredibly lightweight and versitile.

4. What kind of installation will I need to power my home amateur radio station using solar power?

- This certainly depends upon the loads you intend to support. Most radio communications needs are used for a limited timeframe daily and the duty cycle (time in transmit) is usually low. Therefore a solar installation with around 200W of panels and 300 to 500 Amp-hours of battery capacity will usually be sufficient (your mileage may vary).

5. Are there any other issues to consider?

- Yes, we recommend using Anderson Powerpole connectors for portable operations with the connector installation meeting the ARES standard Anderson setup. In the case of fixed stations, we recommend installing the solar power equipment according to code(UL listed inverter, conduit, load centers, grounding, fusing, load disconnects, wiring, etc; all according to the National Electric Code or NEC).

Solar Power for Amateur Radio-3

http://www.ctsolar.com/solarpowerforamateurradiofaq.aspx

Powering radio communications equipment using solar energy.

6. Do you have any products suited to portable or manpack operation?

- Yes, we sell durable lightweight folding panels housed in a zipper rip-stop nylon case. These backpack panels fold into compact sizes and thickness less than an inch. Available in 10.4W, 15.6W, 20.8W and 32W sizes. Our laminate construction makes these panels very sturdy without many of the problems with glass laminated modules. Drop this panel into your backpack and you're good to go. Our backpack panels also feature grommets in their corners to permit temporary mounting to trees or even a backpack so the panel will charge or provide power while on the move.

7. How about remote base or repeater operations?

- We can set you up with the right panel sizing as well as the charge controller, metering and advice on setting your system up for long reliable service. The average amateur or commercial remote base will do fine with between 100 and 300 watts of panels and around 200 to 400AH of batteries. Actual sizing depends upon the duty cycle of use and load sizing. Any remote base needs low voltage disconnect and temperature compensation at a minimum. Good grounding and lightning suppression is also important. We manufacture turnkey aluminum mounts for panel capacities of 36W, 72W, 108W, 144W, 216W and larger side of pole or top of pole mounts. We also manufacture building roof mounts. The panels we use are ruggedized (no glass). We can also provide custom antenna mounting brackets on top of the solar mounts and a platform beneath the panels for a large 32X32X32 inch Pelican Case for the solar power and repeater components. Larger components can be housed in a ventilated aluminum enclosure.

8. How do I power my Elecraft K1 or K2 using solar power?

- Most who use the K1 or K2 with solar power install a power jack on the unused Xverter hole in the back panel. Run a fused red lead to the positive internal battery lead and run the ground/black lead to the battery negative. Attach a charge controller (SunGuard4 available from CTSolar is ideal here) to this direct battery jack. Never attach a solar panel to the power input to the standard power input jack as this will likely harm the unit's charging circuit which (unlike solar charge controllers) is not set up for the full sun voltages generated by solar panels.

Solar Power for Amateur Radio-4

http://www.ctsolar.com/solarpowerforamateurradiofaq.aspx

Powering radio communications equipment using solar energy.

9. Can I run a larger amateur radio Field Day station using solar power?

- Yes. We also sell 20.8W and 32 watt Nylon enclosed folding solar panels which can charge marine deep cycle batteries. Monitoring battery voltage will tell you how fully charged your battery is or is not (0% charge around 11.5V and 100% charge around 13.4 volts depending upon temperature). Our aluminum-framed ruggedized solar panels are also ideal for this application and come complete with a tripod mount. Rapidly deployed and conveniently stored.

10. What's the best option for backpackers?

- The Nor-Cal (www.redhotradio.com) QRP radios are well suited for backpack operation as they are lightweight and consume very little power. Using a 10 watt Expedition panel and a 2 or 4 Amp-Hour battery and the SunGuard4 controller will be lightweight and will permit operation for many hours daily. The SunGuard4 is lightweigh and is a full-function controller. The entire setup will weigh less than 5 pounds depending upon the size of battery you choose. We also market a solar charged lithium battery pack. 3A charge current and 3A load with low voltage disconnect and LED voltage status display. 6AH and 12AH versions available.

11. Do you manufacture ARES command trailers:

- Yes, CTSolar custom manufactures full-sized and smaller solar powered trailers. From 500W to 5KW of panel capacity. A full battery bank and state-of-the-art charging system and inverters. Light bars and optional propane backup generators also available. We can also solarize trailers for built-in communications command post functions. Internal lighting and DC as well as AC outlets also provided. Call us for details.

Solar Power for Amateur Radio-5

http://www.ctsolar.com/solarpowerforamateurradiofaq.aspx

Powering radio communications equipment using solar energy.

12. Can I install a solar power system myself?

- Yes. CTSolar can sell you all the correct components and ship them to you. You then just install and wire/test the system yourself. We can assist you in assuring that you have the correct panel and battery bank capacities. You also will need to be sure that your system is installed according to code and you should have a licensed electrician sign off on the installation prior to completion.

13. How do I size a system for my 100W radio?

- A 100W radio will theoretically draw about 7.5A at 13.2VDC (most small systems have a battery float voltage of 13.2). You will likely only draw 7.5A a fraction of every hour. Most amateur radio equipment is operated 3 to 4 hours a day and during each hour about 1 out of every 3 minutes in transmit.
- So, you need to calculate how many amp-hours you intend to draw per day. Let's say you will run 4 hours a day. Let's say you will transmit 1 minute of every 3 minutes while operating on average (this is referred to as duty cycle). Your transmitter will draw about 7.5A in transmit and let's assume 1A in receive. This is typical for many amateur radio transceivers.
- So out of 4 hours, that's 240 minutes; we'll see 25% transmit (1 minute transmit out of every 4 minutes total) and 75% rcv. That's 60 total minutes (1 hour) transmit and 3 hours receive.
- So this is 1 hour drawing 7.5A or 7.5AH total at 13.2VDC for transmit and it's 3 hours drawing 1A or 3AH total at 13.2VDC for receive. Add transmit and rcv time together and you have 10.5AH total.

Solar Power for Amateur Radio-6

http://www.ctsolar.com/solarpowerforamateurradiofaq.aspx

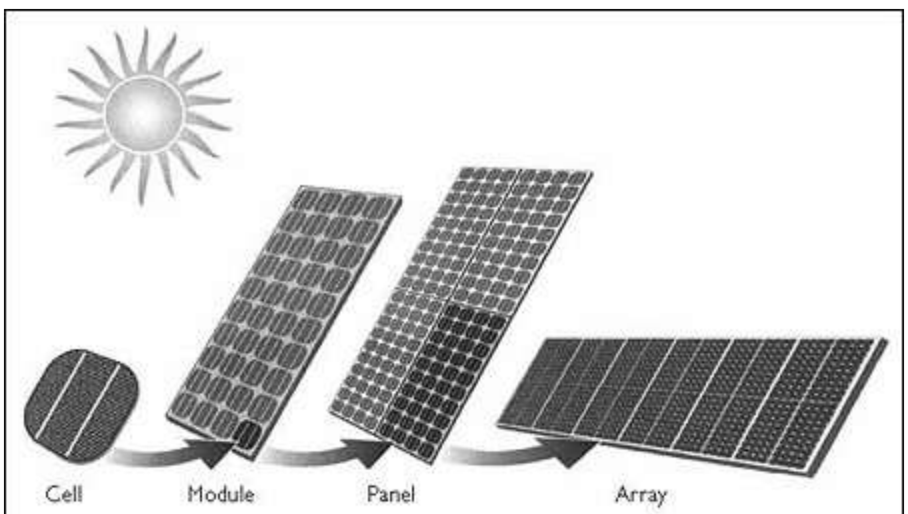
Powering radio communications equipment using solar energy.

Putting this all together:

- 1. You need to put 10.5AH back into your system every day given that you will run every day.
- 2. You have 6 hours of full (peak) sun every day in most areas of the US.
- 3. So this is 10.5AH divided by 6 hours or 1.75A of solar panel output every day to put your used AH back into your battery bank.
- 4. Generally we recommend 3 times you daily AH of energy use as your battery backup bank capacity. This is a deep cycle battery bank (car batteries can't be deep cycled). So this means in your case you want at least 3 X 10.5AH which is about 30AH. 50AH is a common battery size and that would work fine for you.
- 5. You will need a charge controller in addition. You will also need fusing on the battery lead and a lightning arrestor on the panels along with a good earth ground.

Evolution of the intent-1

- Capable of operating a few transceivers over a field day weekend
- Proposed simple “A frame” supports to install the panels facing south next to the trailer



http://www.cmhc-schl.gc.ca/en/co/grho/grho_009.cfm Terminology for larger systems: see NRCan and CMHC

Evolution of the intent-2

Issues with transportable modules/panels using A frame supports:

- Requires time and manpower to deployed
- Needs continuous protection especially at night

Evolution of the intent-3

- Michel proposed to minimize risk by having the PV modules/panels permanently installed on the roof of the OVMRC trailer.
- Darin suggested to use the 12 V DC bus to power the lighting using 12 V led light fixtures (no inverter power loss).
- Brian suggested to use a DC to DC up converter to maximise TX power output.
  (**12 volt to 13.8 volt DC/DC Converters (Regulators)**): 700 Watts (1 to 5 minutes), 20 Amps continuous, less than 200$ http://www.powerstream.com/dc2.htm

Selected method

Find battery size.

•Estimate number of days of autonomy from statistical analysis of radiation data, existing systems, etc.

•Make an educated guess for the type of battery to be used

•Determine depth of discharge (DOD) for battery from manufacturers data sheets of estimate from type of battery.

•Determine battery capacity in Ah

•The load in the following equation is the “corrected” load which takes into account battery, inverter inefficiencies

$$\text{Battery Capacity (Ah)} = \frac{\text{Load (Ah)} \times \text{Days Autonomy}}{\text{DOD}}$$

Source: http://www.eecis.udel.edu/~honsberg/Eleg620/06-PV_systems%2008.pdf

Example of load: Yaesu FT-857

- At 13.8 V
  - Standby: 0.5 A
  - Receive: 1 A
  - Tx HF (100 W) : Max 22 A
- At 12.3 V (89%) my linear estimates are:
  - Standby: 0.4 A
  - Receive: 0.9 A
  - Tx HF (100 W) : Max 19.6 A

Current consumption-1

Current Consumption:	Squelched: 550 mA (Approx.)
	Receive: 1 A
	Transmit: 22 A
Case Size (W x H x D):	6.1” x 2.0” x 9.2” (155 x 52 x 233 mm)
Weight (Approx.):	4.6 lb. (2.1 kg)

Transmitter

RF Power Output:		SSB/CW/FM	AM Carrier
(@13.8 V DC)	160- 6 M:	100 W	25 W
	2 M:	50 W	12.5 W
	70 CM:	20 W	5 W

Current consumption-2

From ARRL discussion:

“I don't see this rated, either, so I made a few quick measurements (not using lab equipment, just the ammeter on my Astron power supply, which might be +/- 10% or so):”

At 14.1 MHz:
RX volume down = 1A
TX 5W = 4A
TX 10W = 5A
TX 25W = 8A
TX 50W = 14A
TX 100W = 21A

WB2WIK/6
https://www.eham.net/ehamforum/smf/index.php?topic=67668.0

Ampere hour required

Calculate load for each month of the year in Ah.
- The voltage used in these calculations must be the same as the system voltage
- Increase load by dividing by battery, inverter, power conditioning efficiency.

OVMRC has intermittent uses that last a day or two. So far for summer activities when more insolation is available for horizontally mounted PV panels.

Load: 2 Tx at 20 A at 50% duty cycle during 6 hours + one Tx at 20 A at 30% duty cycle for 24 hours: total per day 204 Ah. Two days 408 Ah.

One of the challenges is the persistent requirement for sufficient charging of the batteries during winter to avoid their freezing: Winter capacity of PV system.

Using the selected method

Using this approach one can estimate the Ah required.

$$\text{Battery Capacity (Ah)} = \frac{\text{Load (Ah)} \times \text{Days Autonomy}}{\text{DOD}}$$

Depth of Discharge	Starter Battery	Deep-cycle Battery
100%	12–15 cycles	150–200 cycles
50%	100–120 cycles	400–500 cycles
30%	130–150 cycles	1,000 and more cycles

http://batteryuniversity.com/learn/article/lead_based_batteries

State of Charge	12 Volt battery	Volts per Cell
100%	12.7	2.12
90%	12.5	2.08
80%	12.42	2.07
70%	12.32	2.05
60%	12.20	2.03
50%	12.06	2.01
40%	11.9	1.98
30%	11.75	1.96
20%	11.58	1.93
10%	***11.31***	***1.89***
0	***10.5***	***1.75***

For a battery capacity (Ah) of 720 Ah with a load of 204 Ah assuming no contributions from the solar panels on a heavy rain day, so a DOD of 28%. Two days of heavy rain no sun at all, 408 Ah and a DOD of 56%.

Source: http://www.eecis.udel.edu/~honsberg/Eleg620/06-PV_systems%2008.pdf

PV capacity factor-1

The capacity factor is the ratio of the electrical energy generated,
for the period of time considered,
to the energy that could have been generated at continuous full-power operation during the same period.

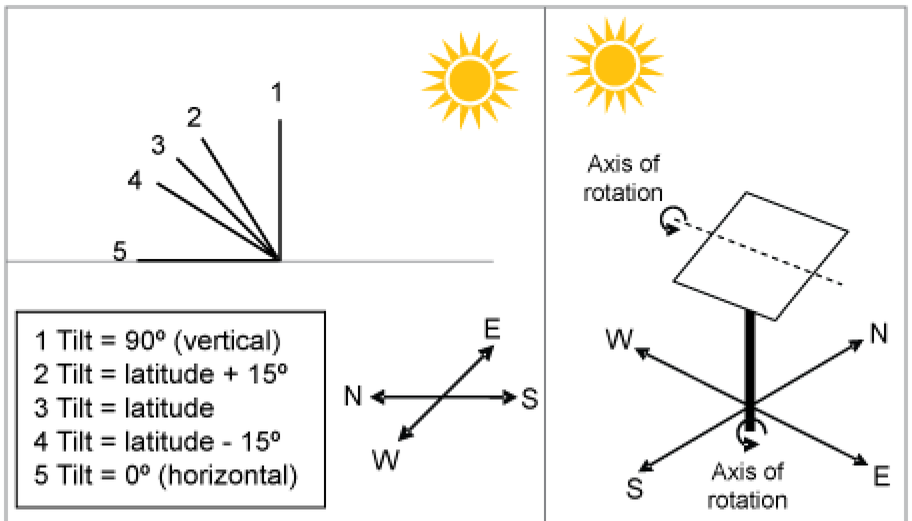
PV capacity factor-2

Solar PV Generator Examples: Nameplate Capacity of 1 kW

- 1 kW x 8760 hours/year x 15% capacity factor =
1,300 kWh/year or 110 kWh/month on average:
1,300 kWh/kW
- A 15% average annual capacity factor is used here for illustrative purposes only. Any specific solar PV system will have a higher or lower capacity factor based on the system type, its physical location, variability in the local weather, and other factors.
- Ottawa average yearly PV potential (for South-facing PV panels with latitude tilt, 45.4214° N) : 1198 kWh/kW
so the capacity factor for Ottawa is about 13.68%
- Cairo, Egypt: 1635 kWh/kW or 18.66% on a yearly average

Using NRL calculator-1

Note that the average capacity factor for PV in Ottawa is 13.68%
South-facing PV panels with latitude tilt, 45.42N.



South-facing PV panels with different tilts | 2-axis tracking PV panels

http://pv.nrcan.gc.ca/

Station Identification	
City:	Ottawa
Country/Province:	ON
Latitude:	45.32° N
Longitude:	75.67° W
Elevation:	116 m
Weather Data:	CWEC
PV System Specifications	
DC Rating:	0.72 kW
DC to AC Derate Factor:	0.950
AC Rating:	0.68 kW
Array Type:	Fixed Tilt
Array Tilt:	0.0°
Array Azimuth:	180.0°
Energy Specifications	
Energy Cost:	0.0862 dollars CAN/kWh

http://rredc.nrel.gov/solar/calculators/pvwatts/version1/International/pvwattsv1_intl.cgi

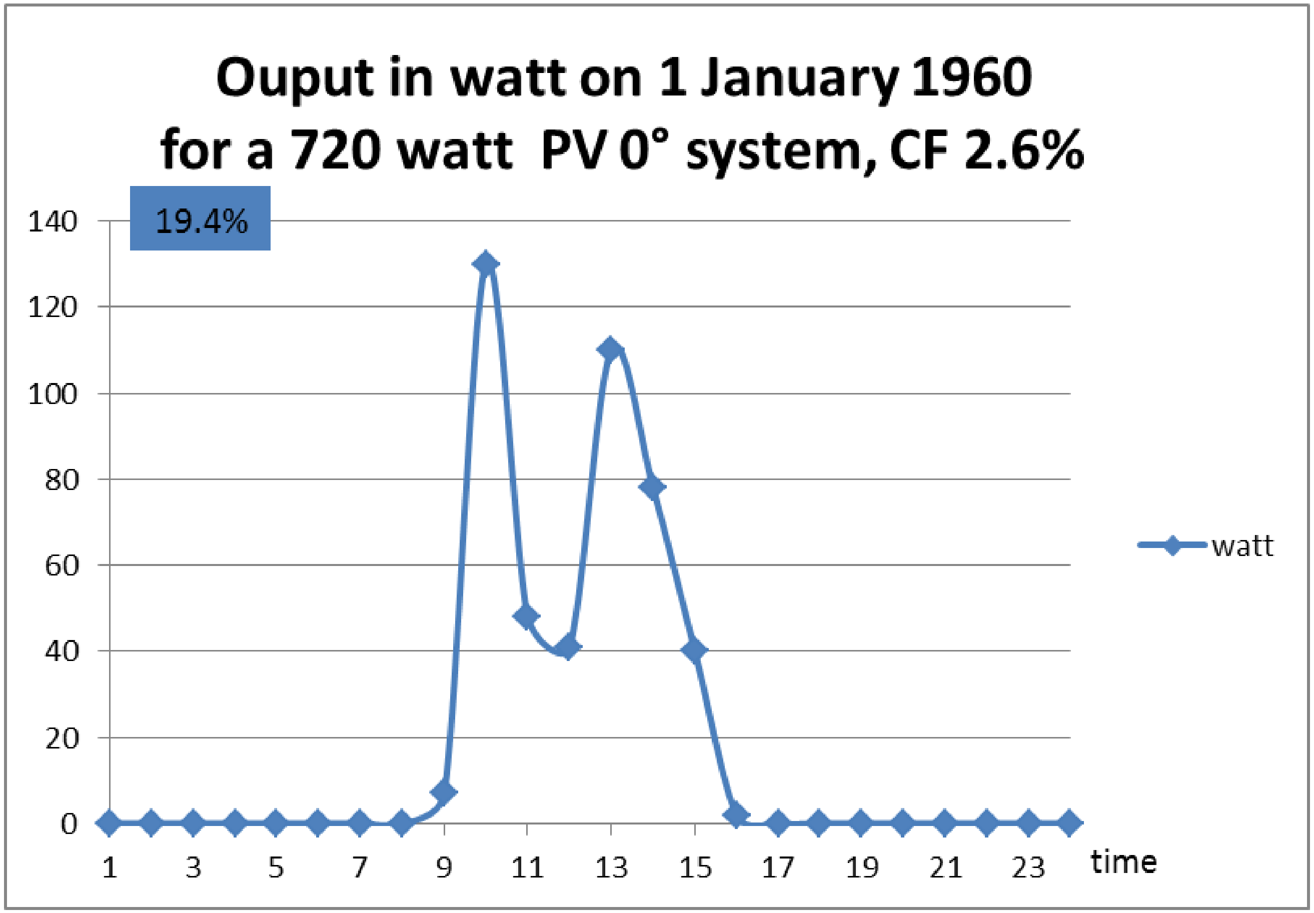
Using NRL calculator-2

DC rating of VE3RAM panel 0.72 kW will deliver about 860 kWh/kW which is 1194 kWh/kW for one kW. The NRCan value is 1198 kWh/kW

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value (dollars CAN)
1	1.49	29	2.50
2	2.69	52	4.48
3	3.91	85	7.33
4	4.65	93	8.02
5	5.49	111	9.57
6	6.09	115	9.91
7	6.04	116	10.00
8	4.84	92	7.93
9	3.75	71	6.12
10	2.39	47	4.05
11	1.33	23	1.98
12	1.30	25	2.15
Year	3.67	860	74.13

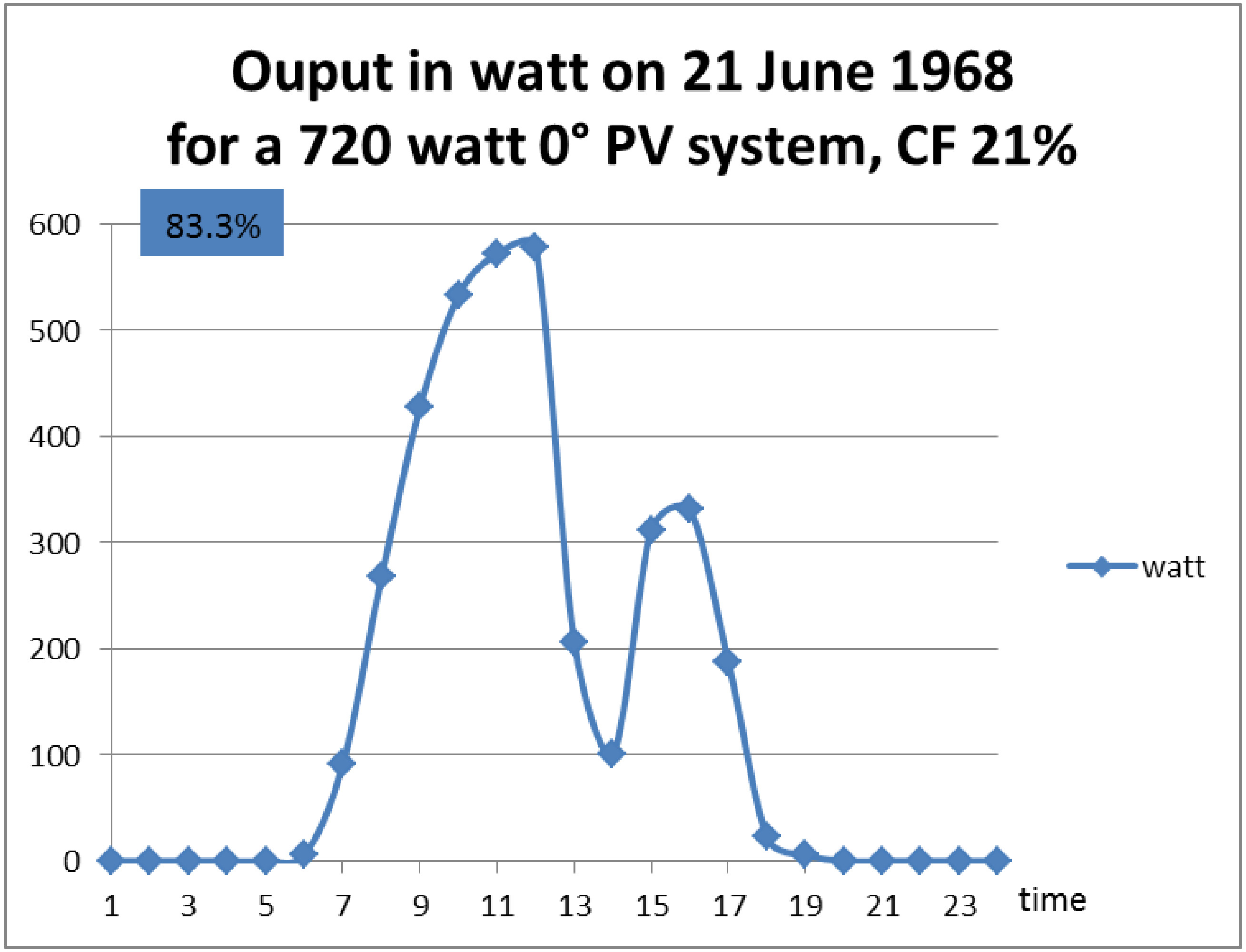
OVMRC case study using NRL calculator-3

456 Wh/24h
19 W
CF: 0.0264

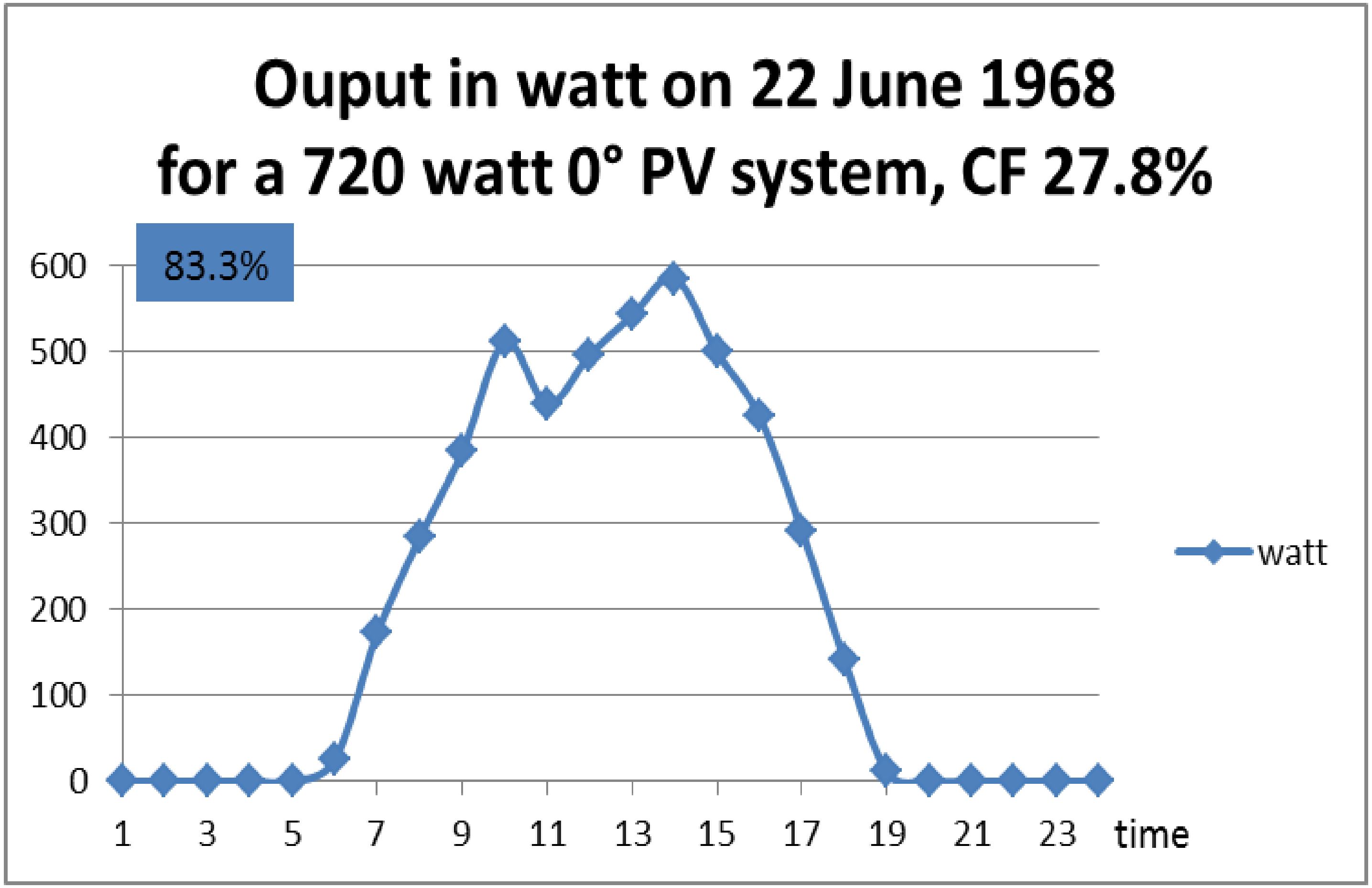


OVMRC case study using NRL calculator-4

3644 Wh/24h
151.83 W
CF: 0.211

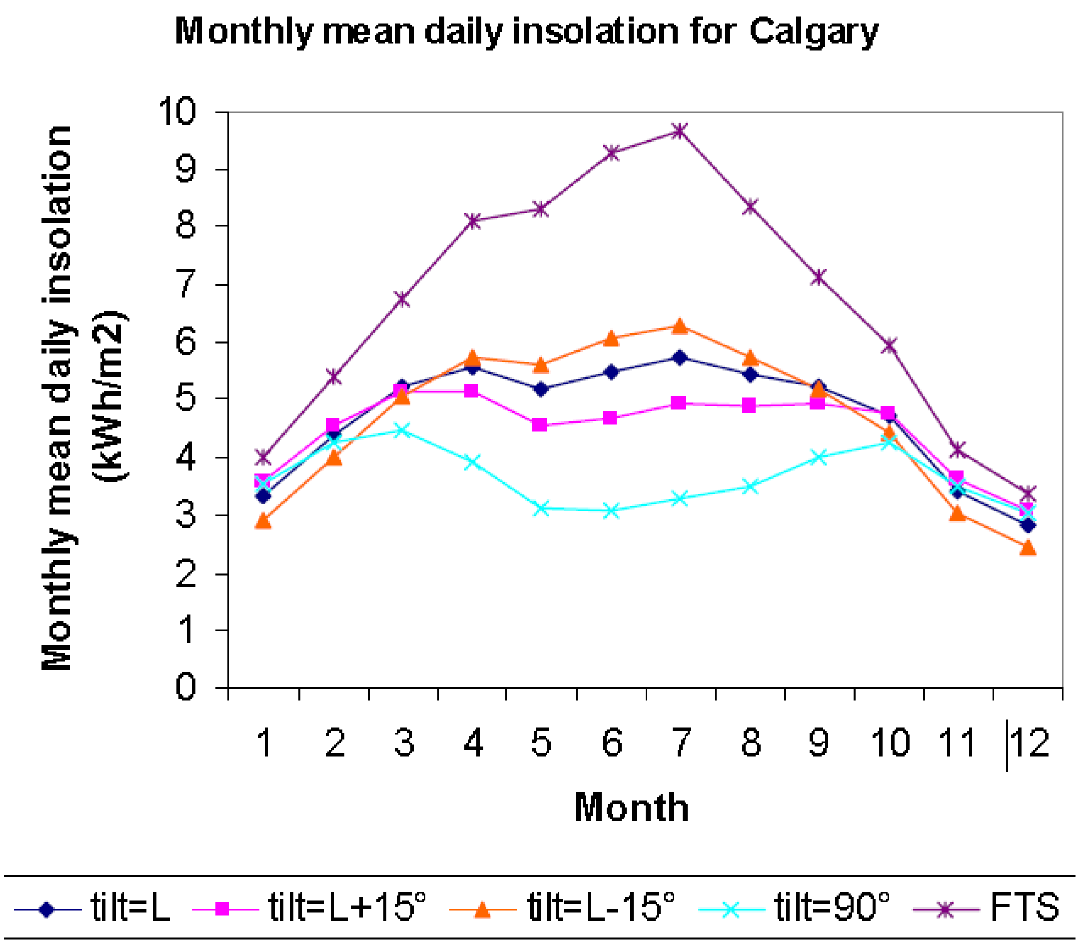


OVMRC case study using NRL calculator-5



4806 Wh/24h
200.25 W
CF: 0.278

NRCan-CANMET data + refs



sun-tracking surface: FTS (follow the sun)
Calgary latitude: 51.0500° N

http://sesci.ca/sites/default/files/pdfs/M06_W1B_3.pdf

Pelland, S., McKenney, D.W., Poissant, Y., Morris, R., Lawrence, K., Campbell, K. and Papadopol, P. (2006), The development of photovoltaic resource maps for Canada, In *Proceedings of Proc. 31st Annual Conference of the Solar Energy Society of Canada (SESCI). Aug*.

NRCan-CANMET data

Photovoltaic (PV) potential (kWh/kW) and mean daily global insolation (MJ/m2 and kWh/m2) data are presented below for the selected municipality. Data is presented for each month and on a yearly basis for different PV array orientations.

Ottawa, Ontario
Geographic location -> -75.70E,45.42N

PV potential (kWh/kW)

	South-facing vertical (tilt=90°)	South-facing, tilt=latitude	South-facing, tilt=latitude+15°	South-facing, tilt=latitude-15°
January	83	79	84	69
February	95	98	102	89
March	103	125	123	120
April	74	115	106	119
May	64	119	104	128
June	58	117	100	129
July	63	124	107	136
August	70	119	107	125
September	70	99	94	99
October	72	84	84	80
November	55	57	60	52
December	65	62	66	54
Annual	872	1198	1137	1198

Mean daily global insolation (kWh/m^2)

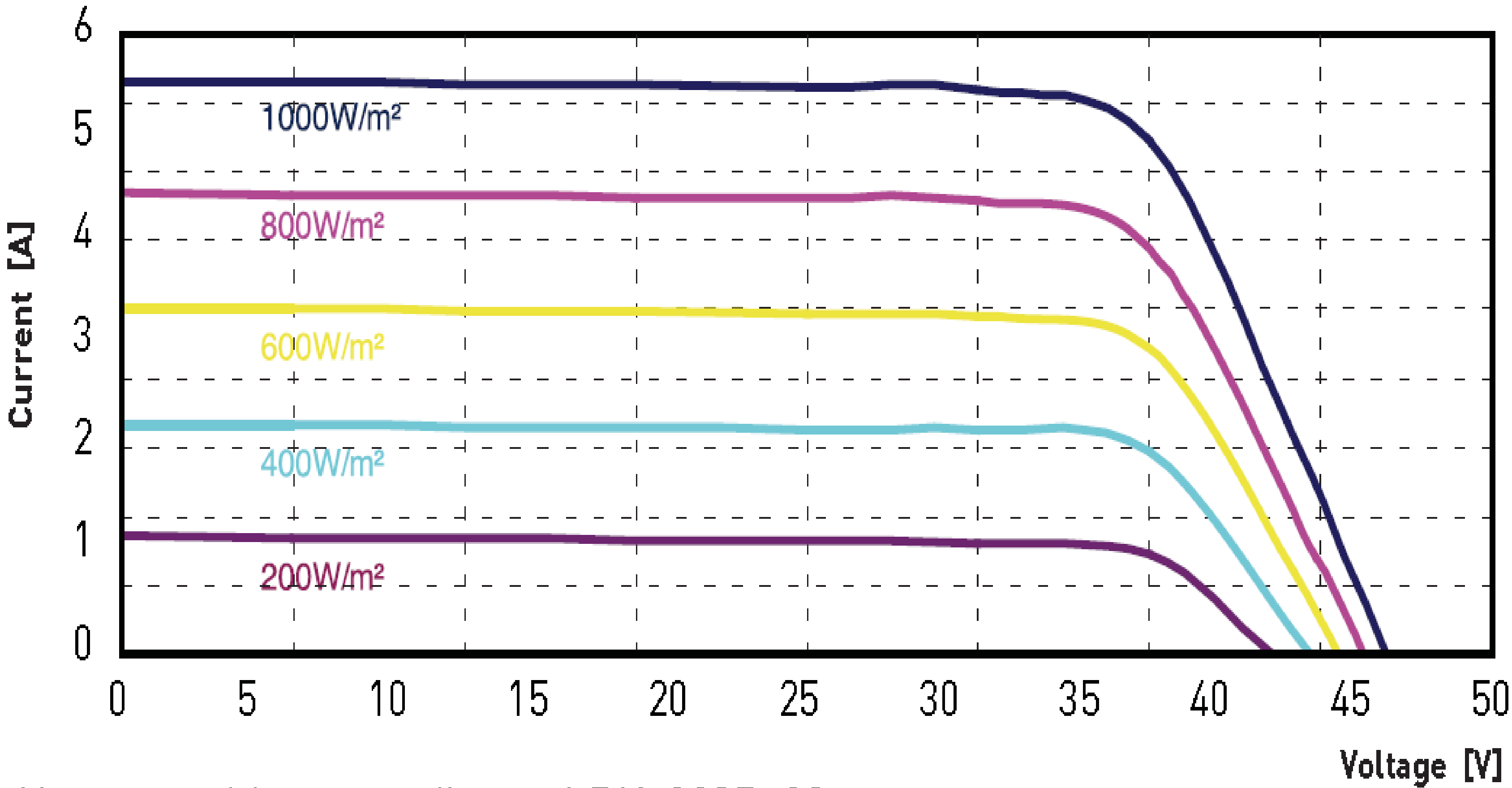
	South-facing vertical (tilt=90°)	South-facing, tilt=latitude	South-facing, tilt=latitude+15°	South-facing, tilt=latitude-15°	Two-axis sun-tracking	Horizontal (tilt=0°)
January	3.6	3.4	3.6	3.0	4.2	1.5
February	4.5	4.7	4.9	4.2	5.8	2.5
March	4.4	5.4	5.3	5.2	6.9	3.7
April	3.3	5.1	4.7	5.3	7.2	4.6
May	2.8	5.1	4.5	5.5	7.8	5.4
June	2.6	5.2	4.5	5.7	8.3	5.9
July	2.7	5.4	4.6	5.9	8.5	5.9
August	3.0	5.1	4.6	5.4	7.5	5.0
September	3.1	4.4	4.2	4.4	5.9	3.7
October	3.1	3.6	3.6	3.4	4.5	2.3
November	2.5	2.5	2.7	2.3	3.0	1.3
December	2.8	2.7	2.9	2.3	3.2	1.1
Annual	3.2	4.4	4.2	4.4	6.1	3.6

http://pv.nrcan.gc.ca/index.php?n=1408&m=u&lang=e

https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&ved=0CFgQFjAD&url=http%3A%2F%2Fcanmetenergy.nrcan.gc.ca%2Ffichier%2F80674%2F&ei=kixgUumYG8qO2wX4rIHoCQ&usg=AFQjCNGwUhgFT1I12AXGpGGtrCiBd7S3UQ&sig2=V7U62ok6ARzYPPPf5o6BfQ

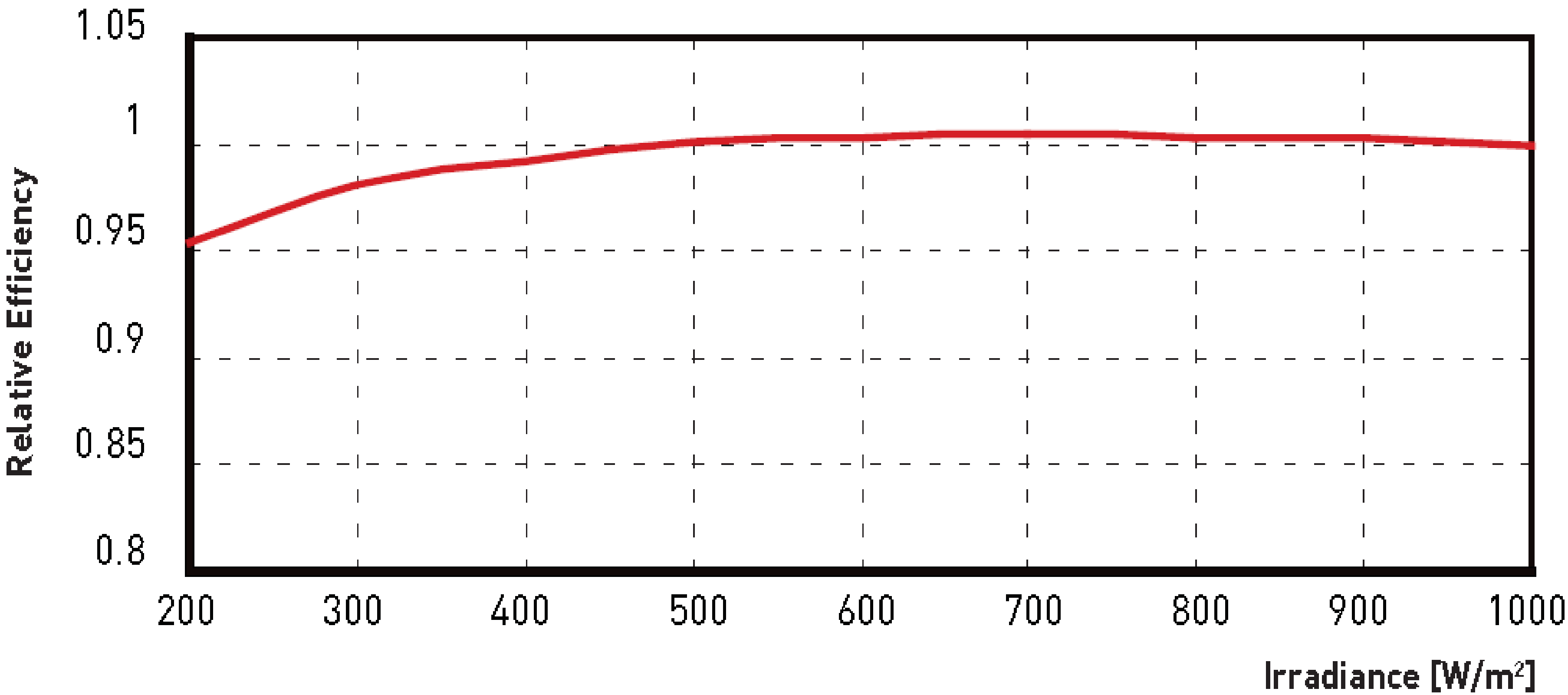
PV specifications-1

I-V curve at different irradiance levels



Above graphics according to LDK-220D-20

PV specifications-2



The typical relative change in module efficiency at an irradiance of 200W/m² in relation to 1000W/m² (both at 25°C and AM 1.5 spectrum) is less than 6%

PV specifications-3

VE3RAM
240D X 3

ELECTRIC CHARACTERISTICS (STC*)

TYPE	200D-20	205D-20	210D-20	215D-20	220D-20	225D-20	230D-20	235D-20	240D-20	245D-20	250D-20
Nominal Output (Pmax) [W]	200	205	210	215	220	225	230	235	240	245	250
Voltage at Pmax (Vmp) [V]	29.5	29.7	29.9	30.6	31.2	31.5	31.8	32.0	32.2	32.4	32.6
Current at Pmax (Imp) [A]	6.78	6.91	7.02	7.03	7.05	7.15	7.23	7.35	7.45	7.56	7.67
Open Circuit Voltage (Voc) [V]	36.1	36.4	36.6	36.7	36.9	37.0	37.2	37.2	37.3	37.4	37.5
Short Circuit Current (Isc)	7.68	7.73	7.78	7.90	8.01	8.11	8.21	8.30	8.39	8.48	8.57
The power tolerance is +/- 3% referred to the Nominal Output											
Maximum System Voltage	IEC: 1000V / UL: 600 V										
Cell Efficiency	14.37	14.74	15.09	15.46	15.81	16.18	16.56	16.90	17.25	17.51	17.93
Module Efficiency	12.25	12.56	12.87	13.17	13.48	13.79	14.09	14.40	14.70	15.01	15.32

STC* (Standard Test Conditions): Irradiance 1000W/m², Module Temperature 25°C, Air Mass 1.5

PV specifications-4

VE3RAM
240D X 3

ELECTRICAL PERFORMANCE AT NOCT

TYPE	200D-20	205D-20	210D-20	215D-20	220D-20	225D-20	230D-20	235D-20	240D-20
Nominal Output (Pmax)	145	149	152	156	159	163	167	170	174
Voltage at Pmax (Vmp)	25.3	25.8	26.1	26.3	26.5	26.8	27.1	27.3	27.7
Current at Pmax (Imp)	5.74	5.78	5.84	5.93	6.01	6.09	6.16	6.23	6.28
Open Circuit Voltage (Voc)	33.2	33.5	33.7	33.8	34.0	34.1	34.3	34.3	34.3
Short Circuit Current (Isc)	6.22	6.26	6.30	6.40	6.48	6.57	6.65	6.72	6.79

NOCT: Irradiance 800 W/m², Module Temperature 45± 2°C, Air Mass 1.5

TEMPERATURE CHARACTERISTICS

TYPE	LDK-D-20 Series
NOCT**	45±2°C
Temperature Coefficient of Pmax	-0.47% / °C
Temperature Coefficient of Voc	-0.34% / °C
Temperature Coefficient of Isc	0.06% / °C
Maximum Series Fuse Rating	20 A
Operating Temperature	-40 to +85°C
Storage Temperature	-40 to +60°C

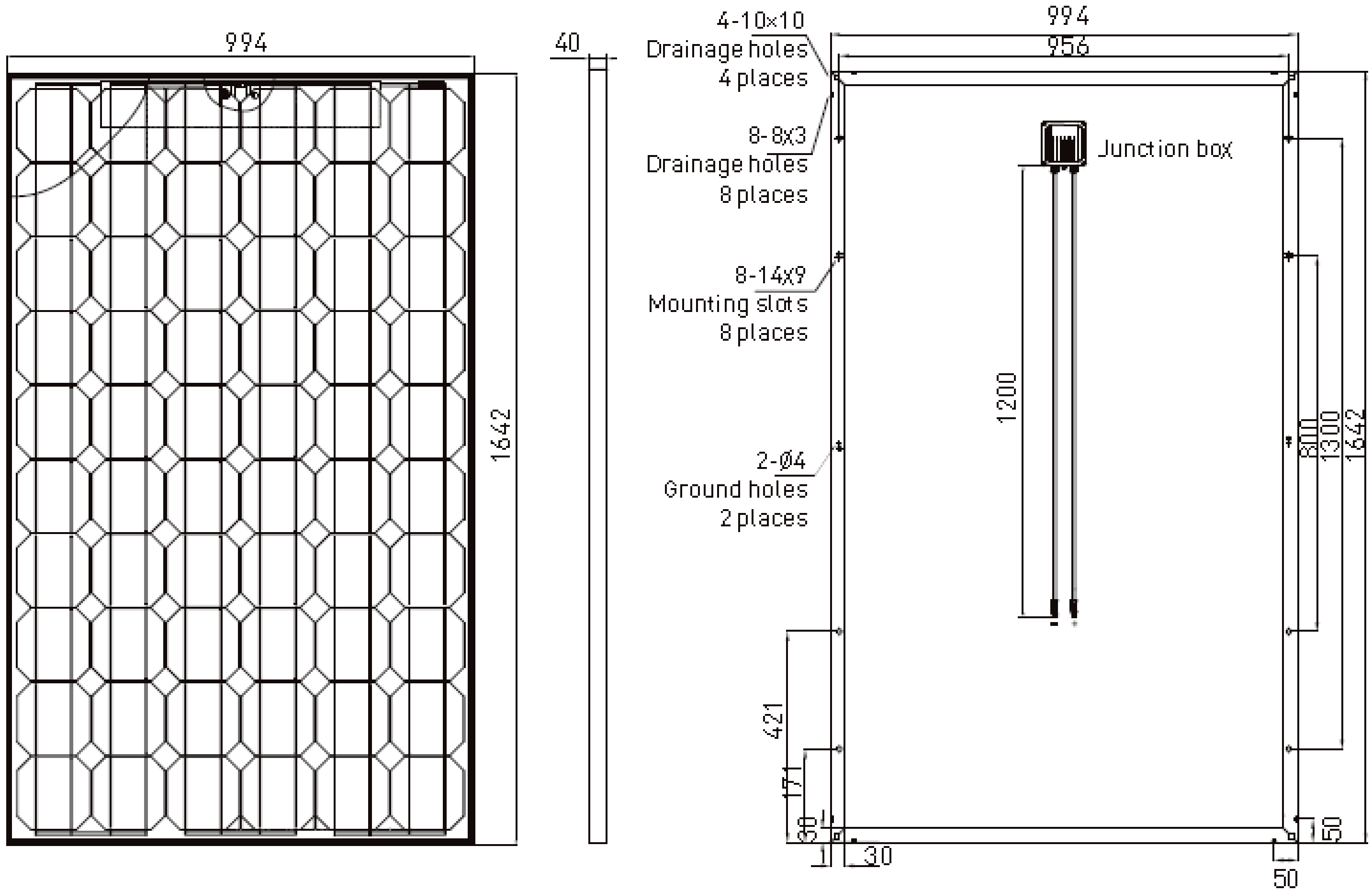
NOCT**: Nominal Operation Cell Temperature Sun 800 W/m²; Air 20°C; wind speed 1m/s

PV specifications-5

MECHANICAL CHARACTERISTICS

TYPE	LDK-D-20 Series
Solar Cells	60 (6x10) monocrystalline silicon solar cells 156 x 156 mm
Front Cover	3.2 mm thick, tempered glass / AR coating glass
Back Cover	TPT (Tedlar-PET-Tedlar) / BBF
Encapsulant	EVA (ethylene vinyl acetate)
Frame	Anodized aluminium alloy, double wall
Diodes	6 Bypass diodes serviceable
Junction Box	IP65 rated
Connector	MC4 or compatible connector
Cables	Lenght: 1000 mm / Section: 4.0 mm^2
Dimension	1642 x 994 x 40 mm / 64.2 x 39.1 x 1.6 inches
Weight	20 kg / 44.1 lbs
Max. Load	Wind Load: 2400Pa / Snow Load: 5400 Pa

PV specifications-6



Tolerance of length and width dimensions is ± 2 mm

As field day was approaching

Michel Barbeau <michel.barbeau@bell.net> 17 June 2013 22:24

Reply-To: ovmrc_exec@yahoogroups.com

To: ovmrc_exec@yahoogroups.com

Cc: Maurice A Vigneault <fs882@ncf.ca>

Field Day is June 22–23, 2013

Field Day is the weekend! The Ottawa Valley Mobile Radio Club (OVMRC) will be on the air under VE3RAM at the Canada

Science and Technology Museum. There will be voice, CW and digital stations, powered with solar panels. Setup starts

at 10 AM Saturday. Come and operate with your own equipment or with the club's equipment. All are welcome!

Michel Barbeau

VE3EMB

Team work

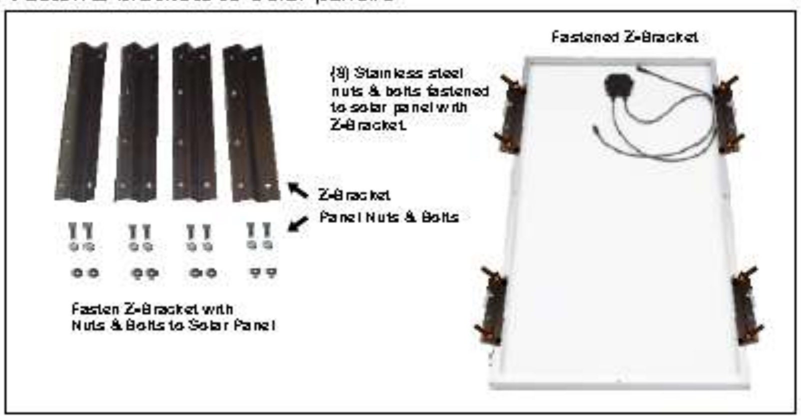
- Flooding in Calgary
- Delay in delivery
- **Panel delivered on Friday 21**
- Joe, Michel and I assembled the material, aluminum bars, panels and hardware
- Drilling and taping thread for assembling components on the trailer roof
- Thread **- Drill** & **Tap** Chart - Steven Henderson's Cutting Edge Designs
- Installation …

PV installation-1

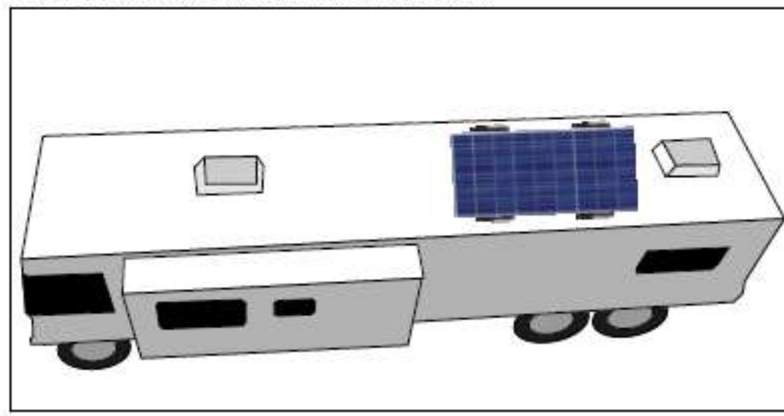
Layout & Configuration

- Install mounting on solar panel frame (12" mounting kit comes with Z-Bracket, nuts and bolts to fasten directly onto solar panel)
- Find a spot that you can run down your cable easily (ventilation or drill a hole through the roof top)
- Place solar panel as close to your wire drop down spot as you can.
- Refer to below diagram for installation.

STEP 1.
Fasten Z-brackets to Solar panel/s



STEP 2.
Place solar panels into permiment position



STEP 3.
Wire panels together and connect Mc4 connectors in series or parallel now. Fish wire down to charge controller.

STEP 4.
Drill Pilot Holes for 12" z-brackets into roof. (make sure drill bit is smaller than bolt size)
In order to keep pilot hole lined up lift one side at a time and liberally caulk the pilot holes with QUAD, and under belly of the two z-brackets. Do the same to other side and than lag bolt the panels down onto roof.

#6 2220 32 Ave N.E.
Calgary, AB, T2E6T4
403-800-9194 www.solarwholesaler.ca

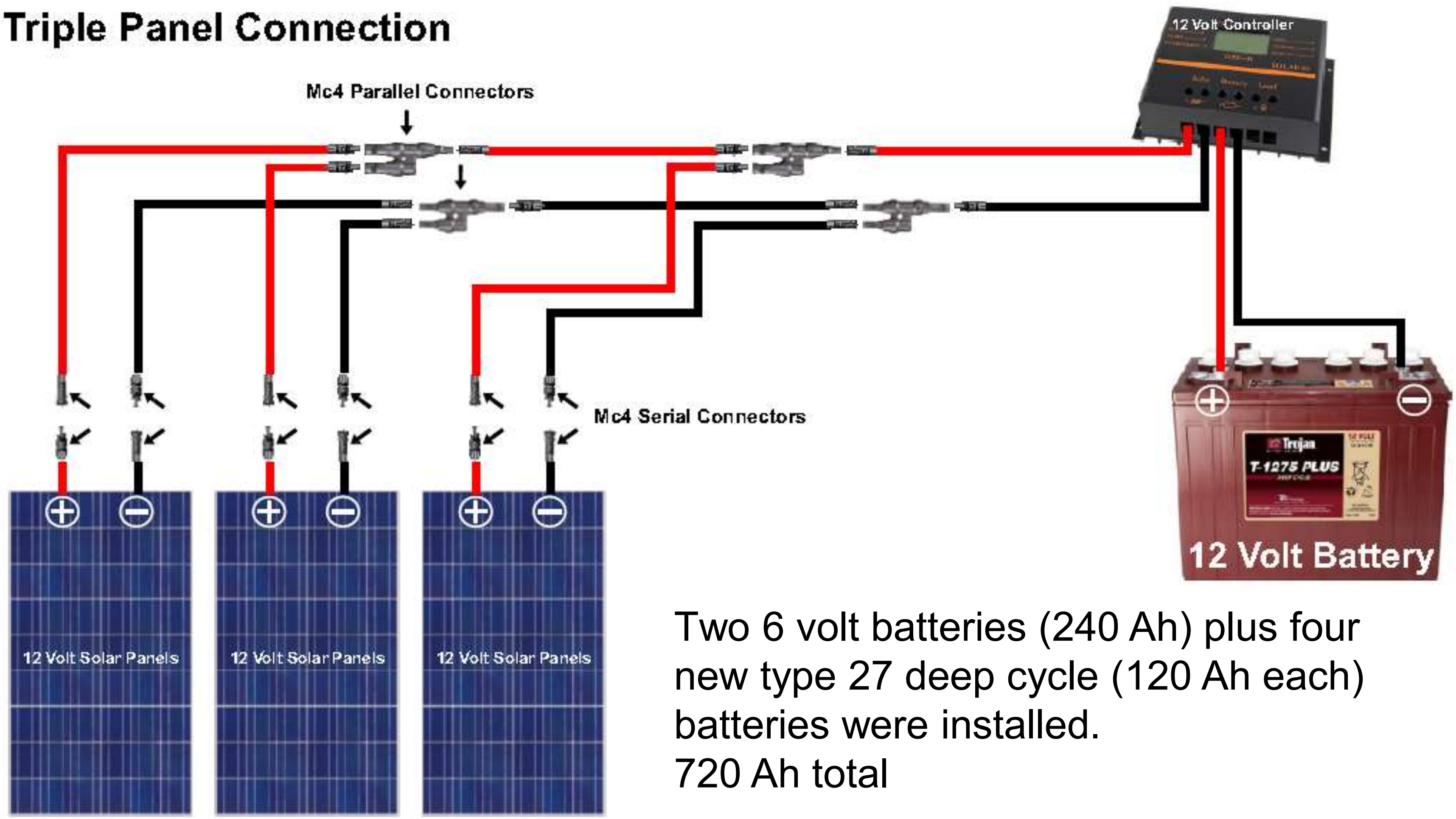
http://solarwholesaler.ca/?s=rv+solar+kit&post_type=product

PV installation-2
OVMRC trailer special case

VE3RAM trailer roof area is small and its roof surface is not appropriate for directly screwing the panels on it.
To install the 3 PV panels suitable spots were identified.
To support the panels cross bars were designed and cut.
Using the 12" mounting kit Z-brackets provided the cross bars were prepared to allow installation using 1/4-20 screws: tap size 1/4-20 and drill size 7/32.
The cross bars were pre-drilled to be screwed along the edges of the trailer roof where good support for anchorage could be found.

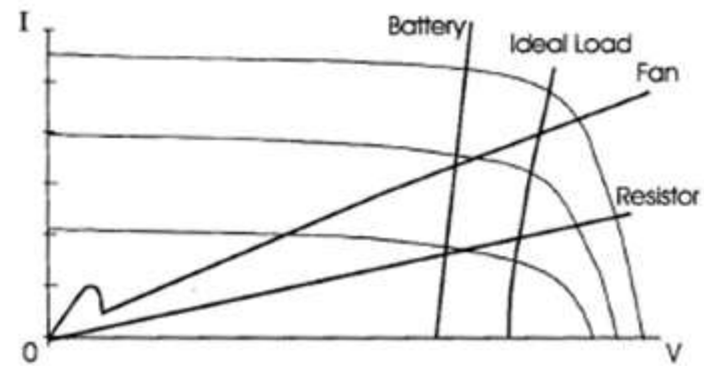
PV installation-3

PV installation-4



Two 6 volt batteries (240 Ah) plus four new type 27 deep cycle (120 Ah each) batteries were installed.
720 Ah total

Controller-battery charger



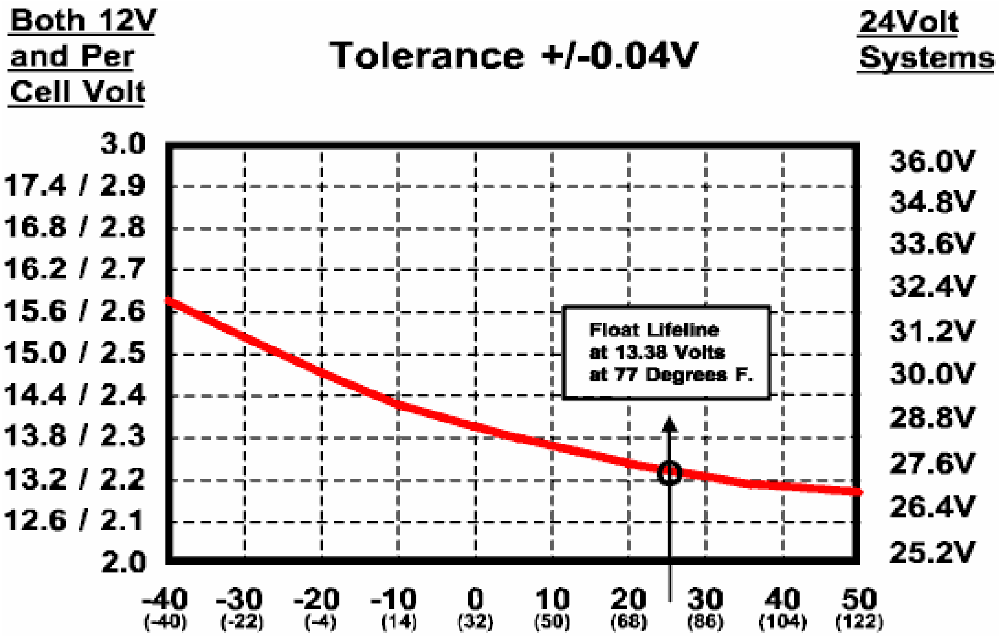
Maximum Power Point Tracking (MPPT) system allows PV panels to output more power by adjusting working condition of the electrical module. The working state of an ordinary controller is at a constant voltage. The VI graph indicates that the ideal load of PV needs to be matched to the battery working load (battery + load on it). The MPPT controller makes the PV always work at the maximum power point (ideal load), thus outputting 10-30% more than a fixed voltage controller.

Controller-charger specifications

Model	WS-MPPT60 40A	WS-MPPT60 50A	WS-MPPT60 60A
Rated Voltage	12V/24V/48V		
Max Load current	40A	50A	60A
Input voltage range	12V~20V / 24V~40V / 48V~80V		
Length≤1m Charge loop drop	0.25V		
Length≤1m Discharge loop drop	0.05V		
Over voltage protection	17V / 34V / 58V		
Full charge cut	13.7V / 27.4V / 54.8V		
Low voltage cut	10.5~11V / 21V~22V / 42V		
Temperature compensation	-3mv/°C / cell		
No load loss	≤30mA		
Max wire area	6mm2	6 mm2	6 mm2
Ambient temperature	-25°C---+55°C		

Note that temperature compensation must match the lead acid battery voltage temperature dependent profile.

Batteries



Battery charging voltage also changes with temperature. It will vary from about 2.74 volts per cell (16.4 volts) at -40 C to 2.3 volts per cell (13.8 volts) at 50 C. This is why you should have temperature compensation on your charger or charge control if your batteries are outside and/or subject to wide temperature variations. Some charge controls have temperature compensation built in (such as Morningstar) - this works fine if the controller is subject to the same temperatures as the batteries.

State	Density	Volts/cell	Volts/battery	Freezing point
Charged	1,265	2,12	12,70	-57ºC
Charged 75%	1,225	2,10	12,60	-38ºC
Charged 50%	1,190	2,08	12,45	-25ºC
Charged 25%	1,155	2,03	12,20	-16ºC
Discharged	1,120	1,95	11,70	-10ºC

State of charge, density, voltage and freezing point for a lead-acid battery

http://www.solar-electric.com/deep-cycle-battery-faq.html

Batteries

DOD	SOC	2 volt battery	12 volt battery	24 volt battery	48 volt battery	specific gravity
0%	100%	2.10	12.70	25.40	50.80	1.265
10%	90%	2.09	12.58	25.16	50.32	1.249
20%	80%	2.08	12.46	24.92	49.84	1.233
30%	70%	2.06	12.36	24.72	49.44	1.218
40%	60%	2.05	12.28	24.56	49.12	1.204
50%	50%	2.03	12.20	24.40	48.80	1.190
60%	40%	2.02	12.12	24.24	48.48	1.176
Discharged	Discharged	1.75	11.90	23.80	47.60	1.120

To check how much has been discharged:

- measure the specific gravity using a hydrometer (not for sealed batteries),
- use a amp hour meter, or
- use the voltage.

Below are listed the 1 hour, 8 hour, 20 hour and 120 hour load voltages during the discharge cycle from full charge to 100% discharge to 1.75V/cell or 10.5V (6 cells) at 25°C (77°F).

I imagine that a first order of estimate of the rate of discharge is our maximum current draw at a given time, e.g., two radios may happen to TX at same time thus 40 A on a 720 Ah battery bank means 18 hour rate.

DOD (%)	1 hr. Rate	8 hr. Rate	20 hr. Rate	120 hr. Rate
10	12.23	12.60	12.65	12.69
20	12.16	12.51	12.55	12.58
30	12.07	12.39	12.42	12.45
40	11.96	12.25	12.28	12.32
50	11.83	12.11	12.15	12.18
60	11.70	11.98	12.02	12.05
70	11.55	11.79	11.83	11.88
80	11.38	11.59	11.61	11.65
90	11.15	11.32	11.34	11.40
100	10.50	10.50	10.50	10.50

http://rimstar.org/renewnrg/off_grid_solar_battery_maintenance.htm

Monitoring the battery bank

- Search on web: lead acid batteries wireless monitoring
- http://www.ti.com/solution/telecom_shelter_wireless_battery_monitoring
- **battery** maintenance and **monitoring** – what's real and what's not?
- www.battcon.com/PapersFinal2003/FountainPaperFINAL2003.pdf by B Fountain Automatic remote **monitoring** of the **Lead Acid Battery** plant. **...**standby energy storage systems in the form of **lead acid batteries**, to make 24 **...**

Wireless battery monitoring

Telecom Shelter: Wireless Battery Monitoring
Telecom shelters generally have Lead-Acid battery back-up mechanism to provide constant -48V supply to the server and tower. 24 2V cells make this battery backup and are kept inside the telecom shelter. Monitoring these 2V cells from a remote location has been a tedious and expensive task. So it is important to have accurate information about the failure to diagnose and fix it properly.
Texas Instruments offers wireless solution to tackle this problem. Today wired solution is established all over the world and has some disadvantages. Connection mismatch, extra cost of implementation makes this solution unattractive. TI with its growing portfolio of**Chipcon SoCs / Transceivers** and **MSP430 Microcontroller** products is in a unique position to help customers solve this problem effectively and efficiently.
TI's SimpliciTI (royalty free RF protocol) is ideally suitable for such application and runs smoothly on Chipcon devices with greater than 8k flash. **Chipcon CC2510 SoC** comes with 12bit ADCs, 8051 core and RF transceiver integrated into a single chip. **MSP430 Microcontroller** offers industry best standby current and enviable amount of battery backup for such remotely monitored systems. Battery health status of each 2V cell (total 24cells) is communicated on a timely basis to a central aggregator inside the telecom shelter, which is further transmitted over GSM/GPRS to Central Exchange for remote monitoring and diagnosis

TI unveils battery **monitor** for **lead-acid batteries** - Apr 16, 2013
newscenter.ti.com › News Room
Apr 16, 2013 - TI unveils breakthrough **battery monitoring** technology for **lead-acid ...wireless** base stations and telecom shelters, e-bikes, inverters and **...**

1. **Lead-acid batteries**: The growing need for **monitoring** state-of **...**
2. www.electronicproducts.com/.../**Batteries**.../**Lead-acid_batteries**_The_gro...
3. Jul 23, 2013 - **Monitoring** SoC and SoH of the **lead-acid battery** with impedance gauging **...** With the proliferation of data servers and remote **wireless** base **...**

New IC to monitor lead-acid batteries

- Gas Gauge IC Monitors Lead-Acid Battery State-Of-Health, State-Of-Charge, An accurate, simple-to-use gas gauge IC monitors lead-acid batteries used in mobile and stationary applications like medical instruments, wireless base stations and telecom shelters, e-bikes, inverters, and uninterruptible power supplies (UPS).

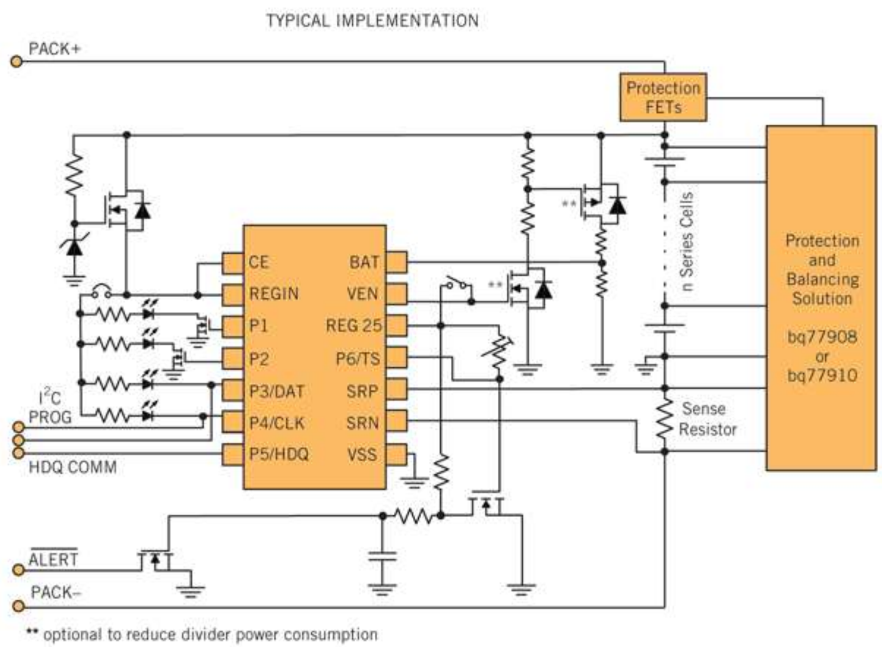
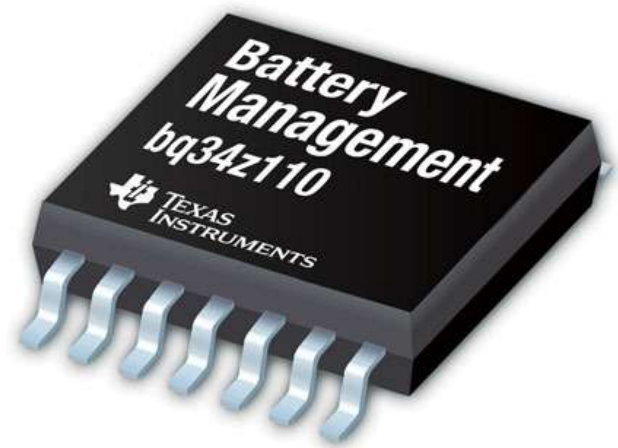


Fig 2. Typical implementation of bq34z110 for lead-acid battery.




THE END

Additional material

Charging at High and Low Temperatures

Rechargeable batteries operate in a wide temperature range but this does not give license to charge them at extreme temperatures. Extreme cold and high heat reduce charge acceptance, and the battery must be brought into moderate temperature conditions before charging.

Older battery technologies, such as lead acid and NiCd, have higher charging tolerances than newer systems and can be charged below freezing at a reduced 0.1C rate. This is not possible with most NiMH and lithium-ion systems. Table 1 summarizes the permissible charge and discharge temperatures of common lead acid, NiCd, NiMH and Li-ion. We exclude specialty batteries designed to charge outside these parameters.

Battery Type	Charge Temperature	Discharge Temperature	Charge Advisory
Lead acid	–20°C to 50°C (–4°F to 122°F)	–20°C to 50°C (–4°F to 122°F)	Charge at 0.3C or less below freezing. Lower V-threshold by 3mV/°C when hot.
NiCd, NiMH	0°C to 45°C (32°F to 113°F)	–20°C to 65°C (–4°F to 149°F)	Charge at 0.1C between –18 and 0°C. Charge at 0.3C between 0°C and 5°C. Charge acceptance at 45°C is 70%. Charge acceptance at 60°C is 45%.
Li-ion	0°C to 45°C (32°F to 113°F)	–20°C to 60°C (–4°F to 140°F)	No charge permitted below freezing. Good charge/discharge performance at higher temperature but shorter life.

Table : Permissible temperature limits for various batteries. Batteries can be discharged over a large temperature range but charge temperature is limited. For best results, charge between 10°C and 30°C (50°F and 86°F). Lower the charge current when cold.

For more information on low-temperature charging and high-temperature charging see:

http://batteryuniversity.com/learn/article/charging_at_high_and_low_temperatures

2013-14 Meeting Dates

November 21
Guest Speaker:
TBD

December 19
Pot Luck Christmas Party,
18:30 h

January 16, 2014
Guest Speaker:
Bryan Rawlings, VE3QN

February 20
Flea Market.
Bring cash, we will have lots of recycled gear for sale.

March 20
Home Brew Evening -
Show us what you've been building this winter....

April 11*
Topic:
Satellites and Amateur Radio

May 15
Mobile Show n Tell
Bring your mobile installation and we'll look and evaluate. Prize(s) to be awarded. To be held outdoors, 19:00h

June 19
Annual General Meeting
Elections

* Tentative change

Rambler deadline

Meeting date minus 13 days

Dec 06
Jan 03
Feb 07
Mar 07
Apr 04
May 02
Jun 06
Jul/Aug 09

Please submit articles for the Rambler to the editor:

Robert Cherry

No later than the deadline for the desired edition.

December Rambler submission deadline is:

Friday, 6th Dec

Ottawa Valley Mobile
Radio Club,
Incorporated

P.O. Box 41145
Ottawa ON K1G 5K9

MEMBERSHIP FORM

- *The membership year starts in September and runs to the end of August of the following year.*
- *Regular membership is open to licensed amateurs.*
- *Associate membership is open to all unlicensed radio enthusiasts.*
- *Membership includes an e-mail subscription to the Club newsletter, the OVMRC Rambler.*

Date: **PLEASE PRINT**

RENEWAL ☐ **NEW** ☐ **CHANGE** ☐ **OVMRC NAME TAG (COST $10.00)** ☐ **NO** ☐ **YES**

Call Sign	Surname	Preferred First Name
Street		Apartment Number
City	Province	Postal Code
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Are you a member of Radio Amateurs of Canada (RAC) Yes ☐ No ☐ RAC ID: ____________ Expiry Date: / /

Full Membership (Not a Member of RAC) **$35.00/year** ☐
Full Membership (Member of RAC) **$25.00/year** ☐
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☐ **Satellite** ☐ **HF Phone** ☐ **HF Digital** ☐ **HF CW**

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If Retired, Former Occupation:
Skills: *(Please list them all)*

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