

Montgomery Amateur Radio Club

Solar Systems

The MARC Trailer

(May 2018)

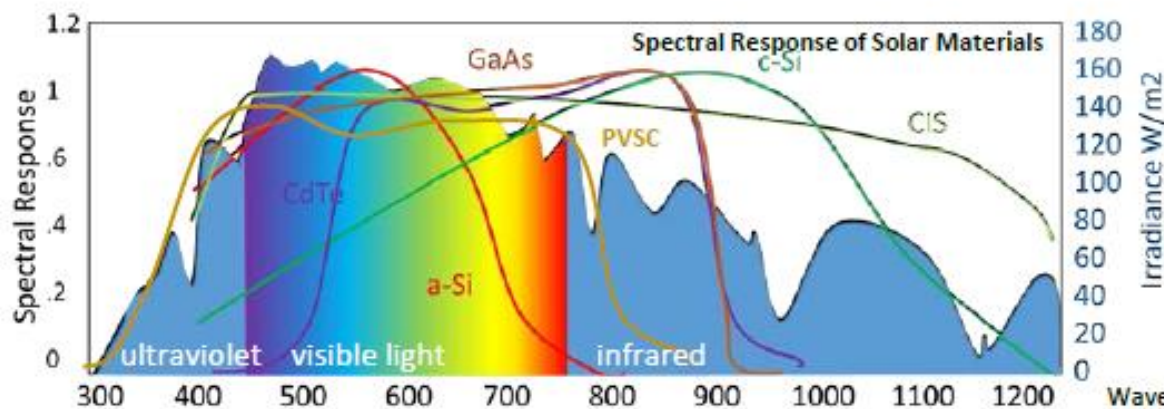
Al Rabassa, NW2M

Introduction

- Solar Basics
- Battery Basics
- Major Components
- A Minimal Solar Station
- Solar with Battery Storage
- MARC Trailer
- Home Systems
- Q&A – Wrap-up

The Sun

- 93,000,000 Miles from Earth. Light takes over 8 minutes to travel.
- Not all Energy Makes it to the Earth's surface. Absorption H_2O , CO_2 , O_3
- About 1,000 Watts (net) per sq Meter.
- 1839 Edmond Becquerel discovered the Photovoltaic Effect. (French)
- 1888 Aleksandr Stoletov built the first Solar Cell. (Russian)
- 1941 Russell Ohl patented the modern Solar Cell. (USA)
- PV Materials Respond to Different Frequencies. Not Just "Light".

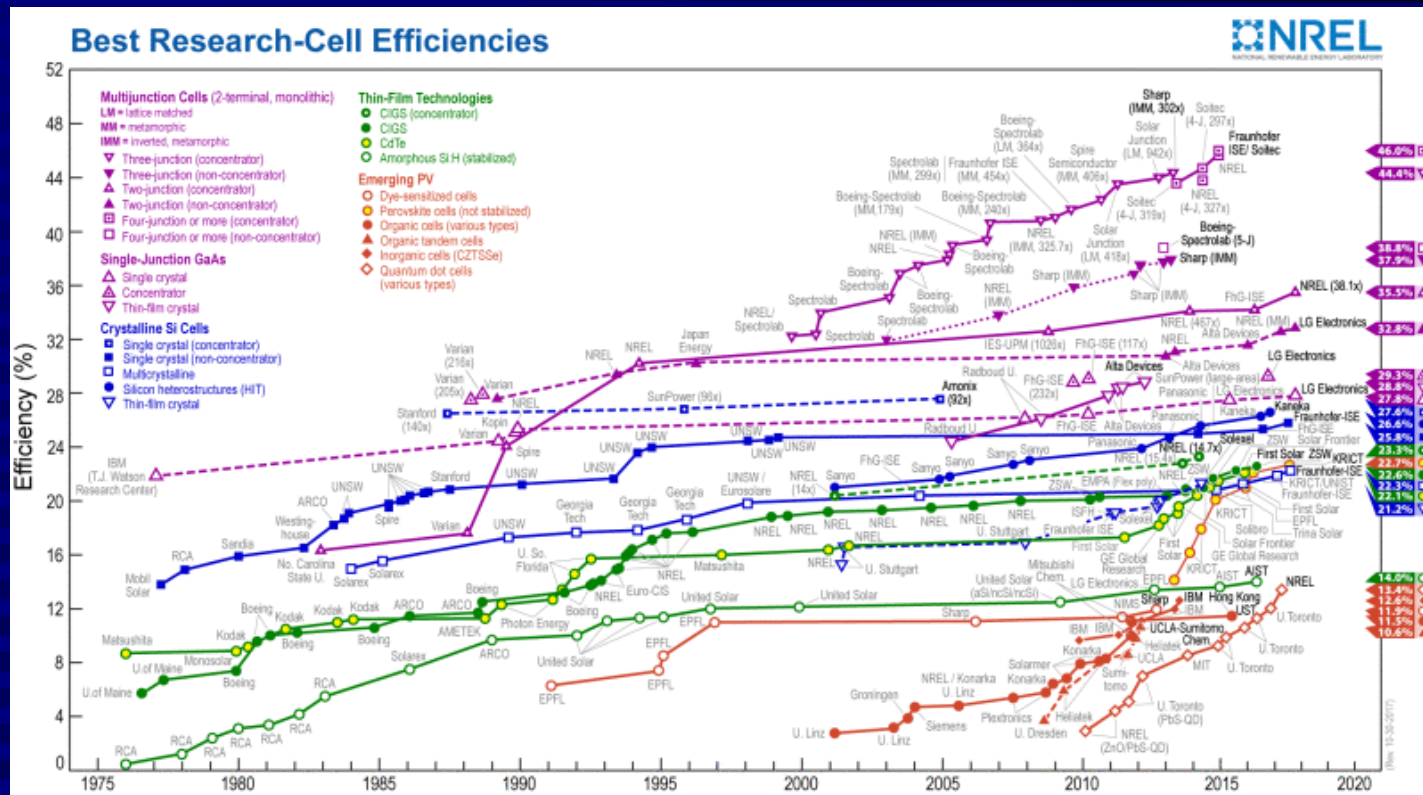


This graph (blue) shows the energy of the light that makes it through the atmosphere. The lines show how various solar materials respond across the wavelengths of light. New materials and solar cell designs will trap more available light.

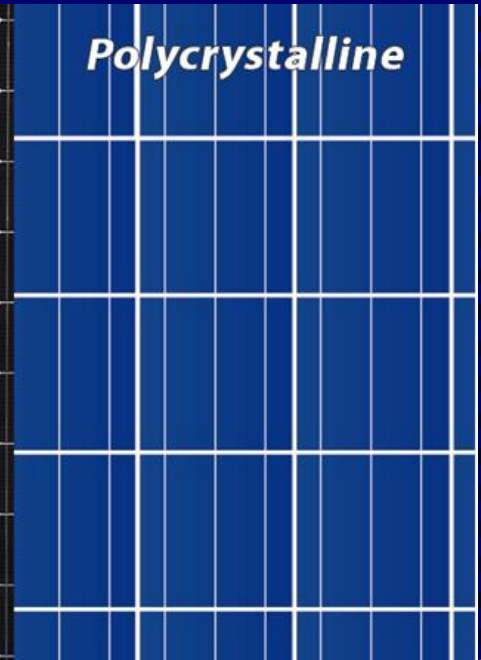
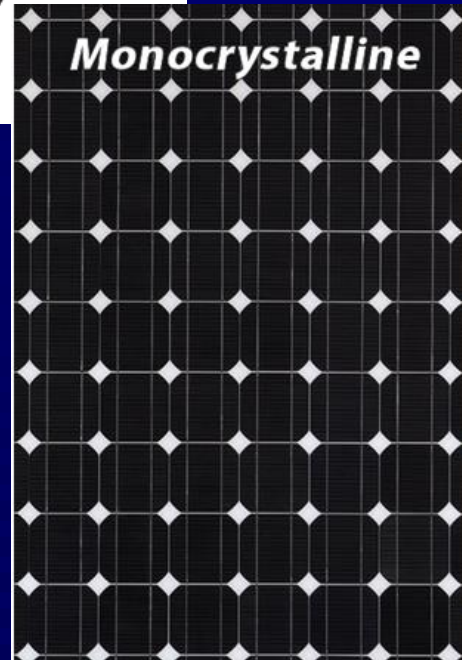
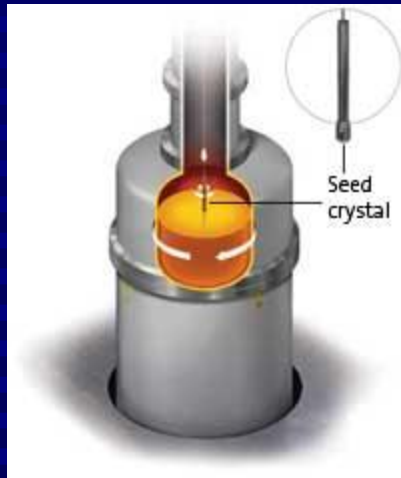
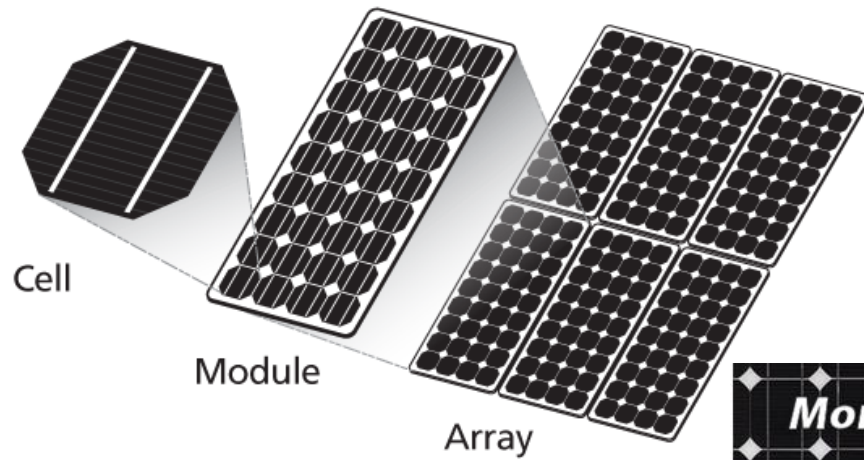
Progress to Date

- Consumer Products: 15%-20% (m²)
- Record: 46% Research Labs (cm²)
- First Solar 22.1% March-2016. Cadmium Telluride ThinFilm
- Crystalline \$0.36 per watt. First Solar \$0.57 per Watt

Grown(2) vs Deposited



Progression and Composition

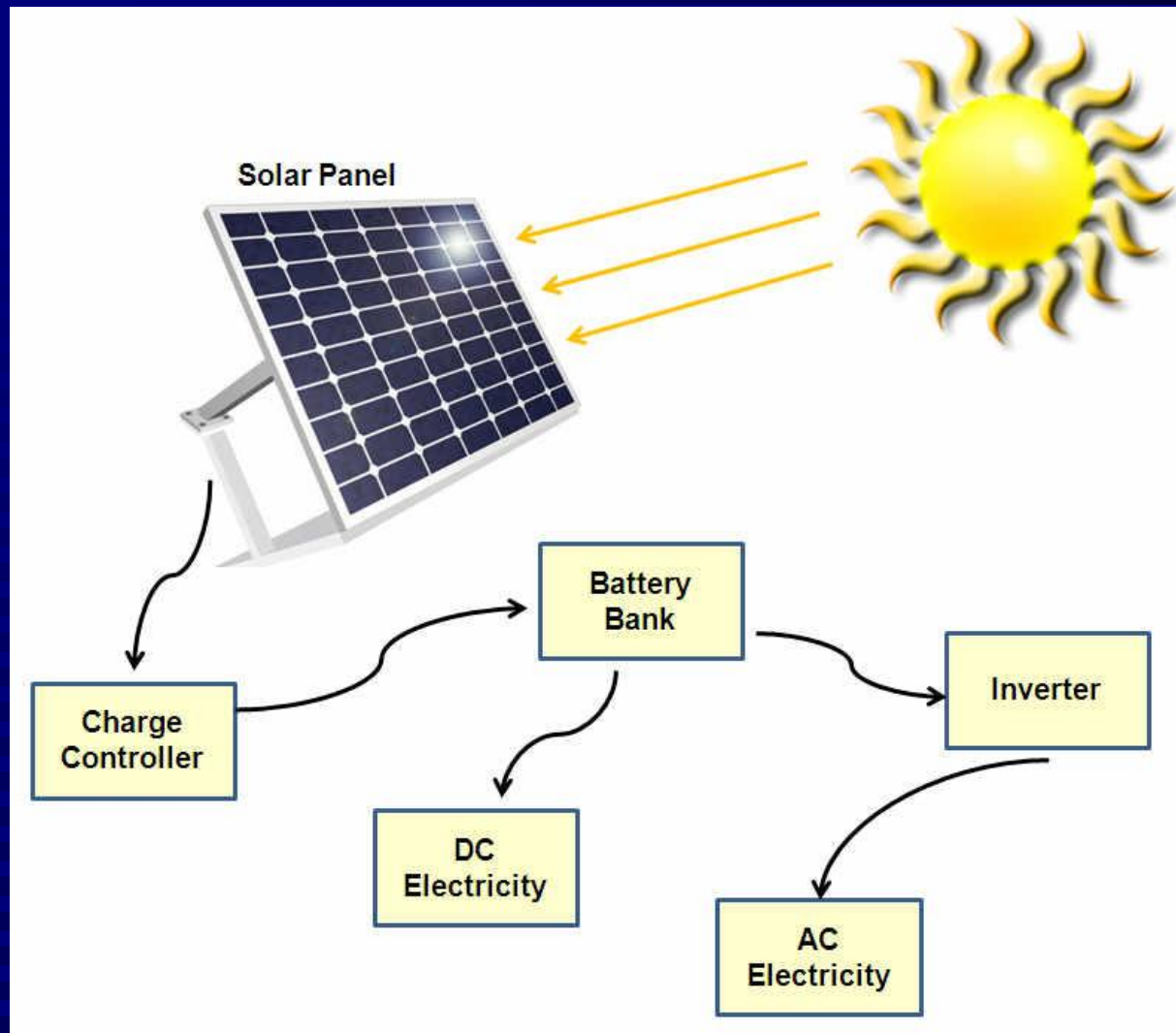


MARC Trailer (Solar)

- Single PV Module, SunWize, HQ
- Monocrystalline Type, +25yr @ >80%
- $9 \times 4 \times 0.5V = 18V = \text{“12V Module”}$
- 21V Open Collector Voltage! (Discussion Point)
- 6.4A @ 18V IV Curve = 115W
- Diode Protected (Schottky)
- Today's Market (2018) 200W+ Same FF
- OSHA/NEC Weight and Voltage Limits

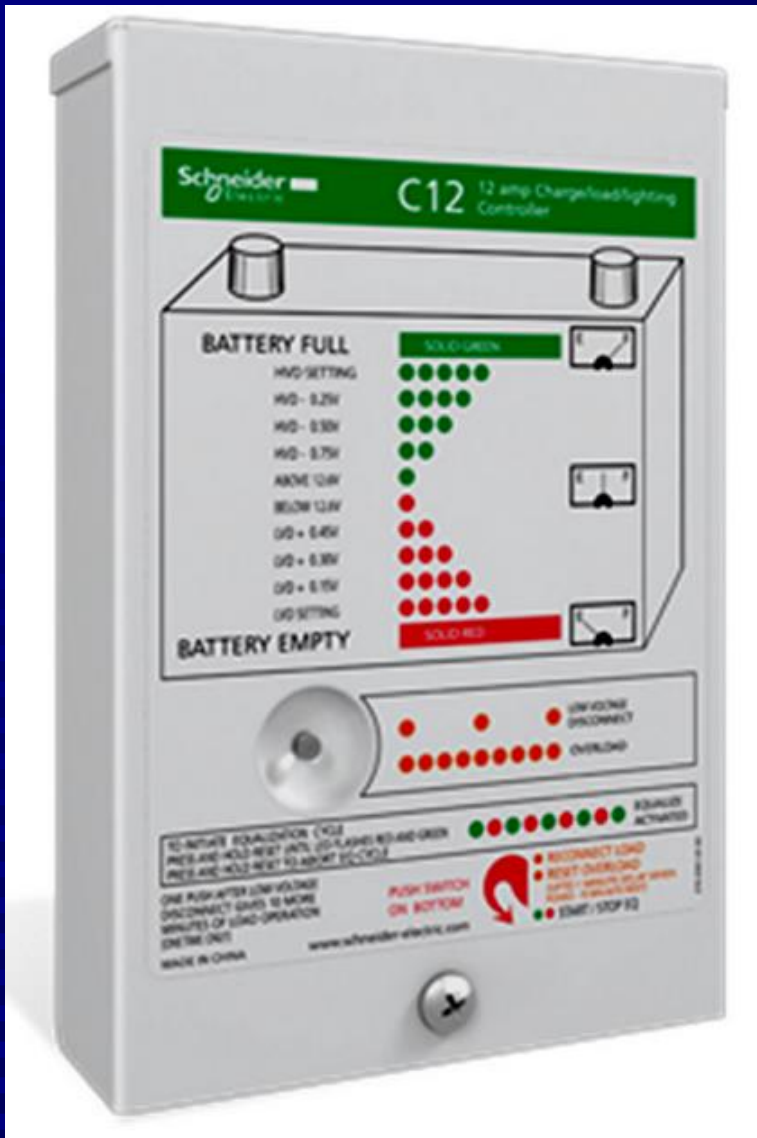


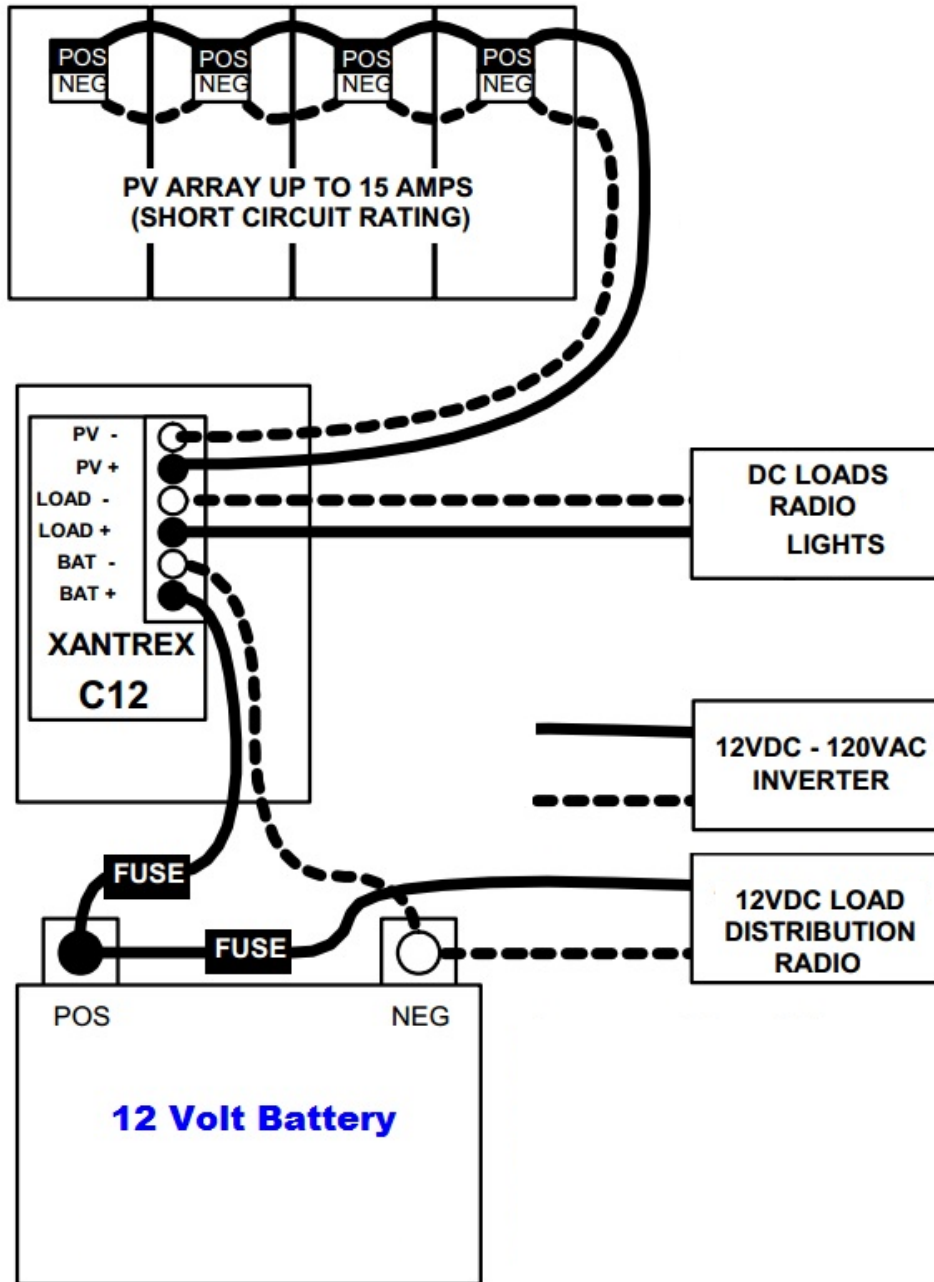
Solar Block Diagram - Simple



Charge Controller

- Manages High Open Collector Voltages
- Manages Battery Charging/Equalization
- Maximizes Voltage/Amperage/Power
- Low Voltage Disconnect (Discussion Point)
- Low Voltage Reconnect
- Night Light Controller / Timer
- Trace/Xantrex C12 & C30/40 Controllers





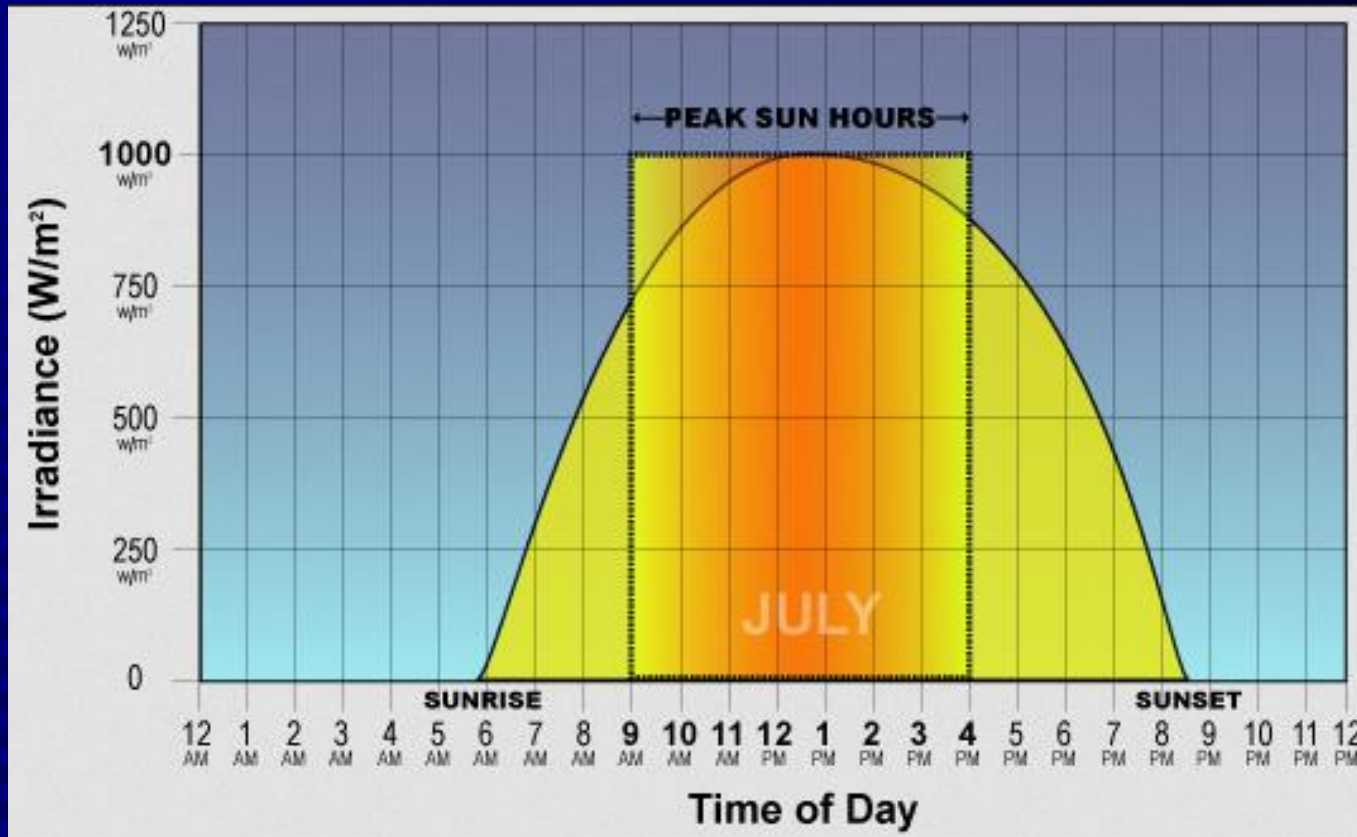
Batteries

- Starting, Marine, Deep-Cycle
- Wet Cell, Gel Cell, Sealed/MF, VLA, AGM
- Isolators, Switches, Multiple Batteries
- Series = More Voltage, Same Current
- Parallel = More Current, Same Voltage
- Toxic, Lead, Sulfuric Acid, Hydrogen Gas
- Requires Maintenance Water (Distilled Water)
- Neutralize: Acid + Base = Water + Salt
- Very Very Very Low Impedance (0.015Ω)

Batteries – Chemistry (Pb)

- Assuming 20°C (68°F) +LessV, -MoreV Sensor
- 3-Stages: Bulk, Absorption, Float
- 12.65V Resting Voltage = 100%
- 1.256 Specific Gravity of Solution = 100%
- 2.15V is the Voltage of Chemistry (12.9V)
- 2.50V is Bulk Charging (14.8-15.0V)
- 2.48V Gassing Voltage (14.5V) Maintenance Req
- Sulfation and Acid Stratification
- 2.66V Equalization Voltage (16V) Every 30-60 dy

Window of Solar Opportunity



The Fine Print

- Heat Lowers the Output Voltage (IV)
- Lab Tests at 68°F (20°C)
- Always Zenith During Tests
- Always 1000W/sq Meter Irradiance
- Summer vs Winter Temperature
- Summer vs Winter Solar Angle

Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)	Energy Value (\$)
January	3.50	11	1
February	3.65	10	1
March	3.41	10	1
April	3.07	8	1
May	2.59	7	1
June	2.48	6	1
July	2.54	7	1
August	2.92	8	1
September	3.34	9	1
October	3.83	11	1
November	3.30	9	1
December	2.95	9	1
Annual	3.13	105	\$ 12

90° Tilt

Radio Math - Consumption

- Assume: 100 Watt Modern Rig, SSB Voice
- 25 Watts Average RF Output TX
- 12 Watts Average DC on RX
- 35% Rig TX Efficiency = 70 Watts
- Assume 50:50 Duty Cycle TX:RX
- $70W / 12.5V = 5.6$ Amps TX
- $12W / 12.5V = 1.0$ Amps RX
- 200 Ah Batteries / 3.3 Amps = 60 Hours
- Replenish with 115W Solar Panel Charging

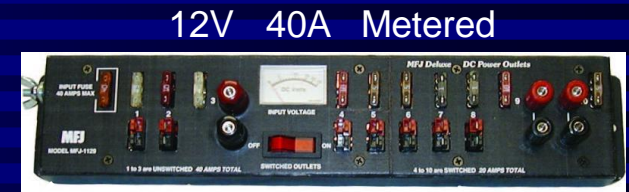
MARC Trailer Power

- Sized for Two Operating Stations
- 115W Solar PV Module
- 2 x 100 Ah Batteries + Controllers
- 350W Inverter (120V for Laptops/USB)
- 40A DC 12V Distribution Panel
- LED Lighting AC/DC/RF Ground System
- Future: Generator Power and Mast
- Start Small Trial Adjust Move Quickly

Solar Topology



115W SunWize



12V 40A Metered



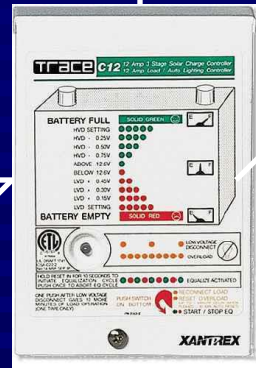
12V 100Ah



12V 100Ah



LVD

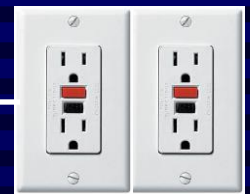


Trace C12

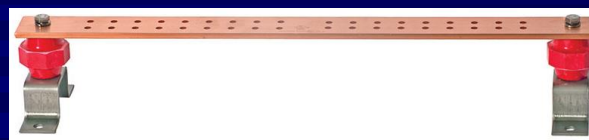
CC
EQ



350 W
LVD



GFCI

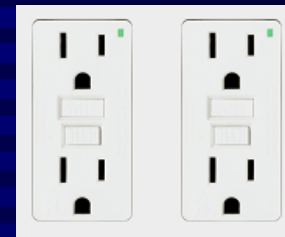


Generator / Utility Topology

Breaker / Disconnect



120V 15A GFCI



Power Port



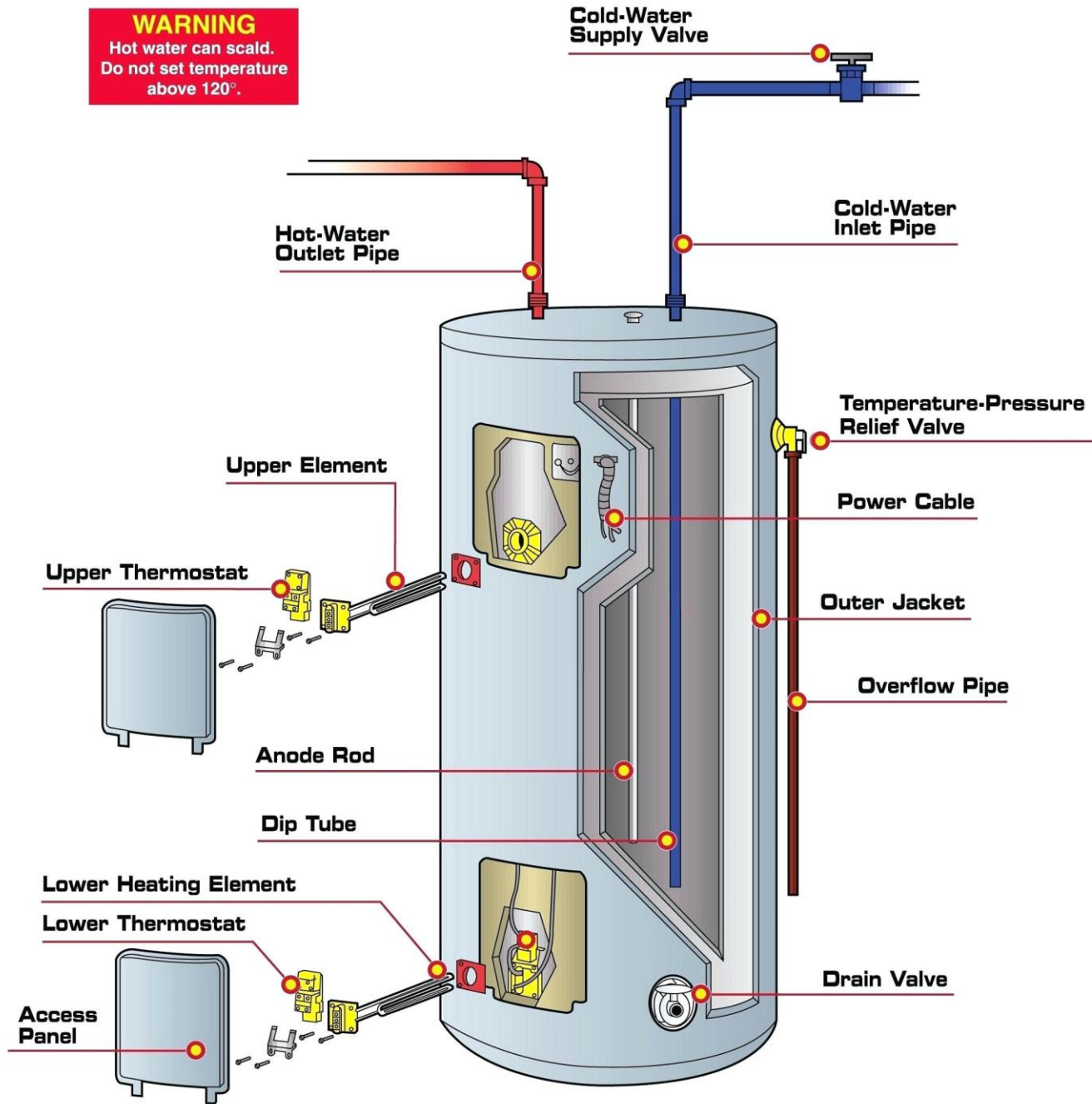
Home Solar

- 10X more Complex!
- 10X more Options!! Salt Water Batteries!
- Grid Tie (Own or Free- but you pay them).
- Beware of Limited System Expansion.
- 60-Cell vs 72 Cell Modules, Optimizers.
- Excellent ROI. Do not Wait for NextGen.
- QRM to Radio Equipment.
- QST Article “Living With Solar”.

My 1st Solar Project – NW2M

- Off-Grid Solar Hot Water Heater. 80 Gal.
- AC Backed (Dual Coils/Dual Thermostats).
- Coil Resistance is 15Ω .
- PV Modules, Mono, 150W, 40° .
- No Batteries. No Controller.
- Solar Connection to Upper Coil. 120°F
- AC Connected to Lower Coil. 110°F

WARNING
Hot water can scald.
Do not set temperature
above 120°.



Q&A

Thank You

73, AI – NW2M