

# **Solar Power for LVMesh on Apex**

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# Overall Design Requirements

- The battery will need to provide on average 2.5 amp/hours of current for two days or about 30 watt/hours.
- During the shortest day of the year, the solar panels would need to be able to completely charge a depleted battery in one day.
- The solar panel structure would need to be able to withstand the harsh conditions on Apex
- The solar control module would need to be able to regulate and control battery charging from the panels and provide 12 and 24 volts outputs.

# Parts List

- [Steel](#) 40' of 1 ¼" Square steel tubing and 4' of 3/16" x 3" bar stock -- \$55
- 2 Lead/Acid AGM [batteries](#), 55 amp/hours -- \$228
- 2 Newpowa 160W Watt Monocrystalline [Solar Panels](#) -- \$312
- [Solar Charge/Regulator PWM](#) (30A/10A) -- \$12, OR
- [Solar Charge/Controller MPPT](#) (30A/30A) -- \$106
- [Distribution Box](#), [Step-up Converter](#), [Voltmeters](#), [Current Sensor](#), Power Distribution Strip, [Fuse Box](#) with Fuses, etc. -- \$70
- [Wires](#), Cables, Conduit, Junction Boxes -- \$150
- Miscellaneous Hardware and Consumables -- \$30

# Construction Costs

- Solar Panel Structure Labor - One Volunteer and One Welder (Family and Friends Rate) -- \$150
- Controller Box Construction – One Volunteer -- \$0
- Installation – Three Strong Volunteers -- \$0

# Panel Mounting Structure Construction



# Completed Panel Mounting Structure





# Panel Mounted on Structure

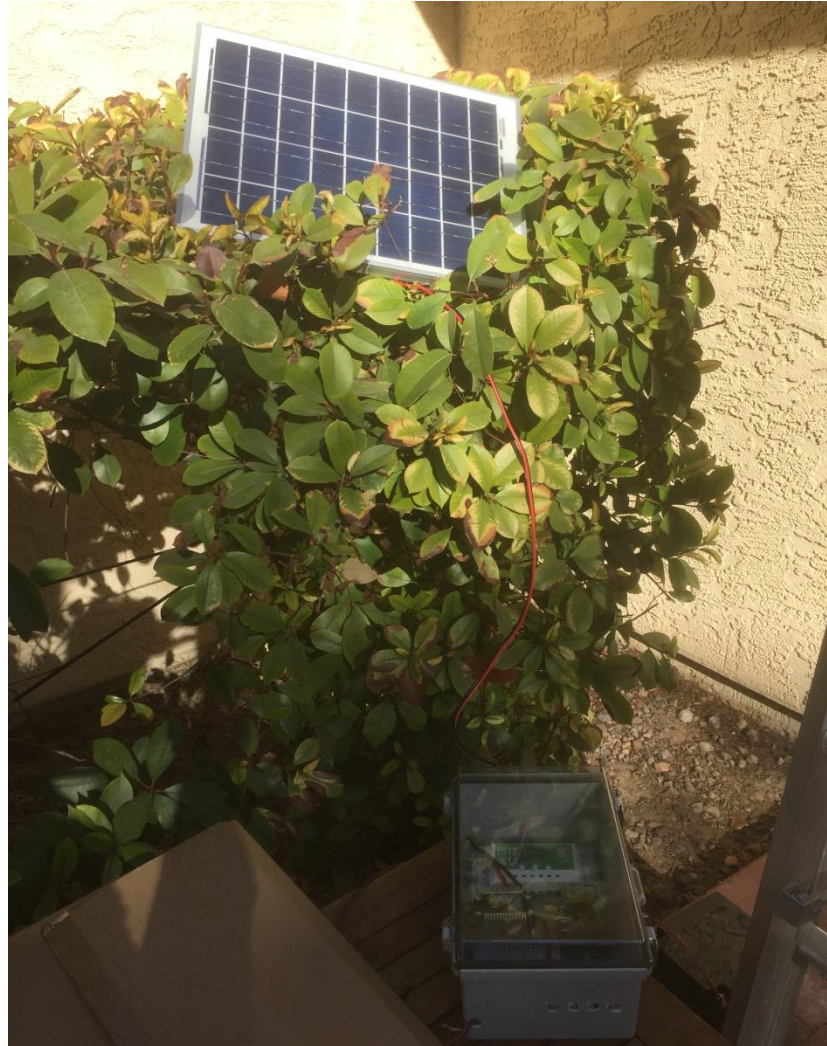


# Power Distribution and Controller Box Construction





# Power Distribution and Controller Box Test



# Power Distribution and Controller Box Test



# Apex Solar Panel Installation Trip





# Solar Panel Structure - Apex

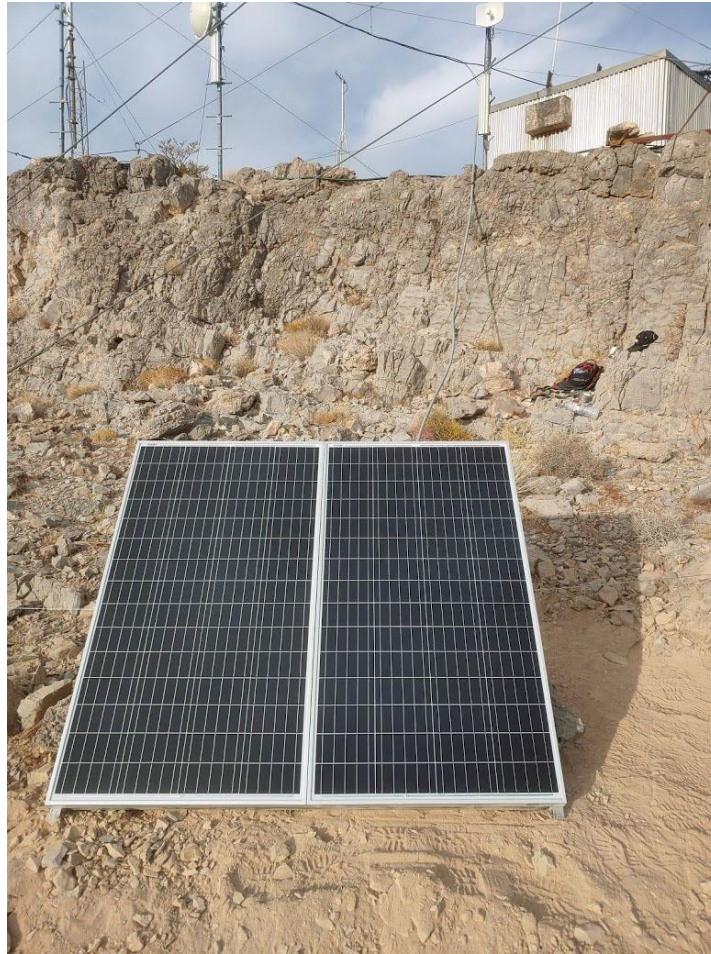




# Solar Panel Structure - Apex



# Solar Panel Structure - Apex

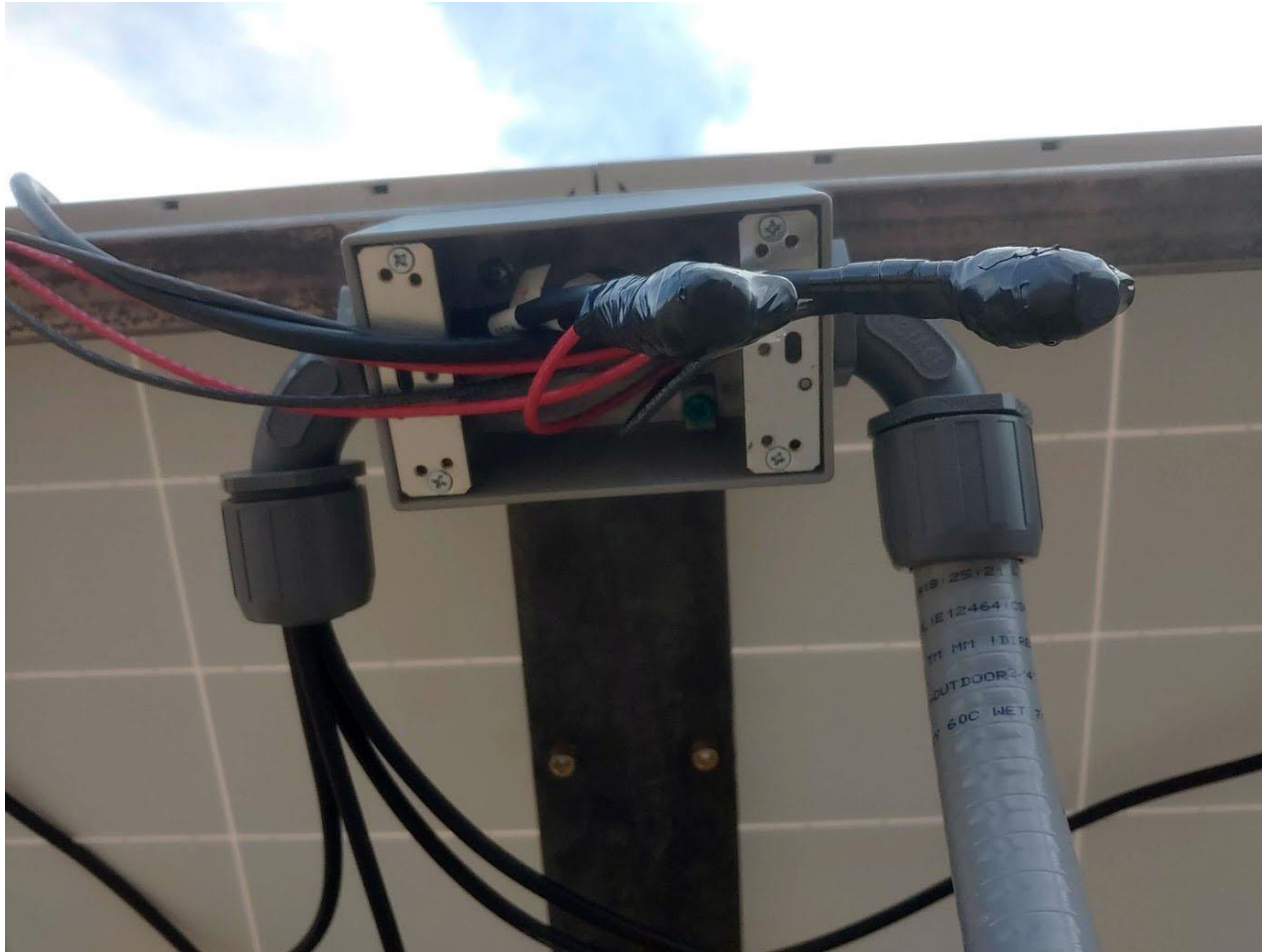




# Solar Panel Structure - Apex

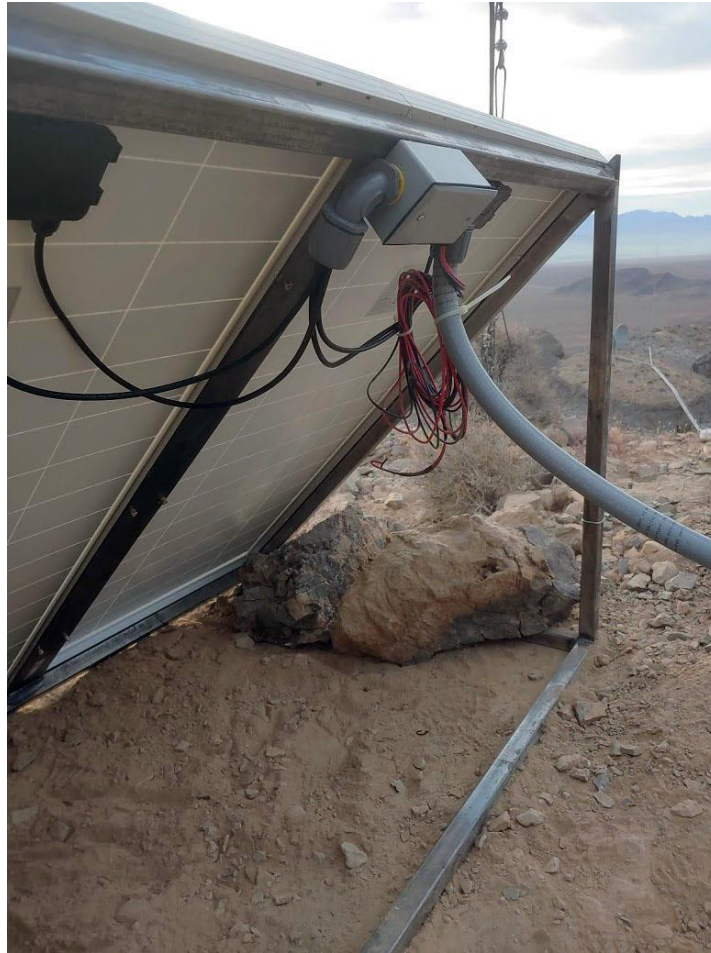


# Solar Panel Wiring - Apex





# Solar Panel Completed - Apex



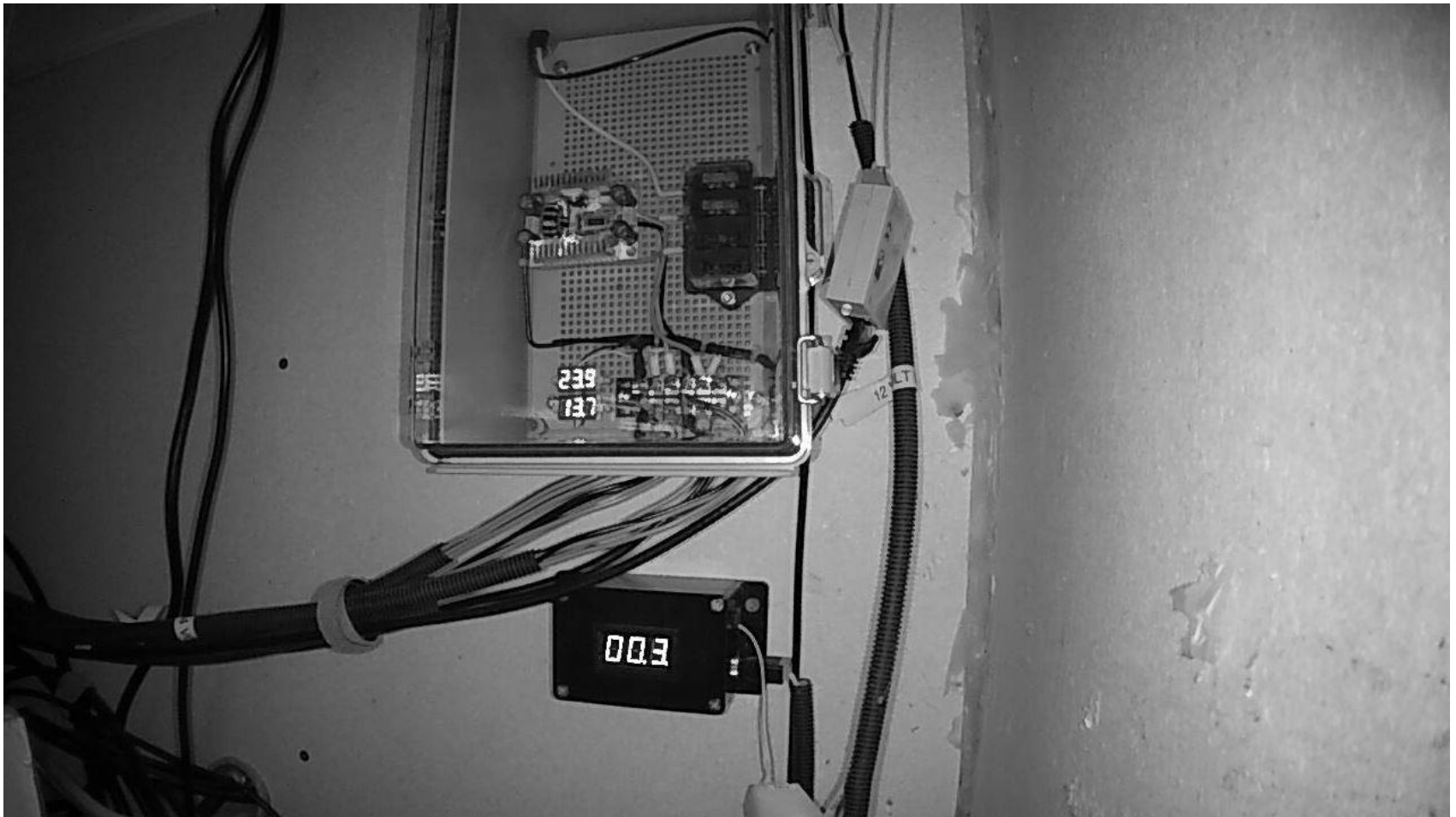
# Batteries and Power/Controller Box



# The End of a Long Day on Apex Peak



# Solar Status 10-11-2021 @1600 Hrs



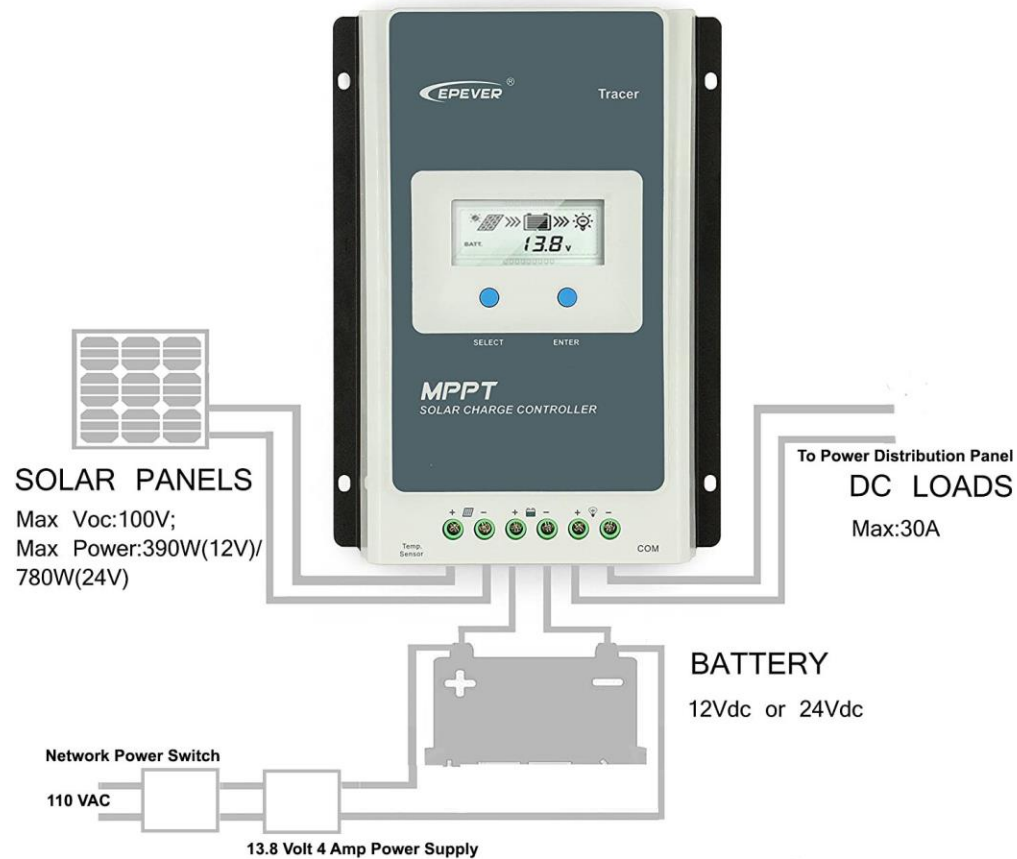


# Solar Power System Upgrade 01-13-21

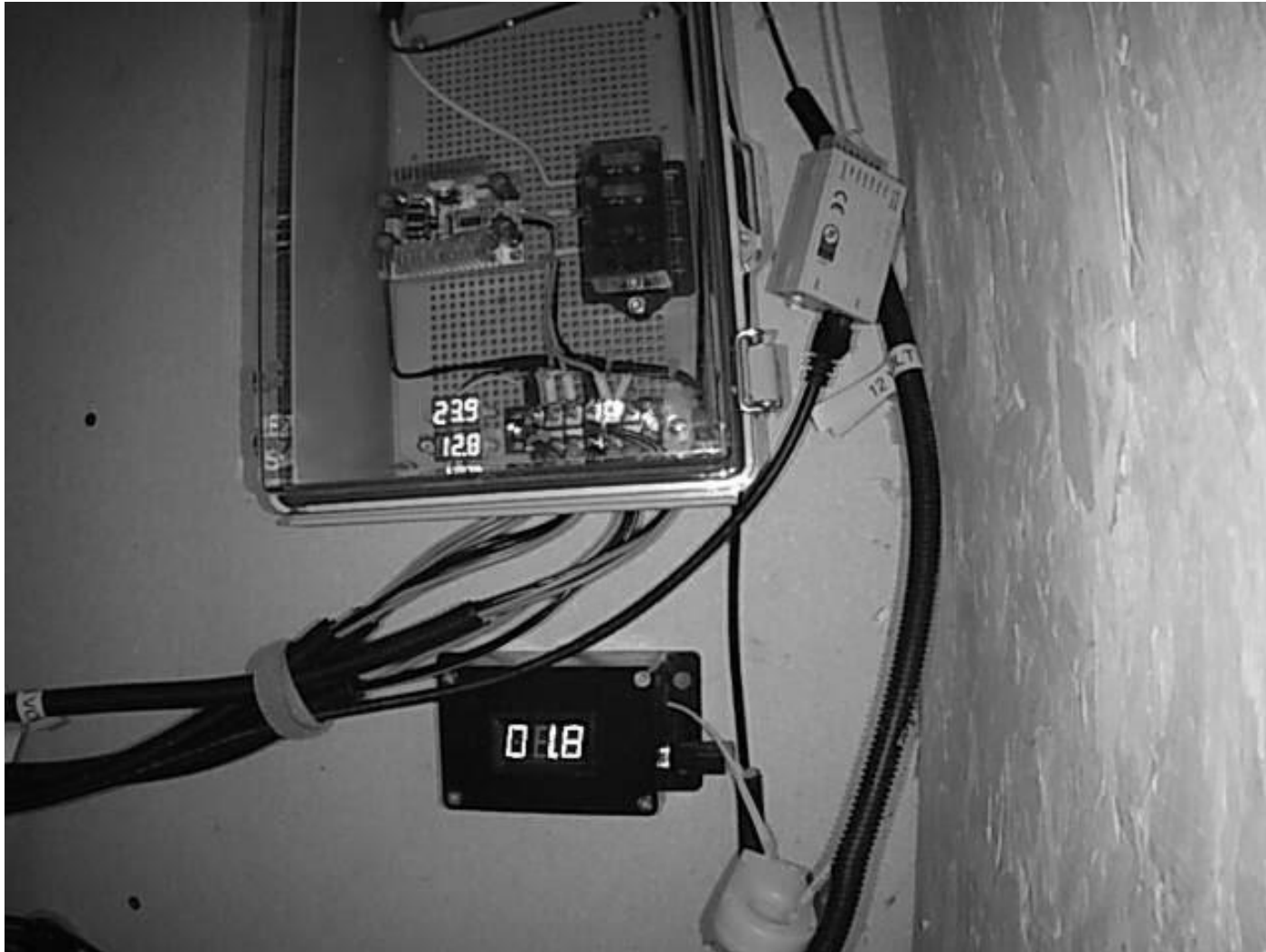


The solar charge controller was changed from a PWM (Pulse Width Modulation) to a MPPT (Maximum Power Point Tracking). The new controller is a EPevers Tracer 3210AN with a RS-485 status port and battery temperature probe.

# Design with New Solar Controller



# Power Distribution Box Camera



# Remote Telemetry from Controller



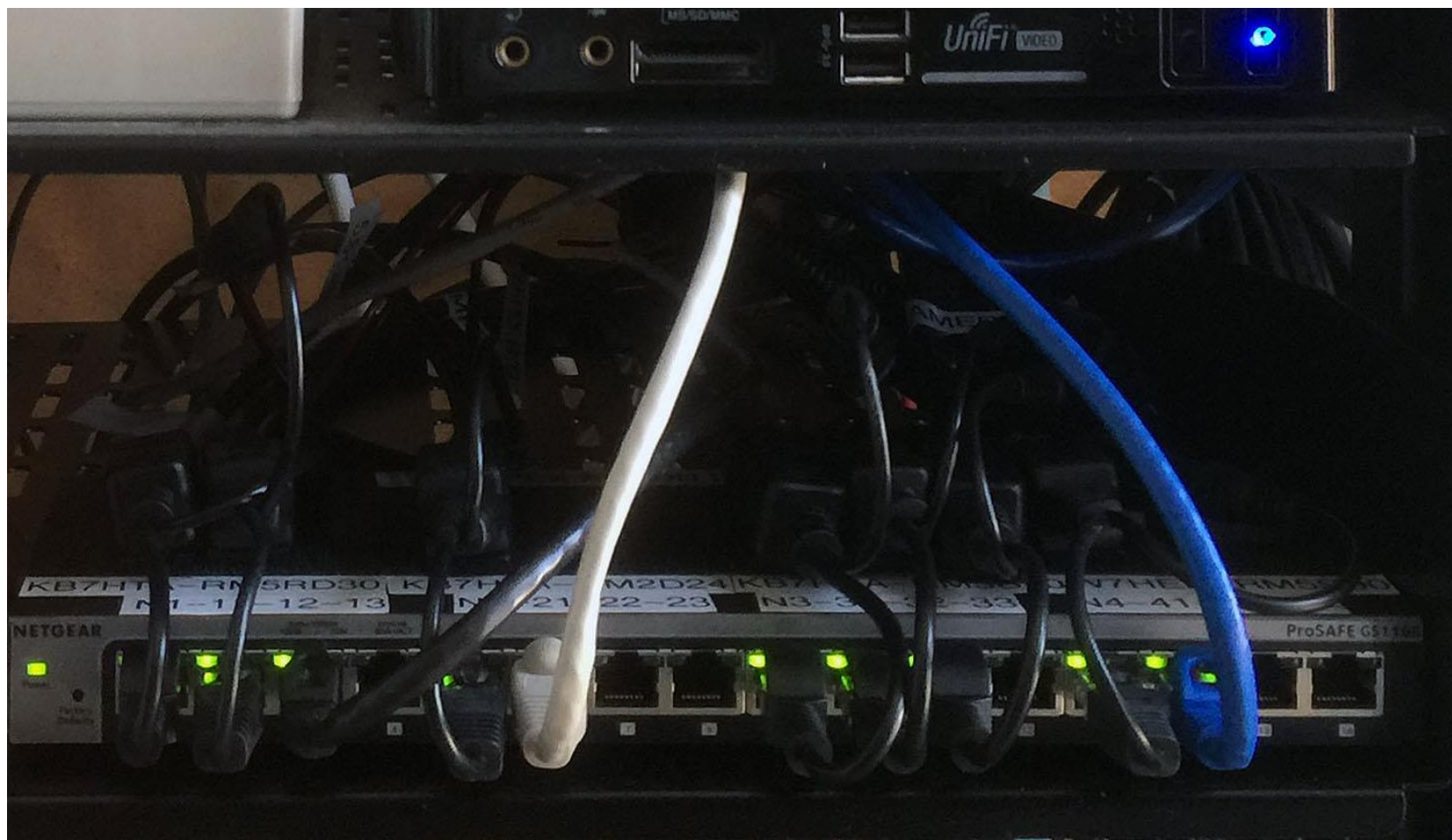
- The Grid Connect NET485 converts the RS-485 status data from the EPeve's charge controller into a TCP/IP transport layer, which is then passed over the LVMesh Network.

# Apex HARC-LVMesh Equipment Bay





# Apex LVMesh Managed Switch

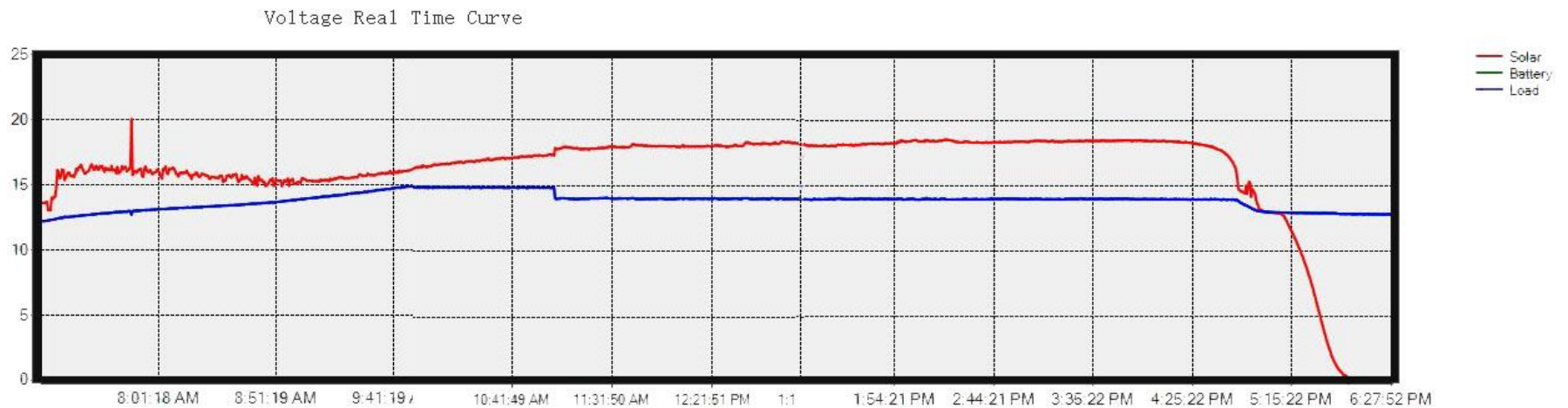




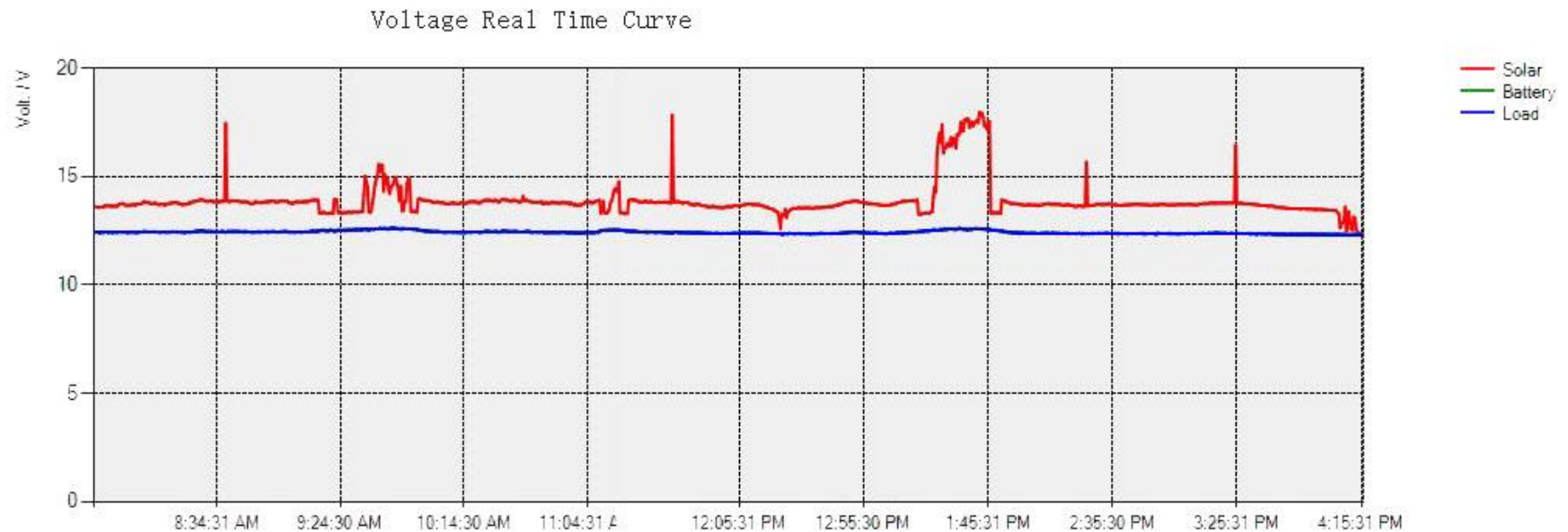
# EPever Admin Console



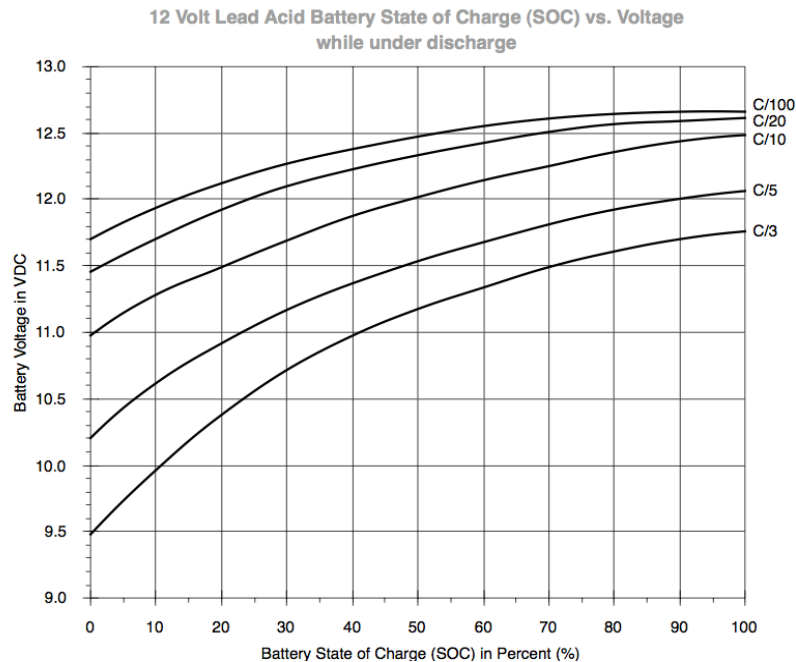
# Good Solar Charging Day on Apex 1-30-21



# Bad Solar Charging Day on Apex 1-25-21



# State of Charge(SOC) – Not an Exact Science



AGM BATTERY STATE OF CHARGE	
Level	Voltage
100%	13.00V
90%	12.75V
80%	12.50V
70%	12.30V
60%	12.15V
50%	12.05V
40%	11.95V
30%	11.81V
20%	11.66V
10%	11.51V
0%	10.50V

# No Design is Perfect – Clouds & Snow



# Apex LVMesh Network Power Outage

- 1-24-2021 - Fair weather all day and the batteries were fully charged by the end of the day.
- 1-25-2021 - Cloudy all day with very little charge for the batteries
- 1-26-2021 - Cloudy all day with very little, charge for the batteries.
- 1-27-2021:0700 - The LVMesh Network on Apex is now completely solar/battery powered. Due to the recent spell of cloudy, rainy and snowy weather, the solar panels have not provided sufficient power for charging the batteries. When the sun returns, so will the Apex LVMesh Network. We are sorry for any inconvenience.
- 1-27-2021:0830 - The LVMesh Network is back online and the solar panels are now charging the batteries. The outage was estimated to be about 12 hours.
- 1-27-2021:1501 - The LVMesh Network batteries continue to charge and should have enough energy to make it through the night.
- 1-27-2021:1630 - The LVMesh Network batteries are no longer being charged at this time, but there should be enough energy to make it through the night.
- 1-28-2021:0555 - The LVMesh Network almost made it through the night. It went offline at about 0545 and with luck and some sun it should be back up in a few hours.
- 1-28-2021:0825 - The LVMesh Network is back online and the batteries are being charged. The network was offline for 2 hours and 45 minutes.
- 1-28-2021:1645 - The LVMesh Network batteries had a good charging day. The batteries are about 80% charged and the voltage under a 1.7 amp load is 12.8.
- 1-29-2021:0930 - The LVMesh Network made it through the night with the lowest voltage being 12.05. The batteries are now starting to charge with 0.2 amps going in.
- 1-29-2021:1720 - The LVMesh Network had a very good charging day. The batteries are about 95% charged and the voltage under a 2,0 amp load is 12.85.



# Modifications

- A Network TCP/IP switchable 110 VAC outlet (EZ-Outlet2) and a 13.8 VDC power supply has been added to power the system during long periods of rain/snow and/or overcast skies. This will not need to be used often.
- Update Power Distribution Box (PDB) in the future with Arduino connected to LVMesh Network to read PDB 12 and 24 buss voltages and currents, turn on/off some power lines and reset all LVMesh nodes.

# Summary

- Is this the kind of project the club might be interested in for 2021?
- Discussion

# The End

- Thanks to everyone who made this possible.
- The presentation will be on the [KB7HTA.COM](http://KB7HTA.COM) website a little way down the page on the right.