Solar Power & Ambient Monitoring

National Ambient Air Monitoring Conference

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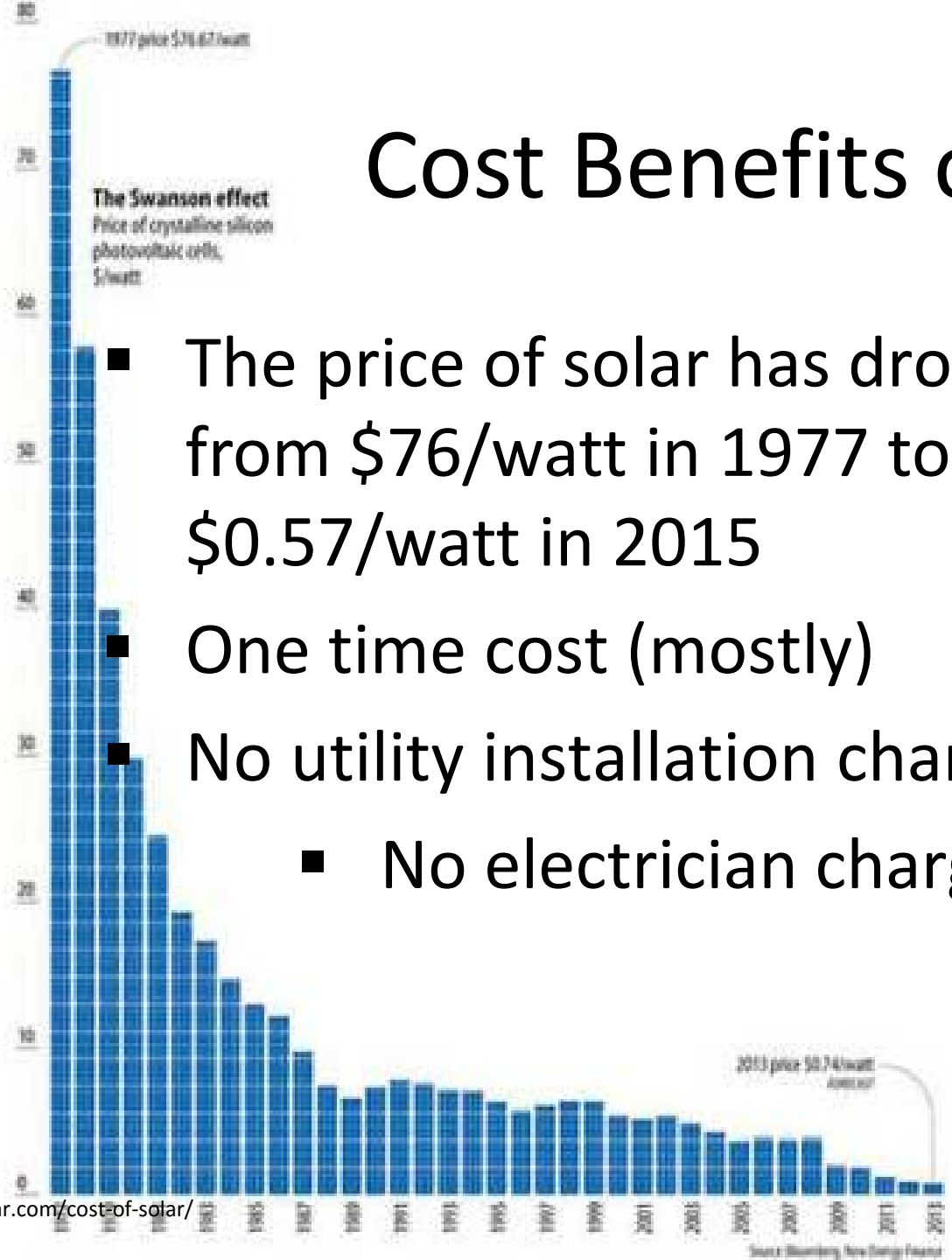
Overview

- **Benefits of solar**
- **Evaluating/optimizing loads**
- **Designing the system**
- **Modifying equipment**
- **Building the system**
- **Battery Technologies**
- **Conclusions**

Cost Benefits of Solar



- The price of solar has dropped from $76/watt in 1977 to $0.57/watt in 2015
- One time cost (mostly)
- No utility installation charges
  - No electrician charges

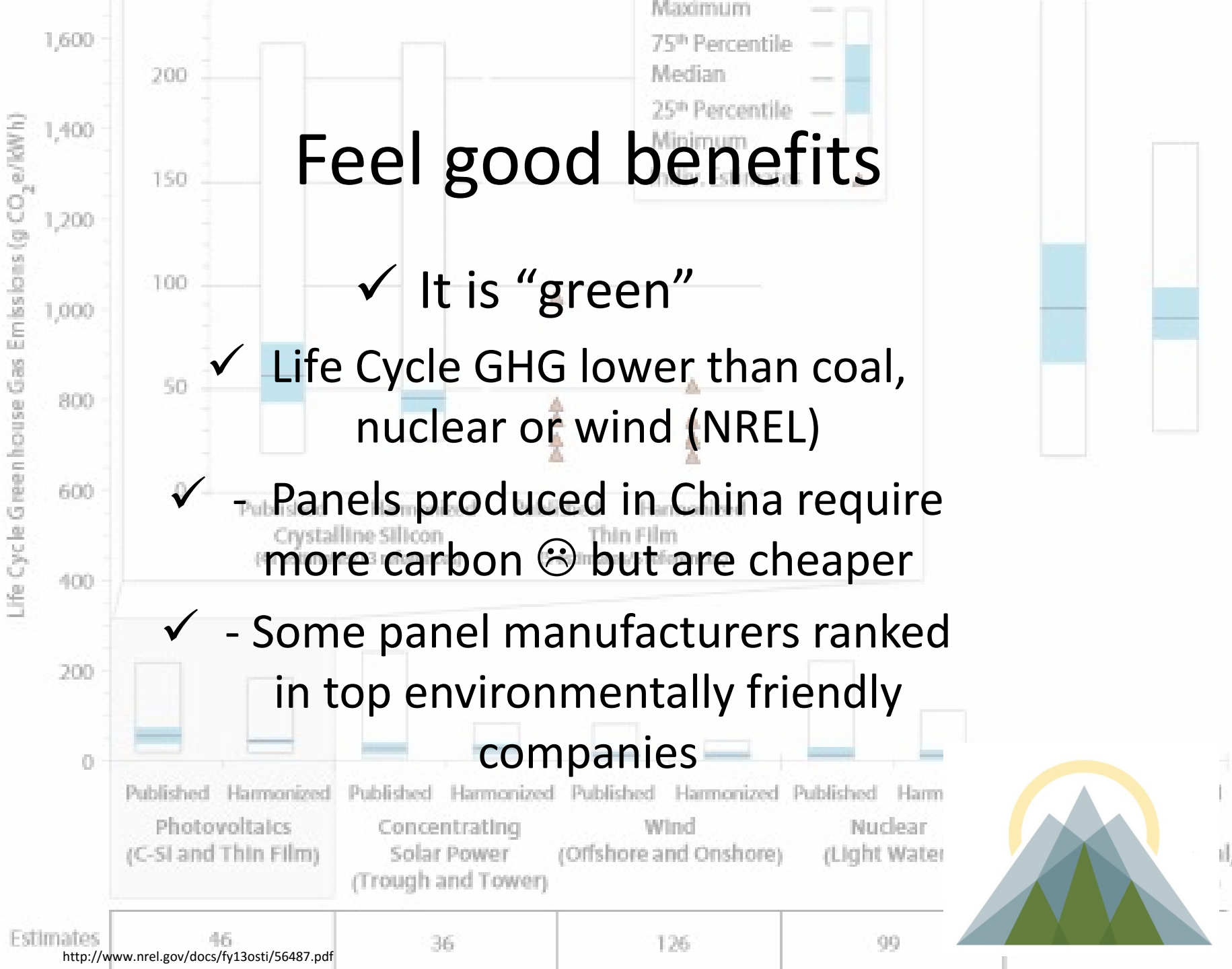
http://understandsolar.com/cost-of-solar/

Logistical Benefits

- Small sensor platforms can be quickly moved and deployed without regard for utility power
- Less coordination involved, simply drop and secure sensors
- If designed correctly, no down time from grid failures

Feel good benefits

- ✓ It is “green”
- ✓ Life Cycle GHG lower than coal, nuclear or wind (NREL)
- ✓ - Panels produced in China require more carbon ☹ but are cheaper
- ✓ - Some panel manufacturers ranked in top environmentally friendly companies



http://www.nrel.gov/docs/fy13osti/56487.pdf

Evaluating Loads

- Solar/Battery still expensive
- Modify devices to use less power
- Good measurements required for calculating power requirements
- Logging the load helps to better understand kWh, esp. for equipment that cycles (heating, valves, etc)
- Minimize heating/cooling demands by reducing enclosure size

Modifying devices

- Consider devices that operate directly on DC. If they use an AC-DC power supply, eliminate it
- Consider environmental requirements. If cooling or heating is necessary, choose instruments that have wider operating ranges
- Modify pumps to run on DC if possible
- Insulate areas that have active heating like benches, etc

Calculating requirements

- Once kWh of loads is known, you can calculate size of solar and battery systems
- Use an online calculator for best accuracy
- Calculators take into account charging efficiencies, hours of sunlight available, etc
- https://www.altestore.com/store/calculators/off_grid_calculator/
- Campbell Scientific offers spreadsheet with loads for their devices

Example, powering a cellular modem

- Measures 450 mA on average at 13.8 VDC, so 6 watts
- Total daily load is 0.144 kWh
- Make worst case assumptions. Coldest battery temp, longest time without sun
- Battery size for 12V = 92 A/h
- Solar panel size = 46W

YOUR INFORMATION

Used if you optionally choose to save your calculator for later use

Name: EPA Test

Date: 08/02/16

Alt-E off-grid calculator

Battery Bank Sizing

This calculator will help you size the battery bank for your system.

STEP 1:

Your Daily Energy Usage

Watt Hours per Day: 150

This value is usually printed on your electric bill. Take your monthly kilowatt-hour usage from your electric bill and divide it by 30 to get your daily kilowatt-hour usage. Since it's in kilowatt (1000's of watts) you'll need to multiply that number by 1000 to get the number into watt-hours. If you don't have a bill, or don't know your consumption, please use our Load Calculator to go through the steps to determine this value.

Is your energy usage too high? Don't despair, our knowledgeable sales folks can help you find other potential solutions. Please call us toll free at: **800-320-9514** .

STEP 2:

How Many Days Should Your System Run without Sun?

How many days of backup power do you want in case of cloudy/rainy days?
(when your solar panels will produce little energy)

2

STEP 3:

Adjust the Effective Capacity of Your Battery Bank Due to Low Temperatures

What is the lowest temperature your battery bank will experience?

20F (-7C) Degrees

RESULTS:

Battery Bank Capacity: **1098 watt hours**

Select a battery bank voltage: 12

Battery Bank Capacity: **92 amp hours**
3 String Configuration: **31 amp hours per string**

Note: All calculations assume only a 50% discharge to your batteries to optimize battery life.

Select the deep cycle battery that fits your needs

Solar Panel and Solar Charge Controller Sizing

This calculator helps you size the solar panel(s) and charge controller(s) needed for your system.

STEP 1:

Determine the Solar Exposure for Your Site

You need to determine the average number of sun-hours per day during the least sunniest month of the year (not the whole year).

Select the State-City Closest to your location (currently only US states are provided)

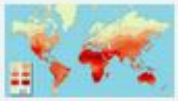
CO - Boulder

or

Manually enter the average sun-hours for your location.

4.2

You can use this world map of solar insolation values to determine an estimate of sun-hours for your location.



STEP 2:

Sizing Your Solar Panel Power Needed

The total wattage of Solar Panels that you need is:

46.4 **Watts, or** 0.05 **kilowatts**

This value takes into account losses due to system inefficiencies.

STEP 3:

Determine How Many Solar Panels You Need in Your Array

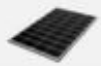
How many solar panels do you need? That depends on the panel you choose.

Select the wattage of the panel your interested in, and see the results below:

50 watts per panel

You will need 1 panels for a total of 50 watts.

Select the solar panel that fits your needs.



Sizing your Solar Charge Controller

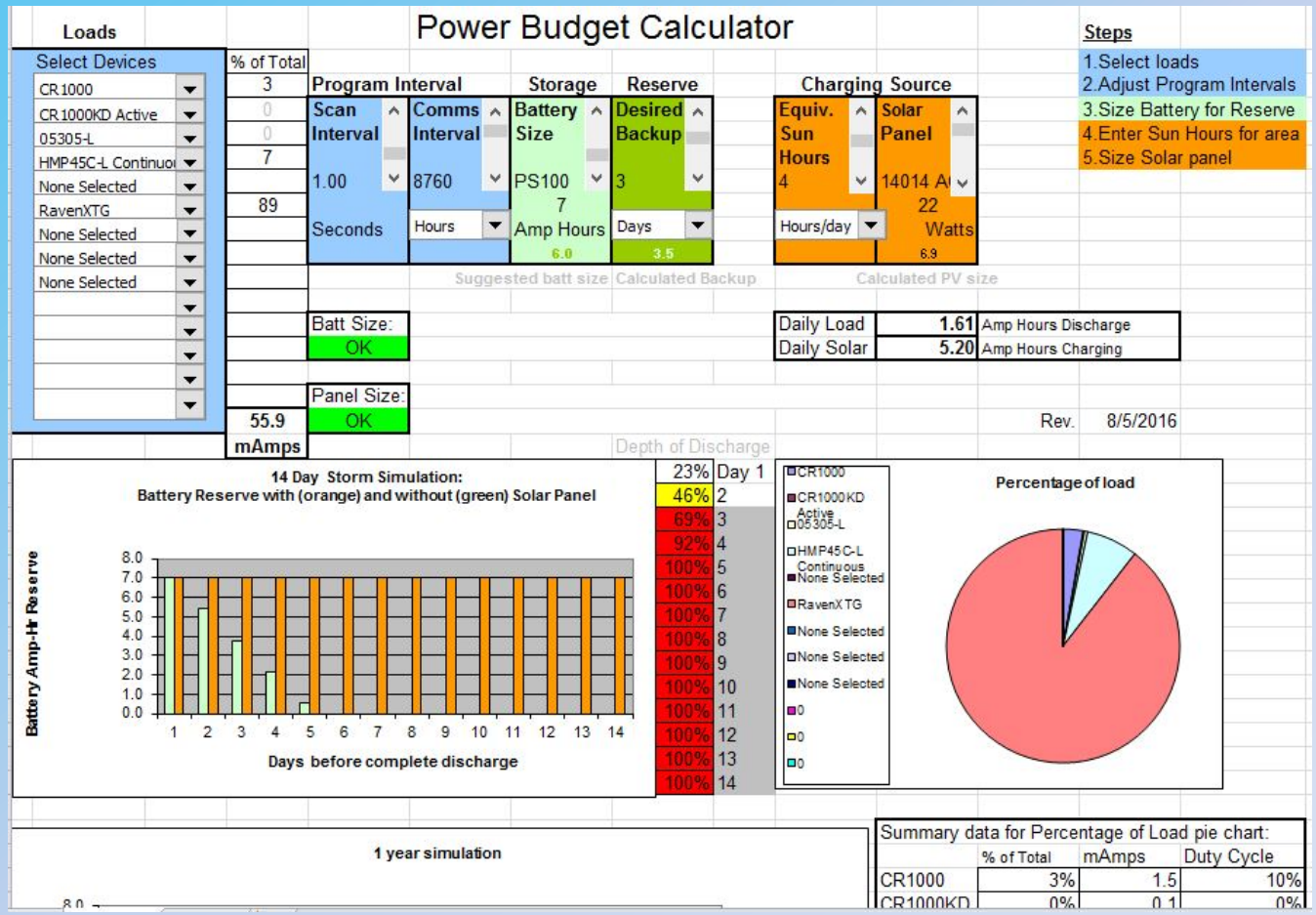
You will need a charge controller that can handle 5 amps

Select the solar charge controller that fits your needs

Sizing a charge controller can be complex, the above answer is a conservative estimate. Please feel free to call us to find a more accurate fit for your needs.

Now that you have sized up the system that fits your needs, call our Knowledgeable Sales Folks at 800-320-9514 and let them help you find the exact products for your system.

Campbell Scientific Power Budget Spreadsheet



Example of power requirements for a Teledyne-API 400e with factory AC pump vs aftermarket DC pump

Teledyne-API 400E w/ IZS		
	AC pump	DC pump
Power Draw	94 Watt	37 Watt
Battery Bank Req'd	1376 A/h at 12V	542 A/h at 12V
Solar Req'd	698 Watts	275 Watts
Cost batt/solar	$5,621	$2,409

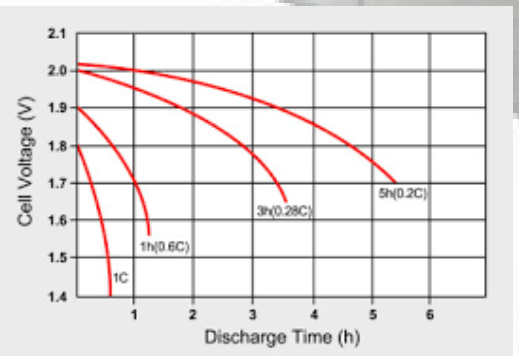
Sensidyne DC pump on factory plate. Pump cost is ~ $250 and lasts ~ 1 year. Disposable

This is battery and solar difference only! Shipping, cooling, support equip, etc. compound these costs

Batteries – Lead Acid

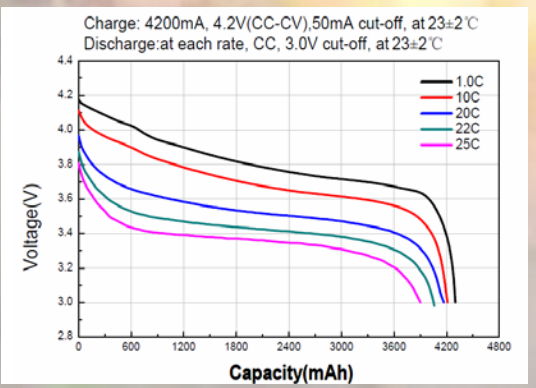
- Sealed or vented
- Cheap, readily available
- Long lasting
- Easily recycled
- Heavy!
- Good for larger projects that don't get moved around much
- Tough, accept abuse
- Do not require complex battery management systems
- Very Safe

Big voltage discharge curve



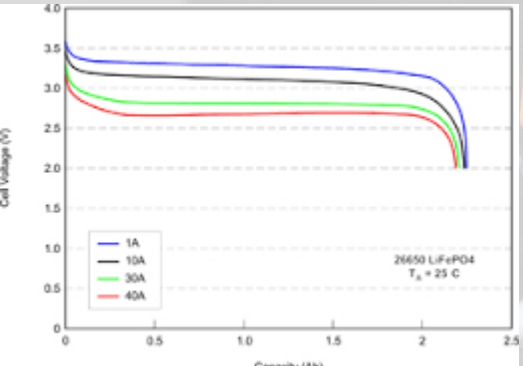
Batteries – Lithium Polymer

- High energy density
- Lightest weight
- Require balancing chargers
- Require battery management systems
- Very dangerous, should not be used unattended

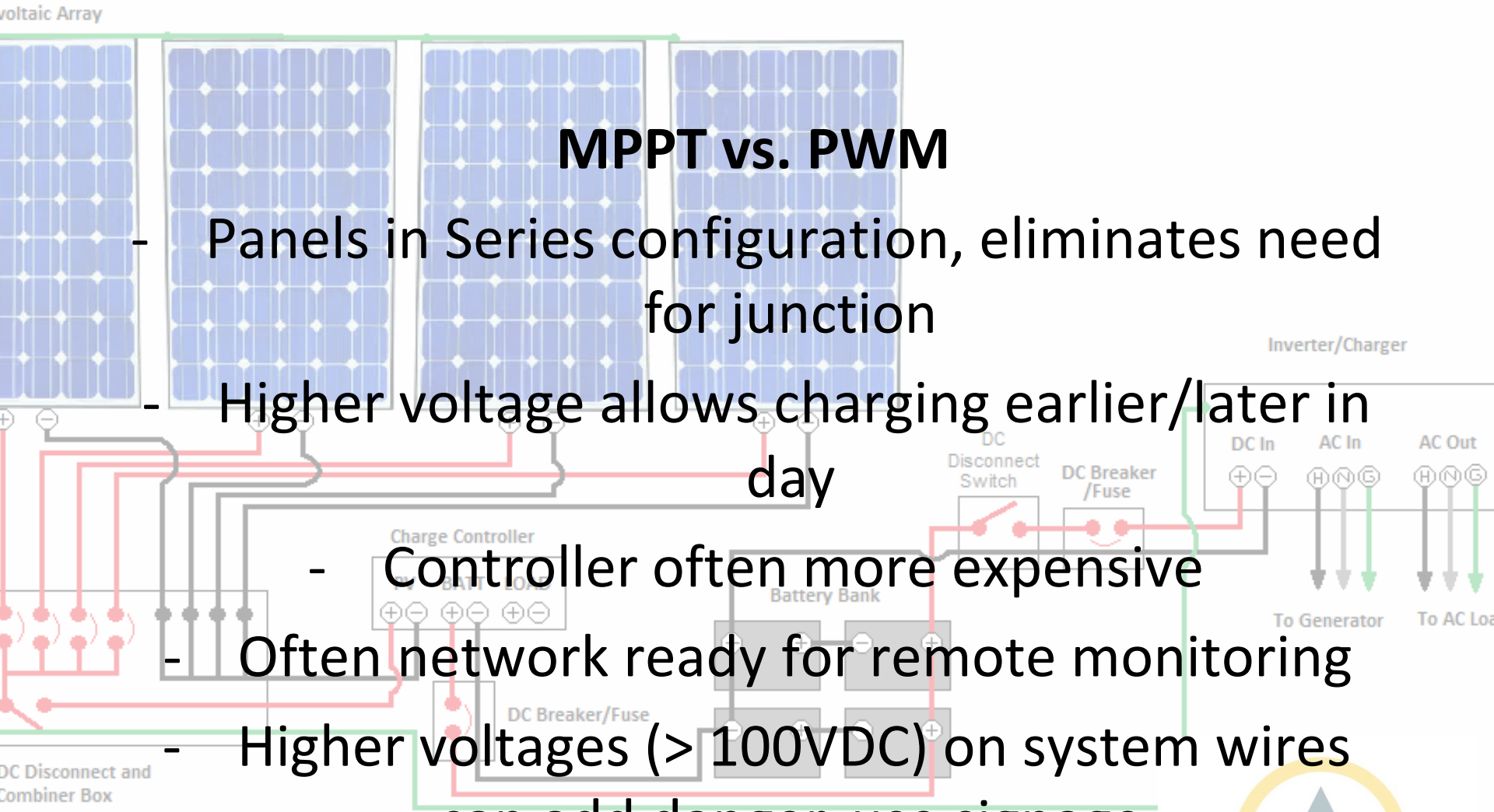


Batteries – Lithium Iron Phosphate

- High Energy density
- Very low voltage discharge curve
- Very safe operation – can't run away
- Requires battery management and balance chargers
- Most of A/H capacity is useable
- Weight is ~ 25% of comparable Pb system



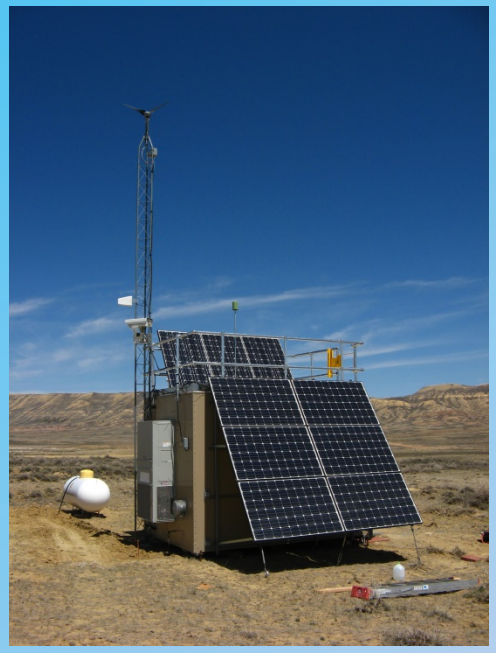
Off-Grid PV System



MPPT vs. PWM

- Panels in Series configuration, eliminates need for junction
- Higher voltage allows charging earlier/later in day
- Controller often more expensive
- Often network ready for remote monitoring
- Higher voltages (> 100VDC) on system wires can add danger, use signage

Examples of ARS solar projects



Hiawatha Gas Field, Wyoming

Joshua Tree Nat'l Park Ozone

Portable Ozone Monitor

Trailer mounted PM monitor

Conclusions

- Utilize solar vendors when choosing components. They will help for free
- Optimize loads and environment before sizing components
- Shop around, scour the internet for ideas