

# BACKUP POWER

---

from Chasing Gasoline to Sun & Batteries  
in 2019 to 2021

Mike Lambert KI5MIK

2023-12-16 v2

# CONTEXT

---

- I am NOT a presenter
- I am NOT an advanced power point user
- I am NOT a Solar Engineer
- I am NOT an Electrical Engineer
- I am NOT an Electrician
- I am NOT selling anything

If you see a problem with anything in this presentation, speak up.

# WHERE I COME FROM

---

## I care about Product

- Safety
- Quality
- Tech Support
- Dependability
- Utility
- Longevity
- Band for the buck
- Elegance

## I don't care about

- Popular
- Trendy
- Brand name
- What other's think

# NOT COVERED MUCH IF AT ALL

---

What I won't be spending much time on, but it matters:

- Series and Parallel Panel configurations
- Mixing panels of different wattage
- Proper cable wire gauge
- Losses over long cable runs

You will need to have a basic knowledge of these subjects.

# ABOUT YOUTUBE AND THE INTERNET

---

- Youtube is a great source of excellent information (I use WaveformScience and HoboTech or sometimes Jasonoid)
- Youtube is a great place to find people who do NOT know what they are talking about
- Youtube has a lot of product reviews that are Junk
- You WILL get some inaccurate information, beware!
- You will get a lot of Opinion stated as fact
- You must verify any information you get from me or other source before you use it

## MY INITIAL PREPARATIONS 2002-2004

---

After the Hail Storm in April 2001 and Alison in June 2001

- Bought a 5000W Gasoline Generator
- Fashioned plywood window coverings
- Created written emergency plans

# BASIC PREPAREDNESS

---

- FEMA

- How to Build a Kit for Emergencies
- <https://www.fema.gov/press-release/20210318/how-build-kit-emergencies>
- Supplies Checklist
- [https://www.ready.gov/sites/default/files/2021-02/ready\\_checklist.pdf](https://www.ready.gov/sites/default/files/2021-02/ready_checklist.pdf)

- Red Cross

- Create Your Emergency Plan in Just 3 Steps
- <https://www.redcross.org/get-help/how-to-prepare-for-emergencies/make-a-plan.html>
- List of things suggested for 3-day supply for evacuation, 2-week supply for home
- <https://www.redcross.org/get-help/how-to-prepare-for-emergencies/survival-kit-supplies.html>

# HURRICANE IKE

THE GAS GENERATOR DID WORK (TO SOME DEGREE)

---

## Pros

- Powered Refrigerator (saved expensive food)
- Powered some cooking and water heating appliances
- (had hot food, hot coffee and cold beer)

## Cons

- Used a LOT of gas (10+ gallons a day)
- NOT EFFICIENT!!
- Gas was hard to find (gas station had to have a generator)
- Gas was expensive (\$5.50 - \$6.50)
- Generator damaged sensitive items (bye-bye microwave)



# RECAP LOCAL RISKS (LAST 40 YEARS)

---

## Hurricane

Alicia 1983 5-10" rain

Ike 2008 8-18" rain

## Flood

Fire & Rain 1994 8-28" rain

Alison 2001 29-36" rain

Memorial Day 2015 11" rain

Tax Day 2016 17" rain

Harvey 2017 52" rain

## Loss of Power

Ike 2008 2-50 days

February 2011 rolling blackouts

Misc Local Outages 1-8 hours

Valentine's Day 2021 1-14 days

# VALENTINE'S DAY 2021 WAS SPECIAL

---

Texas came within 4 minutes 37 seconds from a  
**Total Power Grid Collapse**

Texas would have been with no power for months as the Power Grid would have to  
be reestablished via a Black Start  
(Texas has 13 Black Start plants)

<https://www.kut.org/energy-environment/2021-08-05/if-the-texas-power-grid-had-gone-down-it-would-need-a-black-start-how-long-would-that-take>

About half of Texas' "failsafe" generators failed

<https://arstechnica.com/tech-policy/2021/05/texas-power-outage-almost-became-weeks-long-catastrophe/>

**We must be prepared for extended outages**



## 2019 – 2020

CLEANED OUT AND REFURBISHED THE GARAGE

- 
- Decided to move from Gasoline to Solar
  - Got rid of gasoline generator

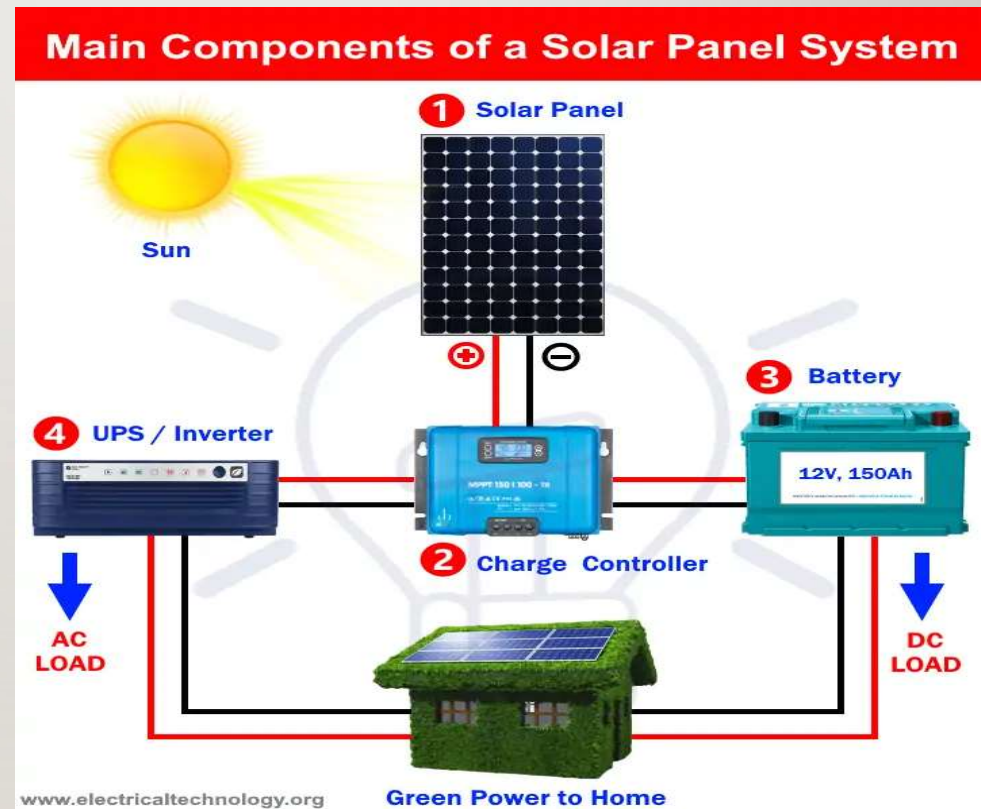
RV community uses solar panels and Deep Cycle and/or AGM batteries

Lithium batteries becoming more popular and affordable



## 2019 COMPONENTS NEEDED FOR SOLAR PANEL SYSTEM

- I don't want to build that big yet
- Look for something simpler
- Solar Generators with Lithium batteries start becoming available



# FIRST SOLAR PANEL



## Big Blue 28W Solar Panel

- 2 USB A connectors on the charge controller
- Bought several USB chargers (bricks)
  - Careful, batteries outside in summer get hot!
- Had to buy long cables to move batteries inside from the solar panel outside
  - USB extension cables
  - (later) 552I extension cables
  - (later) plug adapters



# WHAT CAN I POWER WITH BIG BLUE 28W PANEL?

- Charge Battery Chargers that charge
  - Phone
  - Tablet
  - Emergency Radio (has weather stations)
  - USB lights
  - Ham HT
  - Fans



# LITHIUM BATTERY CHEMISTRIES

---

Lithium Nickel Manganese Cobalt oxides

NMC or NCM

Consumer products and electric vehicle applications because of the material's high energy density and operating voltage

Lithium Nickel Cobalt Aluminium oxides

NCA

high specific energy and a long life span

Heavier

Lithium Iron Phosphate ( $\text{LiFePO}_4$ )

LFP

Cheaper to manufacture

Safer

# DANGERS OF LITHIUM BATTERIES

|     | Safety | Decomposition temperature | Heat release |
|-----|--------|---------------------------|--------------|
| NMC | ★★★    | 210°C(410°F)              | 600J/g       |
| LFP | ★★★★★  | 270°C(518°F)              | 200J/g       |
| NCA | ★★     | 150°C(302°F)              | 940J/g       |

---

## Thermal Runaway

- Fire
- Deadly Fumes
- Explosion

Article here

<https://www.flashbattery.tech/en/safety-and-risks-of-lithium-battery/>



# BATTERY ABUSE AND THERMAL RUN AWAY

- Mechanical Abuse
- Electrical Abuse
- Thermal Abuse

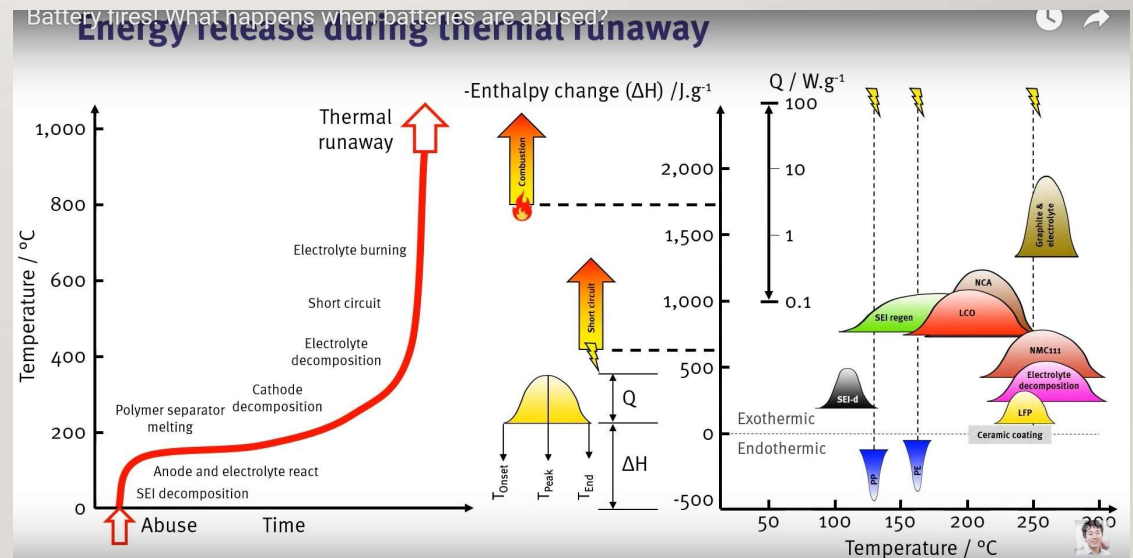
Watch these 2 videos at least twice

What happens when batteries are abused (to abbreviate - 0:0-2:10 and 8:48-12:06)

<https://www.youtube.com/watch?v=VWMfesebyt4>

LiFePO4 Drill Test

<https://www.youtube.com/watch?v=D8xNjz73p80>



# ABUSE SUMMARY & PROTECTIONS

---

- **Mechanical Abuse**

- Protect from physical abuse like puncture, dropping, vibration, etc.

- **Electrical Abuse**

- Do not charge overly fast OR over charge (don't charge to 100% or leave plugged in)
  - Charging from 90%-100% causes more heat and stress on the battery
- Do not discharge overly fast OR over discharge, implement Depth of Discharge (DoD) at least 90%
  - Discharging from 10% to 0% causes more heat and stress on the battery
- Store at 60%-70% State of Charge (SoC)
- Use slowest charge rate you can (#W). Some units have 3 or selectable charge modes (Watt levels)
- Charge to 80%, discharge to 20% for regular use to prolong battery life even more

- **Thermal Abuse**

- Protect from heat and cold
- Ensure adequate ventilation and don't obstruct cooling fan intake and exhaust

Follow the manufacturer's periodic discharge to 0% and charge 100% instructions to maintain battery health

# SAFETY SUMMARY

---

- NMC and NCA batteries are just fine to use, just observe the cautions in the previous slide
- LFP is safer But LFP is heavier
- NMC batteries weigh less per Wh
  - for example a 2000Wh NMC and 1300Wh LFP weigh about the same

# DEPTH OF DISCHARGE (DOD)

---

- **DoD is important.** Discharging a Lithium battery below 10% is very hard on the battery so it is best to not do it.
- You cannot assume that 'someone else' has taken care of DoD, most don't. You are responsible for DoD.
- Before buying a unit, download the Manual and look for DoD
- If you don't see DoD in the Manual, contact the manufacturer TECHNICAL SUPPORT and ask.  
If your response comes from Sales, it is probably not dependable.
- If the manufacturer doesn't implement DoD, calculate your own and write it on the unit so anyone using it does not over discharge the battery

**WARNING!!** Do not discharge below 10%

# SOLAR GENERATOR

## WHAT'S IN THE BOX?

---

- Charge Controller (set for correct battery type and profile)
  - PWM (Pulse Width Modulation) less efficient
  - MPPT (Maximum Power Point Tracking) most efficient
- Lithium Battery
- Battery Management System (BMS)
- DC supply circuit connected to external connectors (hopefully regulated)
- AC inverter connected to external connectors
- **Optional** - Uninterruptable Power Supply circuit (UPS)
- Cooling fans and vents to dissipate heat
- External information display showing current SoC, power in, power out, etc.

# ADDITIONAL FEATURES OF SOLAR GENERATORS

---

- Most Solar Generators have [multiple ways to charge](#) the battery like:
  - AC mains power or gas/propane generator
  - Low voltage DC power sources (12-14 volt like a car or another battery)
  - Solar Panels (18V-150V or more)
- Some Solar Generators can be [charged by more than one source at the same time](#)
  - Usually solar and AC
- Some Solar Generators can be [charged at different power levels](#) for a quicker charge
  - For example low, medium or fast
  - Low charging is less stress on the battery, Fast charging stresses the battery (only use in an emergency, it will decrease battery life)
- Most Solar Generators are Pass-Thru Power capable (but may decrease battery life)
  - You can [charge and discharge](#) at the same time
- Some Solar Generators have [expandable battery \(Wh\) capabilities](#)

# WHAT DOES THE BMS DO?

---

- Manages battery cell voltage and balances charge across cells
- Over charge protection
- Over discharge protection
- Over voltage protection
- Over current protection
- Short circuit protection
- Over temperature protection
- Depth of Discharge (DoD)
- Provides data for external display



# UNINTERRUPTABLE POWER SUPPLY (UPS)

---

- A Circuit that uses AC mains power to power the AC load when available, bypassing the battery and Inverter
- When AC mains power is not available, UPS transfers the load to the battery and inverter (normally in 10-20ms)
- Not every Solar Generator has a UPS circuit
- Not every Solar Generator with a UPS circuit has an indicator on the information display
- Normal use:
  - Plug Solar Generator into AC mains power
  - Turn on Inverter
  - Connect the AC load



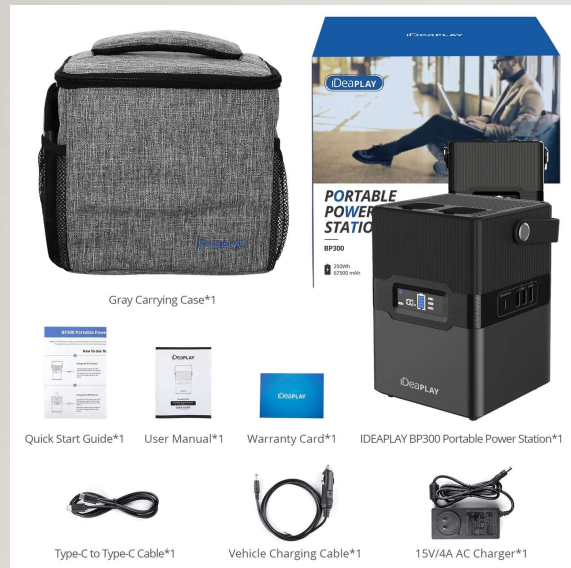
# READ THE MANUAL FIRST!!

## FOR BOTH YOUR SOLAR PANEL AND SOLAR GENERATOR

---

- It is Very Important that you read every page of the manual first, especially the cautions.
- **Know the operating temperature range of the unit** (why you don't put it outside in Texas summer or freezing weather)
- You will make less mistakes and be safer
  - **Always measure the Volts Open Circuit (VOC) to verify the voltage is within specs BEFORE you connect the solar panel to device**
  - If you put 46V (2 120W solar panels in series) into a 12V-28V solar input, you may blow up the Charge Controller.  
(see HoboTech blow up the Leoch solar input in the Nov 2020 Leoch review)
- You will get the most out of your product
- Some manufacturers suggest a discharge to 0% and charge to 100% a few times a year to maintain battery health. Do it.
- Pay special attention to (do NOT exceed)
  - Max solar (PV) input Voltage
  - Max solar (PV) input Amperage
  - Max input Watts

# FIRST SOLAR GENERATOR



## Ideaplay BP300

- 250Wh Lithium Polymer Battery (prob 500 cycles to 80%)
- DoD UNKNOWN (assume it is 100% so don't discharge below 10%)
- Input - 60W max AC, Power Delivery, Solar, Car charger
- 12V - 24V probably 60W 5521 connector
- 300W inverter
- DC output max 12V 10A (5525) use 5525to5521 adapter
- USB A
- USB C PD 60W (In / Out)
- 8 pounds
- Charging modes - AC, Car, Solar Panel (PV)
- Main Job – running portable TV

# FIRST LARGE SOLAR PANEL

---



## Coocheer 120W Solar Panel

- (wasn't 120W, but 60W Buyer beware!)
- Impressive number of charge interface options
  - USB A
  - USB Fast Charge
  - USB C
  - 552I (18V) cable
  - 552I to Anderson cable
  - 552I to Battery Clamp cable
  - 10 adapters for a variety of devices

## SECOND SOLAR GENERATOR



## Bluetti AC50S

- 500Wh LG Lithium batteries (NMC)
- 90% DoD (from manual) (1000+ cycles)
- Pass-Thru charging
- Solar Input 12-40V 120W
- Can charge with AC and Solar at the same time
- 300W inverter
- 10A 12V DC output 12V regulated at 13.3V
- USB A
- USB C 45W PD
- Wireless 15W
- 14 lbs
- Charging modes - AC, Car, Solar panel (PV)
- [Main Job – Backup Power for 2m/440cm radio](#)

## BLUETTI SPI 20 FOLDING SOLAR PANEL


- 
- 120W (23.7V 6A)
  - Portable folding
  - MC4 connectors
  - High Quality





## BLUETTI SP120 120W SOLAR PANEL SPECS

| Technical Details/仕様                |             |
|-------------------------------------|-------------|
| Model/型番:                           | SP120       |
| Peak Power/最大出力 (Pm):               | 120W        |
| Solar Cell / ソーラーセル:                | Sunpower    |
| Solar Cell Lamination/太陽電池積層方式:     | ETFE        |
| Cell efficiency/セル変換効率:             | Up to 23%   |
| Voltage at max power/出力電圧 (Vmp):    | 19.8V       |
| Current at max power/出力電流 (Imp):    | 6.06A       |
| Open circuit voltage/負荷遮断電圧 (Voc):  | 23.7V       |
| Short circuit current/ショート電流 (Isc): | 6.66A       |
| Operating Temperature /作業環境温度:      | -10°C~+65°C |
| Warranty/保証期間:                      | 12 months   |



# DIFFERENT SIZES OF SOLAR GENERATORS

---

The following slides are examples of different sizes of Solar Generators

Note the different:

- Battery sizes in Wh
- AC Inverter sizes in W
- Some have a UPS
- Solar Input voltages ranges
- Higher DC Supply Amperage on some large Solar Generators
- Size and Weight

Based on what you need there is probably a convenient size that will do the job for you



# FOR LARGE SOLAR GENERATORS

---

- Little things don't really matter that much
  - USB charging
  - Power Delivery ports
  - 10 Amp DC sources
- What really matters is
  - Rated Wattage ('Surge Wattage' is not very important since it is mostly only for a second)
    - You should normally only use 80% of this amount
  - Max Amperage of the Inverter
  - Watt hour capacity of the battery
  - Large DC source (over 10A)
  - Type of AC plugs available
  - Weight



# BLUETTI AC200



- Fabulous Touch Screen (lots of detail)
- 1700 Wh LG Electric Vehicle Grade lithium battery cell (NCA)
- DoD 90% (from manual)
- 2000W Inverter
- Pass-Thru charging
- 10A and 25A DC Output regulated at 13.4V
- 35V – 150V, 12A, 700W solar input
- Charging modes - AC, Car, Solar panel (PV)
- Can charge with AC and Solar at the same time
- 53 pounds (I bought a cart for it)
- (First Job was powering my refrigerator, I needed more)
- Main Job – Solar Input Collector and power distribution

## ECO-WORTHY SOLAR PANEL

- 
- 120W (22.5V 6A)
  - MC4 connectors
  - Glass Panel
  - NOT Portable (41.9"L x 23"W x 1.4"H)



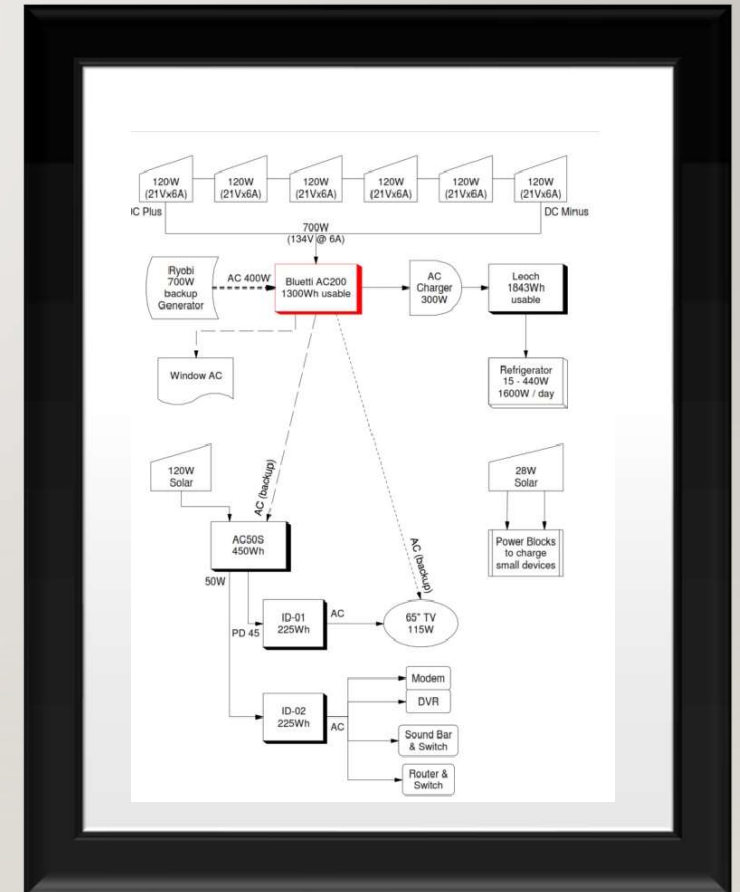
# LEOCH



- 2200Wh LFP Battery
- 2000W Inverter
- **UPS !!**
- Pass-Thru charging
- Measly 10V–35V, 20A, 300W solar input
- Can charge with AC and Solar at the same time
- 68 pounds!!
- Has 2 rear wheels but difficult to move around
- **Main Job – backup refrigerator full time and emergency Microwave (1600W) use**

# MY ORIGINAL PLAN

A 2000W propane generator provides backup for when there is no sun



## MONTEK XI000



- Water and dust resistant (see HoboTech video)
- Durable case (see HoboTech video)
- Has 80W solar panel and all cables fit inside of the unit (very portable)
- 1010Wh Lithium NMC battery
- DoD 96% (Tech Support) because Montek goes by cell voltage (selectable reminder 1%-10%)
- 1000W Inverter
- Pass-Thru charging
- Can charge with AC and Solar at the same time
- Solar input 12V-70V 12A 350W
- Charging modes - AC, Car, Solar panel (PV)
- 10A DC regulated at 13.4V
- USB QC
- USB C PD 100W
- 30 pounds
- Main Job – Washer/Dryer and other medium loads



## BLUETTI EB55



- 537Wh LFP Battery
- 90% DoD (from Tech Support) (it appears to be a 'company policy')
- Pass-Thru charging
- Solar Input 12-28V 10A 200W
- Can charge with AC and Solar at the same time
- 700W inverter
- 10A 12V DC output 12V regulated at 13.0V
- USB A and USB C 100W PD
- Wireless 15W
- Charging modes - AC, Car, Solar panel (PV)
- 17 pounds
- Main Job – Heating water, shuttle power, etc.

## BLUETTI EB3A



- 286Wh LFP Battery
- 90% DoD (from Tech Support)
- **UPS**
- Pass-Thru charging
- Solar Input 12-28V 8A 200W
- Can charge with AC and Solar at the same time
- 600W inverter
- 10A 12V DC output 12V regulated at 13.2V
- USB A and USB C 100W PD
- Wireless 15W
- Charging modes - AC, Car, Solar panel (PV)
- 10 pounds
- Main Job – I to power Network & NAS drives, I to power media center

# WHAT IS USEABLE WH?

---

- **Useable Wh** is the number of Wh you can actually get out of the solar generator (DC and AC)
- Most people 'forget about' DoD and calculate the wrong results

$$\text{Stated Wh} * \text{DoD} = \text{Available Wh} * \text{AC or DC efficiency} = \text{Useable Wh}$$

(For example: 1152Wh Stated \* 90% DoD = 1036 Wh Available \* 90% efficiency = 932 Wh Useable)

- If you measure what you get out, you can calculate AC/DC efficiency

$$\text{Measured (Useable) Wh} / (\text{Stated Wh} * \text{DoD}) = \text{AC/DC efficiency}$$

- If you have measured your load per hour, you can calculate your approximate run time

$$\text{Stated Wh} * \text{DoD} * \text{AC/DC efficiency} / \text{load per hour} = \text{approx. run time}$$



## LET'S RUN SOME NUMBERS

---

- Because the EB3A is small and has a UPS, I decide to use it to power my network router, switch and NAS drives full time.
- When the power fails, I want my router, switch and NAS drives to keep running.
- The EB3A has a DoD of 90% and (in this example) the AC inverter is 92% efficient.
- The network router, switch and NAS drives uses 36W max and 0.5KWh (500Wh) in 1 day (21Wh per hour).
- The EB3A has a 600W inverter and a 286Wh LFP battery. The EB3A can easily run my network equipment.
- $286\text{Wh battery} * 90\% \text{ DoD} = 257\text{Wh Available} * 92\% \text{ AC inverter efficiency} = 236 \text{ Wh Useable AC}$
- So the EB3A will last for 11 hours ( $236 / 21$ ) before needing to be recharged.

## BLUETTI B80 BATTERY



- Used to charge/supplement some other Bluetti Solar Generators
- 806Wh LFP Battery
- DoD 90% (Tech Support)
- Solar Input 12V-28V 8A 200W
- Pass-Thru Charging
- Power Bank Mode (95% efficiency?) 140W – 210W  
(Is this battery to Charge Controller?)  
(This is a new product and I need to research what this mode means)
- DC output 12V 8A
- USB C PD 100W
- 22 pounds

# TESTING YOUR EQUIPMENT

---

1. Charge new unit to 100% using the Grid
2. Discharge unit using the inverter at medium rates to end. If you measure this you can calculate the AC efficiency.
3. Charge new unit to 100% using solar panels
4. Discharge unit using DC at medium rates to end. If you measure this you can calculate the DC efficiency.
5. Test every AC and DC plug and connector
6. Test every button
7. Test every charge speed
8. If it has an app, check each option (for example: Eco mode, turn on/off power supplies, Slow, Medium, High charging)
  - If you measured your AC and DC efficiency, you can calculate your Useable AC and Useable DC. Write it on the new unit for later calculations.
  - For normal use ongoing, if unit has DoD, what is it? If not, implement a 90%

# INTERESTED IN PROVIDING BACKUP POWER? DETERMINE YOUR REQUIREMENTS

---

1. Determine where solar panels will be located
2. Determine the distance and cable routing from solar panel to solar generator(s)
3. Decide what items (Loads) you want to power
4. Measure power used by the items you want to power (highest Watts & Kwh)
5. List the power sources (Vh & W) and connectors (plugs) needed
6. Decide the length of time power needed
7. Do you need UPS circuit?
8. Determine the Solar Generators that will satisfy your power requirements (one unit may do many different things)
9. Purchase the Solar Generators and Solar Panels that satisfy your requirements
10. Install and Test

# SOLAR PANEL LOCATION AND DISTANCE

---

- Where do you get the most reliable sun in Summer?
- Where do you get the most reliable sun in Winter?
- Keep cable runs short but safe
- Higher Amperage requires heavier gauge wire

## DECIDE WHAT ITEMS (LOADS) YOU WANT TO POWER

---

- How long will you be without power?
- Refrigerator
- Microwave, Crock Pot, Rice Cooker, Air Fryer, etc.
- Internet and Network equipment
- Kettle, Coffee maker, etc.
- Washing Machine, Clothes Dryer
- Ham Radio
- TV (250W)



## MAYBE BUYING A PRODUCT FOR EMERGENCY USE IS A BETTER SOLUTION

- Instead of buying a unit to provide power to a 250W TV
- Buy a small Media Center / TV that can be powered for a lot less
- Less than \$100



## KNOW YOUR LOADS

### THE FIRST THING TO BUY

- Use a Watt meter to measure all loads you will need (record Watts Hi and KWh)
- Use 24 hours for things like the refrigerator
- Use 'single use' examples for instance one load of towels in the washing machine and dryer



## HERE ARE SOME OF MY MEASUREMENTS

---

|                 |         |                                |               |
|-----------------|---------|--------------------------------|---------------|
| Refrigerator    | 40-440W | 1.8 KWh (24 hours)             | 75Wh per hour |
| Kettle          | 1450W   | 55Wh (0.75 litre heating)      |               |
| Coffee maker    | 1320W   | 42Wh (one cup)                 |               |
| Microwave       | 1620W   | 265Wh (11 min dinner)          |               |
| Washing machine | 872W    | 200Wh (1 large load of towels) |               |
| Clothes Dryer   | 850W    | 750Wh (1 large load of towels) |               |
| Network, etc.   | 36W     | 500Wh (24 hours)               | 21Wh per hour |
| Media Center    | 31-62W  | 830Wh (24 hours)               | 35Wh per hour |

# DETERMINING EQUIPMENT REQUIREMENTS

---

- Add 20% to Max Watt requirements, do not overload inverters
- If you need special plugs, your equipment needs to accommodate that
- Decide the length of time power that is needed.  
Your power source will have to have enough battery to last the amount of time you'll need or plan on recharging
- When specifying **Stated Wh** needed, remember to calculate that correctly ( $\text{Stated Wh} * \text{DoD} * \text{AC/DC efficiency} = \text{Useable Wh}$ )
- How many Power Sources do you need?
  - need 1800Wh to run refrigerator? you'll need a 2048Wh unit
  - need 0.9KW 850W for washer and dryer? you'll need a 1KWh or more 1000w unit
  - need 1650W for the microwave, you'll need an AC output of 2000W
- One unit that provides lots of Wh and lots of W can do multiple jobs like wash clothes or power the microwave

# WHAT PRODUCT TO BUY

---

- Size and weight matters!
- Look at products that will provide your Watt and [Useable Wh](#) (do your math!)
- Does battery chemistry matter?
- Do you need a UPS?
- How long is the warranty?
- Buy quality equipment
- Buy from companies with excellent technical support (different from customer support)
- Purchase solar panels that will best charge your units, try to keep the panels the same wattage
- Panels of the same wattage are more useful than mixed wattages



# PICKING THE RIGHT SOLAR GENERATOR

---

- I need to power my 440W (max) refrigerator that uses 1.5KWh a day. I want a UPS and I want a safe battery that will run it for 1 day. It does not need to be portable.
  - A unit that has a 1000W inverter, 2048Wh LFP battery with a UPS will work nicely
- I want a general purpose unit that will power my 1600W microwave or 1320W coffee maker or my 875W 1KWh washer/dryer, etc.
  - A unit that has a 2000W inverter and a 1500Wh or more battery will work nicely



# BUYING

---

- Be familiar with the normal prices of the units that fulfill your needs, subscribe to company email list
- Buy while on sale; holidays and email specials are good
- Know what will come in the box, you may need to buy a cable if it is not included
- Generally speaking, for Solar Generators (Watt hour)
  - 50 cents per Wh is great
  - 75 cents per Wh is good
  - \$1.00 or more per Wh is bad
- Generally speaking for Solar Panels (Watts output)
  - \$1.00 or less per Watt is great
  - \$1.50-\$2.00 per Watt is good
  - Over \$2.00 is not so good

# WHAT ARE POTA REQUIREMENTS?

---

- What are the minimum power requirements?
  - DC
  - AC
  - DC PD
  - How many of what plug type?
- What are the maximum desired power requirements?
  - DC
  - AC
  - DC PD
  - How many of what plug type?

## WHAT DOES POTA THINK OF THIS?

---

- 2072Wh NMC battery
- 1500 cycles to 80%
- Selectable DoD and max charge %
- UPS and Pass-Thru Charging
- 2000W Inverter
- 12V-150V 20A 850W max Solar Input
- 90-130V AC Input 1000W max
- 38 lbs Water and Dust resistant
- 3 20A AC outlets
- 1 13.8V DC 30A cig socket
- 1 13.8V DC 15A aviation plug
- 2 13.8V DC 10A 5521 plug
- 2 100W USB C PD
- 2 65W USB C PD
- 2 24W USB A QC
- large briefcase size (20.2 x 15.7 x 5.2 in)

QUESTIONS?

---