Alternative Emergency Power

Small, Portable Systems

RACHEL KINOSHITA, KK6DAC

17 SEPTEMBER 2015

Introduction

- **Why do we need alternative power sources?**
- **How much power do I really need?**
- **What can I do to produce that power?**
- **What are my options?**
- **What's available commercially?**
- **Let's build a system!**

This is Why We Prepare!

Severe Storms Leave Nearly 400,000 Without Power on East Coast

Shawn Marsh/AP | 9:25 AM ET

Public transit was disrupted

(TRENTON, N.J.)—Powerful storms that plowed through eastern Pennsylvania, New Jersey and Connecticut downed trees and power lines, leaving nearly 400,000 customers without electricity and disrupting mass transit service in both states Wednesday.

In Pennsylvania, PECO says more than 165,000 homes and businesses were without power. Chester and Delaware counties were hardest hit, and officials said full service might not be restored until the weekend.

Lightning strikes over Mount Nittany in State College, Pa., June 23, 2015, as a thunderstorm moves through Centre County.

Power outages to continue

COURIER-POST STAFF 5:18 p.m. EDT June 24, 2015

See end of story for Carly Q. Romalino's live reports of South Jersey storm damage.

(Photo: Jim Walsh/Courier-Post)

292 CONNECT | 45 TWEET | LINKEDIN | COMMENT | EMAIL

More than 200,000 homes and businesses l electricity Wednesday after powerful thunder toppled trees and snapped power lines acros Jersey.

Public officials opened cooling centers and "reception stations" that all recharge phones, contact insurance companies and pick up i

Complete utility restoration may take several days.

Power outage shuts down Yonkers offices

June 24, 2015 12:58 PM

Power outage shuts down Yonkers buildingsHundreds of city employees have been sent home for the day. (June 24, 2015 12:56 PM)

The Yonkers Public Library and the several of city's offices in Larkin Plaza are closed this afternoon because of a power outage.

Hundreds of city employees, including some employees from the Board of Education, have been sent home for the day.

PECO: Most Power Outages to Be Restored by Friday Evening

More than 250,000 customers were with out power at the height of last night's storm. Local contractors and workers from other states are helping in the effort.

BY MAX RETTIG | JUNE 24, 2015 AT 12:40 PM

Shutterstock.com

After last night's stormy weather, PECO is working hard to restore power to some 140,000 houses and businesses throughout the area.

The biggest power losses occurred in Chester County — where 52,022 customers were affe — and Delaware County, with a whopping 69,881 outages, according to a **PECO outage map** updated as of 12:23 p.m. Those numbers represent 24%-29% of the homes in those counties.

Downed trees cause power outage in Freeport

Downed trees cause power outage in Freeport WCSH

11:48 p.m. EDT June 23, 2015

(Photo: NEWS CENTER)

36 CONNECT | 5 TWEET | LINKEDIN | COMMENT | EMAIL | MORE

FREEPORT, Maine (NEWS CENTER) -- A tree knocked out power to many homes and businesses along Route 1 in Freeport Tuesday night after a strong storm blew through southern Maine.

"It was a quick shift of the weather. I mean it happened instantly. It became more than just a regular rainstorm. It became something else in the snap of the finger," said the co-owner of the Kendall Tavern Inn, Mark Provost.

Power Outages across Connecticut

WTNH.com Staff

Published: June 23, 2015, 4:42 pm | Updated: June 24, 2015, 7:23 am

(WTNH) — The severe weather is over but there are thousands of homes still without power across the state.

Here are the latest power outage numbers from United Illuminating and Eversource listed by town.

As of Wednesday morning, 18,908 Eversource customers and 567 United Illuminating customers were without power.

The Power Grid is Vulnerable

U.S. Power Grid Being Hit With 'Increasing' Hacking Attacks, Government Warns

Potential to 'take down' U.S. power grids, water systems and other critical infrastructure

SHARE TWEET EMAIL

BY: Adam Kredo
June 24, 2015 5:00 am

Major attacks on the U.S. power grid system are "increasing," with hackers stepping up efforts to penetrate critical systems and to implant malicious software that could compromise the power grid and result in a nationwide crisis, according to a government report.

While experts have long signaled that the U.S. power grid and related systems are vulnerable to physical attacks by terrorists and other individuals, the U.S. government is now warning that sensitive com
Congressional Re
American Scientis

CYBER ATTACK

US White House asks Congress for new hacking protection laws

The US White House has urged Congress to pass new cyber security rules after this week's revelation by the US government that the personal data of millions of current and former federal employees had been hacked.

Hackers attacked the U.S. energy grid 79 times this year

POSTED 7:04 PM, NOVEMBER 18, 2014, BY CNN WIRE

FACEBOOK TWITTER GOOGLE PINTEREST REDDIT EMAIL

NEW YORK (CNNMoney) — The nation's energy grid is constantly under attack by hackers.

In fiscal year 2014, there were 79 hacking incidents at energy companies that were investigated by the Computer Emergency Readiness Team, a division of the Department of Homeland Security. There were 145 incidents the previous year.

The outermost defenses aren't holding up. Between April 2013 and 2014, hackers managed to break into 37% of energy companies, according to a survey by ThreatTrack Security.

HOMELAND INSECURITY

U.S. POWER GRID HIT WITH 'INCREASING' HACK ATTACKS

Malicious software could cause national crisis

Published: 2 hours ago

(FREEBEACON) — Major attacks on the U.S. power grid system are "increasing," with hackers stepping up efforts to penetrate critical systems and to implant malicious software that could compromise the power grid and result in a nationwide crisis, according to a government report.

While experts have long signaled that the U.S. power grid and related systems are vulnerable to physical attacks by terrorists and other individuals, the U.S. government is now warning that sensitive computer systems that maintain the grid are increasingly being attacked, according to a Congressional Research Service (CRS) report that was not made public until the Federation of American Scientists (FAS) disclosed it this month.

The report warns that hackers potentially affiliated with terrorist groups or rogue nations have the ability to insert harmful malware into the internal systems governing the U.S. grid, which increasingly are being hooked into the Internet.

The Infrastructure is Aging

When the power grid fails

JUN 18, 2015

Hurricane Sandy in 2012 knocked out power in Branford, Connecticut for nearly a week.

SCOTT TONG

The nation's system of power plants, utility poles and electrical wires is aging. And compared with other developed countries, it's less and less reliable. Among the worst hit states: Connecticut.

Three historic storms hit the state in 2011 and 2012. Each time, more than 600,000 residents lost power for days. More than lights went out: household water comes from wells in the town of Marlborough.

SECURITY

Power grid's failing infrastructure at risk of cyberattack

By **Christopher Snyder** · Published April 08, 2015 · FoxNews.com 146 454 114

Tuesday's power failure in Washington has once again raised questions about the vulnerability of America's electric power grid.

Fox News National Security Analyst KT McFarland spoke to experts Darren Hammell and Jonathan Pollet about potential threats.

The power grid "is very vulnerable, whether its physical attacks, mistakes like this one or even cyberattacks … there have been a lot of high visibility outages lately and there are just more we can expect," said Hammell, chief strategy officer and

Is the U.S. Investing Enough in Electricity Grid Reliability?

Like it? 4

Posted June 16, 2015

Keywords: Electricity, Energy Security, Tech, Smart Grid, Sustainability, Utilities, Environmental Policy, Risk Management, Electricity Grid, Energy and Economy, Fuels, News, electricity demand, grid infrastructure, grid reliability

5 6 13 2 24

We had a 2-hour power outage at our house last week, together with 45,000 other customers in the East Bay. The lights flickered off just after 8PM and didn't come back on until after 10PM. Nothing like going without something that you take for granted to make you realize just how valuable it is.

My son and I had fun gathering our candles and figuring out that our hand-crank radio played Mariachi music, but that only lasted for about half an hour. As the minutes ticked by without WiFi, the economist in me started thinking about just how much I would be willing to pay to get the electricity back. I had a meeting the next day to prepare for, and it was my turn to take a pass through the slide deck. I couldn't even get good enough cell service to download the presentation to my phone, perhaps because local cell towers were also affected by the outage.

The East Bay outage was reportedly caused by a squirrel

The beauty of the free market is that it allocates resources to the sectors of the economy where they are most valued. (Yes, I'm beating the economics drum, but this is econ 101 – we ALL agree on this

51 year old transformer was leaking – replaced with new transformer

Designing Your System

- **What do you need to power?**
- **How long do you need it to run?**
- **Do you need both AC and DC?**

Designing Your System

- **What do you need to power?**
  - Lights
  - Radios
  - Mobile phones
  - Laptop computer
  - Television
  - Refrigerator
  - Microwave
  - Medical Devices
- **How long do you need it to run?**
  - Short outages during storms
  - Three to four weeks during after an earthquake
  - Months or years after an EMP or CME
- **Do you need both AC and DC?**
  - Inventory your devices and see how many actually use DC, but are charged by AC
  - DC to AC and AC to DC is expensive, try to avoid it

It’s more economical to conserve than to generate

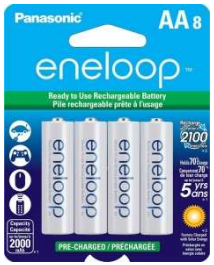
- **Reducing your carbon footprint**

- **Lights**
- **Radios**
- **Mobile Phones and tablets**
- **Laptop Computers**
- **Television**
- **Refrigerator**
- **Microwave**

It’s more economical to conserve than to generate

Reducing your carbon footprint

- **Lights**
  - Switch to LED lightbulbs
  - 12v LED lights – Goal Zero, LED light strips, LED flood lights
  - Solar chargeable lights – LUCI Lights
  - Headlamps and flashlights
  - Batteries – Rechargeables - Panasonic Eneloop, Tenergy Premium
  - Battery charger – Needs to work with both 120vac and 12vdc
- **Radios**
- **Mobile Phones and tablets**
- **Laptop Computers**
- **Television**
- **Refrigerator**
- **Microwave**



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- **Radios**
  - Crank radios are good, but their tuners are often poor to mediocre
  - Purchase a good AM/FM radio that runs on AA’s and use Panasonic Eneloop batteries
  - For extended run-time consider an AM/FM radio that uses rechargeable “D” cells
- **Mobile Phones and tablets**
- **Laptop Computers**
- **Television**
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- **Mobile Phones and tablets**
  - Typically use 5vdc USB chargers
  - Make sure you have a 12vdc to 5vdc USB chargers
- **Laptop Computers**
- **Television**

It’s better to conserve than to generate

Reduce your carbon footprint

- **Laptop Computers**
  - Many laptops use 19vdc powered through a transformer
  - Use a 12vdc to 19vdc up converter to run direct from DC
- **Television**
- **Refrigerator**
- **Microwave**

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Reduce your carbon footprint

- **Laptop Computers**
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- **Television**
  - Get a small, portable, battery operated ATSC LCD TV or a full size HDTV that runs off of 12 – 14vdc
  - Get an HDTV antenna
- **Refrigerator**
- **Microwave**

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- **Refrigerator**
  - See http://expeditionportal.com/overland-journal-portable-12v-fridge-review/
  - Most can run from 12 or 24vdc and 120vac
  - Expensive, but can be used as a small chest freezer for everyday use
  - Thermoelectric coolers are not refrigerators
- **Microwave**

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- **Microwave**
  - Microwave – Use a generator to run your microwave or cook with a gas stove

What are my Options?

Establishing your requirements

- **Generators**
  - Conventional
  - Inverter

➢ **Solar**

  - Types of PV Panels
  - Charge Controllers
  - Batteries
  - Inverters

Portable Generators

- **Conventional**
  - Less expensive
  - Well established, simple design
  - Lots of power output options available
  - Available in gasoline, propane, natural gas and diesel fuel models
- **Inverter Based**
  - More expensive
  - Generally smaller and lighter
  - Quieter
  - More fuel efficient
  - Cleaner power output
  - Can be run in parallel to double the output

Portable Generators

➢How they work

- Conventional generators use alternators to generate AC power and must run at a constant RPM
- Inverter generators such as the Honda EU and Yamaha EF generate AC power, which is then converted to DC through diodes and then inverted back to AC using an Inverter
- Due to this technology, inverter generators can run at lower RPMs (2000 RPMs or less in Eco mode)
- In Eco mode, inverter generators are very quiet and use very little fuel
- Inverter generators don't run as well on propane in Eco mode due to the variable RPMs and how propane is supplied to the generator; When using propane it's better to run them at full power

Establishing Your Requirements

- How much power do you need?
- How long do you need it to run?
- How much noise is acceptable?
- How much should it weigh?
- Can you perform basic maintenance?
- How much do you want to spend?
- How do I hook this up to my house?

How Much Power Do You Really Need?

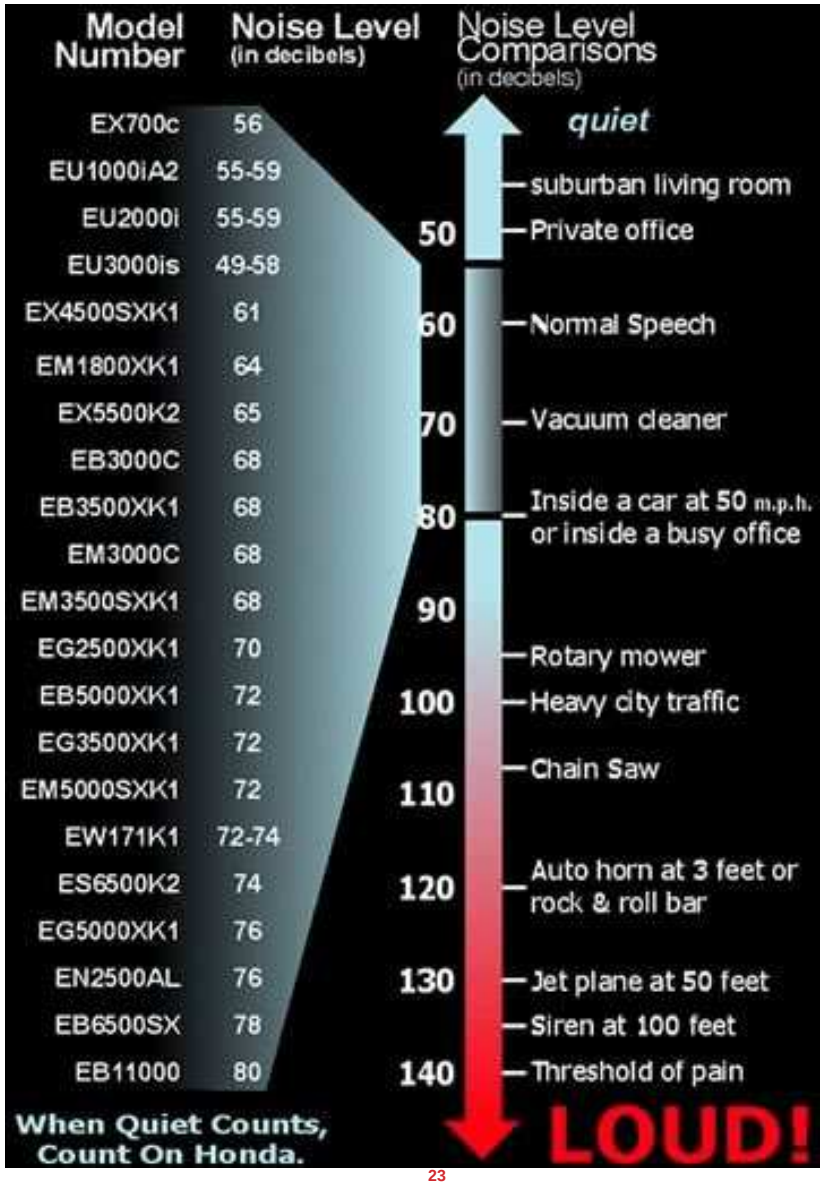
- Get a Kill A Watt monitoring device and plug it into each appliance you plan to run. See how much power each uses over a 24 hour period
- Generators provide lots of power when you need it, but requires fuel and regular maintenance
- Solar, generally, provides less power, but requires no fuel and little maintenance
- Understand peak vs rated output
- Most Inverter type generators can use a parallel kit to double their output
- Adding more power to Solar can be as easy as adding more panels or more batteries

How Long Do You Need to Run?

- Solar systems need sunlight, so batteries are needed to store energy for night time and overcast days
- Generators use fuel (gasoline, propane, natural gas or diesel)
- How much fuel can you store?
  - Treating gasoline (PRI-G) or diesel (PRI-D) for long-term storage
  - Propane can be stored safely for very long periods
  - Natural gas is a good alternative, but may not be available after an earthquake
- Siphoning fueling from cars
  - Modern vehicles have an in-line check valve that makes siphoning difficult
  - Gas Tapper works well

How much noise is acceptable?

- Inverter generators output between 50 to 60 db which is quieter than normal speech
- Conventional generators are typically 65 to 70 db which is about the same as a chain saw or jet engine
- Conventional generators can quieted by welding on a car muffler, installing it in a sound reducing box or running it from a hole in the ground
- Remember, as much noise can come from the crankcase as from the muffler
- The more noise the generators makes, the more likely people will know you have a generator
- During a disaster, there will be far less background noise, so you need to be as quiet as possible
- **NEVER RUN YOUR GENERATOR INSIDE YOUR HOUSE OR ATTACHED GARAGE!!!**



How Much Should It Weigh?

- Small, portable solar panels should weigh no more than 10 to 20 pounds each
- Batteries are usually the heaviest component in a solar setup
  - Lead Acid batteries can weigh anywhere between 30 and 100+ pounds
  - Lithium batteries are significantly lighter, about half the weight of lead acid batteries
- Portable generators need to be portable. How much weight can you carry?
- Small generators weigh less than 50 pounds
- Larger generators are typically on wheels and can weigh over 200 pounds
- You might be able to move a heavy generator, but what if you're not home when a disaster strikes. Ensure that other members of your family can move and setup your equipment as well.

What Maintenance is Required?

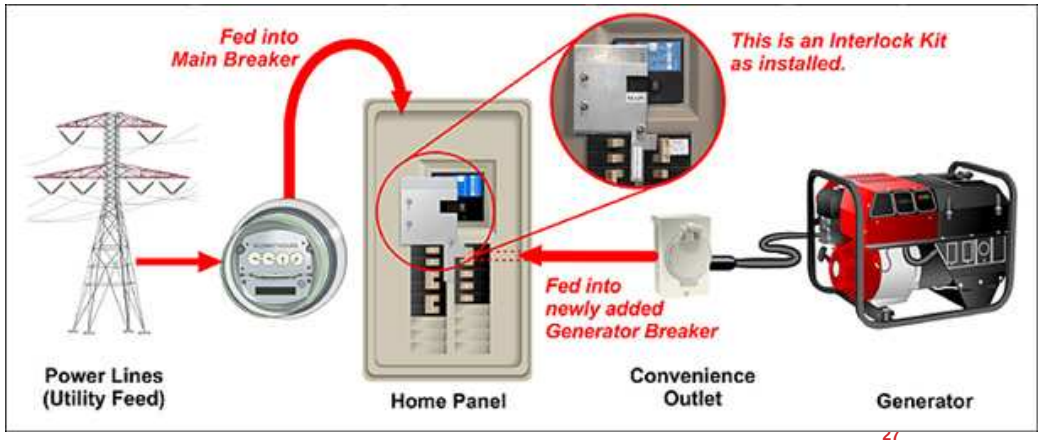
- In general, solar requires very little maintenance, but electronics components can fail. You need to understand your system and keep spare parts available
- Generators need to have their oil changed on a regular basis
- Spark plugs need to be replaced
- Filters need to be cleaned
- Carburetors may need to be cleaned and sometimes rebuilt
- You should have a good set of tools, a multi-meter and shop/service manual

How Much Do You Want To Spend?

- A portable solar systems can be as inexpensive as $300, but a more usable system will often cost $800 to $1500
- Portable generator prices vary widely depending on the type, the rated output, brand and so forth
- You can spend as little as $100 for a low output, two-stroke generator or over $5000 for a high output inverter generator
- Expect to spend about $900 for a good quality, 2000 watts peak inverter based generator
- Keep in mind that on top of the cost of a generator, you need to have fuel, oil, spark plugs, rebuild kits, etc.

How to Connect This To My House

- **Extension Cords**
- **Transfer Switch**



How to Connect This To My House

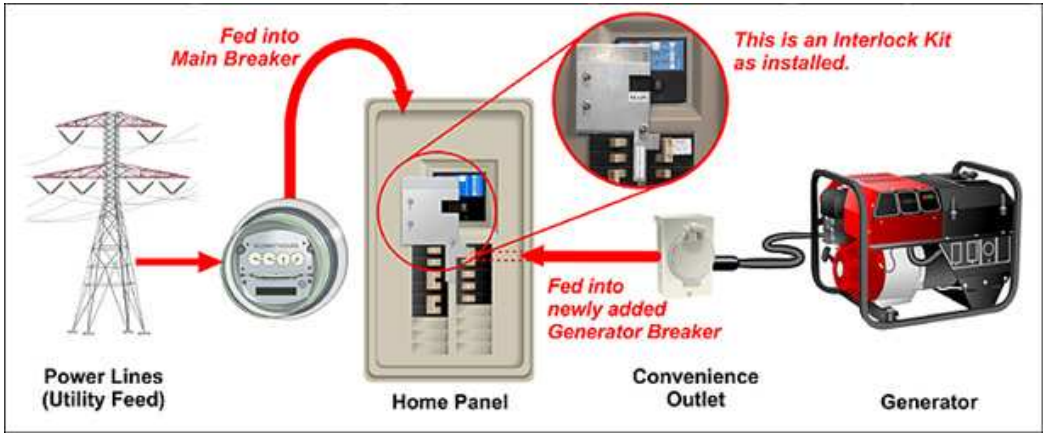
➢ Extension Cords

- Easy, no modifications to your existing wiring
- Can become cumbersome and a trip hazard if you have them all over your house
- Try to minimize the number of cords, by bringing the power in to a central location, then run shorter cords from there
- Use heavy duty 15 amp Contractor type extension cords
- Use heavy duty 15 amp multi-outlet adapters

How to Connect This To My House

➢ Transfer Switch

- More likely to be used with a generator rather than portable solar
- If you plan to hook up directly to your home wiring, please consult a professional electrician
- Must use a utility/power company approved transfer switch
- Most will require a 240vac generator
- An improperly installed transfer switch can back feed electricity to the grid, which can electrocute power company workers working on the lines. You will be held liable for any deaths or injuries
- APC makes an automatic transfer switch specifically for Honda inverter generators (APC UTS6)



How to Connect This To My House

- **NEVER NEVER NEVER USE A SUICIDE CORD**
  - Double male extension cords are dangerous and someone will likely get electrocuted or may overload the wiring and cause a fire
  - Higher probability that you will back feed the grid and injury or kill a lineman
  - DON’T DO IT

Portable Solar Systems

- **Photovoltaic (Solar) panels**
  - Monocrystalline
  - Polycrystalline / Amorphous
  - Foldable
- **Charge Controllers**
  - Pulse width modulation (PWM)
  - Maximum power point tracking (MPPT)
- **Batteries**
  - Lead Acid
  - Lithium
- **Inverters**
  - Modified sine wave
  - Pure sine wave

Photovoltaic (Solar) Panels

- **Monocrystalline**
- **Polycrystalline**
- **Foldable (Thin Film, Copper indium gallium selenide [CIGS])**
- **Hybrid – Bendable Monocrystalline**

Photovoltaic (Solar) Panels

- **Monocrystalline**
  - More expensive
  - Smaller footprint and less weight per watt
  - More efficient

Photovoltaic (Solar) Panels

- **Polycrystalline**
  - Less expensive
  - Larger footprint and more weight per watt
  - Less efficient

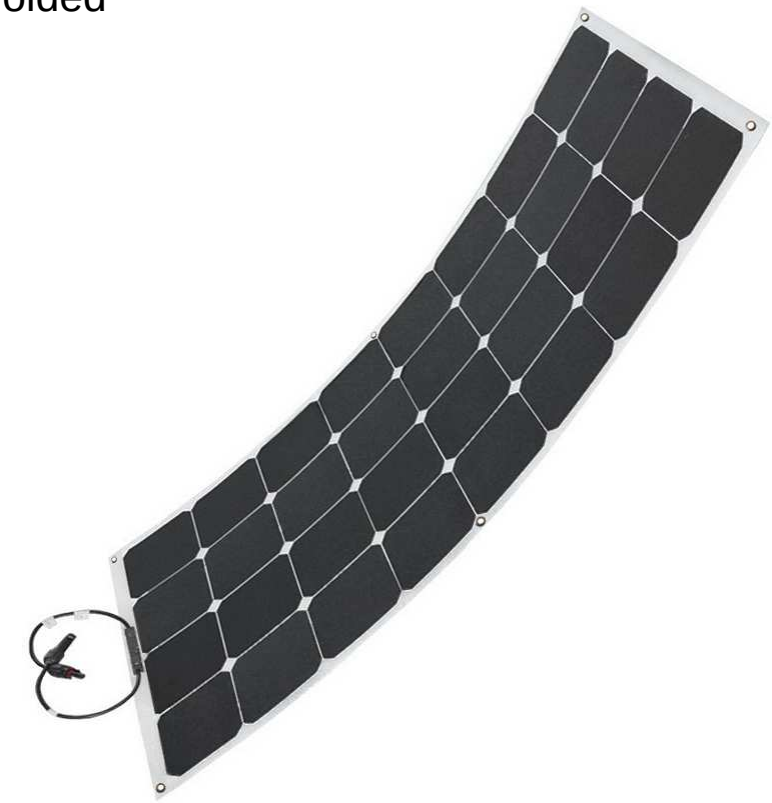
Photovoltaic (Solar) Panels

- **Foldable (Thin Film, Copper indium gallium selenide [CIGS])**
  - Most expensive
  - Larger footprint, but lighter weight per watt
  - Super lightweight
  - Moderate efficiency
  - Not as durable as traditional panels

Photovoltaic (Solar) Panels

➢ Hybrid – Bendable Solar Panels

- More expensive than traditional panels, but less expensive than foldables
- Monocrystalline
- Build on a plastic substrate with no aluminum frame, nor tempered glass
- Can be bent to some degree, but not folded
- Very lightweight
- High efficiency
- Not as durable as traditional panels



Charge Controllers

- **Maximum Power Point Tracking (MPPT)**
- **Pulse Width Modulation (PWM)**
- **Cheap Controllers**

Charge Controllers

➢ Maximum Power Point Tracking (MPPT)

- More expensive
- More efficient with higher amperage
- Converts PV voltage into more amps
- Most are Radio Frequency (RF) quiet (good for hams)
- Highly efficient in overcast and shade
- For example, a 12vdc solar panel is producing 17vdc @ 5.3 amps (17 * 5.3 = 90 watts). An MPPT charge controller would charge the battery at 13.8vdc @ 6.1 amps (13.8 * 6.1 = 84 watts). 6 watts (about 7%) is lost in heat

Charge Controllers

➢ Pulse Width Modulated (PWM)

- Less expensive
- Works well in low amperage systems
- Reduces PV voltage through heat
- Tend to be Radio Frequency (RF) noisy (bad for hams)
- Poor efficiency in overcast skies or shade
- Using the same example, a 12vdc solar panel is producing 17vdc @ 5.3 amps (17 * 5.3 = 90 watts). A PWM charge controller would charge the battery at 13.8vdc @ 4.8 amps (13.8 * 4.8 = 66 watts). 24 watts (about 27%) is lost in heat

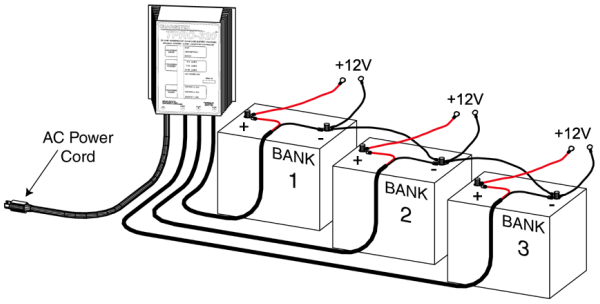
Charge Controllers

➢ Cheap Controllers

- Very inexpensive
- Will likely cook your batteries
- Avoid

Batteries

- **Capacity**
  - Car batteries are usually measured in Cold Cranking Amps (CCA)
  - Deep cycle batteries, AGM, Lithium are usually measured in Amp Hours (AH)
- **Lead Acid**
  - Car batteries
  - Deep cycle batteries (Marine, Golf cart)
  - Sealed Lead Acid / Absorbent glass mat (AGM)
- **Lithium**
  - Lithium Iron Phosphate (LiFePO4)
  - Lithium Polymer (LiPo)



Common Negative, three 12V battery banks

Batteries

➢ Capacity (Amp Hours)

- How many amps can be delivered over a period of time before the battery is completely dead

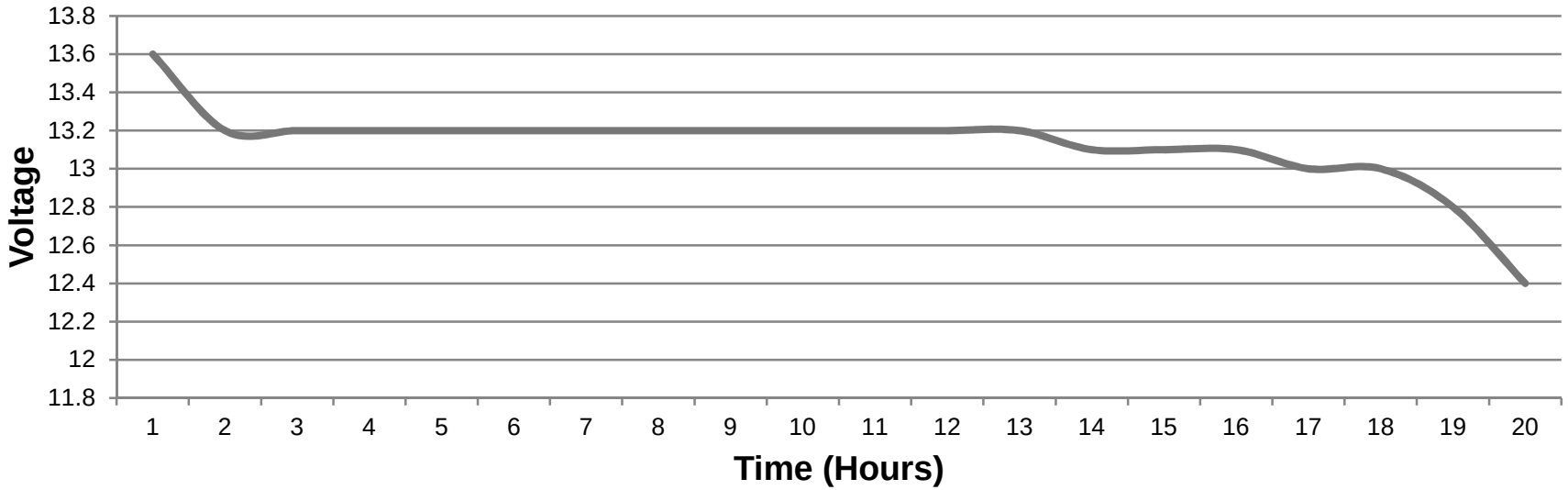
CAPACITY [B] Amp-Hours (AH) Trojan Group 27 - 100 AH AGM Battery				ENERGY (kWh)
5-Hr Rate 15.4 amps	10-Hr Rate 8.2 amps	20-Hr Rate 4.45 amps	100-Hr Rate 1 amp	100-Hr Rate
12 VOLT DEEP CYCLE AGM BATTERY				
77	82	89	99	1.19

- Why the different rates and amp hour capacity?
- Because lead acid batteries have an exponentially shorter amp hour life, the higher the amperage draw
- And keep in mind that this battery will be completely dead (i.e. cannot be recharged) if you use all of this capacity

Batteries

➢ Capacity (Amp Hours)

- Lithium batteries typically have a much flatter discharge curve



- A 40 ah LiFePO4 battery can provide 40 amps for an hour and can still be recharged

Batteries

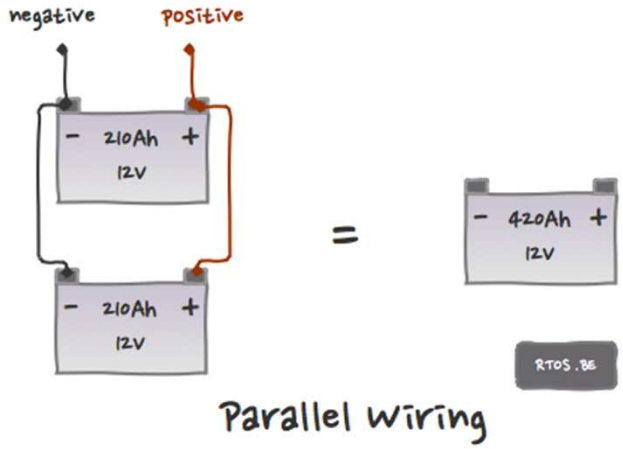
➢ True Capacity

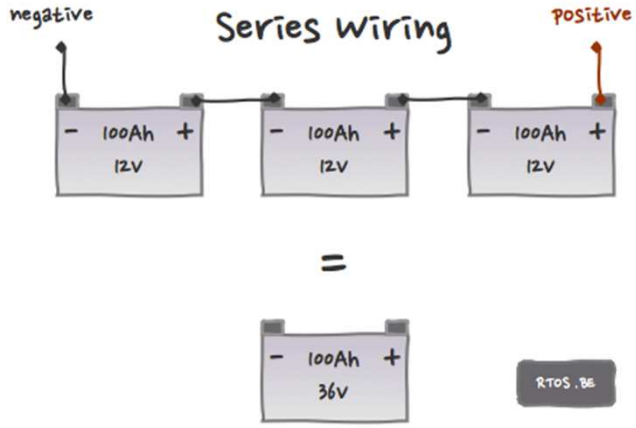
- Lead acid batteries should NOT be drawn down below 75% (12.4vdc) on a regular basis to ensure maximum life
- Lead acid batteries typically cannot provide very high discharge amperage
- Lithium batteries can be drawn down to under 10% with no damage and can be recharged to near full capacity
- Lithium batteries can safely provide a very large number of amps in a short amount of time
- Unless you are willing to kill your lead acid batteries, do not discharge them below 50%
- Because Lithium batteries can be drawn down to below 10%, the true amp hours available in a Lithium battery is nearly double that of an equivalent Lead Acid battery
- Beware of Lithium batteries with an amp hour rating that says PbEq which means Lead Acid equivalent. A Lithium 30ah PbEq battery is really a 15 to 20 amp hour (or less) battery
- Lithium batteries can be recharged thousands of times. Typical deep cycle lead acid batteries are rated for 550 cycles to 50% discharge

Batteries

➢ Adding more capacity

- You can increase the capacity of your battery bank by adding more batteries
- Batteries should be the same voltage and amp hours and if at all possible the same age
- Batteries would be connected in parallel (positive to positive, negative to negative)





- Batteries connected in parallel add the amp hours
- Batteries connected in series add the voltage

Batteries

- **Lead Acid – Car Batteries**
  - Not recommended
  - Designed for starting, not cycling
  - Can be used in an emergency

Batteries

➢ Lead Acid – Deep Cycle

- Not all marine batteries are deep cycle
- Make sure you choose deep cycle batteries for their thicker plates
- Requires venting
- Need to monitor the water level and refill as necessary
- Prices vary depending on AHs and quality
- Can last 5 to 7 years if maintained properly

Batteries

➢ Lead Acid – Golf Cart Batteries

- Typically six volt, so you need to purchase them in pairs and connect them in series to get 12vdc
- Requires venting
- Need to monitor the water level and refill as necessary
- Relatively inexpensive per AH
- Can easily last 5 to 7 years if maintained properly

Batteries

- **Lead Acid - Absorbent glass mat (AGM) / Sealed Lead Acid**
  - Sealed, so venting and adding water is not needed
  - Can be installed in any position
  - Deep cycle
  - Most expensive of Lead Acid type batteries
  - Can last 10+ years if maintained properly

Batteries

➢ Lithium Iron Phosphate (LiFePO4)

- Safe (punch a hole in one and they won't catch fire)
- Over charge/discharge will not explode
- Can be discharged below 10% and will recharge back to 100%
- Thousands of discharge/recharge cycles
- Be careful of how the manufacturer rates them (PbEQ)
- Much more expensive than lead acid
- Over their life, they pay for themselves with more cycles and higher useful capacity
- Need to use a charger designed for this chemistry

Batteries

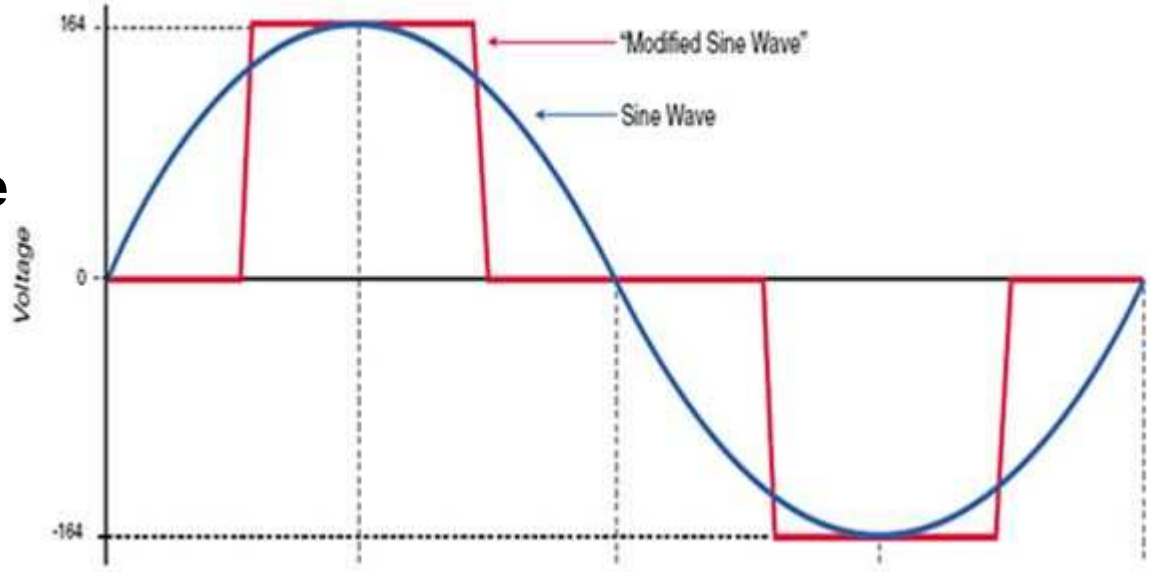
- **Lithium Polymer (LiPo)**
  - Fast charge / discharge
  - Thousands of discharge / recharge cycles
  - Needs to be balance charged
  - Not really recommended for the casual user because…

Batteries

- **Lithium Polymer (LiPo)**
  - Susceptible to fire/explosion when over-charged/discharged
  - Damage to the cells (i.e. exposure to air) can cause fire

Inverters

- **Modified Sine Wave**
- **Pure Sine Wave**



Inverters

➢ Modified Sine Wave

- Inexpensive
- Output is a square wave approximation of sine wave
- Safe for many electronics like TVs and computers
- Motor driven devices such as refrigerators and drills don't like modified sine waves
- Microwaves, fluorescent lights and clocks don't like modified sine waves
- May damage some devices
- Rated and peak output are usually the same

Inverters

- **Pure Sine Wave**
  - More expensive, but prices have come down significantly
  - Outputs a pure sine wave just like grid power
  - Safe for delicate electronics
  - Not as efficient, requires more input for the same output
  - High surge capacity enables them to have much higher peaks than rated capacity

Commercial Solutions

The Grid Eraser BASIC - http://www.grideraser.com/

The Grid Eraser BASIC consists of: a 145 watt solar panel, a 600 watt Pure Sine Wave DC to AC power inverter, a 20 amp PWM solar charge controller, a 84 A/H sealed AGM re-chargeable solar battery, and a fully integrated structural foam cart with telescoping metal handle. Quick attach/detach plug and play connectors for ease and safety. Keep the solar panel plugged in during sun hours and use 145 watts of power without depleting the battery. Re-charge the battery in 4 - 6 hours. Once you receive the unit, call us and we will walk you through the initial start-up.

Photovoltaic Solar Panel

12 volt 145 watt photovoltaic solar panel. Highest output in amps in the industry, which is important when re-charging the solar battery. 25 foot weatherproof heavy duty cord included. 25 year warranty. Solar panel weighs 26 lbs.

600 watt Pure Sine Wave Power Inverter

60 HZ continuous power maximum at 540 watts, peak surge at 1200 watts, DC to AC power. One USB port, dual GFCI AC outlets, and a digital power meter. Short circuit protection, low voltage alarm and shutdown, over voltage protection, overload shutdown, and over temperature shutdown. Two year limited warranty. **Closely resembles the electrical outlet in your home.**

Solar Charge Controller

12 volt, 20 Amp. Battery charging managed by PWM (Pulse Width Modulation) optimized for PV systems. Reverse polarity, high temperature, lightning, overload, short circuit, and high voltage protections. LED display. 5 year warranty.

Solar AGM battery

12 volt, 84 A/H sealed AGM re-chargeable solar battery. Sealed, maintenance free, non-spillable, and generates no fumes. Designed for solar products and used by all branches of the United States military. If you follow our guidelines for charging and discharging, battery should last 4+ years with daily use. One year warranty. Solar AGM battery is **made in U.S.A.**

Multi-level Portable Cart

Heavy duty, multi-level, portable, durable structural foam cart. Three compartments for storing each component, which allows for ventilation per manufacturer's specifications. Telescoping metal handle and heavy duty wheels for maneuverability and portability. 90 day warranty covering defects and workmanship.

Price: $1800.00

Commercial Solutions

Goal Zero Yeti 1250 Solar generator kit – http://www.goalzero.com/

Whether it is for back-up power, camping, tailgating, or light duty construction, the Yeti 1250 Solar Generator gets it done. Silent, safe, and can be used indoors or out. Power a refrigerator for more than 12 hours, a chest freezer for a week, a TV for 35 hours.

Goal Zero Yeti 1250 Solar Generator Kit with cart, (4) Boulder 30 solar panels, (2) panel carrying cases, (1) Solar Tripod (holds 4 panels), (8) Boulder Clips

Price: $2418.00

Commercial Solutions

Solar Stik 100 Lite - http://www.altern-energy.com/Alternative-Energy-Products/Solar-Generators/Solar-Stik/Power-Pak/

The Solar Stik™ Lite is specifically designed as a cost-effective solution for applications ranging from recreational to humanitarian. It can also be used in support of the other ProSeries or Mil-Series Solar Stik™ Systems.

The Lite is the lightest and most compact design in the Solar Stik™ product line. It transports easily, can be rapidly deployed, and all connections are “Plug & Play”. Assembly requires no tools or special knowledge and performed by one person in less than 5 minutes.

The Solar Stik™ Lite has two axes of rotation that allow for maximum solar panel power production. The panels can be rotated on a horizontal and vertical axis.

Three daily panel adjustments of the 100 watt solar panels will yield a tremendous power gain over a static position. The average maximum daily energy production from solar power is about 1.0 kW-h, but depending on location and conditions, may occasionally exceed 1.2 kW-h.

The Solar Stik™ Lite can provide power to any Solar Stik™ Accessory that has a “Solar Only” receptacle.

Built in the USA, the Solar Stik™ Lite has a 1 year limited warranty on materials and workmanship and a 25 year power output warranty. WIth regular care and maintenance the system should last 10 years.

Price: $5700.00

Commercial Solutions

SolarSuite 2K – 2300 watt **http://www.altern-energy.com/Alternative-Energy-Products/Solar-Generators/Portable-Solar-Power-Biz/**

Control Module
1800w, 120v Pure Sinewave Inverter - 3000w Surge
Automatic Forced Air Cooling - Operates with case open or closed
80 Amp - 1100w - MPPT Solar/Wind/Hydro Renewable Energy Input
90 Amp - 1500w - 120v AC Battery Charger
GFIC Protected AC Outlet
Locking Deltran Renewable Energy Input connector port
Dimensions for this case can be found here: Pelican 1620

LFP 180 Battery Module
180 Amp Hour - 2.3 KWh - 12.8v Lithium Iron Phosphate Battery
Digital Battery Monitor
Displays: Voltage - Current - Time To Go Until Empty - State of Charge
250 Amp - 2300w Maximum Output @ 12v DC via 2 Heavy Duty Power Terminals
1 Cigarette Lighter Outlet provides up to 200w @ 12v DC. Auto Reset Breaker
Simple One Button - ON/OFF/Reset Switch turns power output ON and OFF as needed
Dimensions for this case can be found here: Pelican 1440

Portable Solar Panels
120w Glass
Built in Tilting arms to properly align solar panels to direct sunlight
4 stake-down points to secure panel to ground in windy areas
Simple, quick plug and play connectors for easy setup
Panels fold up and lock in place for transport with nice carry handle
System comes with a 50 ft solar panel connector cable
System can handle up to 10 - 120w panels to max out charging ability

Price: $9200.00

Commercial Solutions

Hardened Power Systems Juicebox MK2 -
http://www.portableuniversalpower.com/juicebox-mk2-new/

Case is enameled steel, welded at all seams.
Hinged lid is sealed with a continuous rubber gasket and is removable.
Inverter provides 450 watts constant, 900 watts surge.
40 Amp Hour LiFepO4 Battery Bank. · Battery life is 1,000 to 2,000 cycles
Digital meter displays real-time voltage of the batteries.
Circuit breaker protects sensitive components—no fuses to replace or worry about.
Two marine-grade 12 volt sockets for all common automotive devices.
Two Anderson Power Pole connections for high-power, Low-loss 12 volt power.
Two 115 VAC sockets, three prong, to power common ‘house power’ devices.
Two 3 amp USB ports with twin buck transformers – powerful and very efficient.
10-amp Automatic Battery Charger – Worldwide automatic voltage.
10-amp Solar Controller, Auto-detect 12 or 24 volts, Easily handles up to 120 watts of solar panels.
Tough, mil-spec foam ‘locks’ the system into the can to resist vibration and jarring.
Dimensions: 12” x 13” x 5.5” Weight: 29 lbs

Price: $950.00 (Does not include solar panels)

Build it yourself – A low cost alternative

Parts List

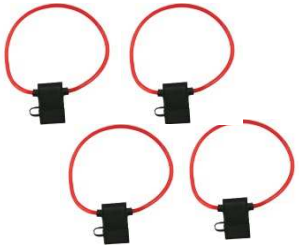
Qty	Item	Price	Total
1	UB121000 Battery 100ah 12vdc battery	$184.95	$184.95
1	Duracell 800 Watt Modified Sine WaveInverter	$56.88	$56.88
1	100 W Watt 100W Solar Panel and Charge Controller	$184.99	$184.99
1	Battery Box	$14.10	$14.10
1	Power Bright 0-AWG3 0 AWG Gauge 3-Foot cables	$32.28	$32.28
1	12 AWG wire 25'	$24.05	$24.05
1	Car DC Digital Voltmeter/Dual USB 2 Port/DC12V Power Socket	$14.40	$14.40
1	5 Pairs of MC4 Male/ Female Solar Panel Cable Connectors	$8.30	$8.30
4	TFH10C-10 ATC Fuse Holder	$7.50	$30.00
1	Fuse Assortment	$9.69	$9.69
1	Stanley 020800R FatMax 4-in1 Mobile Work Station	$75.17	$75.17
1	Misc electrical connectors, heat shrink tubing, etc	$25.00	$25.00
Total			$659.81

Build it yourself – More money, More power

Parts List

Qty	Item	Price	Total
2	UB121000 Battery 100ah 12vdc battery	$184.95	$369.90
1	Xantrex Prowatt 1000 watt pure sine wave inverter	$232.58	$232.58
1	2pcs 100 W Watt 100W Solar Panels (200w total)	$288.99	$288.99
1	MPPT TRACER 3215RN Solar Charge Controller 30A	$168.00	$168.00
1	Dual Battery Box	$24.95	$24.95
2	Power Bright 0-AWG3 0 AWG Gauge 3-Foot cables	$32.28	$64.56
1	12 AWG wire 25'	$24.05	$24.05
2	Blue Sea Systems 12 Volt Dash Socket	$7.99	$15.98
2	Blue Sea Systems Dual USB Charger Socket	$18.96	$37.92
1	5 Pairs of MC4 Male/ Female Solar Panel Cable Connectors	$8.30	$8.30
4	TFH10C-10 ATC Fuse Holder	$10.00	$40.00
1	Fuse Assortment	$9.69	$9.69
1	Stanley 020800R FatMax 4-in1 Mobile Work Station	$75.17	$75.17
1	Misc electrical connectors, heat shrink tubing, etc	$25.00	$25.00
1	Digital Volt Meter	$19.95	$19.95
Total			$1,405.04

Build it yourself – Truly portable solution



Parts List

Qty	Item	Price	Total
1	Tenergy 12.8v 40ah LiFePO4 battery	$444.00	$444.00
1	Samlex 600 watt Pure Sine Wave Inverter	$280.00	$280.00
1	2x 100 W Watt 100W Bendable Solar Panels (200 watt total)	$449.99	$449.99
1	GV-10 | 140W 10A MPPT Charge Controller for Lithium batteries	$180.00	$180.00
1	Power Bright 0-AWG3 0 AWG Gauge 3-Foot cables	$34.83	$34.83
1	8 AWG wire 25'	$49.03	$49.03
1	12 AWG wire 25'	$24.05	$24.05
2	Blue Sea Systems 12 Volt Dash Socket	$7.99	$15.98
2	Blue Sea Systems Dual USB Charger Socket	$18.96	$37.92
1	5 Pairs of MC4 Male/ Female Solar Panel Cable Connectors	$8.30	$8.30
8	TFH10C-10 ATC Fuse Holder	$10.00	$80.00
1	Fuse Assortment	$9.69	$9.69
1	Sportmen's Plus Utility Dry Box	$27.39	$27.39
1	Misc electrical connectors, heat shrink tubing, etc	$25.00	$25.00
1	Digital Volt Meter	$19.95	$19.95
1	Chassis Mount for 4 Powerpoles	$13.99	$13.99
Total			$1,700.12

Conclusion

➢ Generators

- Best for short-term emergencies (one to four weeks)
- Lots of power for the price
- Store fuel wisely and have a plan to acquire more fuel if necessary
- Learn how to perform maintenance – Store oil, spark plugs, filters, carburetor rebuild kits, etc
- Noise means your neighbors will know you have a generator
- Can work round the clock

Conclusion

➢ Solar

- Good for both short and long-term emergencies
- Initial costs are higher, but the only fuel it requires is the sun
- No moving parts to break or wear out
- No noise, no exhaust fumes
- Need sufficient battery reserves to run overnight or for overcast/rainy days
- Not maintenance free – Make sure you have spare parts
- Price per watt is relatively high

Conclusion

➢ Which to use?

- Generators and Solar are not mutually exclusive, but rather complementary systems
- Solar and batteries should be used during good weather, especially during spring, summer and fall
- Generators can be used to charge batteries and run devices during extended periods of poor weather
- By using your generator judiciously, you extend your fuel supply and reduce wear and tear on the moving parts

Questions