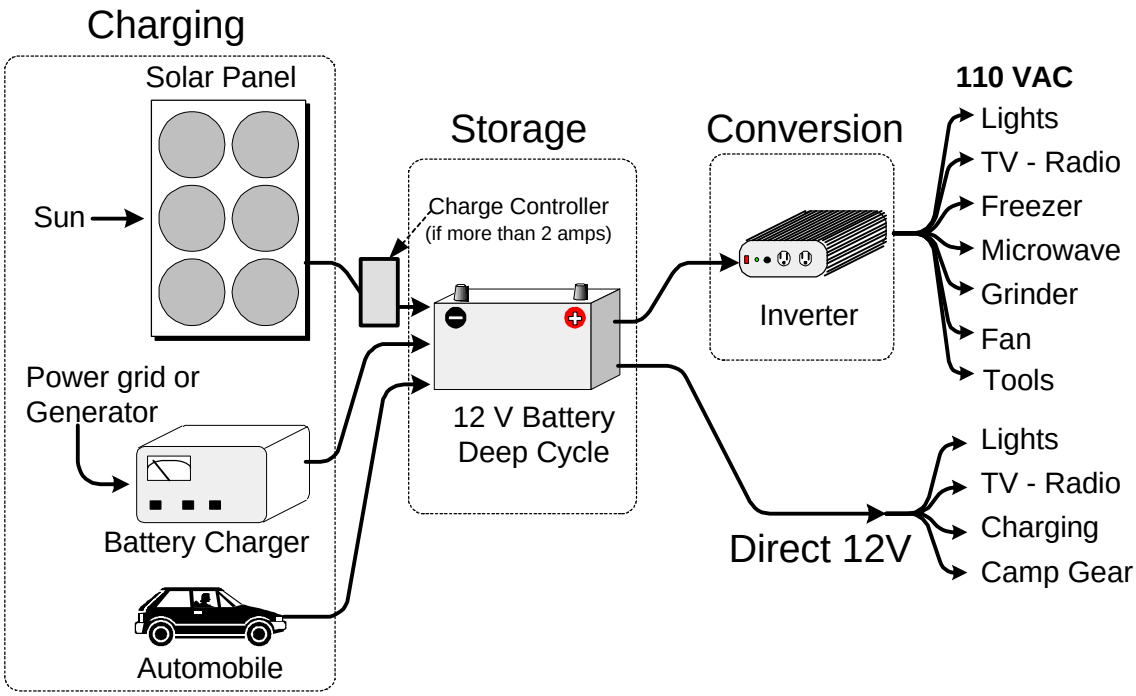
Auxiliary Electrical Power



Types of Photovoltaic-PV (Solar) Systems

Level	Batteries	Charger	Inverter-watts	Uses	Term	Cost
1	1 - 2	Battery charger	400 - 1000	Light, TV, Ham radio	1-2 Days	$100
2	2 - 8	1 - 2 PV panels	1000 - 2000	Medium appliances	Indefinite	$700+
3	4 - 16+	2 - 8+ PV panels	1800 - 5000+	Larger appliances	Indefinite	$1200+

Batteries vs. Solar vs. Generator vs. Other

Batteries: Costly and only a short term solution unless they are rechargeable. Need renewable charging source.

Solar: Renewable. Panels last 20+ years. Batteries 1-5 years. Power levels more limited. Greater initial costs. Quiet. Requires conversion for most uses.

Generators: Require constant fuel supply. Fuel requires special storage. Noisy, must be running to provide power. Lower initial cost. Higher power available.

Other Options include wind and water power. Depends on your location and resources. Watch for fuel cells.

Charging

A simple 6 amp car battery charger ($20) will get you started. Charge batteries when grid power is available. 10 and 15 amp chargers are available which also control the charge rate. These are faster but more expensive ($50+).

Generators can charge batteries, even while powering other things. Some have 12V (12-17V) outputs but most would need a battery charger that runs off 120 VAC.

Cars are made to charge batteries (as a byproduct of transportation.) Hook up your emergency battery with jumper cables and run the engine awhile. Remember this uses precious gasoline and is not a permanent solution.

Charging systems can be used to power appliances or inverters directly. But they only work as long as they are running or the sun is out, etc. For always-available power you will need storage.

Storage

Rechargeable Batteries are the choice of most system builders. The number, size, and type of batteries you use depends on your needs, balanced by your funds.

Sealed batteries are nice. So are industrial batteries. Most of us will have to be satisfied with lead acid batteries, like you have in your car.

Car batteries can be used, but they are not made for deep discharging on a regular basis and will wear out quickly (How many times can you leave your lights on before your battery will no longer hold a charge?)

Deep Cycle batteries are made to handle deep discharging better than regular car batteries. These can be bought for around $50 on up, depending on capacity.

Batteries are available in 6, 12, and 24 volt versions, with 12 being the most common. The capacity is measured in amp-hours – how many amps can they put out for a certain amount of time. For example, a 100 amp hour

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battery can provide 100 amps for 1 hour, 50 amps for 2 hours, 25 amps for 4 hours, or even 1 amp for 100 hours. The greater the capacity, the bigger and heavier the battery.

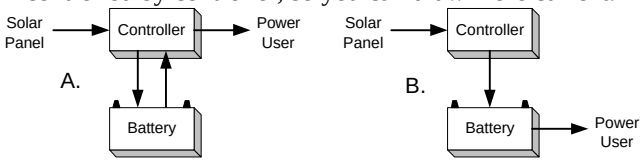
Batteries can be connected in series or parallel to achieve desired voltage (series) or current (parallel).

Charge Controller

Batteries will not last forever. Two things degrade them the most, overcharging and deep discharging. To prevent overcharging, a controller should be used. As a battery reaches its full capacity, the controller senses it and lowers the charging current. This is not as important with charging currents of 2 amps or less but is very important for greater currents (PV panels of more than 20 watts).

They cost from $50 to $200 or more, depending on their capacity. I bought a 20 amp controller for $100. My PV panel produces about 6 amps, so the controller will handle two more panels.

Two configurations possible when using a controller. Configuration A is limited by the capacity of the controller. In B (recommended), discharging is not controlled by controller, so you can draw more current.



Conversion

While 12 volt appliances and lights may be available, most electrical things in your house probably use 120 VAC. Inverters convert DC to AC power. You will need to have an inverter with the proper capacity to run what you want. They can provide from 90 watts to 5000 or even more.

Capacity	Cost	Source
500 watts	$29	Sams
1000 watts	$80	Costco
1200 watts	$100	Pep Boys
2000 watts	$190	Harbor Freight
5000 watts	$2100	various

If you're handy and can find a discarded UPS (uninterruptible power supply) they can often be used as an inverter – maybe as a charger, too.

Discharging

It is best to discharge as little as possible. The more discharge a battery, the more you shorten its lifetime. If you use a single battery, get a backup and swap more frequently.

Another method of reducing the discharge is to connect batteries in parallel, so two or more are working at the same time. This allows two batteries to discharge only half as much as one while providing the same power. Three batteries would be 1/3 as much, etc.

Safety

Fire is always a possibility with electricity. Sparks and heat are both hazards. Minimize sparks and use proper gauge wiring to keep temperatures down. Also reduce the length of DC wires as much as possible. **Keep fire extinguishers at hand**.

Hydrogen Gas: Lead acid batteries emit hydrogen gas when charging. Hydrogen is extremely flammable. Keep batteries in a well ventilated area, away from sparks and heat. **No sparks while charging!**

Acid: Because lead acid batteries have acid you should wash your hands after handling them. Keep **baking soda solution** (baking soda mixed with water) near batteries so you can find it with your eyes closed.

Goggles and **insulated gloves** are also good investments.

Uses

Light, microwaves, fans, forced air heating system motors, swamp coolers, amateur radios, battery charging, computers, entertainment, sound systems, power tools, wheat grinders, freezers, refrigerators, etc.

No heat, except for soldering irons (30 – 100 watts), etc.

Planning and System Sizing

What do you want to run? How often? How long?
Figure up to 20% additional loss in 12 volt systems.
Inverters are not 100% efficient.
12, 24, or 48 Volts? How big do you want to get?

Calculations / Formulas

P=I x E (power in watts = current in amps x volts)
P/I=E, P/E=I, 1 Horsepower = 746 Watts
Amp-hours = amps x hours
Watt-hours = watts x hours (a 1000 watt-hour battery provides 1000 watts for an hour, 500 for 2 hours, 200 for 5 hours, and 100 for 10 hours. If you use a TV and VCR – about 150 watts – you can get 1000 / 150 = 6.6 hours from the battery. Take off some for time for inefficiencies and you should get 5-6 hours.

Other Advice

Use fluorescent, miniature fluorescent, and LED lights where possible.

Where feasible, get equipment that runs off 12V, or modify equipment to use 12V batteries.

Further Information & Sources

Backwoods Solar: www.backwoodssolar.com
Colorado Solar Electric: www.cosolar.com *
Mr. Solar: www.mrsolar.com
Solatron Technologies: www.partsonsale.com *
Guide to PV System Design + more: www.californiasolarcenter.org/downloads.html
DOE Basic Design & Components Manual: www.partsonsale.com/pvbasic.pdf
Inverter Sources: SAMS, Harbor Freight, Checker Auto, Pep Boys.