DIY SOLAR
101

- Basic system component flow: Sun > Solar (PV) Panels > Panel Disconnect > Power Grid (requires DC-AC inverter) and/or Battery Charge Controller > Batteries > DC Loads > Inverter > AC Loads

- Design/Install: Load calculation/independence, site assessment, system type, PV mounting system, wiring and other electrical connections, component selection.

- Load Calculation & Independece: Find load calculator tables online. Convert all loads to watt-hours to determine system needs. (Volts x Amps x #of hours used) = watt-hours. Consider efficiency losses as electricity goes through each component. If off-grid, total usable battery needs (Ah) = # of days desired solar independence x watt-hours/day consumption x efficiency losses. PV array size (watts) = (total usable battery needs(Ah) / expected hours of sun/day) x PV voltage.

- Site Assessment:
  - Panels should be sited to receive as much sun as possible. Winter sun is usually more limited than summer sun, but depends on site. Solar Pathfinder, Skyview or other apps, observation and extrapolation.
  - Path of the full moon = Path of Sun +/- 6 months

- System Type:
  - Fully off-grid: Sun > PV panels > Battery charge controller (MPPT is best) > Batteries > DC Loads > Inverter > AC Loads < Generator
  - Grid tied, net/sell metering: Sun > PV panels > Grid tied meter (***If panel mounted inverters***) > Battery charge controller > Batteries > DC Loads > Inverter > AC Loads < Generator
  - Sell all: Sun > PV panels > Grid tied meter (***If panel mounted inverters***) > Inverter > Grid tied meter

- PV Mounting System:
  - Must be very structurally sound as panels are basically expensive sails to the wind.

- Panels are most efficient when oriented 90 degrees to Sun-Horizon angle. Adjust angle throughout the year or use a solar tracker for maximum efficiency. Sun angle from horizon at mid day on equinoxes = 90°- latitude. Add 23.44° for summer solstice, subtract 23.44° winter solstice

- Wiring:
    - Wiring must be sized depending on amperage and minimizing voltage drop. Low voltage DC electricity experiences major voltage/power drops compared to high voltage AC with same wire size. DC requires larger wires which are more expensive.
    - Best to have disconnect between all system components for servicing any part of the system independently.

- Component Selection:
    - There are varying qualities and efficiencies of all the involved components.

    - Battery Charge Controller: MPPT (Maximum Power Point Tracking) makes the most of incoming electricity by decreasing voltage to increase amperage and charge batteries most efficiently. Non-MPPT can only decrease amperage and/or voltage.

    - Batteries:
        - Lead-acid batteries are most common, but are toxic, don't last long, and don't tolerate much abuse or extreme temperatures. If 10% of battery is used they'll last 5000 discharge-charge cycles (5000/365 days in a year = 13.7 years), if 50% of battery is used they'll last 1000 cycles (1000/365 days in a year = 2.74 years). If not fully charged when temperatures go below freezing, they'll likely break charge plates and become inoperable.
        - Nickel-Iron (Edison) batteries are quite uncommon. They may seem noticeably more expensive per amp/watt-hour at first, usually about 3-5 times $$$/amp-hour compared to lead-acid, BUTTTTTT they can be used to 90+% discharge (if loads/inverter will operate at low voltage of low charge) repeatedly without noticeable negative effects so you get 9 times the power for 3-5 times the cost. Commonly used on forklifts and can be refurbished at home for major $$$ savings. They can be

over-charged/discharged, undercharged, withstand extreme temperatures and vibrations, AND the electrolyte solution can be changed for revitalizing (AND is alkaline Potassium Hydroxide and can supposedly be diluted and used to neutralize acidic soils). The KOH electrolyte could possibly be replaced with wood ash (Pot-ash) in desperate times. Their drawbacks include a relatively fast self-discharge rate of 1%, wide voltage/state of charge range, lower charging/discharging rates and efficiency.

  - Other battery chemistry options continue to be developed and should be considered.

- AC Inverter: Some AC loads (computers, some TVs and stereos, etc) require a "pure sine wave" inverter which is noticeably more expensive. Other loads can run off a "modified sine wave / square wave" inverter.

- Disconnect devices: These are usually glorified, purpose built, metal or plastic boxes. Some are meant for outdoor and/or UV exposure of varying degrees. They house current metering switches called "breakers" that can switch themselves off (or be manually operated) and they sometimes have arc and/or ground fault sensing and control. Surge protectors may also be installed in them.

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