Primer on Solar Energy

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A. Important Definitions & Units

Booing commences…

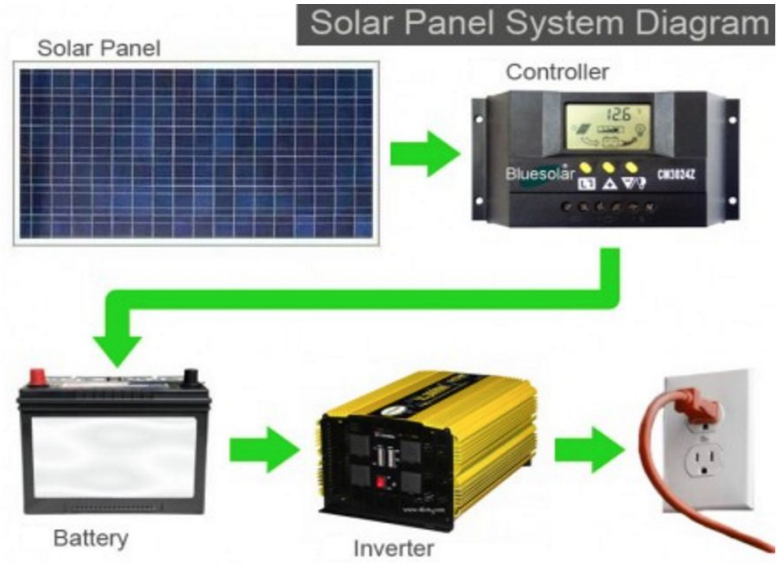
Really briefly, here are some important definitions and concepts:

- E = Energy := the capacity to do work. Exists primarily in two forms: kinetic energy and potential energy. Often measured in *Joules* [J] or *kWh*.
- V = Voltage := Electric potential energy per unit charge, measured in *Volts* [V].
- I = Current := The amount of charge flowing through a junction per second, measured in *Amps* [A].
- P = Power := The amount of energy per unit time that is transferred. This is usually measured in watts [W]. A watt is 1 Joule per second [J/s].
- R = Resistance := A quantity that says how much something resists current. [Ω]

If you feel like you don't have a good intuition for some of this is, that's okay. Hopefully it will make more sense when we talk about them in daily life.

C. Harnessing Solar Energy

How do we harness the rays of our divine sun?



C1. Solar Panels

~ Absorb the energy from the sun rays hitting them and convert it to electrical energy, which we use (a heck of a lot of!). Every second, depending on the sun's strength, and the size & "quality" of the panel, the panel will output a certain amount of electrical energy.

→ A solar panel's capacity to do this is measured in watts [W]. *Example: A panel rated 100W means that in full sun, we expect it to output about 100W of power. This is a bit more than enough to charge a laptop.*

C2. Batteries

~ The energy collected from our solar panels is stored for later in batteries, so that we can run our electronics at night or when there is less sun. "Deep-cycle" batteries are best for a solar system.

→ A battery's capacity is measured in Amp-hours [Ah]. Many batteries are 12 Volts, so we can calculate the net energy output of a charged battery in Watt-hours [Wh] by multiplying these numbers. *Example: A 12V battery rated at 10 Ah has a capacity of (12V)*(10Ah) = 120 Wh.*

C3. Solar Charge Controllers

~ Charge controllers monitor the charge of your battery system AND ensure that a battery doesn't get overcharged during charging or over-drained when used. Overcharging and over-draining both ruin batteries and thus reduce its lifetime.

2 types:

- PWM: Pulse Width Modulation
- MPPT: Maximum Power Point Tracking (Not worth it for ~200W of panels or less, but become useful to maximize efficiency for bigger systems)

[http://www.enerdrive.com.au/mppt-vs-pwm-solar-controllers/]

C4. Inverters

~Change DC power to AC power

Almost all of our electronics run off AC (Alternating current) but solar panels and batteries run off DC (Direct Current), so we need an inverter.

—> Connect a battery to the inverter, and then you can connect and run your (AC) devices from the inverter!

**Note: Can also be used for emergency power from a car, with car on.*

[https://www.donrowe.com/power-inverter-faq-a/258.htm]

D. Understanding Our Energy Consumption

Before we design our solar system, we must understand what our consumption requirements are. Do we just need to charge a cell phone every day? Do we need to run power tools directly off of our system? This is different for everyone, and requires a bit of planning. While some components will fit different systems, this is not generally true. The inverter required to charge a few cell phones and a laptop at the same time will not work if we want to run a fridge, microwave or hair dryer.

Appliance	Power (Watts)	Measured 12 V Battery Draw (Amps)*
DVD player	4	0.38
Cell phone charger	4	0.38
Radio	5	0.48
Light, 7 W LED	7	0.67
Tablet computer	11	1.06
Satellite receiver (off = 13 W)	15	1.44
Printer, inkjet (idle = 2 W)	15	1.44
Light, 13 W CFL	15	1.44
Computer monitor, LCD	22	2.10
Light, 25 W CFL	27	2.59
Laptop computer	34	3.26
TV, 21 in. LCD	38	3.70
Battery charger, drill	62	5.90
Light, incandescent	75	7.20
Wood heater blower	90	8.60
Light, incandescent	100	9.60
Fridge/freezer, 19 c.f. (peak = 300 W)	125	11.90
Desktop computer (idle = 85 W)	140	13.40
PA amplifier, 300 W	150	14.40
Computer projector (idle = 16 W)	260	24.90
Well pump, 1/2 hp (surge = 1.1 kW)	535	51.30
Hair dryer	745	71.40
Microwave, compact	1,030	98.70
Coffee maker, drip	1,070	102.50
Microwave, standard	1,350	129.40

*Assumes 15% losses through inverter supplying 120 VAC power from a 12 VDC battery.
This table originally appeared in “Solar on the Go” in *HP149*.