Solar Power Basics

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Components of a Solar Setup

Devices (Load)

Battery

Charge Controller

Solar Panel(s)

Wires and connectors

1. Determine power requirements

Power (watts)= Voltage (volts) X Current (amps)

Energy (watt-hrs)= Power (watts) X Time (hrs)

Use a INA219+Arduino, 2 Multimeters, or a Watts-Up to determine power consumption and energy usage

Example: TP-Link 703N

Load Voltage:	12.21 V
Current:	82.30 mA

Power consumption of TP-Link 703N:
1.0049W = 12.21V * .08230A

Daily energy usage of a TP-Link 703N running 24/7:
24.12Wh = 1.0049W * 24h

2. Determine battery size

To maximize your battery lifespan, you should plan to use less than 50% of your battery capacity.

So your battery should be **at least** 2x your daily consumption, even if you live in the sunniest place on the planet.

Backup for days without sun

How many days in a row without sun could you have? Multiply that by your average daily energy usage. Now double that to prevent >50% battery utilization!

24.12Wh* 2 days without sun= 48Wh

So you would want a 96+ Wh battery

96Wh battery = 12V 8Ah battery

3. Determine required energy generation

Goal: Enough panel capacity to charge the battery from 50% to 100% **AND** power your device in one day of winter sun.

24.12 Wh to power the 703N for a day +

48 Wh to charge the battery from 50% to full

= We want 72Wh of energy generation per day from our panel.

4. Select a charge controller

$10 ones are fine (AGPTek or similar)

Maximum Power Point Tracking is more efficient, worth it for larger systems.

Prevent overcharging battery
Protects against over voltage of battery
Protects against under voltage of load

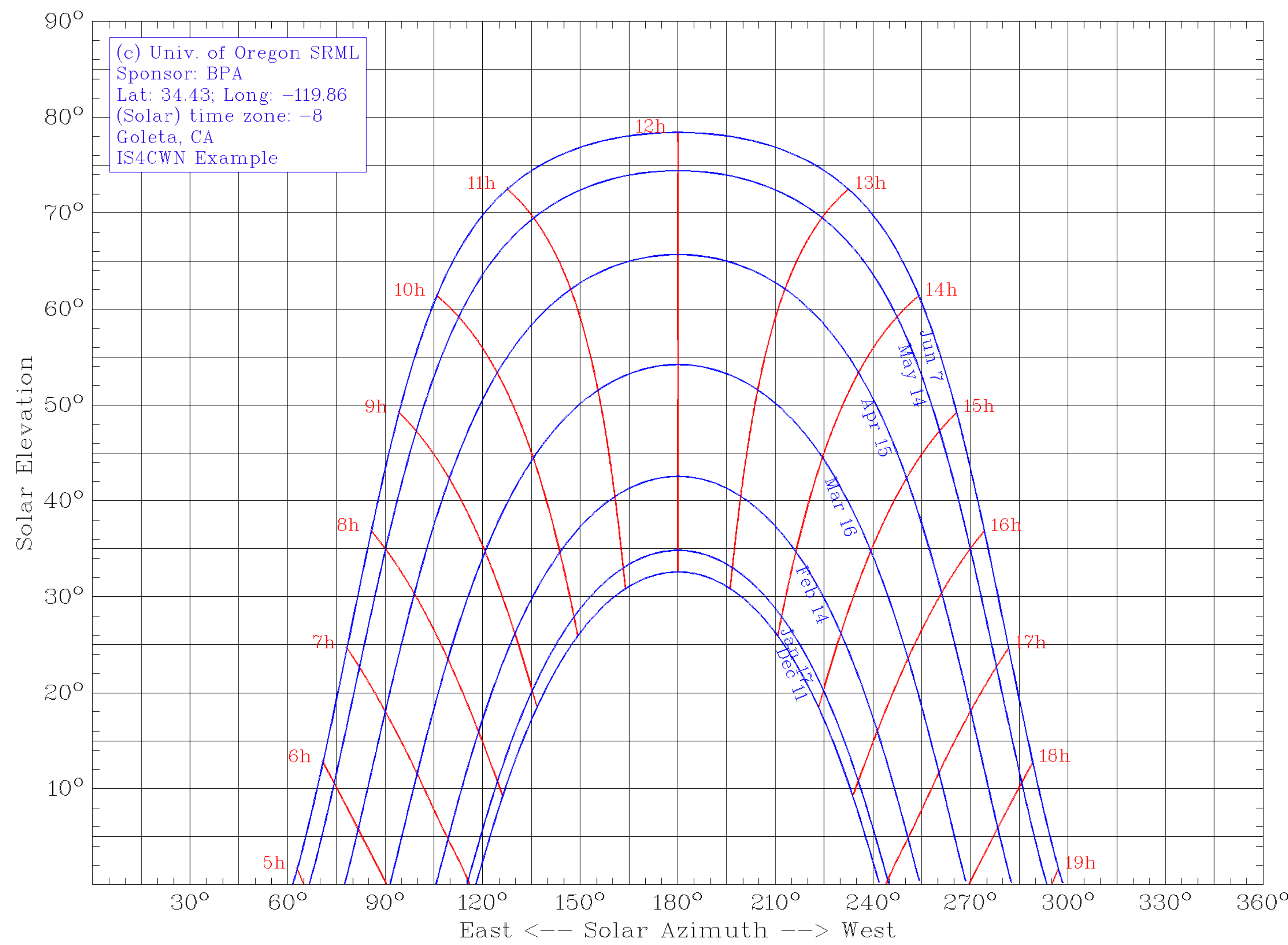
5. Determine worst-case sun

Depends on your location, time of year, the path of the sun, and obstacles.

Gather elevation and azimuth information of objects around your site from the perspective of your panel and plot them on an elevation/azimuth Sun Chart.

http://solardat.uoregon.edu/SunChartProgram.php

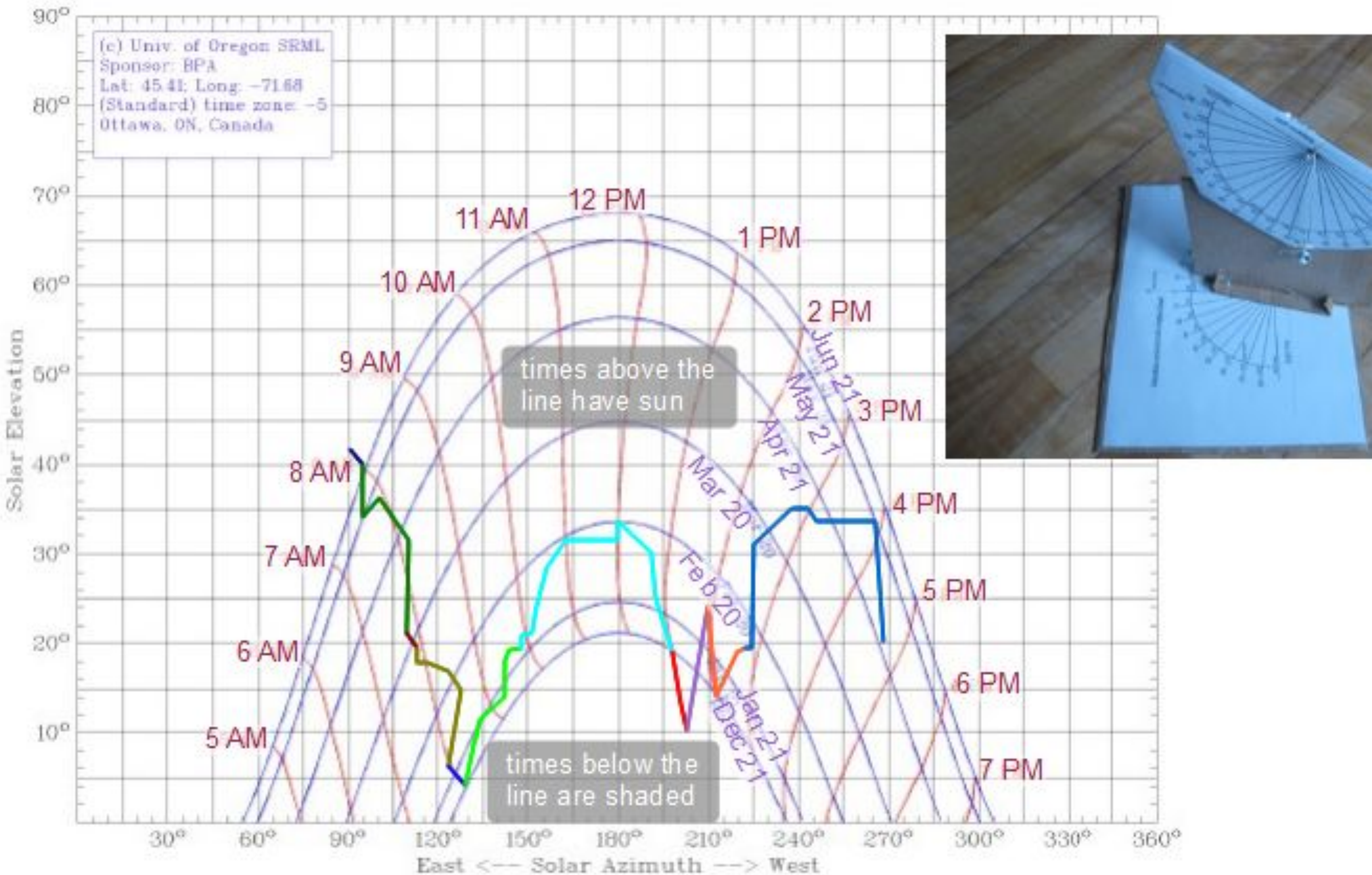
http://solardat.uoregon.edu/AboutSunCharts.html
http://tinyurl.com/chartSun


(c) Univ. of Oregon SRML
Sponsor: BPA
Lat: 34.43; Long: -119.86
(Solar) time zone: -8
Goleta, CA
IS4CWN Example
Solar Elevation
East <-- Solar Azimuth --> West
90°
80°
70°
60°
50°
40°
30°
20°
10°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
360°
5h
6h
7h
8h
9h
10h
11h
12h
13h
14h
15h
16h
17h
18h
19h
Jun 7
May 14
Apr 15
Mar 16
Feb 14
Jan 17
Dec 11

Even bare branches are obstacles!

Elev	Azim	Elev	Azim	Elev	Azim	Elev	Azim	Elev	Azim	Elev	Azim
42	90	18	114	9	130	24	153	19	199	19	224
40	95	18	118	12	133	28	156	13	201	32	225
33	95	17	126	17	142	32	162	10	204	35	239
36	102	15	128	19	143	32	180	24	210	35	243
32	112	6	125	19	148	34	180	14	211	33	259
21	110	4	129	22	149	30	191	18	220	33	265
19	114	8	130	21	152	25	192	19	223	20	269

Source: Steven Dufresne rimstar.org



Source: Steven Dufresne rimstar.org

6. Determine solar panel size

To generate 72Wh per day (assuming 80% charging efficiency) :

10W panel with ~9 hours of sun

30W panel with ~3 hours of sun

90W panel with <1 hour of sun

7. Buy things and hook it up!

12V 8 AH UB1280 Battery	$19.65
2-Port USB Car Charger with 2.1 Amp Output	$9.54
10A 12V/24V Solar Charge Controller	$10.17
10-Watt Monocrystalline Solar Panel or 90-Watt Monocrystalline Solar Panel	$39.99 or $175.00
Female Cigarette Adaptor	$7.42
Wires, connectors, etc.	$1.50
TOTAL	**$88.27- $223.28**

Links!

Calculation spreadsheet

http://tinyurl.com/is4cwnsolar

Making a Raspberry Pi 25% more efficient

http://tinyurl.com/solarpi

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Open source Arduino power monitoring:

https://github.com/dannyiland/SolarPower