Solar system (PV) calculation and design.

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Solar panel (PV) is a device which can convert energy from light energy (proton) to electrical energy. Each panel is rated by its DC output power. Currently the best commercial solar panel (PV) efficiency is around 17.4%. Solar panels are normally 12V DC output. In large solar panel 24V or 48V DC output also seen.

A technical specification (backside of a solar panel) given below.

Technical Details			
Model			SP20 125x125/4x36
Cell Material			Mono Crystalline
Maximum Power		Watts	20 Watts
Cell Grade		A,B,C,D	A
Nominal Voltage		Volts	12 V
Maximum Voltage (Vmp)		Volts	17.6 V
Open Circuit Voltage (Voc)		Volts	21.8 V
Maximum Current (Imp)		Amp	1.14 A
Short Circuit Current (Isc)		Amp	1.25 A
Maximum System Voltage		Volts	600 V
Cell Efficiency		%	17%
Dimensions	Length	Inch	24 1/2"
	Width	Inch	10 3/4"
	Thickness	Inch	1 1/8"
Weight		Lbs	5 lbs
Cell Size			125x125/4 mm
Cell Quantity			36
Frame Structure (Material)			Extruded Anodized Heavy Duty Aluminum
Encapsulation			EVA
Rear Side			DuPont® Tedlar™ (TPT)
Glass Thickness		Inch	1/8" 3.2mm
Max. Wind Resistance			65 m/s – 145 MPH
Max. Hail Diameter Size / Speed			1+ Inch @ 50 mph
Max. Load Capacity			200 kg / m^2

Normally a few common specification are seen all types of solar panel

Like Nominal voltage, Maximum Voltage, Open circuit Voltage, Maximum Current, Short Circuit Current, Maximum System Voltage, and Maximum Power.

Maximum Power: it means it can deliver maximum 20 Watts electricity. If we need total 100 Watts then we need to setup 5 panel in parallel or series (depend on design).

Maximum Voltage: it means its maximum output voltage is 17.6V

Open Circuit Voltage: It means the voltage without load. It is sometimes given the symbol V_{oc}

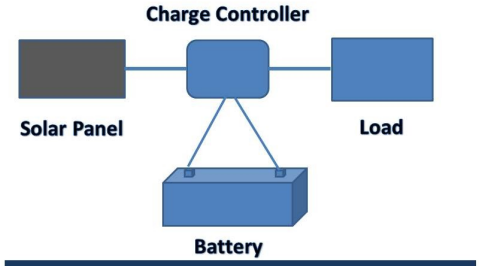
Maximum Current: It means the maximum output current.

Short Circuit Current: It means the current of short circuit of solar panel.

Maximum System Voltage: It means that, when we connect solar panel in series then maximum voltage limit is 600V so we could connect (600/17)=35 solar panel in series.

To calculate the solar system we have to measure

1. Solar Panel
2. Charge controller
3. Battery
4. Inverter (for AC output)



A Simple DC Solar System

Now if a subscriber wants to setup a solar system for 2 bulbs and 1 fan. (12 volt DC)
(1 bulb=10 watt, 1 fan=20 watt) then the total load

2 bulb (10×2)	= 20 watt
1 fan	= 20 watt
Total	= 40 watt

Now if he wants 4 hours back up time.

Then total load (4hour × 40watt) = 160WH^{-1} (watt per hour)

To measure the battery ampere for the above load.

Volt = 12

$$\therefore I = \frac{160}{12} = 13.33\,AH$$

∴ Battery is needed 12 volt, 14 AH.

Now to calculate the solar panel:

Generally a battery charging current = 10% of its AH

$\therefore$ Charging current = 1.4 A $\left(\frac{13.33}{10} = 1.33 \cong 1.4A\right)$

$\therefore$ Solar panel needed = 1.4 A $\times$ 12 V

= 16.8 watt

So recommended the charge controller is 12 Volt, 1.4 Amp

Thus a solar system is calculated

(System loss is not added with this measurement, so approximate 25% system loss will be added.)

So from calculation

1. Solar panel =20 watt (20 watt is available)
2. Battery = 12volt, 15AH (15AH, 20AH battery available)
3. Charge controller = 12 volt, 2A (2A charge controller available)

Efficiency of Solar panel:

$$efficiency = \frac{output\ power}{input\ power} \times 100\%$$

Here output power is the power we get from solar panel. Input power is the light fall in solar panel.
The light comes from sun in earth surface is $1M^2$=1KW.
It means from $1M^2$ space we could get maximum 1KW energy. If a $1M^2$ (dimension) solar panel deliver 170 Watts power then the efficiency of solar panel is

$$efficiency = \frac{170W}{1000W} \times 100\%$$

$$= 17\%$$