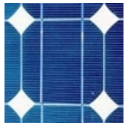
Solar Photovoltaic System Design Info Sheet - Feasibility Study

Use this worksheet to help you design your own off-grid solar power system.

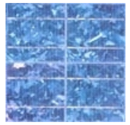
Solar PV technology

Mostly solar cells are made from silicon. The cells are arranged into solar modules with different voltage, current and power outputs. There is a rating label on the back of all solar modules. The main figure to note is the **Watts - Peak (Wp)** value - this is the output under standard test conditions. Also check the voltage is OK for your system. There are three main types:

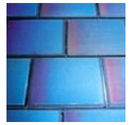
Monocrystalline
Approx 15% efficient
Long lifetime



Polycrystalline
Approx 12% efficient
Long lifetime



Amorphous
Around 7% efficient
Slightly better in diffuse sunlight



START

Load analysis

Why? Higher loads = larger system = higher cost

Accurate load analysis is very important and is the first step in system design. We need to know the power ratings of all appliances and also the time they are used.

Power x time = Energy, which must be supplied by the system. To do this write a list of all loads and times:

Load	Power	Time	Quantity	Energy
Lights	20W X	4hr/day X	3 =	240Wh +
Radio	5W X	10hr/day X	1 =	50Wh
			TOTAL:	**290Wh**

NO

OK?

System design is an iterative process.
Generally the initial system design will be very high cost.
Can you reduce the load? Use more efficient devices?
Use a smaller battery bank?

YES

Create full design
(See other side of this worksheet)

Cost

Why? Economic cost is usually the determining factor

Add up full cost of all parts including: *cables, connectors, mounting structures, battery racks, charge controllers, labour, transport etc.*
This is best done as a spreadsheet.
Always include 20% additional costs for unknowns.

Resource assessment

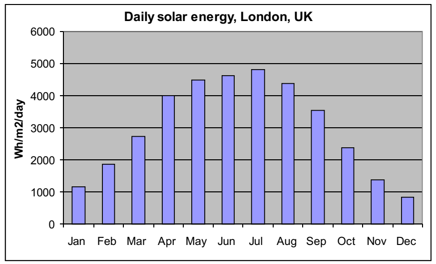
Why? Must know how much solar energy is available at the site

To do this we use online resource databases:

NASA Meteorological Data (*http://eosweb.larc.nasa.gov/sse/*)
PV GIS (*http://re.jrc.ec.europa.eu/pvgis/*)
Meteonorm (*www.meteonorm.com*)

Solar data is accurate and reliable. Need to check seasonal variation. Usually design for worst month. Need to include 80% PV charging Inefficiency factor.

Example: At our site we have 4hours sunlight per day during the worst month.
Must supply*:*
290Wh *(from load analysis)* x 100/80 = 362Wh
Therefore need PV array*:* 362Wh / 4h = 90.5Wp
We usually round up, so use a 100Wp PV module



Storage

Why? Solar energy is variable, hence we need storage

Storage is usually **lead-acid batteries**. Many different types. Must use 'deep cycle' type (NOT car batteries).

Rules of thumb:

1- Storage should be sized for around 3-5 days with no solar input.
2 - Must also never go below 50% depth of discharge.
3 - Must include 80% battery efficiency factor.

Batteries are rated in Ah, therefore need to choose the voltage to find AH storage required.

Example: 290Wh required per day by loads.
Battery must supply*:* 290Wh x 100/80 = 362Wh *(rule 3)*
Battery bank must supply*:* 362 x 4days = 1450Wh *(rule 1)*
Battery bank must be sized at*:* 1450Wh x 50/100 = 2900Wh *(rule 2)*
Assume 12V battery: Battery bank size is 2900Wh/12V = 241Ah

Worksheet designed by:
renewable energy innovation
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Solar Photovoltaic System Design Info Sheet - Electrical Design

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System voltage

Why? This affects the devices which can be used and also the currents flowing in the cables.

High currents = thick and expensive cables fuses and switches.
Typical voltages:

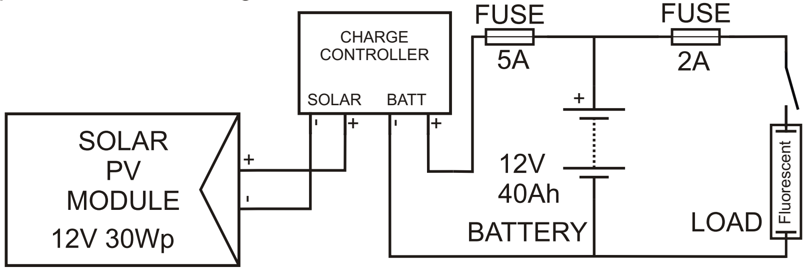
12V < 500W max
24V < 1000W max
48V < 2000W max

But 12V devices are easier to find and cheaper.
Also can use an **inverter** to convert 12VDC to 240VAC.

Wiring diagram

Why? This is to ensure it is wired correctly and for future reference

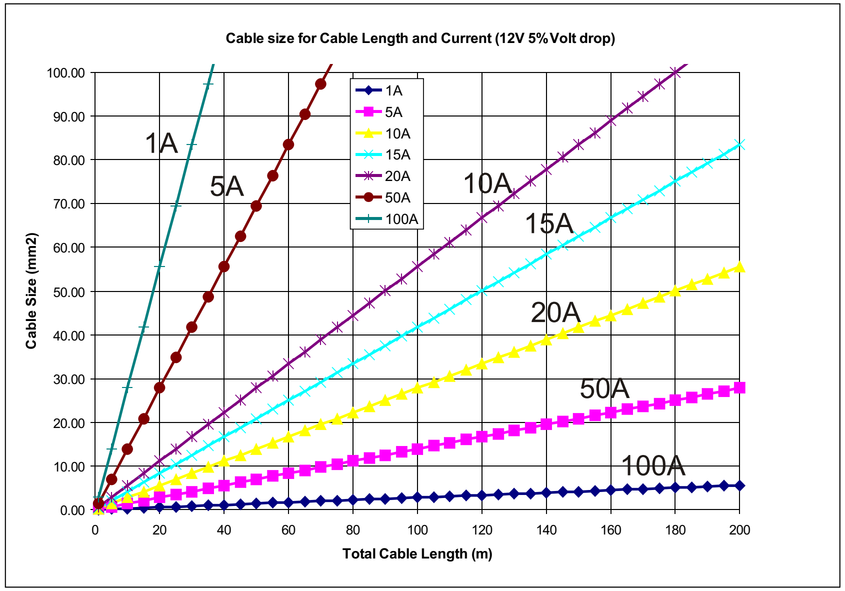
We need to produce a full wiring diagram including all the system components. Check this with an electrician if unsure. Put as much detail as possible on this design.



Cable sizing

Why? Must be correct or the resistance will cause a voltage drop and incorrect operation.

You **must** use the correct thickness cable for the max current flowing and the length of the cable run.
The resistance depends upon the size of cable, the cable material, the length of the cable run, the maximum allowable voltage drop and the operating temperature. Formulas are available.
Rule of thumb: Use 1mm^2 cable thickness for every 5A
Or use the chart here:



Charge controller

Why? This is needed to prevent over-charging and over-discharging of the battery
The charge controller (sometimes called a charge regulator) **provides battery protection** and is very important.
Must be rated for correct current (generally the max current from the PV array) and voltage.
The charge controller acts like a big switch to either disconnect (**series** regulators) or dump (**shunt** regulators) power from the PV array when the battery voltage is too high.
Lots of different types with different features including:

Voltage, current, power and **energy** display
State of charge measurement - like a fuel gauge for the battery
Low voltage disconnect - to stop the battery being too heavily discharged

The choice depends upon your budget and features required.

Fuses

Why? To protect wires and components from over-currents (such as a short circuit).

Battery is the main issue here as it can supply very high currents.
Ensure correct current and voltage rating. Fuse in both +ve and -ve is best.
Place fuses close to the battery side.
Many different types of fuses available. Some must be replaced (such as automotive fuses), some can be reset (such as circuit breakers). This choice depends upon the cost and the typical users.