NEMTEK SOLAR POWER SOLUTIONS

Why Solar Power

It is mainly for economic reasons that a solar power system is used as the supply for Nemtek's electric fence energizers.
A solar system can be a reliable and cost effective supply in places where there is no mains supply or the mains supply is unreliable.
Solar power is also a clean and renewable energy source and if there are concerns about the carbon footprint solar power will be a viable solution.

The Solar Power System

In a solar power system you will typically find:

- Solar Panel(s)
- Regulator
- Deep Cycle Battery
- Load
- Cabling

The Solar Panel

The solar panel converts sunlight into electricity. It is built with a number of solar cells; each cell will generate about 0.5 Volts. A number of cells are wired in series to increase the output voltage of the panel and a group of 36 cells will be sufficient to charge a 12V battery. By paralleling cells or groups of cells the output power of the panel can be increased.
Solar panels can also be wired in series or paralleled to increase the output voltage or power of the system.

The Regulator

The regulator is required in the system to control the output voltage from the solar panels. It prevents the solar panels from overcharging the battery and it will supply the correct voltage to the load. The regulator also protects the battery from being over discharged by disconnecting the load when the battery voltage becomes too low. The life span of the battery will be extended in this way.

The Deep Cycle Battery

Batteries are required in a solar power system as they will store the energy received from the solar panels and will supply the load for the periods when there is no or not enough sun available to power the system.

Since the batteries will go through a charge and discharge cycle every day, not every type of battery is suitable in a solar power system. Car batteries for example are not suitable for the system.
A Deep Cycle battery is required they are specially designed to handle the cycles and if rated correctly they will be able to supply the system for many years.

The Load
The load is the equipment which has to do the work, so this can be a Nemtek Electric Fence energizer, a gate motor, a pump or maybe just a light. What is important to know about the load is what voltage does it operate on, what current does it draw and how long much it operate for. All this information is required before a solar power system can be designed.

Cabling
Electric cables are used to connect the panels to the regulator and the regulator to the battery and the load.
The cables must be rated correctly not only to prevent overheating of the cables but also to ensure low loss of energy.
If all the components in the system (panels, battery, regulator and load) are close together then the cable lengths will be short. This means the voltage drop across the cables will be low which will make the system more efficient and the load will be able to operate for a longer period from the battery.

Location and orientation of the solar panel
The location of the solar panel must be such that no shadows fall on the panel during peak sunlight hours (9am – 4pm).
Solar panels should always face in the direction of the equator, in the southern hemisphere it should face true North and in the northern hemisphere true South.
The best angle of inclination or tilt of the panel depends on the time of the year as well as the latitude where the panel is situated.
If the panel is a fixed panel and the tilt can not be changed then it should be set optimally for the winter position since the energy from the sun will be the lowest during that season, if it works in winter it should work in the other seasons.
If the frame for the panel is adjustable then for the different seasons the following tilts from the horizontal can be used.

- Winter - latitude + 15°
- Spring - latitude – 2.5°
- Summer - latitude – 15°
- Autumn - latitude – 2.5°

For the southern hemisphere the adjustment dates would be April 14, August 27, October 20 and February 22. For the northern hemisphere the dates have to be adjusted by half a year.

Load calculation
The first step in sizing a solar power system is to establish how much power is required by the load and for how long the load is switched on.
The operating time of the load varies by application. An Electric Fence normally has to operate 24 hours a day. A Gate Motor might only operate for 20 minutes in a day.
The power requirement of the load is normally stated by the manufacturer of the equipment, but one has to be careful when reading the manufacturer's label for example a 220Vac mains supplied Electric Fence Energizer which can also work on battery has a rating of 40W but almost half of that power is used to charge the battery of the energizer. The 12Vdc rating of that energizer is most likely 20W. If not sure check the DC rating with the supplier of the equipment.

If one takes as an example a 20W 12V Nemtek Electric Fence Energizer together with a 12V 15A Gate Motor.
The load current for the energizer is 20W/12V = 1.66 Amps if this is to be supplied for 24 hours the load requirement will be 1.66 x 24 = 40 AH/day.
The Gate Motor requires 15 A for 20 minutes a day so the requirement will be 1/3 x 15 = 5AH/day.
The total load requirement will be 40 + 5 = 45 AH/day, one should however allow for 20% losses in the system this will give then 45 x 1.2 = 54 AH/day.

Solar Input calculation
The amount of solar radiation is location dependent. Johannesburg is rated at 5.5 hours full sun hours a day and Cape Town at about 4 hours. Maps are available on the internet for solar insolation for every area in the world.
If the example above was situated in Johannesburg the solar panel must be rated for a maximum power current of 54/5.5 = 9.8 Amps.

Selection of the solar panel
If you multiply the maximum power current of the panel with the maximum power voltage you will get the power requirement of the panel in watts. A solar panel for a 12V system has a maximum power voltage of about 17.5 volts.
The solar panel rating should be 9.8 x 17.5 = 171.5 W
It is always best to go bigger if possible so select 2 x 100W panels.

Selection of the regulator
Most regulators control the output of the solar panel by shorting the panel for short periods, so one should use the short circuit current of the panel to calculate the rating of the regulator.
The rated short circuit current of a 100W panel is 6 Amps so for two panels this will give a total of 12A.
It is best to select a regulator with a 25% margin so that is more than capable of handling the total short circuit current. 12 x 1.25 = 15 A.
Select a 15 Amp regulator for the example.

Selecting the battery

To achieve a reasonable life span from the battery one should not discharge the battery more than 20-25% on a daily basis. This will then also result in a 3-4 day standby period for the system during bad weather conditions.
The battery could discharge 45 AH/day so the capacity of the battery should 45 x 4 = 180 AH.

Wiring and Cabling

The standard wiring (fig 1) is relatively simple. The solar panel(s) must be wired to the solar panel input of the regulator. The battery connects to the battery output of the regulator and the load connects to the load output of the regulator. Attention has to be paid to the polarities since all equipment is polarity sensitive and damage can occur if positive and negative connections are swapped around.

Sometimes it is necessary to connect the load direct across the battery (fig2) for example if the load draws a heavy current for only a short period. A Battery fuse is then recommended in case of a load failure or over current.

The current rating of all the wires in the standard system should be at least 1.5 x the short circuit current of the solar panel array.
If the load is connected across the battery than the load cables should be rated for at least 1.5 x the peak current of the load.
One of the problems with a 12V solar panel system is the volt drop across the interconnecting cables. A drop of not more than 2% is recommended, this is only 0.24V or 240mV in a 12V system, otherwise the losses in the cables will make the system inefficient and standby periods will be reduced.
To achieve low losses one should try to keep panels, battery, regulator and load as close as possible together to reduce cable lengths. A lager cable than required for the current rating can be used to reduce the volt drop across the cable. Table 1 gives an indication of volt drop per ampere per meter of wiring for different wire sizes.

If in the example the solar panel, regulator and battery are close together then we can wire these with a wire that is suitable to carry 1.5 x the short circuit current of the solar panel 1.5 x 12 = 18 A. Table 1 indicates that a 2.5mm² wire with a current rating of 20 A can be used.

For the gate motor example with the motor connected direct across the battery: What wire should be used if the motor is mounted 3 meters away from the battery?
The cable length is 3 meters. The volt drop allowed is 240mV and the current is 15 Ampere. 240/15/3 = 5.32 mV/Amp/Meter, table 1 indicates that a 10mm² wire will be suitable. A 10mm² wire can handle 47 Amps so it is more than the current requirement of 1.5 x 15 = 22.5 A.

For the same example table 2 can also be used. The current is indicated in the left hand column and the wire size in the top horizontal column. The maximum cable length allowed for a 2% volt drop across the cable is displayed at the junction of current and wire size. At 15 A and 6mm² a maximum cable length of 2.2 meters is found which is to short for the distance in the example but under 15 A and 10mm² a distance of 3.7 meter which will be suitable since only 3 meters is required.

For the 20W energizer example: What wire should we use if the energizer is mounted 8 meters away from the regulator?
The cable length is 8 meters. The current rating for the energizer is 1.66 Amp and the volt drop allowed is 240mV. 240/1.66/8 = 18 mV/A/m. Table 1 will show that a 2.5mm² wire can be used since it has a volt drop of 17mV/A/m which is lower than the 18 mV/A/m calculated. . The wire is rated at 20A which is more than 1.5 x 12 (short circuit current of the solar panel) = 18 A.

From the examples it can be seen that it is very important to keep all the components of the solar system as close as possible together otherwise wire sizes become large and it will not be easy to fit large wires into the connectors on regulators or loads.

FIG 1

STANDARD WIRING DIAGRAM

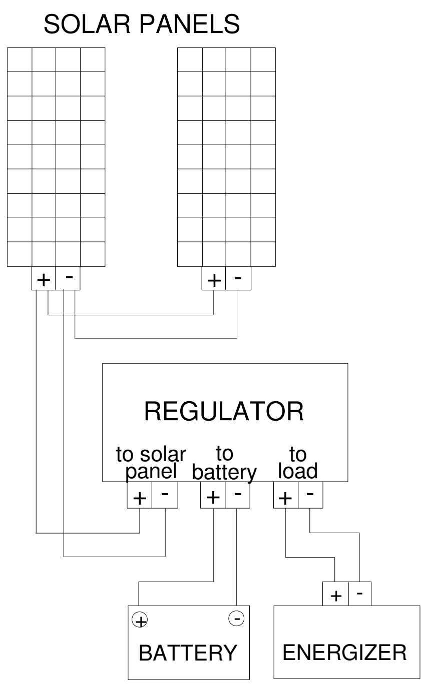

FIG 2

WIRING DIAGRAM WITH LOAD ACROSS BATTERY

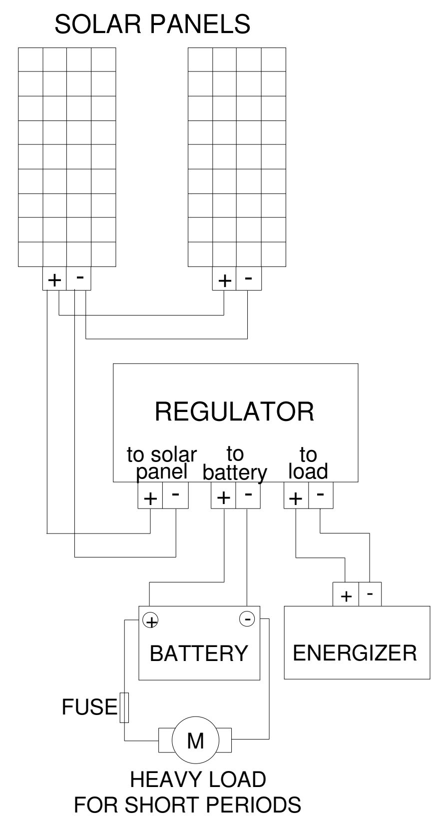

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Table 1

Current rating and Volt drop chart

cross section mm²	current rating A	Volt drop/ amp/meter mV
1	12	43
1.5	15	29
2.5	20	17
4	27	9
6	34	7.3
10	47	4.3
16	61	2.7
25	80	1.8
35	97	1.3

TABLE 2
Maximum Distance Chart
for 2 core cable in 12V solar system with a 2% Voltage drop

wire size	1mm²	1.5 mm²	2.5 mm²	4mm²	6mm²	10mm²
Amps	Distance in meters					
1	5.5	8.3	14.1	21.8	32.9	55.8
1.5	3.7	5.5	9.4	14.5	21.9	37.2
2	2.8	4.2	7	10.9	16.4	27.9
2.5	2.2	3.3	5.6	8.7	13.2	22.3
3	1.8	2.7	4.7	7.3	11	18.6
3.5	1.6	2.4	4	6.2	9.4	15.9
4	1.4	2.1	3.5	5.5	8.2	14
4.4	1.2	1.8	3.1	4.8	7.3	12.4
5	1.1	1.7	2.8	4.4	6.6	11.2
6	---	1.4	2.3	3.6	5.5	9.3
7	---	1.2	2	3.1	4.7	8
8	---	1	1.8	2.7	4.1	7
9	---	---	1.6	2.4	3.6	6.2
10	---	---	1.4	2.2	3.3	5.6
12.5	---	---	1.1	1.7	2.6	4.5
15	---	---	---	1.4	2.2	3.7
17.5	---	---	---	1.2	1.9	3.2
20	---	---	---	1.1	1.6	2.8
25	---	---	---	---	1.3	2.2
30	---	---	---	---	1.1	1.9