

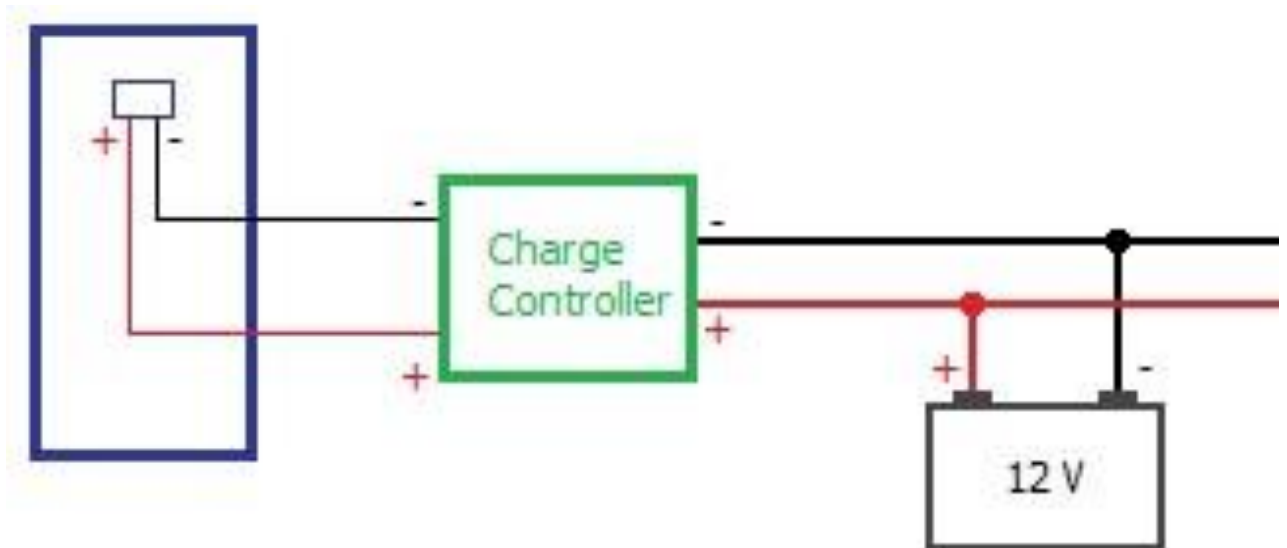
100W Basic Kit (GS-100-Basic) Kit Sizing Guide

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Valid from July 2015

Step By Step Setup

Basic Wiring Diagram



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Overview

This kit is designed for 12v Battery charging.

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Basic Kit Facts

This 100 watt panel kit will produce an average of 25 amp-hours per day when used in a 12 volt system. This equates to approx. 300 watt-hours of usable power per day. The production amount will vary seasonally, depending on your location and the panel placement. For more detailed production estimates, see

<http://pvwatts.nrel.gov/pvwatts.php> .

When your battery is fully charged, you will see very low output from the controller. This is normal, and prevents the battery from being overcharged.

If the battery is discharged below 10.6 volts DC, the controller will no longer function. This is because it is powered by the battery, not the panel. In this case, it is necessary to use an AC-powered trickle charger to bring the battery up to the proper voltage.

System Sizing: Step 1 Determine Consumption

To determine the total system size you must first calculate your consumption in Watt hours (Wh) per day.

Lighting

If you have four 15W LED lights (actual wattage not equivalent wattage) that you plan on running for 8 hours per day, you would take the wattage of each bulb, multiply it by the number of bulbs and multiply that by the number of hours of run time per day.

$$2 \text{ bulbs} \times 15 \text{ W/bulb} \times 8 \text{ hours/day} = 240 \text{ Wh/day}$$

Pumps and Motors

If you plan to run a 1 horse power (hp) pump for 1/2 hour per day you would first convert the hp into Watts: 1hp = 745W, Then multiply that by number of hours of run time per day.

$$1 \text{ pump} \times 745 \text{ W/pump} \times 0.5 \text{ hours/day} = 373 \text{ Wh/day}$$

Misc. Electronics

If you want a system to power your laptop for 6 hours per day plus a microwave oven for 10 minutes per day you would first need to determine the wattage of each device. This information can usually be found

on the device or approximated with the help of an internet search. Let's assume that the laptop consumes 65W and the microwave oven consumes 800W. Multiply each device's wattage by its run time and add the two numbers together.

$$\begin{aligned} &1 \text{ laptop} \times 65 \text{ W/laptop} \times 6 \text{ hours/day} = 390 \text{ Wh/day} \\ &1 \text{ oven} \times 800 \text{ W/oven} \times (10/60) \text{ hours/day} = 134 \text{ Wh/day} \\ &390 \text{ Wh/day} + 134 \text{ Wh/day} = 523 \text{ Wh/day} \end{aligned}$$

Battery Charging

If your plan is to keep a battery bank charged, first add up the Amp hour (Ah) capacity of all the batteries in your system. The Ah capacity is usually shown on the side of the battery. For example, an RV with two 80Ah would have a 160Ah battery bank. For this calculation it doesn't matter if the batteries are connected in series or parallel. Most batteries can only discharge 50% of their Ah capacity so only 50% of the total Ah rating needs to be fed to them to bring them to full charge. In this case that would be 160 divided by two, equaling 80Ah. To convert Ah into Watt hours, multiply 80Ah by 12V.

$$2 \text{ batteries/day} \times 80 \text{ Ah/battery} \times 0.50 \times 12 \text{ V} = 960 \text{ Wh/day}$$

Watts vs. Watt hours

Keep in mind that Watts is an instantaneous power measurement, not to be confused with Watt hours, which is the actual energy consumption. Watts must be multiplied by estimated run time to determine energy consumption. A good analogy would be speed vs. distance. Watts are equivalent to speed, whereas Watt hours would be the distance. In order to determine how many panels are needed you need to know the "distance."

System Sizing: Step 2 Calculate Panel Count

On an average day, a single 100W panel will produce about 300 Watt hours (Wh) of charge. This figure will vary depending on temperature, brightness and time of sun exposure. In the Summer production will be higher than in the Winter. On bright sunny days the output will be higher than on cloudy days.

$$\begin{aligned} &\text{A single 100W panel will have an average daily production of:} \\ &300 \text{ Watt hours (Wh)} = 0.30 \text{ kilo Watt hours (kWh)} = 25 \text{ Amp hours (Ah)} \end{aligned}$$

After determining your consumption in step one, divide that number by the production of a single panel:

Lighting example:

Two 15W LEDs for 8 hours per day

$$240 \text{ Wh} / 300 \text{ Wh/panel} = 0.8 \text{ panels} = 1 \text{ panels}$$

Pumps and Motors example:

One 1hp pump for 1/2 hour per day

$$373 \text{ Wh} / 300 \text{ Wh/panel} = 1.24 \text{ panels} = 2 \text{ panels}$$

Misc. Electronics example:

One 65W laptop for 6 hours and one 800W microwave for 10 minutes, per day

$$523 \text{ Wh} / 300 \text{ Wh/panel} = 1.74 \text{ panels} = 2 \text{ panels}$$

Battery Charging example:

Two 80Ah batteries per day

$$960 \text{ Wh} / 300 \text{ Wh/panel} = 3.2 \text{ panels} = 4 \text{ panels}$$

Area Specific Production:

More accurate panel production estimates can be made by using an online program that takes into account the local climate, latitude, tilt angle and bearing of the panel.

The simulator can be found here: <http://rredc.nrel.gov/solar/calculators/PVWATTS/version1>

1. Click on your State
2. Click on the city nearest to your location
3. Change the DC rating from 4.0 to 100 (to simulate a single 100W panel)*
4. Change the tilt angle to whatever your panel is tilted at (ideal is equal to your latitude)
5. Confirm that your azimuth is correct (180 degrees, facing South, is optimal)
6. Click "Calculate"

A new page will show a "Results" box. The middle column "AC energy" will show your panel output broken down per each month in Watt hours*. For example, the total Watt hour for an optimally tilted panel for one year of production in Eugene is 106,794Wh. The daily production would be 292Wh.

***Please note:** PV Watts deals in kW & kWh. If you typed 0.1kW to represent a 100W panel the program would round your input up to 4.0kW. To adjust for this, mentally substitute W for kW. Input your data in Watts (W = 1/1000 of a kW) and know that your output is in Wh, not kWh as shown on the website.

$$106,794 \text{ Wh/yr} / 365 \text{ days/yr} = 292 \text{ Wh/day}$$

System Sizing: Step 3 Inverter Sizing

The solar panels put out DC power that is fed through a charge controller onto a battery bank. If you have an application that requires AC power you will need an inverter to take that power off of the battery and turn it into 120V AC.



When selecting an inverter it is important to know the total Wattage of your load. In Step 1 we determined the Watt Hour consumption, but for inverter sizing we can go back to just using Watts, and ignore the time factor.

The GS-100+KIT has two options for inverters, a light 450W modified sine and a heavy 2000W pure sine. Because of the modular design of this kit, other inverters may be used as long as they are compatible with the voltage of the battery bank.

Lighting example:

Four 15W LEDs for 8 hours per day

$$4 \text{ Bulbs} \times 15 \text{ W/bulb} = 60 \text{ W} \quad \text{Use the small 450 W inverter}$$

Pumps and Motors example:

One 1hp pump for 1/2 hour per day

$$1 \text{ pump} \times 745 \text{ W/pump} = 745 \text{ W} \quad \text{Use the larger 2000 W inverter}$$

Misc. Electronics example:

One 65W laptop for 6 hours and one 800W microwave for 10 minutes, per day

$$1 \text{ laptop} \times 65 \text{ W/laptop} = 65 \text{ W} \quad \text{Use the 450 W inverter}$$

$$\text{microwave} \times 800 \text{ W/microwave} = 800 \text{ W} \quad \text{Use the 2000 W inverter}$$

$$\text{Together} = 65 \text{ W} + 800 \text{ W} = 865 \text{ W} \quad \text{Use the 2000 W inverter}$$

Battery Charging example:

Two 80Ah batteries per day

No AC required - No inverter needed

Pure Sine vs. Modified Sine

The 450W inverter option uses what is called a modified sine wave. This means that the output of the inverter looks more like a stair step pattern than the smooth wave shown in the diagram above. Modified Sine is fine for charging small devices but if you plan to use anything that has an AC motor you will need the 2000W inverter with pure sine output. Also, some stereos and musical equipment may emit an unwanted “hum” when powered by a modified sine inverter.

System Sizing: Step 4 Battery Bank Sizing

The GS-100+ Preconfigured Kits do not come with batteries, but will work with most deep cycle batteries. A deep cycle battery is designed to be charged and discharged regularly, unlike standard car batteries that are meant to hold a somewhat constant charge. Deep cycle batteries come in many forms including lead acid, sealed AGM and Lithium Ion. A typical deep cycle battery can discharge about 50% of its Amp hour (Ah) capacity.

If you need a battery to store 1200Wh of charge you first need to convert the 1200Wh to Ah by dividing it by 12V (the voltage of a battery) to get 100Ah. Since the battery can only discharge 50% of its capacity, you must divide the 100Ah by 50% to get 200Ah. A 200Ah battery bank will store 1200Wh of usable power.

$$1200 \text{ Wh} / 12 \text{ V} = 100 \text{ Ah} \quad 100 \text{ Ah} / 0.50 = 200 \text{ Ah battery bank}$$

Lighting example:

Four 15W LEDs for 8 hours per day, one day back-up

$$480 \text{ Wh} / 12 \text{ V} = 40 \text{ Ah} \quad (40 \text{ Ah} / 0.50) \times 1 \text{ day} = 80 \text{ Ah battery bank}$$

Pumps and Motors example:

One 1hp pump for 1/2 hour per day, three day back-up

$$373 \text{ Wh} / 12 \text{ V} = 31 \text{ Ah} \\ (31 \text{ Ah} / 0.50) \times 3 \text{ days} = 187 \text{ Ah battery bank}$$

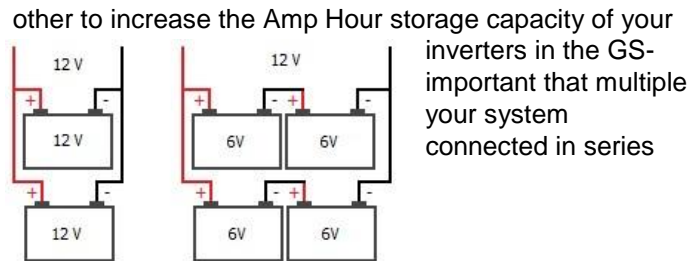
Misc. Electronics example:

One 65W laptop for 6 hours and one 800W microwave for 10 minutes, one week back-up

$$523 \text{ Wh} / 12 \text{ V} = 44 \text{ Ah} \\ (44 \text{ Ah} / 0.50) \times 7 \text{ days} = 616 \text{ Ah battery bank}$$

Battery Connections:

Multiple batteries can be connected to each system. Since the charge controller and 100+KIT are de-signed for 12V systems it is 12V batteries are connected in parallel and if incorporates 6V batteries they should be pairs.



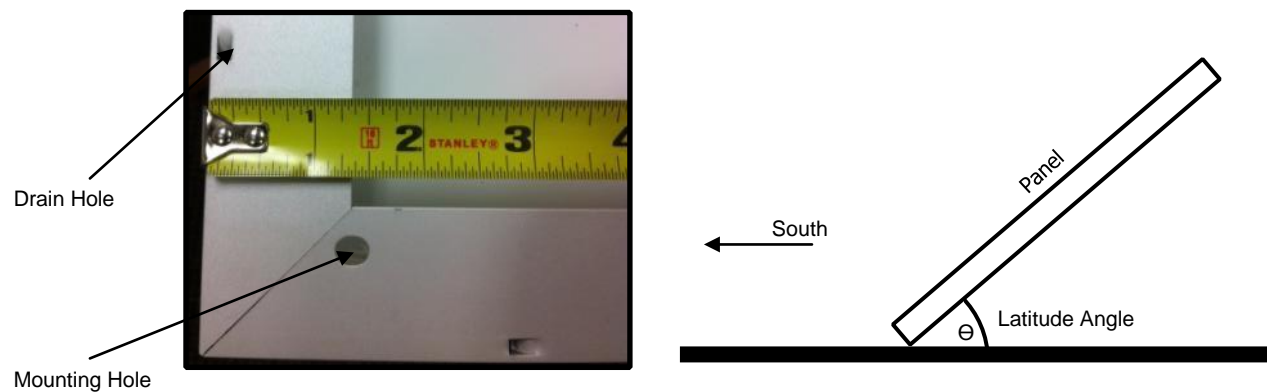
Battery Life:

Batteries have a limited life. A battery that is discharged 50% every day will not last as long as a battery that is only discharged 20% every day. Consider this when designing your system.

Mounting Hardware & Additional Accessories

Mounting

This Kit comes with 4x Grape Solar Zippity Feet for easy installation on a variety of materials.



For optimum energy production solar panels should be pointed in the direction of the sun to maximize the surface area that can receive light. Since the sun is a moving target, this is best approximated by pointing the panel to the South (for those of us that live in the Northern hemisphere) at a tilt angle equal to your latitude.



If you plan to mount your panel to an RV, boat, or other vehicle Grape Solar Technical Support can recommend some quality products. Call Grape Solar Technical Support at **1-877-264-1014**

Breakers and Fuses

The GS-100-Basic kit is designed to include only the basic components needed for operation. In low voltage photovoltaic systems the likelihood of a power surge damaging your equipment is nearly nonexistent, therefore breakers and fuses are not included. However, we do recommend using correctly sized breakers and fuses for your system. Breakers or fuses can be added between the panels and the charge controller (10A per every panel), between the charge controller and the battery bank (60A) and between the battery and inverter (250A).

Grounding

Grape Solar off-grid panels have grounding holes on the panel frame. Please refer to the Safety and Installation Manual included with the panel. We recommend 12 gauge wire for grounding. Inverters and charge controllers should be grounded as per the manufacturer's instructions.

Common Questions

How many batteries will I need to go with my panels?

Batteries have to do with how much power storage your system needs regardless of how much generation capacity you have. You can have 10kW of solar panels charging a 36Ah battery or you could have one 100W panel charging 1200Ah of batteries. The panel just affects how quickly the battery can be charged. If the battery bank is fully charged the charge controller will prevent over charging.

What inverters will work with my panels?

In an off-grid, battery backup system, the inverter is connected to a battery bank and the panels feed power onto the battery bank through a charge controller. Since the inverter isn't directly connected to the panels, you can use any size inverter you want as long as it is compatible with your battery bank and the devices you plan to power. You can have 10kW of solar panels in the same system as a 450W inverter or you could have one 100W panel in the same system as a 7kW inverter. The size of the inverter just limits the size of the devices that your system can power, which affects how quickly the battery bank is drained. Inverter size has nothing to do with panel count.