Small solar power system with battery storage

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Readers have told me they like to build small-scale photovoltaic installations like those that power Low-tech Magazine"s website and office. However, they don"t know where to start and what components to buy. This guide brings all the information together: what you need, how to wire everything, what your design choices are, where to put solar panels, how to fix them in place (or not), how to split power and install measuring instruments. It deals with solar energy systems that charge batteries and simpler configurations that provide direct solar power.

Conventional solar PV installations are installed on a rooftop or in a field. They convert the low voltage direct current (DC) power produced by solar panels into high voltage alternate (AC) power for use by main appliances and rely on the power grid during the night and in bad weather. None of this holds for the small-scale systems we build in this manual. They are completely independent of the power grid, run entirely on low voltage power, and are not powering a whole household or city but rather a room, a collection of devices, or a specific device. Small-scale solar is decentralized power production taken to its extremes.

Most of the work in building a small-scale solar system is deciding the size of the components and the building of the supporting structure for the solar panel. Wiring is pretty straightforward unless you want a sophisticated control panel. You only need a limited set of tools: a wire stripper, some screwdrivers (including small ones), and a wood saw are the only essentials. A soldering iron, pliers, and a multimeter are handy, but you can do without them.

Low-voltage DC power does not carry a risk of electrocution (a fatal electric shock). That is especially so for 12V systems. Depending on the electric conductivity of your body (and other factors), you could go up to 20-50V before an electric shock may kill you. 1

Nevertheless, solar power systems have their risks. The main dangers are electric shock (non-fatal but painful), fire, battery explosion, and component damage. However, if you stick to some simple rules, you will be OK. During seven years of solar power experiments, I have never caused a fire or received an electric shock, although I have fried some components.

Electric power (expressed in watts) equals current (in amp?re) multiplied by voltage (expressed in volts). Consequently, electric power (W) can refer to a low voltage (V) with a high current (A) or a high voltage with a low current. Conventional solar installations for households always use an inverter, which converts the low-voltage DC power from a solar panel into the high-voltage AC power used by main appliances. You can

do the same for a small-scale solar installation, but it"s better to omit the inverter and build a low-voltage DC solar system. 23 That is the type of electrical installation in cars, trucks, sailboats, caravans, and motorhomes.

Power (watts) = V (volt) x A (amp?re)

Directly coupling a low-voltage DC device to the low-voltage DC power produced by a solar panel avoids these energy losses and results in a more energy-efficient system. Practically, you can power the same device with a smaller solar panel. However, this implies that you use low-voltage appliances. Of course, you could plug in an inverter occasionally to power a mains appliance if there is no alternative. Make sure to buy one that is not too powerful, because it has to be operated on high capacity to be efficient. I have not found inverters with less than 150 watts of power capacity.

The sun doesn"t always shine. That is particularly so at night. You can add a battery and charge controller to your solar PV installation, and then you can use solar power when the sun is not shining. However, batteries are expensive, energy-intensive, and have short lifetimes. 4 Across the entire life span, batteries account for 80-90% of total costs and energy invested in an off-grid solar system. 5 They also introduce charge and discharge losses, which have to be compensated for by larger solar panels. For lead-acid batteries, the most cost-efficient option, these losses can be as high as 20-30%.

Batteries account for 80-90% of total costs and energy invested in an off-grid solar system.

This guide does not argue against battery storage, which is handy for some applications. However, you can often build a photovoltaic solar installation without battery storage. Such "direct" or "direct-drive" solar systems are cheaper, quicker, and easier to make. A direct solar power system allows you to use a wide variety of appliances during the day, even powerful ones. Examples are power and workshop tools, sound systems, and ventilating fans. Other devices, such as refrigerators, cooking stoves, and heating systems, can use direct solar energy in combination with heat or cold storage as a cheap and sustainable alternative to batteries. 6