# Solar Systems and Computers: How to Become Independent of Electricity Supply

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Fisheries scientists in many countries rely more and more on modern computer facilities for their work. Handling of large data sets is the order of the day, and neat-looking reports produced with powerful word processing software are expected. Calculators and typewriters seem to have lost their right to exist.

Availability of computers is not necessarily a constraint anymore given the continuous downward trend in hardware prices. Their actual use in some places in developing countries can be plagued, though, with many obstacles. One of these is unreliable supply of public electricity, and its fluctuations are often strong enough to affect the proper functioning of a computer. Surge protectors and Uninterruptable Power Supply (UPS) systems can take care of fluctuations in the mains and occasional "black-outs". However, with the regular absence of electricity over extended periods of time due to remoteness or the collapse of public services, the problem needs a more vigorous approach.

When ICLARM started its research cooperation project with the Institute of Marine Biology and Oceanography (IMBO) in Sierra Leone in 1991, Freetown had no public electricity supply because of the complete breakdown of its power generating system. Though the situation has remarkably improved since, electricity supply to the Institute during working hours is still very unpredictable, often lasting only 2-3 days a week.

Given that an important component of the IMBO/ICLARM project is the transfer of existing fisheries data into modern database systems, continuous operation of the project computers is considered essential. It is against this background that provisions were made for a solar-based power supply system. Its components are basically one or more solar panels that use sunlight to produce electric current, a "solar" battery that stores the energy produced by the panels, an intermediate solar charge controller that protects the battery against overcharge and deep-discharge and a computer operating optionally from a large 12V battery (Fig. 1). For general guidance, more details are provided for the various components, including approximate prices. However, it should be noted that prices vary greatly from country to country.

***Computer.*** This should be a laptop or a notebook computer that explicitly provides for a 12V "Auto Adapter". The computer should come with advanced battery-power-saving technology. The auto adapter is a computer-specific accessory which features a plug that fits into a normal car cigarette lighter socket. It allows the use of 12-14V DC (direct current) from an external battery in contrast to the 110/220/240V AC (alternating current) provided by the mains. Care should be taken to select a computer that is rated to operate at 12V DC voltage. Many of the older laptops actually need around 13V, which allows them to run from a battery only if it is fully charged. At this point the voltage is about 14V, but the current drained from the battery in the course of using the computer causes the voltage to drop, meaning that only a rather limited part of the battery's total capacity can be used. Prices for such computers vary largely according to the hardware configuration, making the indication of a price meaningless.

Note that an internal modem in the computers will allow communication through, e.g., E-mail, independent of the availability of electricity (see article by Hoenig and Garcia on p. 31). However, good telephone lines are essential.

***Solar panels*** **(US$300-500).** Typically, their nominal capacity is 50 W/12V. Attention should be paid to protective measures, such as a sturdy aluminium frame, sealed back of the panel, and a trustworthy mounting system.

***Solar battery*** **(US$200-250).** While car batteries are not unsuitable in principle, the purchase of specific heavy-duty "solar" batteries is recommended. Because of their technical design, they are absolutely maintenance-free for their entire lifetime, about 10 years, which more than justifies the higher initial purchase cost. These batteries usually come as individual 2V cells; six such batteries must be connected in series to set up a 12V system, which should then have a total battery capacity of around 240 Ah (Ampere hours).

***Charge/Discharge Controller*** **(US$250-300).** All current flows (solar panel to battery, battery to computer) are controlled through this unit and eventually shut off to ensure that the battery is neither overcharged nor discharged below a critical minimum capacity. Both events would decrease the battery's optimal operation and life expectancy. Some controllers have a display to provide information on battery voltage and net current flow.

A simple system comprising the elements described above is presented in Fig. 1. An important point, of course, is the number of solar panels needed to provide sufficient power for the computer. Unfortunately this cannot be answered straightforwardly,

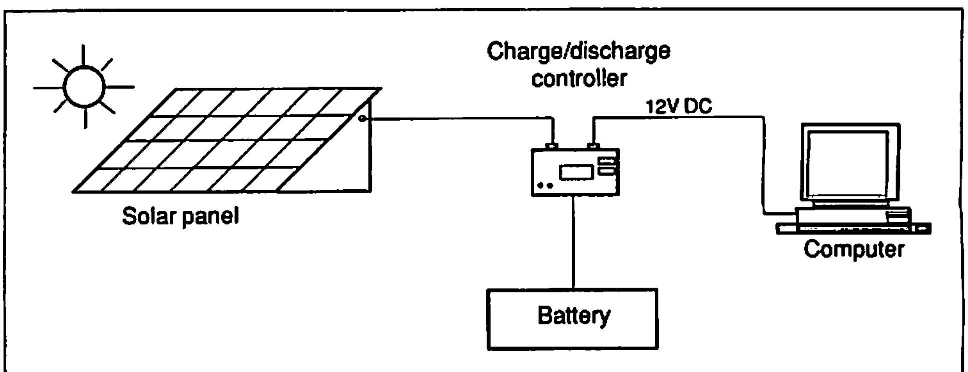


***Fig. 1. A simple link circuit required for running a personal computer on solar electricity.***

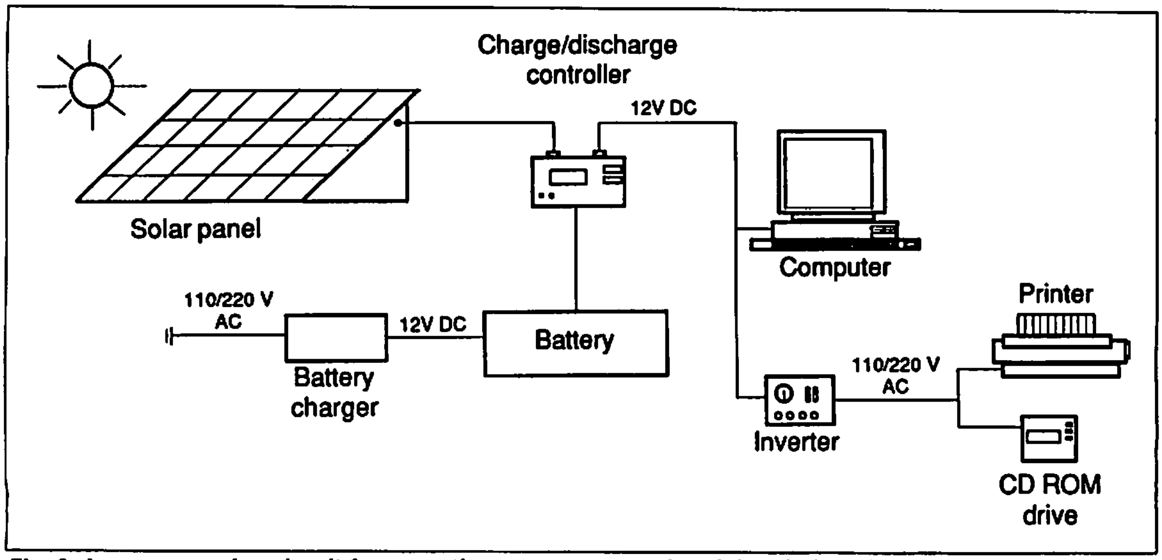


*Fig. 2. A more complex circuit for operating a computer and peripherals from both solar panels and/or a mains.*

for it depends on a number of variables such as the power consumption of the computer and the general weather conditions.

The average current flow per hour (A) of a computer can be estimated from

$$A = W/V$$

with "W" being the power consumption (in Watts) of the computer (usually stated in the chapter on technical specifications in the owner's manual) and "V" the voltage, here 12V. Thus, if a laptop is rated with 40 Watts, the "amount" of current drained in one hour of computer operation is about 40/12, or around 3.3 Amperes. If the computer is used for 6 hours a day, total capacity taken from the battery would be 3.3 A x 6 hours, or around 20 Amperes per day.

The power-generating capacity of a 50W/12V solar panel depends largely on factors such as light intensity and temperature. Thus, the current produced changes over the day with minima in the early morning and late afternoon and a maximum around noon. Experience has shown that in the tropics on a bright day, such a panel produces around 10 A over the whole day. This means that for the mode of operation described above, a solar system with at least two panels is needed. Clouded skies during the rainy season, of course, drastically reduce the current produced, making it mandatory to either work less hours on the computer or increase the number of panels.

Battery capacity per se is usually not a limiting factor, as 20 A drained from a 240 A battery (in the example above) would not make much difference. However, a large capacity can be handy to "bridge" one or two cloudy days with energy accumulated during days of less intense computer use (e.g., weekends).

In situations where electricity supply is very irregular, but not completely lacking, two additional options might be considered to make the system more flexible (see Fig. 2).

One is the addition of a 110/220 V battery charger, permanently connected to the solar batteries. Such a battery charger would ensure "topping-up" of the batteries whenever electricity is available, making the whole system less dependent on weather conditions. However, it is absolutely necessary to purchase an "intelligent" charging unit (ca. US$200) that automatically switches to maintenance charge, once the battery capacity has reached a certain level. A simple unit, as often used to quickly charge car batteries, would invariably damage the solar batteries over time.

Another option is the addition of an inverter, which changes 12V DC to 110/220V AC (ca. US$600). This might be useful if other hardware components should be operational even in the absence of electricity, such as a printer or a CD ROM Drive. However, two aspects should be considered: Inverters have only a 90% efficiency, meaning, 10% of the available battery capacity is lost (in form of heat) during operation. Secondly, 110/220V appliances are also usually not energy-efficient, because of the heat they produce. This means that a 240A battery will not support use of such appliances over an extended period of time. It might, though, be a viable alternative to a UPS system in situations where only occasional power failures occur, as it allows operation of computer and peripherals beyond the 15 minutes usually provided by UPS systems.

In contrast to 110/220V AC, cabling in a 12V DC system needs careful attention. Power losses occur when the cables are too long and if the diameter of the cable is too small. It is therefore recommended to keep the distance between solar panels and batteries as short as possible (<10 m) and to use cables of 4 mm diameter. Other cables should not be less than 2.5 mm in diameter. Electric appliance shops might sell cable junction boxes for mounting on walls, in rooms that are wired. In some cases, these holes provided for in these boxes have exactly the diameter required to fit a car cigarette lighter socket. It is worthwhile checking it out, as it allows to arrange a secure connection to the computer's 12V adapter.

Which of the systems described above is appropriate in a given situation will largely depend on the assessment of the present and future situation of the electricity supply. In some circumstances, they might actually be the condition *sine qua non*, enabling the use of a computer in otherwise forbidding circumstances. In other cases, they might just provide the little extra security against loss of data that quickly pays off and provides in such situations the needed peace of mind.


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