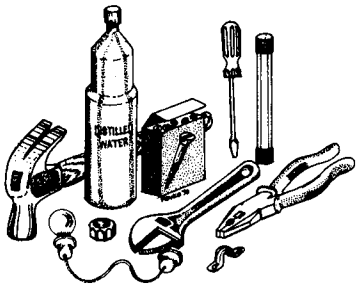
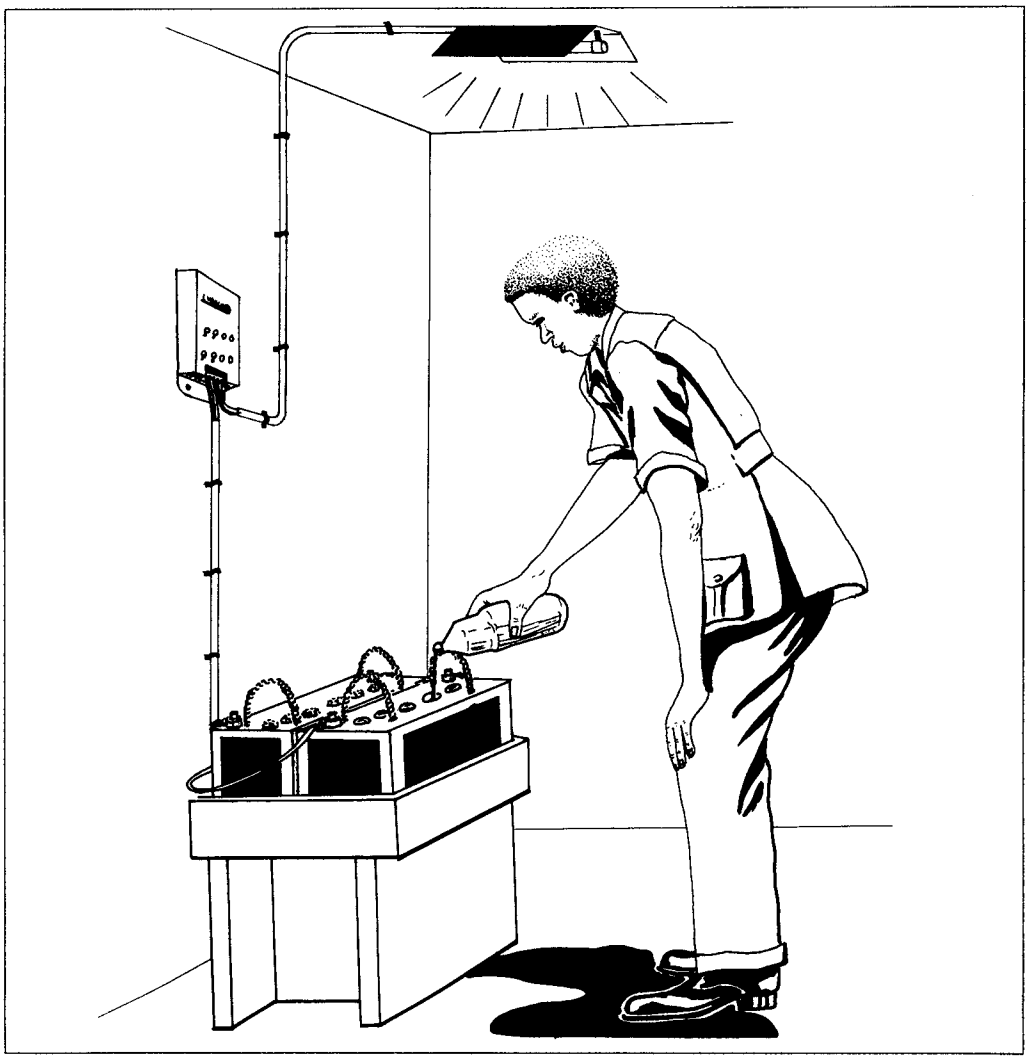
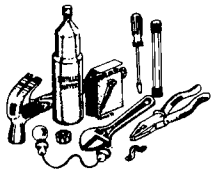


Chapter 12
Maintaining and Servicing Solar Electric Systems

This chapter explains how to take care of a solar electric system, and how to fix it if there is a problem. It explains routine maintenance tasks involved in the care of the battery, modules, wiring and control, and loads. The section on troubleshooting explains how to identify the causes of problems and how to solve them when the system fails to work.





Maintaining and Servicing

Routine Maintenance

A properly installed solar electric system requires very little maintenance. In fact, the work involved in maintaining a solar electric system is much less than that needed to maintain a diesel or petrol-powered generator. The best maintenance practice is to make regular inspections of the equipment (especially batteries and modules), to make sure things are kept clean, and to make sure all electrical contacts are tight.

The following section describes most of the tasks that need to be done when managing a system. You do not have to go out and check each wire in the system every two weeks. However, you should follow the suggested procedures below, and you should at least make an annual system check to look for problems not covered below. These include checks for tree growth that has shaded your modules, birds' nests in your module junction boxes, *shambas* above buried wires, and other unexpected problems.

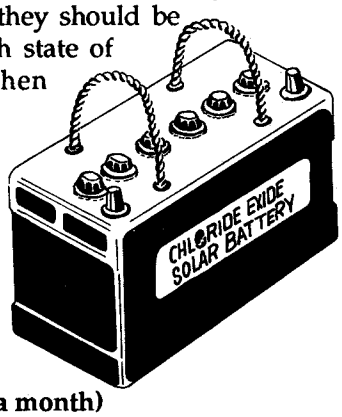
Table 12.1
Useful Tools and Materials for Maintenance of Solar Electric Systems

Hydrometer	Measuring battery and cell state of charge
Voltmeter	Measuring state of charge, checking wiring
Adjustable spanners	Tightening loose connections
Distilled water (or rainwater)	Replenishing battery electrolyte
Petroleum jelly	Protecting battery terminals
Chapa cha mandazi (Baking soda)	Neutralising spilled battery acid
Spare switches	Replacing broken switches
Spare tubes and globes	Replacing burned out lamps
Spare fuses (of the proper size)	Replacing blown fuses
Extra screws and wires	Replacing stripped or worn screws and wires

Give your battery an equalizing charge once every few moths, preferably during cloudy weather.

BATTERY MAINTENANCE

Batteries require careful maintenance. For long life, they should be cleaned monthly, they should have their electrolyte level checked and they should be kept in a high state of charge. When cleaning batteries, beware of the battery acid and do not short the terminals.



Cleaning
(do this once a month)

Carry the battery outside when cleaning it to avoid spilling acid. Keep plenty of water nearby to rinse spills.

1. Turn OFF or disconnect the solar charge
2. Disconnect the battery from the leads, and remove the terminals from the posts.
3. Clean the top and outside of the battery with water (do not allow water to enter the cells).
4. Clean the terminals and posts until they are shiny. If the terminals are corroded (i.e if they are covered with white powder), clean them carefully using a solution of baking soda (*chapa mandasi*) and water. If the terminal has been badly corroded buy a new one at an auto supply store.
5. Replace the clean terminals and tighten bolts. Apply petroleum jelly or grease to connected terminals.

Checking and topping up electrolyte level
(do this once a month)

1. Remove the caps of each cell one at a time and check the level of the electrolyte. Acid should be within two cm of the top of the battery. If you can look inside the batteries, check the plates to see their condition.

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Do not add acid, tap water, or tonics to batteries.

2. If the electrolyte level is down, add deionised or distilled water until the level is about two cm below the cap opening. Distilled water can be bought at petrol stations (It can also be made in most secondary school labs using glass beakers). Rain water collected in glass or plastic (but not metal) containers can also be used to replace distilled water.

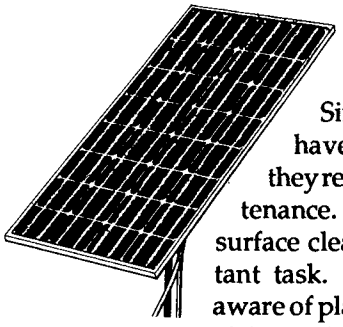
Checking state of charge (do this once a month or as required)

- For information on checking battery state of charge, see page 31. If the battery is in a low state of charge reduce use of the load, allow the battery to be charged up by the module, or have it charged at a petrol station.

- With large systems (i.e. in schools and institutions), keep records of battery state of charge, age and performance. This allows users to judge more easily whether a battery needs replacement; if a new headmaster comes the records will enable him to budget for new batteries.

Equalizing charge (once every 4 months)

- An equalizing charge is a 'hard' charge from a grid or generator powered batter charger that takes the battery a bit above its normal full state. It causes bubbling which mixes up the acid inside the battery, and also helps remove accumulated sulphate from the battery plates. Give your battery an equalizing charge during the cloudiest month of the year.



MODULE MAINTENANCE

Since modules do not have any moving parts, they require minimum maintenance. Keeping the glass surface clean is the most important task. You should also be aware of plants or trees that grow up around the module and shade it. Check ocassionally for loose nuts in the mounting hardware.

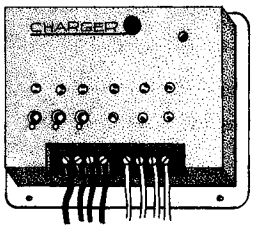
Inspecting for dust and cleaning the modules (do this once a month).

1. Solar modules must be kept clean to produce maximum power. If dust is allowed to collect on top of the module, its electric output will be reduced. During the dry season, inspect the module every two weeks to see if dust has collected on top of it. Run a finger along the top of the module to check for dust.

2. Clean modules with water and, if necessary, a mild soap. Wipe the glass with your hands, a sponge, or a soft cloth. Hands or soft cloth are used to avoid scratching the glass (if the glass is wiped with a rough cloth, it will be scratched, and its output will be reduced).

Checking connections (do this every few months)

- Inspect the junction box on the back of each module to make sure that the wiring is tight. Make sure than the wires have not been chewed by rodents and that there are no spiders living in the junction boxes.



WIRING AND CONTROL

If wiring is installed properly, there should be no wiring problems for the life of the system. However, it is useful to check the wiring of a system at least once a year, especially in places where it might be chewed by rodents, tampered with or accidentally pulled.

Inspecting wiring, fuses, indicator lamps and switches (do this once a year)

1. Check the tightness of all connector strips. Make sure that no bare wire is visible.

2. Inspect system wire runs for breaks, cracks in the insulation or places where it has been chewed. This is especially important for old or exposed wire.

3. Inspect junction boxes to make sure they have not become homes for insects, and, if they are in an exposed location, to make sure they are still watertight.

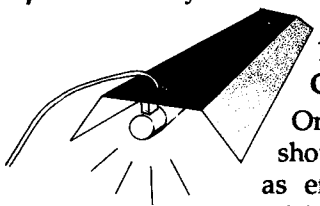
4. Check switches to make sure they are operating properly.

5. Check fuses to find if any has blown. If so, find the cause and repair it or replace it with a new one of the same size.

6. Check the indicator lamps on the control. The solar charge indicator should come ON when the sun is up. If it is not ON, check to see if batteries are being charged. Check whether the other LED indicator lamps are working (i.e. battery full and low voltage).

You should operate the loads as efficiently as possible on a daily basis.

7. Check grounding wires to make sure they are still intact.



LAMPS AND OTHER LOADS

On a daily basis, you should operate the loads as efficiently as possible. Maintenance of loads includes turning lights and appliances OFF when not in use.

1. Clean lamps, reflectors and fixtures once every few months. Dust and dirt will reduce lamp output as much as 20%.

2. Check for blackening tubes in fluorescent fixtures. If tubes blacken at one end, this is an indication that they are approaching the end of their lives, and that their output is reduced. Replace blackened or blinking tubes.

3. Replace burnt out globes.

System Records and Manuals

Keep all information about the system in a safe place, preferably under lock and key, where it can be referred to when necessary. Update it periodically. Most of the important information can be kept in one ledger or file. Large institutional systems work better when someone is given the job of maintaining the system and keeping records up to date. This information includes:

- Circuit diagrams and maps showing the location of batteries, loads, wire runs, junction boxes, and buried cables.
- Manuals, warranties, and manufacturers' specifications for system components.
- Records of battery state of charge & history, installation dates, repairs, equipment replacement and system maintenance.

Trouble Shooting

Trouble-shooting means fixing problems as they occur. Although the equipment in properly installed systems is unlikely to fail, problems that need attending to sometimes rise up. This section explains how to tackle problems in solar electric systems when they do occur.

The first thing to do is not to panic. Most problems have very simple causes, and can be discovered simply by checking in a few key places. The battery, for example, is the most likely source of problem in a small solar electric system.

It is especially useful to have a voltmeter when trouble-shooting, as you can use it to quickly measure the battery's state of charge, check for broken wires and shorts, check the output of the module and measure voltage drops. If you do not have a voltmeter, make sure you have a hydrometer (see page 31) for checking the battery's state of charge. Learn how to tell whether a fuse is blown where you buy your fuses and electrical equipment.

There are two sections below. The first provides basic questions you should first ask about the system to identify the source of the problem. The second section is a detailed table that should help you identify specific problems. If you are not confident with dc electric principles, then you should try to answer the questions in the first section, and, if you cannot identify the problem or solve it with them, consult an electrician familiar with solar electricity.

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If a system failure occurs, check for basic problems first, then consult the detailed trouble shooting guide on the next page.

Check for Basic Problems First

- What was the weather like for the weeks before the problem? Has the weather been cloudy? Is it likely that the load has been using more energy than the solar modules produce?

  If this is the case, then the problem may be due to mis-use of the system, and not due to the failure of any part of the system.

- Is the system new? Do the owners know how to use and maintain it properly?

  If the system is only a few weeks old or less, then the problem may be due to failure of one of the parts (due to faults in the components) or improper installation. On the other hand, if the owners do not know how to use the system, you should question them carefully (Have they been trying to run six lights with a 10 Wp module?).

- What is the type, condition and age of the battery? Can it still hold a charge?

  If the battery is corroded and looks like it has not been cleaned in months, then you should immediately begin to suspect it. Similarly, if the system uses an eight year old automotive battery, there is reason to suspect that the problem is the battery. If, however, the battery is new, clean and well-charged, then you should look elsewhere.

- Are all the fuses and circuit breakers okay?

  Locate all the fuses in the system and see if any have blown. Check to see what caused the fuse to blow (i.e. overload, short circuit) before replacing it.

- Are all the wires connected securely? Are any corroded? Is there any place where a wire is likely to have broken?

- Are the modules dusty? Are they shaded?

Detailed Trouble-Shooting Guide

If you cannot find the problem with your system after using the above basic check, then you may have to do a bit more exploring to find what is wrong, with the help of an electrician if possible.

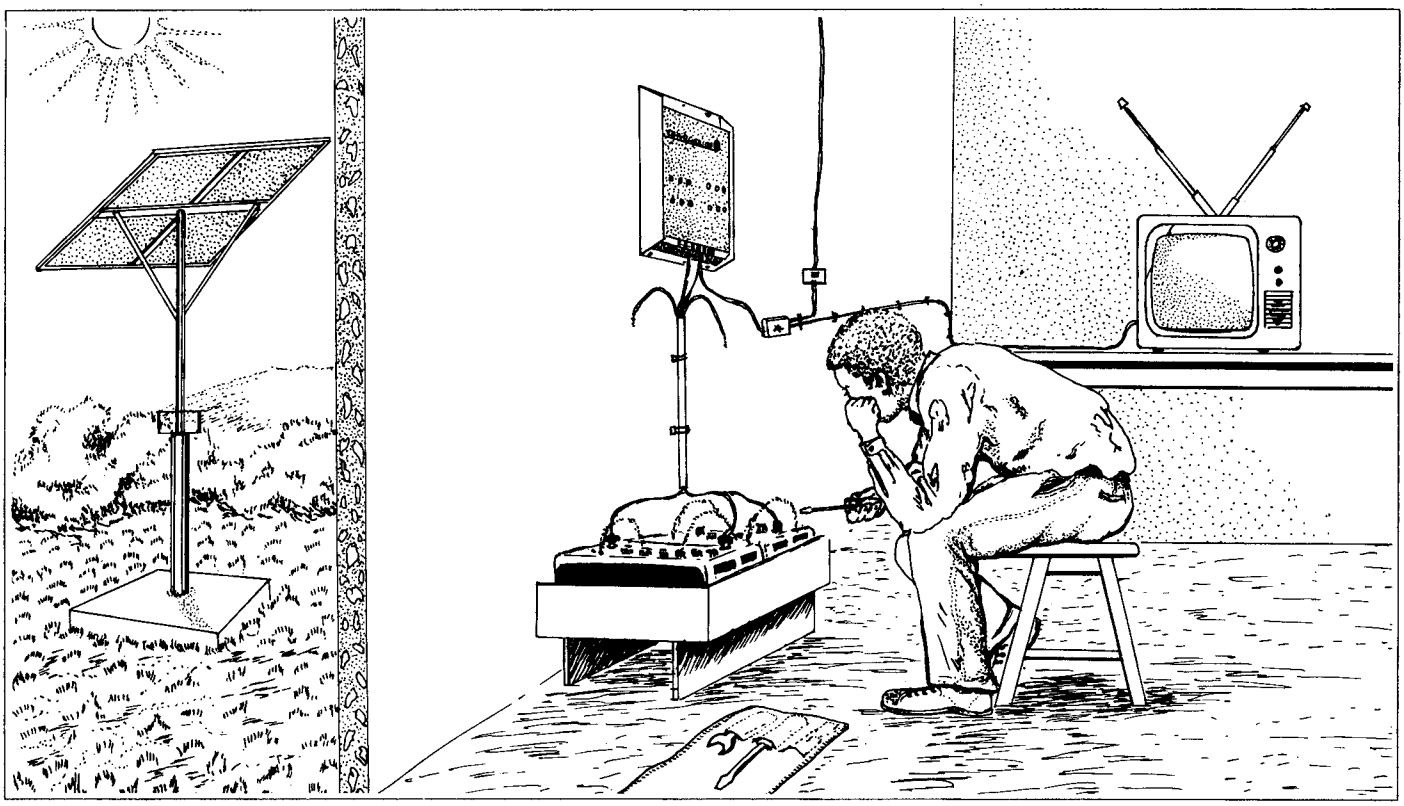

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Table 12.1: Trouble-Shooting Guide

Problem	Cause	How to Fix
Battery state of charge is low "Battery low" indicator comes on, low voltage disconnect turns OFF load, or battery state of charge is constantly below 11.5 volts	• There is no solar charge • Battery acid low • Bad connection to control terminal • Defective (bad) battery or cell • Loose or corroded battery terminal • Dusty modules • Blown fuse • Overuse of system • Battery will not accept charge • Voltage drop between module and battery too high • Defective controller	• Check and fix connection to module • Add distilled water to cells • Check for broken wire or loose connection • Check state of charge of each cell. If there is a significant difference between cells, replace or repair • Clean and tighten battery terminals • Clean modules • See 'blown fuse' section, below • Leave appliances and lamps OFF for a week to allow recharging or recharge battery by other means • Find out age and history of battery. Replace if old, or if ruined by careless use • Check voltage drop. Replace cable with larger diameter if required • Check operation of controller with dealer. Replace or repair if necessary
No solar charge Solar charge indicator does not light up during the day. There is no current in wires from module.	• Short circuit along wires to modules • Loose connection in wires connecting battery to the control • Blown fuse • Thick coating of soot or dust on module • Broken module	• Locate and repair short circuit • Locate and repair loose connection • See "Blown fuse" below • Clean module with water and soft cloth • Check for broken cells, broken glass, or poor connection inside module. Replace solar cell module
Appliances or lamps do not work One or more lamp or appliance fails to come ON when connected.	**Lamps** • Bad tube or globe • Bad ballast inverter • Bad connection in wire • Switch is "OFF" • Tubes or globes have very short lifetimes **Appliances** • Bad connection in wire • Switch is "OFF" • Bad socket • Broken appliance	**Lamps** • Replace with new tube or globe • Replace ballast inverter with new one • Locate broken or loose wire and repair • Turn switch "ON" • Check voltage of system: too low or too high? (Voltage is always lower when load is ON). **Appliances** • Locate broken or loose wire and repair • Turn switch "ON" • Check socket. If bad, replace • Try appliance where there is a good power supply. Replace or repair.
Blown fuse When the fuse is removed, the wire inside is broken	• Short circuit along wire to solar cell module • Fuse was too small • Lightning or power surge	• Locate and repair short circuit • Use fuse 20% larger than combined power of loads • Replace fuse