PV Mounting

Array Angle

Consider the following when determining PV tilt angle.

- If the PV system is used only in the summer: subtract 10 to 15° from the latitude to get the proper tilt angle. The tilt is closer to horizontal because of high sun angles in the summer (Figure 7).
- If the PV system is used only in the winter: add 10 to 15° to the latitude to get the proper tilt angle, especially if snow reflection is to be considered. The tilt is closer to vertical because of low sun angles in winter. Where snow is a factor, be sure to angle the panels steeply enough (almost 90°) to make sure the snow will slide off the panels, even if this is steeper than ideal.
- If the PV system is used year-round: consider adjusting the panel seasonally. If the panel cannot be adjusted seasonally: consider your peak load season, average sun-hours per day, sun angles during the peak load season, and tilt the panel accordingly.

Panel Placement or Mounting

Although PV panels will perform equally well whether they are vertically or horizontally oriented, panels should be mounted vertically. When the panels are mounted horizontally, snow, leaves, pollen, or other debris can collect over the frame's horizontal metal seam and get stuck there. As "stuff" accumulates, it can easily cover more and more of the surface area of your panel. In some cases, horizontally mounted PV panels have warped from snow loading, cracking the PV and separating it from the frame (Figure 8). The same problem can occur with a vertically oriented panel, but the collecting edge is much shorter. Even with a lot of accumulation, a much smaller region of the vertically oriented panel will be covered.

Figure 8—Snow crushed the bottom panel. Vertical mounting would probably have been better than horizontal mounting for this installation. Voltage increased 14% and current increased 7% when these panels were cleaned.

PV panels mounted vertically shed snow and other debris more easily.

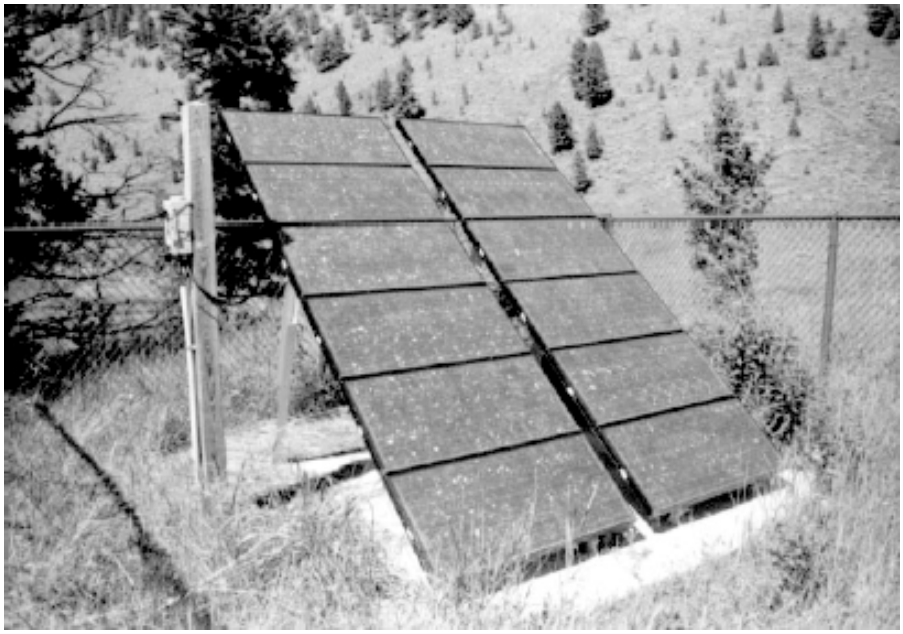

Figure 7—Tilt angle is important for solar panels. This panel is tilted about 37°, probably too steep for its location in southwestern Montana.

PV Trailer Systems

Everything you need can often be included in these portable, trailer-mounted systems. They have several advantages:

- They are portable and can be easily removed during the off season, reducing the potential for damage due to extreme weather or vandalism (Figure 9).

Figure 9—Photovoltaic systems can be mounted on trailers for portability or to allow safe indoor storage during winter.

- They can easily accommodate changing needs for PV power.
- They make yearly maintenance easier since the system is brought in for storage during the off season.

If the trailer is going to be parked somewhere for a long time, remove the wheels.

PV Maintenance

PV panels require little in the way of maintenance. However, if pollen, dirt, dust, leaves, and other debris collect on the surface of your panel, remove the debris by wiping, brushing, or spraying the panel with water. Dirty panels can reduce your system's power output.

DC Wiring and Fuses

DC wiring is a little different than AC. Because the current flows continuously, it is more difficult to stop the flow of power with a switch or fuse. Also, DC systems lose more voltage in longer wire runs. Consequently, DC wire sizes are large for given current-carrying capacity. To further reduce your voltage drop, you may try using a wire gauge that is one size larger than the National Electric Code.

DC fuses differ from AC fuses. If at all possible, DC fuses should be used in DC systems. AC fuses and switches can rely on the intermittent flow of AC power to help stop the flow of electricity. Your local PV dealer should be able to help you find some DC fuses.

Be sure to follow National Electric Code color convention when wiring. Labeling your wires is also a good idea—it really simplifies things, especially when someone other than the installer must do maintenance or troubleshooting. If only one color of wire is available, be sure to use colored tape to mark the wires correctly. Special attention must be given to the DC color code because DC negative is black in automobile electrical systems, while all negatives by National Electrical Code are white or green. Do not assume that if the two DC wires are black and white that the black is negative and the white is positive. According to convention in AC power, white is negative and black is "hot," so a DC appliance or DC light with black and white wires could be wired either way.

Make secure wire connections by either using a "crimper" or the "solder and plastic shrink" method. Both are effective. Make sure solder connections are physically solid before adding solder so solder isn't the only thing holding the connection together.

Control Boxes

To make maintenance easier, keep spare fuses, circuit breakers, and connector screws in the panel box or control box. That way, if one of those parts needs to be replaced during an inspection you can replace it right away, minimizing the system's downtime and eliminating the need for a return trip.

Include maintenance forms in the control box. That way you or anyone else can quickly assess maintenance that has been done in the past, as well as tasks that might need to be done now.

Controllers

Controllers regulate how much current and voltage go into your load. Your load may be your batteries. Trace Engineering makes controllers that users have found to be reliable and effective. The Trace C-40 Controller can work in a 12V, 24V, or 48V system. It can effectively meet your needs even if your system changes due to expansion or new loads. The Trace C-12 Controller is only suitable for a 12V system. If you are using gel-cell batteries, make sure your controller does not allow the voltage level to go too high, and make sure the controller does not automatically (or manually) equalize these batteries. Remember that the C-40 controller is adjustable, so you must make sure the adjustable set-points are set correctly.

Low-Power PV Systems

If all you need is a simple PV system for two or three lights and maybe a small fan for ventilation, consider this system:

- 1 PV panel
- 1 12V battery
- 2 LED lights that provide enough light for a restroom
- 1 outside DC light
- 1 small fan

This system has been designed for simplicity, low cost, and ease of operation. It has been installed in several State parks in Colorado. Contact Chris Dunn (phone (303) 543-8525) for more information. He designed and installs these systems.

Sources of Information About PV Systems

- Your local PV dealer

- Sandia National Laboratories
  Maintenance and Operation of Stand-Alone Photovoltaic Systems is a very thorough, yet readable, step-by-step guide. It includes information about battery equalization and other useful topics. And it is free.
  Internet: *http://www.sandia.gov/pv/lib/98TLREF13.pdf* (this large file may take one-half hour or longer to download)
  Phone: (505) 844-3698

- Photovoltaic Systems Assistance Center
  Sandia National Laboratories
  Albuquerque, NM 87185-5800
  Phone: (505) 844-3698

- *The Solar Electric Independent Home Book* by Paul Jeffey Fowler
  Fowler Solar Electric, Inc.
  226 Huntington Rd.
  Worthington, MA 01098
  ISBN 1–879523–01–9

- Center for Renewable Energy and Sustainable Technology
  Internet: *http://solstice.crest.org*

- National Renewable Energy Laboratory
  Internet: *http://www.nrel.gov*

- Gel cells
  Internet: *http://www.alt-energy.com/catalog/batteryinfo.html*