Solar Water Pumping

8

☑ Overview

Direct pumping of water with solar electricity is one of the most effective demonstrations of the relationship solar-electric panels have with the sun. As the panel is aimed more toward the sun, the pump moves the water more vigorously. A student casting a shadow on the panel will slow or stop the water flow. The immediate response of solar water pumping systems lends itself easily to practical experiments in solar electricity. Voltage and current data can be gathered from solar modules both when powering a pump, and when unloaded. The power formula can then be used to develop maximum power characteristics of the modules. This type of experimentation can also give students experience with series and parallel wiring as they attempt to maximize pump performance.

Carolyn Griffith, a high school Environmental Science teacher in Alameda, California, used solar water pumping as part of a solar electricity lab. Following a worksheet developed by the Solar Schoolhouse, students performed photovoltaic experiments to understand how to maximize power.

Students began by drawing a compass rose with chalk on the schoolyard. Solar Power Monitors (available from the Solar Schoolhouse) were used to test the open circuit voltage (Voc) and short circuit current (Isc) of solar modules at different sun angles and orientations.

Students use a Solar Power Monitor to test the pumping performance of four, 3-volt modules wired in series.

☑ Materials List

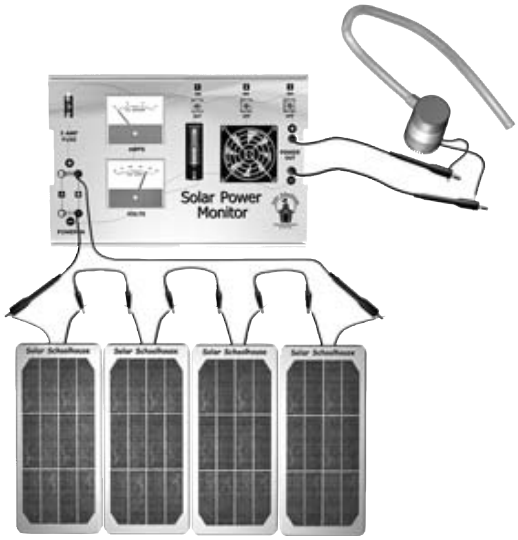
☐ (2) 10-15 watt 12V PV modules
OR (8) 3 watt, 3V modules
☐ Solar Power Monitor OR digital multimeter
☐ Assorted jumper cables
☐ 12v water pump
☐ Flexible tubing
☐ Protractor or Sun Angle Quadrant (p.9)
☐ Compass
☐ Large bucket
☐ 1 gallon milk jug
☐ Stop watch
☐ Chalk

Appendix Worksheets

☐ Solar Power Monitor Project Guide, *p.103-109*

Resource List

☐ *Your Solar Home Guidebook*



Power Monitor experiments are detailed in Appendix A, p.103-109

Small 12-volt modules were used for these tests, in addition to groups of four, 3-volt modules wired in series to make 12-volt solar arrays.

The power formula was used to measure output in watts, and the data graphed. From the experiments students answered questions about module performance, and found the angle and orientation that delivered maximum power.

Next students connected the wires from the 12-volt water pumps to the solar modules. They tested the flow rate of the pumps (in gallons per hour) using one gallon milk jugs and stop watches.

They also recorded the voltage and amperage of the circuit during pumping. Additional 12-volt modules (and 12-volt arrays) were connected in parallel as students attempted to meet the maximum manufacturer specifications for the pumps. This data was graphed with gallons per hour on the x-axis, and watts on the y-axis.

☑ How To Tips

The *Using the Power Monitor Set* video tutorial is included on this book's accompanying DVD. It demonstrates the Solar Lab experiments, including among other things: measuring module output, wiring 3-volt modules into 12-volt arrays, wiring in parallel to increase current, and using the Solar Power Monitor with a water pump.

The Solar Power Monitor - Project #15 in the *Your Solar Home Guidebook* is also in Appendix A (p.103-109). Digital multimeters can be used in lieu of Solar Power Monitors. See *Using the Digital Multimeter Tutorial* on the Teaching Solar DVD and Appendix E (p.143) for details.

A Solar Power Monitor Set video tutorial is included on this book's DVD.

☑ Related National Standards

(see: www.education-world.com/standards/national)

Math: NM-DATA.9-12.1, NM-DATA.9-12.2, NM-DATA.9-12.3, NM-MEA.9-12.1, NM-MEA.9-12.2, NM-GEO.9-12.2, NM-NUM.9-12.1, NM-NUM.9-12.2, NM-NUM.9-12.3, NM-PROB.PK-12.1, NM-PROB.PK-12.2, NM-PROB.PK-12.3, NM-PROB.PK-12.4, NM-PROB.COMM.PK-12.1, NM-PROB.COMM.PK-12.2, NM-PROB.COMM.PK-12.3, NM-PROB.COMM.PK-12.4

Science: NS.9-12.1, NS.9-12.2, NS.9-12.4 through NS.9-12.7

Social Science: NSS-G.K-12.5