



Experiment 08

The Sunlogger™

Overview

In Experiment 06, Tracking and Fixed Solar Arrays, a considerable amount of time was needed to acquire measurement data. Many grid-connected photovoltaic systems are equipped with in-built data acquisition systems that automatically take measurements and store data.

The Pacific Solar Sunlogger™ is a data acquisition system that was designed specifically for the educational environment. Via the front panel, students can display such things as kWh generated and CO₂ saved for the day, power in watts going into the electricity grid, and inverter temperatures. Solar data is measured and recorded at two minute intervals throughout the day. When a Sunlogger™ is connected to a computer, students can download the data, graph it and perform data analysis.

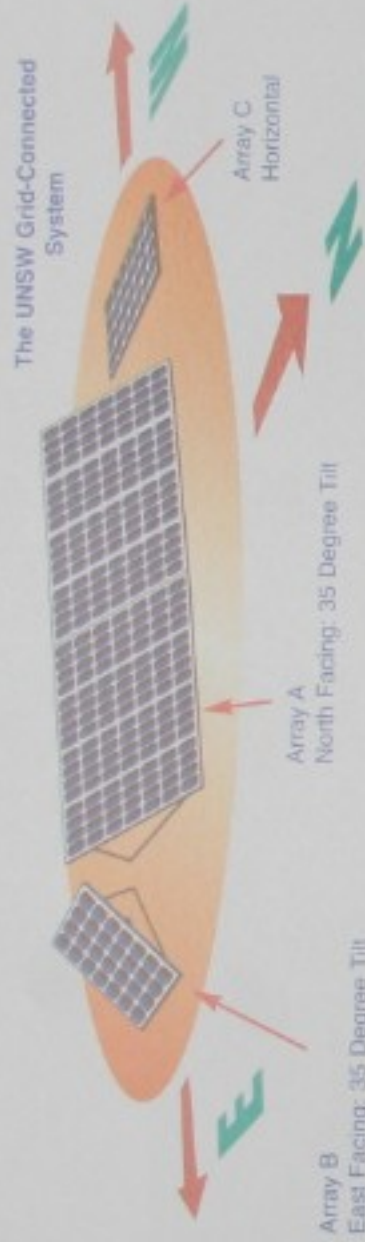
Students at schools that don't have grid-connected systems can still participate in data analysis. Solar data from the UNSW grid-connected system and from high schools participating in the UNSW Greenhouse Friendly Schools Program is available at the web site <http://www.greenhouseschools.pv.unsw.edu.au>

This program allows schools having grid-connected systems to share their solar data with other schools throughout Australia.

Value

By graphing solar data from arrays in different orientations and weather conditions students can observe the effect of tilt angle and orientation on the quantity of electricity generated.





Spreadsheet Data

Array A North Facing: 35 degree tilt; Sydney
 Array B East Facing: 35 degree tilt; Sydney
 Array C Horizontal;
 Array A, B & C are single grid-connected sub-units of larger arrays. A, B & C are of the same size and power.

Method

Students download the file "UNSW Solar Data.xls" from the web address:

<http://www.greenhouseschools.pv.unsw.edu.au>

Using the method at the end of this experiment students graph selected columns of data.

Dates

7 Jan 03 Summer: Clear sky some clouds in evening
 19 Mar 03 Autumn: Clear sky
 24 Mar 03 Autumn: Very dark rainy day
 25 Mar 03 Autumn: Clear except puffy clouds late morning and early afternoon



Observations for Graph A

"Array A Red" (summer, clear sky) is a very clear day with some cloud in the late afternoon. Peak Power is a bit over 80 watts around noon.

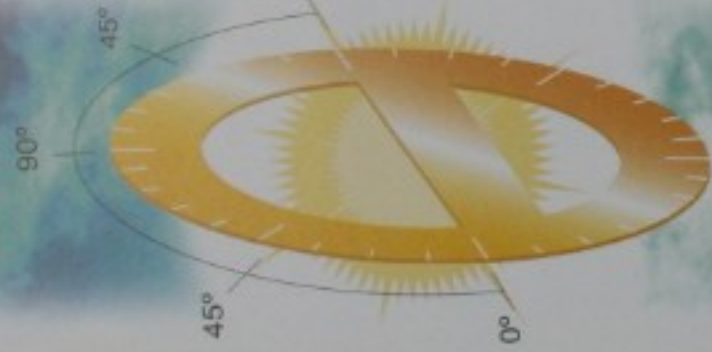
"Array A Green" (autumn, clear sky) is also a very clear day. Nearly the identical power and energy is generated as on a clear sky summer day. The 35 degree tilt at the equinox has the noontime sunrays normal to the solar module's surface. In summer the sun is higher in the sky at noon so there is some loss of available summertime energy because of the 35 degree tilt angle (Lambert's Law).

"Array A Yellow" (autumn, very dark rainy day) shows that a significant amount of solar energy is generated even on the darkest of days.

"Array A Cyan" (autumn, slight haze, puffy white clouds) shows some energy loss from the slight haze (compared with the green graph). When the puffy white clouds are not shadowing the array, the white clouds reflect sunshine onto the array. The additional light from the clouds adds to the light coming directly from the sun. The energy output peaks at a level higher than the summertime clear sky level. At about 11:15 a.m., the energy level as determined from the graph is 20% greater than on the clear summer day (red graph). When the clouds cover the sun the energy output drops dramatically.



SOLAR CELLS



RESOURCES FOR THE SECONDARY SCIENCE TEACHER EXPERIMENTS



Observations for Graph B

Note: Both curves for the same day.

"Array A Red" (NORTH Facing, summer, clear sky) is a very clear day with some cloud in the late afternoon. Peak Power is a bit over 80 watts around noon.

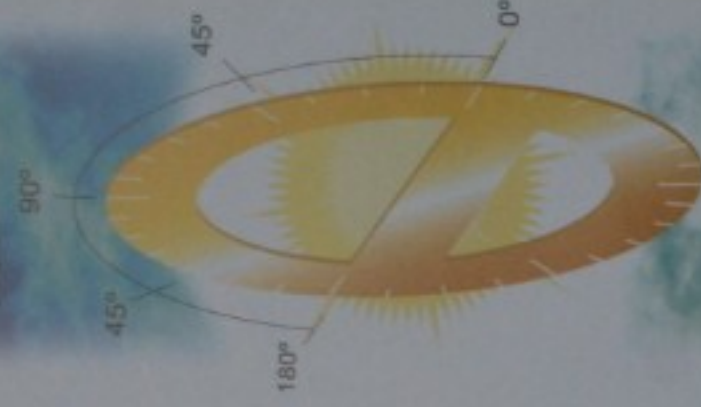
"Array B Yellow" (EAST Facing, summer, clear sky) is a very interesting graph. During the summer, the east-facing array with a 35 degree tilt has the morning sunshine virtually normal to the plane of the array. Although there is very little output in the late afternoon, the area under the two curves is nearly identical. From this graph it can be seen that (at least for summer) if the roof is at 35 degrees then, in Sydney, it doesn't matter if the solar array is on a north facing roof or on an east facing roof. Students can sum the data in the two columns of the spreadsheet for these graphs to see the nearly identical energy values.



Observations for Graph C

"Array A Red" (NORTH Facing, autumn, clear sky), shows early morning building shadows with morning light first striking the array at 8:13 a.m.





"Array A Green" (NORTH Facing, autumn, very dark rainy day), "Array B Yellow" (EAST Facing, autumn, very dark rainy day), and "Array C Cyan" (HORIZONTAL, autumn, very dark rainy day) all show very similar values. On cloudy days, the diffuse light comes from the entire sky and there is not much difference between north facing and east facing arrays. Horizontal arrays gather a little more light from the cloudy sky than the north and east facing arrays. By summing the columns (Red Array A 19 Mar 03) and (Green Array A 24 Mar 03) on the spreadsheet and taking the ratio it can be seen that 28% of energy of a clear day was delivered into the electricity grid on the cloudy, rainy day.

Additional comparisons are easily made by graphing columns of interest.

How to quickly graph the solar data in Microsoft Excel

The data in column A will display as the x-axis. Multiple y-data columns can be selected and graphed versus the x-axis data.

- 1 Place the mouse directly on the letter "A" in the grey box and left click. This will select the entire column. This is the x-axis.
- 2 Place the mouse on the letter in the grey box. Control left click will select the entire column and keep prior selections. These are the y values.
- 3 Left click the chart wizard.

The screenshot shows the Microsoft Excel interface. The spreadsheet has columns labeled A through N. Column A contains dates from 07_Jan_03 to 14_Feb_03. Columns B through N contain numerical data for different solar arrays. A 'Chart Wizard' dialog box is open, showing the 'Line' chart type selected. Red arrows point to the 'A' column header, the 'Chart Wizard' dialog, the 'Line' chart type, and the 'Finish' button.

4 Left click on "Line".

5 Left click this "line" option.

6 Left click Finish.