

Photovoltaic Array Data Analysis

Student Inquiry

Overview

This task requires you to analyse real data and look for predictive patterns that could assist in advising on the appropriateness, orientation and size of any solar array to meet expected domestic energy demands in any location in New Zealand or Australia.

Key Questions

Daily (Diurnal) Solar Cycle

1. How predictable is the diurnal pattern of solar radiation incident at a location on Earth's surface – and can it be approximated mathematically, for example, by a trigonometric function? (Remember Excel trigonometric functions work in radians.)
2. Seasonal changes in the solar cycle – how much does seasonal change affect solar generation? Is it predictable?
3. Latitudinal influences on the solar cycle – in terms of total daily generation, how much does the increase in summer daylight hours at higher latitudes compensate for the lower average solar altitude? How much does latitude affect solar generation?
4. The size of the solar array – how can the number of panels and their capacity in the schools photovoltaic array be taken into account in planning a sampling regime?
5. Orientation and inclination of the solar array – how much does variation in the inclination and orientation of photovoltaic arrays influence their effectiveness?



Survey Design

To answer the questions above, you will need data from several sources and have a strategy to ensure adequate statistical sampling that is reliable and robust. The first step will be to select enough schools in the area under investigation. Three would be sufficient for this exercise. Research sources for all data are needed – these are provided as URLs below.

What you will need

A computer with internet access and a spreadsheet program

Data Collection

The following key data will need to be collected from different sources and entered onto spreadsheets for later collation.

- Hourly sunshine-hours data – get this data from the NIWA website (<http://cliflo.niwa.co.nz/>) for a weather station in the same region as your school sample. For Auckland schools this station will be Mangere EWS.

Select a recent 24 hr period when the weather has been fine (for example, when was about 0.7 to 1.0 hours of sunshine for each hour recorded).

- Photovoltaic array hourly generation from your sample set of schools – get this data from the Schoolgen website (<http://www.schoolgen.co.nz/ss/default.aspx>) for New Zealand schools. You will need to select the same fine 24 hr period that you identified above (unlike the example in this graph). Obtain power output data for that period for each school.
- Daily (Diurnal) solar cycle – use Skyglobe© software to obtain the suns altitude each daylight hour for the same time period and location as the photovoltaic array data.

The software is shareware and is available from <http://www.sidewalkastronomy.com/skyglobe.html>. The data will allow you to map time with altitude (°) above the horizon.

Extension

Seasonal Solar Cycle

Use the Skyglobe© software to obtain the sun's altitude each daylight hour for one day in mid-winter and another in mid-summer, in the same location as the available photovoltaic array data. Record the latitude of the study area from the top left of the Skyglobe© screen.

Latitudinal Variations

Find a companion school in either Sydney or Brisbane in Australia. Obtain weather data from the Australian Bureau of Meteorology website <http://www.bom.gov.au>, select a fine day (high sunshine hours), and then the schools photovoltaic array data from their website www.solarschools.net. You can obtain solar altitude data from SkyGlobe© as before. Record the latitude of each school region.

Data Graphing, Analysis and Conclusions

The data will need to be arranged on a spreadsheet and presented in graphical form for preliminary visual analysis.

1. Solar altitude vs. time – what general shape curve is suggested?
2. Photovoltaic array output vs. time – is the shape similar to the previous curve? Can you plot both on the same set of axes? Is this coincidence or can you suggest a causal relationship?
3. Compare the sample schools in the same region – are they comparable? Can you explain any anomalies? Is the pattern the same for all schools?
4. Mathematical modelling – suggest a mathematical relationship between the time of day and either solar altitude or photovoltaic array output? Use the spreadsheet to express this relationship.
5. Compare data from summer with that from winter – use schools from the same region. Suggest a cause for any pattern.
6. Compare data from different latitudes – use data from the same dates. Suggest a cause for any pattern.