PLOTTING AND COMPARING DOWNLOADED DATA

Graphing and Normalization Using Online Data and Spreadsheets

Overview

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Footnote:

Graphing and Normalization Using Online Data and Spreadsheets, Heliotronics, Inc. 2007. www.heliotronics.com

Learning Objectives:

- Use of spreadsheets in analyzing data.
- Normalization of data for the purpose of qualitative comparison.
- Observation of the close relationship between irradiance and the power output of a solar array.

Materials Needed

Computer connected to the Internet.
Spreadsheet software, preferably Microsoft Excel

Grade Levels

Safety

There are no safety issues associated with this lesson.

INTRODUCTION

Often people want to compare two or more sets of graphical information but the units and scales are so different that it is difficult or impossible to recognize similarities or pick out correlations. There is a mathematical tool that is used to make comparing data much easier. The tool is called normalization. Normalization is a relatively simple technique for modifying the scales of multiple sets of data in such a way that they are easily compared. While it will be demonstrated here using data from a solar array, this technique can be applied to many types of data for many purposes.

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PROCEDURE

Using www.sunviewer.org/portals/NYSERDA_SPN/ we select the *Beaver River Central School* from the pull down menu. Set the date to March 10, 2006. Select the radio button for *Power* in the *Daily data* section and make sure that *Graph* is selected in the *Output Format* section. Click the *Get Data* button and you should see the Figure 1 below.

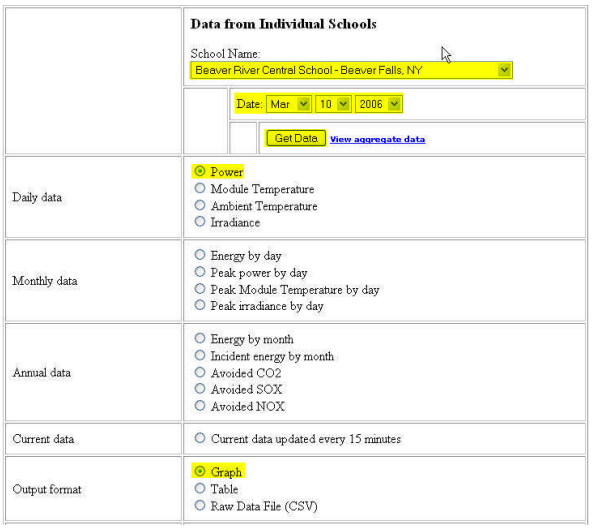

Figure 1a Query table selecting power plot

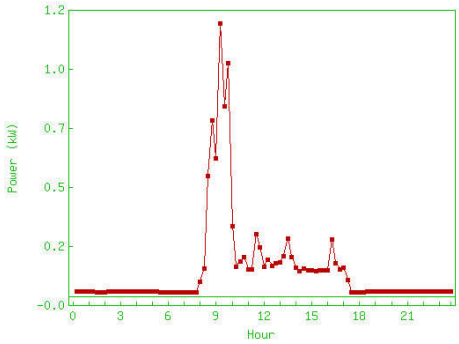

Figure 1b Resulting graph

This same data can be downloaded simply by changing the radio button in the *Output Format* section from *Graph* to *Raw Data File (CSV),* see Figure 2. The exercises below are done using Microsoft Excel. However the data is in a nearly universal Comma Separated Variable (CSV) format which can be used in most data management software including databases, spread sheets and math packages.

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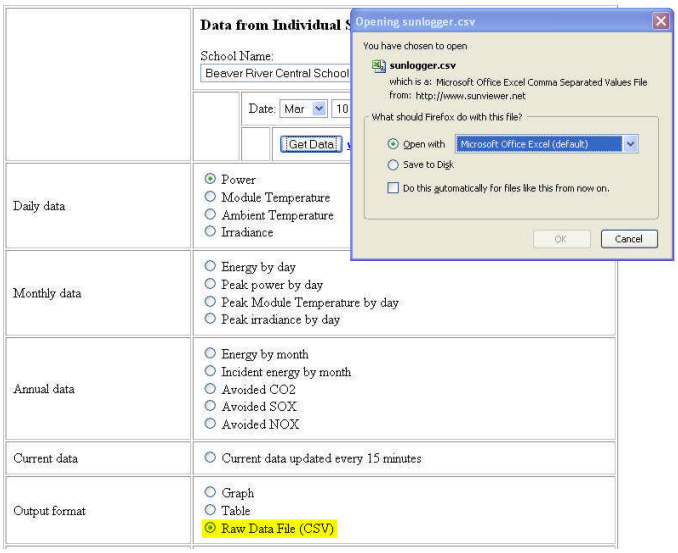

Figure 2a Query page for data table downloading.

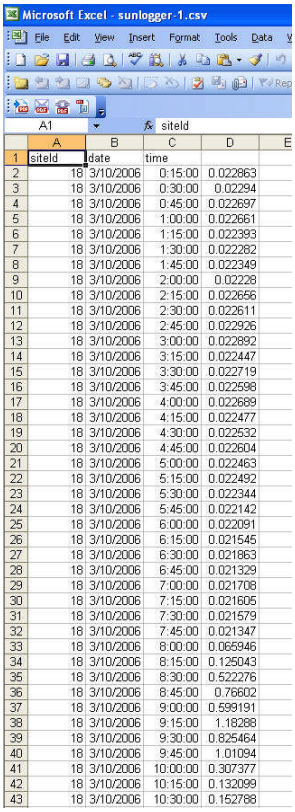

Figure 2b Screen shot of data in the Excel table.

It is interesting to compare the irradiance and power data. However the scales are dramatically different. Below we repeated the above procedure for irradiance data and then cut and pasted it into the column adjacent to the power data. Selecting the three right most data columns and using the XY (Scatter) plotting function we can plot these two data sets overlaid on top of one another.

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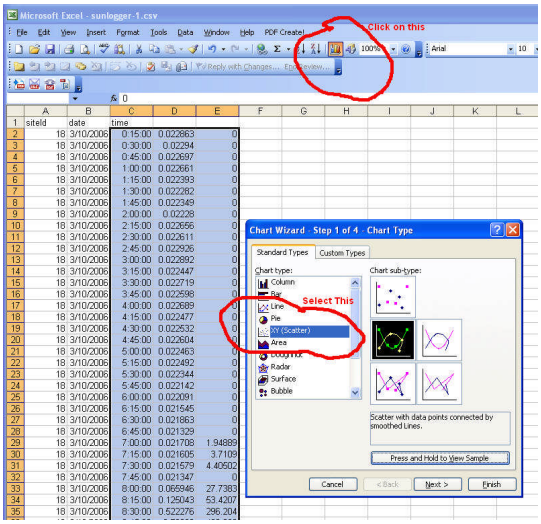

Figure 3a Setting up the plotting with Excel spreadsheet.

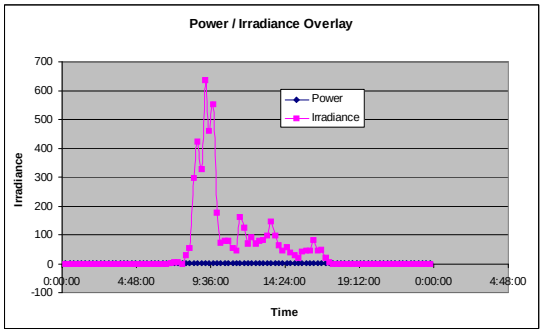

Figure 3b Plot of irradiance and Power

Notice that the power appears to be a flat line. Looking back at Figure 1b notice that power is maximum at about 1.2 kw whereas, looking at 3b, irradiance is almost 700 W/m^2 at its peak. So to compare the two, it would be helpful to find a way to get them on the same scale. The process for doing this is called normalization. This is surprisingly easy to do. We just find a way to make both scales go from zero to 1. The units become arbitrary. So quantitatively, the graph will no longer be useful. However qualitatively, it will allow any correlation between the two data sets to become much more apparent.

Proceed as follows: Using your spreadsheet copy the data from the Time column into the empty column G. In the data in Figure 3a the Power data is in column D. If we search that column we can find the highest value that the power reaches is 1.18 kw in line 38. Now divide each value in column D by 1.18 and place that value in the same row in column H. Find the highest value in column E. Not surprisingly, it is in the same row and is 636 W/m^2 . So divide each number in column E by 636 and put it in the same row in column I. Do this for all of the rows with numbers in them.

Now make another overlay plot. Select the data in the three new columns G,H and I. Then use the XY Scatter Plot function and plot the data. Notice that now they are

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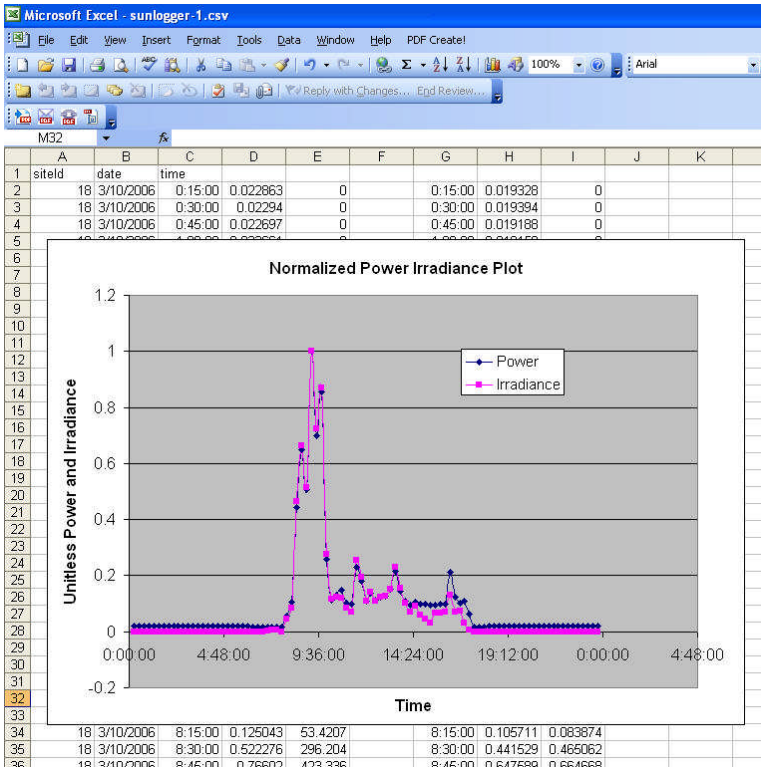

Figure 4 Plot of normalized power and irradiance.

of comparable scale. Also notice how closely they match. This is not surprising since the solar array gets its energy from the sunlight. When you have two data sets with very different scales, normalization acts like a magnifying glass for the one with the smaller scale, allowing you to observe possible correlations in the data sets.

A linear relationship is one for which two data sets are compared and differ only by a multiplicative constant and an offset. Look at these two data sets and think about whether they are linearly related.

You don't have to stop at two variables. You can normalize several data sets and plot them atop one another to explore their relationships. Try adding temperature to the plot above. How does it correlate? Can you explain this?

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