



GRAPHING REAL WORLD SOLAR ENERGY DATA WITH EXCEL

Facilitator/Student Resource

This resource guides students to download, process and present real-world numerical data from the Schoolgen online database of solar energy generation.

Students will learn important cross-disciplinary skills in Microsoft Excel 2010 as well as emphasising the links between science and maths, and the usefulness of maths as a tool in science.

Schoolgen Data Activity TEACHER NOTES

Rationale for the Activity

The Schoolgen programme has installed 2 kilowatt solar photovoltaic (PV) systems in more than 40 New Zealand schools. Each PV system uploads how much solar electricity it has generated every 30 minutes into the Schoolgen online database. The first schools started producing their own solar electricity in 2006 so there is now a very large set of data available. Measurements of solar radiation intensity are also recorded from the nearest NIWA weather station thus allowing direct correlation between the output of the solar panels and the amount of sunlight received.

This activity enables students to download, process, visualise and evaluate real-world data from their own school, or another school's solar photovoltaic (PV) system.

Students will learn important cross-disciplinary skills in Microsoft Excel 2010. The activity can also be used to emphasise to students the links between science and maths, and the how maths is used as a tool in science. This activity could operate at a range of levels but here it is aimed *explicitly* at Maths/Statistics Level 3 - 4.

The scientific concepts that are *implicit* within this activity could be used for extension work in science and as a basis for introducing concepts at higher curriculum levels in science and physics, such as:

- Energy and different units that are used to measure it: the electricity industry uses kWh (kilo-Watt hours), solar radiation intensity measured in MJ/m² (Mega-Joules per square metre).
- Conversion between units: 1 kWh = 3.6 MJ
- Dependence of solar generated electricity on the intensity of sunlight and its duration (Energy = Power x time).
- Efficiency of energy transformation from solar/radiant energy to electrical energy.
- Efficiency of the energy transformation by the photovoltaic cells.
- Seasonal variation of solar radiation due to Earth's tilt and orbit around the sun.
- Dependence of solar radiation on time, latitude, local weather.

Learning Outcomes (Students will ...)

1. Interpret graphs from a secondary source (Schoolgen website)
2. Gather data from a secondary source (Schoolgen online database)
3. Edit the data so it is easier to process (Using an Excel spread-sheet).
4. Create graphs (column & line) from the data:
 - i. 'Energy Generated' vs. 'Date/Time' (single variable time-series)
 - ii. 'Energy Generated' & 'Solar Radiation' vs. 'Date/Time' (multi-variable time-series)
5. Compare column and line graphs
6. Interpret the trend/pattern of the graph/s
7. Identify the relationship between 'Energy Generated' & 'Solar Radiation'

Managing the activity

- Requires a classroom pod of computers enough for at least one computer per pair of students.
- The activity is written for Microsoft Excel 2010 version and would need to be modified if using an earlier version of Excel.
- Internet connection and the ability to access the www.schoolgen.co.nz website.

New Zealand Curriculum Links

Subject Areas

Maths/Statistics Level 3 –4

*Identifying patterns and trends in context within and between data sets.
Display multivariate category, measurement and time-series data to detect patterns, variations, relationships and trends.*

Science Level 5-6

Physical World

Explore, describe, represent patterns and trends ... light, electricity, ... energy transformations.

Nature of Science (Investigating & Communicating)-

Recognition of multiple variables, visual and numerical literacy. Use wider range of ... symbols and conventions.

Principles

- **Future Focus** (exploring future focused issues such as sustainability).
- **Coherence** (makes links, provides for coherent transitions and opens up pathways to further learning).

Key Competencies

- **Thinking**
- **Using language, symbols, and texts**

Post-activity Class Discussion (possible focus questions)

- 1 a) Do PV panels convert all of the sun's energy into electricity?
b) What is efficiency?
c) Why is it good to have more efficiency?
- 2 a) Why does the amount of solar energy vary through-out the year?
b) Is this variation predictable or is totally different from year to year?
c) What might affect the output of PV panels more unpredictably from day to day?
- 3 a) How are solar panels made and how do they work?
b) How does the use of solar energy help to offset carbon emissions?
c) Why do many power stations produce carbon emissions?
d) Why is it important to reduce carbon emissions?

Supporting resources

- http://www.schoolgen.co.nz/ss/about_the_data.aspx
- There are over 1500 similar schools in the Australian Solar Schools programme. Here you can compare your Schoolgen school with Australian ones to see how a New Zealand generating environment compares to different Australian environments: <http://www.solarschools.net/compare/>

- **STUDENT INSTRUCTIONS** -

HOW TO DOWNLOAD DATA FROM THE SCHOOLGEN WEBSITE

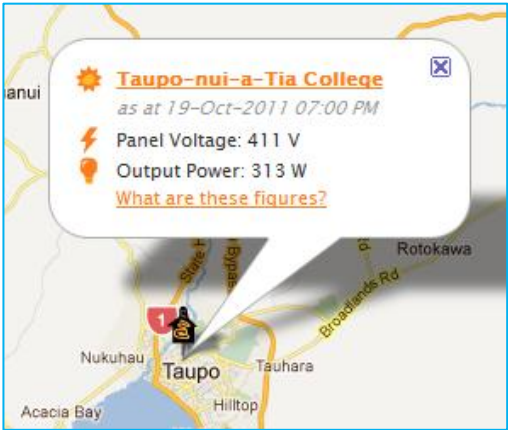
- 1. Go to the schoolgen website: www.schoolgen.co.nz
- 2. Click on the NZ map to select your region/school:
- 3. What is the Output Power of your schools PV panels right now?



Answer question on your answer sheet

- 4. Click on the school link to go to the school's page:

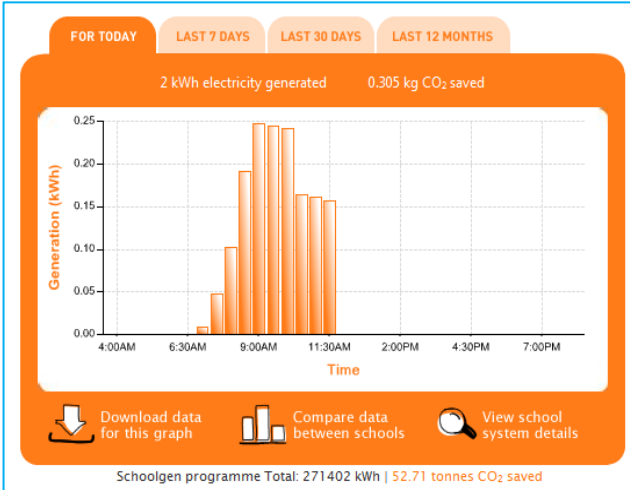
Answer question on your answer sheet



- 5. View the graph showing the output of your schools solar PV panels and record energy generated in units of KWh for:

If the data has not been reported for any reason, select another school which has complete data.

6. →



- 7. Your school will be automatically selected and the option of comparing with up to 4 other schools is available (don't use this today).

Select a school

Select up to five schools to generate a data report for using the form below.

Region: District:

Generate data for

1. Taupo-nui-a-Tia College - Taupo District (Central North Island) ✕

For the period

From: To:

Export data as

CSV File (Best for Excel) XML File

[Download Now](#)

8. Select the dates you want data for

From: To:

9. Request **1 year of data** eg.

to

Choose whole months.

10. Select the CSV File option.

11. Download the data file.

12. SAVE the **data file** to your computer and OPEN.

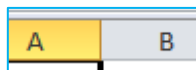
13. Your file gets opened in a very useful program called Excel and should look like this →

14. Well done! 😊


15. We will now **process** this raw data so that it is easier to work with.

	A	B	C	D	E
1	1. Taupo-nui-a-Tia College				
2	Date/Time	Energy Ge	CO2 Save	Radiation. (Mj/m2)	
3	Sep-10	178.4425	34.79629	366.03	
4	Oct-10	295.898	57.70011	622.6	
5	Nov-10	304.842	59.44419	722.97	
6	Dec-10	262.085	51.10658	644.56	
7	Jan-11	287.1435	55.99298	748.32	
8	Feb-11	218.8445	42.67468	572.63	
9	Mar-11	246.2835	48.02528	523.37	
10	Apr-11	190.402	37.12839	363.19	
11	May-11	151.5035	29.54318	240.89	
12	Jun-11	135.5295	26.42825	185.05	
13	Jul-11	152.9715	29.82944	236.82	
14	Aug-11	190.96	37.2372	337.03	
15	Summary Table				
16	Date/Time	Energy Ge	CO2 Save	Radiation. (Mj/m2)	
17	Sep-10	178.4425	34.79629	366.03	
18	Oct-10	295.898	57.70011	622.6	
19	Nov-10	304.842	59.44419	722.97	
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28	Aug-11	190.96	37.2372	337.03	
29					

MICROSOFT EXCEL (VERSION 2010) SPREAD-SHEET BASICS:

1. SELECT summary table data by clicking (once) and dragging.
2. DELETE using the delete key.
3. Hover your mouse over the column heading  row: and move it so that is on the boundary line of that column – a vertical line with arrows should then appear.
4. Double click on each column boundary line to expand it so that the column shows all information. Your data should now look something like this:

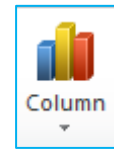
	A	B	C	D
1	1. Taupo-nui-a-Tia College			
2	Date/Time	Energy Generated (kWh)	CO2 Saved (kg)	Radiation. (Mj/m2)
3	Sep-10	178.4425	34.7962875	366.03
4	Oct-10	295.898	57.70011	622.6
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6	Dec-10	262.085	51.106575	644.56
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13	Jul-11	152.9715	29.8294425	236.82
14	Aug-11	190.96	37.2372	337.03

5. The numerical data is given to high precision with many decimal places and is unnecessary for general purposes. The data can be easily ROUNDED:
 - Select (click and drag) all data with decimal points in them.
 - On the tool-bar (top right) use the DECREASE DECIMAL control to round to **whole numbers**. 

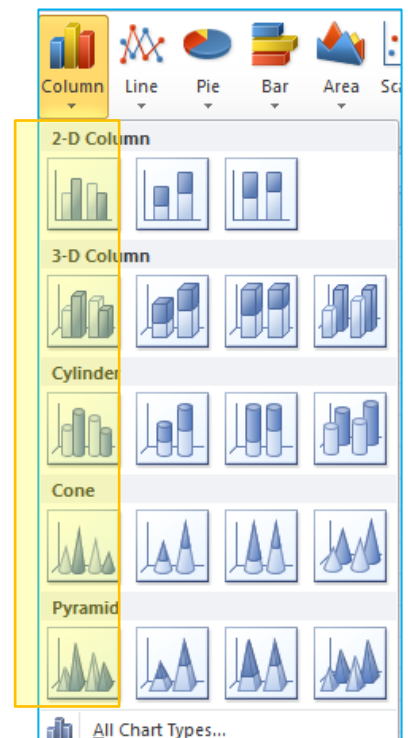
CREATING A ONE COLUMN GRAPH OF YOUR DATA

1. SELECT the 'Date/Time' and 'Energy Generated' columns together (headings & data).

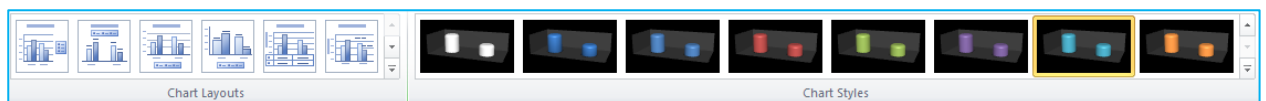
2. Go to the INSERT MENU & click on the COLUMN GRAPH icon in the toolbar:



3. SELECT one of the column graph options to create a graph.



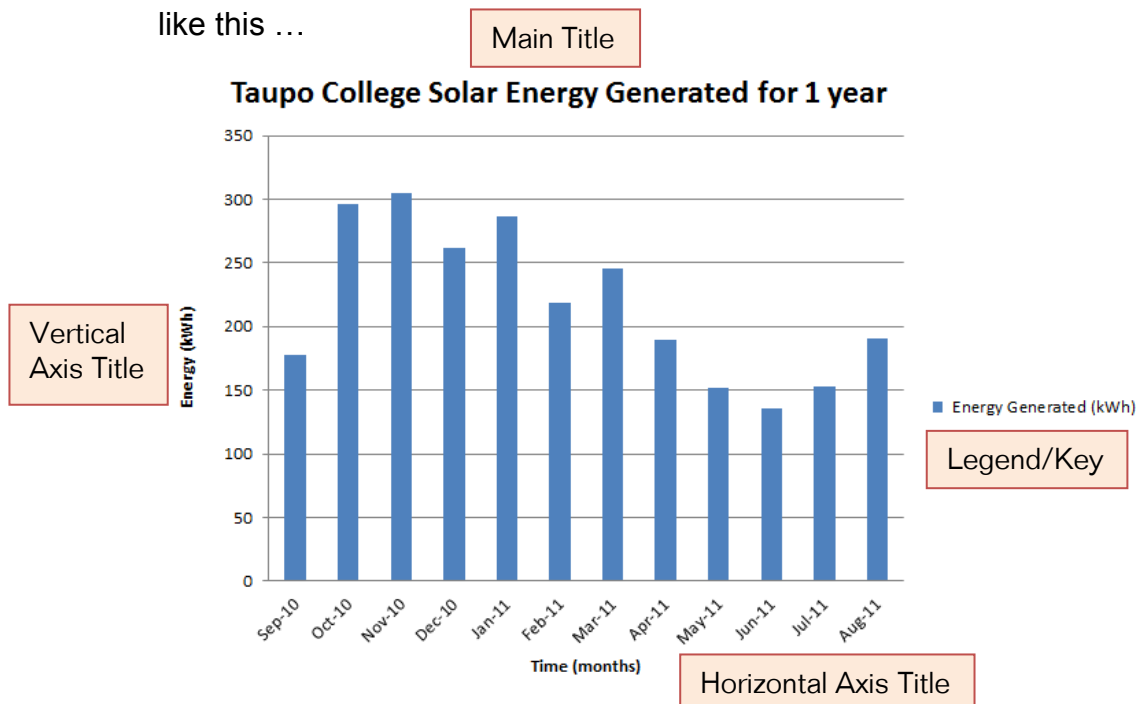
4. Click on your graph, then in the toolbar you can customise your graph using the 'CHART LAYOUTS' and 'CHART STYLES'



5. Go to the 'CHART LAYOUTS' box and scroll down to the second row; choose 'LAYOUT 9' – this will give you labels for both **axes**, and also a **title** which you can now change.



6. EDIT both of the **Axis Title's** and the **Main Title** so that it clearly communicates what the graph is about. Your graph should now look a bit like this ...



How to Quickly and Easily make New Graphs

1. Click on your graph and COPY it.
2. Click somewhere on the spread-sheet and PASTE the copy of the graph.
3. Click once on a graph column: a **blue box** will appear around your data.

Column Headings

Energy Generated (kWh)	CO ₂ Saved (kg)
178	35
296	58
305	59
262	51
287	56
219	43
246	48
190	37
152	30
136	26
153	30
191	37

4. DRAG the **blue box** to the neighbouring column (eg 'CO₂ Saved'), do the same with the column heading (**green box**) to create the **correct legend/key** on your graph.

5. Make sure you change the **vertical axis label** to match the new column headings!

CREATING A TWO OR MORE COLUMN GRAPH OF YOUR DATA

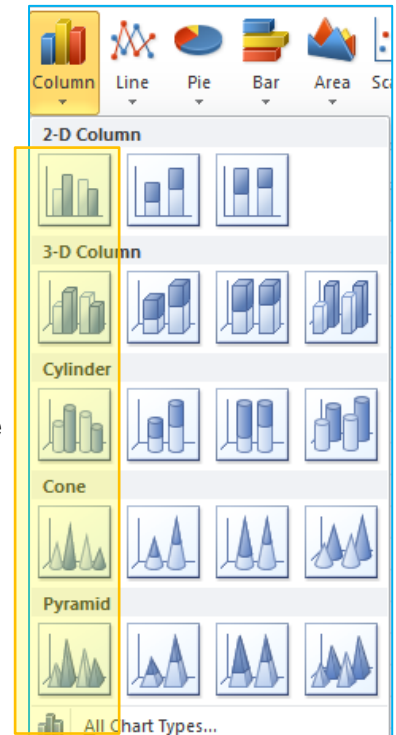
1. SELECT the 'Time' column plus two other columns of numerical data that you decide to graph.

2. Click on the INSERT GRAPH



icon.

3. SELECT one of the graph options (only use options from the **left hand side**).

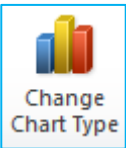


4. CLICK on any column in your graph. A **blue box** will appear around the data. DRAG the box to display other columns of data.

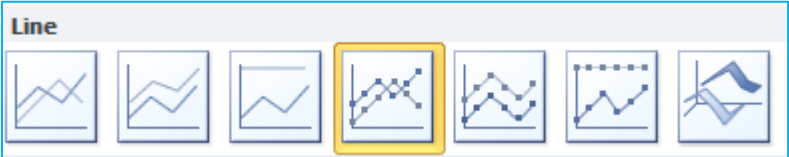
5. Make a graph comparing the amount of electrical energy generated by the solar panels and the amount of solar radiation energy*

**The solar radiation energy measures the amount of energy from the sun that has hit the earth on every square metre (it is measured at the nearest NIWA weather station to your school).*

6. Change the CHART TYPE



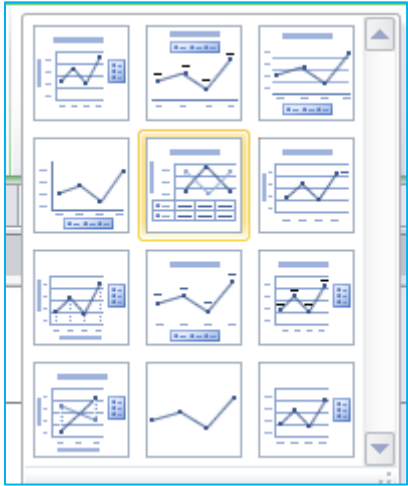
7. Make it a LINE GRAPH



Answer question on your answer sheet

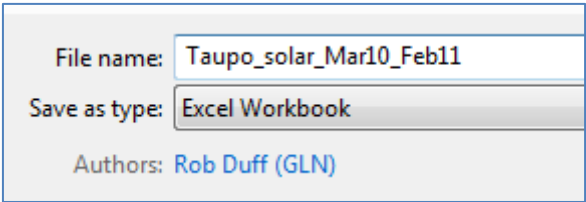
8. To view the graph only, RIGHT-CLICK on the graph and select 'MOVE CHART'. Select 'NEW SHEET'.

9. If you still want to see the DATA TABLE used by the graph then click on the graph, go to the menu and select 'CHART LAYOUTS'. Select the options showing the table underneath the graph.



10. EDIT both of the **Axis Title's** and the **Main Title** so that it clearly communicates what the graph is about.

11. SAVE AS your hard work with an descriptive file name and you might like to change the file type as well ...



12. If you can, PRINT out your final masterpiece! ☺

NAME/S: _____

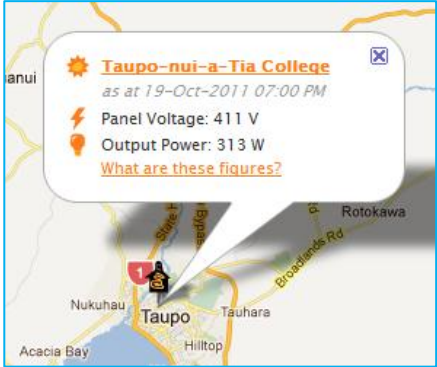
QUESTIONS (ANSWER DURING THE ACTIVITY)

1. What is the Output Power of your schools PV panels right now?

_____ W
What does "W" stand for? W _ _ _ _

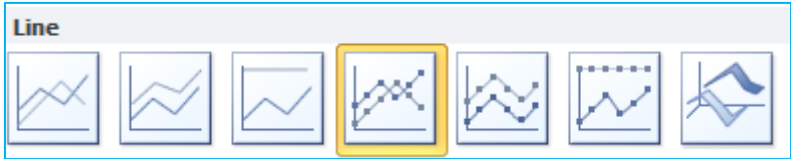
2. Click on the school link to go to the school's

page: Today _____
Last 7 Days _____
Last 30 Days _____
Last 12 Months _____



When you have finished questions 1 & 2, go back to the main instructions and finish the graphs before continuing.

3.



Question: Which type of graph (column or line) is better for showing the overall **trends and patterns** in the data?

QUESTIONS (POST-DISCUSSION)

ANSWER THESE WITH YOUR GRAPH

a) In which month did the PV panels generate the most electrical energy?

b) In which month did the PV panels generate the least electrical energy?

Please turn over page

c) Explain why the energy trend-line follows the solar radiation trend-line.

d) Write your own question about the graph for someone else to answer !

e) **Explain** how generating electricity with solar panels reduces CO₂ emissions and why this is a good thing:

f) **Research** how efficient modern PV panels are at transforming solar energy in sunlight into electrical energy. How efficient could they be in the future?