



Solar Energy & Aircon Project

Introduction

Modern living often involves technology that once was considered a “luxury”. As the standard of living rises for many, appliances like air conditioning and solar panels are becoming part of standard home builds and retrofits. But with the growth in both air-conditioning and solar panels, what do we know about the impact on energy demand locally, and nationally?

In this project we will explore the relationship between air-conditioning use, energy consumption and the impact on the environment.

To do this we will need to understand the datasets and find meaningful ways to compare the different sets of figures so that we can make sense of them.

Inquiry questions

- Are solar panels an effective way of off-setting the energy demands of running air-conditioning?
- What is the difference in loading between summer and winter?
- How much battery storage and how many more solar panels would a selected household need to cover night time aircon?
- What do consumers need to consider when deciding to install air-conditioning, solar panels and/or battery storage?

Data Sets

- Solar Analytics Datasets showing Solar energy generation, total electricity use, and air conditioning energy use

Year levels

- Levels 7 and 8

Curriculum Areas (VCAA v1.0)

CURRICULUM AREA	STRAND	SUB-STRAND
Science	Science Understanding	Science as a human endeavour
Science	Science Inquiry Skills	Questioning and predicting Recording and Processing Analysing and evaluating Communicating
Mathematics	Number and Algebra	Real numbers Linear and non-linear relationships
	Statistics and probability	Data representation and interpretation
Digital Technologies	Data and Information Creating Digital Solutions	
Humanities	Eco and Business	Resource Allocation and Making Choices Economic and Business Reasoning and Interpretation
English	Reading and Viewing Writing Speaking and Listening	Expressing and developing ideas Interacting with others Creating Texts
Geography	Geographical Concepts and Skills	Place, space and interconnection Place and Liveability Environmental change and management
Capabilities	Ethical Capability	Understanding Concepts

Equipment needed

- Computer and a copy of the dataset
- Internet access for further research
- Extension: Python programming software

Success Criteria

In this unit the student will improve their data literacy and data analysis skills by :

Knowing:

- What data is and how it is collected
- That data can help tell a story about the world around us and help us solve problems

Doing:

- Applying basic mathematical skills to make sense of data
- Sharing the data story with others in different ways.

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- Identifying the relationships between:
 - Air-conditioning usage and energy consumption
 - The impact of solar panels on household energy costs
 - Seasonal variations
 - Green-house gas emissions
- Learn the graphing skills that enable these comparisons.

Understanding:

- How to check your data for possible errors
- How data may be used to change people's behaviours

Step 1

- Download [06.csv](#) from the Photovoltaic (solar energy) dataset and open it in a spreadsheet such as Excel, Numbers, or Google Sheets.
- Spend some time getting to know the dataset.
 - *What does each column represent? Is the value recorded an instantaneous measurement or a total over the preceding time period? How might you work this out?*
 - *Read the readme file. What assumptions did you make about the data that turned out to be wrong? Which ones were right?*
 - *What time range does the dataset cover?*
 - *What are the highest and lowest values in each column?*
 - *Bearing in mind that these datafiles are Victorian, what season(s) does the dataset cover?*
 - *Find the average sunshine hours per day for Melbourne over the period covered by this dataset.*
 - *What are the average maximum & minimum temperatures for Victoria in the months covered by this dataset?*
 - *You will notice that the solar panels are occasionally recorded as producing negative energy. How could this be?*

Step 2

- ❑ You will notice that the energy used for air conditioning has numbers *over 100* or *under 10*, and very little in between. *Why might that be?*
- ❑ Duplicate the sheet so that you can work with a copy of the data without changing the original dataset. {Tip: This is a really important habit to get into!}
- ❑ Calculate the average energy used, the average solar (PV - PhotoVoltaic) energy generated, and the average air conditioner energy used.
- ❑ Compare total solar energy generated with total energy used.
- ❑ Assuming the house exports all of the excess solar energy, and that their utility pays them a feed-in tariff of 9.9cents per Kilowatt Hour,
 - *How much will they be paid for the energy generated by their solar cells?*
 - *What is the impact if the price of power increases by 10%? 20%? 50?*
 - *Can you find any predictive data that might indicate the forecasted price of power in say, 2050?*

Step 3

- Assuming the low numbers are when the air conditioning is on standby, calculate the total energy used by air conditioning on standby over the 3 months of data.
- Calculate the average energy used on standby for the first day.
- Calculate the average daily energy used on standby for each day in the 3 months in the dataset.
- Calculate the average daily energy use by air conditioning not on standby.
- Calculate the average daily energy generated by the solar cells.

Step 4

- Graph these three sets of values on the same graph.
- What percentage of this household's total energy used is provided by their solar panels?
- What kind of graph could you use to compare daily energy produced with daily energy used? Make this graph.

Step 5

- How could you creatively represent the total energy used versus the total energy produced by the solar panels, to show people how much of their energy comes from the electricity grid, compared with their solar panels? Develop some visualisations that show this.
- Calculate the CO₂ emitted by the air conditioning in this dataset, if all of the electricity came from coal? Visualise this result. Note: You will need to research the CO₂ emitted by electricity that comes from coal. A useful search phrase might be "coal co₂ emissions per kwh".
- Now calculate the CO₂ saved by the energy generated by the solar panels. Visualise this result.

Step 6

- Compare the times when solar energy is produced with the times when the air conditioning is on.
- Make a graph so that you can see clearly when the air conditioning is using solar energy.
- How effective are the solar panels at meeting the energy needs of the air conditioning for this household?

Step 7

- Look over all of your calculations, graphs and visualisations from the previous steps. What does this dataset tell you? What message do you want to communicate to the wider community about this data, on the topics of energy use, climate change, and renewable energy?
- Decide on what you want to communicate, and make an online poster that uses some of your graphs and visualisations (or new ones!) that effectively gets your message across.

Extension Coding Activity

- ❑ Write a Python program to create a new csv file that contains hourly averages instead of the total every 15 minutes. How much does this change the accuracy of the calculations above? How different do the graphs look? How much information do you lose by averaging?
- ❑ 06.csv is just one household. Write a python program to compare the calculations for this csv file to the calculations for all of the others. How different are they? What difference does this make to the conclusions you drew?

Curriculum Links (VCAA 2016)

The following table identifies the Curriculum links relevant to the delivery of this unit of work. More detailed assessment rubrics have also been provided for each Curriculum Area.

Curriculum Area: Strand: ● Sub-strands	Year 7	Year 8
Science: Science Understanding: ● Science as a human endeavour	<ul style="list-style-type: none"> ● Scientific knowledge and understanding of the world changes as new evidence becomes available; science knowledge can develop through collaboration and connecting ideas across disciplines and practice of science. ● Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations. 	
Science: Science Inquiry Skills: ● Questioning and predicting	<ul style="list-style-type: none"> ● Identify questions, problems and claims that can be investigated scientifically and make predictions based on scientific knowledge 	
Science: Science Inquiry Skills: ● Recording and processing	<ul style="list-style-type: none"> ● Construct and use a range of representations including graphs, keys and models to record and summarise data from students' own investigations and secondary sources, and to represent and analyse patterns and relationships 	
Science: Science Inquiry Skills: ● Analysing and evaluating	<ul style="list-style-type: none"> ● Use scientific knowledge and findings from investigations to identify relationships, evaluate claims and draw conclusions ● Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method 	
Science: Science Inquiry Skills: ● Communicating	<ul style="list-style-type: none"> ● Communicate ideas, findings and solutions to problems including identifying impacts and limitations of conclusions and using appropriate scientific language and representations 	
Mathematics: Real Numbers	<ul style="list-style-type: none"> ● Round decimals to specified number of decimal places. ● Find percentages of quantities and express one quantity as a percentage of another, with and without digital technologies 	<ul style="list-style-type: none"> ● Solve problems involving the use of percentages, including percentage increases and decreases and percentage error, with and without digital technologies
Mathematics: Linear and non-linear relationships	<ul style="list-style-type: none"> ● Investigate, interpret and analyse graphs from real life data, including consideration of domain and range 	<ul style="list-style-type: none"> ● Plot graphs of non-linear real life data with and without the use of digital technologies, and interpret and analyse these graphs
Mathematics: Data representation and interpretation	<ul style="list-style-type: none"> ● Identify and investigate issues involving numerical data collected from primary and secondary sources. ● Calculate mean, media, mode and 	<ul style="list-style-type: none"> ● Investigate the effect of individual data values including outliers, on the range, mean and median

	<p>range for sets of data. Interpret these statistics in the context of data.</p> <ul style="list-style-type: none"> Describe and interpret data displays using median, mean and range. 	
Digital Technologies: Data and Information	<ul style="list-style-type: none"> Acquire data from a range of sources and evaluate their authenticity, accuracy and timeliness Analyse and visualise data using a range of software to create information, and use structured data to model objects or events 	<ul style="list-style-type: none"> Analyse and visualise data to create information and address complex problems, and model processes, entities and their relationships using structured data
Digital Technologies: Creating Digital Solutions	<ul style="list-style-type: none"> Define and decompose real-world problems taking into account functional requirements and sustainability (economic, environmental, social), technical and usability constraints 	<ul style="list-style-type: none"> Define and decompose real-world problems precisely, taking into account functional and non-functional requirements and including interviewing stakeholders to identify needs
Humanities: Eco and Business: <ul style="list-style-type: none"> Resource Allocation and Making Choices 	<ul style="list-style-type: none"> Examine the way consumers and producers respond to and influence each other in the market, particularly through the price mechanism. 	
Humanities: Eco and Business: <ul style="list-style-type: none"> Economic and Business Reasoning and Interpretation 	<ul style="list-style-type: none"> Identify relationships and trends, and generate a range of alternatives for an economic or business issue or event, evaluating the potential costs and benefits of each alternative and the consequences of proposed actions. 	
English <ul style="list-style-type: none"> Reading and Viewing: Expressing and developing ideas Writing: Creating Texts Speaking and Listening: Interacting with others 	<ul style="list-style-type: none"> Analyse how point of view is generated in visual texts by means of choices, including gaze, angle and social distance. Use a range of software, including word processing programs, to create, edit and publish written and multimodal texts. Identify and discuss main ideas, concepts and points of view in spoken texts to evaluate qualities, using interaction skills when sharing interpretations or presenting ideas and information. 	<ul style="list-style-type: none"> Investigate how visual and multimodal texts allude to or draw on other texts or images to enhance and layer meaning. Use a range of software, including word processing programs, to create, edit and publish texts imaginatively. Identify and discuss main ideas, concepts and points of view in spoken texts to evaluate qualities, using interaction skills when sharing interpretations or presenting ideas and information.
Geography: Geographical Concepts and Skills: <ul style="list-style-type: none"> Place, space and interconnection 	<ul style="list-style-type: none"> Identify, analyse and explain interconnections within places and between places and identify and explain changes resulting from these interconnections 	
Geography:	<ul style="list-style-type: none"> Factors that influence the decisions people make about where to live and 	

<p>Geographical Concepts and Skills:</p> <ul style="list-style-type: none"> • Place and Liveability 	<p>their perceptions of the liveability of a place.</p> <ul style="list-style-type: none"> • Influence of accessibility to services and facilities; and environmental quality, on the liveability of places.
<p>Geography: Geographical Concepts and Skills:</p> <ul style="list-style-type: none"> • Environmental change and management 	<ul style="list-style-type: none"> • Environmental, economic and technological factors that influence environmental change and human responses to its management • Application of environmental economic and social criteria in evaluating management responses to an environmental change, and the predicted outcomes and further consequences of management responses on the environment and places, comparing examples from Australia and at least one other country
<p>Capabilities: Ethical capability:</p> <ul style="list-style-type: none"> • Understanding Concepts 	<ul style="list-style-type: none"> • Investigate criteria for determining the relative importance of matters of ethical concern • Discuss the role of context and experience in ethical decision making and actions