Solar Car Challenge - Teacher Resource

Intended Use of Resources

This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

There are three **student workbooks - Open, Guided and Scaffolded,** that go along side this resource; all have the same suggestions for activities, however they have been written and edited to provide differentiated learning options to support good teaching practice**.** Teachers may pick and choose which versions they give which students, and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open-ended investigation then you could just give the students the challenge and background information section of the Student Workbook.

The Woodside Australia STEM Project aims to be accessible and supportive for teachers and students, please contact us if you have questions, require assistance or would like to arrange an incursion or a professional development workshop - www.wasp.edu.au

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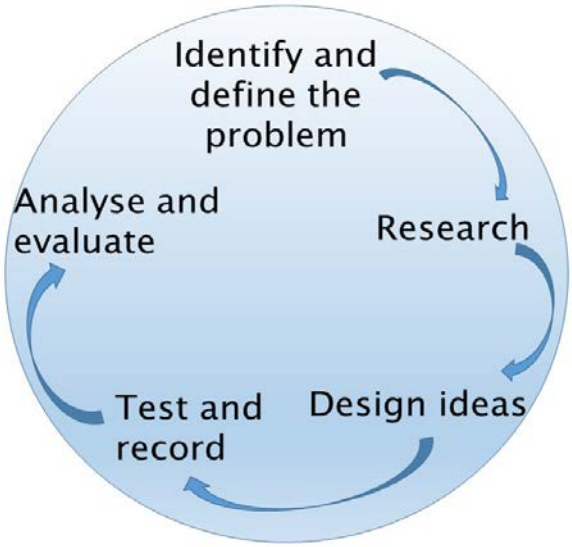
The Challenge

Every two years the World Solar Challenge takes place in Australia. This is a solar powered car race which starts in Darwin and finishes in Adelaide (3,022 km). It runs through the Australian outback and was created to foster the development of experimental, solar-powered vehicles. The race attracts teams from all across the globe, most of which are made of people from large corporations or universities. Sometimes high schools also enter teams.
The student challenge is to investigate the factors which effect the efficiency of a solar car and to use their findings to design a solar car.



Background Information

It is well known that transport that uses petrol or diesel produces carbon dioxide and other gases (and particulates) which have a negative impact on the environment and people's health. As scientists become more aware of the causes and impacts of global warming there has been more focus on designing more environmentally friendly cars – solar cars being one of them.

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Figure 1. Solar car - with solar panels on the top of it. (Hideki Kimura, 2009)

Solar panels work by absorbing light energy from the Sun and converting it into electrical energy. This electrical energy is then used to turn the motor and make the car run. There are different types of solar panels, some are more efficient than others. This means they turn more of the light energy into electrical energy. Most solar panels are between 15 – 20% efficient, with the top of the range being around 23% efficient. This means they convert 23% of the light energy hitting them into electrical energy (that's just less than a quarter).

There are several factors which will effect the efficiency of a solar panel:

- the material used in the solar panel,
- the wiring – how the panels are wired up and what the wires are made of, and
- the amount of reflection (this will depend on the type of glass used) – the more light that is absorbed the more efficient the panel will be.

There have been massive improvements in solar car designs since the first World Solar Challenge took place in 1987. The Dutch Nun team were the first to beat an average speed of 100 km/h in 2005. This has brought about a change to the race rules and class entries. For example, the introduction of the Cruiser category, which focuses on designing solar cars that can fit multiple occupants and carry larger loads. The aim is for solar cars to become more like commercial cars and to be more practical for the everyday user.

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Activities

This booklet contains extra information on each activity including syllabus links, the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links. Please note that any reference websites provided in the entirety of our resource documents were current at the time of publication. Please advise if links are no longer accessible.

The syllabus links have been colour coded – please see the colour key below:

Covered in Scaffolded, Guided and Open student workbook
Covered in Guided and Open Student workbook
Covered in Open student workbook

List of Activities

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Background Research

Objective

In this activity students will gain more understanding on what is meant by renewable energy. They will research the advantages and disadvantages of solar panels, particularly in relation to powering a car. They will compare solar cars to electric cars in terms of environmental impact and consider some environmental concerns associated with solar cars.

Students will find that solar cars can still be used in the dark, if they have enough energy stored in their batteries. Solar cars are more environmentally friendly than electric cars in general as most electric cars still get their energy from the grid – which gets most of its energy from burning fossil fuels. However, the batteries which are used in both solar and electric cars are very difficult to recycle so prove to be an environmental challenge.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the Sun) ACSHE081 Scientific knowledge is used to solve problems and inform personal and community decisions ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted
Technologies	ACTDEK019 How people address competing considerations when designing products, services and environments

Useful website:

- Britannica Article on renewable energy
  https://www.britannica.com/science/renewable-energy
- Information on the advantages and disadvantages of solar cars
  https://solarpowernerd.com/benefits-of-solar-energy-cars/
- Information about different types of solar panel
  https://www.energysage.com/solar/101/types-solar-panels/
- Website explaining the breakdown of where Australia's energy comes from
  https://www.originenergy.com.au/blog/electricity-generation-in-australia/

Weight and Speed

Objective

In this activity, students will conduct an investigation to determine how the load on a car impacts the speeds it can achieve. They will relate this to solar car design and consider the pros and cons of having lots of solar panels in respect to how this can affect weight and power.

Students collect data from the investigation and in the Guided and Open book are asked to plot their results in a column graph. Students reflect on the fairness of the experiment and how they could improve it.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the Sun) ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS090 Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	ACTDEK020 Forces can control movement, sound or light in a product or system
Mathematics	ACMMG108 Choose appropriate units of measurement for length, area, volume, capacity and mass. ACMSP119 Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies. ACMSP120 Describe and interpret different data sets in context

Streamlining

Objective

Students will find out what is meant by streamlining and investigate the effect this has on the speed of a moving object. In the Open book students create their own method to investigate streamlining.

After conducting the investigation students evaluate the experiment, considering if it was a fair test and how it could be improved. In the Guided and open booklet students are asked to consider how practical a streamlined car would be.

Subject area	Australian syllabus links
Science	ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS086 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks ACSIS091 Reflect on and suggest improvements to scientific investigations
Design Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task ACTDEK020 Forces can control movement, sound or light in a product or system

Useful websites:

- Article on how cars are tested for streamlining https://auto.howstuffworks.com/classic-dream-cars-wind-tunnel-aerodynamics.htm

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Temperature and Efficiency

Objective

The aim of this experiment is for students to investigate how the temperature of a solar panel effects how efficient it is. The Open students are asked to come up with their own method to conduct this investigation, the Guided students use a method to create an equipment list and the Scaffolded students are given an equipment list and method to follow. All students evaluate the investigation once they have completed it.

Students should find that the solar panels work best when they are coldest, contrary to what many may believe. The scientific reason for this is that when the wires in the solar panel are cold they have low resistance, as the atoms are not vibrating as much so the electrons (carrying the current) can flow through more easily. However, when the panel heats up the atoms in the wires have more energy and vibrate more, this create more resistance for the electrons.

As this experiment will be conducted using sunlight it is recommended to conduct a few trials as clouds or fluctuations in the atmosphere can affect how much sunlight reaches the solar panel.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations. ACSIS086 Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS087 Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate ACSIS090 Construct and use a range of representations, including table and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate.

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	ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task WATPPS28 Identify available resources WATPPS30 Select, and apply, safe procedures when using components and equipment to make solutions WATPPS32 Work independently, or collaboratively when required, to plan, safely develop and communicate ideas and information for solutions
Mathematics	ACMMG108 Choose appropriate units of measurement for length, are, volume, capacity and mass. ACMSP118 Pose questions and collect categorical or numerical data by observation or survey ACMSP119 Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

Time of Day

Objective

Students will investigate if the time of day that a solar toy is used affects how fast it goes. Guided and Open students will make predictions about when they think this will be.

In the Open and Guided book students are shown how to measure the angle of the sun, so they can also see how this changes throughout the day. This will relate to the next experiment "Incident Light Angle" if they conduct that.

All students are given a method for this investigation, however Open students are asked to use the method to create an equipment list. Once they have conducted the experiment all students are asked to evaluate it.

Students should find that the toy goes the fastest at midday when the light shines directly down on the solar panel (the angle of the sun is zero). However, this may also be the hottest time of day, which could cause the solar panels to be less efficient. There may also be cloud cover or atmospheric variations which can affect the results.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations. ACSIS090 Construct and use a range of representations, including table and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate. ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS28 Identify available resource

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Mathematics	ACMMG108 Choose appropriate units of measurement for length, are, volume, capacity and mass. ACMMG112 Estimate, measure and compare angles using degrees. Construct angles using a protractor. ACMSP118 Pose questions and collect categorical or numerical data by observation or survey ACMSP119 Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

Incident Light Angle

Objective

In this activity students find out if there is any relationship between the angle of incident light and the amount of energy produced in a solar cell. This links back to the previous activity and students may be able to make predictions based on what they found out about how the angle of the Sun affects the speed of a solar toy.

For this experiment it is good if you can use a toy, such as a solar bug, that will not move too much when the light is shone on it (using a car could be difficult).

Students should find that the lower the incident angle the more active the toy is, and it is most active when the light is shone directly down on it. This should relate to the angle of the Sun as well – with solar panels generally being most efficient at midday (note explanation of why this may not be the case in previous experiment notes).

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS231 With guidance, pose clarifying questions and make predictions about scientific investigations. ACSIS090 Construct and use a range of representations, including table and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate. ACSIS218 Compare data with predictions and use as evidence in developing explanations ACSIS091 Reflect on and suggest improvements to scientific investigations
Mathematics	ACMMG112 Estimate, measure and compare angles using degrees. Construct angles using a protractor. ACMSP118 Pose questions and collect categorical or numerical data by observation or survey

Designing a Solar Car

Objective

Students will research previous solar car designs and evaluate their strengths and weaknesses. Using their evaluation and what they have learnt from their investigations they will design and build a model solar car to enter into a class race. The objective is slightly more challenging for the Open students, as their model must be able to hold a specific number of passengers.

For this activity you may wish to give your class premade model solar cars which they can adapt and modify.

Subject area	Australian syllabus links
Science	ACSSU078 The Earth is part of a system of planets orbiting around a star (the sun) ACSSU080 Light from a source forms shadows and can be absorbed, reflected and refracted ACSIS091 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS27 Define a problem, and set of sequenced steps, with users making a decision to create a solution for a given task ACTDEK020 Forces can control movement, sound or light in a product or system WATPPS28 Identify available resources WATPPS29 Develop and communicate alternative solutions, and follow design ideas, using annotated diagrams, storyboards and appropriate technical terms WATPPS30 Select, and apply, safe procedures when using components and equipment to make solutions WATPPS31 Develop negotiated criteria to evaluate and justify design processes and solutions WATPPS32 Work independently, or collaboratively when required, to plan, safely develop and communicate ideas and information for solutions

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Mathematics	ACMMG108 Choose appropriate units of measurement for length, area, volume, capacity and mass. ACMMG111 Connect three dimensional objects with their nets and other two-dimensional representations

Bibliography

Figure numbers from scaffolded booklet

Figure 1. Solar Car, https://en.wikipedia.org/wiki/Solar_car, accessed 16/6/2020