Model Solar Car Challenge

Curriculum Unit

Castlemaine Secondary College

State Government Victoria
Department of Education and Early Childhood Development

Castlemaine Secondary College

Central Victoria Solar City
Local energy solutions.

Australian Government
Solar Cities

Bendigo Bank generation green
Central Victorian greenhouse alliance
origin
Powercor Australia
Sustainability Victoria
State Government Victoria
SRA Sustainable Regional Australia

Introduction

In the Model Solar Car Challenge students from Castlemaine Secondary College work in groups to design, build, test, modify and race a model solar powered car. They see how energy from the sun is used to power a small motor through the use of a solar panel. Students learn about engineering principles related to solar energy, photovoltaic cells and energy efficiency. They also learn how to design and build to specification. The aim of the unit is to produce a model solar car to race at the Victorian Model Solar Vehicle Challenge, held each year in Melbourne[1]. It encourages student teamwork, enterprise and learning with a 'hands-on' project.

The unit also requires significant financial input. Each car costs approximately $300 to build and the construction of a testing track can be expensive. At Castlemaine Secondary College, teacher Phillip Scoles recieved financial support from various local businesses, as well as through the Central Victoria Solar City project, part of the Australian Government's Solar Cities program. Through funding from Central Victoria Solar City, Castlemaine Secondary College has been able to purchase materials, such as new class sets of solar panels, for students' cars.

Outcomes

Students build a model car powered by a solar panel. They see how solar energy can be used to generate electricity to power a motor. Students design and engineer a model car to strict specifications provided by the Victorian Model Solar Car Challenge. They test the cars and make modifications as necessary. They also create a poster that outlines their learning about solar energy and greenhouse gasses and details the design, manufacture and modification processes of their model solar car.

[1] http://www.modelsolar.org.au/

Equipment

General

- A3 graph paper (for car design)
- Basic tools such as spanners, screw drivers, saws, sand paper, glue, pliers, drills etc.

Cars

- Commercially available silicon photovoltaic cell (1 per car)
- Front axle assembly (carbon fibre axles)
- Rear axle assembly
- Set of guide rollers (4 per car)
- Electric motor
- On/off switch
- A maximiser (the electronics that match panel output to motor characteristics)
- Micro plugs (to fit the maximiser) and wires are also supplied

To build the body the following parts are supplied:

- Very thin 3 ply, balsa wood
- High density solid foam
- Velcro and different adhesives (Araldite, gap filler etc).

Testing Track

The testing track was constructed from builders ply, the metal interlocking parts were made from 2.5cm square steel tube and the guide rail is made out of 19mm nylon draw runner.

The testing track is composed of interlocking sections of track, approximately 80 cm wide. It has a guide strip along the middle of that is used to steer cars around the track.

Suggested duration:

Twelve weeks with 5 x 45 minute lessons per week. This unit is ideally undertaken over Term 3 and the first weeks of Term 4, leading up to the Victorian Model Solar Vehicle Challenge, which takes place in late October.

Week 1-2	Design car and draw up a full scale plan and side view.
Week 3	Cut out base from thin 3-ply and sand smooth. Attach front and rear axles to base. (Consult www.modelsolar.org.au for instructions on how to assemble front and rear axles).Test the cars' tracking (if it runs straight), by running it along the floor. Adjust the axles where necessary. Add guide rollers.
Week 4-6	Start to build up the body by adding the foam parts then the balsa and clear acetate where required.
Week 7	Fit motor and electrics/electronics.
Week 8	Attach panel by gluing Velcro to panel and car.
Week 9-10	Add name/stickers to car and start track testing.
Week 11	Car is now ready to race.

Process

Construction

At scrutineering during the Victorian Model Vehicle Challenge, students must be able to explain and discuss:

- Wheel and bearing selection and rolling resistance
- Effect of weight and tires on rolling resistance
- Design of steering mechanism
- Design of chassis
- Design of cockpit
- Effect of cloud on solar intensity
- How solar cells work
- How gear ratios and panel wiring can be changed to suit weather conditions (if not using electronics)
- The function of any electronic controls on their car
- Their team's organisation and decision making.

HOW TO BUILD A SOLAR CAR

Timeline

The solar car is built and tested over a 12 week period. Here are the timeline instructions for each stage of construction.

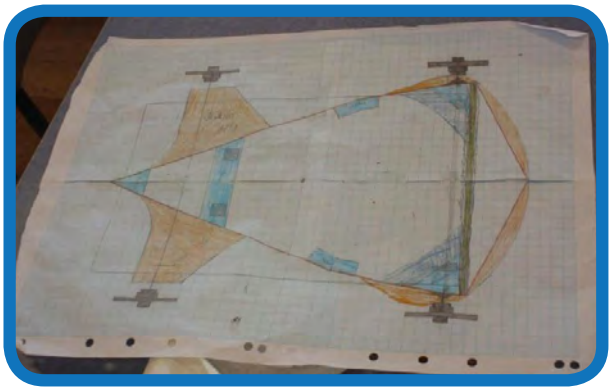
Week 1-2: Design the car

1. Meet with students to discuss the project and show them a video of the Victorian Solar Cars Challenge.[2]
2. Explain to students that they will be working in groups to build and race a model solar car.
3. Look at examples of solar cars so students can begin to get an idea of what their cars might look like.[3] Discuss advantageous design aspects such as weight, dimensions, aerodynamics and orientation of the solar panel.
4. Distribute copies of the current regulations and design specifications4 and read through relevant sections as a group ('Car Specification' section in particular).
5. Draw up a full scale plan and side view.
6. Create a materials list. This list may consist of balsa wood, high density foam, aluminium, thin ply wood, carbon fibre axles etc.

Look again at examples of past designs at http://www.modelsolar.org.au/Galleries/ModelSolarCars

As stated in the regulations of the Model Solar Car Challenge, the "*design and manufacture must be predominantly that of students. Teachers, parents, or other adult advisers, are encouraged to teach the students the appropriate scientific and technical principles. Some components may need to be made for the car using equipment unavailable to the students, but they must understand the working of their car and must be able to make all necessary adjustments or repairs on the weekend of the race.*"

Have students create a design on A3 graph paper. Their design will be a 1:1 scale that they will work from during the construction process.



Week 3: Construct the base and front and rear axels

1. Cut out the base
2. Attach the front and rear axles
3. Test the car's tracking and adjust axles where necessary
4. Add guide rollers. (5cm between centres).

[2] http://www.youtube.com/user/BillanookCollege?blend=1&ob=5

[3] http://www.modelsolar.org.au/Galleries/ModelSolarCars

[4] http://www.modelsolar.org.au/GettingStarted/Regulations

Week 4-6: Build the body

1. Build up the body by adding the foam parts use gap filler as an adhesive
2. Add balsa and clear acetate where required
3. Sand the foam to make it smooth
4. Paint and decorate the body as required.

Week 7: Fit the motor and electrics/electronics

1. Fit two wires from the solar panel to the maximiser input
2. Fit two wires from the maximiser output to the motor
3. In one of the wires from the maximiser, cut the wire and fit a switch
4. Fix the switch to the left hand side of the car.

Week 8: Attach the solar panel

1. Attach the solar panel to the car using velcro
2. Attach the velcro to the car and panel using Araldite. Other adhesives are not strong enough.

Week 9-10: Test the car

1. At this stage the car needs to be thoroughly track tested. The things to look for are:

- Handling does it stay on the track does it pull to one side?
- Gearing is extremely important. Try using different gears in different sun conditions to see whichones perform best in which conditions
- Most important is the car's reliability. Track testing will soon expose poor wiring etc. Make sure your car is reliable!

Week 11: Ready to race

1. Use the check list supplied by Victorian Model Solar Car Challenge to make sure your car conforms to the association's guidelines.
2. Prepare a basic tool/repair kit to take with you. You will need it!
3. Good luck and enjoy the racing.

An excellent overview of the entire process of building model cars for the Victorian Model Solar Car Challenge is available at: www.modelsolar.org.au/Build/ModelSolarCarDesignOverview.pdf

Victorian Education Learning Standards (VELS)

This unit is suitable for students working towards Level 6 (Years 9 and 10). It can be adapted for students working towards Level 5 (Years 7 and 8).

This unit covers the following Progression Points across several Domains:

Discipline-based Learning

Science

Progression Point 5.25 Science knowledge and understanding

-- Knowledge, including understanding of symbols, of the energy involved in everyday changes in chemical, physical, biological, earth and/or space science contexts; for example, the operation of diodes and capacitors in electronic circuits, reactions which occur in vehicle air bags

- Awareness of the development over time of a scientific concept related to matter, space, energy and/or time, including evidence and technology used to refine understanding of the concept; for example, theories of atomic structure

Progression Point 5.25 Science at work

- Development of an experimental design which includes a given hypothesis, and the justified use of procedures, equipment, electronic components and instruments, as appropriate

- Reporting which includes identification of sources of experimental errors and comments related to the supporting or disproving of hypotheses

Physical, Personal and Social Learning

Interpersonal Development

Progression point 5.25 - Working in teams

· Application of questioning and listening skills to explore the attributes of all team members when allocating roles

· Positive and helpful attitudes and behaviour when working in a team

· Use of strategies for exploring different perspectives and ideas

· Acknowledgment of the contributions of all team members

· Careful attention to detail and clear recording processes

Civics and Citizenship

Progression point 5.25 Community Engagement

· Identification of strategies for addressing a social or environmental issue,including strategies for raising public awareness about the particular issue

Progression point 5.5 Community Engagement

· Justification of a point of view about a national or global issue, presenting it with substantiating evidence from a range of sources, including the mass media

Interdisciplinary Learning

Design, Creativity and Technology

Progression point 5.25 Investigating and designing

- Teacher-assisted identification of considerations and constraints within a student-developed design brief that require research; for example, into the needs of a potential client or user, or factors such as expected function and performance, energy/nutritional or other requirements, and suitability of materials or ingredients
- Development, from a brief, of a range of design alternatives, using technical language, selecting a preferred option, and providing evidence of decisions about materials, ingredients and/or system components
- Logical sequencing and planning of production stages, and listing of required materials, equipment, ingredients and/or systems components

Progression point 5.25 Producing

- Production of a product/system that shows consideration of the quality, aesthetic, functionality, nutritional or performance requirements of the design brief
- With teacher guidance on safety/hygiene, implementation of a range of production and finishing/ presentation processes, selecting and using tools, equipment and machines with some degree of accuracy
- Selection and use of materials/ingredients or system components, accompanied by an explanation of the suitability of at least one of these
- With teacher prompting, modification of production methods (if needed) and justification of changes made

Progression point 5.25 Analysing and evaluating

- Use, under teacher direction, of safe procedures in product testing
- Use of student-developed criteria and the results of testing to evaluate their product/system in terms of safety, function and suitability for the intended purpose
- Identification, through discussion, of changes that could be made to their processes, materials/ingredients, systems components and/or equipment that would lead to an improved outcome
- Consideration of the possible social, cultural, legal or environmental impacts of their own and/ or others' products/systems, and of an innovative new technology

Thinking Skills

Progression point 5.25 - Reasoning, processing and inquiry

- Using teacher-provided structures, application of information from a variety of sources in different forms
- With teacher support, employment of appropriate methodologies for checking knowledge; for example using surveys, data searches and primary and secondary sources

Progression point 5.25 - Creativity

- willingness to take risks with innovative possibilities when undertaking set tasks

Progression point 5.25 - Reflection, evaluation and metacognition

- consideration of their thinking processes and tool selection, and of any changes in their thinking, when reviewing information
- analysis of similar and alternative viewpoints on information or an issue

Communication

Progression point 5.25 - Listening, viewing and responding

- Use of a variety of verbal and non-verbal responses in different contexts; for example, small-group or whole-class discussions

Progression point 5.5 - Presenting

- Choice of appropriate domain-specific vocabulary and conventions for particular tasks; for example, specialised language and procedures for a toolbox design brief in Design, Creativity and Technology

Resources and Links

An excellent overview of the entire process of building model cars for the Victorian Model Solar Car Challenge **http://www.modelsolar.org.au/Build/ModelSolarCarDesignOverview.pdf**

The Victorian Model Solar Vehicle Challenge **www.modelsolar.org.au**

Acknowledgements

We would like to acknowledge the passionate and tireless work of Phillip Scoles, science teacher at Castlemaine Secondary College, in developing and driving this program at their school and making the benefits and potential of renewable energy come alive to students.

Central Victoria Solar City is part of the Australian Government's Solar Cities Program, a partnership between all levels of government, industry, business and local communities to trial sustainable energy solutions. Central Victoria Solar City Consortium members include Bendigo and Adelaide Bank, Central Victorian Greenhouse Alliance (CVGA), Origin, Powercor and Sustainable Regional Australia, the commercial entity set up by CVGA to manage the project. This project is also supported by the Victorian Government Sustainability Fund and Sustainability Victoria.

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