

FUTURE TRAVEL

Research Project
For Teachers **p2&3**, for Students **p4**

HEALTH AND SAFETY

Students should be encouraged to make their own risk assessment before they carry out any activity, including surveys. In all circumstances this must be checked by a competent person. Students using specialised equipment should be supervised at all times.

Combustion of fuels requires careful risk assessment and close supervision. Students should plan and carry out their project, but all practical work must be vetted.

The aim of the project is to investigate how CO₂ emissions can be measured. Petrol and other low flash point hydrocarbons must not be used. Alcohols, paraffin, cooking oil and gaseous fuels may be acceptable.

Students may want to set up unorthodox experiments and you may need to seek specialist advice. Organisations such as CLEAPSS and the Royal Society of Chemistry are able to help.

FUTURE TRAVEL:

Silver Research Project - For Teachers



A solution to pollution?

Vehicle exhaust fumes pose serious pollution problems in cities. One suggestion is to use hydrogen instead of petrol and diesel – but that's not as simple as it sounds. Hydrogen-powered vehicles do exist, but so far they are still experimental. At least twelve cities around the world, including in England, are trying out hydrogen buses. Several car manufacturers are developing hydrogen models.

Are you about to witness a 'green transport' revolution?

HAVE YOU EVER WONDERED?

... whether vehicles can really be pollution-free, with zero emissions as is claimed?

You might like to imagine yourself in a situation such as...

In their Council election manifesto, your local Green Party candidates propose to replace local buses with hydrogen-powered ones. You're not sure what difference this will make, so you decide to **research information** to:

- help you decide whether hydrogen-powered vehicles really are 'greener' than petrol and diesel ones
- evaluate the advantages, disadvantages and problems of using hydrogen as an energy source.

POSSIBLE EQUIPMENT, MATERIALS AND RESOURCES

Though primarily a 'theoretical' research project, 1-2 hours could usefully be spent in the laboratory – to illustrate, and explain or clarify, aspects already investigated theoretically.

Model kits for hydrogen fuel cells and solar cells are available from laboratory suppliers.

Prompts

The **Student Brief** gives some triggers to start students thinking. They should realise that each trigger implies several items to research and compare. Encourage students to identify these themselves. However, if necessary, prompts such as those below might be given, to point students in suitable directions.

- **Various ways in which hydrogen might be used to provide motive power**
 - Can an internal combustion engine burn it?
 - How can a fuel cell drive an electric motor?
- **Comparing exhaust emissions of vehicles using different fuels**
 - What are the main reaction products? What else is emitted?
 - Are the reaction products from hydrogen combustion and from a fuel cell the same or different?
 - Why do petrol/diesel engines emit NOx (Nitrous Oxide)? Would hydrogen i-c (internal combustion) engines also produce NOx?
- **Ways of obtaining sufficient continuous supplies of hydrogen**
 - Some aspects:
 - possible raw materials and sources
 - possible reactions / processes
 - energy requirements and by-products of processes
 - economics of various manufacturing methods
 - **Environmental implications of the different methods for manufacturing hydrogen**
 - What resources are consumed and pollutants released, when hydrogen is generated by each method?
 - Can hydrogen be classified as a renewable energy resource?
- **The problems of storing hydrogen**
 - What problems are there within vehicles, and at refuelling points?
 - What are the technologies for storing hydrogen – current and possible future methods?
 - From a safety point of view, how does hydrogen compare with petrol?

Suggestions for supporting students

Though primarily based on secondary data, the Research project is likely to provide a more meaningful experience if the student includes some practical work. One possibility is for two students to undertake their projects – one Research, the other Practical – working independently, but coming together, to share mutually useful information and activities.

It is recommended that, wherever possible, Silver Award students should have a scientist or engineer as Mentor for their project. Please contact your CREST Local Coordinator to discuss Mentoring.

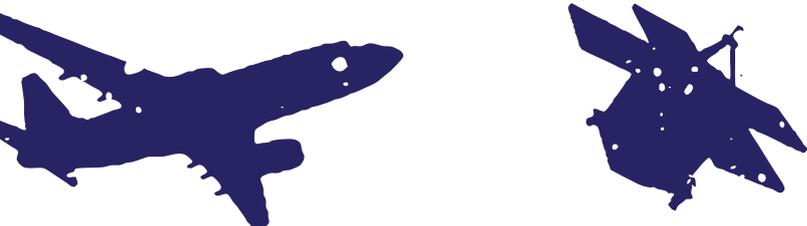
A Mentor with knowledge and/or experience of hydrogen technologies would be ideal. The Mentor might be involved in...

- **academic or industrial research into, for instance:**
 - use of hydrogen for motive power
 - compact storage methods for hydrogen
 - fuel cell development
 - use of photovoltaics (solar cells) for generating hydrogen by electrolysis
- **scientific publishing**
- **a commercial trial of hydrogen-powered vehicles, such as Transport for London's Citaro BZ fuel cell fleet**
- **developing hydrogen-powered cars with a manufacturer**
- **Students should decide their focus, although this may alter in the light of experience as the project progresses.**

Internet search

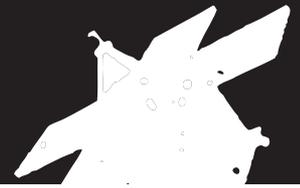
Combine 'hydrogen' with terms such as: powered, vehicle, car, bus, ICE, fuel cell, generation or production. Or try:

- **Hydrogen vehicles worldwide**
www.netinform.net/H2/H2Mobility/
 (Click 'Hydrogen and Fuel Cell Vehicles Worldwide' for an illustrated timeline of hydrogen vehicle development.)
- **Hydrogen-powered BMW**
cars.uk.msn.com/Reviews/article.aspx?cp-documentid=1284786
- **Hydrogen bus trials**
global-hydrogen-bus-platform.com
 (Click 'Technology' for technical details, or 'Information Centre' for further resources.)



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- help you decide whether hydrogen-powered vehicles really are 'greener' than petrol and diesel ones
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Some things to think about...

- Various ways in which hydrogen might be used to provide motive power
- Comparing exhaust emissions of vehicles using different fuels
- Ways of obtaining sufficient continuous supplies of hydrogen
- Environmental implications of the different methods for manufacturing hydrogen
- The problems of storing hydrogen
- The balance between the advantages and disadvantages of using hydrogen vehicles

Health and Safety

Should you carry out any experiments to support your research, you should be aware that hydrogen is flammable, and hydrogen-oxygen mixtures explosive.

- (a) find out if any of the substances, equipment or procedures are hazardous
- (b) assess the risks (think about what could go wrong and how serious it might be)
- (c) decide what you need to do to reduce any risks (such as wearing personal protective equipment, knowing how to deal with emergencies and so on)
- (d) make sure your teacher agrees with your plan and risk assessment

NOTE: Your teacher will check your risk assessment against that of your school. If no risk assessment exists for the activity, your teacher may need to obtain special advice. This may take some time.

- (e) if special tools or machines are needed, arrange to use them in a properly supervised D&T workshop.