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| **Pros and cons of hydrogen fuel** | | | |
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| Pros, cons and applications of hydrogen fuel | | | |
| **Subject(s):** Science, Design & Technology, Mathematics  **Approx time:** 2 x 60 mins |  | | **Key words / Topics:**   * fuel * energy * hydrogen cells * electrolyser * applications and implications of science and technology |
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| **Suggested Learning Outcomes** |  | |  |
| * To be able to describe the operation of hydrogen fuel cells * To be able to explain the reasons for the development and application of hydrogen fuel cells | | | |
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| **Introduction** |  | |  |
| In the Burning Water scheme of work, students investigate the potential of hydrogen fuel cells as a means of energy generation and storage, through practical activities and a group research project. Background information can also be provided using the Power House video and the Hydrogen Fuel Cell Resource Sheet. | | | |
| **Purpose** | | | |
| In this activity, students will carry out research into the development and application of hydrogen fuel cells.  This could be used as a main lesson in Science or Design & Technology. It could also be carried out in more detail as a short research project over an extended period of time. | | | |
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| **Activity** |  | | **Teacher notes** |
| Divide the students into groups of between 2 and 4. Each group must prepare a presentation on hydrogen fuel cells to share with the class. The presentation should be of 5–10 minute duration and could be in the form of a video podcast episode (or series) or a video recorded presentation with slideshow.  It should include, as a minimum:   * An explanation of what hydrogen fuel cells are * A description of how they work * The advantages (and disadvantages) of hydrogen fuel cells compared to other energy sources * Examples of current applications of hydrogen fuel cells |  | | You may wish to consider team-to-team presentations to reduce the amount and repetition of presenting from the front: have 2 teams in each corner presenting to each other, then asking questions of each other – the teacher can circulate and gain a more representative slice of what each has done. |
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| **Differentiation** |  | |  |
| **Basic** |  | | **Extension** |
| The Pros and cons of hydrogen fuel (worksheet) could be used to provide teams with a clear structure for the activity and a list of references. Similarly, the Hydrogen fuel cell resource sheet (handout) could be used to provide teams with additional resource material.  Rather than compare hydrogen fuel cells with a range of other energy sources, each team could be allocated a single (different) energy source for this comparison. |  | | Students could compare the economics of different energy sources, such as nuclear energy, coal-fired power plants, wind turbines and solar panels. Relevant financial data can be found on the internet. For example:   * What are the capital/set-up costs? * What are the running costs? * What is the cost per unit of energy produced? * What do their findings suggest for future decisions about energy sources? |
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| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * Projector/Whiteboard * Internet (for research purposes) |  | | icon-doc Pros and cons of hydrogen fuel (Worksheet)  icon-doc Hydrogen fuel cell resource sheet (Handout) |
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| **Additional websites** |  | |  |
| The following websites contain useful technical information about the operation and applications of hydrogen fuel cells. They could be used as a useful starting point.   * Hydrogen fuel cell: <http://www.youtube.com/watch?v=oy8dzOB-Ykg> and <https://www.youtube.com/watch?v=5_lDGna9MBM> * Fuel cell animation: <https://www.youtube.com/watch?v=3hxQysS0hyA> * How stuff works: <http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm> * Hydrogen cars funding: <http://www.autoexpress.co.uk/car-news/93180/hydrogen-cars-new-government-funding-for-fuel-cell-vehicles> * Green TV: <http://www.green.tv/> | | | |
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| **Related activities (to build a full lesson)** |  | |  |
| **Starters** (Options)   * VIDEO: Power House * ACTIVITY: What is energy efficiency * ACTIVITY: What is fuel poverty   **Main** (Options)   * ACTIVITY: Analyse energy consumption data * ACTIVITY: Fuel poverty calculation * ACTIVITY: Heating through the Ages | | **Main (cont.)**   * ACTIVITY: Making hydrogen experiment (Practical) * ACTIVITY: **Pros and cons of hydrogen fuel (Research)**   **Plenary**   * Opportunities within activity for presentations, peer/self assessment * Reflection on Objectives and PLTS skills used | |
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| **The Engineering Context** film |
| * **The story** Power House * **How it works?** Baxi’s Ecogen Boiler * **Who makes it work?** David Willets |

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| **Curriculum links and PLTS** | |
| **England**  Science   * KS3 2a, 23e, 25a, 40b   Design & Technology   * KS3 3b, 3d | **Northern Ireland**  Technology & Design  (Objective 1) Developing pupils as Individuals   * Respond to a personal design challenge in relation to their own lifestyle   (Objective 2) Developing pupils as Contributors to Society   * Explore technical inventions and designs that have met a social need cost-effectively   (Objective 3) Developing pupils as Contributors to the Economy and the Environment   * Identify product needs and pursue sustainable harmonious design solutions in a local outdoor/indoor context * Education for Sustainable Development * Economic Awareness   Learning Outcomes   * Research and manage information effectively to investigate design issues, using Mathematics and ICT where appropriate * Show deeper understanding by thinking critically and flexibly, solving problems and making informed decisions, using Mathematics and ICT where appropriate * Communicate effectively in oral, visual (including graphic), written, mathematical and ICT formats showing clear awareness of audience and purpose * Work effectively with others |
| **Scotland**  Technologies   * TCH 3-01a, TCH 3-02a | **Wales** |
| **GCSE D&T**  AQA D&T   * 3.1.2   Edexcel D&T   * 1.3   Eduqas D&T   * 2.1 Core: 3   OCR D&T   * 3.2 | **GCSE Engineering**  AQA Engineering   * 3.1.3 |
| **GCSE Science**  AQA Combined Science Trilogy   * 5.4.3.1, 5.4.3.4, 6.1.3   AQA Combined Science: Synergy   * 4.4.1.5, 4.8.2.4, 4.5.2.5, 4.7.5.2, 4.7.5.3   Edexcel Combined Science   * Chemistry: 3.23, 3.24, 3.28, 3.29, 8.14 * Physics: 3.13   Eduqas Combined Science   * 2.2: 6f, i, n * 2.3: 1.2f   OCR Gateway Science: Combined Science A   * C3.4a, d, e * P6.2a   OCR 21st Century Science: Combined Science B   * C3.3: 1, 3, 5 * P2.2: 1, 2, 3 | **GCSE Chemistry**  AQA Chemistry   * 4.4.3.1, 4.4.3.4   Edexcel Chemistry   * 3.23, 3.24, 3.28, 3.29, 8.14   Eduqas Chemistry   * 6f, i, n   OCR Gateway Science: Chemistry A   * C3.4a, d, e   OCR 21st Century Science: Chemistry B   * C3.3: 1, 3, 5 |
| **GCSE Physics**  AQA Physics   * 4.1.3   Edexcel Physics   * 3.13   Eduqas Physics   * 1.2f   OCR Gateway Science: Physics A   * P8.2a   OCR 21st Century Science: Physics B   * P2.2: 1, 2, 3 |  |
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| **Personal, learning & thinking skills (PLTS)** |
| * Creative thinker * Independent enquirer * Reflective learner * Team worker * Self manager * Effective participator |