Should we replace our power station?

Secondary: (ages 11 – 14)	Science

Students discuss the merits of pumped storage for producing electricity to meet sudden high levels of demand in the national grid and discuss other sources of energy and their consequences. The unit of work is built on two steps for students: reading an article illustrated with pictures of the Dinorwig site in North Wales (this can be adapted to the national context) and in-group investigations of methods of generating electricity.

Time allocation	3 lesson periods
Subject content	Investigate characteristics of different sources of energy Learn how natural forces can be transformed into sources of energy Devise and apply numerical reasoning in a problem-solving strategy
Creativity and critical thinking	This unit has a **critical thinking** focus: • Consider several perspectives on the generation of energy • Explain strengths and limitations of different ways to generate energy • Reflect on chosen source of energy relative to alternatives
Other skills	Collaboration, Communication
Key words	power; energy; electricity; generating; alternatives; national grid; storage; distribution

Products and processes to assess

This activity involves products and processes in which students make visible the complexity of a problem, appropriately challenge and justify assumptions, and collectively produce a video-based synthesis of their work. At the highest level of achievement, student work shows a scientific understanding of the processes of energy transformation and puts forward arguments that reflect active analysis, critique, and inquiry concerning the subject matter and novel contributions to the task at hand. In the role-playing exercise, students fully embrace the assigned position whilst appreciating the positions of others.

Teaching and Learning plan

This plan suggests potential steps for implementing the activity. Teachers can introduce as many modifications as they see fit to adapt the activity to their teaching context.

Step	Duration	Teacher and student roles	Subject content	Creativity and critical thinking
1	Lesson period 1	The teacher introduces the topic by presenting the article (from Dinorwig site) and/or scientific photos of power stations (see for example the gallery from industcards.com). The teacher may also facilitate a preliminary discussion about how energy is produced and used in students' homes and environment. Students, in groups, find different ways of transforming natural forces into energy for human activities (e.g. water, sun, nuclear, coal, wind). The teacher can provide reference material to support this or ask students to do internet research as appropriate to the teaching context. The teacher may also introduce the idea of efficiency, how it is calculated, and how it is only one of a number of criteria that can be assessed when deciding how energy is produced As a homework assignment, students choose one example of energy production and prepare a simple scheme or diagram to explain it to the rest of the class.	Learning about how energy is produced and stored, and about how it can travel from one place to another Identifying and exploring different methods of energy production Calculating efficiency	Generating ideas to solve a scientific problem Making connections between natural forces and energy Questioning assumptions about the efficiency of different energy sources
2	Lesson period 2	Students present their diagrams to the class. They consider all the methods presented and make proposals to replace the local facility with another source of energy. In a class discussion, students present arguments based on various criteria (capital costs, operating costs, environmental costs, aesthetic considerations) to assess whether these proposals can be considered or not. Students may have to engage in internet research to help inform their use of these criteria. The teacher moderates the discussion and introduces new perspectives and considerations (e.g. power generation, storage, distribution).	Articulating the process used in different methods of energy production Considering scientific and other data and information to inform a decision	Formulating and evidencing arguments about energy production from different points of view Considering several perspectives to suggest solutions to the problem of energy production in the local area
3	Lesson period 3	Students, in groups, play roles in favour or against one solution. Each group chooses a role (e.g. economist, environmentalist, journalist, tourist guide) to consider the feasibility and opportunities for the selected method. Students should use at least 3 or 4 calculations to justify their arguments and again should do internet research to find the information needed. Each group makes and shows a 60-second video presentation expressing its position according to the chosen role and in a closing discussion reflect on what they have learned	Finding relevant evidence from the perspective of a particular stake-holder (e.g. vocabulary, concerns) Making a video with good content	Appraising strengths and limitations of a solution Reflecting on chosen approach or solution relative to possible alternatives

Resources

Web and print

- Support material for teachers on this pedagogical activity: http://learning.gov.wales/docs/learningwales/publications/141216-power-station-or-not-en.zip
- The Dinorwig power station website: https://www.fhc.co.uk/
- Gallery of power plants around the world: http://www.industcards.com/
- An article of the world nuclear association: http://www.world-nuclear.org/info/Energy-and-Environment/Environment-and-Health-in-Electricity-Generation/
- Engineering and technology history: http://ethw.org/Category:Energy

Other

- Document evidence of student work at each stage. Consider asking students to use recording sheets for noting discussions and final decisions
- Projector or interactive whiteboard for visual display of examples of power stations
- Cameras (either students' own devices or supplied by school)
- Computers and Internet connections for investigations on power stations

Opportunities to adapt, extend, and enrich

- Further links can be made with physics (by asking students to investigate and identify types of energy or by engaging in lessons around the conservation of energy, and working with the concepts of power and energy conversion efficiency
- Links can be made with earth and environment topics by engaging in activities where students explore relationship of land management to human use
- There are also potential links with history (history of science and technology) and mathematics (arithmetic skills)

Creativity and critical thinking rubric for science

- Mapping of the different steps of the lesson plan against the OECD rubric to identify the creative and/or critical thinking skills the different parts of the lesson aim to develop

	CREATIVITY Coming up with new ideas and solutions	Steps	CRITICAL THINKING Questioning and evaluating ideas and solutions	Steps
INQUIRING	Make connections to other scientific concepts or conceptual ideas in other disciplines	1-2	Identify and question assumptions and generally accepted ideas of a scientific explanation or approach to a problem	1-3
IMAGINING	Generate and play with unusual and radical ideas when approaching or solving a scientific problem	2	Consider several perspectives on a scientific problem	2
DOING	Pose and propose how to solve a scientific problem in a personally novel way	2-3	Explain both strengths and limitations of a scientific solution based on logical and possibly other criteria (practical, ethical, etc.)	2-3
REFLECTING	Reflect on steps taken to pose and solve a scientific problem		Reflect on the chosen scientific approach or solution relative to possible alternatives	3