STEM LEARNING

BORN TO ENGINEER

Born to Engineer teaching resources

Teachers' notes – Electricity supply

Curriculum links

Electrical power transmission features in the English GCSE subject content for Combined Science (2015) in the physics section under 'Electricity, energy transfers'.

Explaining patterns and trends in the use of energy resources is featured in the physics section under 'Energy, conservation, dissipation and national and global energy resources'.

The National Grid also appears in the Scottish N4 Physics curriculum.

Background information

The National Grid is responsible for the networks that supply homes and businesses with energy. The company owns the transmission and distribution networks for electricity and gas, but is not responsible for the supply of these energy resources.

National Grid has the responsibility of managing the flow, security and quality of electricity delivered to customers, ensuring that demand and supply is matched, second by second. They need to manage sudden spikes in demand, or find solutions when a power station develops a fault.

Electricity is generated from a range of sources, which previously have been categorised as 'renewable' (eg wind, solar, hydro, biomass) or 'non-renewable' (eg coal, oil, gas). Whether nuclear sources should be categorised as renewable needs an understanding of fission and fusion reactions.

Recent concerns around climate change have introduced the idea that some sources can be classified as 'low carbon'. Such sources include wind, solar, biomass and nuclear. Governments have set targets for increasing the amount of electricity to be generated from low carbon sources. In the UK, the target is to reduce emissions in 2050 by 80% of 1990 levels. This would be consistent with limiting a global temperature rise to as little as possible above 2 degrees. The target for 2017 (second carbon budget) is to restrict emissions to 2782 $MtCO_2e$ (do not confuse with $mtCO_2e$, or metric tons of CO_2 equivalent). Recent newspaper reports suggest that the country is on target to reduce emissions (see for example this Guardian report), although close monitoring of electricity supply sources shows that there are daily and hourly fluctuations in sources of electricity that can be difficult to control.

In this lesson, students will take a closer look at fluctuations in electricity sources by analysing large data sets.

Faye Banks, 37, is the North-East Electrical Transmission and Asset Manager for National Grid. Since growing up in care and returning to education to retake her GCSEs while working at a packing plant, she has become Young Woman Engineer of the Year 2004 and the youngest ever fellow of the Institution of Engineering and Technology (IET), where she is helping to draft the frameworks for the Trailblazer Apprenticeships scheme.

(Source: http://www.telegraph.co.uk/education/stem-awards/stem-hq/stem-hero-national-grid-faye-banks/)

Her role is to ensure the reliable transmission of electrical energy and a safe working environment in substations to guarantee resources are effectively utilised, driving forward a culture of continuous improvement.

(Source: http://www.theiet.org/membership/types/fiet/meet-members/faye-banks.cfm)

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Expected outcomes

Students will be able to:

- describe patterns in the demand and supply of electricity
- describe how scientific principles can be used to create engineering solutions
- recognise the personal attributes and motivations of people choosing a career in engineering

Introducing the activity

Use the video clip of National Grid Electrical Transmission Manager Faye Banks, produced by the ERA Foundation and available on the Born to Engineer website, or from STEM Learning.

Video clips are an effective way of familiarising students with a topic, and can provide a useful introduction at the start of a lesson. You could choose one of these four activities to help to direct attention to specific points, or to ensure that students have an opportunity to consider key messages.

1. Adapting for different audiences

Working in small groups of two to three students, suggestions are made on how the video clip could be repurposed for a different audience, such as a class of children in primary school, aged 10 and 11.

Watch the entire video clip as a class, and then set the task to small groups, asking them to consider different modifications, such as:

- What content needs to be removed?
- What additional content could be helpful?
- What changes should be made to the language used?
- What additional images would help convey the key messages?

The video clip should then be made available for groups to review whilst making their suggestions. Set a time limit for the activity after which groups feed back their main points.

2. Going further

Generate questions that could be put to the presenter to find out more about the topic.

Watch the entire video as a class, and then ask students individually to generate one question that they would like to ask the presenter. In addition, you could ask individuals to generate one question that could be answered from the video clip. Students could then exchange questions with a partner, and attempt to answer each other's questions after watching the clip a second time.

3. Designing a quiz

Individual students generate questions and these are used as a quiz for the class.

Watch the video clip as a class. Set each student the task of generating one question that can be answered from the clip, and which has a single word answer.

Collect up the questions and insert the initial letter from each answer into a cell in the Blockbuster grid template. This will work best if each student is allocated a different letter of the alphabet as the initial letter of their answer.

To play the quiz, you take on the role of question master. Divide the class into teams. Two teams can take part in the quiz at once – one team moves from A to B on the grid, the other from C to D. The team that reaches their destination first is the winner. To move on the grid the team select a letter, and you read out the corresponding question. If they answer correctly, they 'own' that cell, which can be filled in in a specific colour to indicate ownership. A team's cells must touch to make a pathway from their start point to their destination. Use presentation software such as Keynote to display the grid to the class and to fill cells with different colours.

4. Supporting evidence

Does the presenter use evidence (verbal, visual, implied) to give the key messages credibility?

Watch the video clip as a class, and then ask the class to suggest the key messages that they took from the video. Refine the list of suggestions using discussion to reach a class consensus, and agree on a list of no more than three key messages.

Watch the video for a second time, and ask the class to note any evidence used to support the three key messages. Finally, have a brief class discussion to share views on the evidence presented.

Student activity

A student sheet is provided, containing data downloaded from mygridgb.co.uk via Twitter. This site provides current data on sources of electrical power and the site campaigns for reducing carbon emissions.

Introduction

Some students may be overwhelmed by the amount of data provided, so you may choose to familiarise them with the table by asking questions such as:

- What was the demand for electricity at 01:00 on 6 December? (answer: 33GW)
- What percentage of the electricity supplied at 17:00 on 9 December came from hydroelectric sources? (answer: 1.3%)
- How did the weather on Monday 5 December compare with that on Thursday 8 December? (answer: Monday was cold, foggy and still whereas Thursday was warm, wet and windy)

Looking for patterns in the demand and supply of electricity requires the students to identify patterns and trends in a large data set.

Demonstrate how to identify patterns in complex tables of data, for example, step 1 may be to read across a row of numbers – row 1 shows that gas is the source of most electricity.

Checking this observation with other rows shows no exceptions, and so an observation from the data provided is that gas is the source of most electricity generated.

Step 2 may be to read down a column of numbers – looking down a column such as wind % and relating the pattern to the weather description.

Step 3 is to set a more complex task such as identifying a pattern in selected rows or columns, for example by looking at the percentage of electricity from solar sources at specific times during each day. Students may find it helpful to highlight parts of the table in different colours, to focus attention on specific parts of the data set.

Task

Once students are familiar with the data, their task is to work in pairs to generate five questions that could be answered from the data set.

After ten minutes their questions are exchanged with those of a different pair of students. Each pair then has five minutes to answer the questions they have been given, before returning their responses.

Through class discussion, identify which questions were effective at getting students to identify important trends and make observations from the data.

List the trends and patterns observed in the data by the class.

Ask students to individually identify what they think are the three most important patterns observed, and to explain why. Relate these observations to carbon emission reduction targets.

Extension activity

The http://www.mygridgb.co.uk/ website monitors the supply of electricity and campaigns for reductions in CO_2 emissions. The home page displays a pie chart showing the proportion of various sources of electricity, which is constantly updated. It also gives an indication of the percentage of electricity generated from low carbon sources.

Using the 'Electricity data' section of this website, check whether students' observed patterns are supported by the evidence provided for the last 28 days and for the last 12 months.

Summary activity

A suggested summary activity is included to help focus students on the characteristics of this sort of engineering career.

Provide students with the sheet with Faye's photo in the centre and three coloured pens. You may find it useful to print this in A3, or stick the photograph in the centre of a larger sheet.

Working in small groups or pairs, give students five minutes to discuss and write down what they think they know about engineering and Faye's career in one colour around the photo.

Watch the film of Faye again and see if they can add anything to their sheets.

Then give students a further five minutes to discuss and write down what they would like to find out in another colour.

Draw out some of the ideas about her career/work as an electrical transmission manager. Ask groups to feed back some of the questions they would like to find out more about. Elicit ideas of how and where they could find this out. They can then carry out research to find out what they wanted to know.

You could provide prompt questions to scaffold the activity:

- Faye does not work in isolation. What other jobs are part of the team?
- What do you think excites Faye about her job?
- What qualifications do you need to be an engineer?
- How much do engineers earn?
- What personal skills do you think Faye uses in her job?
- How is engineering changing people's lives?

Useful sources of information on careers in engineering include:

https://www.borntoengineer.com

http://www.tomorrowsengineers.org.uk/students/career-finder/

http://faraday.theiet.org/careers/case-studies/index.cfm

http://www.raeng.org.uk/education/what-is-engineering/engineer-case-studies

Additional information about careers with National Grid is available at: http://careers.nationalgrid.com/what-we-do/