Unit 7I Energy resources

About the unit

In this unit pupils:
- are introduced to the concept of energy in the context of fuels as convenient and therefore valuable sources
- consider the nature and origin of fossil fuels and renewable sources of energy and how their use has implications for the environment
- consolidate and extend their ideas about energy resources for living things: food for people and sunlight for plants
- link the energy resources to the role of the Sun as the ultimate source of most of the Earth's energy resources

In scientific enquiry pupils:
- recognise hazards and take safety precautions
- decide what variables are relevant and how to control these to make fair comparisons
- consider the reasons for repeating measurements and observations
- use the Bunsen burner and thermometers safely and effectively
- make measurements of volume, mass and temperature
- investigate the energy resource in foods, controlling relevant variables

This unit is expected to take approximately 9 hours.

Note on the teaching of energy

This unit provides an introduction to energy through the idea of foods and fuels as energy resources. The term 'resource' is used in preference to 'source' to try to encourage the idea that energy is not just a kind of stuff, like fuel. Energy transfer is associated with change, in particular changes that can perform useful tasks, as a first step towards more formal understanding. This enables pupils to make connections between apparently disparate phenomena, as contexts are drawn from across the sciences, *eg burning fuel, movement, eating food and plant growth*. Pupils can begin to distinguish energy from stuff (the energy resource) and from linked concepts, *eg force, power* (the rate of transferring energy) *and activity*. A common misconception is that activity gives you energy because it makes you healthier – and so more able to do more activity.

Where the unit fits in

This unit introduces pupils to a topic which may be new to them, although it has links with work done in key stage 2. It builds on ideas introduced in unit 6A 'Interdependence and adaptation' (green plants need light), unit 6D 'Reversible and irreversible changes' (burning), unit 6G 'Changing circuits' (electrical conduction) and unit 4C 'Keeping warm' (temperature; thermal insulation) in the key stage 2 scheme of work.

In unit 8I 'Heating and cooling', pupils will study energy transfer and change of state, and use particle explanations. In unit 9I 'Energy and electricity', pupils will study energy transformations and energy conservation.

This unit relates to unit 7A(ii) 'Understanding materials (resistant materials)' in the design and technology scheme of work. There are opportunities for citizenship education in this unit, in dealing with energy-supply issues.

Expectations

At the end of this unit

in terms of scientific enquiry

most pupils will: plan a fair comparison of the energy output of a range of fuels or foods; control relevant variables; reduce error by repeating readings; comment on the accuracy of results; find information from selected secondary sources about fuels and energy devices; produce rules for the safe operation of a Bunsen burner

some pupils will not have made so much progress and will: make a fair comparison of the energy output of a range of fuels or foods and with help produce a bar chart or line graph of results; use information from a secondary source in reporting on fuels and other energy sources; use a Bunsen burner safely

some pupils will have progressed further and will: compare the effectiveness of different energy-transforming appliances, *eg camping stoves, windmills*; select secondary sources to provide information about the use of fuels or other energy sources

in terms of physical processes

most pupils will: state that fuels release energy when burnt and describe how renewable energy resources can be used to generate electricity and provide heating; explain why conservation of fuels is important; identify energy transfers within a range of systems including those involving living things

some pupils will not have made so much progress and will: name a range of fuels used domestically and in industry and some renewable energy resources; give examples of how to save fuels; identify energy transfers in some systems

some pupils will have progressed further and will: compare the advantages and limitations of a range of energy resources and give examples of how to use fuel economically; describe energy transfer links between the Sun, energy resources and themselves

Prior learning

It is helpful if pupils:
- have experience of burning materials
- know that plants and animals need food for growth and that plants need sunlight to grow

Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:
- plan an investigation into the burning of fuels
- burn a variety of foods

Model risk assessments used by most employers for normal science activities can be found in the publications listed in the *Teacher's guide*. Teachers need to follow these as indicated in the guidance notes for the activities, and consider what modifications are needed for individual classroom situations.

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:
- words with similar but distinct meanings, *eg energy, activity, force, power, fuel*
- words and phrases relating to scientific enquiry, *eg accuracy, control of variables, reliability of results, repeat reading*

Through the activities pupils could:
- find information using contents, index, glossary, key words, hotlinks, etc
- group sentences into paragraphs with subheadings as appropriate
- develop ideas and plans into continuous text

Resources

Resources include:
- 'spirit burners' and alcohols or a similar range of fuels
- samples of food, *eg dry breakfast cereals, crispbread, toast*
- unpainted tin lids
- videos and other secondary sources of information on fossil fuels and renewable energy sources
- aluminium 'takeaway' trays or similar for making solar panels
- samples of coal and oil
- solar cell
- role cards for class debate on issues related to energy use

Out-of-school learning

Pupils could:
- use the internet to find out about fossil fuels and renewable energy sources
- collect magazine pictures to illustrate use of energy resources

1	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
	Why are fuels useful?			
	• that fuels are substances which burn to release energy	• Review pupils' understanding of the word 'fuel'. • Ask pupils *What fuels can you name and what do we use them for?* This leads to a general statement that when fuels burn they make things happen. Introduce the definition of 'energy' as what burning fuels release to make things happen.	• identify some common fuels • identify fuels as sources of light, heat and movement, all of which can be called energy	• Energy is not covered in the key stage 2 programme of study, but all pupils will have used the word in a variety of contexts.
	• how to use a Bunsen burner and heating apparatus safely • how to use and read a Celsius-scale thermometer with care • to decide which factors need to be controlled to make a fair comparison	• Demonstrate and then instruct pupils in the safe use of the Bunsen burner and associated heating equipment. Tell pupils they are going to explore the output from natural gas fuel with the Bunsen burner set at different flames by measuring the temperature rise of a fixed volume of water in a beaker. Ask pupils to decide which factors they should keep the same in order to make a fair comparison.	• use a Bunsen burner safely and recognise the need for eye protection and other safety precautions • use a thermometer accurately • make a fair comparison of the output of different flames	• Pupils could be issued with a 'licence' to use a Bunsen burner, which could be revoked for rule infringements. • The concept of temperature is developed in unit 8I 'Heating and cooling'.
	• to consider factors involved in making a fair comparison between different fuels	• Ask for examples of uses of different fuels. Discuss with pupils how to carry out a fair test of which is the best fuel, *eg liquid fuels (alcohols) in 'spirit burners', or solid fuels for camping stoves.* Burn the fuel and record the temperature rise of water as a cooperative whole-class demonstration. Ask pupils to discuss how good they think the results are. Encourage pupils to consider factors which have not been controlled that may affect the results, and to consider possible errors of measurements.	• produce a chart which shows temperature rise from a range of fuels • describe how to improve accuracy by repeating readings or by controlling variables more carefully	• Discuss the hazards and precautions with the class. They will have the opportunity to plan and carry out a similar comparison, for foods, later in the unit. ⚠ **Safety** – employer's risk assessments on the use of fuels should be followed. Eye protection should be worn. Small quantities should be used, and kept clear of stock supplies. Do not allow unsupervised use of fuels. Do not use petrol

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
What are fossil fuels?			
• that coal, mineral oil and natural gas are examples of fossil fuels, which are formed from organic and non-renewable materials over many millions of years • about the need for fuel conservation • to find information using contents, index, glossary, key words, hotlinks • to group sentences into paragraphs with subheadings as appropriate • to plan and develop ideas and lines of thinking into continuous text	• Show pupils fossil fuels, *eg pieces of coal, sealed samples of artificial crude oil,* and ask them what they know of their origins and that of natural gas. Build on this by: – providing appropriate resources, *eg video of how fossil fuels were formed, their extraction and present-day uses; a range of secondary sources including ICT (CD-ROM or internet)* – setting a clear task to present some aspects of the topic, *eg a poster on the formation of fossil fuels or how our use of fossil fuels has changed; a simple drama or narrative such as 'From trees and T-Rex to fossil fuels', based on information from the video or other secondary sources* – discussing a question about the future use of fuel, *eg As these fuels are non-renewable, will there be enough fuel in the future?* Discuss what could be done and how pupils can contribute to conserving fuel supplies. Focus on what that could mean for pupils' lifestyles, *eg walking to school, wearing warmer clothes, going to bed at dusk.* Ask pupils to prepare a leaflet to explain the issues to year 6 pupils	• name several fossil fuels and explain why they are described as fossil • explain that fossil fuel reserves are limited because they are non-renewable • provide coherent accounts of the formation or use of fossil fuels by writing, pictures or other means, such as class wall display • contribute to a discussion on fossil fuels	• The distinction between 'conservation of energy' and 'conservation of energy resources' is explained in unit 9I 'Energy and electricity'. • Pupils may need support to engage in productive discussion, *eg prompt questions on cards.* • Some pupils may prefer a report that is primarily image based, *eg computer clip art or images from magazines.* • This work could be linked with unit 8 'Public information systems' in the ICT scheme of work.
What are renewable energy resources?			
• that renewable energy resources include wind, waves, running water, sunlight, biomass and some geothermal sources • how a device works using a renewable energy resource • that renewable energy resources can be used to generate electricity	• Some pupils will probably have suggested renewable resources in the previous discussion. Ask pupils what they know, and support this, *eg show a video of the range of types of renewable energy resources*. • Demonstrate the use of a device and discuss the role of the renewable resource, *eg solar cells transform solar energy into electrical energy by driving a small motor, solar panels transfer solar energy to water, running water on a turbine, etc.*	• identify the main renewable energy resources • explain the term 'renewable energy resource' • describe the operation of a device driven by a renewable energy source, *eg solar cell to generate electricity*	• Pupils may have seen wind farms, hydroelectric generating stations or water-power installations.
• to make and explain predictions • to find patterns in results • to decide whether evidence supports their predictions	• Show pupils images of solar panels and help them to identify key features, *eg large surface, black colour, contain water.* • Tell them they are going to use black and silver trays of various sizes, *eg aluminium 'takeaway' containers,* containing the water and covered with clingfilm, to see which rises in temperature by the greatest amount over the length of the lesson if left in the sun. Use a microscope bench lamp if there is no sunlight. A datalogger could be connected in order to look at the relative changes in temperatures dynamically. Ask pupils to decide what factors they need to control to make a fair comparison and to predict which of their containers will show the greatest temperature rise, giving their reasons. Discuss their results with them and ask them to think again about the predictions they made and, if appropriate, why they weren't supported by the evidence.	• give a reason for the prediction made • evaluate evidence collected, saying whether it supports the prediction	• This is intended as a quick comparison; pupils may identify limitations in the arrangements. The description of differential absorption of radiation by black and silver objects is not expected. • Collaboration with the design and technology department could develop the design aspect of this work. • An 'energy resources kit' with solar panels and model windmills would be useful.

3	Learning objectives	Possible teaching activities	Learning outcomes	Points to note
	Pupils should learn:		Pupils:	
	• about the ways in which scientists work on developing energy devices, etc • to use secondary sources of information as the basis for creative thought about an energy device or resource • to contribute and evaluate the contribution of others to the discussion	• Provide pupils with access to up-to-date resources on energy provision and the work of scientists in developing these. Ask them to propose a useful device for the future. Encourage creative approaches, but based on science, *eg giant windmills, solar collectors in space.* This work could then be used to generate discussion on the pros and cons of renewable energy sources. The discussion could be extended to compare the needs and current energy use of western and less-developed nations.	• make presentations, *eg through oral or written descriptions*, of an energy device or resource for the future • make a written generalisation about energy resources after a discussion, *eg wood is a useful energy resource in many parts of the world*	
	Checking progress			
	• to synthesise what they know about energy and energy resources	• Brainstorm pupils' understanding of the word 'energy', or ask them to work in pairs to write an answer to *What is energy?* Summarise the contributions by associating energy with changes. • Help pupils construct a spider diagram, or concept map, covering the range of renewable and non-renewable fuels, their uses, advantages and disadvantages.	• state in their own words the idea that energy is associated with changes • link key ideas, *eg in summary, spider diagram, concept map*	• Help pupils distinguish energy from activity, force and power.
	How do living things use energy?			
	• that we (and all living things) need energy for every activity • that food is the energy source of animals • that energy is measured in joules	• Review with pupils their ideas about food as the energy resource for plants and animals. This will have been covered at key stage 2, although the word 'energy' will not have been used. Link this use of the word 'energy' to its use in situations they have just studied. • Use pupils' knowledge of 'calorie counts' for slimming or body-building to introduce the idea of measuring energy input. Introduce the joule as the unit of energy. Demonstrate that it is quite a small unit, *eg lifting an apple by 1 metre takes about 1 joule of energy.* Look at the energy ratings of food, *eg a chocolate bar.* Ask pupils to consider the question *If you ate the chocolate bar how high would you have to lift the apple before all the energy is used up?* Tell them about the famous physicist John Tyndall, who worked out that the energy he needed to climb the Matterhorn was contained in a ham sandwich, so that was all the food he took with him.	• know that living creatures need energy to live • identify the energy contents of a sample of food, *eg from a label*	• Teachers will be aware of the need for sensitivity in discussing slimming and diet. • Pupils may think that exercise gives them energy, because of the link with health. Stress that exercise is an activity, and like others requires an energy input. • Pupils will learn about the need for a balanced diet in unit 8A 'Food and digestion'. This unit concentrates on the 'energy food' types, *eg sugars, carbohydrates and fats.*

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
• to apply the procedures used with fuels to compare the energy outputs of foods • to repeat readings to improve results • to control relevant variables • to compare results and consider reasons for differences	• Ask pupils in groups to investigate the energy resource in foods, *eg breakfast cereals, snack foods, crispbread and marshmallow,* by burning them and measuring the rise in temperature of some water. To help pupils plan, remind them of the fuel enquiry at the beginning of this unit. • Draw together results from different groups and ask pupils to suggest how results could be presented so that those of different groups could be compared. Ask pupils for results which do not fit the overall pattern and to suggest reasons for this.	• describe how they have carried out a comparison of foods, making sure the comparison was fair • produce and present records of temperature rise to compare energy output of different foods • evaluate reliability of their results compared with other groups, *eg better control of heating, less heat 'lost'*	⚠ **Safety** – avoid peanuts if pupils are known to suffer allergic reactions to them – pupils should be reminded of the safety precautions used in the fuels enquiry earlier – pupils should wear eye protection. This activity can be smelly and smoky. Check ventilation
• that light is the energy source of green plants	• Ask pupils where the plants that produced the burnt foods get their energy from. Remind them of plants' need for light to grow. This will help elicit pupils' knowledge of how plants acquire energy for growth. Pupils will probably recall exceptions, *eg carnivorous plants, fungi*. Reinforce this by devising food chains for typical habitats and trace the energy source back to sunlight.	• draw a food chain and extend it to show the link to sunlight and to themselves	• Pupils will study the difference between temperature and energy in unit 8I 'Heating and cooling'. • Many pupils think that plant food is in the fertilisers. Photosynthesis is covered in unit 9C 'Plants and photosynthesis'.
Reviewing work			
• to relate use of energy resources to effects on the environment • to use their knowledge in addressing a moral or social issue • that the Sun is the energy source of almost all the Earth's energy resources	• Consolidate the learning of this unit by: – setting up a class debate introducing the moral and social issues of energy use in the context of application of their scientific understanding. This could involve the use of 'role cards', *eg the views of scientists of different specialisms, of consumers, members of conservation organisations and those concerned with developing countries*, or – extending the 'energy story' from key stage 2 by asking pupils to develop food chain diagrams so that they can show the network of energy from the Sun to a wide range of foods, fuels and devices and to all aspects of pupils' lives	• contribute a view or appropriate evidence to the debate/role play • describe, *eg in an energy diagram,* how energy from the Sun links to everyday activities, *eg a car ride to school*	• The chemical effects of fossil fuel burning are covered in unit 9G 'Environmental chemistry'. • Pupils will have constructed food chains in key stage 2. Food webs are introduced in unit 7C 'Environment and feeding relationships'. • The Sun as a star is covered in unit 7L 'The solar system and beyond'.