Ashton Island – a problem in renewable energy

Contents: Information and problem-solving exercise on the use of renewable energy sources.

Time: 1 to 2 periods.

Intended use: GCSE Physics, Chemistry or Integrated Science. Links with work on energy sources, alternative energy and fuels.

Aims:

- To complement and revise prior work on alternative and renewable energy sources.
- To develop an awareness of the problems of energy provision and of the importance of renewable energy sources, particularly in situations where fossil fuels are not available or need to be conserved.
- To develop problem-solving skills and an imaginative approach to the application of scientific ideas.

Requirements: Students' worksheets No. 107.

The information about renewable energy sources given on the students' worksheets is only a summary, and it is envisaged that the topic of renewable energy will have been introduced in a prior lesson, perhaps by means of a film, video or tape-slide programme. A number of useful films are available dealing with this topic. A particularly good one is *Time for Energy*, produced in 1982 (running time 33 minutes). It is available on free loan, as film or video, from:

Shell Film Library
25 The Burroughs
Hendon
London NW4 4AT

Having read the information in Part 1, pupils should tackle the questions on Ashton Island in Part 2, preferably working in small groups.

At some stage, the teacher may wish to discuss the economic viability of various alternative energy sources in Britain. At present most of the sources discussed in this unit are marginal in economic terms, and indeed in 1985 the government reduced funding for geothermal and wave energy research projects. Much depends on the price of competing energy sources, and alternative sources may only become viable when the prices of fossil fuels rise substantially due to depletion of reserves.

The SATIS units 'Energy from Biomass' and 'The Second Law of What?' deal with related topics.

Acknowledgements Figure 1 is reproduced from *Science in Society*, Book F, published by the Association for Science Education. Figure 4 is based on a diagram in *Science in Society*, Book F.

ASHTON ISLAND – a problem in renewable energy

Part 1 gives information on renewable energy sources. Read the information, then tackle the questions on Ashton Island in Part 2.

Part 1 Renewable Energy Sources

Fossil fuels like coal, oil and gas are **non-renewable** energy sources. Once used, they cannot be replaced. **Renewable energy** is energy which does not get used up. The energy provided by the source can be renewed as fast as it is used.

Some of the most important forms of renewable energy are described below.

Solar power

The Sun produces an enormous amount of heat and light energy. There are a number of ways we can use the Sun to produce useful energy on earth.

Solar panels

Solar roof panels can be used to provide hot water for homes. The Sun shines through a transparent cover and the heat is absorbed by a black panel (Figure 1). A liquid is passed around pipes by a small pump. As the liquid slowly passes the panel it heats up. It then passes through a tank where it heats up the water. This hot water can then be used in the building. Solar panels are used in buildings all over the world, particularly where it is hot. In Britain they obviously work best in summer, but even in winter the Sun can help to heat water.

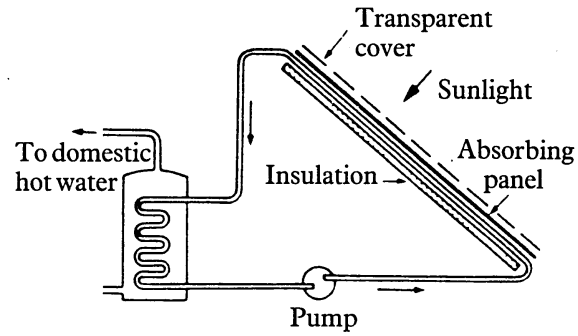

Figure 1 A solar panel

Solar power stations

Solar power stations use lots of concave mirrors to reflect the Sun's rays onto a boiler (Figure 2). The water in the boiler heats up to produce steam. The steam can then be used to drive turbines and produce electricity. The Americans have built such a power station in a hot desert. Some people say we could build solar power stations in space and beam the electricity to Earth.

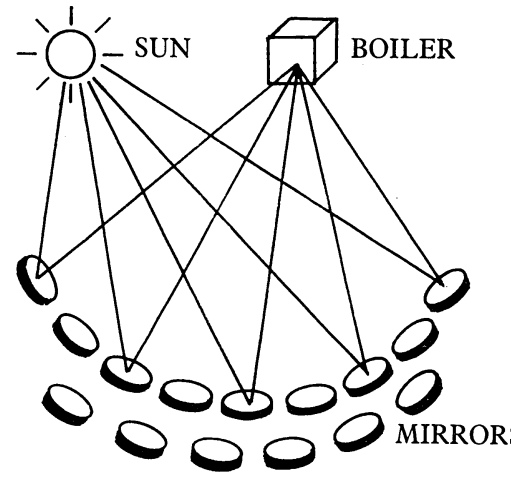

Figure 2 A solar power station

Solar cells

These are cells or batteries that can be charged by the Sun's energy (Figure 3). Spacecraft often use solar cells to work their instruments but here on Earth solar cells are still expensive and do not give a lot of electricity.

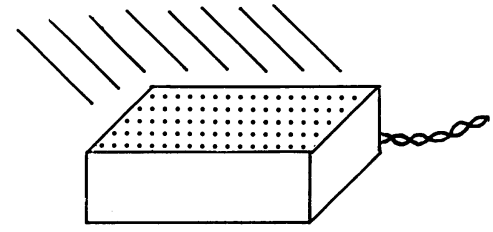

Figure 3 Solar cells

Geothermal energy

The rocks under the Earth are very hot and can be used to produce hot water and steam. This is called *geothermal energy*. In Southampton scientists have drilled 1600 metres down and found they can obtain hot water at 70°C. This could be used to heat nearby homes or factories and to provide hot water for washing.

Another way of using the heat in the Earth is to make a *geothermal power station*. Two parallel holes are bored down. An explosive charge is placed at the bottom of the holes and the resulting fracture joins the holes up. Cold water is then passed down one hole. It heats up and comes back as steam. The steam is then used to drive turbines and generate electricity (Figure 4). Geothermal power stations are already working in New Zealand, America, Mexico, Iceland and Japan. In Cornwall scientists have found they will have to drill down nearly 5 kilometres to reach temperatures of 200°C.

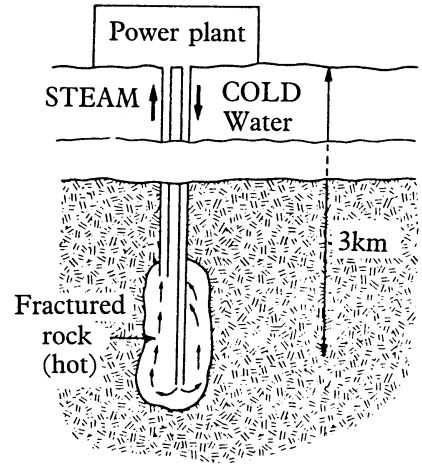

Figure 4 A geothermal power station

Tidal power

The idea of tidal power is to place a barrier or dam across an estuary and use the rushing of the tide to turn turbines and produce electricity (Figure 5).

There is a large tidal power station in France on the River Rance. There are possible sites in Britain too. The government is considering a tidal station across the Severn Estuary which could produce up to 10% of all the electricity we now use. There is also a possibility of building one across the River Mersey near Liverpool.

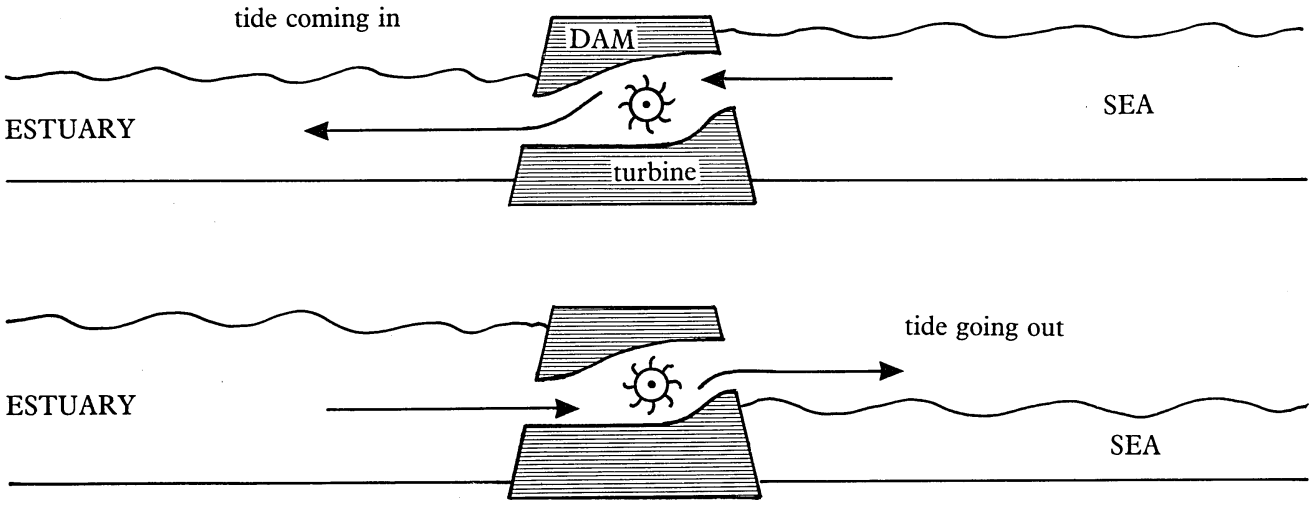

Figure 5 A tidal power station

Wind power

Windmills have been used to drive machinery for hundreds of years. We do not use many today but there is now a lot of interest in building large windmills to produce electricity. These **wind turbines** can generate 3 megawatts. Even so, 200 or more of these turbines would be needed to generate as much electricity as a conventional power station (Figure 6). One way to get around this problem is to have **windfarms** at sea. This involves lots of windmills being built along the coast. One idea is to build them off the East Anglia coast, where it is very windy. The electricity could be sent to shore through cables.

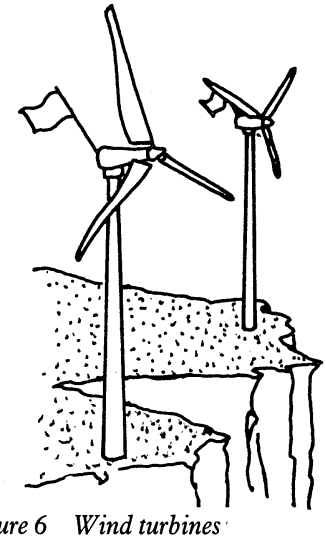

Figure 6 Wind turbines

Wave power

The motion of waves can be used to generate electricity. One design being looked into is called the Salter Duck. The action of the waves makes the duck bob up and down in the sea and the motion is used to produce electricity (Figure 7).

The idea is that a number of wave power machines, each with a number of ducks on, could be placed out in the ocean. Britain, being an island, has a number of good sites. The best is probably off North West Scotland.

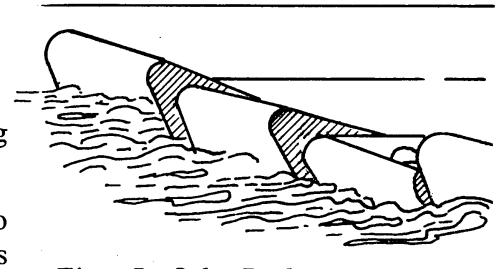

Figure 7 Salter Ducks

Other renewable energy sources

There are many other renewable energy sources that are being developed in Britain and other parts of the world.

- *Energy from rubbish* Nottingham burns a lot of its rubbish to produce hot water. 7000 dwellings, shops and public buildings get hot water this way. The rubbish, together with some coal, can also produce electricity. Scientists at Manchester University have found a way of producing oil from the city's rubbish.
- *Energy from plants* Energy from plants is called **biomass energy**. Some plants grow very fast and can be burnt as fuels. Wood has been used as a fuel for thousands of years, but it is important to conserve it so it is not used up faster than it grows. In some countries, sugar is grown as an 'energy crop'. The sugar is fermented to give alcohol, which is used as a fuel.
- *Energy from rotting matter* If manure and organic matter are left to rot in a closed tank, methane gas is given off (Figure 8). This is called **anaerobic digestion**. The gas, called **biogas**, can be used for cooking, heating or lighting. This is a common way of producing energy in many parts of the world, particularly China. Some farms in Britain are beginning to use it too.

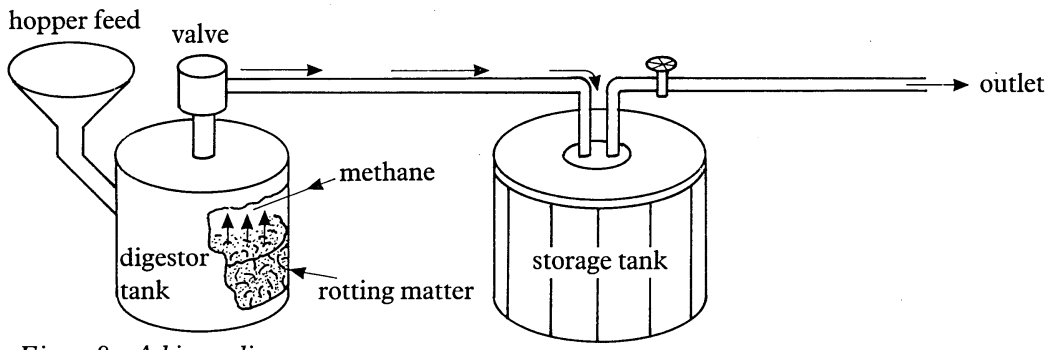

Figure 8 A biogas digestor

Part 2 Ashton Island

Ashton Island is in the Pacific Ocean and many miles from the mainland (Figure 9). You are a member of a 20-strong scientific team which is planning to study the island for five years. You are the expert given the job of providing all the energy which the team will need. The island has:

- No oil, coal or natural gas
- Hot weather by day, but cool nights
- Strong winds from the south west
- Mountains with fast-flowing streams
- Forests
- Hot springs

Answer questions 1 to 8 on the next page.

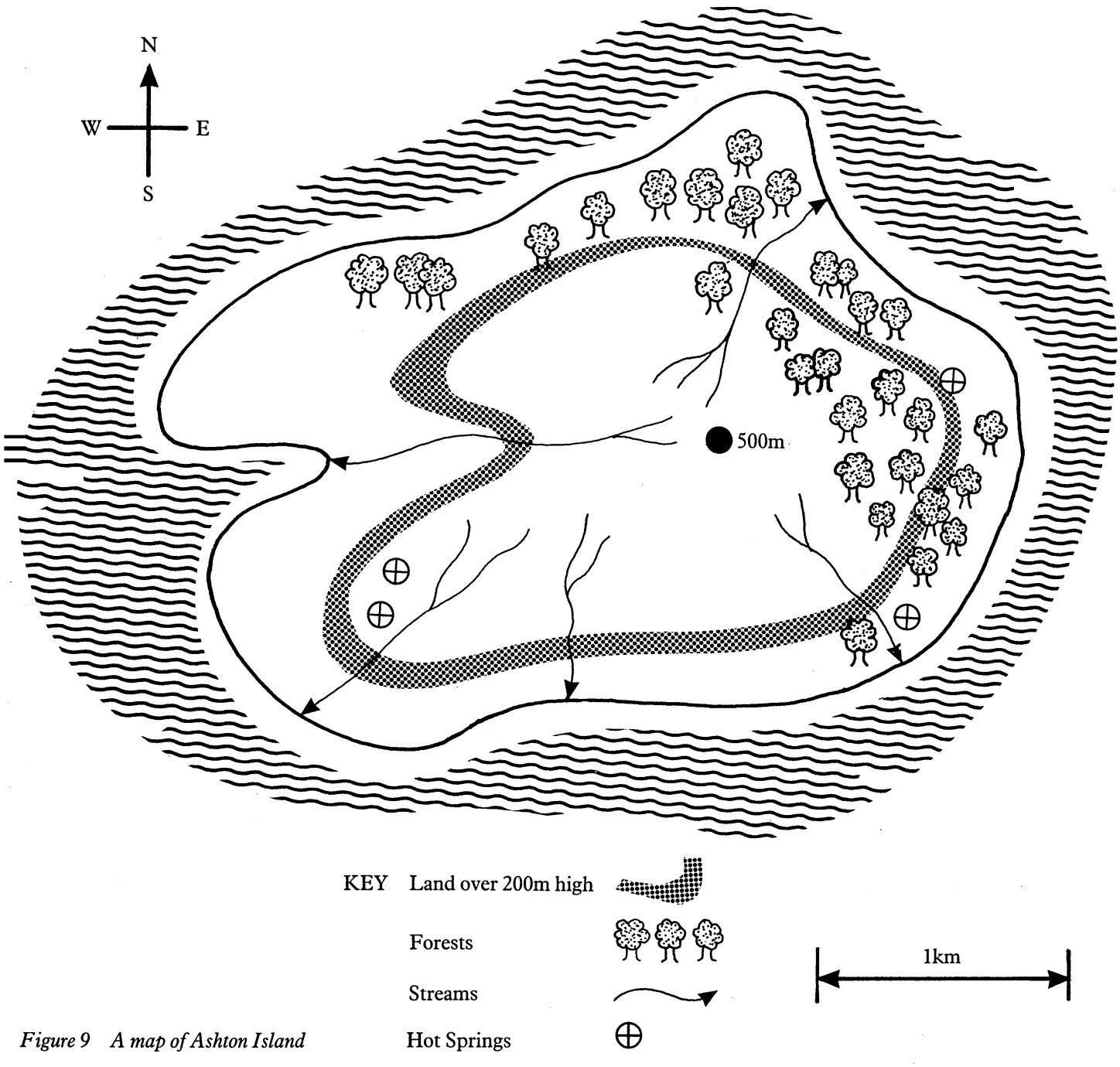

Figure 9 A map of Ashton Island

Questions

1 *The team will need four wooden buildings and a laboratory. Describe two ways by which the buildings could be heated.*

2 *Describe a source of hot water for the buildings.*

3 *Describe two possible ways of supplying heat for cooking food.*

4 *How would you supply the electricity needed to run machinery?*

5 *The team will have medicines and chemicals which must be kept cool at all times. How would you make sure that the supply of electricity to run the refrigerators was continuous?*

6 *Which natural resource on the island should be carefully conserved?*

7 *Copy the map of the island. (Use colours instead of shading if you wish – but remember to change the key if you do so.) Mark on your map where you would plan to site the buildings. Mark on your map the various energy-producing installations you would provide and show how the energy would be transferred (if necessary) to the buildings. Explain your reasons for choosing these particular sites.*

8 *So far we have not mentioned the* cost *of providing energy. Would your answers be different if the team had only a limited amount of money to spend on supplying energy? Explain your answer.*