



Biographies

John Roberts (aged 44), farmer: "I've lived on the farm all my life; my dad had it before me. We own most of the land east of Mill Beck. We have a dairy herd of 40 cows and on the fell we keep about 300 sheep. On the lower ground we have a mix of pasture for the cows and crops. It's a tough life: there's not much money in this kind of farming."

Alison Roberts (aged 38), farmer: "I'm from Greendale village down the valley. John and I work together on the farm. I take in some summer visitors and we have one of the miner's cottages that we rent out as well. I do the accounts, so I know our energy costs – diesel, LPG and electricity – keep going up. The farm advisor says we need to diversify – try to make money from different things."

Sandra Roberts (aged 17), student: "I'm at sixth-form college down the valley. After that I will probably go to university. I'd like to come back to the farm, but I'm not sure if there'd be enough money to keep us all employed. I may have to move to the town to find work. I've tried to interest Mum and Dad in bio-energy – the old barn would be ideal."

Paul and Isobel Bridge (aged 25 and 24), day visitors: "We've driven down for the day. The walks are fantastic – the waterfalls are Paul's favourite thing, but I like the wildlife, especially the birds. The pub does a good lunch too."

Michael and Elaine Patterson (aged 50 and 42) own 5, Miners Cottages: "We bought the cottage for a snip a few years ago and we have spent a lot on it. We come down four or five weekends a year and we rent it out to other holiday visitors. We love the valley; we like the pub and the hotel does really good food. The best thing is the view. We wouldn't want anything to change."

Jan and Sally Petric (both aged 28); Sally teaches at the local school and Jan runs the wood mill. "The wood mill was in ruins when we bought it. I buy local wood from the farm and from the High Valley Estate, and sell to builders and other wood merchants across the south-west. Things are going well for us, but I would like to expand."

Jo Burroughs (aged 46) runs the Three Feathers pub: "We do a mix of local trade and B&B. I'm kept busy, especially in summer, but the price of everything keeps going up."

Bob and Joyce Greaves (both aged 72), Bob is a retired civil servant who moved to Greendale from London: "We live in Lower Bridgeton. We've bought one of the cottages. Greendale is beautiful. We love it here; we used to come on walking holidays. I'm involved in the local council and Joyce helps at the school. We go out walking on the fells nearly every day. There's so much wildlife."

Philippe LeGrande (aged 32), owner of the High Valley Hotel, moved to Greendale from France: "I like Britain and when the hotel became available I just had to buy it. This is a beautiful valley and it is popular with tourists, walkers especially. Local people also come to the restaurant. It's a good business, but energy costs are very high, for cooking and heating especially. Recent rule changes also mean that it costs a lot to dispose of food waste."

Frank and Tracey Thomas (aged 25 and 22), both born in the village. They rent 4, Miners Cottages: "I work in a factory 45 km away and Tracey does shifts at the hotel. We'd like to start a family but we can't afford it. We can't afford to buy a house here. I'd love to work in the valley, but jobs here are like gold dust."



Greendale

information sheet

Greendale is an imaginary valley. It could be anywhere in the south-west of England, in Cumbria or the north-east. People who live in these areas face the same kind of problems as the people in Greendale.

About Greendale

Greendale is a popular tourist spot with both day visitors and longer-term holidaymakers. The main attractions are the River Tore and its tributaries, Joule Head Castle and the High Fell walk. Joule Head Castle is a twelfth-century stone keep and is owned by the National Trust. A variety of birds can be seen on the fells, including buzzards, plovers and curlews.

On a typical summer's day, around 200 day visitors will travel to the area, spending an average of £5 each. There are 65 visitor beds in Greendale: 32 at High Valley Hotel and the rest at B&Bs. The overnight visitors spend an average of £60 a day.

Most of the land in the valley is owned by the High Valley Estate, and is used for forestry, fishing and shooting. Mill Beck and High Valley Beck are both used for fishing, with the rights owned by the estate and by Roberts Farm. Mill Beck used to power an old water mill, which is now a family home, although the mill weir is still there.

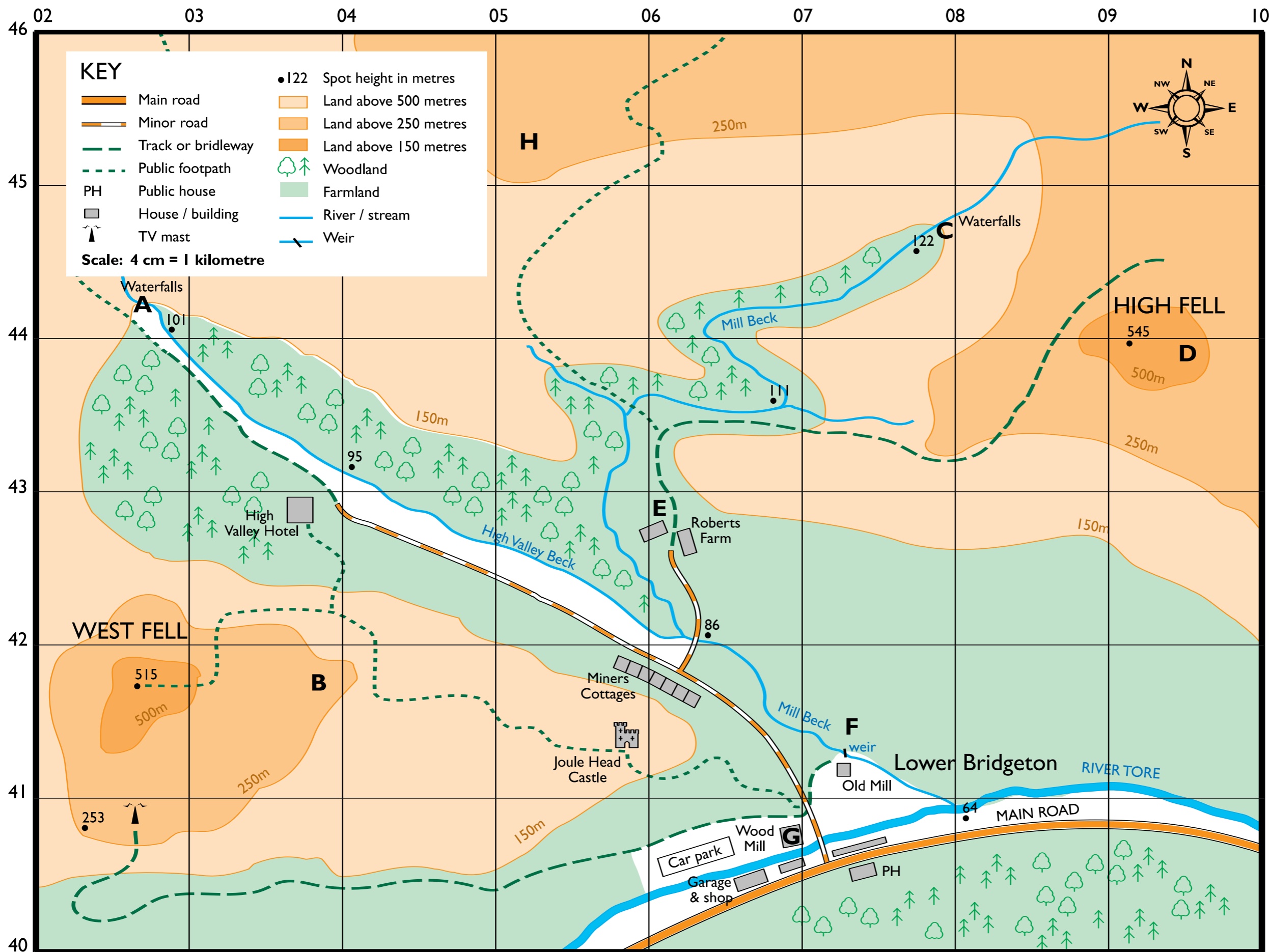
There are 40 people living in the valley, including some temporary staff who live at the High Valley Hotel. Two years ago, an energy company submitted plans for a wind farm on High Fell. The local council turned this down.

Employment

| | |
|-------------------------|-------------------------------------|
| High Valley Estate | 3 full-time |
| High Valley Hotel | 4 full-time, 8 part-time (seasonal) |
| Roberts Farm | 2 full-time, 3 part-time (seasonal) |
| Bridgeton Wood Mill | 1 full-time, 1 part-time |
| Three Feathers pub | 1 full-time, 3 part-time |
| Bridgeton garage & shop | 1 full-time, 2 part-time |



What renewable energy sources does Greendale have?





Energy for Greendale

Key question

- What issues should we consider when choosing a site for a renewable energy project?

What you need

- The map of Greendale (2.2)
- The Greendale information sheet (2.1)
- The renewable energy information cards

What to do

You are an energy expert, and Greendale Rural District Council has asked you to look at the possibilities for renewable energy in the Greendale valley.

First complete the three tasks below, then write a report for the council.

Task 1: You need to assess all the available sites, using the table below. For each site, give a score out of ten for how suitable the site would be for each type of renewable energy. For example, if you think Site F would be a good place for a wind turbine, put a high score in the wind power box in row F. The energy type with the highest score in each row will be the renewable energy type you will recommend for that site.

| Site | Types of renewable energy | | | | Result |
|----------|---------------------------|------------|-------------|------------|---|
| | Hydro-electric | Wind power | Solar power | Bio-energy | |
| | | | | | Which renewable energy type do you recommend? |
| A | | | | | |
| B | | | | | |
| C | | | | | |
| D | | | | | |
| E | | | | | |
| F | | | | | |
| G | | | | | |
| H | | | | | |

Task 2: Now pick three of your high scores and explain why you think that site is suitable for the kind of renewable energy you have chosen.



Task 3: Look at the statements made by the people in Greendale. How would these people react to the suggestions you have made? Pick one of your recommendations and then select one person who would be for it and one person who would be against.

Explain why you think they would react that way.

Report: Write a report for the council entitled 'Possibilities for renewable energy in Greendale'.

Your report should contain the following headings and information.

- **Introduction.** Write one paragraph to introduce the topic of renewable energy and the role it could play in Greendale. (You may want to refer to some of the points raised by the council, e.g. tourism, employment, the need to diversify, government targets for renewable energy, etc. See box below.)
- **Recommendations.** Make recommendations for which types of renewable energy should be developed and where they should be located. Give reasons.
- **Concerns.** Let the council know of any objections that the locals may have to your recommendations, and suggest ways to address these concerns.

The council has asked you to consider the following points in your report:

- Tourism is the main employer in this area. Developments that would damage the tourist trade are not acceptable.
- There is a real need to create jobs in the area that DO NOT depend directly on tourist visitors.
- Farming and estate management are both seeing lower profits. There is a need to diversify (find new ways to make money) for both types of business.
- The council is keen to encourage recycling and to reduce its very high refuse (waste) disposal costs.
- Funding from the government might be available for some of the costs involved in setting up a renewable energy generating plant.
- The central government in London has set a target of 10 per cent of the UK's energy needs to be met from renewable energies by 2010. Local councils are under pressure to say what they are doing to meet these targets.



Double diamond

Key question

- Which sources of energy are the best choice for the UK today?
- Which sources of energy might be best for the UK in the future?

A Diamond Nine is where you put NINE things in order. These could be football teams, TV programmes or types of food. As a group you arrange your choices in the shape of a diamond, with your top choice first.

Here's an example.

- (1) Bolton Wanderers
- (2) Liverpool (3) Arsenal
- (4) Chelsea (5) Leeds (6) Newcastle
- (7) Norwich (8) Southampton
- (9) Manchester United

In this selection the writer thinks that Bolton is the best team and Man U the worst.

The task

Which renewable energy sources are the best choice for Britain today, and which will be the best choices in 25 years' time? To find out, your group has to produce TWO diamonds.

The nine things your group has to consider are sources of energy. Here they are in alphabetical order: bio-energy, fossil fuels, fuel cells, geothermal energy, hydroelectric power (HEP), solar energy, tidal energy, wave power, wind power.

This is a group exercise. You should discuss the nine energy types and try to agree on the order. If you cannot agree, you should VOTE. Don't allow one person to make all the decisions.

Diamond 1 What are the best forms of energy for Britain today? What kinds of energy should we be spending our money on? What types of power plant/station should we be building?

You should take into account: the availability of the energy type, how much it costs to produce, the effect on the environment and the impact on global warming and pollution. You also need to ask yourselves whether the technology to use the energy is available.

Diamond 2 Imagine you have been transported to Britain 25 years in the future. Technology will have moved on, some things will be easier; other things will be more difficult. Do the same exercise, but see if your choices end up in a different order.



Renewable energy presentation

Key question

- How can we, as a group, present our information in a way that is clear, memorable and interesting?

The task

Each group will prepare a short talk about a different renewable energy source and present it to the rest of the class. Your talk should include diagrams and pictures.

Your teacher will give you an information sheet about ONE source of renewable energy. You may be able to find out more information from your school library or from the internet.

In your talk you should explain these three points as clearly as you can.

- What is this type of renewable energy?
- How do people use the energy source to make electricity or fuel?
- What are the advantages and disadvantages of this energy source?

What to do

You need to work as a team.

- Find out the information FIRST – then work out the best way to explain it to the others in the class.
- You should not expect one person to make the whole presentation. Instead you should write a script (like a play) with different people in the group explaining different things.
- Pictures are important because they will help the class to understand and remember the information you are presenting. You could present your pictures on a flip chart, on an overhead projector, as a Power Point presentation, or on a whiteboard, depending on what is available in your classroom. Make sure the words and pictures are big enough for people to read from the back of the room.
- You should have a rehearsal (just like a play) to check that people know what they have to say and that the timing is right. People do not have to learn their lines by heart but it will help if they have read it through several times OUT LOUD before they do it in front of the class.
- You have 5 MINUTES for your presentation. That may seem a long time, but it will fly by. So BE PREPARED.



Ludlow

information sheet

About Ludlow

Ludlow is a market town in Shropshire. It has a population of around 7,000 people. In the past, Ludlow was a defensive centre, and a commercial centre for local landowners. Today the castle is a tourist attraction and the commerce is mainly made up of local shoppers and tourists.

Ludlow holds summer festivals that bring in thousands of visitors. An arts festival uses the castle site to stage plays, while the food and drink festival brings people into the town's pubs and restaurants. Ludlow is well known for good food, with three Michelin-starred restaurants – more than any other place outside London.

This part of Shropshire is well known for its countryside and much of the surrounding area is classed as an AONB – an area of outstanding natural beauty.

The River Teme runs through the town, and there are several weirs. The prevailing wind in the area is south-westerly and Ludlow is therefore in the rain shadow of the Welsh hills. Despite this, the Teme has average flows of around 11.5 cubic metres per second.

On Clee Hill, approx 10km north-east of Ludlow, there is a radar installation used by National Air Traffic Services. Ludlow is connected to the national electricity grid and the town has a mains gas supply. The outlying rural areas have neither mains gas nor a high-voltage grid connection.

Key question

- How can we use maps and other information to make decisions about where to site renewable energy schemes?

The task

For this task you will need the map of Ludlow (Activity sheet 4.3).

1: Study the map of Ludlow carefully, then locate and identify the following using six-figure grid references and place names.

- Four hill sites that would be possible wind turbine locations.
- Four river sites for small-scale hydroelectric power (HEP) turbines. Include at least one that is NOT on the River Teme.
- Sites for two different kinds of bio-energy.

2: Identify three kinds of map evidence to support the fact that Ludlow is a tourist centre.

3: Explain the factors that might make it difficult to persuade companies to invest in renewable energies in the Ludlow area.

4: Which renewable energy type has the best chance of success – and why?



St Bride's Bay

information sheet

About St Bride's Bay

St Bride's Bay is in Pembrokeshire, Wales. To the north is the smallest city in Britain, St David's, with its cathedral. To the south is Milford Haven, one of the biggest deep-water harbours in Britain.

Milford Haven once had four oil refineries. Two are still in operation and a disused refinery site may soon be turned into a terminal for gas imports. The port of Pembroke has a ferry terminal.

Pembrokeshire National Park covers most of the area and the coast relies heavily on tourism and agriculture. Coastal villages such as Dale, Broad Haven and Solva rely almost completely on visitors. Some beaches have good surf. Whitesands Bay, north of St David's, is a surfing centre.

The two peninsulas north and south of St Bride's Bay have high cliffs and offshore islands; these are Ramsey Island in the north and the two islands of Skomer and Skokholm to the south. All three islands are nature reserves, with big populations of seabirds.

Between the islands and the mainland there are narrow sea channels, less than a kilometre wide. The channel between Skomer and the mainland is called Jack Sound and the northern channel is called Ramsey Sound.

The high tidal ranges of the neighbouring Bristol Channel affect this coast. As a result there are very strong tidal streams – up to 6 knots – around headlands and through the two Sounds. The prevailing wind is south-westerly and can be very strong, especially on the headlands and cliff tops.

Key question

- How can we use maps and other information to make decisions about where to site renewable energy schemes?

The task

For this task you will need the map of St Bride's Bay (Activity sheet 4.4).

1: Using the map sheet and the text, identify:

- three possible wind turbine locations
- a site for wave energy
- sites for three different kinds of tidal energy
- a site for bio-energy.

2: Explain the factors that might make it difficult to persuade companies to invest in renewable energies in the St Bride's Bay area.

3: Which renewable energy type has the best chance of success – and why?



Ludlow map





St Bride's Bay map



| | |
|-------------------|--------------------|
| | PEMBROKE to |
| Rosslare | 4 hrs |
| Cork | 9 hrs |
| (4 days per year) | |



Renewable energy

survey

Key question

- How can we measure people's knowledge and feelings about renewable energy?

The task

Design a questionnaire and use it to find out what people know and feel about some of the issues that relate to renewable energy.

You should aim to discover the following.

- How much people know about renewable sources of energy.
- What people know and feel about the issue of global warming.
- How people would react if a wind turbine were to be installed near the school or near their homes.

How to write your questionnaire

1: First write down the names of 15–30 people who will answer your questions.

You could choose:

- people in your tutor group
- people in the same year group
- teachers
- parents and neighbours.

2: Then decide what your questions will be, and write them down. You'll need about 15 questions.

Use some factual questions and some that ask for an opinion. There are two types of factual question: questions with Yes/No answers; and multiple choice questions. Questions that ask for an opinion are a little more difficult to write. You should avoid asking questions that lead to a particular answer, for example:

Do you think that wind turbines are very noisy and ugly?

This is a leading question. A fairer version of this question would be:

Wind turbines are noisy and unattractive.

Circle the answer closest to your opinion.

Strongly agree / agree / no opinion / disagree / strongly disagree

This is called a spectrum response and it is a fairer way of measuring people's opinions.

3: When you have people's answers, enter the data into a spreadsheet or table, and produce bar charts to show the results.



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On Clee Hill, approx 10km north-east of Ludlow, there is a radar installation used by National Air Traffic Services. Ludlow is connected to the national electricity grid and the town has a mains gas supply. The outlying rural areas have neither mains gas nor a high-voltage grid connection.

Key question

- What factors should be considered when analysing the potential for the use of renewables in the market town of Ludlow?

The task

For this task you will need the map of Ludlow (Activity sheet 4.3). Use all the resources you have been given, plus any other information you can access from libraries and the internet.

- 1:** Assess the potential for the use of renewable energy in the area of Ludlow.
 - Explain the factors that might make it difficult to persuade companies to invest in renewable energies in the Ludlow area.
 - Which renewable energy type has the best chance of success – and why?
- 2:** In groups, prepare a 15-minute presentation of your findings.



St Bride's Bay

information sheet

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Key question

- What factors should be considered when analysing the potential for the use of renewables in St Bride's Bay?

The task

For this task you will need the map of St Bride's Bay (Activity sheet 4.4). Use all the resources you have been given, plus any other information you can access from libraries and the internet.

- 1:** Assess the potential for the use of renewable energy in St Bride's Bay.
 - Explain the factors that might make it difficult to persuade companies to invest in renewable energies in this area.
 - Which renewable energy type has the best chance of success – and why?
- 2:** In groups, prepare a 15-minute presentation of your findings.



Renewable energy survey

Key question

- How can I create a reliable measure of people's knowledge and attitudes, and compare differences between two groups? What are some of the options for presenting my results?

The task

Produce a questionnaire with the aim of comparing adults' and students' knowledge about and attitudes to renewable energy.

- The questionnaire should take less than 5 minutes to answer.
- It should use a mix of question types using the following examples.
 - Closed questions require a simple Yes/No answer.
 - Open-ended questions allow people to make a short response in their own words. This type of question is the most difficult to summarise and it's recommended that you ask only one or two open-ended questions.
 - Spectrum response questions provide a statement and offer a range of possible answers, for example:

Wind turbines are noisy and unattractive.

Circle the answer closest to your opinion.

Strongly agree / agree / no opinion / disagree / strongly disagree

Sample

Choose a sample group from each age group that reflects the make-up of the wider group. For example, do not choose all girls unless you are in a girls' school.

Results

The aim of the survey is to compare adults' and students' knowledge and attitudes, so you will need to present the results in such a way that makes easy comparison possible. You may like to do some research on pie charts, graphs, tables, etc.



Renewable energy quiz

- 1:** Name two energy sources – one fossil fuel and one renewable.
- 2:** Why are fossil fuels running out?
- 3:** Why does the UK need to think about alternative energy sources?
- 4:** Why is the UK a good place for wind and tide energy?
- 5:** Give two examples of a good place to site a wind turbine.
- 6:** Give two examples of a bad place to site a wind turbine.
- 7:** What causes the tide to rise and fall?
- 8:** Give one disadvantage of building a dam to provide hydroelectric power.
- 9:** What is pumped storage?
- 10:** What is geothermal energy?
- 11:** Name three ways to produce bio-energy.
- 12:** Give two ways to use the sun as an energy source.
- 13:** If you were putting a solar panel on the roof of a house in the UK, which direction should it face – north, south, east or west?
- 14:** Fuel cells rely on which common element?
- 15:** Give one disadvantage of fuel cells as an alternative energy source.
- 16:** How much of the UK's energy would the government like to see produced from renewable sources by 2010?



Renewable energy quiz

- 1:** Name two energy sources – one fossil fuel and one renewable.
- 2:** Name two types of energy storage system.
- 3:** Which fossil fuel is likely to run out first? Why is this?
- 4:** Why does the UK, in particular, need to think about alternative energy sources?
- 5:** What geographic factors make the UK a good site for wind and tide energy?
- 6:** Give three examples of a suitable site for a wind turbine or wind farm, e.g. out at sea.
- 7:** Give three examples of an unsuitable site for a wind turbine or wind farm, e.g. in a city centre.
- 8:** What causes the tide to rise and fall? Where in Britain would we find very large differences between high and low tides? Why is this?
- 9:** What is a tide race? Give an example.
- 10:** Give one advantage and one disadvantage of damming a river to provide hydroelectric power. Name one country that relies heavily on hydroelectric power.
- 11:** What is pumped storage? Is it really a renewable energy source?
- 12:** Give one problem with using wave energy to generate power.
- 13:** Explain the difference between the two types of geothermal energy. Why does Britain have so few sites that are suitable for geothermal energy?
- 14:** Name two countries that use geothermal energy extensively.
- 15:** Name three ways to produce bio-energy.
- 16:** Give one advantage and one disadvantage of bio-energy.
- 17:** Explain the difference between a passive and active solar panel. If you were putting a solar panel on the roof of your house which direction should it face – north, south, east or west?
- 18:** Fuel cells rely on which common element? Give one disadvantage of fuel cells as an alternative energy source.
- 19:** Are fuel cells more likely to be used in cars or in other devices such as mobile phones or torches? Explain your answer.
- 20:** How much of Britain's energy would the government like to see produced from renewable sources by 2010? How much is produced from renewable sources now?



Reference sheet

Words and statistics

A **watt** is a measurement of power. A kilowatt is 1,000 watts and a megawatt is 1,000,000 watts.

A **watt hour** is an amount of energy, defined as one watt of power sustained for one hour, so a 100-watt bulb operating for 6 hours would consume $(100\text{W}) \times (6 \text{ hr}) = 600$ watt hours.

Power stations are rated in megawatts. Drax Power Station in Yorkshire is the largest and most efficient coal-fired power station in the UK. The output capacity of its six generators is 4,000MW, and they provide enough energy to meet 7 per cent of the UK's electricity needs. The Seabank gas-powered plant near Bristol has a capacity of 755MW. The average cost of electricity from a traditional power plant is 2.4 pence per kilowatt hour (p/kWh).

No generating plant produces power all the time. Conventional plants shut for maintenance. Wind turbines only operate when the wind is strong enough, which, in most locations, is around 30 per cent of the time. This figure is called a plant's **load factor**, and may vary widely between different technologies and different locations.

To find out the output rating of a power plant, multiply capacity by the load factor. In the following example, capacity is the maximum possible output, 8670 is the number of hours in a year and the load factor is 30 per cent.

Example

For a wind farm with a capacity of 20MW:

$$20 \times 8670 \times 30\% = 52020\text{MWh/year}$$

Comparison of energy sources

| Name and place | Type | Capacity | Approx output MWh/year | Installation cost | Approx energy cost: pence/kWh |
|---------------------------|--------------------|-----------------|------------------------|-------------------|-------------------------------|
| Swaffham | Wind | 1.8MW | 4700 | £1.25 million | 1.3p/kWh |
| Various | Solar PV | 1 kW | 0.8 | £6000 | 40p/kWh |
| Various | Solar water heat | | Varies | £4000 | 13p/kWh |
| Dinorwig | HEP pumped storage | 1728MW | 3 million | | |
| Southampton area heating | Geothermal | 4MW | 35000 | £4 million | |
| Pelamis, Orkney (planned) | Wave | 30MW | Not known | Not known | Not known |
| La Rance | Tidal | 240MW | 640,000 | Not known | Not known |
| Experimental | Fuel cell | Not known | | Not known | Not known |
| Ludlow | Biomass | 250kW plus heat | 2920 | £1.35 million | Approx 2p/kWh |