

It's Only Natural: Geography resources for 11- to 18-year-olds

Teachers' notes

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Introduction

This pack is part of the Department of Trade and Industry's **It's Only Natural** programme, which is all about **renewable energy resources** in the UK.

The programme includes these materials for the Geography curriculum, and another set of materials for the Science curriculum.

The geography resources are designed for students aged 11 to 18 years.

The key objectives of the pack are to provide students with information about what renewable energy is, what the sources are and how each source works. Issues surrounding the planning and siting of renewable energy projects are also considered. Older students can look into some of the local and global dimensions of climate change, and at national policies on renewables.

It's Only Natural is for teachers in England, Wales and Scotland. Since school structures vary between these countries, and to provide flexibility for differing abilities, the materials have been organised into three age levels, roughly corresponding to 11–14s, 14–16s and 16–18s.

Contents of the pack

This programme contains the following

- These teachers' notes.
- **Introduction to renewable energy** for three age groups.
- **Renewable energy information cards** at two levels (level 1 aimed at 11- to 14-year-olds, level 2 for 14- to 18-year-olds) on bio-energy, hydrogen fuel cells, geothermal energy, hydroelectricity, solar, tidal, wave and wind energy.
- A **website**, www.dti.gov.uk/renewables/schools, which contains case studies, links to relevant online resources and PDFs of this pack.
- **15 geography activity sheets** for three age groups. The activities are designed for use in Geography/Environmental Studies lessons for 11- to 18-year-olds, although teachers of English, Citizenship and sixth-form General studies will also find them useful. There is also a reference sheet.

The energy issue

Increasing population and industrial expansion mean that there is a continually increasing demand for energy. The fossil fuel resources that supply most of the world's energy needs are finite but we are far from exhausting them. Most estimates of proven oil reserves are high enough to meet projected world demand over the next three decades. Proven reserves of gas and coal are even more plentiful than those of oil and there is considerable potential for discovering more of all these fuels in the future.

Most scientists now believe that the earth's climate has begun to change at a greater rate than it has for many thousands of years. One reason for this is believed to be our continued emission of increasing amounts greenhouse gases, such as carbon dioxide and methane. The undisputed source of the vast majority of these emissions is the burning of fossil fuels.

There is a growing consensus that we need to change the way we meet our energy requirements, and this change needs to come sooner rather than later. This is why the UK Government has signed the Kyoto Protocol, which came into force on 16 February 2005, and is committed to generating 10 per cent of its energy needs from renewable sources by 2010.

This pack has been created because it is important that young people understand the issues and the technology involved in the question of how we meet our energy needs in the future. After all, climate change and dwindling supplies of fossil fuels are set to become the major issues for their generation.

Background information

The subject of energy, fossil fuels, global warming and pollution is huge – and these notes and activities do not attempt to cover everything. The focus is on renewable energy. The wider debate about global warming is not covered as a separate topic, and these resources do not attempt to make a detailed comparison between renewable and non-renewable sources of energy. There is no direct comparison with nuclear energy, and the option of reducing consumption is not covered here. That doesn't stop teachers from including those aspects of the debate in discussion or follow-up.

This resource is aimed at a wide age-range of students, which creates an issue about differentiation. The activities and information sheets aim to deal with this in three ways.

- Activities have been written for three age groups and ability ranges (approximating to 11–14, 14–16 and 16–18). This allows the teacher the flexibility to mix and match the materials to allow for different abilities in the same class.
- Activities are open-ended in that they are written to be as accessible as possible, while allowing able students the possibility of further development of the topic.
- Many of the activities are group-work-based, allowing teachers to set more challenging work for some groups. These activities assume some prior knowledge of the mechanics of global warming. Students should have covered OS map work in 11–14 Geography/Environmental Studies, but teachers should check students' understanding before attempting the map work exercises.

This resource is designed to be flexible, and can be used either as a complete resource or as a 'pick and mix' selection of activities.

Curriculum links

Geography / Environmental Studies

Curriculum links for students aged 11–14 are given for each activity. At GCSE and equivalent levels, the activities in this resource will assist students in the preparation for their courses.

In particular the resource will help students with their understanding of the following.

- Tectonic activity
- Rivers, flood control, drainage basins and settlement
- Coasts, the power of the sea, coastal features
- Ecosystems and the human effect on biomes
- Managing resources, energy, power and global warming
- Tourism and conflict
- Maps, graphs and charts

Students aged 16–18 will have to demonstrate that they can offer a comprehensive mental view of an issue. Examiners call this a 'synoptic assessment' and its aim is to test candidates understanding of the connections between the different elements of a subject.

This resource, and the research and presentation exercise that is specifically aimed at the older students, should help candidates rehearse the skills they will need to answer questions synoptically.

Key Skills

Students on GNVQ programmes may also find these exercises useful for the Key Skills requirements of their work, especially ICT and Communication.

Citizenship

The analysis of a serious contemporary problem is a good way to excite students' interest in Citizenship. In particular, this resource will help teachers meet the following targets in the Citizenship requirements.

11–14

- Show how the public gets information and how opinion is formed and expressed, including through the media; and how and why changes take place in society.
- Take part in school and community-based activities, demonstrating personal and group responsibility in their attitudes to themselves and to others.

14–16

- Obtain and use different kinds of information, including the media, to form and express an opinion.
- Take part effectively in school and community-based activities, showing willingness and commitment to evaluate such activities critically.

In terms of skills the resource and its activities will clearly help with the Citizenship requirements, which ask for:

- skills of enquiry and communication.
- skills of participation and responsible action.

Education for Sustainable Development

There is also the relevance to Education for Sustainable Development (ESD), which the Qualifications and Curriculum Authority promotes as "an approach to the whole curriculum and management of a school". See www.nc.uk.net/esd.

The Clear Skies initiative offers grants to people who are interested in renewable energy projects. The money is available for new energy systems that use renewable technology – solar water heating, wind power, hydroelectric, wood fuel systems and ground source heat systems. Homeowners can get grants of up to £5,000 and, if your school has community links, there could be up to £100,000 worth of help on offer. See www.clear-skies.org for more information about the initiative.

The PV programme provides grants of between 40 and 50 per cent towards the installation of solar electricity equipment. You can apply by calling the PV helpline on 0800 298 3978 or visit the website, www.est.org.uk/solar/about/.

The activities

A brief outline of the activities is given below, with full teachers' notes and curriculum links given on the following pages.

Activity	11 – 14	14 – 16	16 – 18
1: Introduction to renewable energy	■	■	■
2: Energy for Greendale	■	■	
3: Double diamond: renewable energy for the UK	■	■	
4: Ludlow & St Bride's Bay	■	■	
5: Renewable energy survey	■	■	■
6: Advanced activities for 16- to 18-year-olds			■
7: Quizzes	■	■	

1: Introduction to renewable resources

Curriculum links

Geographical enquiry and skills	E: 1a,b,d,e,f; 2a,d
Patterns and processes	E: 4b S: People and place: The physical environment
Environmental change and sustainable development	E: 5b W: 3.10
Environmental issues	E: 6j W: 3.8

Recommended age:
11–14, 14–16

Number of lessons: 2

Resources needed:

- Introduction sheet for relevant age group
- Renewable energy information sheets for relevant age group
- Renewable energy presentation sheet (3.2)

The Introduction sheet aims to establish three basic messages about finite fossil-fuel resources, the impact on the environment and the need to safeguard future supplies. It stresses the need for clean and sustainable energy supplies.

- Hand out the *Introduction sheet* and read it through with the class. As a starter activity, you may want to do a board exercise listing the machines and devices that the class has used in the last 24 hours. Or you could ask students to do an individual energy audit, listing each energy source they have used in the last 24 hours.

Example:

Energy source	Used by	Used for
Electricity	electric toothbrush	brushing teeth
Petrol	mum's car	getting to school
Gas	home central heating boiler	hot water and heating
Electricity	school lighting system	reading this sheet

- Check their understanding of the main teaching points in the sheet. Do they understand why industrial development leads to increased demand for energy? Do they understand the connection between CO₂ pollution and global warming? Do they understand the concept of sustainability?
- Now move on to the renewable energy information sheets. For this exercise you need to divide your class into eight groups. Each group is given a different Information sheet along with the *Renewable energy presentation sheet* (3.2). Each group works together to prepare a presentation, which they will present to the rest of the class in a subsequent lesson, allowing some homework time for the preparation.

The aim is to develop students' knowledge of the eight different types of renewable energy. How much information the students are given depends on the time constraints. There is enough basic information in the pack, but teachers may want to supplement this using other school materials or the internet. More able students should certainly be encouraged to do this if time allows.

2: Energy for Greendale

Curriculum links

Geographical enquiry and skills	E: 1a,b,d,e,f; 2g
Places	E: 3c,d S: People and place: Human-physical interactions W: 1.5
Patterns and processes	E: 4b S: People and place: Physical environment
Environmental change and sustainable development	E: 5b W: 3.10
Environmental issues	E: 6d(ii), f(iii), h(i) and (ii), j, k(ii) W: 3.8

Key question

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

Recommended age:
11–14, 14–16

Number of lessons: 1

Resources needed:

- Greendale information sheet (2.1)
- Greendale map (2.2)
- Energy for Greendale (2.3)

This exercise is based on a sketch map of an imaginary rural valley. The aim is to develop students' understanding of the issues that have to be considered when choosing sites for renewable resource power plants. The focus is on the kinds of renewable energy most often considered in the UK – hydroelectric power (HEP), wind and biomass.

The students have the sketch of a rural valley, and information about the people who live there and the work they do.

- The students have to pretend that they are a team of energy experts working for the local council. They have to prepare an energy assessment for Greendale focusing on renewable energies. This involves them assessing eight sites marked on the sheet and filling out a simple comparison table.
- They could do this work individually or in teams. Either way, the teacher should pull all the answers together in a plenary session, allowing some time for discussion of the strengths and weaknesses of each selection.

There are no right answers to this exercise – although there are some wrong ones – the focus is on the reasoning behind the assessments they make.

Students may like to visit www.dti.gov.uk/renewables/schools for additional information.

3: Double diamond: renewable energy for the UK

Curriculum links

Geographical enquiry and skills	E: 1a,b,d,e,f; 2g
Places	E: 3c,e S: People and place: Human-physical interactions W: 1.5
Environmental change and sustainable development	E: 5b W: 3.10

A Diamond Nine exercise is a way to facilitate group discussion. It's a good way for the class to follow up the Greendale exercise because it offers a way for them to consolidate their learning.

- Hand out the *Double diamond activity sheets* and read through the sample diamond based on football. Await the howls of protest and disagreement.
- Point out that in a real diamond activity, the aim is to discuss the strengths and weaknesses of each choice, perhaps scoring them out of ten, before trying to agree on an order. One possibility would be for the groups to do just that – score the energy sources on these or other criteria: availability, cost, effect on the environment, impact on global warming and pollution.

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?

Recommended age:
11–14, 14–16

Number of lessons: 1

Resources needed:

- Double diamond activity sheet (3.1)
- Renewable energy information cards for relevant age group

- Once the first exercise has been done, do a full class diamond on the board to see which groups came to which decisions.
- Then move onto the second exercise by leading a short class discussion about what changes we might see over the next 20 years. Will global warming speed up and make politicians – and the public – more willing to invest in renewable energies? Will technology offer a solution to the energy crisis – via nuclear fusion perhaps, or through cheap and plentiful fuel cell energy?

Visit www.dti.gov.uk/renewables/schools for additional information.

4: Ludlow & St Bride's Bay

Curriculum links

Geographical enquiry and skills	E: 1a, d; 2c, g
Places	E: 3c S: People and place: Human-physical interactions
Environmental change and sustainable development	E: 5b
Environmental issues	E: 6f(iii), h(i) and (ii), k(ii) W: 3.8

These two exercises take the process one step further by introducing real communities into the equation. Teachers could choose to do one exercise only, or they could set half of their group to do one location with the other half doing the other. This would allow for some interesting discussion at the report back stage.

For each location the students have to study the map and suggest possible renewable energy sites. For the Ludlow exercise they will need to be familiar with OS grid references and symbols.

Some discussion about location needs to be led by the teacher before the students attempt the exercise. This will be simpler if the students have done the Greendale exercise (see page 7), but they do need to be reminded of the following points.

- Planning restrictions may limit the number of possible sites.
- Do sites have road access?
- How close is the site to its energy customers?
- Biomass sites need to be very close (less than 10km away) to their raw material suppliers.
- Environmental impact of the site itself – including visual impact and effect on wildlife. Once the students have completed the exercise let them know how close they were to the truth.

Key question

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

Recommended age:
14–16

Number of lessons:
1 or 2

Resources needed:

- Ludlow sheets 4.1, 4.3; St Bride's Bay sheets 4.2, 4.4
- Renewable energy information cards (level 2)

There is an existing biomass facility in Ludlow. A company called Greenfinch (see www.greenfinch.co.uk) has a plant on the Ludlow by-pass to the east of the town at OS 527 747.

There are also plans to site a small-scale HEP turbine on the Dinham weir in the town, and south Shropshire (but not Ludlow) also has small-scale schemes for 'ground heat' and heat from wood-chip fuels.

Wind power is probably a non-starter in this area. It's an area of outstanding natural beauty for one thing, but did they also realise that the Clee Hill radars (mentioned on their briefing sheet) would rule out any wind turbine in the Ludlow area? The National Air Traffic Service (NATS) routinely object to planning proposals for wind farms within 10km of a radar installation.

In Wales there are also existing plans for the use of biomass, both wood chip fuel and bio-diesel (see web links on www.dti.gov.uk/renewables/schools).

Did they see the potential for tidal stream technology in the two tide races (Jack Sound and Ramsey Sound) off the Welsh coast? An experimental underwater turbine has been tested successfully in Milford Haven and there are proposals for a 'farm' of turbines in the area.

Did they realise that wind turbines are probably unacceptable in this area, especially on the coasts where they would be most viable? Wind technology is however being considered by one of the oil refineries in Milford Haven. Refineries are heavy users of power and aesthetic considerations hardly apply on the refinery site!

5: Renewable energy survey

Curriculum links

Geographical enquiry and skills	E: 1a-f; 2a
Environmental change and sustainable development	E: 5b
	W: 3.10

The final exercise for all three age groups is a survey. Allow two lessons – one for the questionnaire design and one for the reporting of results. The survey itself should be done as work outside the lesson, although if students are to ask other students or teachers it would be wise to warn colleagues in advance.

The aim is to consolidate what they have learned, through a process of writing a questionnaire to test other people's knowledge of the issues.

To be a worthwhile exercise this needs some preparation. The teacher needs to lead some discussion about the different kinds of question highlighted on the task sheet. For younger pupils some supervision of the choice of sample would also be advisable.

Reporting back the results will be critical in this exercise, not just so students can see the importance of clear presentation, but also because it allows an opportunity to reflect about people's readiness to accept the need

Key question

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

Recommended age:
11–14, 14–16, 16–18

Number of lessons: 2

Resources needed:

■ Renewable energy survey activity sheet (5.1 or 6.3)

for action on renewable energies.

6: Advanced activities for 16- to 18-year-olds

Depending on the group, the subject of renewable energy could be introduced using some of the exercises for the lower age groups – the Diamond Nine exercise in particular is suitable for all age ranges.

The central exercise for the older students is a presentation. Allow for two to three hours' lesson time, with equivalent time outside the lesson for research.

This exercise aims to develop students' understanding of the issues surrounding renewable energy by asking them to do their own research.

They begin by studying one single location; this could be Ludlow, St Bride's Bay, or the local area where the students live. Then they build from that knowledge and look at the energy needs of the UK as a whole.

Resources needed:

- Renewable energy information cards (level 2)
- Words and statistics reference sheet
- Ludlow information sheet (6.1)
- St Bride's Bay information sheet (6.2)
- Maps (4.3 and 4.4)
- Renewable energy survey sheet (6.3)
- www.dti.gov.uk/renewables/schools for web links

The presentation

Divide the class into two or three equal groups.

Distribute the information sheets, including maps and as much material from the resource as you feel is appropriate. They could be given some of the materials aimed at younger students, with an explanation that they are not expected to do the activities. The one restriction is that students studying one area must not be given information about the other.

The internet will be a key resource for this age group. They should be briefed that key information for the project will be found on the web. Depending on their ability they could start from scratch, doing their own searches and building their own sources – or you could short-circuit the process by getting them to use the website links available at www.dti.gov.uk/renewables/schools, particularly the local sites for the two areas to be studied.

Their task is to use all the information available to identify opportunities for renewable energy generation in the area they have been asked to study.

The information sheets will give them pointers, but they may follow their own research lines. After a suitable period they present their findings about the local study to their classmates, who, because they have been looking at the same issues, ought to be able to ask challenging questions. This should create some lively debate as one group attempts to pick holes in the other group's reasoning and decision-making.

Look back at the teachers' notes for the 14–16 age group. Did the older students spot the actual potential for renewable energies in the two study areas?

Students who choose to study their own local area will find it easier in one sense because they know the area. But they will also be beginning from a blank sheet. Teachers should be prepared to do some research alongside their group to ensure that all the local possibilities are covered.

Each area will have a local group that is funded to promote energy saving projects, which will be a good starting point for the students' research.

Here are some of the reasons why companies may not invest in renewables in Ludlow and St Bride's.

- Planning restrictions – both are tourist destinations in areas of outstanding natural beauty.
- Both are rural with low concentrations of population.
- Neither is on the national high-voltage grid – map evidence is the absence of pylon routes.
- Both sites are unsuitable for large-scale energy schemes; there are no high-volume rivers, or steeply flowing rivers.
- The Shropshire hills are too near centres of population and aircraft routes to be considered suitable for wind farms, whilst the Pembrokeshire coast is protected.

Geothermal power plants would not be possible because the rock geology is not suitable (although ground heat exchange schemes do operate in Shropshire).

This leaves small-scale HEP, wave and tide power in Pembrokeshire, and biomass – which, coincidentally, are the three alternative energy forms actually being developed in both areas.

7: Quizzes

There are two quizzes supplied (sheets 7.1 and 7.2), which can be used for extension or homework. The answers are supplied at the end of the teachers' notes.

Students of any age who have the interest and ability to take the subject further could try the following research exercises.

- Examine the consequences for the UK if the world fails to halt the steady rise in temperature caused by global warming. What effects might we expect and how long would it take for these effects to appear?
- Countries like India and China are industrialising rapidly. If these countries were to use clean and sustainable energy sources to power their industrial expansion, their energy costs would be higher than if they used traditional forms of energy. Why should they have to bear these costs? Did the UK and the US have to suffer these high costs during their big industrial expansion in the nineteenth century? Examine this issue from both sides – from the point of view of an Indian or

Chinese industrialist, and from the point of view of someone in a developing country (such as Bangladesh) who is directly threatened by global warming.

- To meet the government's target of providing 10 per cent of the UK's electricity from renewable resources by 2010, more renewable energy projects are needed. Government policies that promote and encourage the development of renewable energy resources are crucial. Ask students to summarise key objectives of planning policies on renewables in England, Scotland and/or Wales. They could start with the following: England: Planning Policy Statement 22 (PPS22)
Scotland: National Planning Policy Guidance 6
Wales: Planning Policy Wales, Technical Advice Note 8

Answers for the quizzes

- Students might also be interested to look at the government's energy white paper at www.dti.gov.uk/energy/whitepaper/ourenergymfuture.pdf.

Quiz 1

- 1: Name two energy sources – one fossil fuel and one renewable.
Fossil: oil, gas, coal; allow oil derivatives such as petrol and aviation fuel
Renewable: biomass, fuel cells, geothermal, HEP, solar, tidal, wave, wind
- 2: Why are fossil fuels running out?
Higher population; increased industrialisation; greater use of transport and labour-saving devices
- 3: Why does the UK need to think about alternative energy sources?
Finite resources; imminent loss of the North Sea oil and gas supply
- 4: Why is the UK a good place for wind and tide energy?
Position next to an ocean; high tidal ranges; greater wind speeds
- 5: Give two examples of a good place to site a wind turbine.
Out at sea; on hilltops and ridges; on west-facing coasts
- 6: Give two examples of a bad place to site a wind turbine.
Close to buildings; out of the prevailing wind (on the lee-side of a hill for example); in a shipping lane; in an area of outstanding natural beauty
- 7: What causes the tide to rise and fall?
The gravitational pull of the moon
- 8: Give one disadvantage of building a dam to provide hydroelectric power.
Loss of nutrient flow downstream; effect on fishing; visual effect; permanent loss of a valley; cost
- 9: What is pumped storage?
Using off-peak energy to pump water above an HEP turbine so that it can be released to drive the turbines at peak demand
- 10: What is geothermal energy?
Heat energy from deep within the earth,

usually found near tectonic plate boundaries

- 11: Name three ways to produce bio-energy.
From organic waste; from wood; from crops such as oilseed rape and sugar beet
- 12: Give two ways to use the sun as an energy source.
Solar water heating; PV solar panels
- 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?
South
- 14: Fuel cells rely on which common element?
Hydrogen
- 15: Give one disadvantage of fuel cells as an alternative energy source.
Cost
- 16: How much of the UK's energy would the government like to see produced from renewable sources by 2010?
10%

Quiz 2

- 1: Name two energy sources – one fossil fuel and one renewable.
Fossil: oil, gas, coal; allow oil derivatives such as petrol and aviation fuel
Renewable: biomass, fuel cells, geothermal, HEP, solar, tidal, wave, wind
- 2: Name two types of energy storage system.
Battery; an HEP pumped storage system, which is basically just a huge energy store
- 3: Which fossil fuel is likely to run out first? Why is this?
Oil; huge increase in use for transport over past 50 years
- 4: Why does the UK, in particular, need to think about alternative energy sources?
Finite resources; imminent loss of the North Sea oil and gas supply
- 5: What geographic factors make the UK a good site for wind and tide energy?
Position next to an ocean, with high tidal ranges
- 7: Give three examples of an unsuitable site for a wind turbine or wind farm, e.g. in a city centre.
Close to buildings; out of the prevailing wind

(on the lee side of a hill for example); in a shipping lane; in an area of outstanding natural beauty

8: *What causes the tide to rise and fall? Where in the UK would we find very large differences between high and low tides? Why is this?*

The gravitational pull of the moon. In the Bristol channel area, because the western approaches channel the tide-flow into the narrowing gap between the Devon/Cornwall peninsular and Ireland

9: *What is a tide race? Give an example.*

A place where coastal geography forces the tide through a narrow gap or channel; the Menai Straits between Anglesey and the mainland

10: *Give one advantage and one disadvantage of damming a river to provide hydroelectric power. Name one country that relies heavily on hydroelectric power.*

Disadvantages: Loss of nutrient flow downstream; effect on fishing, visual effect; permanent loss of a valley; cost

Advantages: High power capability; fast turn-on speed; very low cost after initial construction

Countries – Norway; Scotland

11: *What is pumped storage? Is it really a renewable energy source?*

Using off peak energy to pump water above an HEP turbine so that it can be released to drive the turbines a peak demand.

No, pumped storage isn't a resource; it's a way of using other resources more efficiently.

12: *Give one problem with using wave energy to generate power.*

Cost; vulnerability to extreme weather; interference with shipping and leisure craft

13: *Explain the difference between the two types of geothermal energy. Why does the UK have so few sites that are suitable for geothermal energy?*

One uses escaping superheated water and steam; the other uses a borehole drilled down to a hot aquifer. The UK is thousands

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