

SCIENCE A C R O S S EUR*O*PE

BP Amoco



Renewable energy in Europe
Regenerative Energiequellen in Europa
Energía renovable en Europa
Energie renouvelable en Europe
Energia rinnovabile in Europa
Energia renovável na Europa

Renewable energy in Europe

This unit reviews the use of renewable energy sources in small and large scale applications. It asks students to investigate the small scale use of renewable energy in their neighbourhood and to study one large scale application in their region or country. This information is shared with students studying the same unit in other schools in Europe. By making comparisons, students should gain insight into how these sources are used in other regions of Europe and into their potential for future use.

There are many possibilities for extending this study and for linking it with subjects such as geography economics and foreign languages.

The aims of the unit are

- to extend prior work on energy and energy sources in the science curriculum;
- to make students familiar with the actual and potential use of renewable energy sources;
- to promote students' insight into policies to promote the use of these sources;
- to raise students' awareness of the perspectives of people from different countries;
- to raise students' confidence in using a variety of European languages.

Prior knowledge and skills

The unit is intended for use by students in the age range 14 to 17 years. Students should know about non-renewable and renewable energy sources. They should recognise the need to reduce dependence on fossil fuels and be aware of public concerns for the safety of nuclear power stations. They should know of the problems caused by burning fossil fuels, especially acid rain and the rising concentration of carbon dioxide in the atmosphere with its implications for global warming. Students should know how to use the following:

- Units**
joule (J), kilowatt-hour (kWh), watt (W), degree Celsius (°C);
- Concepts**
energy, power, efficiency, non-renewable and renewable energy sources;
- Data**
in the form of diagrams, graphs and tables;
- Geographical knowledge**
familiarity with the general geography of Europe.

Instructions for teachers

Requirements

Before beginning the lesson, copy the following material:

- the student pages for each student,
- the Exchange Form to send to participating school(s). It would also be helpful to make an overhead transparency so that data can be entered on it during the lesson.

For Part 3 teachers may wish to arrange a visit to a site where renewable energy is harnessed or to assemble information about it, about proposals for a new scheme or about a scheme that was abandoned.

After receiving Exchange Forms from other schools, copy:

- the Exchange Forms received from partner schools and the class's own Exchange Form for students to analyse,
- the examples received of the large scale uses of renewable energy for group work or for the whole class,
- the maps on overhead transparency for teacher use, and/or on paper for student use.

Preparation

Before starting the unit teachers should make arrangements to contact classes to exchange information. If you have sent in the Registration Form you will receive details of participating schools. If you have not registered, do so now.

Part 1 Introduction

The teacher introduces the project and the unit. Students work through the introductory information in Part 1 and plan their survey for Part 2.

Part 2 Survey

Students survey the small scale use of renewable sources in their neighbourhood.

Questions

The class collates the information gathered in the survey. The questions may be answered as a class activity by students working in small groups and reporting back to the class, or given for home work.

Teachers may wish to record their classes' findings on the Exchange Form or wait until the class has completed Part 3.

Part 3 Report

Students produce a report on a large scale scheme for harnessing renewable energy. The scheme chosen for Part 3 should preferably be local, and may be one that the class has studied already. The work could be divided among groups, each group producing a short report for one of the exchange schools. Alternatively a single report may be produced and copied for each school to be contacted.

Exchange of information

Send the exchange form and report.

Discussion

When Exchange Forms and reports have been received, students should analyse the information along with any maps and discuss answers to the questions posed in Part 5. Students may be divided into groups to discuss the points and make recommendations. A spokesperson from each group could present the group's opinions to the class. Alternatively, teachers may wish to do this part as a full class discussion, or as a written exercise.

The image shows two overlapping forms. The top form is titled "Science across Europe" and "Renewable energy in Europe". It has fields for "User", "Teacher's name", "School", and "Address". Below these fields is a section titled "We would like to learn more about the use of information with your class." The bottom form is titled "exchange form page 2" and contains seven numbered questions:

1. The renewable energy sources used in our neighbourhood in small scale applications for homes, in farms, in small enterprises are:
2. The following are used most because:
3. Our government promotes the use of renewable energy by:
4. The renewable sources of energy that we think should be promoted in our region/country are:
5. We think people would/should not be willing to pay more for energy from non-polluting renewable sources.
6. We would particularly like to know from your class:
7. Our report on the large-scale use of renewable energy is about:

Answers to questions and further information

Part 1

- 1 Norway and Iceland generate 100% of their electricity from renewable sources. Norway uses hydropower. It has been investigating the possibilities for wind and wave energy. Iceland uses hydro and geothermal power.
- 2 Most of the renewable energy is derived from hydropower.
- 3 It is interesting to note the differences. Countries without mountain ranges use little renewable energy. This is because of the lack of hydropower. Denmark and The Netherlands plan to increase their contribution from renewables by providing 10 per cent of their electricity from wind power early next century.

These figures do not account for imported electricity. Some countries without nuclear power import nuclear generated electricity from France.

- 4 Small scale uses: figures 1, 2, 3, 4, 7 and 8.
Large scale uses: figures 5, 6 and 9.
- 5 Energy from biomass which is considered to be renewable.

Heat pumps. Although they concentrate thermal energy, the electricity they use to do so must be taken into account and this may or may not be from renewable sources. The overall efficiency of supplying electricity to the consumer is low (25% to 35%) and this has to be balanced against the claims for the efficiency of heat pumps from 125% to 400%.

- 6 Other renewable energy sources not dealt with in the unit include: energy from fast-breeder reactors, from hydrogen fusion, from variations in the salinity of sea water.

Part 5

Here are some points that may be brought up.

- In larger countries such as France, renewable energy resources differ greatly from region to region.
- Solar energy potential is greatest in the south of Europe.
- Mountainous terrain tends to have higher rainfall and therefore greater hydro-potential.
- Low-lying European countries are seeking to exploit wind energy.
- The continental shelf provides great tidal variations which could be harnessed by Britain and France.
- Volcanically active regions can provide high temperature geothermal reservoirs. Lower temperature geothermal reservoirs have been explored in some regions.
- Unlike the exploitation of nuclear and fossil fuels, the exploitation of hydro, wind and solar energy on a large scale uses large areas of land. New schemes have often met with stiff opposition from environmentalists and have had to be abandoned. More plans now aim to site wind farms off shore.
- There has been criticism too of solar cells because their manufacture involves the use of toxic chemicals and stringent precautions are necessary to avoid any hazard to health.

The following maps are provided

Map 1 Solar energy

Map 2 Geothermal reservoirs

Science Across the World

Renewable energy in Europe

Date

To
(teacher's name)

School

Address

Tel: (with international
dialling code)

Fax

E-mail

Web address of school

We would like to know more about the use of renewable energy in Europe and exchange information with your class.

From
(teacher's name)

School

Address

Tel: (with international
dialling code)

Fax

E-mail

Web address of school

1 *The renewable energy sources used in our neighbourhood in small scale applications (in homes, on farms, in small factories) are:*

2 *The following are used most because:*

3 *Our government promotes the use of renewable energy by:*

4 *The renewable sources of energy that we think should be promoted in our region/country are:*

5 *We think people would/would not be willing to pay extra for energy from non-polluting renewable sources.*

6 *We would particularly like to know about the following from you:*

7 *Our report on the large-scale use of renewable energy is about:*

Renewable energy in Europe

Part 1 Harnessing renewable energy

Much of the energy used in Europe comes from nuclear or fossil fuels, sources that are non-renewable. Today with rising fuel costs and worries about pollution, many countries plan to use more energy from renewable sources.

Sources of energy such as solar, geothermal, hydro, tidal, wind, and wave have advantages - they are everlasting and unpolluting. They do not contribute to the greenhouse effect. Their energy can be used directly or converted into electricity. People in Iceland, for example, use geothermal wells both for heating homes and for running power stations.

However, even renewable energy schemes can have disadvantages. Many require large areas of land. Hydro schemes have often met with strong opposition from environmentalists and plans have had to be abandoned.

In this unit you will:

- learn about small scale and large scale uses of renewable energy;
- collect information about the use of renewable energy in your neighbourhood and in your region or country;
- exchange this information with students in other countries;
- compare the use of renewable energy in other countries with that in your own and make suggestions for future developments.

Your teacher has a list of classes in schools across Europe that are studying the same unit of work. Your class will be able to contact them and exchange information.

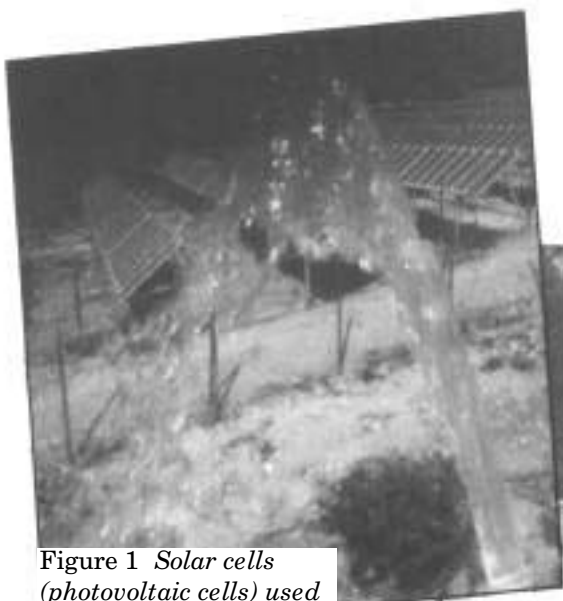


Figure 1 *Solar cells (photovoltaic cells) used to generate electricity for pumping water in Greece*



Figure 2 *Solar panels using the sun's energy to heat water for a home in Greece*

How much renewable energy do we use today?

Most renewable energy is used for generating electricity. Table 1 compares the percentages of electricity produced from renewable sources, nuclear and fossil fuels in 1990.

Table 1 *The percentage of electricity generated from different sources*

	Renewable Energy	Nuclear Power	Fossil Fuels
Austria	74	–	26
Belgium	2	61	37
Denmark	1	–	98
Finland	36	35	29
France	13	75	12
Germany	5	34	61
Greece	6	–	94
Iceland	100	–	–
Ireland	22	–	78
Italy	20	–	80
Luxembourg	67	–	33
Netherlands	1	5	93
Norway	100	–	–
Portugal	28	–	71
Spain	14	38	48
Sweden	51	46	3
Switzerland	57	42	1
Turkey	35	–	65
UK	2	23	75



Figure 3 *A 3 MW wind turbine in Orkney, Scotland*



Questions

- 1 Which two countries in the table generate all their electricity from renewable sources?
- 2 Suggest what source of energy accounts for most of the renewable energy in the table.
- 3 How does your country compare with the others? Suggest reasons for the similarities and differences between the countries in the table.

Figure 4 *A geothermal power station in Iceland*

How can renewable energy be used?

It is convenient to divide the use of renewable energy into two types of application:

- ❑ small scale uses, where the renewable energy is used for a single purpose, for example, solar panels to heat water for a house;
- ❑ large scale uses, where the energy is shared with many end users, for example, a large hydro-electric scheme serving a whole region.



Figure 5 *The tidal barrage at Rance in France*



Figure 6 *A wind farm in Jutland, Denmark*

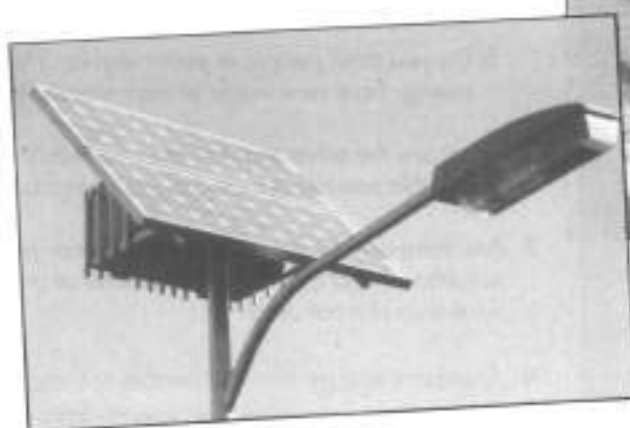


Figure 7 *Solar cells used to run a lamp in Spain*

Questions

- 4 Which of the examples illustrated in figures 1 to 9 do you think are
 - a small scale uses,
 - b large scale uses?
- 5 Can you suggest other renewable energy sources that are being investigated and are not mentioned in this unit?
- 6 Is energy obtained from
 - a biomass,
 - b heat pumps,
 renewable and non-polluting?

Part 2 Small scale uses of renewable energy

How is renewable energy used in your neighbourhood? Do people in other countries have different ideas for small scale applications?

- ❑ *Survey your neighbourhood for examples of the small scale use of renewable energy in homes, on farms and in small factories. You may share this task between members of your class.*
- ❑ *Make a note of what you find. Make sketches or take photographs if possible. Always ask permission before taking a picture*
- ❑ *Collect together the results of the class. Count how many examples you found of each type. Group them into:*
 - a** *those that use the energy directly,*
 - b** *those that convert it into electricity*



Questions on the surveys

- 1 **a** *What sources of energy are used for generating electricity in your country/region? Are they renewable or non-renewable?*
b *Do you think people in your neighbourhood get more of their energy from renewable or non-renewable sources?*
- 2 *What are the advantages of the renewable sources used? If no renewable sources are used in your neighbourhood, why is this?*
- 3 *Are there any sources of renewable energy available in your neighbourhood that are not exploited at present? Why do you think they are not used?*
- 4 *At present energy from renewable sources such as wind and solar is more expensive than energy from fossil fuels. Do you think people are willing to pay more for energy from renewable sources?*
- 5 *Does your government encourage people to use renewable energy, for example, by advertising, by providing grants or tax incentives?*
- 6 *Is there anything you would like to know about the schools you have arranged to contact and their surroundings?*

Figure 8 A wind pump in Britain

Part 3 Large scale uses of renewable energy

Advances in science and engineering have made it possible to use renewable energy on a large scale. A few schemes are now working and more are planned for the future. Plans for other schemes, such as hydro schemes on the Loire and Danube and the tidal barrage on the river Severn in Britain, have been put aside.

In this part you will produce a report about a large scale scheme, preferably one in your region, and send it to the schools you have chosen to contact.

It is likely that students across Europe know very little about the development of renewable energy in your country. Choose an example that you think will be of interest. You may choose a large scale scheme that is already working, one that is planned for the future, or tell the story of a scheme that was never built. Find out as much as you can about it. If it is possible, visit the site, take photographs and interview local people about its benefits and disadvantages.

Remember that students in other countries may not be able to read your language well, so keep your report short - no more than 1 page) It will help if you type it and use diagrams or photographs when you can. Your teacher may ask you to work individually, in groups or as a whole class.



Here are suggestions for the information you may need. (If the scheme has not been built, describe the proposals.)

- 1 *What is the source of renewable energy? For example, wind, solar, geothermal, etc.*
- 2 *How is the energy harnessed? (For example, by a wind turbine and generator, solar cells, heat exchanger, etc.) Explain how it works.*
- 3 *What is its power output?*
- 4 *Does it produce energy cheaply?*
- 5 *What are its advantages and why was the site selected?*
- 6 *Does the scheme have any disadvantages?*
- 7 *What happened when the scheme was proposed? Did local people welcome it? Or were people concerned about possible effects on the environment? Was the scheme modified because of these concerns? Who took the decision for the scheme to go ahead or to cancel it?*
- 8 *Are the users satisfied with it?*
- 9 *Could a similar scheme be used in other places?*

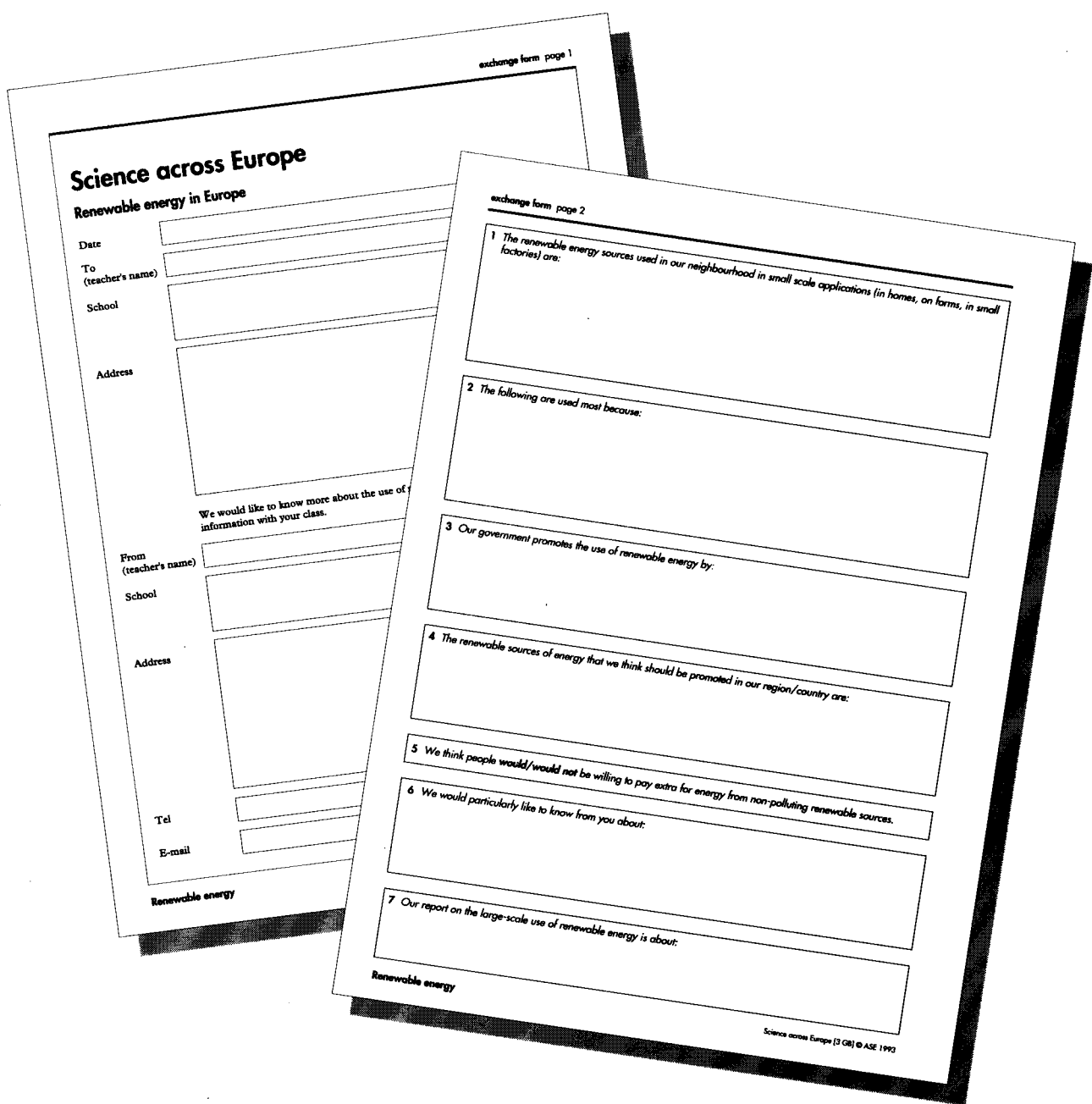
Figure 9 A solar power station in Sicily

Part 4 Exchanging information with students in other countries

A form is provided for your class to exchange information with other schools in Europe.

- For Part 2: the form has spaces for information your class collected and for a special question on renewable energy that you would like to ask of your partner school(s). The form can be photocopied and copies sent to each school you have arranged to contact.

- For Part 3: include a copy of your report with the Exchange Form.



Part 5 Points for discussion

Use a map to find the school(s) from which you received information. Compare your findings with those of your partner schools. You may find maps showing the distribution of renewable energy sources useful when considering your answer to questions 1 and 5.

- 1 Are there any important differences between the uses of renewable energy in other countries and your own?

Suggest reasons for the
a similarities,
b differences.

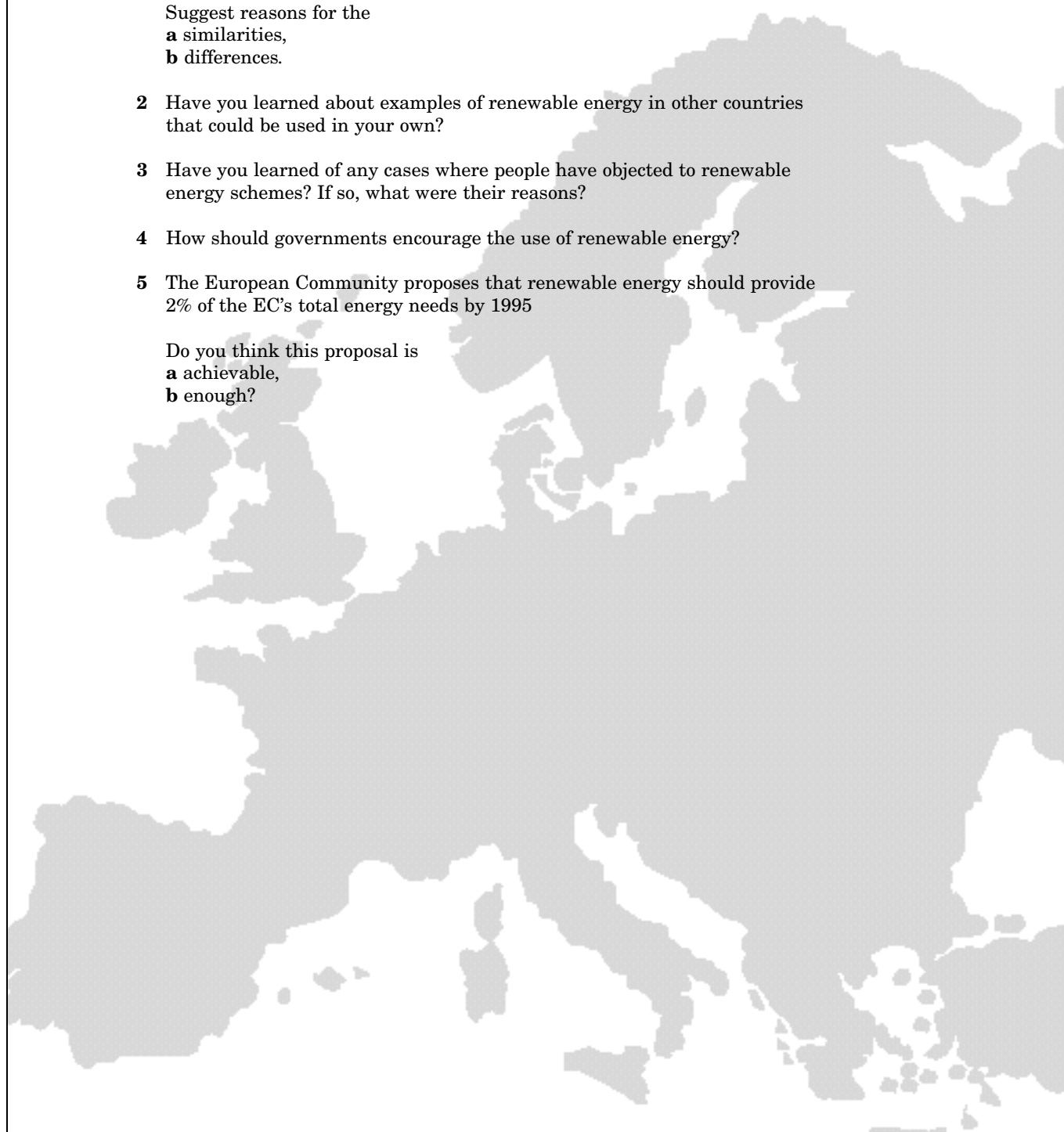
- 2 Have you learned about examples of renewable energy in other countries that could be used in your own?

- 3 Have you learned of any cases where people have objected to renewable energy schemes? If so, what were their reasons?

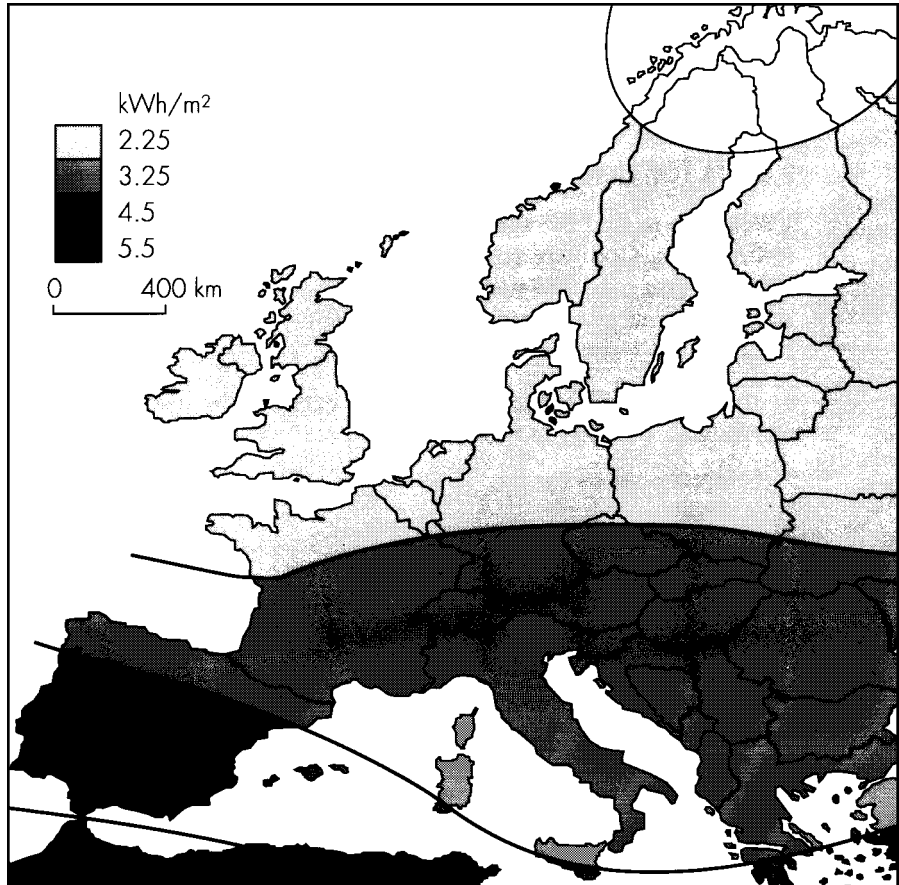
- 4 How should governments encourage the use of renewable energy?

- 5 The European Community proposes that renewable energy should provide 2% of the EC's total energy needs by 1995

Do you think this proposal is
a achievable,
b enough?



Map 1 *Sunshine hours in kWh m⁻²*



Map 2 *Geothermal reservoirs of hot rocks 1500 m underground*

