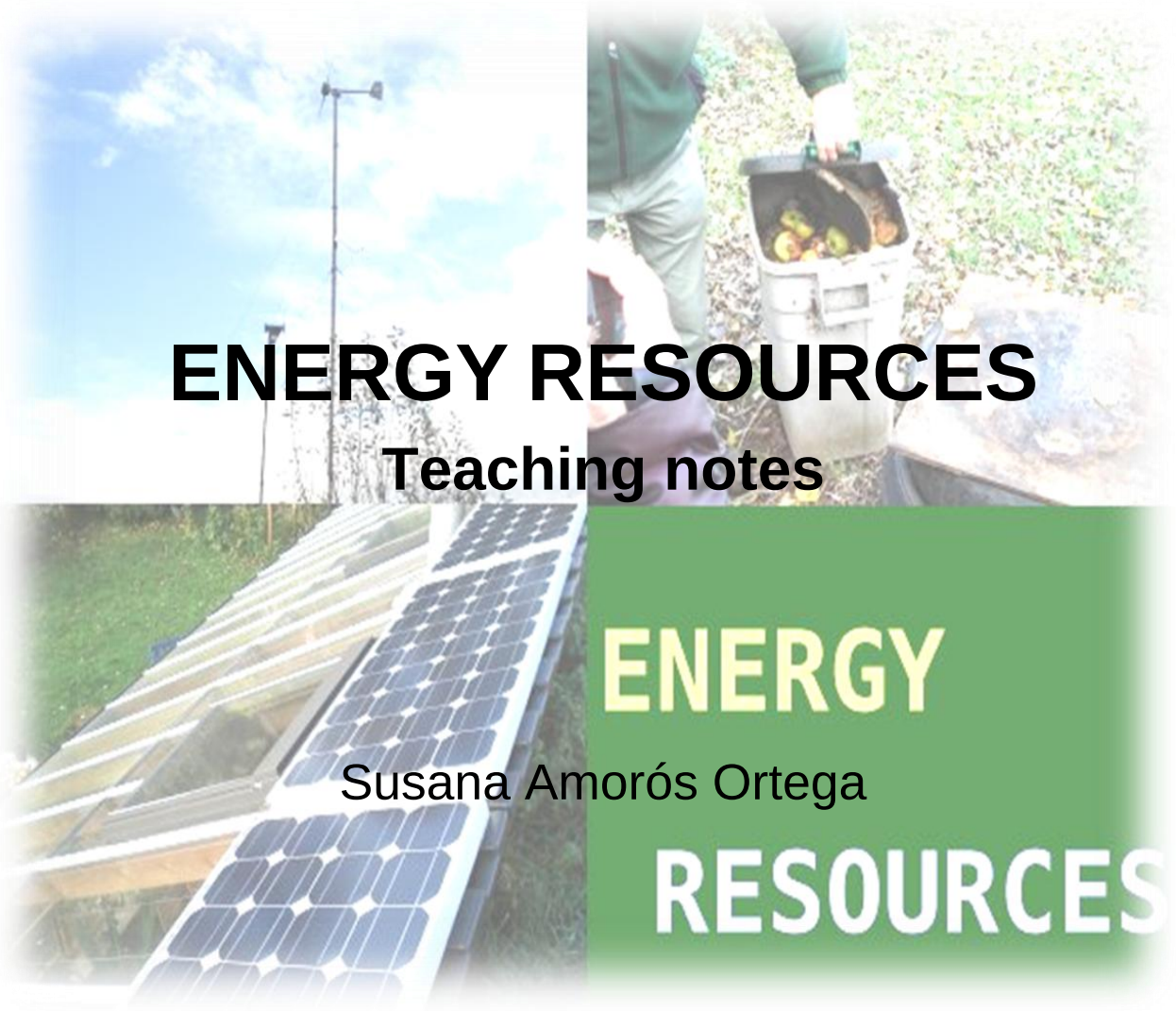

ENERGY RESOURCES

Teaching notes

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LESSON 1.- ENERGY RESOURCES AND POWER STATIONS

1. Introductory activity to work on new vocabulary and the difference between renewable and non-renewable energy resources.

   a) b) and c) are activities to make the students think about the resources they already know. The teacher can ask the whole class and write on the blackboard the key words and the students can write them on their worksheets.

   d) They have a short explanation to complete a table:
   Renewable: solar energy, wind power, hydropower, biomass, geothermal, ocean energy (wave and tidal).
   Non-renewable: fossil fuels (oil, natural gas and coal), uranium (nuclear energy).

2. Fill in the gaps activity which can be done individually to check the understanding.

   a) Non-renewable – energy.
   b) Renewable – can.
   c) Fossil fuels.
   d) Open question.

3. Activity to make students think about the usage of all the energies and to learn new vocabulary.

   - ✓ Wave power uses the energy of the waves to turn turbines that make electricity.
   - ✓ Geothermal power uses the heat that comes from deep rocks under the surface of the Earth.
   - ✓ Fossil fuels were formed in the Carboniferous period millions of years ago (before the dinosaurs!)
   - ✓ Hydroelectricity is generated from running water. Dams are built across a lake or river in a valley to trap water. The water flows through tunnels and turns the turbines which make electricity.
   - ✓ Nuclear energy is made from radioactive uranium ore which occurs naturally in the ground.
   - ✓ Wind energy is used to turn wind turbines and make electricity.
   - ✓ Tidal energy comes from the movement of water in the sea by the tides. These tides happen twice a day.
   - ✓ Biomass uses the energy from plants and waste materials to make electricity.
   - ✓ Solar panels are used to convert the Sun's energy into electricity.

4. This activity can be done individually or in pairs, as the teacher wishes.

   1. Looking at the picture they have to write the names of the steps:

      1.- power station; 2.- transformers; 3.- power lines; 4.- substation; 5.- underground cable; 6.- wooden pole

   2. Looking at the picture they have to put the steps in the correct order:

      1. Power stations make electricity. They usually burn coal or oil to work the generating

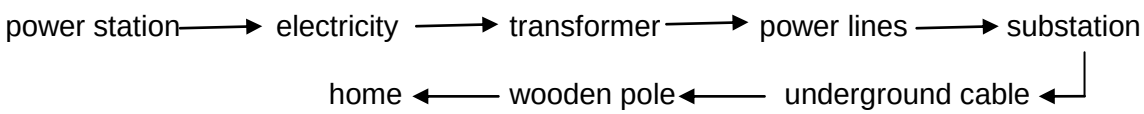
machinery.

2. Transformers change the voltage of the electricity up to 400,000 Volts so it can travel long distances.
3. The electricity is carried along thick metal cables called power lines. Some of them are carried overhead on pylons.
4. In towns and cities there are more transformers in substations. These change the electricity down to 11,000 Volts.
5. Small local substations reduce the voltage to 230 Volts for houses, schools and businesses. In towns, most cables are underground.
6. In some areas, cables are carried to buildings on wooden poles.

3. They have to write the process using the connectors and explain it to the partner.

4. Before doing this activity the teacher has to make sure that students already know what a flow chart is and how to draw it. If they don't know, the teacher explains it in an easy way for them to understand as "an useful tool to describe a process consisting of different steps in an easy way, by writing the key words inside boxes connected by lines and arrows".

   Different flow diagrams are possible, but one solution could be:



5. Talking activity in pairs to remember the route of electricity from power stations to home by asking questions and answering them.

LESSON 2.- FOSSIL FUELS: COAL, OIL AND NATURAL GAS

This activity is done with the PowerPoint presentation ***fossil_fuels.ppt.*** Each slide has different activities to be done by students, the teacher doesn't explain the theory. He/she will ask the questions and let students think individually and do the activities in their worksheets; once they've finished they'll discuss the results.

1. Put the pictures in the correct order: B, C, A.

2. Match each picture with the suitable text: B-F, C-D, A-E

3. Explain the process of how coal was formed. You have a possible answer in slide 5.

4. Make sentences with the information in the table. It's a revision activity.

    - Oil was formed from sea plants and animals
    - Coal was formed from plants
    - Coal was formed in swamps
    - Oil was formed in oceans
    - Coal was formed 100 million years ago
    - Oil was formed 50-100 million years ago

5. They look at the diagram and try to understand it. Students have to put the steps in the correct order and write the process by using connectors. To correct the activity, click on the picture and you will visit the E.ON UK website and see a flash animation.

    - Crude oil is delivered to the power station
    - The oil is burned to heat water, producing steam
    - The steam pushes the turbines, forcing them to spin very fast
    - The turbines turn the generators, which create electricity
    - The electricity flows into the grid

6. They have to explain the electricity production in a coal-fired power station. The diagram with key words will help them. There is a link to a video from YouTube; it's worth watching the video twice before doing the activity. The students can write key words or phrases from the video to do the activity.

7. Draw the flow chart of the process of electricity production. You have the answer in slide 10.

8. The teacher reads the statements and the students have to decide in groups of 2 which of them are advantages and which are disadvantages and explain why.

9. Talking activity with all the students. The teacher asks the questions and leads the debate.

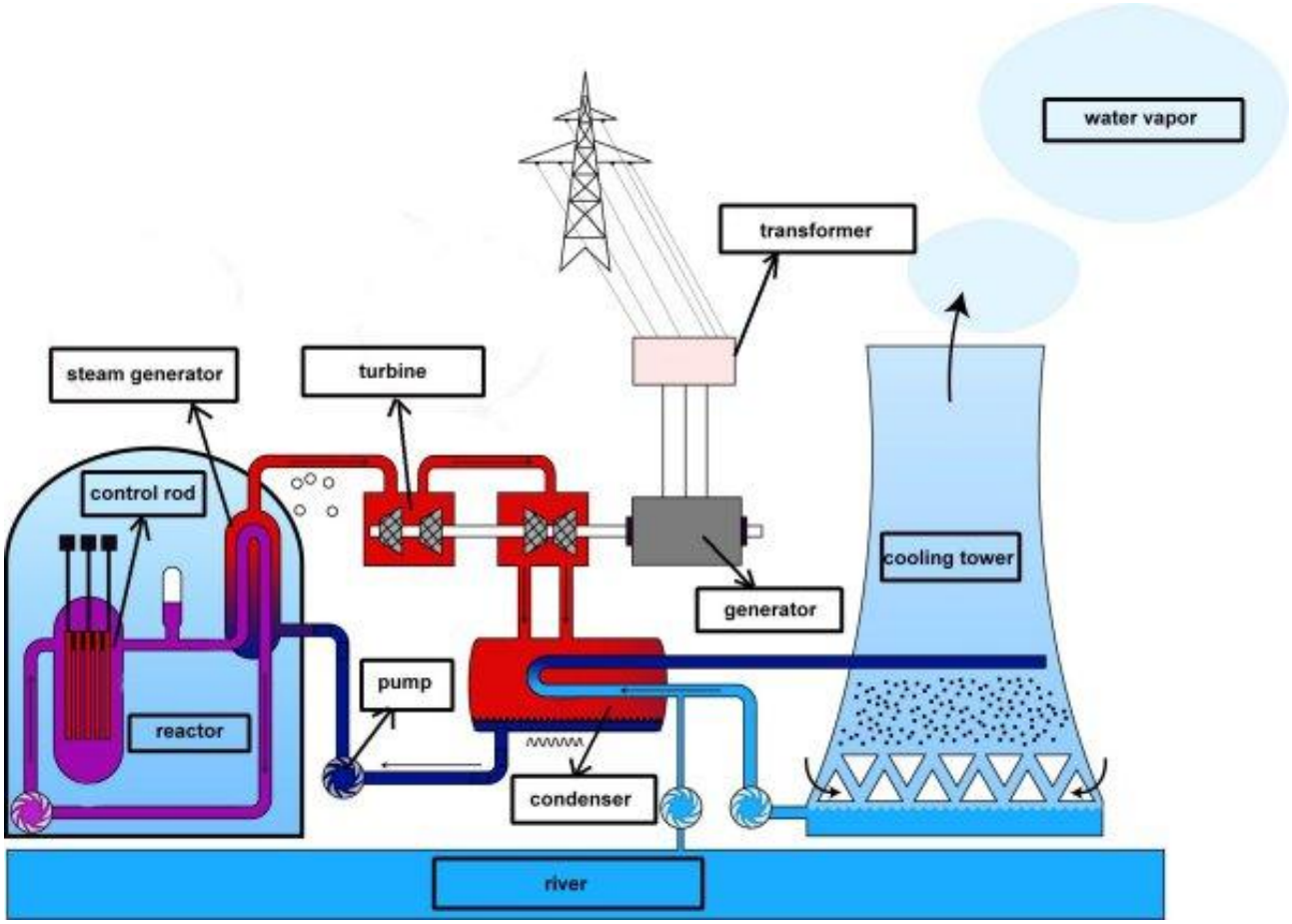
LESSON 3.- NUCLEAR POWER

This lesson is done with the PowerPoint presentation ***nuclear_power.ppt.*** The teacher explains the theory about nuclear energy by means of the PowerPoint. The students have a worksheet with different activities to do. The activities will be done after the teacher's explanation.

1. The students can visit a website about nuclear energy and answer the questions they have in their worksheet. This activity can also be done without computers, since the teacher has already explained all the key words with the PowerPoint presentation.

   a) Is nuclear power renewable? ***No***.
   b) Nuclear power stations use ***uranium*** as fuel. They need very little, compared to a "fossil" power station because there is much more ***energy*** in nuclear fuel.
   c) The ***chain*** reaction inside the ***reactor*** creates heat, which turns ***water*** into steam to drive ***turbines***, which drive generators to make electricity.
   d) ***Nuclear*** power stations do not create atmospheric pollution, because they do not ***burn*** anything. However, the small amount of ***waste*** that they do produce is very ***dangerous***.

2. The students have to label the picture of the nuclear power station with the words in the box. The result would be:



- **Here you have some help for the explanation:**

Nuclear Fission

An **atom's nucleus can be split apart**. When this is done, a tremendous amount of energy is released. The energy is both heat and light energy. Einstein said that a very small amount of matter contains a very LARGE amount of energy. This energy, when let out slowly, can be harnessed to generate electricity. When it is let out all at once, it can make a tremendous explosion in an atomic bomb.

A nuclear power plant uses **uranium as a "fuel".** Uranium is an element that is dug out of the ground in many places around the world. It is processed into tiny pellets that are loaded into very long rods that are put into the power plant's reactor.

The word fission means to split apart. Inside the reactor of an atomic power plant, uranium atoms are split apart in a controlled **chain reaction**.

In a chain reaction, particles released by the splitting of the atom go off and strike other uranium atoms splitting those. Those particles given off split still other atoms in a chain reaction. In nuclear power plants, control rods are used to keep the splitting regulated so it doesn't go too fast.

The reaction also creates **radioactive material**. This material could hurt people if released, so it is kept in a solid form. The very strong concrete dome is designed to keep this material inside if an accident happens.

This chain reaction gives off **heat energy**. This heat energy is used to boil water in the core of the reactor. So, instead of burning a fuel, nuclear power plants use the chain reaction of atoms splitting to change the energy of atoms into heat energy.

This water from around the nuclear core is sent to another section of the power plant. Here, in the heat exchanger, it heats another set of pipes filled with water to make steam. The steam in this second set of pipes turns a turbine to generate electricity.

Information source: http://www.energyquest.ca.gov/story/chapter13.html

3. They have to write down the process using the words in the box and the connectors they learnt in previous lessons.

4. In pairs they have to explain what they know about 4 different aspects of nuclear energy.

    a. Pollution: nuclear power plants cause very little pollution compared with using fossil fuels to generate the same amount of electricity.

    b. Radioactivity: Radioactive waste. Much of the waste produced by the nuclear power industry is radioactive and some of it is extremely radioactive and therefore extremely dangerous.

    c. The Chernobyl disaster: In April 1986 the world's worst ever nuclear accident happened at Chernobyl in the north of Ukraine, close to the border with Belarus.

        Late at night on 25th April 1986 engineers at the Chernobyl nuclear power station carried out unauthorised tests on one of the four reactors and set off an uncontrolled chain reaction. Cooling water in the reactor began to react with hot metal, releasing

hydrogen gas which exploded early the next morning, exposing the reactor core which then caught fire. The explosion at Chernobyl was not a nuclear explosion: it was a chemical explosion which caused the release of radioactive material.

Several tones of radioactive material were released into the atmosphere. Officials in the USSR did not admit what had happened until instruments in Sweden detected radioactive fallout. Fire-fighters and workers at the power station worked heroically to seal off the reactor core.

Most reports agree that 31 people died because of radiation exposure during the Chernobyl incident but it is very difficult to know how many may have died later. Some people believe that thousands of people may eventually die because they have been exposed to fallout from the accident.

d. Greenhouse effect and global warming: The actual operation of a nuclear power station does not release carbon dioxide into the atmosphere. This is important because carbon dioxide is an important greenhouse gas. Nuclear power plants do not contribute neither to the greenhouse effect nor to global warming.

LESSON 4.- RENEWABLE ENERGY RESOURCES (I)

1. SOLAR ENERGY: Activity in pairs (*handout 4.1*)

a) Each student has one part of the document about solar energy (student 1- student 2) and has to read it for 5 minutes. He / she has to try to remember as much information as he / she can, they can underline key words to help them.

b) Without looking at the document, they try to complete the captions.

<table>
<tr><td>  </td><td colspan="2">  </td></tr>
<tr><td>Solar panels (PV) in a solar farm</td><td colspan="2">Solar power satellite</td></tr>
<tr><td rowspan="2">  </td><td>  </td><td rowspan="2">  </td></tr>
<tr><td>  </td></tr>
<tr><td>Solar water heater</td><td>Wristwatch / calculator</td><td>Street lighting</td></tr>
</table>

c) In pairs, they answer the questions without looking at their handouts:

1. It comes from the sun.
2. heat (thermal energy) / electricity.
3. Heat water (for use in homes, buildings, or swimming pools) and heat spaces (greenhouses, homes, and other buildings).
4. sunlight / electricity.
5. Calculator, wristwatch, street lighting, satellites, heater.

d) They correct themselves. It's worth correcting with the whole group and check if they have understood.

e) They have to think about the advantages and disadvantages of solar energy and write them down. Then the teacher corrects and discusses the answers with all the students:

Advantages

- ✓ Solar energy is renewable and the Sun's heat and light are free.
- ✓ Solar energy can be used to generate electricity in remote places where other electricity supplies are hard to come by.
- ✓ It does not produce any carbon dioxide, which contributes to the greenhouse effect.
- ✓ Energy is usually generated at or near to the location where it will be used. This keeps transmission and distribution costs to an absolute minimum.
- ✓ In our country, it's a good renewable energy resource because we have a big amount of sunlight during the whole year.

Disadvantages

a) PV cells do not work so well when it is cloudy and do not work at night.

b) In not very sunny countries, such as the UK, Norway or Finland, its use is limited.

2. BIOMASS: Activity in pairs (*handout 4.2*)

Each student has one version of the same document about biomass (student 1- student 2) and has to read it for 5 minutes. In both versions there are some gaps and the students have to fill in the gaps by asking questions to their partner. Once they have all the missing words, they have to read the text again and understand the meaning.

The full version is:

Biomass is an organic material made from **plants** and **animals**. Plants absorb the sun's energy in a process called **photosynthesis**. Biomass is a **renewable** energy source because we can always grow more trees and crops, and waste will always exist. Some examples of biomass fuels are **wood**, **crops**, manure, and some garbage.

Biomass can be used in different ways:

- ✓ Biomass can be burned to produce **steam** for making electricity, or to provide **heat** to industries and homes.
- ✓ It can also be converted to other usable forms of energy like methane gas (also called **biogas** or **landfill gas**).
- ✓ Today, new ways of using biomass are still being discovered.
    - One way is to produce **ethanol**, a liquid alcohol fuel. Ethanol can be used in **special types of cars** that are made for using alcohol fuel instead of gasoline. The alcohol can also be combined with gasoline. This reduces our dependence on oil - a non-renewable fossil fuel.
    - Another way is to produce **biodiesel**. It is a fuel made with **vegetable oils**, fats, or greases - such as recycled restaurant grease. Biodiesel fuels can be used in diesel engines without changing them. It is the fastest growing alternative fuel in the

United States. Biodiesel, a renewable fuel, is **safe**, **biodegradable**, and reduces the emissions of most air pollutants.

3. OCEAN POWER: WAVE AND TIDAL ENERGY

a) The students (individually or in pairs) have to explain the generation of electricity looking at the pictures. The process can be summarized like this: “First the waves push the air up and down. Then the air makes the turbine rotate and finally the turbine turns the generator which produces electricity”.

b) They have to write the key words on the first picture.

c) They have a piece of information about tidal energy and they have to answer the questions. To answer the questions the students have to think about how electricity is produced (they can imagine it will be a similar process as wave power stations) and where this kind of power station can be found (in a coastal region with tides, for example in the North of Spain: Basque Country, Galicia, Santander, Asturias).

LESSON 5.- RENEWABLE ENERGY RESOURCES (II)

WIND ENERGY, HYDROPOWER AND GEOTHERMAL ENERGY: Activity in groups of three students A, B, C (*handout 5*)

Activity 1.- The teacher splits the class in groups of 3 students. The three students of the same group work with the same handout (A, B or C). Each group of 3 students has handouts with information about **one** of the above energy resources. The students have to complete their worksheets working in group. They have to complete the following table.

Energy resource		***Wind energy***	***Hydropower***	***Geothermal power***
1	***Primary energy***	Wind	Water source (ocean, river, waterfall)	Geothermal energy (Earth's heat)
2	***Final energy/energies***	Electricity / movement	Electricity / movement	Heat and electricity
3	***Name of the device***	Wind turbine / wind mill	Dam (hydroelectric power station) / Water wheel	Geothermal power station
4	***How electricity is generated***	The wind turns the rotor of the wind turbine. The rotor turns a generator (a dynamo), which makes electricity.	Dams are built to trap water, usually in a valley where there is an existing lake. The water flows through tunnels and turns the turbines which drive generators which make electricity.	The water is heated by the earth. It goes into a special turbine. The turbine blades spin and the shaft from the turbine is connected to a generator to make electricity.
5	***Some years ago this energy was used for…***	Sailing, grinding grain, pumping water and for irrigation	Grinding cereals such as wheat to produce flour	Hot springs for bathing and cooking food
6	***Examples of today's use***	Electricity production	Electricity production	- Heating swimming pool water, - growing plants in greenhouses, - drying crops, - heating water at fish farms, - pasteurizing milk.
7	***Location***	Places where the wind is strong and reliable: coastal areas, hills,…	Water source	Volcanically active places

d) They have to write six questions which can be answered with the information they have in the table:

1. What does a *wind turbine / hydroelectric power station / geothermal power station* use to make electricity?

2. Which is the final energy?

3. How is *wind energy / water energy / geothermal energy* transformed into electricity? By means of *generators which are driven by turbines / wind turbines / dams / geothermal power stations*.

4. *How is electricity generated*?

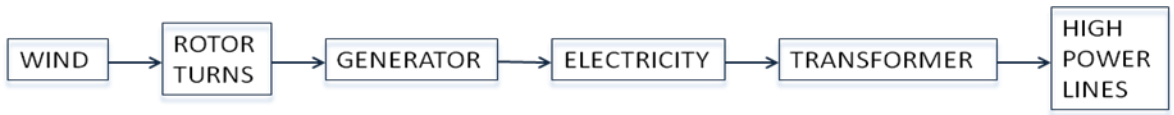
5. *What was wind energy /hydropower / geothermal energy used for many years ago*?

6. *Write examples of today's uses of this energy.*

7. *Where are wind farms / dams / geothermal power plants built*?

e) They already know how to draw a flow diagram (lesson 1). They have to extract the key words from the information they have been given in order to draw the flow chart.

The three flow diagrams would be:



f) The students have to think about advantages and disadvantages related to the energy resource they are studying.

Energy source	***Advantages***	***Disadvantages***
Wind	• No air pollution • Does not produce CO_2 • No risk of greenhouse effect • No risk of acid rain • Renewable and free	• Noisy • Depends on the weather • Unreliable if there is no wind • Unsightly
Hydropower	• No air pollution • Reliable in wet regions • Does not produce CO_2 • No risk of greenhouse effect • No risk of acid rain • Renewable and free	• Floods a large area • Expensive to build • Affects the ecology of the area
Geothermal	• No air pollution • Good for remote locations • Does not produce CO_2 • No risk of greenhouse effect • No risk of acid rain • Renewable and free	• Only reliable in volcanic areas

Activity 2.- The teacher makes new groups of three students with different handouts (one student A, one student B and one student C) and they have to share their information to complete the activities in their worksheets:

a) By asking and answering the questions they wrote in part I, they have to complete the grid with their partners' information. The solutions are in the grid in the previous page.

b) Each student has to explain the process with the flow diagram they have drawn. They have a writing frame to help them.

Activity 3.- The teacher can use the PowerPoint presentation ***renewableII.ppt*** to summarize the most important content of the lesson and it will help the students to correct their flow diagrams.

LESSON 6.- THE FUTURE OF ENERGY

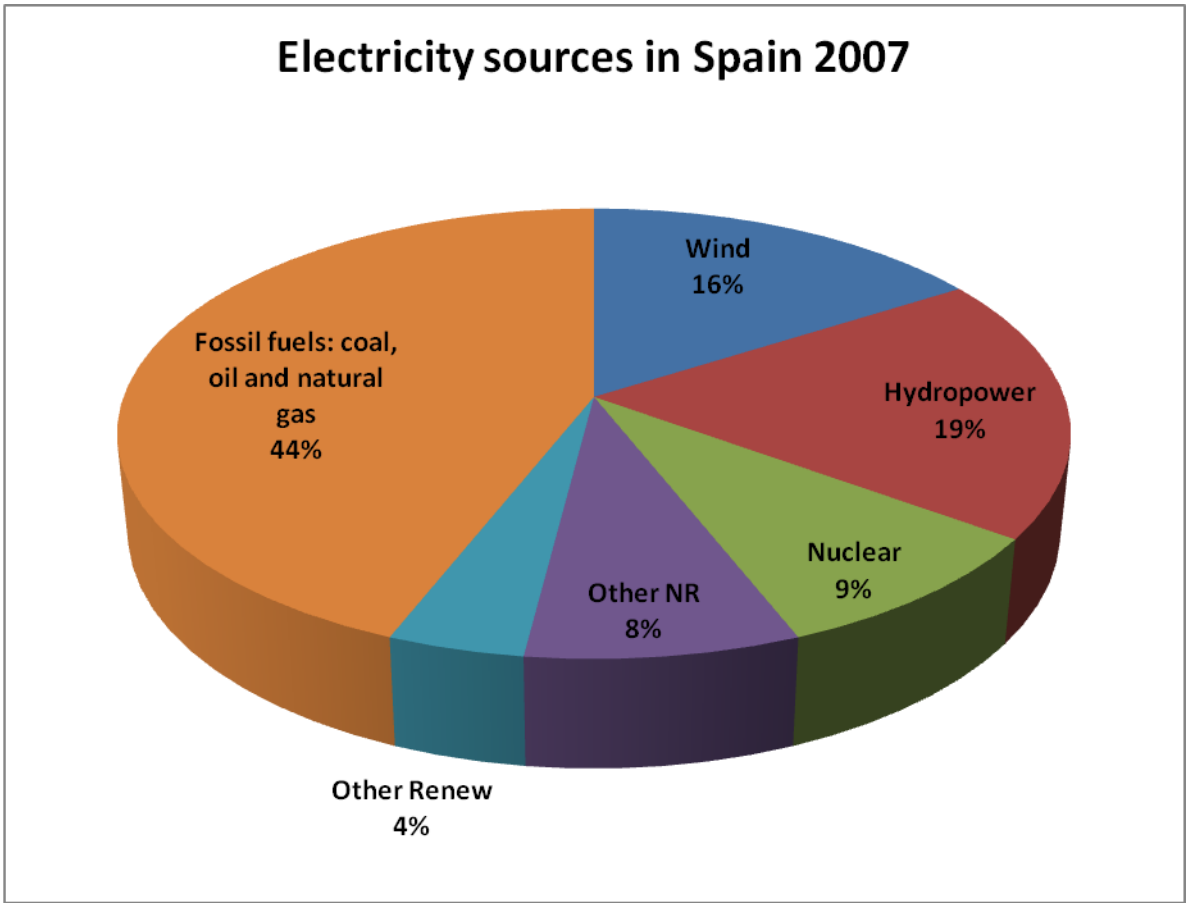
Activity 1.- Let's review... Activity in pairs: After giving handout 6 to each pair, the teacher asks students to read the sentences and explains the unknown vocabulary. It is worth doing this first part with all the class. After that, the students work in pairs and complete the table.

Energy source	Advantages	Disadvantages
Coal	Will be the last fossil fuel to run out	Emits CO_2 Non renewable
Oil-natural gas	Quick start-up if there is a sudden demand	Emits CO_2 Non renewable
Nuclear	No air pollution Does not produce CO_2 No risk of greenhouse effect No risk of acid rain	Risk of big accident Non renewable Unpopular Problems with waste
Wind	No air pollution Does not produce CO_2 No risk of greenhouse effect No risk of acid rain Renewable and free	Noisy Depends on the weather Unreliable if there is no wind Unsightly
Hydropower	No air pollution Reliable in wet regions Does not produce CO_2 No risk of greenhouse effect No risk of acid rain Renewable and free	Floods a large area Expensive to build Affects the ecology of the area
Solar	No air pollution Good for remote locations Does not produce CO_2 No risk of greenhouse effect No risk of acid rain Renewable and free Reliable in sunny regions	Depends on the weather

Activity 2.- Drawing a pie chart.

Individual activity. The students have to draw a pie chart from the percentages of the table. The teacher has to tell them how to do it; a good way could be showing an example of a pie chart and explaining that it is a diagram consisting of a circle that is divided into sections to show the size of particular amounts in relation to the whole. This activity will show the students that the use of diagrams and visuals when dealing with amounts and percentages is the best and easiest way to compare and present data.

The result will be:



Source: REE (Red Eléctrica de España)

Activity 3.- ROLE PLAY: A debate about renewable and non-renewable energy resources

The teacher splits the students in groups of three and gives each group a role (A, B, C). The students of each group have to think about arguments to defend their point of view and write them (5 or 6 sentences). They have a grid with useful vocabulary to help them.

After 5 minutes, the teacher makes new groups of three students: in each group there must be one student A, one student B and one student C. They will simulate broadcasting a radio programme and the teacher will go round the class listening and correcting if it is necessary.

After 10 minutes, three students (either volunteers or selected by the teacher) will broadcast the radio programme and the rest of the class have to listen to them and may ask questions when the presenter asks them to do so. It might be a good idea to record them as if it was a real radio programme.

The roles are:

- ***Group A:*** You are ***for nuclear energy*** and you think that this energy is the only solution to produce electricity in the future. You have to write 5 or 6 arguments for nuclear energy and think about the disadvantages of renewable energies.

- ***Group B:*** You are a member of Greenpeace and therefore you are ***for renewable energy resources*** (wind, solar, hydropower). You think that our future depends on increasing their usage. Write 5 or 6 arguments for renewable energies and think about the disadvantages of nuclear power.

- ***Group C:*** You are the presenter of the radio programme: “The future of Energy”. You have to ask questions and moderate the discussion. Write 5 questions you will ask.

LESSON 7.- SAVING ENERGY IN THE HOME

Activity 1.- Calculating the energy consumption in our homes

1.- This activity can be done as homework, because the students have to complete the grid with all the electrical appliances they have at home and calculate the total energy consumption in kW·h per DAY. In case they don't know the consumption of any electrical appliance, they have a table with some of the most important ones. In the table they have the average consumption of some electrical appliances:

Electrical appliance	Consumption (kW)	Electrical appliance	Consumption (kW)
Air conditioning	2-5	Refrigerator	0.4-0.8
Bulb (60W/100W/150W)	0.06/0.1/0.15	Television	0.15
Water heater	2.2	Oven	4.5
Coffee maker	0.9-1.2	Hair dryer	1.2-1.9
Computer	0.8	Microwave oven	0.75-1.1
Laptop	0.05	Iron	1-1.8
Vacuum cleaner	1-1.4	Toaster	0.8 -1.4
Dishwasher	1.2-2.4	Washing machine	0.35-0.5
Clothes dryer	1.8-5	Portable heater	0.75-1.5

Once in the class, the students calculate the **daily kW·h consumption** by means of the formula they are given.

2.- The students have to bring an electricity bill and the teacher comments on the most important items on it. They do the exercise individually: the aim of this activity is to make the students aware of the price of electricity and the consumption of different appliances. (price of 1 kW·h in 2008 = €0.105834).

3.-

a) In this exercise, the students have to compare the energy efficiency of two washing machines and they will realize that depending on the efficiency, the energy consumption varies.
The teacher can explain them that by law, the European Community Energy Label must be displayed on all new household products of the following types displayed for sale, hire or hire-purchase:

- Refrigerators, freezers and fridge-freezer combinations
- Washing machines
- Electric tumble dryers
- Combined washer-dryers
- Dishwashers
- Lamps
- Electric ovens
- Air conditioners

The more efficient the product, the less energy it needs and the more you get for your money. 'A' rated products are the most efficient and 'G' rated products the least efficient. The most efficient fridges and freezers can be identified by new 'A+' and 'A++' markings on the large black arrow appearing against the green 'A' arrow. Using less electricity is better for the environment and for our pocket.

b) The students have to calculate the amount of energy (kW·h) they would save when using an A efficient washing machine and therefore the economical saving.

Activity 2.- How to save energy in our homes and reduce the electricity bill.

In pairs, the students have to think about ways of saving energy at home and write them down. By doing this exercise, they may realize that it's possible to save energy (and therefore, money) by switching off the TV or laptop when not using them, or by buying more efficient electrical appliances.

- Use energy-efficient appliances, such as energy-saving light bulbs
- Lower the thermostat by 4 to 5 degrees Celsius during the night and when nobody's home.
- Close the windows when the heater is on.
- Turn off entertainment devices when not in use: TV, computers, laptops, DVD player, game systems…
- Turn off lights.
- Use natural light, heat and cooling.
- Unplug your phone charger when not in use.

PROJECT.- Making our school green

This project is planned to be done with half of the class in **four hours**. It's a group activity working in groups of 4 students. The aim of this project is that students plan and design how to save energy in the school and how to use renewable energy resources. Moreover it could be used as an assessment activity because it is the summary of all the work done in the unit.

The teacher splits the class in **four groups** of 4 students. Each group has a part of *project.pdf* where they have the instructions and activities they have to do:

Group 1: SAVING WATER
Group 2: SAVING ELECTRICITY
Group 3: SAVING HEATING
Group 4: RECYCLING AND REUSING

The students will practise cooperative work as they have many different tasks to do and every group has to get organised in order to finish the task on time.

1.- The teacher explains the aim of the activity and gives each student the worksheet with the instructions. Moreover each group will be given a part of ***project.pdf*** with the tasks and activities they have to do.

2.- The students have to move around the school because they have to make different surveys. As they also need computers to look for some information, the project can be done in a computer room or even in an ordinary room (or the workshop) with some computers with internet access.

3.- The students have to work in groups and each member of the group will have a specific task:

- Student 1: **Coordinator**. He/she will be in charge of ensuring *that the different tasks are achieved on time*. He/she has to check that everybody does his/her job. He *will help the investigator with the survey*.

- Student 2: **ICT expert**. He/she will be in charge of preparing the final presentation of the project with the results and materials the group will prepare. The first two sessions he/she will work with the designer

- Student 3: **Investigator**. He/she will be in charge of the survey. When he/she finishes, she/he will help the ICT expert to prepare the presentation.

- Student 4: **Designer**. He/she will be in charge of drawing plans, pictures and all kind of visuals needed. The first two sessions he/she will work with the ICT expert to complete the tasks.

4.- They have 3 hours to complete the tasks.

5.- During the 4th session each group will give an oral presentation of their results and findings to the rest of the class. They have to prepare a PowerPoint presentation and explain their conclusions in 10 minutes. The rest of the classmates will assess the presentation using the *assessment sheet 1 included in the student worksheets*.

6.- At the end of the 4th session each student will fill in the *self-assessment sheet* in order to assess him/herself.

7.- The teacher will collect the assessment sheets and the written projects and will use them to assess the progress of the students.

Some information that students will have to find out is:

- ✓ In Lleida it rains 369 l/m^2 on average per year.
- ✓ A led power is 30-60 mW.
- ✓ Group 3 “Saving heat” Part II, exercise 3: we will need 8 collectors and we will recover the money in 16 months’ time.