www.escuela.pamplonetario.org
www.pamplonetario.org

SCHOOL OF STARS
didactic guide

ENERGY FOR LIFE

2º Ciclo ESO / Bachillerato

planetario de pamplona

FUNDACIÓN CAJANAVARRA

Obra Social "la Caixa"

Table of contents

Activity 1 *The concept of energy*

Energy for life is a planetarium show which explores the relationship between our civilisation and the energy that we use. We have decided to take a broader perspective on this in order to help us to analyse the current situation and the options that are available to us at present and in the future.

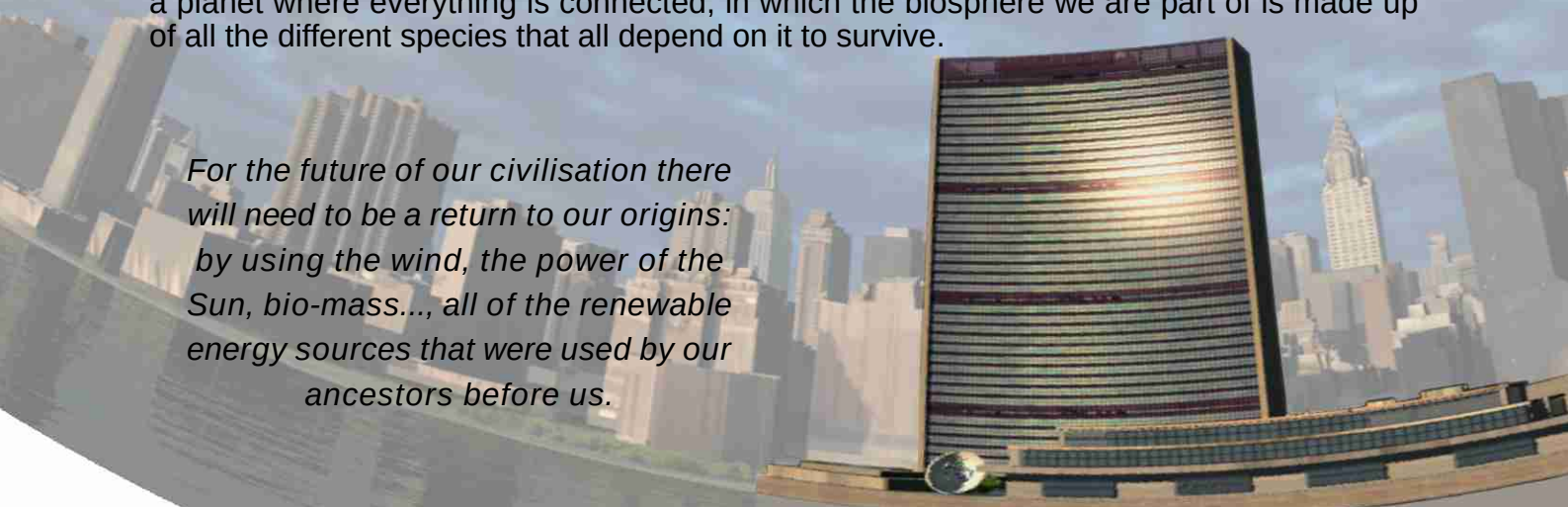
Our ancestors used the natural resources that were within their grasp, devising ways of controlling them for their own benefit. The control of fire gave them a great advantage over the other competing species within their ecosystem.

Throughout history, the progress of our civilisation has been linked to an increase in its need for energy, but now that the production, distribution and sale of energy has become one of the largest and most important businesses worldwide, more energy consumption doesn't always mean that there is more development. The fact that the more advanced countries possess the most efficient technology is proof of that. These countries are able to produce more output while consuming less energy (vehicles, household appliances, buildings, industrial processes, etc). On the other hand, the developed countries use more services which demand more energy therefore, although they are more efficient (generally), they are also the biggest consumers of energy.

If we look at the origins of the energy which is currently consumed by humanity we realise that the majority of it comes from the burning of fossil fuels such as oil, coal and natural gas. Stored within the molecules of these so-called fossil fuels is energy from the Sun which was used millions of years ago by living organisms in their biological processes. The large scale combustion of these compounds is upsetting the current ecological balance and the consequences for the environment are already being felt.

For human civilisation to continue progressing, so that future generations can have a better life and be able to further develop the technological society which we have already begun to build, in order that this marvellous planet which has given us life can continue being home to our species, it will be necessary to change the forms of energy and the way in which we use them. Fossil fuels urgently need to be done away with and replaced with renewable energy sources. We need to use energy in a sustainable way and be aware that we inhabit a planet where everything is connected, in which the biosphere we are part of is made up of all the different species that all depend on it to survive.

For the future of our civilisation there will need to be a return to our origins: by using the wind, the power of the Sun, bio-mass..., all of the renewable energy sources that were used by our ancestors before us.



NOTE: We will now present the collection of activities related to energy, the main subject of this teaching material. These activities are not designed to be carried out in any particular order, so you can choose which ones are best suited to your subject matter, the interest of your students or current concerns.

We hope you will find it useful for your teaching work and helps to reflect upon the origins of energy and the way our society uses it.

Activity 1 *The concept of energy*

Answer the following questions

1) Try to define the word *energy* without looking it up in a dictionary. Then put the definitions of each member of the class together: are they similar in any way?

2) Ask the teachers of different subjects what is energy: the idea is that they answer as teachers of their given subject, not as physicists.

3) Look up the definitions of energy in the dictionary. Which one would you choose? Why?

4) Study these texts. What kind of energy do they refer to? Do you think that energy is treated in these contexts as something subjective? Why? Does it actually exist as such?

"...The next level is even more impressive when we consider that for Kardashev, a type 3 civilisation is one that can manage an amount of energy similar to that found within an entire galaxy. If we bear in mind that a typical galaxy such as ours, the Milky Way contains around 200 billion stars, we begin to grasp an idea of the enormous capacity that a civilisation reaching this level of advancement would have..."

"...It is no mystery to anyone that positive thinking is an excellent way to help bring better results to our lives. It is proven that a positive thought is 100 times more efficient than a negative one, however if you put more energy into your negative thoughts, then the results would obviously tend to lean towards the negative side..."

"...The positive energy released by every human being is the result of a motivated mind and a healthy body. Imagine if we combine this positive energy with a smile, one which reflects our well being, then we have the key to getting even further and reaching the goals and objectives we have set ourselves and in this way become a successful person. Our daily lives require not only physical energy, but also positive energy, considering that our bodies reflect the way in which we act and think, then it is only a question of harmony; if we think positively, maintain a healthy body and our attitudes really are in accordance with what we think and say, then our organism should function properly..."

"...It is something of a paradox that the most effective form of energy today, is how to save it and use it efficiency. It's not a case of reducing our quality of life and committing ourselves to a future which limits our use of energy. On the contrary, if we are able to use energy more efficiently and only use the amount needed, when and where it is necessary, we would have more resources available to us in order to maintain this quality of life for us and for the generations to come...."

In any case, the definition of energy that we are interested in is this:

The capacity to do Work.

Activity 1 *The concept of energy*

Answer the following questions

5) What would you associate energy with, cold or heat? What is cold? What is heat? What is the difference between thermal energy and heat? What is the unit of measure for heat? What is the unit of measure for energy?

6) What were the "basic" sources of energy used by our ancestors?

7) WORD SEARCH. Find 20 words (vertically, horizontally or diagonally) which have something in one way or another to do with ENERGY.

WORD SEARCH

B	K	R	D	A	E	I	P	U	M	J	Y	T	G	E	N	E	R	A	T	O	R	A	F
R	I	E	V	E	U	Z	H	Z	I	T	P	C	O	A	Q	D	S	M	B	I	S	C	T
S	A	O	T	Y	S	C	O	O	U	Q	P	W	N	I	N	D	S	M	T	I	O	S	I
C	H	D	M	H	S	K	T	Z	I	A	M	E	D	R	L	F	O	S	S	I	L	A	D
I	X	M	I	A	O	R	O	O	W	N	N	N	O	C	E	A	N	W	O	Z	L	U	E
C	C	R	W	O	S	I	V	P	A	G	U	N	M	D	D	D	I	U	I	G	D	R	M
R	T	J	I	U	A	S	O	F	S	S	C	A	I	C	Z	S	M	Z	X	N	X	A	D
Q	I	T	Z	I	B	C	L	U	R	C	L	U	G	H	P	P	E	U	W	P	D	N	I
F	I	S	S	I	O	N	T	S	O	O	E	B	I	G	O	E	E	R	D	P	J	I	L
R	E	S	I	D	U	E	A	I	M	A	A	W	E	I	A	F	Q	V	O	P	V	U	A
H	E	Y	D	H	Q	D	I	O	V	L	R	C	Y	S	D	S	W	A	T	E	R	M	R
N	G	Z	F	I	W	I	C	N	D	I	Z	O	R	E	F	I	N	E	R	Y	J	P	E
T	U	I	S	O	L	A	R	K	C	N	T	T	B	K	R	D	A	E	I	P	U	M	J
X	C	T	U	R	B	I	N	E	I	K	O	Y	R	T	J	I	U	A	S	O	F	S	S

8) The main forms of energy transfer are radiation, conduction and convection. What do they consist of? Explain how energy is transported from one place or medium to another.

RADIATION

CONDUCTION

CONVECTION

Activity 2 *Limited resources: Fossil fuels*

Energy that comes from what we call fossil fuels is the energy obtained from the combustion of oil, natural gas, coal and their derivatives. Given that the formation of these fossil compounds requires an incredible amount of time and the fact that we consume them at a terrible rate, means that these energy sources are non-renewable. For the last 200 years our civilisation's progress has been based on the use of fossil fuels.

Let us reflect upon and so understand the current global panorama.

COAL, OIL, NATURAL GAS

INTRODUCTION. How was the coal, oil and natural gas found on this planet formed? Was there a certain geological age in which most of these compounds were formed? Which one? What are the main differences between coal, oil and natural gas?

COAL.

Answer the questions

1) Where in the world are the most important coal deposits found?

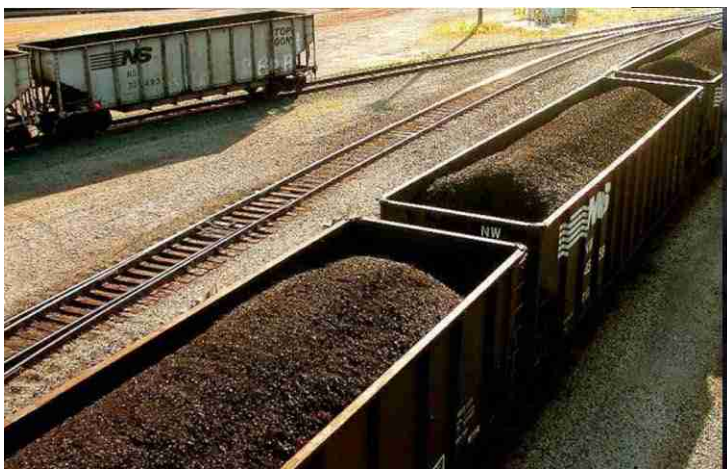
2) How many types of coal are there? Place them in order of their heat capacity.

3) During the Industrial Revolution carbon became the primary source of energy used. What was its most common use? Was it later replaced? How?

4) Do the gases released through the burning of coal cause pollution? What kinds of problems can arise from this widespread burning of coal, which is exactly what we have been doing for the last 200 years? Is it harmful to our health?

5) Other than burning it, what other uses does coal have?

6) Is much coal consumed in the world today? What percentage of the total energy consumed does it represent? Look up last year's statistics.



Activity 2 *Limited resources: Fossil fuels*

OIL.

1) What is oil? Is it a natural resource? Is it renewable? Why?

2) The process of separating the different derivative products of oil is known as "refining" Write a list of the most important products which are obtained through this process.

3) Some of the derivatives of oil are used as fuel in different vehicles which transport people or goods. On your previous list mark the ones that are used in each case.

Example: *petrol* ..... ▸ *cars*
kerosene ..... ▸ *aeroplanes*

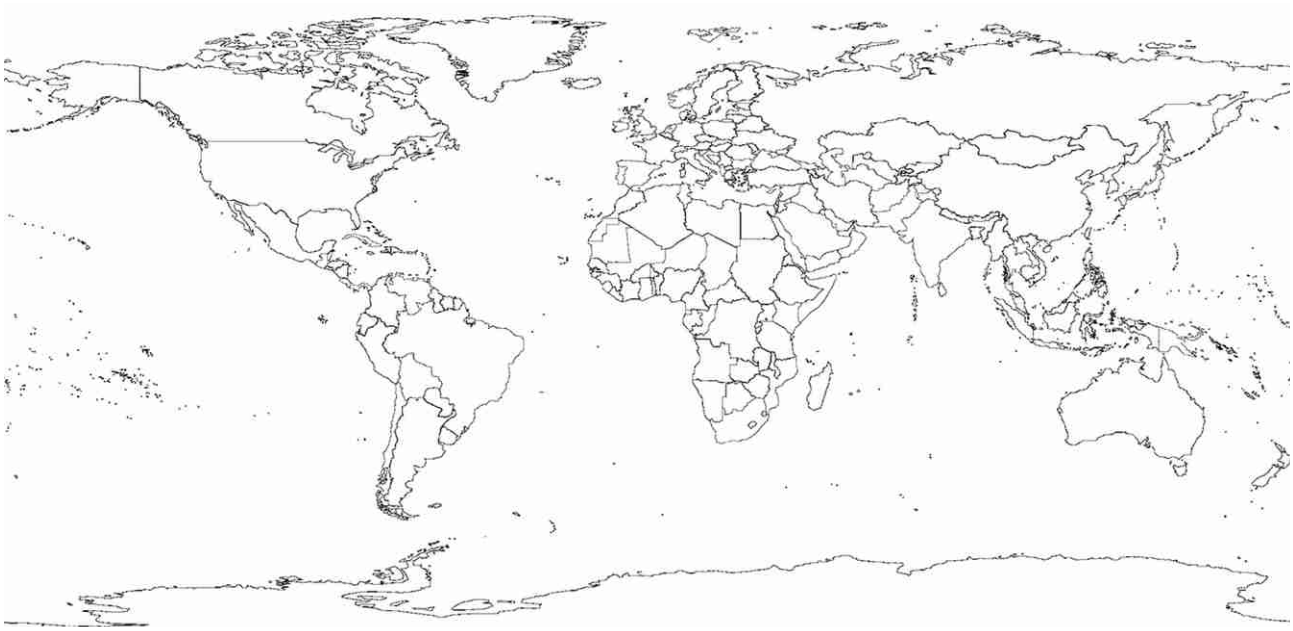
4) Mark the oil derivatives which are used as fuel to produce heat for buildings or electricity in power stations.

5) Mark which of the oil derivatives are not used as fuel. Write a list of products which are manufactured using some of them. Do you think that the best use for oil is to burn it? Look around you: your clothes, the building you are in, your classroom equipment...look for the "oil footprint" in all of them.

6) A world without oil: Use your imagination to write a composition about what a day in your life would be like if you were to use nothing that contained any derivatives of oil. Read out the different compositions and discuss the subject in class.

7) Diesel or petrol. Create a table using the different types of diesel and petrol which you find in petrol stations stating the proportion of hydrocarbons and the price. Although we don't use thousandths of Euros in our everyday lives, thousandths of Euros do appear in the fuel prices shown at the petrol stations. Why do you think that is?

8) Write a list of the oil exporting countries and mark them on this blank map.
Are the exporting countries also big consumers of oil? Are there countries that only import oil? Do these latter countries consume large amounts? How do they get their supply? In general terms, how does this affect their economies? What is the situation in our country?



Activity 2 *Limited resources: Fossil fuels*

9) THE UNIT OF MEASURE: BARRELS OF OIL AND OIL WARS

Regardless of the fact that oil is transported through pipelines and oil tankers, the unit of measure for the trading of oil is the barrel, the volume of which is 42 American gallons, approximately equivalent to 159 litres. Its price has varied a great deal over the last few decades and there are numerous factors which influence these price changes: SPECULATION plays a very important role among them. Answer these questions in your notebooks

- What is the current price of a barrel of oil? Search for the oil price graph from the previous month and the previous year. Is it rising? Is it falling? Do you think the price of oil is high? Compare it to the price ten years ago. You can find all this information by clicking on OIL in the price graph on the website: http://www.24hgold.com/english/home.aspx

cotización y precio del petróleo en los últimos 5 días 24hGold

- The rise in the consumption of oil has always been linked to economic development. What role did oil play in the First and Second World Wars?
- In the 1970's there were two important oil crises. What happened?
- What is OPEC? Which countries are members? What role did it play in the so-called *Oil Crises*? What role does it carry out today?
- Do any of the current armed conflicts have interests in oil as their basis? Name the most important ones of recent decades.
- What is the function of the IEA (International Energy Agency)? Has it intervened in any of the previously stated conflicts? In what way?

10) OIL SPILLS. Accidents involving the transportation of crude oil have exploded into the headline news on several occasions. Despite the fact that the safety measures due to current technology should be "practically flawless" reality shows us that unfortunately it is quite a different matter. The accidents involving the transportation of oil that occur at sea produce huge oil spills which affect vast expanses of seawater (coastlines and the sea bed).

- Search for the most serious oil spills occurring in recent years: the causes, the consequences, the areas affected, the current situation of the coastlines, the impact on the local economies, etc. Ah! And the names of the ships or the infrastructures that caused them.

11) How much oil is consumed in the world today? What percentage of the total energy consumed does it represent? Look up last year's statistics.

Activity 2 *Limited resources: Fossil fuels*

12) The World's biggest companies and the GDP of countries. Activity for comparing statistics. Study the following tables: The first shows the biggest companies in the world according to their annual turnover for 2012 (http://tinyurl.com/bwf6rqc). The second shows the nominal GDP of some countries for 2012 as obtained from this website: (http://tinyurl.com/cmxybu3).

Answer the questions. (NOTE: *mdd = millions of dollars. If you wish, you could create your own tables updating the information according to the last financial year).*

- What kind of companies have the biggest turnover?
- Add together the oil companies' annual turnover for 2012. Imagine that they were to merge into one company: Their income would become higher than which countries?
- Compare the turnover of each oil company to the GDP of its country of origin. (You will need more information than what is found in the table: use the previous links for your search).
- In 2012, how many companies made more money than the entire GDP of Portugal?

	COMPANIES	BILLING 2012
1	Royal Dutch Shell	484.489 mdd
2	Exxon Mobil	452.926 mdd
3	Wal-Mart Stores	446.950 mdd
4	BP	386.463 mdd
5	Sinopec Group	375.214 mdd
6	China National Petroleum	352.338 mdd
7	State Grid	259.142 mdd
8	Chevron	245.621mdd
9	ConocoPhillips	237.272 mdd
10	Toyota Motor	235.364 mdd

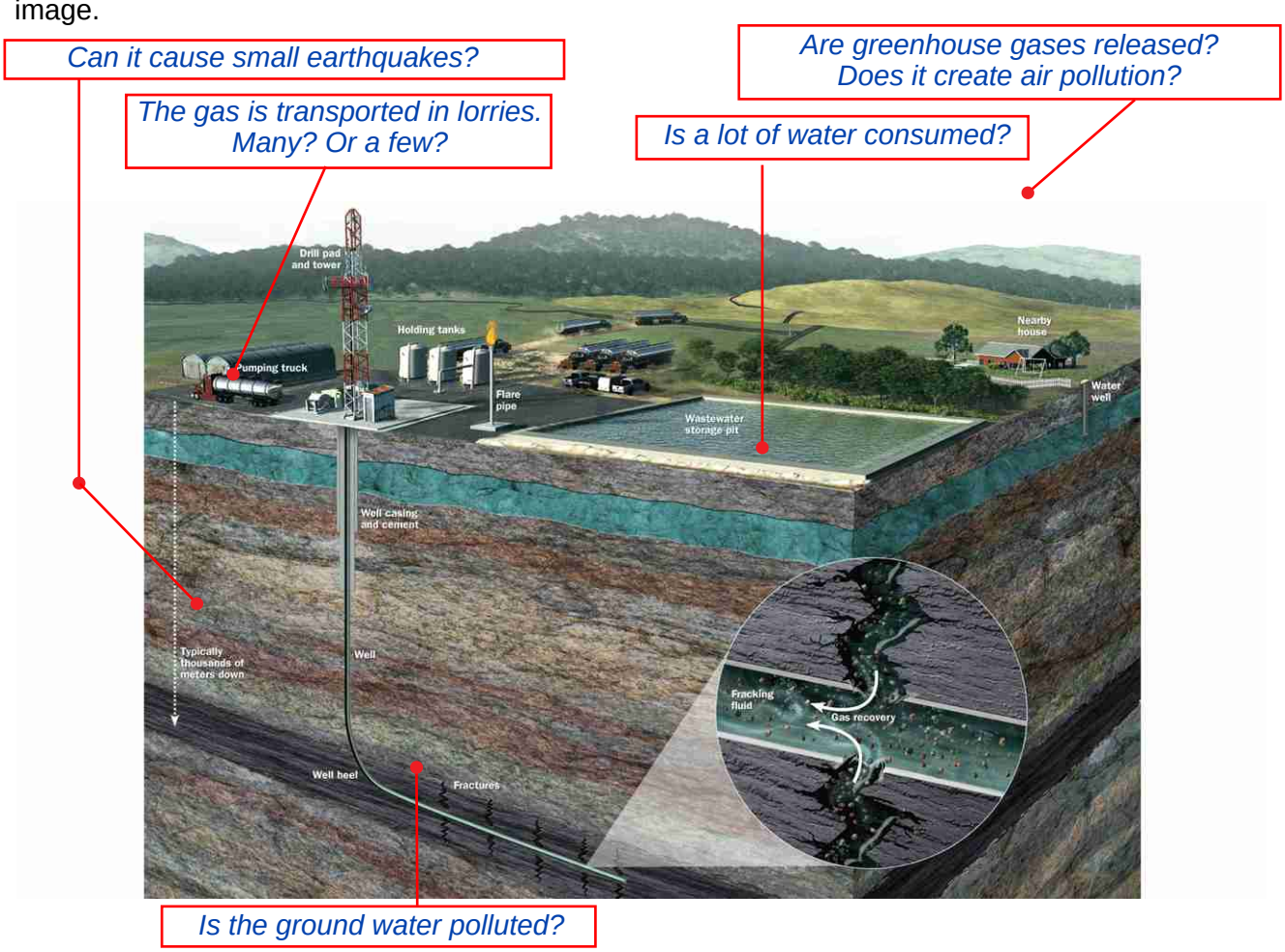
COUNTRY	Nominal GDP 2012
EU	17.070.011 mdd
U.S.	15.653.366 mdd
China	8.250.241 mdd
Germany	3.336.651 mdd
France	2.580.423 mdd
Spain	1.340.266 mdd
Belgium	476.796 mdd
Poland	470.354 mdd
Chile	268.278 mdd
Portugal	210.620 mdd

Activity 2 *Limited resources: Fossil fuels*

GAS. FRACKING

There are conventional and non-conventional ways of extracting gas. We will be looking at this latest technique.

1) Hydraulic fracturing or fracking refers to the non-conventional technique of extracting gas from underground deposits. Explain what it consists of by answering the questions which appear in the image.



2) Terminology. Gas... *natural*? We often find the adjective *natural* alongside the word gas. A well known Spanish company has it as part of its name. What is meant by its use? Is it coincidental? What is it trying to claim? Are there positive or negative connotations to the use of *natural* as the adjective? What happens after its combustion? Does it cause pollution? Does that mean that oil and coal are also *natural*? And also Uranium? Explain your answers

3) Look for news items about fracking in the media. Were they difficult to find? In which news sections do they appear? Are there any fracking projects taking place nearby or around you local area? Has it attracted your attention? Did you find any *letters to the editor*? Analyse the news items you found.

4) Do you consider hydraulic fracturing to be a safe technique for obtaining energy? What are its advantages? What are its disadvantages? Write a list of pros and cons.

5) Imagine that deposits of natural gas have been found in your town or city. One day there is a knock at your door and someone offers you some interesting benefits in exchange for voting in favour of a hydraulic fracturing well being installed close to your home. How would you respond? What would you think? How would you respond to the well being installed 100km away from your home? Share your opinions with the rest of the class.

6) How much gas is currently consumed worldwide? What percentage of the total energy consumed does it represent? Look up last year's statistics

Activity 3 *Nuclear power*

NUCLEAR POWER STATIONS

What is the first thing that comes to mind when you think about *nuclear power stations*? More often and inevitably we associate these power plants with nuclear accidents and radioactive spillage, etc. But what do we really know about nuclear power stations?

The principle behind the basic function of a nuclear power station is the same as that found in any thermal power plant be it oil, gas or coal: the heating of water to generate high pressure water vapour that spins a turbine to generate electricity through induction.

The big difference in the case of each plant is the fuel which is used in order to heat the water: the "traditional" power stations use fossil fuels, whereas the fuel used by the nuclear power stations, just as the name suggests is nuclear. Both kinds of installations share common elements, because part of the process is the same, but the fact that they use different sources of energy means that each of them has its own particular way of functioning. All power plants or stations cause pollution, but depending on the primary energy source used, they do it in different ways.

In the previous section we have studied and worked on fossil fuels. Now we will be looking at nuclear fuels. Answer the questions.

1) The word that changes everything: FISSION vs FUSION ¿Qué diferencia hay entre ellas?
   What is the difference between them?
   In nature we can find examples of both. Where?
   Which one is currently used in the reactors of nuclear power stations?
   What is the ITER? Search for information about this project.

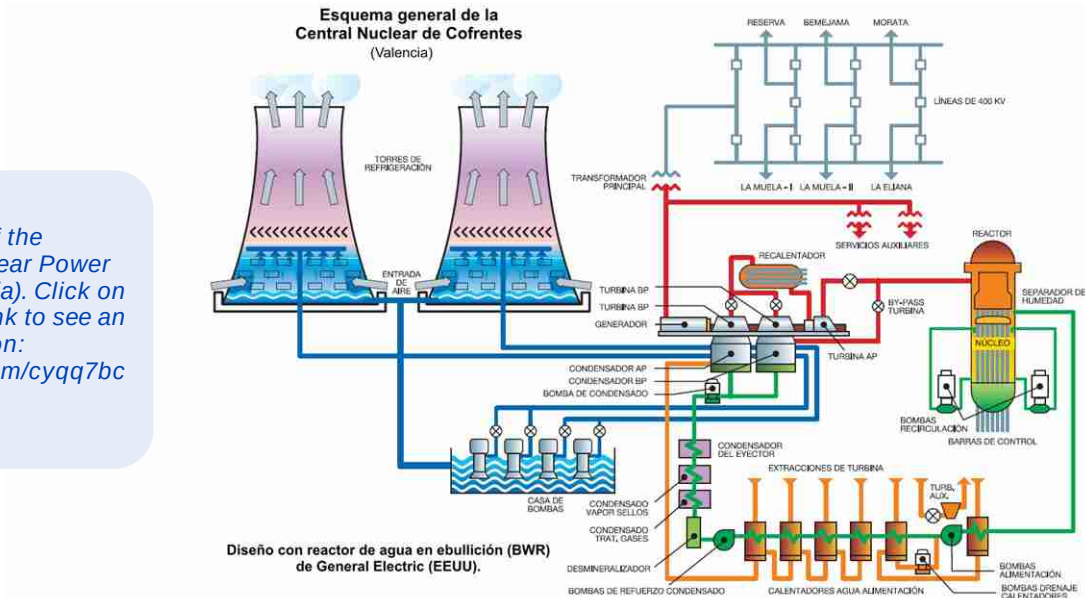
2) The main fuel used in nuclear power stations is uranium. Is it renewable? How is natural uranium treated before it is able to be used as a fuel?

3) Explain what is meant by critical mass and chain reaction within this context.

4) One common element present in most thermal power plants (be it nuclear or not) are refrigeration towers. What is released from the top of these towers? Identify them in the diagram below. Look for similar images of towers from other thermal non-nuclear power plants.

5) Water is a fundamental compound in the functioning of a nuclear power station. List its main functions.

General plan of the Cofrentes Nuclear Power Station (Valencia). Click on the following link to see an enlarged version: http://tinyurl.com/cyqq7bc



Activity 3 *Nuclear power*

NUCLEAR ACCIDENTS

6) Work in groups: divide the class into groups in order to work on the suggested topics. After collecting information on the chosen topics, each group with the aid of a Power Point or similar means will do an oral presentation explaining to the rest of the class what they have learned; each group will then share the material compiled in their files with the others, so that each student will have access to all of the information gathered. Try to be original in your presentations.

With help from the teacher, group 1 should present their work first, so that the other groups use it as a guide.

Group1. Basic concepts

- Classification of nuclear accidents.
- The INES scale.
- Operational guidelines. The organisations or bodies that come into play after a nuclear accident.
- Activation of emergency plans: who defines the incident, who gives the orders, who carries them out.

Group2. Spain

- What nuclear incidents have there been in Spain? When, where and the level reached on the INES scale
- Repercussions of the incidents in the media. Media coverage.
- Current situation of the power plants that have recorded incidents.

Group 3. Chernobyl (1)

- Where and when did it happen? Why? Effects in space and to the weather: Do the consequences still exist?
- Media coverage: local, national, international...

Group 4. Chernobyl (2)

- Classification according to the INES scale.
- The area affected (include a map).
- Population: fatalities, people affected, people displaced...
- The role of the "Liquidators": Who were they? Soldiers, firemen, volunteers, engineers...?
- Consequences for nuclear safety protocols.

Group 5. Fukushima (1)

- Where and when did it happen? Why? Effects in space and to the weather: Do the consequences still exist?
- Media coverage: local, national, international...

Group 6. Fukushima (2)

- Classification according to the INES scale.
- The area affected (include a map).
- Population: fatalities, people affected, people displaced...
- The role of the "Fukushima 50": Who were they? Soldiers, firemen, volunteers, engineers...?
- Consequences for nuclear safety protocols.

- The documentary RADIOACTIVE WOLVES won the "Cuidad de Pamplona" award at the Telenatura film festival in 2011:

"25 years after the worst nuclear accident in history, the explosion of the central reactor at Chernobyl nuclear plant on the 26 of April 1986, the area uninhabitable for humans and contaminated by radiation known as the "exclusion zone" is now dominated by wolves. Over the years a rich ecosystem has evolved where the wolf population has thrived unchecked."

Here you can find the documentary in English: (http://tinyurl.com/d9o37fo): after watching it what are your conclusions?
Here at the Planetarium we have a version of the documentary with Spanish subtitles. It can be shown on the day of your visit if required (with prior notice).

Activity 3 *Nuclear power*

NUCLEAR POWER IN SPAIN

Spain's nuclear power stations supply around 20% of all electricity consumed. In contrast to other countries, Spain has not developed a decided policy for nuclear power. However, since the 1960's there have been several nuclear power stations in operation. Let's look at the current panorama of this energy in our country.

1) Make a list of the names of all the nuclear power stations found in Spain and their locations.

2) State whether they are in operation, are in the process of being shut down or are projects which have been scrapped.

3) Where do Spain's nuclear power stations currently obtain their uranium from? Has this always been the case? Find out about any old uranium mines in Spain, are there any still being worked today?

4) There is a huge difference between high level radioactive waste management and intermediate and low level radioactive waste management, but in Spain they are all dealt with by which company?

4.1) INTERMEDIATE AND LOW LEVEL RADIOACTIVE WASTES. Define them. Where are they stored? What kinds of installations produce these types of waste? Do they only come from nuclear power stations?

4.2) HIGH LEVEL RADIOACTIVE WASTES. Define them. Where are these types of waste produced? Where are they stored? Are there any cases in which the waste from a power station is stored outside Spain? Which power station? Some years ago, a place for centralising the storage of these types of waste was outlined. Look for information on the places that were considered as possible sites. Which site was finally decided on for its installation? Look for information on the media coverage and social repercussions that ensued. What exactly is the current location of this project? Where will the waste that is to be stored there come from? Is this a final solution for this waste? What is the installation's storage capacity? What percentage of its capacity is destined for the waste coming from Spain's nuclear power stations? Will this installation contain waste from other countries?

Check out this application on Enresa's website: http://tinyurl.com/lhjt2ea

CLOSED FUEL CYCLE NUCLEAR POWER STATIONS

En un reactor nuclear de fisión tienen lugar reacciones que producen distintos núcleos radiactivos. De todas ellas la que más interesa es la fisión del Uranio-235, pero también se producen reacciones de captura neutrónica que dan lugar a núcleos más pesados. Estos elementos, especialmente el plutonio, son potencialmente fisionables y por tanto contienen energía que se puede aprovechar. En las centrales nucleares de ciclo cerrado, el combustible gastado es reprocesado para separar el plutonio e introducirlo de nuevo en el proceso.

Search for and locate on a map the world's working and planned closed fuel cycle power stations. How many are there in Spain? Which countries are opting for the closed fuel cycle? Which countries are doing away with them?

The fuel used in open fuel cycle power stations is enriched uranium (which has a higher quantity of U-235 than found in natural uranium). What is the fuel used in a closed fuel cycle? What is MOX fuel?

Search for and locate on a map the world's nuclear reprocessing plants. Are there any countries with closed fuel cycle power stations which have no reprocessing plants? Where do they obtain their reprocessed fuel from? Mark on the world map its shortest transport route. Search for the countries officially listed as possessing the atom bomb. Are there any countries which are not on the list which have nuclear reprocessing plants? Which is the only Muslim country which has nuclear power stations? Which other has them in the pipeline?

In a typical case it would take 4,000 years of confinement for non reprocessed radioactive waste to be considered as non hazardous. What length of time in confinement would be necessary for the waste from closed fuel cycle power stations? Does a permanent storage place for them actually exist? What is it like? Which civilisations flourished 4,000 years ago? What kingdoms existed in the Iberian Peninsula? Could you imagine what the world will be like when the reprocessed radioactive waste is no longer dangerous? And when the waste from the open fuel cycle stations is safe too?

Activity 4 *Renewable energy and sustainability*

Renewable energies are those derived from natural sources which are naturally replenished or those which do not run out for a considerable length of time. The following types of energy can be considered as renewable: solar, tidal, wind, hydroelectric, geothermal and biomass. Answer the following questions. You can consult the infographics on this website: http://tinyurl.com/og8uu6e.

1) Where does tidal power come from?

2) What geographical characteristics are necessary for the installation of a tidal power station?

3) Look for different types of power stations that use the energy of the waves. Explain about one which you find particularly ingenious.

4) How many metres are necessary between the high and low tides in order to make a tidal power station viable? Check out this link www,tablademareas.com and name 5 places where it would be possible to install a tidal power station and 5 places where it would not.

5) Where does wind power come from?

6) What is a wind turbine? How do they work? Where are they located? What kinds of winds can be utilised with the current technology?

7) Hydroelectric power. What is the difference between run-of-the-river, conventional (dam), and pumped-storage hydroelectric power stations? Which of them demands a more rational approach to the management of resources?

8) Where in the world is the largest hydroelectric power station found? What do you think about it?

9) Solar power. What energies are obtained from the Sun?

10) Photovoltaic solar power. In photovoltaic solar panels the electricity is generated directly from sunlight. Search for the advantages and disadvantages of this energy source in comparison to others. In what kinds of installations does it have a particular advantage?

11) Solar thermal energy. These installations use the solar energy from sunlight in order to heat water. Search for a diagram in order to help you understand how it works. Which applications use this method to harness the energy from the Sun? Which countries have the largest potential for using it?

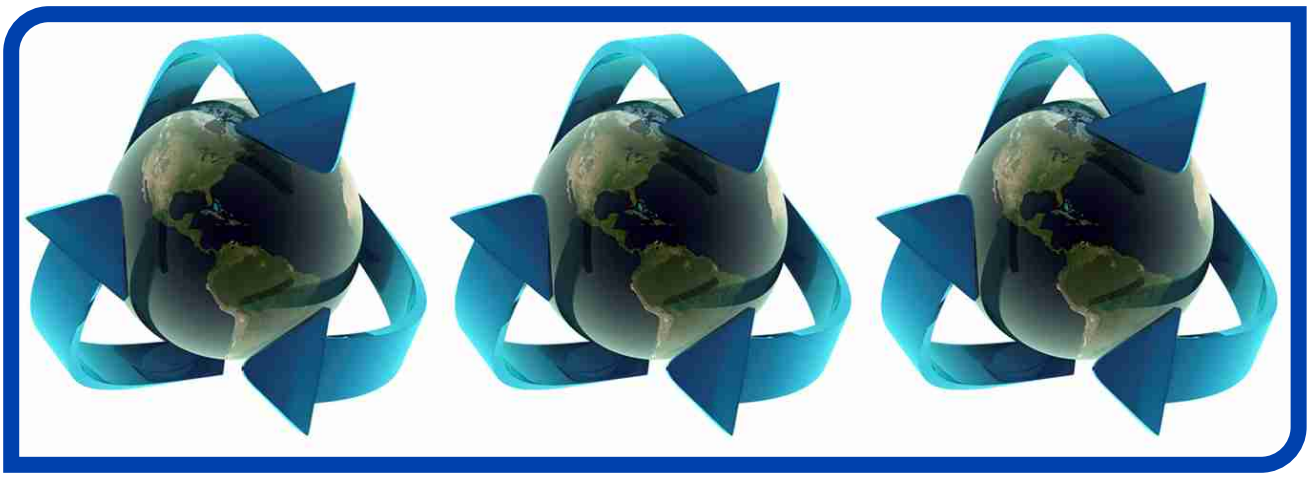
12) Concentrated solar power. These kinds of power stations concentrate the sunlight from a large area onto a single point to heat water or other compounds in order to turn turbines which generate electricity. Find the different power stations of this kind around the world. For which countries could this form of energy be a viable alternative? Find out where they are located in Spain.

13) Geothermal energy. Where does this renewable form of energy come from? Give a short explanation of what it is.

14) Ocean thermal energy conversion. Look up the basic principle behind these kinds of power stations.

15) Biomass. There are three basic kinds of biomass: natural, waste and produced. Explain what each of them are. What are the different systems employed in the exploitation of biomass? What is the difference between the emissions from biomass combustion and that released by fossil fuels?

16) Look up data on the concentration of CO2 in the Earth's atmosphere. When was the last time in our planet's history that the amount of CO2 was so high? Is there a general consensus on the origins of that increase



Activity 4 *Renewable energy and sustainability*

Renewable energy and *sustainability* are two concepts which more than often go hand in hand; however they are not synonyms. Let us think a little about them.

Sustainable development is a term that was first used in 1713 by Hans Carl von Carlowitz, the man in charge of forestry in Saxony, Germany at that time. His book Sylvicultura oeconomica contained the first comprehensive concept of sustainable forestry: *"If we only cut down a few trees from a forest, then it will regenerate itself, but if we cut all the trees down then that forest will disappear forever"*

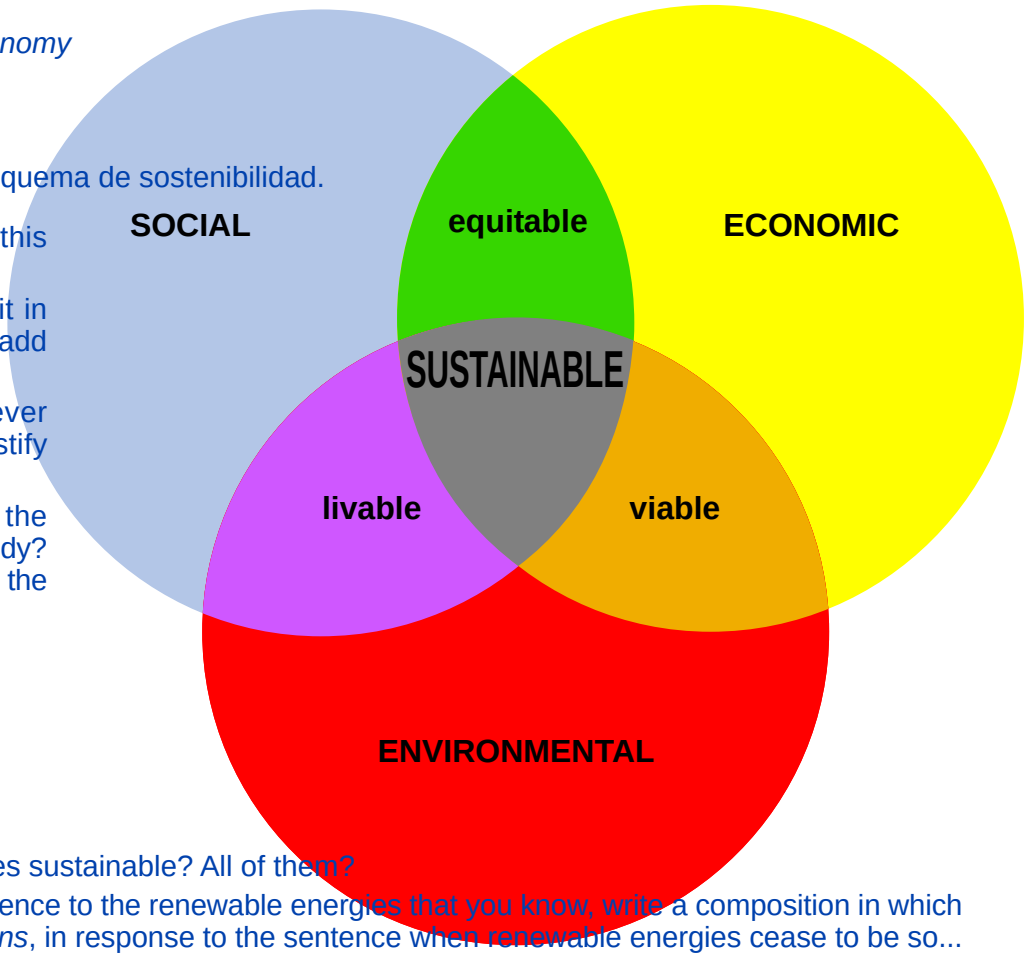
1) Sustainability indicators. What are they? Different sustainability indicators are used; list some of them.

2) When is it possible to use the adjective *sustainable*? To which words can it be applied, and in each case what does that imply? Make a list.

- *e.g. Sustainable economy*
- *Sustainable city*
- *Sustainable school..*

3) Te presentamos un esquema de sostenibilidad.

- Do you agree with this diagram?
- Would you change it in any way? Would you add or remove anything?
- Change it in whatever way you like. Now justify those changes.
- How sustainable is the building where you study? Analyse it according to the diagram.



4) Are renewable energies sustainable? All of them?

- Composition. With reference to the renewable energies that you know, write a composition in which you expose their *limitations*, in response to the sentence when renewable energies cease to be so...

  If need be, you can take the following points into account: Whether or not they pollute, in what way they do pollute, whether they are silent or noisy, whether they are available throughout the year, how their installation affects the environment, the consequences for wildlife, whether or not their power is limited, whether their installation is expensive, the time it takes to become viable...

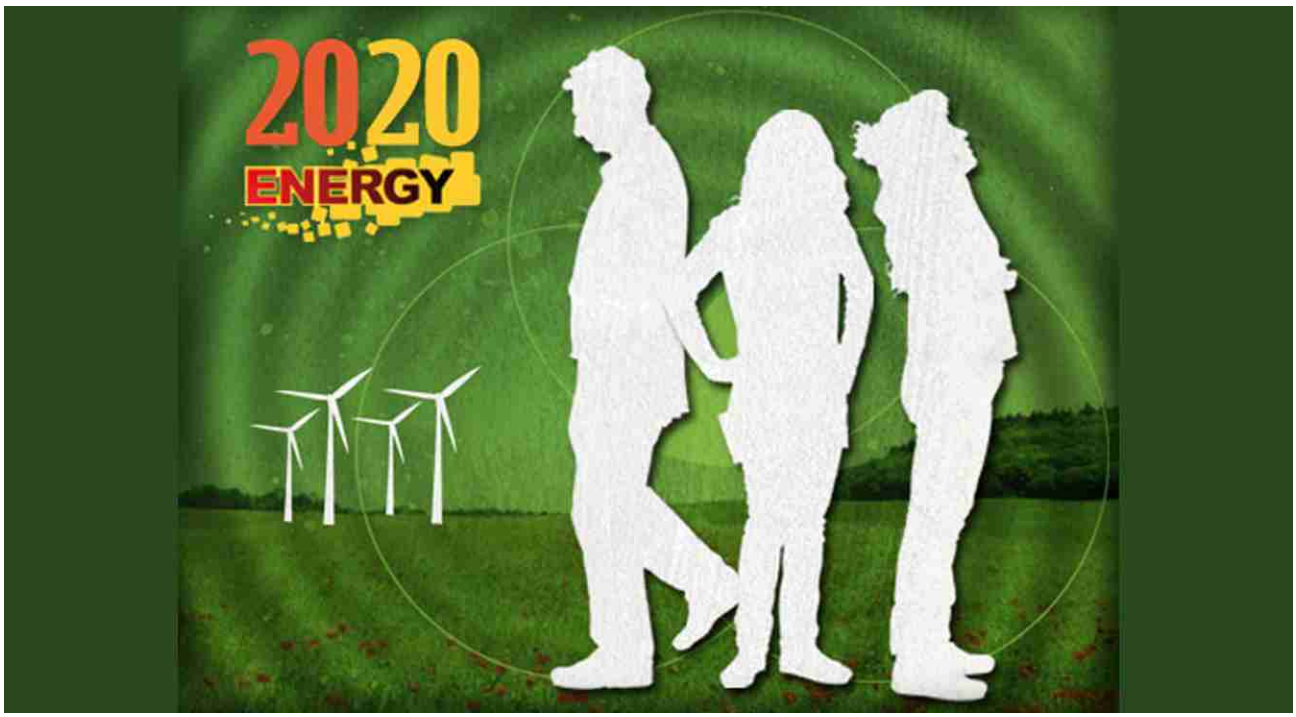
5) Choose an existing renewable energy power station (of any type) and compare it with another non-renewable one in terms of sustainability. Gather information and put the energy companies, the socio-economic conditions of the area, etc into context.

Activity 4 *Renewable energy and sustainability*

Check this interesting European project about energy

ENERGY BITS 2020: http://www.2020energy.eu/es

ENERGY BITS is a cross-media project on sustainable energy and energy saving, supported by Intelligent Energy Europe (European Commission),with the aim to stimulate behavioural change and promote innovative pratices among the 14-18 years old. Its ressource platform propose a collection of 24 documentaries, a webdocumentary, participative tools and a serious game in 9 languages.



The serious game 2020 Energy was designed within the framework of ENERGY-BITS a European cross-media awareness programme for teenagers (14-18 years old) financed by the Intelligent Energy Europe programme. Energy-BITS encourages more responsible and efficient behaviours in energy consumption and promotes renewable energies.

ENERGY-BITS, for educators and the general public: 24 documentaries, 1 webdocumentarY, 1 serious game, 1 collaborative and social space

These resources were created by 13 partners across Europe and are available in 9 European languages on the platform www.energybits.eu.

The serious game introduces energy issues with a sustainable development message in a fun way through 9 interactive missions. It can be used as an introduction to the notion of sustainable development or to assess the acquired skills at the end of a school programme.

The Energy-Bits documentaries are linked to each mission of the game. They show a concrete answer by one European country to a question raised by the game. They can be used for case studies.

The Energy-Bits programme has a collaborative dimension and invites the young, individually or collectively in their educative sphere, to get mobilized. After playing and watching the documentaries, you can participate in the contest “Have your say” by directing a video with your class on the theme of Energy.

Activity 5 *Energy in Spain*

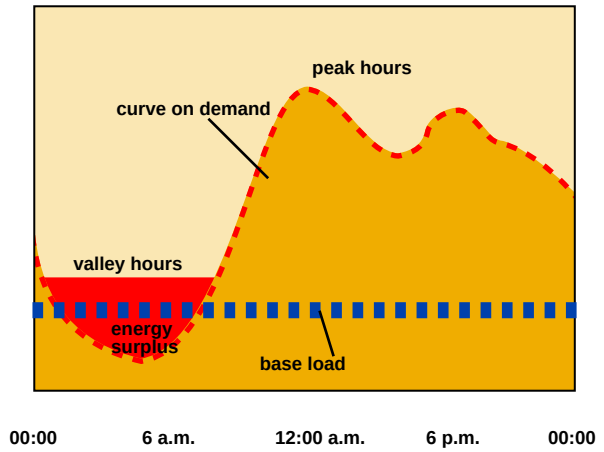
ELECTRICITY. Red Eléctrica de España S.A. (www.ree.es), was founded in 1985 and is the TSO (Transmission System Operator) of the Spanish electricity system. As the system's operator, it guarantees the safety and permanence of our country's supply by maintaining a constant balance between generation and consumption. It also manages the electricity distribution grid and is the sole operator of this network in Spain.

¿HOW MUCH ELECTRICITY DO WE CONSUME?

Can we predict the consuption of the whole country? How is the energy consuption distributed?

Daily consumption. The consumption of electricity drops drastically as from midnight and reaches a minimum during the small hours. From around 6 a.m. it begins to rise again and reaches its maximum by mid morning, there is a slight fall around lunchtime and then a second peak in the early evening.

The curve on demand is due to a combination of many different types of consumption: domestic, industrial, for transport, etc. And depends on many factors: temperature (electric fires in winter and air conditioning in summer), hours of sunlight, national holidays, etc.



Because electricity cannot be stored in large quantities, it is necessary to constantly maintain the base load, with a strategy that allows both the basic demand as much as the possible peaks in demand to be met.

1) Make two lists: in the first include situations and products related to the base load; and in the other those related to the peaks in demand.

BASIC	PEAK
- Refrigerator	*- Christmas Night*

2) Annual consumption. Do you think you can draw a graph which represents the approximate annual consumption of electricity? At which time of year do we consume more energy? Why?

3) Which type of power station is most suited for the retaining of electricity during off-peak hours? Why?

Activity 5 *Energy in Spain*

Next there will be some questions on the different kinds of energy we have studied until now. Answer the questions using your notebooks and the blank maps whenever you consider it necessary.

Note: this can also be carried out as a group exercise (1 group per type of energy). If you want, you can also use Google Earth and its placemarks to mark the different locations. We will use a different colour for each energy. You can also consult these websites: www.unesa.es/ www.minetur.gob.es/, www.ree.es/ etc.

FOSSIL FUELS IN SPAIN

OIL

1) Where are Spain's oil fields found? Are there many? Who administers them? Mark these oil fields on the map.

2) How much oil was produced in Spain over the last year?

If we take the primary energy consumption in Spain into account, what percentage of the energy we consume comes from oil? What percentage of that oil is produced in Spain?

3) To what extent does Spain depend on imported oil? Which countries do we import the oil from?

COAL

1) Where are Spain's coal deposits found? Are there many? Who administers them? Mark the deposits on the map.

2) How much coal was produced in Spain over the last year?

If we take the primary energy consumption in Spain into account, what percentage of the energy we consume comes from coal? What percentage of that coal is mined in Spain?

3) To what extent does Spain depend on coal imports? Which countries do we import the coal from?

4) Mark the different routes through which the imported coal enters our country.

GAS + LPG (Liquid Petroleum Gas)

1) Where are Spain's gas + LPG deposits found? Are there many? Who administers them? Mark the deposits on the map.

2) How much gas + LPG was produced in Spain over the last year?

If we take the primary energy consumption in Spain into account, what percentage of the energy we consume comes from gas + LPG? What percentage of that gas is produced in Spain?

3) To what extent does Spain depend on imported gas + LPG? Which countries do we import the gas + LPG from?

4) Mark the different routes through which the imported gas + LPG enters our country.

5) Find out which places in Spain have decided not to allow the procedures to go ahead for the carrying out of hydraulic fracturing (fracking).

- What are the main uses for these energy sources? Write a list of examples

Activity 5 *Energy in Spain*

ELECTRICITY

We transform different energies into *electricity*. We obtain electricity through power stations which are supplied by either renewable or non-renewable energies.

1) Which five big companies administer Spain's electricity? Look it up on www.unesa.es

2) What are the different kinds of installations that generate electricity? Approximately how many of each kind of power station do we have? Where in the country are they located? Mark them on the map.

3) What percentage of electricity is produced by each kind of power station?

4) The distribution of electricity.

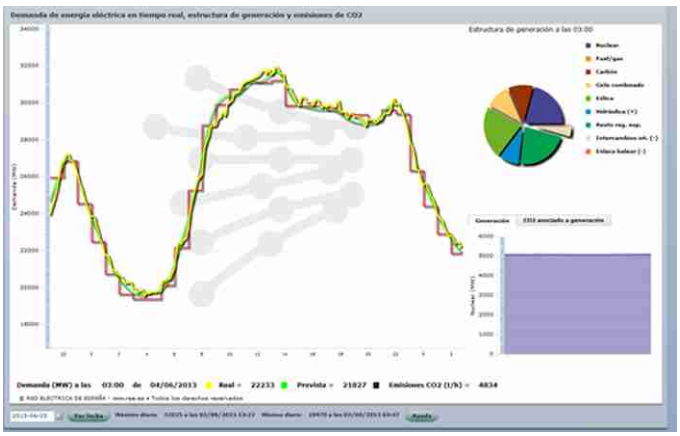
4.a) When it comes to storage, what is the main difference between electricity and the other types of energy? What does this imply?

4.b) How is electricity distributed through the national grid? Write a summary. Perhaps this animation will help: http://tinyurl.com/cudoprs

4.c) Which countries does Spain exchange electricity with? Which predominates, import or export? Mark them on the map.

5) On the Red Electrica de España website you are able to see Spain's demand for electricity in real time: http://tinyurl.com/nf3wlx.

Red Electrica use very advanced technology in the installations which they have around the country in order to obtain the precise information needed to ensure that the electricity grid functions correctly. This data allows them to supervise the availability of the power stations' production, the possible restrictions in the distribution network and the international exchanges and also to make previsions for demand as well.



5.a) Fill out a table in Excel (or similar program) with information from the website. Search in the date picker box, and fill in information from the previous August and November (write down the actual and the forecast data for both months).
5.b) Which days in each month was the actual consumption the highest? What day of the week did these days fall on? When is most electricity consumed, in summer or in winter?

6) Electricity transmission networks. Find and draw Spain's high tension power lines and major power stations (nuclear, thermal, etc) on the corresponding map below. Is there any relation between the high tension lines and the power stations? Considering the information on your map, which places consume the most electricity?

It is an undeniable fact that high tension power lines are a blot on the landscape, and nobody likes them near their homes. Some people claim that these power lines produce negative affects to our health. .. Is there any truth in this? Do some research and form your own opinion. Do you think laying high tension power cables underground could be a solution? What problems would it solve and what problems could it cause?

Find out about protest movements against the instalment of new high tension power lines. Discuss it in class.

Activity 5 *Energy in Spain*

Energy deposits

Energy transportation routes

Activity 6 *Energy and the Environment*

GLOBAL EXTINCTIONS. Our planet, the Earth, is a living and changing planet. It is constantly evolving; there have been 5 mass extinctions throughout its history: the most well known one happening 65 million years ago and which led to the end of the age of the Dinosaurs.

- Do some research and summarise the 5 mass extinctions.
- Think about: What the next one will be? Is the sixth extinction already underway? Are we responsible?

Study the following text from the WHO (World Health Organisation):

Today, humankind's activities are altering the world's climate. We are increasing the atmospheric concentration of energy-trapping gases, thereby amplifying the natural "greenhouse effect" that makes the Earth habitable. These greenhouse gases (GHGs) comprise, principally, carbon dioxide (mostly from fossil fuel combustion and forest burning), plus other heat-trapping gases such as methane (from irrigated agriculture, animal husbandry and oil extraction), nitrous oxide and various human-made halocarbons. In its Third Assessment Report (2001), the UN's Intergovernmental Panel on Climate Change (IPCC) stated: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

RECOMMENDED READING:**The Sixth Extinction. Patterns of life and the future of humankind.**

Richard Leakey. Roger Lewin.

Richard Leakey. Roger Lewin.

ROUND TABLE - QUICK DEBATE. Arrange the tables in your classroom into a circle so that all the students are facing each other; the teacher will give the floor to whoever wishes to speak and the rest of the class must listen attentively.

One of the students, instead of taking part in the debate will write down the ideas and opinions of his or her classmates, these ideas will then be displayed in a mural done by the whole class at the end. The topics to be discussed are as follows (some information will need to be collected in advance). It is not essential that the teacher selects all of the topics in question.

Topics to be discussed:

Considering the different energies that we use, what does the future hold? What changes do we need to bring about? Do we have enough willpower to achieve it?

What role do fossil fuels play in our lives? Do we benefit from them or not? Discuss their positive and negative aspects. To what extent are we dependent on fossil fuels? Could this pose a problem? Suggest possible consequences.

What role does nuclear power play in our lives? Do we benefit from it or not? Discuss its positive and negative aspects.

What role does renewable energy play in our lives? Do we benefit from it or not? Discuss its positive and negative aspects.

What energy model would you suggest for solving the serious problems arising from the waste produced from the burning of fossil fuels?

What ideas and conclusions have you come to?

Debate *current issues*: You could organise a debate on a current energy issue: you will need to look in the media for news items relating to different power stations.

Activity 7 *The origins of the different Energy sources*

As part of this teaching material we have dealt with renewable energy. To conclude, we would suggest you take a moment to consider the concept of RENEWABLE, but from a much broader perspective in time. You will come across some very surprising results when you increase the time scale.

In the following table we give a description of the primary origins of the different energy sources which are used by our society, as well as their ratings as renewable or non-renewable on different time scales:

	Planet Earth	Gravitation (Earth/Moon-Sun/Earth)	Sun	Wind	Fresh water	Life	Renewable 10.000 años	Renewable 1 m.. years	Renewable 500 m.. years	Renewable 10.000 m.. years
FUENTE DE ENERGÍA										
Biomass			1			2				
Coal	3		1			2				
Wind	2		1	3						
Natural Gas	3		1			2				
Geothermal	1									*
Hydroelectricity	2		1		3					
Sea - the Tides	2	1								
Sea – the Waves	2-4		1	3						
Sea - Oceanic thermal energy	2		1							
Nuclear from Fission	1									
Nuclear from Fusion	1*									**
Oil	3		1			2				
Photovoltaic solar power			1							
Solar thermal energy:			1							

- Each **line** represents an energy source; and each **column** the different systems which contain energy.
- The **numbers** refer to the chain which according to our criteria the energy source in each line follows. Therefore a blue number one refers to the system which is that energy's primary source of origin.

Renewable or inexhaustible (within this time)

Non-renewable or exhaustible (within this time)

* the temperature of the Earth's core is reduced by about 100º C every thousand million years

** There is Hydrogen and other "fusionable" nuclei within the Universe

THE TABLE IS EXPLAINED AS FOLLOWS:

Biomass: On Earth, the energy from living organisms derives foremost from the Sun through the process of photosynthesis

Coal: The same as for biomass except for the intervention of geological processes (of the Earth)

Wind: The Sun heats up the air which rises and is displaced by the Earth's rotation.

Natural Gas: The same as for coal

Geothermal: The use of Earth's internal heat

Hydroelectricity: The Sun evaporates water that is contained in rising hot air. Earth's rotation displaces this water vapour which falls to the ground above sea level. The kinetic energy produced by the water descending toward the sea is utilised by turbines

Sea - the Tides: The gravitational pull of the Sun and Moon deforms the surface of the sea producing low and high tides

Sea – the Waves: Waves are formed due to the interaction of the wind with the sea, therefore the primary origin of this energy lies in the Sun

Sea - Oceanic thermal energy: Due to the heat from the Sun, the water on the surface of the oceans is warmer than that of the ocean deep.

Nuclear from Fission: Uses the energy from the fission of nuclei of Uranium found here on Earth

Nuclear from Fusion: Uses the energy from the fusion of lighter nuclei with other heavier nuclei

Oil: The same as for coal and natural gas

Photovoltaic solar power: Sunlight is converted straight into electricity using photovoltaic solar panels

Solar thermal energy: Sunlight is used to heat water or other compounds

Study and discuss our suggested description in class and then make the changes that you feel are appropriate and explain those changes.

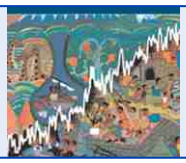
Extras: *Find out more...*

There are so many aspects to the subject of energy that we have decided to offer the following sections in order to help broaden your knowledge even further. You can search for information, create murals and diagrams, hot potatoes... approach them as freely as you wish.

THE KYOTO PROTOCOL:

What is it? Which countries are party to it? When was the last meeting? Agreements, compliance, future...

ENERGY IN YOUR AUTONOMOUS COMMUNITY
Find out about the places that produce energy in your autonomous community: Classify them according to type and mark them on a map.



WHO:

Climate change and human health. Risks and responses.

http://tinyurl.com/d6pzwfz

¿QUÉ ES LA HUELLA DE CARBONO?
Existen páginas web en las que puedes calcular aproximadamente cuál es tu huella. Busca alguna de ellas y compara los resultados entre los alumnos de clase.

ENERGY THROUGH FUSION:

Find out about the different international projects which are currently investigating and testing this type of energy. What is ITER? Are there any other designs for hydrogen fusion reactors?

WHICH ENERGY DO THEY USE?

Make the longest list you can of all the types of vehicles you can think of and the energy source which drives them (car, bicycle, submarine, rocket, space probes, train...).

THE ARFRISOL PROJECT: http://www.arfrisol.es/ARFRISOLportal/

Sustainable architecture.

NIKOLÁI KARDASHOV:

Look up references to the work of Nikolái Kardashov and more recently (Carl sagan, Michio Kaku...).

Useful links

Planetario de Pamplona:
www.escuela.pamplonetario.org , www.pamplonetario.org

Educative game - ENERGY BITS
http://www.2020energy.eu/es

Featured Links:
http://www.who.int/es/
maps.google.es
http://www.endesa.com/
http://www.iberdrola.es
http://www.enresa.es/
http://www.ipcc.ch/home_languages_main_spanish.shtml#.UgNqHKyAa3x
http://www.who.int/globalchange/es/
http://www.world-nuclear.org/
http://www.tablademareas.com/
http://www.vidasostenible.org/

Some images used in this tutorial come from the following websites:

http://www.fotosimagenes.org/imagenes/petroleo-5.jpg
http://upload.wikimedia.org/wikipedia/commons/8/8e/Meyers_b15_s0272b.jpg
http://commons.wikimedia.org/wiki/File%3AMeyers_b15_s0272b.jpg
http://www.sciencenews.org/pictures/090812/feat_fracking_footprint_zoom.gif
http://ahorralia.net/wp-content/uploads/2013/03/repostando.jpg
http://upload.wikimedia.org/wikipedia/commons/2/22/Bateaux_comparaison2.svg
http://www.cosmonoticias.org/wp-content/uploads/2012/02/impacto-asteroide.jpg
http://static.blogo.it/ecologiablog/ecologiablog_walle_1786.jpg
http://img.scoop.it/MWef4-B9l5Dzh3EIpCZnujl72eJkfbmt4t8yenImKBVaiQDB_Rd1H6kmuBWtceBJ
http://navarra.definde.com/_archivos/imagenes/galeria_21180_post.jpg
http://4.bp.blogspot.com/-yovr7lQtqhE/UAFDXCR2fgI/AAAAAAAASeQ/M9wAISaq-oU/s1600/mapa-espana-politico-mudo1.jpg
http://www.certificadosenergeticosmalaga.es/wp-content/uploads/2013/05/ENERGIA-RENOVABLE.jpg
http://www.mtholyoke.edu/~tiern20l/classweb/climatechange/images/kyotoprotocol.jpg
http://www.tokamak.se/tokamak.jpg
https://upload.wikimedia.org/wikipedia/commons/1/18/Tcv_int.jpg
http://tinyurl.com/krbjbsk
http://www.daviddarling.info/images/Kardashev.jpg

planetario de pamplona

www.escuela.pamplonetario.org
www.pamplonetario.org

Las actividades de divulgación y educación científica del Planetario de Pamplona cuentan con el impulso de laObra Social "la Caixa" y la Fundación Caja Navarra