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GLOBAL WARMING

Fact Sheet Series for Key Stages 2 & 3

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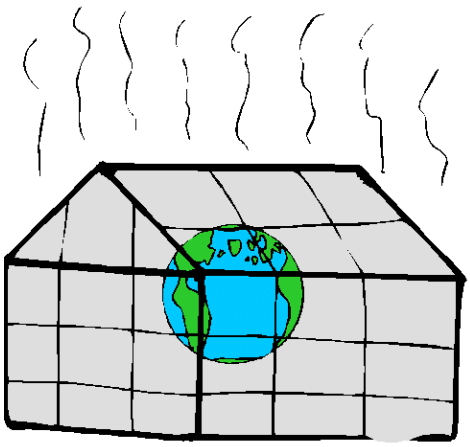
1999 (updated 2002)



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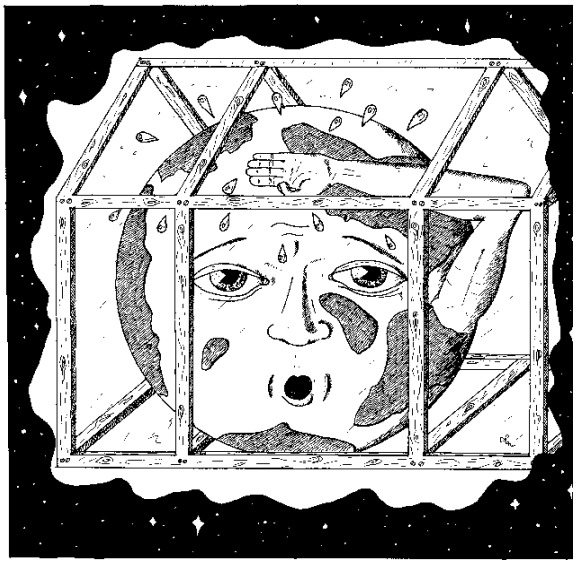
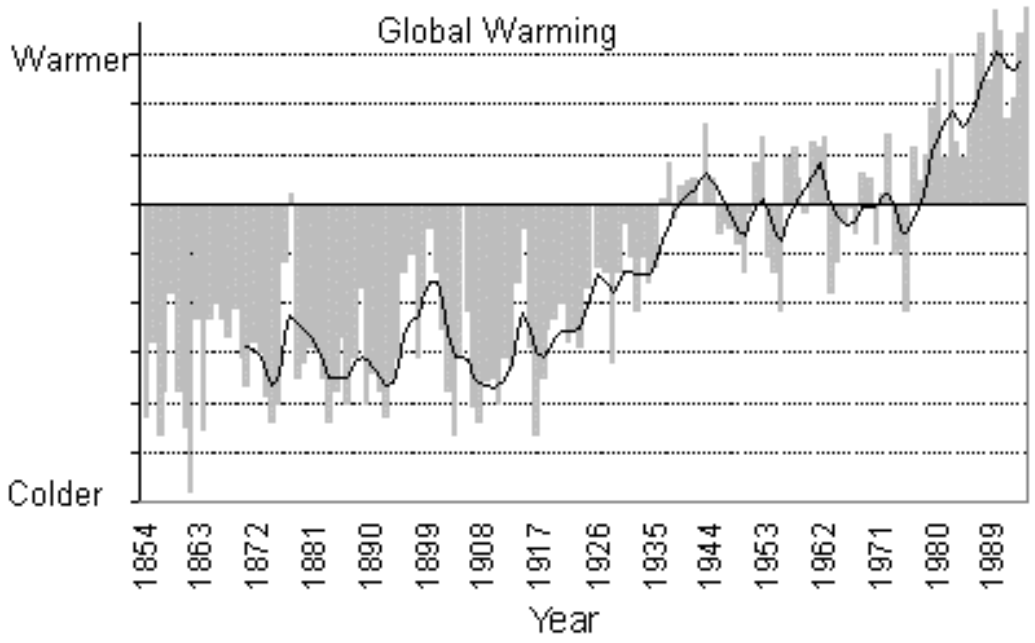


Greenhouse gases keep our planet warm. They exist naturally in the ***atmosphere***, heating it by trapping energy that has originally come from the Sun. This process is called the ***greenhouse effect***. Without the greenhouse gases the surface of the Earth would be as cold as the surface of the Moon (about -18 ***degrees Celsius*** or °C). In fact the typical surface temperature of the Earth is about 15°C.

Changing Temperatures

Measurements taken from all over the world, however, have shown that the global climate is changing. In the last 100 years the atmosphere has warmed up by about half a degree Celsius.

Also during this time humans have been ***emitting*** extra greenhouse gases, which are the result of burning ***fossil fuels*** (like coal, oil and gas). These gases include carbon dioxide, methane and nitrous oxide.



Greenhouse Gases

It is thought that the man-made emissions of greenhouse gases, from the increased use of fossil fuels, are responsible for some of the warming of the global climate during the 20th century. The extra greenhouse gases in the atmosphere trap more energy and therefore enhance the greenhouse effect. This may cause more warming. Greenhouse gases are also released by the exhausts of motor vehicles. The cutting down of

rain forests also releases carbon dioxide, which is a greenhouse gas and causes global warming.

Natural Changes

There are also natural ways in which the climate can be altered. Volcanoes release gases, which mix with water vapour in the air to make ***aerosols,*** and cool the atmosphere. Changes in the Sun's energy and the ***circulation*** of the ocean also affect climate.

The Future

If the Earth continues to warm as ***climate models*** have predicted, the ***temperature*** at the Earth's surface may be 3***°C*** warmer by 2100 than it is today. This rapid change in temperature would be harmful to many ***ecosystems***, and many ***species*** of plants and animals.

Impacts

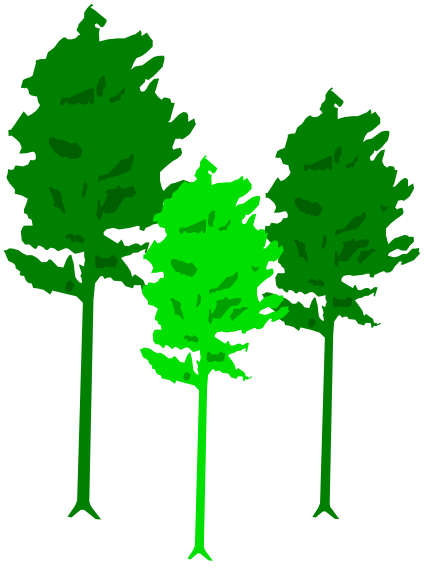
Climate change will affect rainfall, sea level and storm events, and humans would also be affected by these factors. Food crops would be altered, as well as forests and water supplies. People's health will also be affected.

2. What are the Greenhouse Gases?

Introduction

Since the ***Industrial Revolution*** 200 years ago, the amount of greenhouse gases in the air has been increasing. This is thought to be due to human activities. During the last fifty years mankind has also introduced CFCs, which not only damage the ***ozone layer*** but also act as greenhouse gases. Greenhouse gases also include carbon dioxide, methane, and nitrous oxide.

Carbon Dioxide



Carbon dioxide (CO_2) is produced naturally through breathing or ***respiration***, decay of plant and animal matter, and from natural forest fires.

Man-made sources of carbon dioxide include the burning (or combustion) of fossil fuels,

changes in land-use (especially ***deforestation***), ***biomass burning*** and the manufacture of cement.

Carbon dioxide is taken out of the atmosphere by the oceans, and by plants, especially forests, through ***photosynthesis***.

Methane

Methane (CH_4) is a major greenhouse gas. It is formed naturally in ***wetlands*** when organic material decays, and also by ***termites***. Man-made sources of methane include the growing of rice, cattle farming, fossil fuel burning and the disposal of household waste in ***landfill sites***.

Nitrous Oxide

Nitrous oxide (N_2O) is a greenhouse gas naturally produced by oceans and by lightning strikes, but humans have increased its abundance by the production

of ***nylon***, ***nitric acid***, and through agricultural practices and biomass burning.

Chlorofluorocarbons

Chlorofluorocarbons (CFCs) are a group of man-made substances containing ***chlorine, fluorine*** and ***carbon***. They were invented in the 1930s for use in fridges, but have other uses, including aerosols.

Summary

The main human contribution to enhancing the greenhouse effect and global warming has been made by carbon dioxide, but more recently the CFCs have also had a large impact. CFC production has now been limited to protect the ozone layer, and so it is thought that their effect on global warming will become less in the future.

3. What are Atmospheric Aerosols?

Introduction

Atmospheric ***aerosols*** are made up of particles suspended in air which are around one millionth of a metre across. They are formed by the mixing of gases in the atmosphere, or by the upward movement of fine material from the ground.

Even though these particles are so small, they have the ability to stop some of the Sun's energy from reaching the Earth's surface.

Where do atmospheric aerosols come from?

Atmospheric aerosol particles may be ***emitted*** from primary sources as particles, or they may be formed in the atmosphere from gases (secondary sources).

Natural sources of aerosols are usually greater than man-made ones, except in certain areas of the world, such as in industrial regions.

Primary sources of aerosols include the burning of plants, especially through forest fires. Fires may be natural or man-made. Other natural sources include wind-blown dust from rocks, soils, and volcanic eruptions. Volcanoes also produce ***sulphur dioxide*** when they erupt. When this mixes with water vapour in the air, ***sulphuric acid*** aerosols are produced.

Where do atmospheric aerosols go?

Most aerosols are removed from the atmosphere by rainfall. This is called wet deposition. Aerosol particles may also be removed from the atmosphere directly by falling to the ground. This is known as dry deposition.

When a volcano emits gases high into the upper atmosphere (***stratosphere***) above the level at which rain is usually produced, the aerosols that form from them may remain there for several years, gradually spreading around the world. If the eruption is only into the lower atmosphere (***troposphere***), the pollution will be removed within days by rain.

What do atmospheric aerosols do?

Atmospheric aerosols influence the global climate in two ways, both resulting in cooling. Firstly they can ***scatter*** the sunlight, so less of it reaches the Earth's surface. This effect is particularly important and long-lasting when the aerosols are high up in the atmosphere as a result of a volcanic eruption.

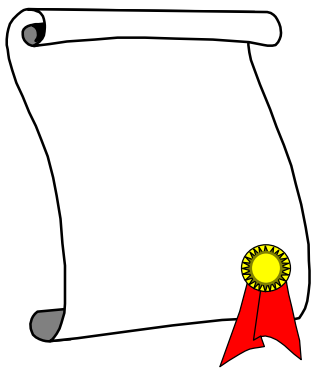
Secondly, aerosol particles help to form clouds, which reflect sunlight back out to space, so making the atmosphere cooler.

4. How Do We Measure Climate Change?

Introduction

Climate change has been taking place throughout the history of the Earth. It is only recently that mankind has begun to exert its own influence. Natural factors that have caused these changes have been due to changes in the Sun, volcanic eruptions and ocean circulation. We have been able to work out what the climate was like in the past by using a number of scientific methods.

Historical Records



Historical records of climate are useful in determining just what past climates were like. Such records include ancient inscriptions, government records, commercial records and diaries. Firstly, we can use records of weather events such as heavy snowfall or severe frosts. Secondly, we may use records of

environmental events that are caused by weather, such as floods and droughts. Lastly, there are records of events that affect plants and animals, and depend on the weather, such as the flowering of trees or the migration of birds.

Ice Cores

As snow and ice builds up, it lays down a record of the conditions in the environment at the time of its formation. This information can be taken from the snow and ice and used to work out what the climate was like at that time.

Dendroclimatology

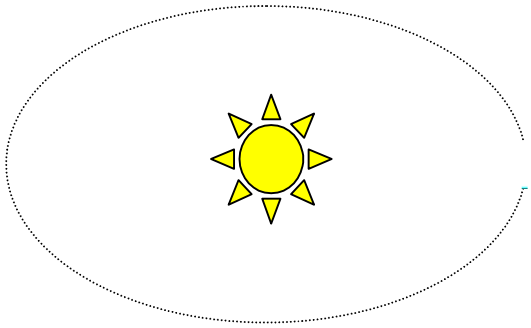
Dendroclimatology is the study of tree rings, and how they are linked to the climate. When the growth of a tree is stunted, the width of the tree ring for that year is narrower than the ones before and after. This

lack of growth may be due to a climatic factor such as temperature or rainfall, and so we can tell what the weather was like in that year.

The Ice Ages

Records of past climates have been used to show what the climate was like during the last several hundred thousand years. These records have demonstrated that the global climate has changed from being fairly warm, as it is now, to being very cold. These cold periods are known as the Ice Ages, and the last one affected the Earth only 18,000 years ago.

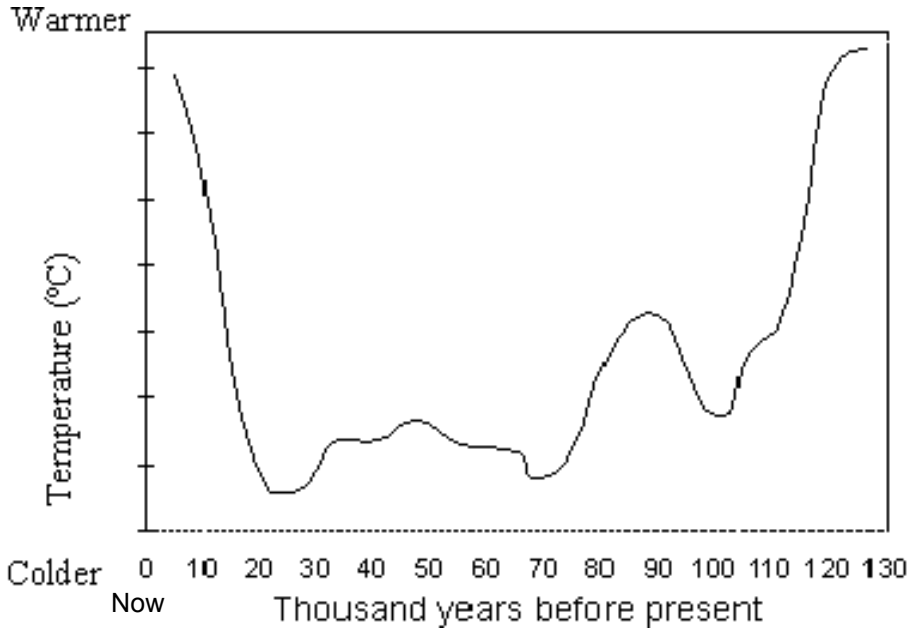
It is thought that the change in global climate between Ice Ages and warm periods is linked to the Earth's changing orbit around the Sun.



5. How Do We Predict Future Climate Changes?

Introduction

In order to predict future climate changes it is necessary to look at past patterns and trends. The graph below shows how the global temperature has changed over the last 130 thousand years. Between 20,000 years ago and the present, the Earth warmed by as much as 6°C.



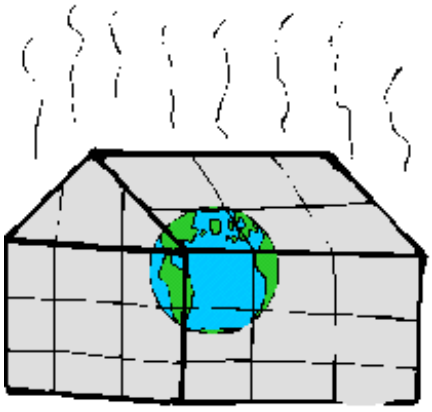
Predictions of climate change over the next 100 to 150 years are based only on climate models.

Climate Models

Climate models are special computer programmes. Climate models have attempted to show man-made influences on climate change. Firstly, climate models are used to gain a clearer picture of past climates. Then they compare their results with real data from observations of climate changes. If a good match is found between the model results and the real observations, the model is believed to be working well, and it can then be used to predict future changes in climate. All climate models, however, are subject to a lot of uncertainty, and their predictions should not be considered to be fool proof, but as intelligent estimations based on existing knowledge.

6. The Effects of Global Warming on Sea Level

Introduction



As the Earth warms up a number of changes in the weather will occur, including hotter summers. This may seem like a good idea, but a rise of a few degrees Celsius in temperature could change the conditions on Earth, which are currently just right for existing plants and animals.

Warmer Seas and Melting Ice

When the Earth warms, the oceans will warm and expand causing an increase in the level of the sea. This process is thought to be responsible for about a quarter of the sea level rise recorded during the 20th century. The melting of ice sheets in Greenland

and Antarctica could be another major cause, although it is not known what contribution this makes.

According to many studies, sea levels have been rising by 1-2 millimetres (mm) each year for the past 100 years. Current predictions suggest that the sea level may rise by half a metre in the next 100 years.

Flooding

Higher sea levels will threaten the low-lying coastal areas of the world such as the Netherlands and Bangladesh. Many important fisheries would become threatened and coastal ***ecosystems*** damaged.

In Britain, East Anglia and the Thames Estuary will be particularly at risk from flooding as sea levels increase.

= East Anglia and the Thames Estuary

7. The Effects of Global Warming on Agriculture

Introduction

Climate plays a large part in determining plant growth and the production of crops. Crop growth is often limited by temperature and rainfall. An increase in temperature may suit some crops, but the accompanying increase in the ***evaporation*** of water will leave less moisture available for plant growth.

The changes in the weather will affect the type of crops grown. Some crops such as wheat and rice grow better in higher temperatures, but other plants such as maize and sugarcane do not. Changes in the amount of rainfall will also affect how many plants grow.

Food & Water Shortages

The effect of a change in weather on plant growth may lead to food and water shortages in some countries of the world. ***Droughts*** in countries that currently experience them may become more severe. Brazil, South East Asia, China and parts of Africa are likely to be affected most, and many people could suffer from hunger.

Low-Lying Land

Low-lying agricultural land is at risk from rising sea levels. South East Asia would be badly affected as most farming takes place on low-lying ***deltas***. If salt water entered the land it would need treating. This would increase costs for farmers and mean higher food prices for the public.

Carbon Dioxide

Plants grow as a result of ***photosynthesis***. This involves plants taking in carbon dioxide and giving off oxygen. Climate change is associated with an increase in the levels of carbon dioxide in the atmosphere and hence plant growth rates could increase.

Uncertainty

It is not certain what the effects of climate change on agriculture will be, but it is though that crop production will be reduced in some parts of the world, whilst it will increase in others.

8. The Effects of Global Warming on Wildlife

Introduction

As the climate changes, the composition and distribution of ecosystems will alter and individual species will respond to the changes. Some species in ecosystems may become extinct.

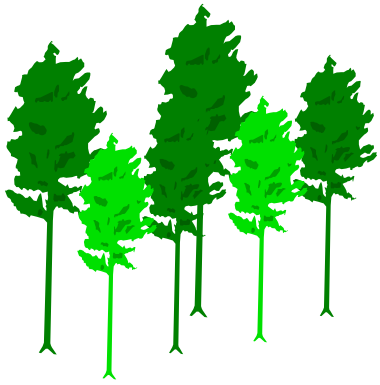
Climate Zones

Groups of organisms will tend to move towards the ***poles*** as warming occurs. It is predicted that a warming of 2°C over the next 100 years would shift current climatic zones towards the poles by about 300 km. The ecosystems most at risk from global warming will include those that are presently subject to harsh climates. These include:

- Tropical forest
- Coral reefs
- Deserts
- Polar (ice) regions
- Coastal marshes
- Mountains
- Low lying land

The occurrence of extreme events, such as flooding and drought in these environments, may become more likely.

Forests



Forests cover around a quarter to a third of the total land surface of the Earth. They are essential for the maintenance of a stable global climate. Global warming will increase the risk of forest fires as soils and plants will become drier. Changes in pest populations may also place stress on forests.

Forests are known to strongly moderate local climates and use up carbon dioxide during photosynthesis, helping

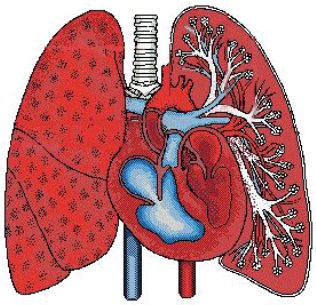
to remove some of the carbon dioxide released by mankind. As forests are cut down, this potential is removed. Furthermore, forest clearance through burning releases a lot of carbon dioxide into the atmosphere.

9. The Effects of Global Warming on Health

Introduction

The health of human populations depends on the continued use of the Earth's natural systems. Climate change is likely to have a negative effect on health, with significant loss of life through a variety of illnesses.

Effects of Warmer Temperatures



Warm temperatures can increase local air pollution, which in turn can lead to an increase in breathing problems and respiratory diseases.

Effects of Extreme Events

Extreme events may lead to a large number of deaths at a set time. For example, a landslide or flood could wipe out a large number of people. Events like this are set to increase as global warming takes place.

Infectious Diseases

Many infectious diseases only appear in warm areas. Warmer trends would enable insects and other disease carriers to expand their range. Mosquitoes and other insects will spread further across the globe. Currently, 45% of the world's population live in the climate zone suitable for the spread of malaria. Models estimate that by 2070 this figure could be 60%.

Positive Effects

Although global warming may have a number of negative effects on health, warmer temperatures may decrease the number of deaths from cold weather.

Summary

Poorer countries will be the most vulnerable to global warming, as they will find it difficult to adapt to change.

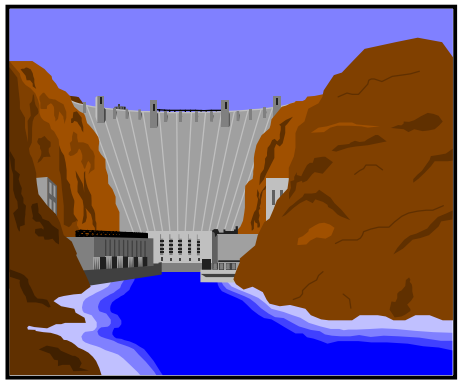
10. The Effects of Global Warming on Water Resources

Introduction

Scientists agree that global warming will generally result in milder winters and hotter summers, although there will be differences between countries. In winter it may rain more, but in the summer, it may become dryer. Water resources would generally benefit from wetter winters but warmer summers with longer growing seasons and increased water ***evaporation*** would put greater pressure on them.

Changing Evaporation and Rainfall

Water is essential for human life and development. Much of the world's agricultural, ***hydroelectric power*** and water supplies depend upon the water cycle.



Global warming will affect the water cycle, placing stress on water resources.

In some areas of the world water evaporation may increase by a greater amount than rainfall. This would lead to lower water levels in rivers and lakes. Global warming may mean that rainfall becomes concentrated into large storms that could cause problems with flooding.

Hydroelectric Power

Water is used for a number of different purposes that will be affected by global warming. Rivers may become prone to flooding or drought. Hydroelectric power generation depends upon a high water flow to make electricity. If flows decrease, less hydroelectric power will be generated. The supply and demand for water to homes and workplaces may also be affected if the levels of reservoirs and ***aquifers*** decrease.

Looking after future water resources with care will become increasingly important as global warming takes place.

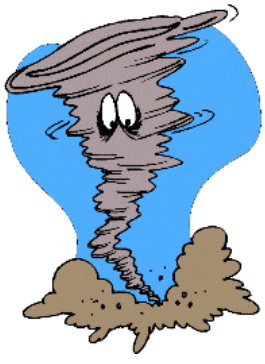
11. The Effects of Global Warming on Storms, Floods and Droughts

Natural Events

The Earth's climate changes naturally and often produces climatic extremes and disasters. On a time scale of days, months and years, changes in weather and climate can produce:

heat waves;
river and ocean flooding;
droughts;
landslides;
storms and hurricanes;
tornadoes.

Effects of Global Warming



As global warming raises the temperature of the Earth's surface these events may become more frequent. This may have a negative

effect on society as the events damage homes and villages and can lead to loss of life.

As the global temperature increases, we would expect the amount of moisture in the atmosphere to increase, due to an increase in evaporation of water from the sea's surface. It is predicted that for every 1°C rise in temperature, water vapour in the air over the oceans will increase by 6 - 8%. This will lead to an increase in rainfall rates in some parts of the world, causing more frequent floods and landslides. In other parts of the world a decrease in rainfall may be experienced, causing an increase in very dry periods.

Summary

In order to tackle future increases in extreme events we must learn how to predict and cope with them. It is certain that the poorest and most vulnerable societies in the developing world will be the least able to cope.

12. What Can You Do to Prevent Global Warming?

Energy & Carbon Dioxide

Energy is produced to generate electricity and to keep us warm. Most energy is produced by the burning of fossil fuels, like coal, oil and gas, which release carbon dioxide, a greenhouse gas. Fuel burnt in our cars also releases carbon dioxide.

As an individual, you have little control on how your energy is produced. However, you can control the way in which you use that energy. Using less energy means less needs to be produced. Hence less carbon dioxide is released into the atmosphere.

Saving Energy

There are a number of ways that you can help to save energy in your home:

- Turn off lights and ***appliances*** when they are not needed;
- ***Insulate*** the walls and loft;
- Have a shower instead of a bath;
- Fit double glazing;
- Turn your heating down. (Turning it down by 1°C saves 10% on energy bills.)

Recycling

At present in the UK we produce 28 million tonnes of household rubbish a year. 90% of this waste is dumped into ***landfill sites***. Landfill waste produces the second most important greenhouse gas, which is methane. If we can recycle more of this waste, the need to mine raw materials will decrease and less waste will need to be buried as landfill.

Leaving the Car at Home

Road transport is the fastest growing sector in the UK. A quarter of carbon dioxide emissions comes from road transport. By using public transport, and by cycling and walking more, we can reduce the amount of carbon dioxide released by our cars.

13. What is the Government Doing?

The Framework Convention on Climate Change

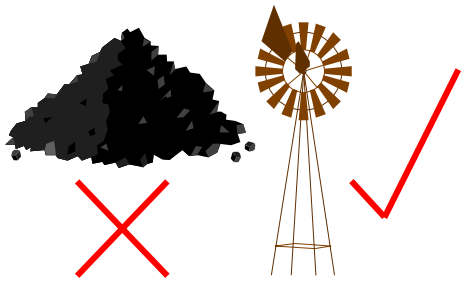
In an effort to reduce or remove the environmental threat of global warming, nations around the world have adopted the Framework Convention on Climate Change. This agreement was made at the Earth Summit in 1992 and signed by 162 countries. Through the use of national programmes and international information exchange, along with the promotion of ***sustainable development***, the agreement aims to prevent interference with our climate. Currently, countries are trying to reduce global greenhouse gas emissions by about 5% by the period 2008-2012.

The UK Climate Change Programme

The United Kingdom signed the Convention on Climate Change and is now required to meet its commitments and objectives. The UK is committed to reducing greenhouse

gases emissions by 12.5% but believes that 23% is achievable by 2010. The UK Climate Change Programme is also seeking to reduce carnbon dioxide emissions, the main greenhouse gas, by 20%.

Energy Efficiency & Renewable Energy



One way to reduce emissions of greenhouse gases is to become more energy efficient, so that less energy needs to be produced. An increase in the use of ***renewable energy*** supplies, instead of fossil fuels, will also reduce greenhouse emissions. Sources of renewable energy include wind power, solar power, tidal and wave power, and hydroelectric power.

Summary

The new challenge for today's people is to ensure that future development and the use of the Earth's resources are managed sustainably, thereby safeguarding the quality of life for generations to follow.

14. How Can Renewable Energy Reduce Global Warming?

Introduction

Renewable energy is energy created by sources that are not used up or depleted. Most forms of renewable energy do not produce carbon dioxide and other harmful gases. Using more renewable energy sources would reduce carbon dioxide emissions and minimise global warming.

Hydroelectric Power

Hydroelectric power (HEP) uses the force of moving water to create electricity. However, HEP stations often require large ***dams***, which disrupt ecosystems and displace people. HEP is the most widely used renewable source, providing 20% of the world's energy.

Solar Power

The Sun provides the main source of energy for all living things. Solar energy is free and will never run out. We can use solar panels to turn the Sun's energy into useful energy.

Wind Power

Wind turbines harness the movement of air to produce energy. They are often found grouped together in wind farms.

Biomass

This is the term used to describe plant materials and animal waste, which can be burnt for energy.

Geothermal Energy

Geothermal energy is energy that is generated by using the heat beneath the Earth's surface.

Glossary

Aerosols:
Fine particles of liquid, which together act more like a gas.

Agriculture:
Growing of crops on land.

Appliance:
Electrical machine or device.

Aquifer:
An underground body of water.

Atmosphere:
An envelope of gases around the Earth.

Biomass Burning:
The burning of organic material for energy.

Carbon:
A non-metal element found in all living things.

Catalytic Converter:
A device fitted to the exhaust of a car to remove some harmful gases.

Chlorine:
An element that is poisonous in large amounts, and usually found as a greenish-yellow gas.

Chlorofluorocarbons:
Also known as CFCs, these man-made chemicals contain carbon, fluorine and chlorine and were used to cool fridges.

Circulation:
The movement of air or water around the world.

Climate Model:
A programme on a computer that allows us to predict what may happen to the climate in the future.

Cultivation:
The planting, tending and harvesting of crops and plants.

Dam:
A barrier of concrete or earth built across a river to create a body of water.

Deforestation:
The removal of forests, often by burning.

Degree (Celsius):
A unit used to measure temperature.

Delta:
A flat piece of land at the mouth of a river that is sometimes covered by water.

Dendroclimatology:
The study of tree rings, and how they are linked to the climate.

Drought:
A time when there is very little rainfall.

Ecosystem:
A network of living plants and animals that interacts with the non-living environment.

Emit:
Release to the atmosphere.

Evaporation:
The change from liquid to vapour.

Fluorine:

A gaseous element that can be poisonous.

Fossil Fuels:

Sources of energy such as coal, oil and natural gas.

Geothermal:

Relating to the heat inside the earth.

Greenhouse Effect:

The process by which greenhouse gases naturally in the atmosphere keep the Earth warmer than it would otherwise be without them.

Hydroelectric Power:

Energy made from flowing water.

Industrial Revolution:

A time around 200 years ago when many factories were built and powered using coal.

Insulate:

To keep warm by preventing energy loss.

Landfill Site:
Places where waste materials are buried under the ground.

Nitric Acid:
A colourless or yellowish fuming corrosive liquid.

Nylon:
A man-made material used for clothes and other items.

Ozone Layer:
A layer of ozone high up in the atmosphere, which shields us from the harmful rays of the Sun.

Photosynthesis:
The use of light, carbon dioxide and water by plants to grow.

Poles:
The two extreme points at the ends of the Earth in the North and South.

Precipitation:
Rain, snow, hail, etc.

Renewable Energy:

Energy from sources that can never be used up, like wind and solar power.

Resources:

A supply of something - land, minerals or wealth.

Respiration:

The process of living organisms taking in oxygen and giving out carbon dioxide.

Scatter:

To disperse in different directions.

Species:

A particular group of plant or animal that can only reproduce with others of the same kind.

Stratosphere:

An upper layer of the atmosphere.

Sulphur Dioxide:

A colourless gas produced by burning sulphur.

Sulphuric Acid:

A strong acid containing sulphur.

Sustainable Development:
Growth today that will not have harmful impacts on either the environment or on future generations.

Temperature:
The measurement of cold and heat.

Termites:
A whitish ant-like insect that lives in warm countries. Some species feed on wood and produce methane.

Troposphere:
The lowest layer of the atmosphere.

Wetlands:
Areas of marshy or swampy ground.