

INTRODUCTION

The film The Day After Tomorrow shows us an apocalyptic view of the world, in particular the United States of America, after a sudden melting of the Arctic ice cap. The meltdown of the Arctic causes dramatic changes in the Earth's climate – sudden destructive storms, tidal waves and flooding - a new Ice Age.

In big blockbuster event films such as The Day After Tomorrow we are used to seeing superb special effects, storylines which put the central characters in danger and thrilling rescues. Nearly always the blockbuster film is set in an imaginary situation (think of Spiderman, The Hulk, Men in Black etc.). Is this true with The Day After Tomorrow?

A feature film needs to tell its story in about two hours, with clearly defined characters and also a resolution to the story. The climate changes that we see happen in The Day After Tomorrow all happen within a very short period – a couple of weeks. Whilst the time span might be 'unrealistic' the possibilities of each of the climate changes are not.

In 2004 we have already seen two thirds of Bangladesh disappear under flooding. Freak tropical storms have brought parts of London to a standstill. Changes in the temperature of the sea have seen birds and wildlife threatened as their food chain is broken down. Forest fires rage because of unusually high temperatures. All of this in the space of a few months.

So, whilst The Day After Tomorrow is 'fiction' alas the facts on which it is based seem to be developing apace. Perhaps in twenty years or more the events shown in the film will not appear quite so fictional.

The work that you will be carrying out will look at the issue of global warming, its causes, its effects and its possible prevention. It will also look at the ways in which scientists can help bring about a stop to these developments.

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CAUSES OF GLOBAL WARMING

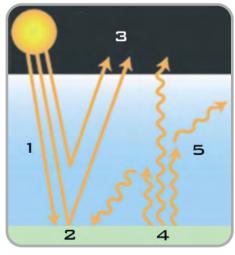
THE GREENHOUSE EFFECT

Global warming occurs through the process dubbed the 'greenhouse effect'. The earth is enclosed and surrounded by a layer of gas in the atmosphere that insulates it, like the glass of a greenhouse.

This layer of gas traps heat around the earth and prevents it from escaping, which is essential to the continuation of life on earth. Without the insulating layer the earth would be 33°C colder and life as we know it could not be sustained. So the greenhouse effect has always been around and is an important part of life.

Heat is trapped in the following way: visible radiation (sunlight) enters the earth's atmosphere and warms it, and although some heat (infrared radiation) escapes again, much is trapped by, and stored in, this insulating layer. This process can be split into stages:

- 1. Solar radiation passes through the clear atmosphere.
- Most radiation is absorbed by the Earth's surface and warms it.
- **3.** The Earth and the atmosphere reflect some solar radiation.
- **4.** Infrared radiation (heat) is emitted from the Earth's surface.
- Some of the infrared radiation is absorbed and re-emitted by the greenhouse gases.



The effect of this is to warm the surface and lower atmosphere.





GREENHOUSE GASES

The insulating layer of gas around the earth is made up of several different gases. The main 'greenhouse gases' in order of significance are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons, or CFC's and ozone (O_3).

Greenhouse gases are essential to the continuation of life on earth, by trapping heat. Most of these gases occur naturally and a balance of carbon dioxide is maintained by the carbon cycle. Some carbon dioxide is produced by burning of hydrocarbons (such as occurs naturally in forest fires) and animals' respiration and some is converted back to oxygen by plants' photosynthesis.

OXYGEN IS CONVERTED TO CARBON DIOXIDE

Burning (of hydrocarbons):

natural gas + oxygen	→	water + carbon dioxide + energy				
[combustion]						
$CH_4 + 2O_2$	→	$2H_2O + CO_2$				

Respiration:

glucose + oxygen	+	carbon dioxide + water + energy
$C_6H_{12}O_6 + 6O_2$	+	$6CO_2 + 6H_2O$

CARBON DIOXIDE IS CONVERTED TO OXYGEN

Photosynthesis:

water + carbon dioxide \rightarrow glucose + oxygen 6H₂O + 6CO₂ \rightarrow C₆H₁₂O₆ + 6O₂

Normally, this layer of gas is maintained at a regular thickness by this natural balance. However, greenhouse gases can also be produced by human activities.





Carbon dioxide (CO_2) is the main gas that makes up the greenhouse layer, and as well as being naturally produced in forest fires, can be produced in large quantities by deliberate burning of fossil fuels such as coal, petrol, oil and gas. Global warming has been observed primarily in the twentieth century, following the Industrial Revolution around two centuries ago, when large-scale industry and energy production started, and it is developed or industrial nations that produce by far the most CO_2 emissions (see table on page 6). In the last twenty years, three quarters of human-made (anthropogenic) carbon dioxide emissions have been from burning fossil fuels.



These CO₂ emissions are mostly produced by big industries across the world, particularly power stations where fossil fuels are burned to produce energy. Cars and other motorised vehicles, which also burn petrol to produce energy, also produce significant amounts. Industrial processes also produce other greenhouse gases.







SOURCES OF GREENHOUSE GASES

Carbon Dioxide (CO ₂)	Produced by respiration and the burning of hydrocarbons (including fossil fuels)
Methane (CH ₄)	Produced by burning of fossil fuel, livestock farming, rice cultivation and waste management
N ₂ O (Nitrous Oxide)	Produced by burning of fossil fuel, sewage treatment and agricultural soil management
CFC's (Chlorofluorocarbons)	Spray cans, coolants in refrigerators and air conditioners
O ₃ (Ozone)	Formed from volatile organic compounds (VOC's) produced by power plants and the chemical industry

TASK

For each of the above emissions, think of as many industries and daily human activities that contribute to the build up of harmful gases in the atmosphere. At this stage, try to think of one way of combating each of these emission buildups. Then, think of the way that your method of combating the build up of each emission might change the way in which we live.

This increased emission of greenhouse gases has resulted in an excessive build-up of these gases and the consequent thickening of the insulating layer. This is causing an unprecedented accumulation of heat that cannot pass through, sometimes called the enhanced greenhouse effect.

TASK

If the temperature of Earth is increasing then what do you think could be some of the possible effects of this? In groups, try to write a list of effects of global warming. From your list, compare what you think are the effects with some of the climate changes shown in the film The Day After Tomorrow.





In the last couple of centuries, huge tracts of forests and rainforests have been cut down to create fields for farming, particularly cattle-grazing. This large-scale deforestation is responsible for a reduction in the amount of CO_2 converted to oxygen by photosynthesis. So not only do people burning fossil fuels produce more CO_2 , but also less CO_2 is removed from the atmosphere by plants, further changing the delicate balance of the natural carbon cycle. Humans produce 6.1 billion metric tonnes of carbon dioxide emissions annually (measured in carbon equivalent terms), but 3.2 billion metric tonnes are not absorbed and are added to the atmosphere each year. Greenhouse gas emissions are expected to grow at an average of 1.9% per annum between 2001 and 2025.

Country	CO ₂ emissions from fuel combustion in Megatonnes	Per capita CO ₂ emissions
USA	5,673	19.84
China	3,075	2.42
Russia	1,519	10.50
Japan	1,132	8.90
India	1,013	0.98
Germany	850	10.32
United Kingdom	541	9.20
Canada	520	16.72
South Korea	436	9.21
Italy	425	7.34

CARBON DIOXIDE (CO2) EMISSIONS

As the table shows, the main producers of CO_2 are either highly developed countries or densely populated ones that have heavy industry and a great per capita demand for energy production. The USA emits 20-25% of global emissions. In 1997 an international summit was held in Kyoto, Japan, to control emissions, at which the USA refused to agree to cut emissions. Almost all other developed countries have signed an agreement to cut CO_2 emissions by 5.2% (from 1990 levels) by 2012.

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TASK

Why do you think that the USA refused to cut CO_2 emissions? If emissions are produced by industry, what does this tell us about the economy of the USA and why they might put pressure on the government not to cut the rate of emissions?

A NOTE ON THE OZONE LAYER

People have become confused by the difference between the ozone layer and the greenhouse effect. Although ozone is a greenhouse gas, the two environmental problems are completely different! The ozone layer is a thin layer of the gas ozone (O_3) in the upper atmosphere that protects the earth from ultraviolet radiation. Because of man-produced chemicals such as CFC's (which are also, confusingly, greenhouse gases!), this layer is thinning and breaking up and allowing more harmful ultraviolet radiation through which causes skin cancer.



EFFECTS OF GLOBAL WARMING

Over the course of the twentieth century, there has been an overall 0.6°C rise in temperature globally, and in recent years the change in climate and weather has become more apparent even in the British Isles. The global climate often undergoes slight fluctuation in temperature, but warming in the twentieth century was greater than at any time in the last 400-600 years. This is thought to be due to increased carbon emissions from the burning of fossil fuels since the Industrial Revolution in the early nineteenth century. Seven of the ten warmest years of the century occurred in the 1990s and 1998 was the hottest year on record, followed by 2000 and 2001.

The film The Day After Tomorrow is a fictional representation of the kind of weather conditions that could result from global warming. The conditions that global warming produces are unprecedented in world history and the effects are difficult to predict, although attempts are being made using computer-generated models, and the process may slow if CO_2 emissions are significantly cut. It is important to remember that the extreme weather of the film's hypothesis could indeed be a possible result of warming. However, global warming is already affecting the climate in a way that is not so immediately apparent, but is nevertheless dramatic for the delicately balanced ecosystems of the globe.

PHYSICAL EFFECTS

As the name suggests, the main feature of global warming is an increase in temperature as heat is trapped under the layer of carbon dioxide that surrounds the globe. Fires are more common in hot areas that, due to global warming, become drier. These fires can be destructive to whole regions, forests, crops, and the animals and people that depend upon them. Also, increased temperature causes the melting of large bodies of ice.





ARCTIC WARMING & POLAR ICE CAPS

At the extreme north and south of the globe, areas such as Alaska, Siberia and the Arctic and Antarctic have undergone more accelerated warming than the rest of the globe. For example, the Antarctic Peninsula has experienced warming of five times the global average, at 2.5°C over the last forty-five years.

Antarctica itself (which contains 90% of the world's ice) is unlikely to melt, as the average temperature is -37°C. If it did, sea levels would rise around 61 metres. However, large sections of ice periodically break off from its coastline and melt in the sea, a process greatly increased by warming. The increased ocean temperature also causes the melting of floating sea ice. Large ice masses have been slowly melting in the last century, and there have been several dramatic collapse events recorded, such as the 35 day



disintegration of the northern section of the Larsen B ice shelf in Antarctica, an area of 3,238 km². The melting of polar ice, as well as raising sea levels, affects the balance of freshwater in the oceans against the amount of saltwater, a theory used in the film.

NASA satellites have shown that the area of permanent ice cover in the Arctic is decreasing at a rate of 9% each decade. At that rate, by 2100 there will be no ice in the Arctic summer. The melting of permafrost has also exposed the soil beneath to erosion and has increased the risk of landslides as well as necessitating the reconstruction of many buildings and roads. Sea ice and ice shelves also melt, reducing the habitat of wildlife in those areas.



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RISE IN SEA LEVEL

Global warming also greatly affects the oceans, which cover around 70% of the Earth's surface. Increased heat causes the water particles to vibrate more vigorously and the water expands in volume, causing the sea level to rise. Due partly to the melting of polar ice caps and partly to the thermal expansion of water, sea levels have been shown to be rising. According to sea level rise (SLR) data collected from throughout the globe over the past hundred years the sea level has risen between 10cm and 25cm. This produces several knock-on effects on coastal regions, eroding coastline and causing the loss of beaches. On average, for every 30cm rise in sea level, 15-30 metres of beach are lost.



In 1995 the Intergovernmental Panel on Climate Change issued a report that contained various projections of the sea level change by the year 2100. They estimate that the sea will rise 50cm with the lowest estimates at 15cm and the highest at 95cm. This rise of 50cm could have a big effect on coastal cities, especially during storms and could cause widespread flooding.





TASK

Look at an Ordnance Survey map of the nearest coastline to where your school is situated. Look at the 'metres above sea level' contour lines. Assume that the sea level rose by one metre (which it may do over thirty years). Shade in the areas which would be flooded by such a rise of the sea levels i.e. all areas below one metre above sea level.

You might discover that your local area is safe. If so, look at an Ordnance Survey map of any area in East Anglia. What would happen there?

GLACIERS

The increase in temperature has caused the ice of glaciers to melt, and mountain glaciers that are monitored by scientists have been shown to be shrinking, whilst glaciers at lower altitudes have disappeared altogether. According to some predictions of warming, the majority of glaciers will have disappeared by 2100. Glaciers are the source of important summer water flow that is relied on for power, and the shrinking of the glaciers will cause a reduction in this flow. The dramatic melting of other mountain ice has also been recorded. Since 1912, 82% of the ice on Mount Kilimanjaro in Tanzania has disappeared, and in fifteen years it will have completely gone.



IMPACT ON WILDLIFE & HUMANS

EFFECT ON WILDLIFE

Global warming poses a threat to the carefully balanced ecosystems around the world by changing the climactic conditions to which species are so carefully adapted. Species of plants and animals may either shift their areas of distribution (generally northwards to cooler areas), as summer temperatures gradually increase and winters become drier, or die out altogether. Hardier species that can adapt to climate variation are likely to be more successful, easing out more delicate species that cannot adapt fast enough.

As certain populations move northwards, a knock-on effect is observable, as the species that depend on them for food can suffer a reduction or even loss of their principal diet. As can be seen on page 13, the loss of one species from an area can alter the whole balance of the food chain.

As populations move, animal and plant species will have to cope with competition for limited resources (such as space and food) from new, non-native species that are adapted to warmer and drier weather, and move for the first time into areas that were previously too cold. This affects the delicate balance of the ecosystem, as more species and more individual animals compete for the same food, which may cause some species to decrease their range, or even become extinct. Field biologists in several different countries throughout the globe have already observed this.

With the increase in temperature, animals that pupate or hibernate may emerge earlier, to find that the plants that they feed on have not similarly shifted their calendar with the result that the animals find it more difficult, or impossible, to find food. This has already been observed, for example, the early emergence of Edith's Checkerspot Butterflies in California in 1989, which caused the extinction of an entire local population. The butterflies hatched out of their pupae early because of warmer temperatures, but found that the plants that they usually fed on had not yet begun to flower and so they starved. The loss of a population like this could have several consequences, including starvation in whatever birds or other creatures eat the butterflies (a consequence similar to the loss of the sandeel population for the Scottish seabirds – see page 13). For more information on this issue go to http://www.nwf.org/nationalwildlife/article.cfm?articleid=292&issueid=31





CASE STUDY:

SEABIRDS ON SCOTTISH ISLANDS

On 30th July 2004, the Independent newspaper produced a report that shocked the country. Hundreds of thousands of Scottish seabirds, they reported, have failed to breed this year and may be dying out. The cause, scientists believe, is global warming.

In the last twenty years the temperature of the North Sea which surrounds the Orkney and Shetland Islands has increased 2°C which has caused the plankton in the area to move northwards in search of colder water. As a result the new generation of sandeels, a plankton-feeding fish very common in those seas, cannot find food and the young sandeels have not survived, causing a massive decrease in the population. The sandeel is the principal food of many seabirds, and the near-disappearance of the fish has caused widespread starvation amongst the birds, and they have failed to breed.

FOOD CHAIN:

Plankton	→	Sand	leels	→	Seab	irds	
Plankton mo	ve	→	Fewe	r Sano	deels	→	Fewer Seabirds

The 172,000 pairs of guillemots recorded in a 2000 census have produced almost no young. The 6,800 pairs of great skuas have probably produced fewer than ten chicks in total, and the 1,120 pairs of arctic skuas, 24,000 pairs of arctic terns and 16,700 pairs of Shetland kittiwakes have probably produced no young at all. The puffin has probably suffered a similar fate.

As global warming continues to rise, there is no prospect of the seas cooling and the sandeels' food returning and so the islands now face the very real possibility of a future with no seabirds.



Marine life is also affected, particularly by the bleaching of coral reefs that is caused by global warming. Bleaching can occur in water that is only 1.1 - 1.6°C warmer than usual and is the result of the death of the microscopic algae that live on corals. This affects overall marine biodiversity. Wetland habitats around coastlines are also threatened by rising sea levels and, in places, may disappear altogether.

Arctic and Antarctic species face a particular threat because of the higher rate of warming in their habitats, and the melting of the ice that they live on. Polar bears and penguins are particularly threatened. In the Antarctic, the Adelie penguin population has reduced by between 20% and 50% in the last twenty-five years as a response to the melting of winter sea ice. Polar bears have also been affected by the earlier seasonal break-up of sea ice from which they hunt seals, which is preventing them from storing up sufficient fat to survive throughout the non-hunting season and to maintain breeding levels.

EFFECT ON AGRICULTURE

Up to a point, increased levels of carbon dioxide increase photosynthesis and growth, thus potentially increasing farmers' yield. However, there are many dangers for farmers associated with global warming.

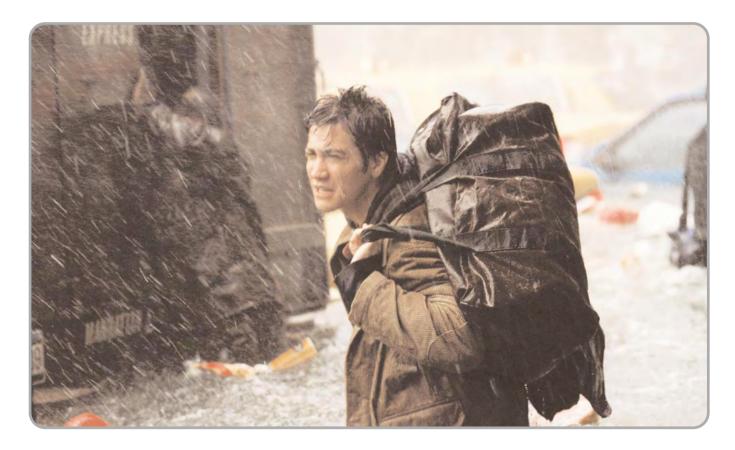
The intensified summer heat and the warmer winters affect the wild flora of the British Isles and Europe, but also have an impact on the commercial farming sector. Farmers will no longer be able to rely on the amount of rain they previously did and instead resort more frequently to increased, expensive artificial watering or, in areas that cannot afford this option, the loss of crops and both financial loss and the risk of famine.

The increasingly unpredictable weather conditions could also seriously affect farmers, with more crops destroyed due to freak weather conditions such as flooding and storms, or unseasonable cold or warm spells. Various farmers, gardening associations and news companies have expressed their concern in this area. In warm countries, the increased incidence of fires also causes devastation of entire crops.



THREAT TO HUMANS

Climate change affects humans. Similarly to animals and plants, humans and humanbuilt environments are in fact quite specifically adapted to the climactic conditions in which they live, and even slight change in these conditions can cause many problems. For example, European countries, particularly in the north of the continent, are not well adapted to deal with extreme heat. Across western Europe there has been a growing death count from the summer heat waves, particularly in the warmer countries. The 2003 death count from the French heat wave that year almost reached 15,000 (see http://www.usatoday.com/weather/news/2003-09-25-franceheat_x.htm). However, conversely it has been proved that the milder winters have decreased the death toll in that season, especially among the elderly.



Water provision, carefully controlled in hotter countries but relatively casually regulated in Europe, has periodically been defeated by the hot weather and water restriction measures, such as hosepipe bans, have been put in place. In addition, infrastructure can be affected, as road tarmac melts.





Humans will also be affected by the change to the flora and fauna in their area, particularly in poorer countries that are more dependent on natural resources for food, fuel, shelter and medicine. These countries are also more likely to be dependent on very restricted water supplies and on rain-fed agriculture. A decrease in rainfall could deprive communities of both food and water and cause starvation and drought. Scientists have said that Africa is the region likely to be most severely affected in human terms by climate change, because of the precariousness of everyday life there.

The serious impact of global warming is being seen in third-world countries that do not have the money to adapt to changing conditions. Many developing countries, such as Bangladesh, would be at serious risk from freak flooding (resulting from a rising sea level and increased precipitation) which would destroy crops and homes, a crisis which the country lacks the money and resources to deal with.

Drought and flooding, as well as malnutrition, contribute to the spread of disease and could cause widespread humanitarian disaster. Disease also spreads and germs multiply faster in hot climates so an increase in temperature could have a devastating effect on already disease-stricken countries. Insects such as mosquitoes that carry diseases such as malaria, dengue fever and encephalitis also have longer life spans and larger ranges, thus infecting more people.



In coastal areas, towns could be flooded. Many Pacific islands, such as the Maldives, lie at less than 1.8 metres above sea level, as do major cities such as Shanghai and Lagos. Low-lying countries such as Bangladesh are also at considerable risk.

Statistics courtesy of: www.climatehotmap.org







DIAGNOSIS AND RESEARCH

ICE CORES

The Day after Tomorrow mentions the use of ice cores as a tool for examining climate change. Ice cores are extracted by drilling into ice using a hollow tube so that a cylinder of ice is cut and then drawn up to the surface. By analysing the ice, scientists can examine the composition of the ice laid down during past ages, and thus extrapolate a better overall picture of climate change through time. Some ice cores contain information dating back hundreds of thousands of years. Through analysis, scientists can extract information about precipitation, temperature, gas composition of the lower atmosphere, and other climate indicators.

MONITORING THE SITUATION

Scientists across the globe are now monitoring many types of information on the progress and effects of climate change. Some of these, such as greenhouse gas emissions and sea level rise are collated in order to gain a global picture of the physical effects of global warming. Day by day climate readings can be seen at: http://lwf.ncdc.noaa.gov/cgi-bin/res40.pl?page=climvisgsod.html

Particularly important are the monitoring stations in the Arctic and Antarctic, not only because of the significance of melting ice caps, but because these very sensitive regions are often the first to be affected by climate change. Extreme weather conditions are also recorded throughout the world and the information is collated.

Several organisations perform this task, such as the World Resources Institute, the Union of Concerned Scientists, Environmental Defence and the World Wildlife Fund. Conferences of scientists are periodically held to debate and discuss the issue, and share information.

Local wildlife populations are monitored in an attempt to gauge the effect on flora and fauna.

A simple overview of all these factors and risks specific to different countries and regions is available at www.climatehotmap.org



PREVENTION

In trying to slow global warming and avoid its consequences, there are long-term measures that can be taken. However, these are very expensive, and global warming as a result has become one of the most politically charged scientific debates in the modern world.

TASK

Look back at the work you completed on the problems of emissions. Scientists around the world meet to discuss the problems of global warming. In what ways do you think that their findings might not please industrialists who generate the world's wealth?

The immediate effects of global warming can be slowed in some circumstances. For example, the sea rising can be treated with various coastal pumps and sea walls. This is already used on many coastlines across the globe to a small extent. However, long-term and sustainable solutions to the problem are still being considered at local, national and international levels.

NATIONAL POLICY

Scientific research is contributing to the reduction of greenhouse gas emissions by developing alternative energy sources to fossil fuels and also in investigating fuel types that are less damaging to the environment. Fuels are being developed for the car manufacturing industry as alternatives to petrol that burn cleaner and produce fewer harmful emissions. These include bio diesel, ethanol, hydrogen and propane.

However, although choices exist that can minimise energy usage (thus reducing the burning of fossil fuels to produce energy), by far the greatest source of CO_2 emissions is big industry, which has often been resistant to proposed changes. Therefore governments can play a crucial role in using legislation to force industry to become more environmentally friendly. Considerable attempts at both national and international legislation have been made in recent years.

Governments can demand the use of environmentally friendly technology, particularly in the manufacture of automobiles. A case in point is the legislation passed in Britain in the early 1990s for the compulsory fitting of catalytic converters in all new cars.





National energy policy is also key in controlling emissions, and a move away from fossil fuel burning towards renewal energy forms such as wind, solar or waterpower would produce a significant difference.

A FEW TYPES OF ALTERNATIVE ENERGY

In the chart below are listed some of the possible ways of generating alternative energy. For each of these, try to think of the advantages and disadvantages to each.

WIND: The movement of air (wind) contains kinetic energy, which can be used to turn wind turbines that produce electricity.	Advantages	Disadvantages
HYDROELECTRIC: The water stored in dams has potential energy. When it is released, it produces kinetic energy that can be used to turn turbines.		
TIDAL: As the tide rises, the water can be trapped behind a barrier and, as with a dam, when it is released the kinetic energy can be used to turn turbines.		
SOLAR: Photocells can convert sunlight directly into electricity, or solar panels can trap the energy and use it for heating.		
NUCLEAR: Energy is produced by either forcibly splitting or merging individual atoms of uranium or plutonium.		



When you have completed the chart on page 19, think carefully about the advantages and disadvantages of each type of alternative energy. Are they scientific or economic or both? What do you think government, industry and the people's reactions to each might be? Give reasons for your answers.

UK ENERGY POLICY

Prime Minister Tony Blair has described climate change as '...the most important environmental issue facing the world today'. The UK government has pledged to cut CO_2 emissions by 20% by 2012. The Department of the Environment has also pledged to cut carbon emissions by an extra twelve million tonnes through energy efficiency over the next six years.



The government also commissioned an energy review by the Performance Innovation Unit (PIU) that was released in February 2002. This report recommended that 20% of the UKs energy should come from renewable sources by 2020. The UK government has set a target of 10% of energy coming from renewable sources by 2010, and to that end is considering offering tax advantages for industry if they follow low carbon programmes.





The Department of Environment, Food and Rural Affairs (DEFRA) also aim to support energy-related programmes abroad.

'We will encourage developing countries to consider the need for increased levels of spending in support of energy for poverty reduction, and are prepared to provide additional funding for these in the future.'

In April 2004, the UK government lent its support to the creation of The Climate Group, which aims to unite financial institutions, business leaders and politicians in order to identify 'best practice' on managing carbon emissions and climate change.

INTERNATIONAL POLICY

A famous conference on climate change was held in 1997 in Kyoto, Japan, and was attended by many world leaders and resulted in one of the most important global emission-related documents to date. This is the Kyoto Protocol, which all international global warming conferences have been based on since. At that conference delegates from many of the developed countries in the world stated their own specific targets for cuts in emissions by a certain date.







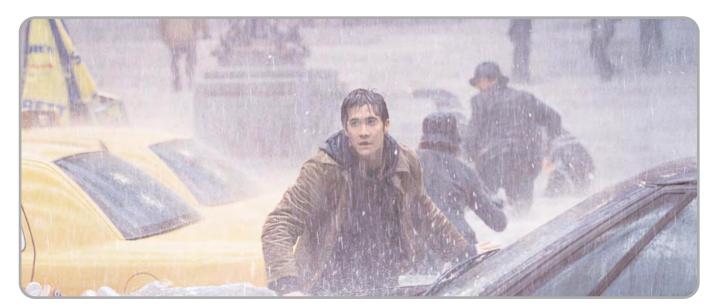
The US proposed not to cut emissions, but only to stabilise them, whereas the European Union called for a 15% cut. Eventually a compromise proposal was reached and industrialised countries were committed to an overall reduction of emissions of greenhouse gases to 5.2% below 1990 levels for the period 2008 - 2012. The Intergovernmental Panel on Climate Change said in its 1990 report that a 60% reduction in emissions was needed.

There were many political factors involved during the conference and many industries such as oil and coal mounted a huge campaign to discredit the conference. Greenpeace has called the Kyoto Climate Change Conference and its eventual outcome '...a tragedy and a farce'.

At the end of March 2001, US President George Bush stated that he '...opposed the Kyoto Protocol'. One of the reasons he cited was because India and China would not be subject to Kyoto measures and would increase their emissions. However, on a per capita basis, the United States produces more CO_2 emissions than India, China and Japan combined, more emissions per capita than any other nation. Furthermore, the US produces 20-25% of the world's carbon dioxide emissions, for just 4-5% of the world's population.

INDIVIDUAL ACTION

There are several measures that the ordinary person can take to reduce carbon dioxide emissions, principally by saving energy.







Heating a house uses up a large amount of energy and individuals can reduce this by effectively insulating their house. In an average house (estimates only):

35% of heat is lost through the walls.
SOLUTION: Get insulation fitted in the wall cavities.
RESULT: Less than half as much energy lost through walls.
25% of heat is lost through the roof.
SOLUTION: Get insulation fitted in the loft.
RESULT: One third as much energy lost through roof.
15% of heat is lost through gaps under doors and around windows.
SOLUTION: Fit draught excluders.
RESULT: Half as much energy lost through gaps.
15% of heat is lost through the floor.
SOLUTION: Get carpet and underlay fitted.
RESULT: Half as much energy lost through floor.
10% of heat is lost through windows.
SOLUTION: Get through windows.

which traps either an insulating layer of air or a vacuum.

RESULT: Half as much energy lost through windows.

Energy-efficient appliances waste less of the energy produced in unwanted forms, such as heat. No appliance is 100% energy efficient, but some are much more efficient than others. Choices of energy-efficient appliances are now wider, and appliances that are particularly energy-efficient are often labelled as such. The United States has an 'Energy Star' labelling system for appliances that are considerably more energy efficient than government stipulations. The UK also has an 'Energy Efficiency' label that indicates that the appliance uses up to a third less energy than an unlabelled appliance.





Light bulbs also vary greatly in energy efficiency. Fluorescent light bulbs use a quarter of the energy of incandescent bulbs and give out the same amount of light. They also last ten times longer than incandescent bulbs.

Cars also vary hugely in their energy efficiency. Hybrid electric vehicles (HEV's) are now made that combine a petrol engine with a battery powered electric motor and are considerably more fuel-efficient than petrol-only vehicles. Energy can, of course, also be saved by choosing to drive less often and instead using public transport or walk.

TASK

You have seen what we, as individuals, can do to save energy and cut down on emissions. How would these change your lives? Do you think these activities are valuable if industry does not follow suit and cut down on their emissions and activities that pollute the atmosphere?

THE ROLE OF THE SCIENTIST

It is easy to blame scientists for all of the ills of the world. Film and television both love the stereotype of the mad scientist who dreams up experiments that will destroy the world. However, the future of our planet mainly lies in the hands of scientists. It is up to them to try to find ways of slowing, if not eradicating the effects of global warming. It will be up to them to find alternative ways of sustaining our life on Earth means of ensuring that our way of life will continue.

TASK

We tend to think of scientists being grouped under three heading – physicists, chemists and biologists. Try to think how each of these might help us in our struggle against global warming. We need to think of scientists as people who will prevent and not simply warn and alert.