

## Energy Production

### Introduction

Globally, the demand for energy is increasing, especially in developing countries. However, it is the rich industrialised countries that use most of the world's energy production.

The USA has about 6% of the world's population but consumes around 30% of the world's energy production. In contrast, India has about 20% of the world's population but consumes only 2% of the world's energy production.

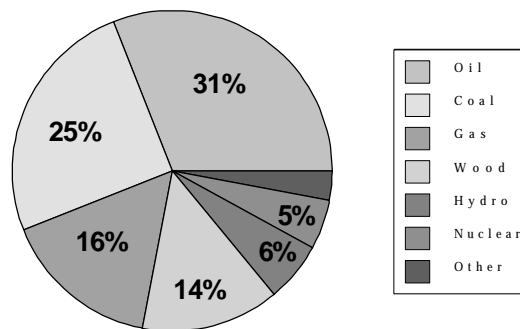
In the 1990's oil, coal and natural gas accounted for 90% of the world's energy production. These are called fossil fuels. They were formed from solar energy stored in plants. These plants decomposed and over millions of years have been converted into coal, oil, gas and other materials such as peat.

As they take so long to form, they are considered as being non renewable. Until now, fossil fuels have been relatively easy to obtain and cheap to use. Unfortunately, they are major polluters of the natural environment.

Nuclear energy production uses uranium. This is not a fossil fuel and sometimes is considered as non renewable. However, nuclear energy production uses only small quantities of uranium and therefore should take a very long time to consume the known global resources. In addition, nuclear fuel can be recycled to some extent so it could be regarded as a renewable resource.

In many parts of the developing world wood is used, non commercially, to provide energy. It provides more than a third of the developing world's energy requirements.

Energy sources that are considered to be sustainable and known as **renewable**. Currently only the use of running water, to produce hydro electric power, is a source of renewable energy on the global scale. Other potential renewable sources of energy include the sun (solar power), the wind, waves on the sea, changes in sea level due to tides, heat from the Earth (geothermal) and energy from vegetable waste (biomass).



Global energy production - 2000

As the supply of fossil fuels runs out, these renewable sources will be used more and more. Although these sources do not produce waste products such as carbon dioxide, sulphur dioxide and nitrogen oxides it should be understood that all methods of energy production have some effects on the environment.

**Non renewable energy sources****Fossil fuels**

At the moment coal, oil and gas are the most widely used sources of energy. However, they will not last for more than a few hundred years at current consumption rates. It took nature 1 million years to produce the amount of fossil fuel that is currently consumed in 1 year.

- **Coal**

Coal is the longest used fossil fuel. Approximately a quarter of the world's energy is still produced from coal. Despite the development of clean coal technology which can remove most of the damaging emissions from coal combustion there is a reducing demand for producing power from coal.

It is not just the burning of coal that affects the environment. Extraction of coal leads to dereliction of land by mining, subsidence, waste disposal and water pollution.

- **Advantages of using coal**

1. Coal is found in many locations around the world.
2. Coal reserves are predicted to last another 300 - 400 years.
3. It is an effective source of heat energy being burnt in stoves or open fires.
4. Improved technology has made conversion to electricity more efficient.
5. Clean coal technology has reduced emissions of noxious gases and fumes.
6. Coal produces a wide range of by products.

- **Disadvantages of using coal**

1. As more easily accessible deposits are used up production costs are rising.
2. Burning coal produces carbon dioxide which causes global warming.
3. Burning coal produces sulphur dioxide which causes acid rain.
4. Emission of fumes and particles cause human health problems.
5. Coal mining operations produce huge quantities of waste.
6. Coal is heavy and bulky so transport costs are high.
7. Open cast mining takes up large areas of land and destroys the countryside.
8. Deep mining causes subsidence which can damage buildings and roads.

- **Oil**

Oil has been the main source of energy since the Second World War. It now accounts for about 31% of the world's energy production. Its distribution around the world is uneven. It is often found in remote areas such as deserts and Alaska or under the sea. Pollution is caused by burning the oil and from accidental spillages during transportation.

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**Non renewable energy sources**

- **Advantages of using oil**

1. Oil is transported easily over land by means of pipelines.
2. Oil burns more efficiently than coal.
3. Used in various forms in internal combustion engines to provide transport.
4. Also used as a source of heat for buildings.
5. It is a raw material for a wide range of products such as plastics.

- **Disadvantages of using oil**

1. Oil is not evenly distributed around the world - supply is politically vulnerable.
2. Oil reserves expected to last only another 100 years at current rate of use.
3. Location in hostile environments requires massive investment for extraction.
4. Burning oil produces carbon dioxide which causes global warming.
5. Burning oil produces carbon monoxide and unburnt hydrocarbons which cause health problems and smog.
6. Spillages of oil caused by tanker accidents pollute coastlines and oceans.

- **Natural gas**

Natural gas is often found in the same locations as oil. Currently there is a world surplus and supplies are, therefore, relatively cheap. Natural gas provides about 16% of the worlds total energy production at present.

- **Advantages of using gas**

1. Gas is cheaper than oil.
2. Gas burns more efficiently than oil and coal.
3. It is less damaging to the atmosphere than oil or coal.
4. Also used as a source of heat for buildings.
5. Gas is transported easily over land by means of pipelines.

- **Disadvantages of using gas**

1. Known gas reserves are expected to last another 120 years at current usage.
2. Gas combustion releases methane which adds to the greenhouse effect.
3. Gas combustion releases nitrogen oxide and sulphur dioxide which lead to acid rain.
3. Location in hostile environments requires massive investment for extraction.
4. Gas leaks can lead to explosions.
5. As for oil, gas is not evenly distributed around the world - supply is politically vulnerable.

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## **Non renewable energy sources**

### ▪ **Nuclear power**

Nuclear power is produced by the fission of atoms using radioactive uranium. The process does not release smoke, sulphur dioxide, carbon dioxide or monoxide into the atmosphere. However, there is a risk of releasing radioactivity into the environment.

There have been major accidents - Three Mile Island in the USA in 1979 and Chernobyl in the Ukraine in 1986. These have turned public opinion against nuclear power. However, in some industrialised countries such as France, Japan, South Korea and Taiwan (where fossil fuels are in short supply) their governments are using nuclear power despite concerns about its safety.

### • **Advantages of using nuclear power**

1. It does not cause air pollution
2. It does not contribute to the greenhouse effect.
3. Only small amounts of uranium are used.
4. Running costs are low.
5. Many safeguards make risk of accidents small.

### • **Disadvantages of using nuclear power**

1. Huge amount of money spent on research.
2. Power stations are very expensive to build.
3. There will be extremely high decommissioning costs.
4. Risk of radioactive waste contaminating the environment.
5. Risk of nuclear accidents.
6. Potential health risks.

### ▪ **Fuelwood**

Trees are being removed at an increasing rate in underdeveloped parts of the world. They are needed for shelter as well as for fuel. Collecting fuelwood is a time consuming task for many women and children. They have to walk many miles each day to find enough wood to cook their food. As populations grow this leads to over use of sparse resources resulting in desertification.

Alternative energy sources are badly needed in these areas.

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## **Renewable energy sources**

Sources of power that harness the natural energy are currently under exploited. Currently only the use of running water, to produce hydro electric power, is a source of renewable energy on the global scale.

Other potential renewable sources of energy include the sun (solarpower), the wind, waves on the sea, changes in sea level due to tides, heat from the Earth (geothermal) and energy from vegetable waste (biomass).

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## **Renewable energy sources**

### ▪ **Hydroelectric power (HEP)**

At present HEP accounts for approximately 6% of the world's energy consumption. However, in some countries it accounts for much higher proportions, E.g. Norway generates 95% of its electricity and Brazil generates 85% of its electricity in this way. Thus it is important in both developed and developing countries.

#### • **Advantages of using hydroelectric power**

1. It does not usually contribute to the greenhouse effect.
2. It does not contribute to smog or acid rain.
3. It does not cause water or land pollution.
4. Reservoirs can also be used for water supply and recreation.
5. Water is a renewable resource.

#### • **Disadvantages of using hydroelectric power**

1. Construction requires enormous capital expenditure.
2. Construction work can damage the environment.
3. Large areas of farmland and wildlife habitats may have to be flooded.
4. People may have to be relocated if settlements are drowned.
5. There is always a risk of the dam bursting.
6. Archaeological and cultural heritage may be destroyed.
7. When flooded, decaying vegetation can release methane and carbon dioxide, contributing to the greenhouse effect.

### ▪ **Wind power**

Although the first large scale wind farms were built in California, by the late 1990's European countries were producing more energy from wind farms than the USA. At present, apart from hydroelectric power, this is the only renewable option being actively developed in the UK.

Modern wind powered generators have good efficiency, but need to be located in areas which have high and regular wind speeds. These conditions are usually found in upland areas and on exposed coastlines. As wind turbines are expensive to build and maintain they are usually built in groups of 25 or more to form a 'wind farm'.

#### • **Advantages of using wind power**

1. It does not usually contribute to the greenhouse effect.
2. It does not contribute to smog or acid rain.
3. It does not cause water or land pollution.
4. Production costs are relatively low.
5. It does not depend on sunshine - operates night and day.
6. It uses simple and safe technology.

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## **Renewable energy sources**

- **Wind power**

- **Disadvantages of using wind power**

1. Wind does not blow all the time.
2. Wind farms spoil the visual appearance of the countryside.
3. Wind farms can disrupt radio and TV reception locally.
4. Wind farms cause noise pollution in areas which would otherwise be quiet.
5. Large numbers of windmills would be needed to replace conventional power stations - approx. 7000 turbines needed to replace a nuclear power plant.

- **Geothermal energy**

Geothermal means heat from the Earth. In some parts of the world, such as Iceland, New Zealand and Japan, where there are active volcanoes, heat from the interior of the Earth can be accessed from the surface. In theory, geothermal energy is a limitless source of energy in the form of very hot water or steam.

- **Advantages of using geothermal energy**

1. It is renewable.
2. It provides a constant supply of heat.
3. It is not a major source of pollution.
4. It is cost efficient in suitable locations.

- **Disadvantages of using geothermal energy**

1. Construction requires large capital expenditure.
2. Emissions of sulphurous gases causes pollution.
3. There is a danger to the power station from volcanic activity.
4. Its use is limited to volcanic areas.

- **Energy from the sea**

The harnessing of wave and tidal power has not been extensively used. Many rivers around the world have a tidal range which could generate electricity. Many different designs to extract energy from waves have been tested. These involve nodding, bobbing, pushing and pulling mechanisms either on the surface or submerged.

- **Advantages of using energy from the sea**

1. It is renewable.
2. It is clean, safe and reliable.
3. Tidal barrages can provide areas for recreational activities and fish farming.
4. Upstream areas are protected from tidal surges.

## **Renewable energy sources**

### ▪ **Energy from the sea**

#### • **Disadvantages of using energy from the sea**

1. Construction of tidal barrages requires large capital expenditure.
2. Problems with reliability of machinery to harvest energy from waves.
3. Tidal barrages destroy wildlife habitats.
4. Little power generation around high and low tides.

### ▪ **Solar power**

The amount of solar energy that reaches the earth far exceeds all other sources of energy. Solar energy can be used to generate electricity either directly, by using photo voltaic cells or indirectly using solar cells to heat water which is then converted into steam to drive a turbine.

In countries like the UK, where there is a lot of cloud cover, solar power will only generate a few per cent of the overall energy needs. However, its potential in developing countries which lie in warmer and sunnier latitudes is enormous.

#### • **Advantages of using solar power**

1. It is renewable and free from pollution.
2. Some small systems are portable and could be used by nomadic people.
3. It is safe and efficient.
4. It has low maintenance costs.

#### • **Disadvantages of using solar power**

1. It is of limited use in cloudy areas.
2. Initial costs are relatively high.
3. Energy is only produced during the day.

### ▪ **Energy from biomass**

This involves the production of energy from organic materials such as wood or animal dung. The organic material is placed in a 'digester' to produce 'biogas' which is mainly methane.

In the UK, landfill sites produce methane from the decomposition of household waste. Methane is a greenhouse gas so it is important that the landfill is constructed in such a way that the methane is trapped and drawn off for use as a fuel.

#### • **Advantages of energy from biomass**

1. It is renewable and cheap.
2. Sometimes the digester residue can be used as a fertiliser..
3. There is little pollution.

#### • **Disadvantages of energy from biomass**

1. There can be pollution from methane and carbon dioxide.
2. Crops grown for fuel may take the place of food crops.

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## Assessment

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### Energy Production

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**Questions 1 to 5 - Select the correct response for the following questions :**

1. What percentage of the world's energy production is consumed in the USA ?  
  
A 2%  
B 6%  
C 20%  
D 30%
  
2. In the year 2000, what percentage of global energy production was obtained from coal, oil and gas ?  
  
A 90%  
B 84%  
C 72%  
D 60%
  
3. Which of the following is **not** classed as a renewable method of energy production ?  
  
A Hydro electric power  
B Nuclear power  
C Wind power  
D Solar power
  
4. Which of the following is **not** considered to be a non renewable energy source?  
  
A Coal  
B Gas  
C Biomass  
D Oil
  
5. What is the usual minimum number of wind turbines in a wind farm for it to be economical ?  
  
A 25  
B 15  
C 8  
D 1



**Questions 6 to 10 - Decide whether each of these statements is True (T) or False (F).**

6. i) Nuclear energy production uses uranium. This is not a fossil fuel and sometimes is considered as non renewable.  
ii) However, nuclear energy production uses only small quantities of uranium and therefore should take a very long time to consume the known global resources.

Which option best describes the two statements?

- A i) T ii) T  
B i) T ii) F  
C ii) F ii) T  
D ii) F ii) F

7. i) Approximately one quarter of the world's energy is still produced by burning coal.  
ii) Oil now accounts for only 10% of the world's energy production.

Which option best describes the two statements?

- A i) T ii) T  
B i) T ii) F  
C i) F ii) T  
D i) F ii) F

8. i) Natural gas supplies 31% of the world's energy production.  
ii) Known gas reserves should last another 120 years at current usage.

Which option best describes the two statements?

- A i) T ii) T  
B i) T ii) F  
C i) F ii) T  
D i) F ii) F

9. i) A disadvantage of nuclear energy production is that it contributes to the greenhouse effect.  
ii) Hydro electric power production requires little capital expenditure.

Which option best describes the two statements?

- A i) T ii) T  
B i) T ii) F  
C i) F ii) T  
D i) F ii) F

10. i) Currently it would take approximately 7000 wind turbines to replace one nuclear power station.  
ii) Solar power production is renewable and free from pollution.

Which option best describes the two statements?

- A i) T ii) T  
B i) T ii) F  
C i) F ii) T  
D i) F ii) F