Renewable Energy

EARTH SCIENCE • EARTH'S RESOURCES • RENEWABLE ENERGY

Section 1: Solar Power

• Where does solar energy come from?

Solar energy originates from the Sun. When the Sun was formed, billions of years ago, it contained huge amounts of hydrogen gas. Since its formation, the Sun has been converting this hydrogen into helium in a process known as nuclear fusion, which involves the sticking together of hydrogen atoms to form helium and release energy. This process occurs continuously in the Sun's core, and the energy produced is transported across the Solar System in the form of light and heat, and we encounter this energy as it strikes the Earth. The Sun provides enough energy in just one hour to meet the energy needs of the Earth for a whole year, but we are not yet able to harness all of this energy on Earth.

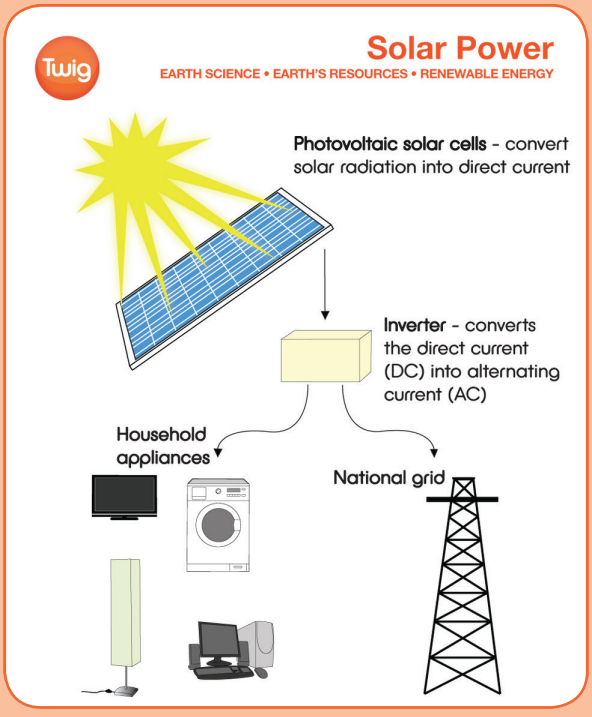
The Sun provides non-polluting and renewable energy

• Suggested Film

- Solar Power

• How do we harness solar energy?

DIAGRAM 01:



We can harness the Sun's power both directly and indirectly. We can convert the energy from Sunlight into electricity using solar, or photovoltaic, cells. When the Sunlight hits the material in the photovoltaic cell (usually silicon), it releases electrons to produce an electrical current known as Direct Current (DC), which can then be converted to Alternating Current (AC), which can be easily distributed as mains electricity. These solar cells tend to be clustered together in solar panels in order to generate enough electricity. Solar panels can also collect heat from the Sun and use it to heat water, which can be used to provide hot water and heating in buildings.

• Suggested Films

- Solar Power
- Geothermal Power

Photovoltaic solar cells produce usable electricity

Extension Question

Q1. What is geothermal energy?

Geothermal energy is generated within the Earth and can be harnessed in similar ways to solar energy, either to heat water or homes, or to create electrical currents. It is effectively heat generated by various geological processes within the Earth.

• What are the advantages and disadvantages of using solar power?

Solar power is a renewable energy source, and is effectively free and limitless. It is clean and environmentally friendly with little in the way of waste. It is useful as a way to harness renewable energy in remote locations, and is easy to install on a small-scale, domestic basis. However, because large-scale projects require a large number of panels and therefore a large area, it is often impractical to implement. Also, the Sun only provides energy to Earth during the day; we therefore need to be able to store the energy when it is available so that we can use it at another time, but current levels of technology make this difficult to achieve.

• Suggested Film

- Solar Power

Section 2: Wind Power

• How is wind generated?

Wind turbines turn wind energy into electricity

The production of wind power is linked to solar power, because winds are generated by the effects of the Sun's energy (as heat) on the Earth's surface. Wind is the movement of air, and is generated because the Sun heats the Earth unevenly. This process occurs at different scales. On a global scale, the parts of the Earth nearest the equator are heated most by the Sun, and when the air here warms and rises, it is replaced by a rush of cooler air from the polar regions. On a smaller scale, winds are generated because the air above land and sea heat up and cool down at different rates. As the air over land heats up quickly during the day, it rises and its place is taken by cooler air rushing in.

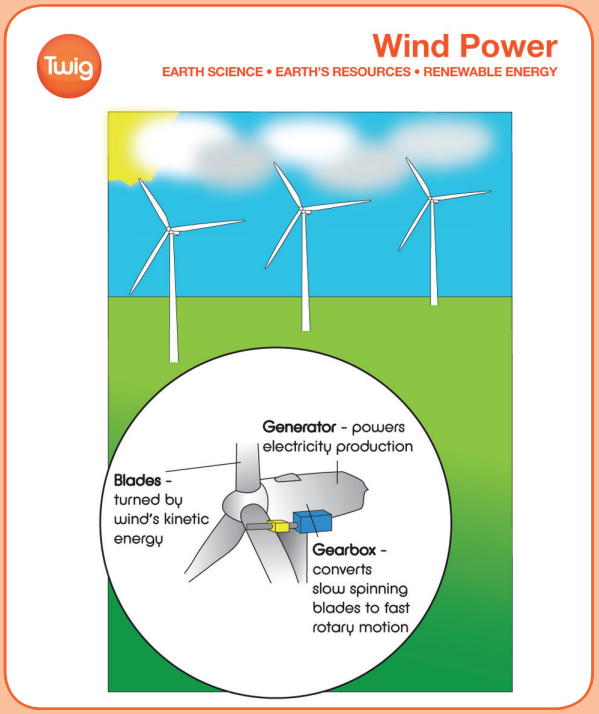
• How is electricity generated from wind?

As wind is air in motion, it holds kinetic energy. This kinetic energy can be captured by large blades and converted to electrical energy. The wind flows over the blades of a wind turbine, causing the blades to turn. Usually the blades will be connected to a shaft or rotor, which in turns moves a generator to produce electricity. Wind farms are collections of wind turbines clustered together in areas with strong winds; different designs of turbine can be used to maximise the amount of wind energy harnessed. The best sites for wind farms are those which are either exposed to high winds or are in areas where wind is funnelled or concentrated, such as on exposed hilltops, near shorelines or in the gaps in mountain ranges.

• Suggested Film

- Wind Power

DIAGRAM 02:



• What are the advantages and disadvantages of using fossil fuels?

Like solar power, wind is renewable and therefore effectively limitless. The process of generating wind energy does not itself cause any pollution in the form of emissions, although the production of turbines and the day-to-day running of wind farms may require the input of energy from other sources, usually fossil fuels, which may contribute to pollution indirectly. Turbines require a small physical area relative to how much energy they produce, but the turbines themselves are often very large and can create a visual obstruction on the landscape that many people are displeased with. Wind farms can also disrupt ecosystems and may cause particular problems for birds and bats.

• Suggested Films

- Wind Power
- The Wind Power Debate

Section 3: Biofuels

• What is a biofuel?

A biofuel is any fuel that is derived from biomass. Biomass refers to organisms which were recently alive, or the products of their metabolism or decomposition. In the most general terms, biofuels include solid fuels such as peat, liquid fuels such as bioethanol or biodiesel, and biogases such as methane from the decomposition of organic material. Biofuels are considered a good alternative to traditional fossil fuels because they do not contribute directly to global warming through the release of carbon dioxide. Any carbon dioxide released during burning was recently taken up from the atmosphere by the organisms which created the biofuels. The most commonly used biofuels are bioethanol and biodiesel.

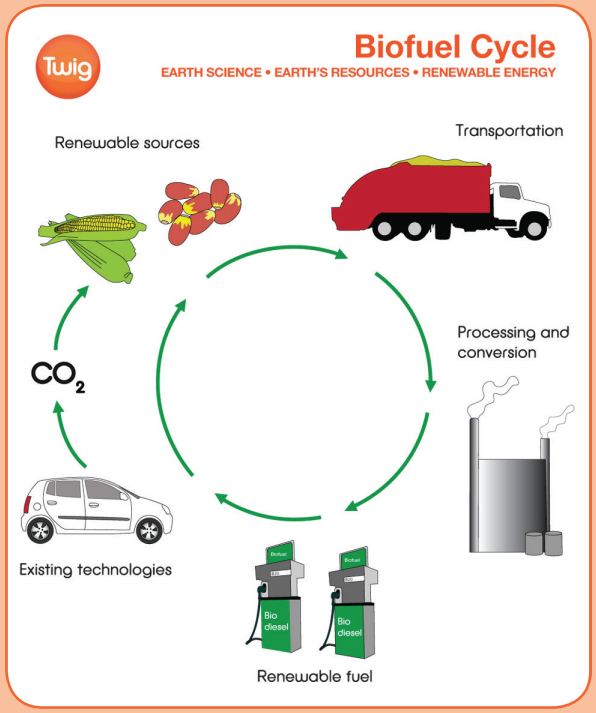
Palm oil is made from palm fruit and is used in biodiesel

• Suggested Film

- Biofuels

• How are biofuels formed?

DIAGRAM 03:



Biodiesel is similar in composition to mineral diesel produced from fossil fuels, but is produced from oils or fats, typically from feedstocks. Feedstocks are the raw materials used to produce another product, and biofuel feedstocks include vegetable oil, soya beans, sunflower oil, rapeseed oil or palm oil. These oils undergo a process called transesterification, where they react with an alcohol, such as methanol or ethanol, to produce biodiesel. Bioethanol is a form of alcohol and can therefore be made from any sugary or starchy feedstocks that can be used to produce alcoholic drinks. Typical feedstocks include sugar beets and sugarcane, wheat and corn. The ethanol is formed by fermentation of sugars and starches, via the action of enzymes and microorganisms.

• Suggested Films

- Biofuels
- Palm Oil: Biofuel of the Future

• How do we use biofuels?

Biofuels are burned to release the chemical energy stored within them, in much the same way as fossil fuels. Ethanol is the most common biofuel worldwide, but biodiesel is common in Europe. Ethanol can be used in petrol engines and it can also be mixed with petrol. Similarly, biodiesel can be used in its pure form, but can also be added to mineral diesel from fossil fuels. The addition of ethanol or biodiesel to traditional fossil fuels will increase the fuel efficiency and reduce levels of emissions. Ethanol has a smaller energy density than 'normal' petrol, which means it takes more fuel to get the same energy from the fuel.

Biofuels can be used as an alternative to petrol and diesel

• Suggested Film

- Biofuels

Extension Question

Q2. What are the issues surrounding the use of biofuels?

The feedstocks used to produce biofuels are often the same as those used for food for humans or animals in developing countries. The production of biofuel feedstocks often uses fossil fuels, for example, in cultivating the crops and transporting the fuels. Production also often occurs far from the region where the fuel is used, causing adverse environmental impacts in areas of the developing world. Work is currently being done to produce second generation biofuels: these use the waste products from food crops instead of food crops themselves.

• Quizzes

Solar Power

Basic

• Solar energy comes from the

A – Sun
B – Moon
C – biosphere
D – wind

• Which of these can we NOT use the Sun's energy for?

A – heating our homes
B – heating water
C – generating electricity
D – burning fossil fuels

• What type of energy is created in solar cells?

A – kinetic
B – chemical
C – potential
D – electrical

• What are solar cells usually made of?

A – silicon
B – plastic
C – wood
D – metal

Advanced

• Solar energy is initially produced by

A – combustion
B – nuclear fusion
C – nuclear fission
D – evaporation

• What is the scientific name for solar cells?

A – photosynthetic
B – photovoltaic
C – photographic
D – hypervoltaic

• The Sun produces enough energy in an hour to meet the power needs of the Earth for

A – 1 day
B – 1 week
C – 1 month
D – 1 year

• What is the main limit to our use of solar energy?

A – the amount of energy produced by the Sun
B – the lack of efficient storage solutions
C – the availability of materials to make solar cells
D – the speed with which solar panels can be made

Wind Power

Basic

• Wind is

A – cold air replacing warm air

B – wet air replacing dry air

C – warm air replacing cold air

D – dry air replacing wet air

• Wind energy is captured by

A – barrages

B – turbines

C – dams

D – solar cells

• The blades of the turbine are connected to

A – a rotor

B – a solar panel

C – a dam

D – a fuel cell

• What are collections of wind turbines called?

A – wind seas

B – wind farms

C – windmills

D – wind valleys

Advanced

• Why are global wind cycles generated?

A – because of the rotation of the Earth

B – because of the rotation of the Sun

C – because there is more intense heating of the equator

D – because there is more intense heating of the poles

• What form of energy is captured from wind?

A – chemical

B – potential

C – kinetic

D – electrical

• The energy generated by turbines is

A – chemical

B – potential

C – kinetic

D – electrical

• Which of these is NOT a disadvantage of wind power?

A – the energy is non-renewable

B – wind energy is unpredictable

C – wind turbines are noisy and affect the landscape

D – wind turbines can affect ecosystems

Biofuels

Basic

• What are biofuels derived from?

A – biomass
B – hydrocarbons
C – minerals
D – rocks

• Which of these CANNOT be a biofuel?

A – ethanol
B – biodiesel
C – petroleum
D – methane

• Which of these CANNOT be used to produce biofuels?

A – palm oil
B – sunflower oil
C – motor oil
D – rapeseed oil

• Burning biofuels releases energy gained by plants during

A – photosynthesis
B – evaporation
C – respiration
D – decomposition

Advanced

• What is the name for biofuels sourced from the waste from food production?

A – second wave
B – second generation
C – second sector
D – second production

• What is the generic name for the crops used for biofuels?

A – bio-crops
B – feedstocks
C – hydrocarbons
D – carbohydrates

• How is bioethanol produced?

A – fermentation
B – evaporation
C – combustion
D – reduction

• What do feedstocks react with to form biodiesel?

A – water
B – oil
C – alcohol
D – air

• Answers

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