Digital information builds up images from many small dots called pixels. The colour and brightness of each pixel is set by binary digits.

An advantage of using digital signals is that they are easily stored in electronic memories so can be processed by computers.

Physics 3: Sustainable energy

Unit 1.1: Energy sources and power

A primary energy source is used in the form that it is found. Primary energy sources include:

* Fossil fuels
* Nuclear fuel
* Biofuels
* Wind, waves and sunlight

Primary energy sources can transfer their energy to secondary energy sources, e.g. electricity.

The burning of fossil fuels is increasing the amount of carbon dioxide in the atmosphere.

The greenhouse effect is causing global warming, an increase in the temperature of the Earth's surface.

Global warming is likely to result in climate change.

Power is the amount of energy transferred in one second, i.e. the rate of energy transfer.

A power of one watt (W) transfers one joule of energy in one second. This is shown by:

Energy transferred(J) = Power(kW) X Time(s)

A joule is a very small amount of energy, so domestic electricity measures energy transfer in kilowatt-hours (kWh). There are 1000watts in 1 kilowatt.

A kilowatt-hour is the energy transferred by a power of 1kW in an hour:

Energy transferred(kWh) = Power(kW) X Time(h)

The flow of electricity in a circuit is called current. It is measured in amperes.

The voltage of a power supply is measured in volts (V).

Electric current in an appliance transfers energy to it from the power supply. This is found by:

Power (W) = Current (A) X Voltage (V)

Unit 1.2: Efficient electricity

Electricity supplied = Power(kW) X Time (H)

Cost of electricity = Number of units supplied X Cost per unit.

Sankey diagrams show the energy transfers in a component. The sum of the energy transfers out of a component equals the input energy. This shows that energy is conserved.

The efficiency of a component tells you the proportion of electricity that it transfers into a useful form:

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Components with a high efficiency, e.g. 95%, don't waste much electricity.

A component with a low efficiency, e.g. 20%, wastes a lot of electricity.

Unit 1.3: Generating electricity

Moving a magnet near a circuit causes an electric current to flow in the circuit.

The current flows only when the magnetic field is changing – when the magnet is moving.

1. Power stations use primary fuels, such as fossil, nuclear and biofuels, to boil water into steam.
2. The steam passes through a turbine, making its shaft spin round. The turbine shaft spins the magnet inside
3. Increasing the current drawn from the coil requires an increase in the rate of transfer of energy from the primary fuel

Primary energy sources used to turn turbines directly include wind and water.

How power stations work:

1. The turbine spins the shaft of the generator to make electricity
2. It is set spinning by steam, wind and water.
3. Thermal power stations use coal, oil, gas and nuclear power to spin the turbine from high pressure steam

* Coal-fired power stations do this by burning coal to transfer energy into water.
* Gas-fired power stations burn natural gas to make hot gas for a turbine; another turbine is spun by steam from water heated by the hot gas.
* Hydroelectric power stations use a jet of high pressure water at the base of a dam to spin a turbine.
* Wind-driven power stations use convection currents in the atmosphere caused by the heating effect of the Sun on the land.

Nuclear power stations make high pressure steam by:

* putting fuel rods close to each in the reactor so that they heat up
* taking away the heat with high pressure water circulating around the rods
* using the high pressure water to boil low pressure water in a boiler.

Unit 1.4: Electricity matters

Waste from nuclear power stations is radioactive and a serious health risk – is carefully stored until it becomes safe

Nuclear waste emits ionising radiation, which affects body cells.

An object is only irradiated when it is placed in the path of the radiation.

An object is contaminated when it gets mixed up with radioactive material.

Renewable energy sources can be used over and over again.

|  |  |
| --- | --- |
| *Advantages of hydroelectric schemes* | *Disadvantages of hydroelectric schemes* |
| Provides large amounts of electricity | Flood large areas of land |
| Can be turned on and off quickly | Rotting plants within produce methane. |
| Can store energy in dam | Costs a lot to build |
| *Advantages of wind turbines* | *Disadvantages of wind turbines* |
| Inexpensive | Needs to be put in windy places |
| Needs little maintenance | Only generates energy when there is wind. |

Electricity is convenient because it can transfer energy over long distances for many uses.

The National Grid is a network of cables which carries electricity throughout the UK.

Increasing the voltage of a power cable reduces the current. The National Grid carried electricity at a very high voltage to reduce wasteful energy transfer in cables.

Substations connected to the National Grid reduce the voltage to 230 V for our homes.

Unit 1.5: Electricity choices

The energy sources that can produce large amounts of electricity are: fossil fuels; nuclear power; hydroelectricity; biofuels.

The energy sources that rely on the right sort of weather are: win; waves; solar.

Energy sources that do not produce greenhouse gases: nuclear power; wind; waves; solar; geothermal.

Some energy sources will eventually run out: fossil fuels; nuclear power.

Some energy sources are free: wind; hydroelectric; tidal; solar; geothermal.

When choosing an energy source you should consider:

* its impact on the environment
* the cost of building and running the power station
* how much waste products is produces
* reliability
* cost of using
* efficiency