

GCE LEVEL

FACT FILE

Environmental Technology

For first teaching from September 2013

For first award in Summer 2014

Power Generation



environmental
technology

Counting the Cost of Reliance on Fossil Fuels

Specification Content

Students should be able to:

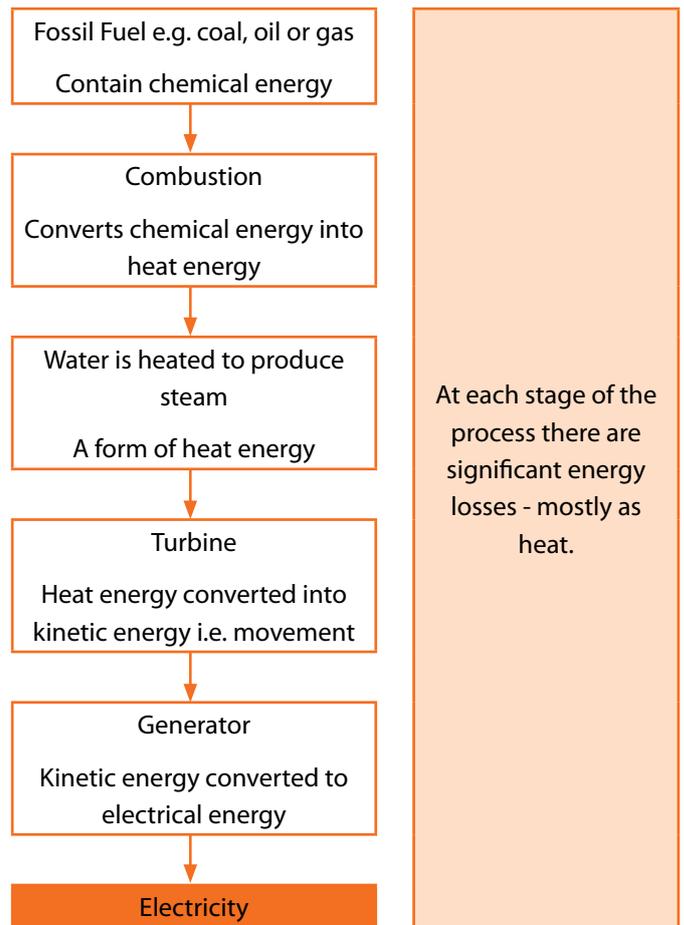
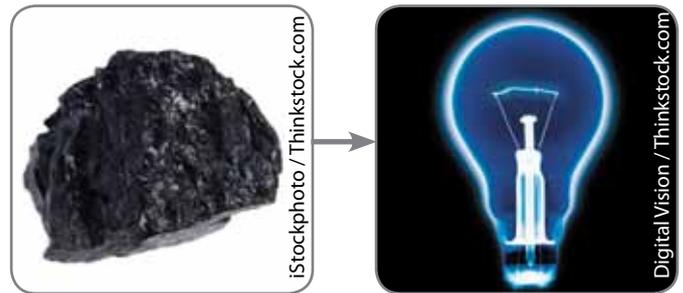
- outline the main phases in the large-scale generation of electricity from fossil fuels, that is the combustion of fuel to produce steam which is used to drive a turbine coupled to a generator; and
- explain how renewable energy sources can be used directly (wind, hydroelectric, wave/tidal) or indirectly (solar PV or biomass) to generate electricity.
- identify the energy changes involved in generating electricity from each of the following renewable energy sources: wind, solar, hydroelectric, tidal, wave and biomass;

Course Content

Macrogeneration – Large scale generation of electricity



Generating electricity from fossil fuels.





Generating electricity using renewable energy sources

Wind power



Wind power turbines have blades mounted on a tall tower. The blades are connected to a housing that contains gears linked to a generator. As the wind blows, kinetic energy from the wind is transferred directly to the blades, which rotate driving a gear system which in turn drives a generator. Several wind turbines are normally grouped together in windy locations to

form wind farms. There has recently been an increase in the number of off shore wind farms.

Hydroelectric



Hydroelectric power stations use kinetic energy from moving water. The water normally comes from behind a dam built across a river valley. The water high up behind the dam acts as a store of potential energy. This is transferred to kinetic energy as the water passes down through the inside of the dam. The moving water directly **drives turbine blades which in turn drive electrical generators, which are normally housed inside the dam.**

Wave/tidal



Wave

Water in the sea rises and falls because of waves on the surface. Wave machines directly use the kinetic energy in this movement to drive electricity generators. This method of generation has potential but is still being developed. The amount of electricity generated this way is still relatively small.

Fossil fuels are non-renewable energy resources in that their supply is finite and they will eventually run out. Fossil fuels cannot renew themselves. Fuels such as wood can be renewed endlessly, but this is a long term option. Approximately 75% of the electricity generated in the UK is from fossil fuels.

Fossil fuels also release carbon dioxide into the atmosphere when they burn, which adds to the greenhouse effect and increases global warming. The burning of fossil fuels also releases sulphur dioxide which is linked with acid rain. Of the three fossil fuels, for the same amount of energy released, coal produces the most carbon dioxide and natural gas produces the least.

The finite nature of fossil fuels and their potential danger to the environment has led to the development of a number of renewable energy sources. These are sources which when captured can provide energy in the normal manner but which either have an infinite potential source and/or pollute the environment much less.

Wind, hydroelectric, wave/tidal, solar PV, and biomass are examples of renewable energy sources.

Direct and indirect renewable energy

Renewable energy sources can be classified into two main groups;

- Direct – these take energy from a renewable source such as the wind or waves in the ocean and can convert this into electrical energy directly e.g. wind, hydroelectric and wave/tidal.
- Indirect – these take energy from a renewable source such as the sun and using a physical characteristic of the material being used, convert this energy into electrical energy e.g. solar PV and biomass.

(For more information see <http://www.renewableuk.com/en/renewable-energy/> and <http://www.energy-uk.org.uk/energy-industry/renewable-power.html>)



Questions

Tidal

Large amounts of water move in and out of river mouths each day because of the tides. A tidal barrage is a barrier built over a river estuary to make direct use of the kinetic energy in the moving water. The barrage contains turbines, which are driven by the water rushing through tubes in the barrage driving the generators. One of the first tidal stream generators connected to the grid is in Strangford Lough (the SeaGen project <http://www.seageneration.co.uk/>).

Solar PV



Light energy from the Sun is converted into electrical energy in the photovoltaic cell contained within the panel. The PV cells produce DC which can be converted to AC by an inverter if it is to be connected to the grid.

Biomass



Biomass is plant matter used, either to generate electricity (in the same way as fossil fuels i.e. combustion), or to produce heat (via direct combustion). Wood remains the largest biomass energy source in use today e.g. forest residues (such as dead trees, branches, clippings, wood chips and even municipal waste). Biomass also includes plant or animal matter that can be converted into fibres or other industrial chemicals called biofuels (e.g. corn starch or sugarcane being converted to bioethanol).

Agricultural waste can also be used to produce methane which can be used as a fuel to generate electricity.

1. Comment on the increased use of renewable fuels and why their use to generate electricity is an important issue.
2. Draw block diagrams showing the energy conversion process which identify the energy changes involved in generating electricity from each of the following renewable energy sources:
 - wind,
 - solar,
 - hydroelectric,
 - tidal,
 - wave, and
 - biomass;
3. For each of the renewable sources of energy provide a description of how each is used to provide energy.
4. Compare the advantages and disadvantages of fossil fuels and renewable sources as energy sources.

