203: Electrical installations technology  
**Handout 25: Electricity generation**

**Learning outcome**

The learner will:

1. know how electricity is supplied.

**Assessment criteria**

The learner can:

5.1 identify **methods** of generating electricity for distribution.

**Range**

**Methods**: Coal, oil, biomass, wind, wave, hydro, nuclear, photo-voltaic, gas, micro‑generation.

**Electricity generation**

Electricity is a vital part of our everyday lives in the United Kingdom and, compared with the rest of the world, we are large consumers. For example, although the UK accounts for less than 1% of the global population, in 2008 it used 2% of the total electrical energy generated in the world.

There are many means available to generate electricity, including the following:

* coal
* oil
* biomass
* wind
* wave
* hydro
* nuclear
* photo-voltaic
* gas
* micro‑generation.

Each has its advantages and disadvantages. We generally cannot choose where the electricity that comes from the supply company is generated; this will be a combination of the methods listed above.

However, we need to be able to give advice to customers who may want to install their own small‑scale generation systems in their premises, such as biomass, wind or photo‑voltaic, which can all fall under the category of micro‑generation.

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| **Coal**  During the 1940s some 90% of the UK generating capacity was fired by coal, with oil providing most of the remainder. By 2004 the use of coal‑fired power stations had dropped to about 40% of the total generating capacity.  Coal‑fired power stations burn coal that heats water and produces steam which powers turbines connected to generators. | 01 coal-fired power station.jpg |

The biggest problems with the use of coal are:

* it uses non‑renewable fossil fuels
* it produces a lot of air pollution
* it requires large quantities of cooling water.

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| **Oil**  The use of oil to generate electricity has dropped considerably and by 2004 had dropped to just over 1% of the total generating capacity.  Larger oil‑fired power stations produce electricity in a similar manner to coal but instead they burn oil to heat water that produces steam, which powers turbines connected to generators. | 02 oil-fired power station.jpg |

On a smaller scale, generators can be powered by internal combustion engines (petrol or diesel) and these are used frequently on‑site. Alternatively, some power stations that can be run‑up quickly to meet transient demand are powered by aero gas turbines driving generators.

The biggest problems with the use of oil are:

* it uses non‑renewable fossil fuels
* it produces air pollution
* larger stations require large quantities of cooling water.

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| **Biomass**  Biomass is biological material derived from living or recently living organisms. In the context of biomass for energy this is often used to mean plant-based material, but biomass can equally apply to both animal- and vegetable-derived material.  It usually involves the burning of organic material to heat water for local hot water supplies (hot water and central heating) or to produce steam to power generators.  These can be either small scale ‘micro‑generation’ or much larger plants feeding into the National Grid.  It is also possible to produce ‘bio‑fuel’ for use in internal combustion engines to power generators.  Biomass is currently the largest source of renewable energy in the UK. | 04b types of biomass.gif | |
| **Wind**  Wind power currently constitutes the second largest source of renewable energy in the UK with over 5 gigawatts capacity in 2010 and still increasing.  Whilst generating, the turbines produce no pollution. However, provision must be made for ‘windless’ days when the turbines will not be generating.  The installation and maintenance costs are quite high and the turbines will require replacing after 20–25 years.  There are aesthetic implications of land‑based wind turbines, with a large number of the population objecting to them being built near their homes.  Individual consumers can supplement their electrical supply by installing small scale wind generators (C.1‑2kW). | | 05 Wind Turbines.jpg |

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| **Wave**  Wave power is the transport of energy by ocean surface waves, and the capture of that energy to do useful work, such as electricity generation, water desalination, or the pumping of water (into reservoirs). Machinery able to exploit wave power is generally known as a wave energy converter (WEC).  Wave-power generation is not currently a widely employed commercial technology, although there have been attempts to use it since at least 1890. In 2008, the first experimental wave farm was opened in Portugal, at the Aguçadoura Wave Park. The major competitor of wave power is off-shore wind power. | | 05 Wave power.jpg |
| **Hydro**  Hydroelectricity is the term referring to electricity generated by hydropower: the production of electrical power through the use of the gravitational force of falling or flowing water.  It is the most widely used form of renewable energy, accounting for 16% of global electricity generation – 3,427 terawatt-hours of electricity production in 2010 – and is expected to increase about 3.1% each year for the next 25 years. | 06 Hydroelectric.JPG | |

Despite being one of the cheapest forms of renewable energy, it has limited applications in England and Wales due to the limited locations that are suitable for this type of project.

However, pumped‑storage systems have been used, eg Dinorwig, to store energy generated during off‑peak periods, which can be utilised during periods of high electricity demand.

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| **Nuclear**  A nuclear power station is a thermal power station in which the heat source is a nuclear reactor.  As in a conventional thermal power station, the heat is used to generate steam that drives a steam turbine connected to a generator, which produces electricity.  Nuclear power plants are usually considered to be base-load stations, since large quantities of energy generation can be sustained to meet the regular demand of the nation.  In the UK approximately one sixth of electricity generation is from 16 operational nuclear reactors. | 07 Nuclear power.jpg |

The biggest problems with the use of nuclear are:

* it uses non‑renewable fuels
* radioactive material is highly dangerous
* safe disposal of spent radioactive fuel is very difficult.

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| **Photo‑voltaic**  Solar panel electricity systems, also known as solar photo-voltaics (PV), capture the sun’s energy using photo-voltaic cells. These cells don’t need direct sunlight to work – they can still generate some electricity on a cloudy day.  The cells convert the sunlight into electricity, which can be used to run household appliances and lighting. | 08 Photovoltaic.png |

These are gaining widespread popularity in the UK thanks to incentive schemes for consumers to have them installed.

Apart from reducing the consumers’ electricity bill by supplementing the electricity supply, the customer can ‘sell back’ surplus electricity to the electricity supplier via a ‘smart meter’, using a feed‑in tariff.

Whilst the equipment is relatively expensive to install initially, the payback over a number of years will benefit the consumer. Additionally, as photo‑voltaic is another example of a renewable energy source, the consumer’s carbon footprint is greatly reduced.

**Gas**

A gas-powered station is a thermal power station in which the heat source is obtained by burning natural gas.

As in a conventional thermal power station, the heat is used to generate steam that drives a steam turbine connected to a generator, which produces electricity.

In 1990 only 0.05% of electricity in the UK was produced using gas but this had risen to 39.93% by 2004.

The biggest problems with the use of gas are:

* it uses non‑renewable fossil fuels
* it produces air pollution
* larger stations require large quantities of cooling water.

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| **Micro‑generation**  Micro‑generation is the small-scale generation of heat and electric power by individuals, small businesses and communities to meet their own needs, as alternatives or supplements to traditional centralised grid-connected power.  Although this may be motivated by practical considerations, such as unreliable grid power or long distance from the electrical grid, the term is mainly used currently for environmentally conscious approaches that aspire to zero or low-carbon footprints. | 09 Micro-generation.jpg |

Examples include:

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| * solar thermal (hot water) * ground source heat pump * air source heat pump * biomass * solar photo-voltaic | * micro-wind * micro-hydro * micro-combined heat and power (heat led) * rainwater harvesting * greywater re-use. |