OCR (B) Physics GCSE

Chapter 2: Sustainable Energy

Summary Notes

(Contents in bold is for Higher Tier Only)

P2.1 How much Energy do we Use?

Energy Transfers in Everyday Appliances

Energy is considered as being stored in a limited number of ways: chemical, nuclear, kinetic, gravitational, elastic, thermal, electrostatic and electromagnetic and can be transferred from one to another by processes called working and heating.

Energy in chemical stores in batteries, or in fuels at the power station, is transferred by an electric current, doing work on domestic devices, such as motors or heaters. Energy is transferred from chemical potential in batteries to electrical energy in wires to any form of useful energy in the devices they power.

Work done is when charge flows through a circuit, and is also equal to energy transferred, as all the electrical energy (ideally) gets transferred to the appliance. Electrical energy may be transferred by the appliance in different ways: Kinetic energy for a motor, thermal energy in a kettle.

Power

Power rating of an appliance shows the power it uses in Watts, so greater power rating means it uses more energy.
Power is defined as the rate at which energy is transferred or the rate at which work is done:

$$\mathrm{P} = \frac{\text{Energy Transferred}}{\text{time}} = \frac{\text{Work Done}}{time}$$

The power, P, is in watts, W, the energy transferred E, is in joules, J, the time t, in seconds, s and the work done W, in joules, J. An energy transfer of 1 joule per second is equal to a power of 1 watt.

Energy Transfers

A system is an object or group of objects. When a system changes, the way energy is stored also changes. For example:

- Ball rolling and hitting a wall
  - System is moving ball
  - When it hits the wall, (some of) the kinetic energy is transferred as sound
- Vehicle slowing down
  - System is vehicle moving
  - When it slows down, kinetic transfers to thermal due to friction between wheels and brakes

Wasted Energy

Energy can be transferred usefully, stored or dissipated but cannot be created or destroyed. In all system changes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being 'wasted'.

Reducing energy waste:

- Lubrication
  - Oil in a motor
  - Reduces friction
  - So less energy is lost (as heat) through friction
- Thermal Insulation
  - Double Glazing
  - Less useful thermal energy lost

Thermal Conductivity

The higher the thermal conductivity of a material, heat is allowed to travel through the material more easily, so the higher the rate of energy transfer by conduction across the material.
In context of a building, rate of cooling is low if walls are thick and thermal conductivity of the walls are low. If the walls are thin metal sheets, heat would be lost very quickly.

Efficiency

The efficiency is the ratio of the useful work done by a machine, engine, device, etc, to the energy supplied to it, often expressed as a percentage.

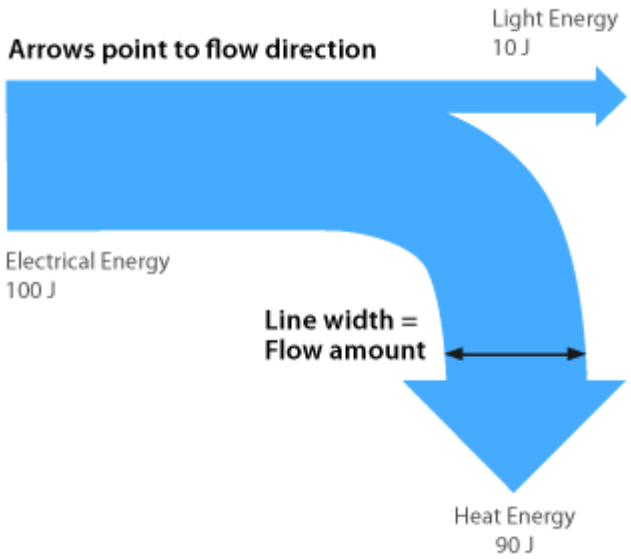
$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} = \frac{\text{useful power output}}{\text{total power input}}$$

The efficiency of a system can be increased by:

- **Reducing waste output (lubrication, thermal insulation, etc.)**
- **Recycling waste output (e.g. absorbing thermal waste and recycling as input energy)**

Sankey Diagrams

Sankey diagrams are used to show all the energy transfers in a system, including energy dissipated to the surroundings; the data can be used to calculate the efficiency of energy transfers.



1: datavizcatalogue.com

P2.2 How can Electricity be Generated?

Main Energy Sources

Non-renewable

- Fossil Fuels (coal, oil, gas)
- Nuclear Fuel

Renewable

- Biofuel
- Wind
- Hydro-electricity
- Geothermal
- Tidal
- Solar
- Water waves

Renewable vs Non-Renewable Energy

Renewable energy is energy which can be replenished as it is used (e.g. wind will never stop). Non-renewable energy is used more for large-scale energy supplies due to the large energy output per kilogram of fuel

Renewable energy has become more important due to the finite lifetime of fossil fuels, and so their development has become more important.

Renewable energy is not always the most reliable: solar doesn't work in bad weather or night and wind is only intermittent.

Domestic Uses and Safety

Mains electricity is an AC supply. In the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V.

AC is alternating current, which comes from the mains. Current continuously varies, from positive to negative (charge changes direction). DC, direct current, is the movement of charge in one direction only (cells and batteries supply direct current).

In a plug there are 3 wires:

1. Live wire is brown and has a PD at 230V. Carries the alternating potential difference from the supply. This may be dangerous even if mains circuit is off, as current may still be flowing through it.
2. Neutral Wire is blue and has a PD at 0V. It completes the circuit.
3. Earth wire has green and yellow stripes, at 0V. A safety wire to stop the appliance becoming live; it only carries a current if there is a fault.

Earthing

The Earth wire is connected to the earth and to the casing. If the live wire touches the metal casing of the appliance, it will become live (you'll get a serious electric shock if you touch it, as current flows through you to the ground). When there is a fault the appliance the Earth carries the current to the Earth so that the appliance does not become live.

National Grid

The National Grid is a system of cables and transformers linking power stations to consumers across the UK. Electrical power is transferred from power stations to consumers using the National Grid.

Transformers change the potential difference.

- Step-up Transformers increase the pd from the power station to the National Grid. So as the power is constant (P = IV) current decreases so less energy is lost.
- Step-down Transformers decrease the pd from the National Grid to consumers. It is used for consumer safety.

Patterns and Trends of Energy Use:

- During industrial revolution, fossil fuels became an important source of energy as it was easy to mine, and provided a lot of energy.
- Only recently has renewable energy become more suitable – technology has had to develop a lot since industrial revolution to be able to harness such energy sources efficiently.
- It is easier to use energy resources due to increasing pressure to cope with the public's increasing power demands but harder to solve environmental issues due to political, social, ethical and economic considerations.