

## Student Revision Notes (age 14 – 16): Transmission of Electricity

Electricity is mainly generated in power stations and from there it is transmitted across the country by power cables to towns and villages. All cables have resistance and so as the electricity passes through them it will lose energy as heat in the cable.

The energy lost in a power cable that is carrying a current  $I$  and is of resistance  $R$  is given by the formula:

$$\text{Power loss (W)} = I^2R$$

The power loss depends on the resistance of the cable and so to reduce this power loss the resistance of the cable must be as small as possible.

The resistance of a given length of cable can be reduced by:

- Using thicker cables — but this will make them too heavy;
- Using material which is a better electrical conductor such as silver — much too expensive;
- Cooling the cables with a jacket of liquid hydrogen — too expensive.

So changing the resistance is not a practical idea, but the current passing through the cable can be altered using a transformer. The following worked example illustrates the different energy losses for different current levels through a cable:

*Typical resistance of power cable is  $0.1 \Omega/\text{km}$  so the following energy losses per kilometre would apply -*

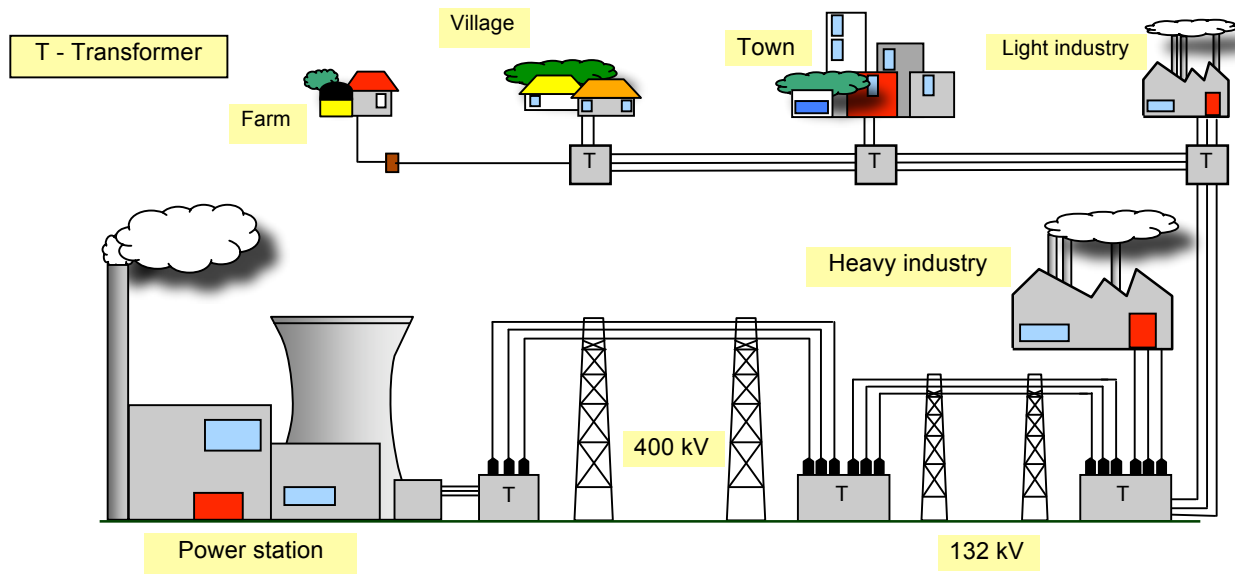
- Let the current in the power cable be 1000 A. Power loss =  $1000 \times 1000 \times 0.1 = 100,000 \text{ W}$ .
- Now use a 1000:1 step-up transformer to give a current in the power cable of 1 A. Power loss =  $1 \times 1 \times 0.1 = 0.1 \text{ W}$ .

This is an enormous saving - and for this reason electricity is transmitted at low current and high voltage. To keep the power loss as small as possible the transmitted voltage is very high. Electricity generated in a power station at 25 000 V (25 kV) is stepped up to 275 kV or 400 kV for transmission across large distances. Near towns, villages and industrial sites there are transformers that step down the voltage ready for use. The photograph shows a transformer on a pole in farmland.



## The grid system

The diagram shows how electricity is transmitted round the country by the national grid system. Note the step-up and step-down transformers and the voltages used.



## **Linked Resources**

[www.twothirtyvolts.org](http://www.twothirtyvolts.org):

Transmission of Electricity (14-16) Student Quiz