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Fact Sheet

TRANSMISSION AND DISTRIBUTION OF ELECTRICITY

Electricity is generated in a power station when a magnet (rotor) is made to spin inside a copper coil (stator). These two components form the generator. Most of Eskom's power stations generate electricity at about 22 000 volts (22 kV).

From station to home

Electricity is transported along power lines from the power stations to the areas where it is needed. Houses and factories cannot all be next to power stations. The electricity is therefore transported to consumers at high voltages which make up for losses that occur over long distances and limit the number of power lines needed. Transmission lines usually consist of overhead conductors suspended from transmission towers. In many built-up areas, underground cables are used instead of overhead lines. In the illustration these are shown as dotted lines. Underground cables are invisible but are much more expensive than overhead conductors.

Transformers

Transformers are installed at power stations to increase the voltage of the electricity to a level that will be suitable for transmission over long distances. These transformers step-up the voltage from, for example, 22 kV to 220 kV, 275 kV, 400 kV or 765 kV and feed the electricity into Eskom's national grid. This voltage is eventually stepped down to a level usable to the consumer. This could be 11 kV in large factories and 380/220 volts in shops and homes.

A step-up transformer increases the voltage. To do this, it has many more copper wire turns on the secondary winding, where the electricity goes out, than on the primary winding where the electricity enters the transformer from the power station.

The electricity is transmitted over long distances to different substations in the system. In substations the voltage is decreased by step-down transformers. In step-down transformers the secondary winding has fewer turns than the primary winding. There may be several stages of step-down transformers.

A typical distribution system

As shown in the diagram the overhead power lines transmit electricity at voltages ranging from 22 kV up to 765 kV. Eskom is the first utility in the world to successfully operate transmission lines at 765 kV at high altitudes above sea level. Conductors are made of aluminium and steel in various combinations and in various shapes and sizes. Aluminum is used because it is a good conductor of electricity. Steel is used to add strength.

When the electricity arrives at the distribution station (3), bulk supplies of electricity at 22 kV are taken for primary distribution to towns and industrial areas, groups of villages, farms and similar concentrations of consumers. The lines are fed into intermediate substations (4a and 4b) where transformers reduce the voltage to 11 kV. Secondary distribution lines radiating from these substations carry the power into the areas to be supplied and terminate at distribution substations (5). Here the voltage is reduced to its final level of 380/220 V for use in shops, office buildings, schools and homes.

Some consumers use electricity in such quantities that they are supplied at a higher voltage than is used in the home. Heavy industries may have their own link (6) from the distribution station at 132 kV. Light industries (7) and hospitals are often supplied directly from substations at 11 kV. The railways have special substations (8) alongside the tracks, which draw electricity from distribution stations. The latest rail electrification schemes operate at 25 kV and 50 kV.

The distribution of electricity must be arranged so that as far as practicable, supplies are not interrupted if there is a fault in one section of the system. How this is done is shown in the illustration. Lines carrying 132 kV run from the distribution station (3) to the substation (4a) and to the substation serving heavy industry (6). A further 132 kV line connects point (3) to point (6). If the direct connection to either substation breaks down, supplies can still be maintained by means of this connecting link.

Metering

In the home there is a distribution board which houses a main safety switch and other switches called circuit breakers. These switches cut off the electricity if there is a fault.

The electricity that we use is measured by a meter. When we switch on a light or an electrical appliance, a disc inside the meter begins to turn. The disc moves the figures on the meter dials, to show how much electricity has been used. This kind of meter is read periodically by a meter reader and the user receives a bill for the electricity consumed.

Another kind of meter, requiring prepayment, is increasingly being installed in South African homes and businesses. Payments are made at an official vendor to purchase tokens or codes for a specific amount of electricity. These are then fed into the meters. The meter will indicate how much electricity is available to the user.

From the meter, electric wires run to light and plug points to which lights and appliances can be connected.

The National Grid

The network of high-voltage power lines linking the power station to the cities, towns, rural and residential areas where electricity is used is called the national grid or interconnected grid. All electricity that Eskom generates is fed into this grid for national distribution. However, Eskom does not distribute electricity directly to all consumers. Most municipalities buy electricity in bulk from Eskom and resell it to consumers.

Control centres

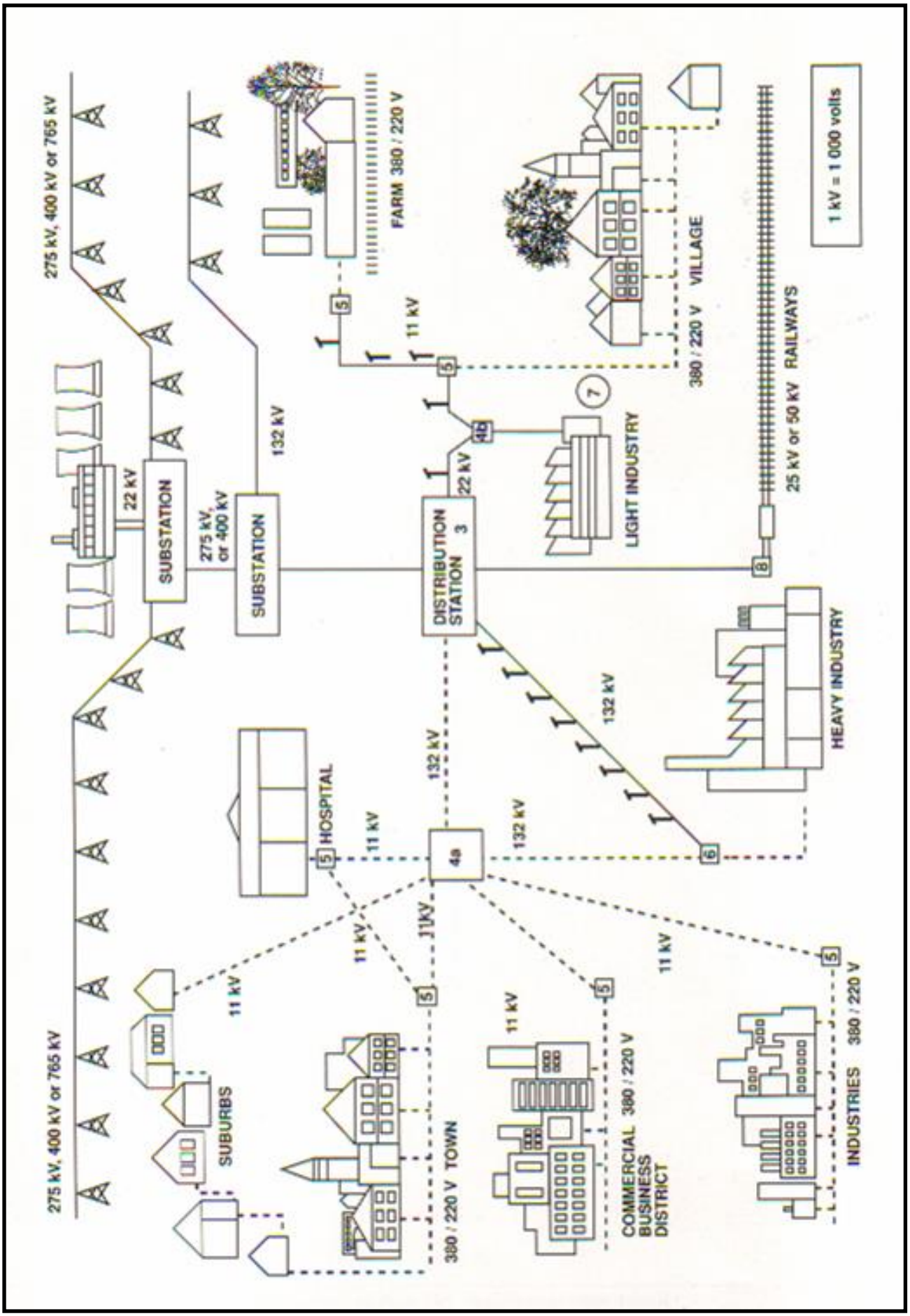
The electricity generated by power stations cannot be stored like water in a tank. It must be used as it is generated. Computers in special control centres monitor how much electricity is needed throughout South Africa. The information from these centres establishes how much electricity must be generated to make sure there is enough at all times. This must be done under constantly changing conditions. For instance a spell of cold weather or a popular TV programme can add unexpectedly to the demand for electrical power. Power stations adjust the amount of electricity they generate according to the instructions from the control centres. In Eskom, this function is fulfilled by the National Control Centre at Simmerpan, Germiston. It works in cooperation with six regional control centres in different parts of the country.

Substation equipment

Substations are self-contained units which are controlled from the main control centres and are mostly in remote areas. They are specially designed to work 24 hours a day without attention and to operate outdoors in all weather conditions. The switchgear is able to interrupt and reconnect very high voltages and very high amounts of power.

Protection systems

For the substation to perform, it needs sophisticated protection equipment to detect faults and abnormal conditions. “Messages” are received in the form of electronic data, which initiate certain operations and also give feedback to the control centre when operations are carried out. Operations could consist of automatically switching the power off and on again to cater for abnormal conditions such as lightning strikes or trees falling on lines. This action is necessary to protect people when there is an accident or to keep the electricity supply constant.



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