

Electricity

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Slide 2: *Generating Electricity*

- In 1831 Michael Faraday discovered that if magnets and a conductor (e.g. a piece of copper wire) move in relation to one another, electricity can be generated.
- Faraday found that the mechanical energy used to move a magnet inside a wire loop (coil) could be converted into electrical energy, flowing through the wire.
- Faraday's discovery could be summarised as the flow of electrons when a wire loop or coil rotates in a magnetic field.
- A generator converts mechanical energy into electrical energy. That is when a wire loop or coil rotates in a magnetic field.
- A generator consists of a coil, magnets and split rings.
- The magnets can be permanent magnets or electromagnets which produce a magnetic field.
- The ends of the coil wires are connected to the split rings.
- The electric current flows from the coil to the external circuit by means of brushes which come into contact with the split rings.
- It is this discovery which has led to the development of modern power plants, providing a constant and reliable supply of large quantities of electricity to consumers.

Slide 3: *SA Power Grid*

- Eskom is a utility company which generates electricity. They transmit it throughout South Africa by means of a national transmission system, from where it is distributed to approximately four million end users.
- Eskom also delivers bulk supplies to approximately 180 municipal distributors.
- Power stations all over South Africa are linked by transmission lines.
- Transmission lines are supported by pylons.
- 'Transmission' means 'to send from one place to another'.
- Transmission lines are manufactured predominantly from aluminium and copper, with steel wire for structural integrity.
- The network of transmission lines is called the National Grid.

- Eskom also imports electricity from neighbouring countries such as Mozambique and exports to Namibia and Botswana.

Slide 4: SA Electricity Supply

- Coal, oil, gas and nuclear fuels can be used for heating water, converting it into steam at high temperatures and under high pressure.
- This is done in boilers or reactors.
- The steam, which is usually heated up to temperatures of between 500°C and 535°C, is released to turn a large turbine that is connected to a generator to generate electricity.
- In this way the energy in the fuel is converted into electrical energy.
- Alternatively, gas turbines are used to generate electricity. Gas or liquid fuels (diesel in the case of Eskom) is used in an engine very similar to an aircraft jet engine to drive an electric generator.
- In SA Eskom relies on coal-fired power plants to produce approximately 90% of its electricity.
- Eskom uses over 90 million tons of coal per annum.
- At the end of 2007 Eskom had a nett power generating capacity of 37 761MW (megawatt).
- Eskom sold 225 000 GWh (gigawatt-hour) of electricity in 2011.
ref. <http://af.wikipedia.org/wiki/Eskom>

Energy sources responsible for generating Eskom Electricity:

Coal 90%	Nuclear 5%	Hydro 2%	Gas 1%	Other 2%
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Ref. CRSES 2008

Slide 5: Abundant Energy Source: Coal

- In South Africa our most abundant source of energy is coal – a fossil fuel.
- However, most of the coal we use is of a low quality with a low heat value and high ash content – the high quality coal is exported.
- Coal mining in South Africa is relatively inexpensive compared to the rest of the world.
- These low costs have had an important effect on the nation's prosperity and potential for development.
- This enabled us to keep our electricity costs per unit quite low, especially compared to Europe, where the cost per unit is four times more.
- However, this scenario is rapidly changing.

Slide 6: Supply vs Demand: Electricity Demand Pattern

- Much of the electricity and electronic equipment we use depend on voltage and frequency remaining accurate and constant.
- So, the instantaneous amount being fed into the grid (i.e. electricity generated) must always match what the consumers are taking out. This varies not only from day to day, but from minute to minute.

- As the demand increases, more stations must be brought online.
- The pattern of the daily demand can be predicted fairly accurately, unless something unexpected happens, such as a sudden deterioration in the weather.
- The main peaks usually start at about 06:00 in the mornings and last until about 10:00.
- A second peak period is normally from about 17:00 until 21:00.

Slide 7: *Supply vs Demand: The Energy Balance Problem*

- Electricity supply should be consistent and reliable.
- Electricity has to be generated as needed since batteries are not capable of storing the enormous quantities.
- There is no realistic way of storing large quantities of electricity required for distribution to the user besides large pump-storage schemes like Palmiet, Drakensberg and Ingula.

Practical Example of Energy Supply vs. Energy Demand:

- To supply electricity to a 220 W computer used 365 days per year, 938 kg coal is needed – that is one ton, or a whole bakkie load!

Slide 8: *Renewable vs Non-Renewable: Alternatives to Fossil Fuels*

There are many other methods by which electricity can be generated, for example, by harnessing solar or wind energy.

The main renewable resources used today are:

- **Solar Energy** – converted to electricity in photovoltaic panels OR converted into useful heat by solar collectors OR converted into electricity in thermal power stations.
- **Biomass** – converted into useful heat through combustion or gasification OR converted into biofuels.
- **Wind** – converted into electricity by wind turbines.
- **Hydro/Water** – converted into electricity by hydro turbines.
- **Ocean: tidal, wave and ocean current energy** – converted into electricity by ocean devices.
- **Geothermal** – converted into electricity utilizing a steam turbine or used thermal energy.

Slide 9: *Renewable vs Non-Renewable: Comparison of Energy Technologies*

- At this point in time we are still making use of more non-renewables rather than renewables.
- This is due to SA's cheap electricity environment (based on coal) and the capital costs of renewable energy plants, such as wind farms.
- This situation is changing.
- Electricity costs are rising at about 16% per year and will continue to do so over the next 5 years.
- Mining costs of coal, our main source of energy, are rising.
- The environmental impact of burning fossil fuels is escalating.
- At the same time the research and development of renewable energy technologies are becoming better and better.
- The demand for renewables is becoming bigger.

- Subsequently it is becoming cheaper to install renewable energy.
- This means that renewable energy is becoming a viable option for generating electricity.
- Apart from the installation costs of renewable technology, which is currently higher than that of non-renewables, the operational costs are much lower and the energy sources – whether wind, solar or hydro – are free.

Slide 10: *Renewable vs Non-Renewable: The Choice!*

- Decisions will have to be made as to whether to invest in renewable energy systems or to carry on burning fossil fuels and paying the environmental cost that is linked to releasing more and more CO₂ into the atmosphere.

Slide 11: *Renewable Energy Targets: European Union*

- The EU is working to reduce the effects of climate change and establish a common energy policy.
- By 2020 renewable energy should account for 20% of the EU's final energy consumption (8.5% in 2005).

	EU Member State	2005 Figure	2020 Target	% To cover:
1	United Kingdom	1.3%	15%	13.7%
2	Denmark	17%	30%	13%
3	Ireland	3.1%	16%	12.9%
4	France	10.3%	23%	12.7%
5	Germany	5.8%	18%	12.2%
6	Italy	5.2%	17%	11.8%
7	Netherlands	2.4%	14%	11.6%
	EU	8.5%	20%	11.5%

PRESENTED BY [ENERGY.EU](http://www.energy.eu)

Ref. <http://www.energy.eu/#renewable>

Slide 12: *Practical Assignment*