



ALTERNATIVE ENERGY

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OPTIONS

INTEGRATED RESOURCE PLAN (IRP)

New build options:

- Coal,
- Nuclear
- Import Hydro
- Gas OCGT or CCGT
- Wind
- Solar PV
- Biogas
- Biofuel
- Wave generation

COAL POWER

- Most widely used primary fuel, approximately 36% of the world's electricity production likely to remain until at least 2020.
- Traditionally dominated the energy supply sector in South Africa, from 1880 from Vereeniging supplied to Kimberly diamond fields. Presently, about 77% of our country's primary energy needs are provided by coal.



COAL POWER



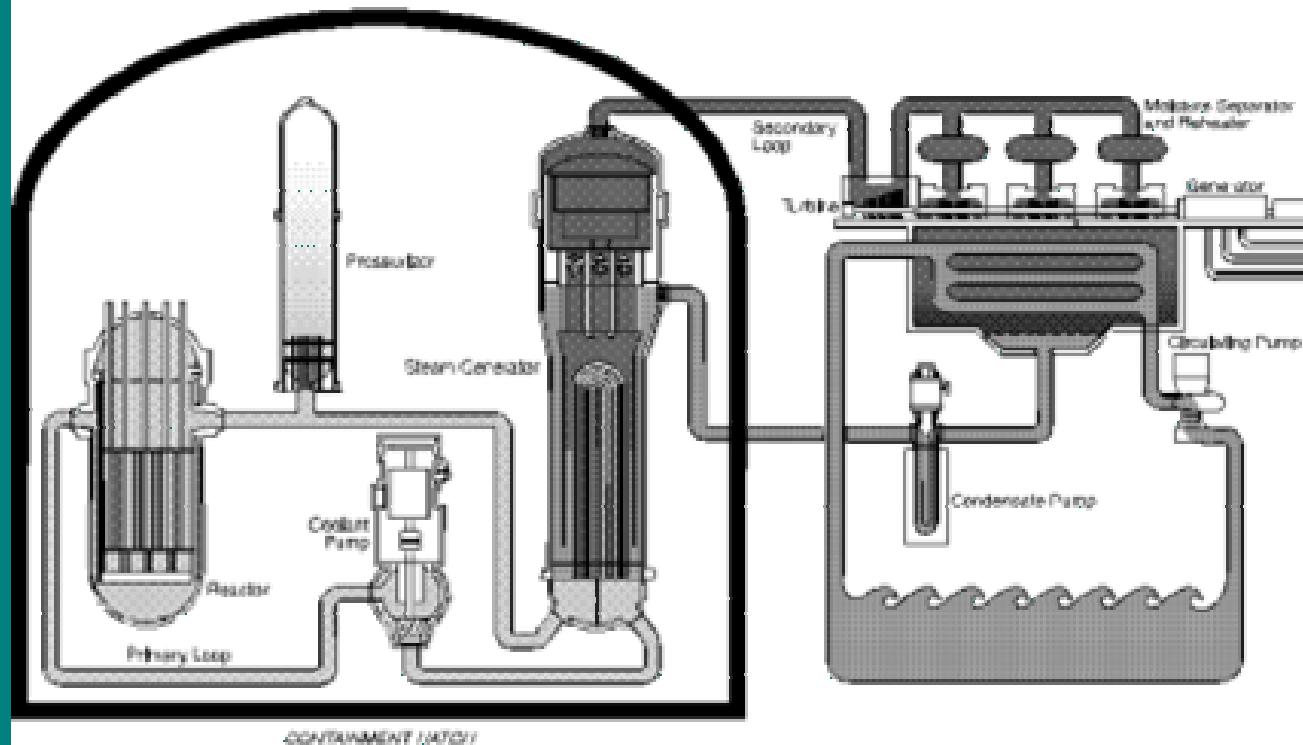
- Producing electricity from coal:
- Coal is pulverized in huge mills into a fine powder before it is blown into huge kettles- boilers.
- Heat in the boiler, coal particles combust and burn to generate heat to turn water into steam.
- Steam from boilers is used to turn the blades of a giant fan or propeller - turbine.
- Turbine turns a coil made of copper wire (rotor) inside a magnet (stator). - generator.
- Generator produces an electric current, which is sent to the homes and factories of consumers - power lines.

COAL POWER

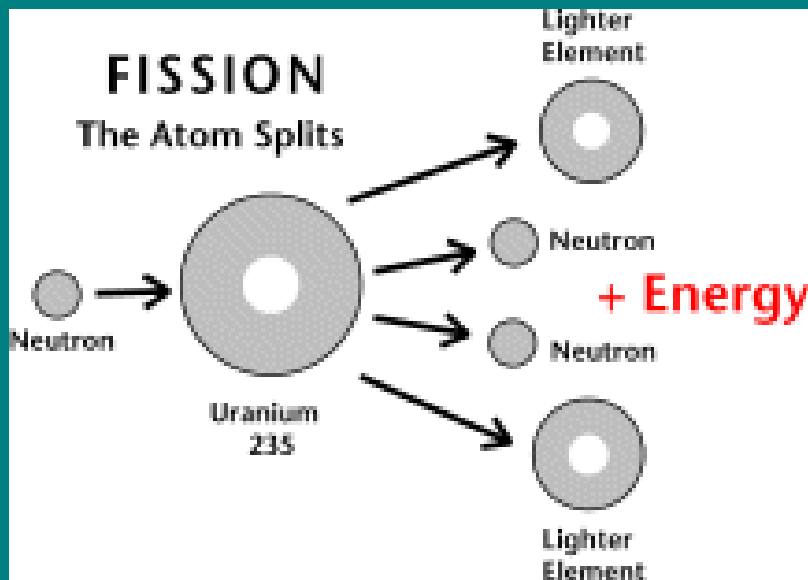
- South Africa produces an average of **224** million tonnes coal annually,
- **Fifth** largest coal producing country in the world.
- **25%** is exported internationally.
- **Third** largest coal exporting country.
- **53%** used for electricity generation.

NUCLEAR POWER

Figure FE1. Nuclear Steam Supply System
(U-bend Design Steam Generator)

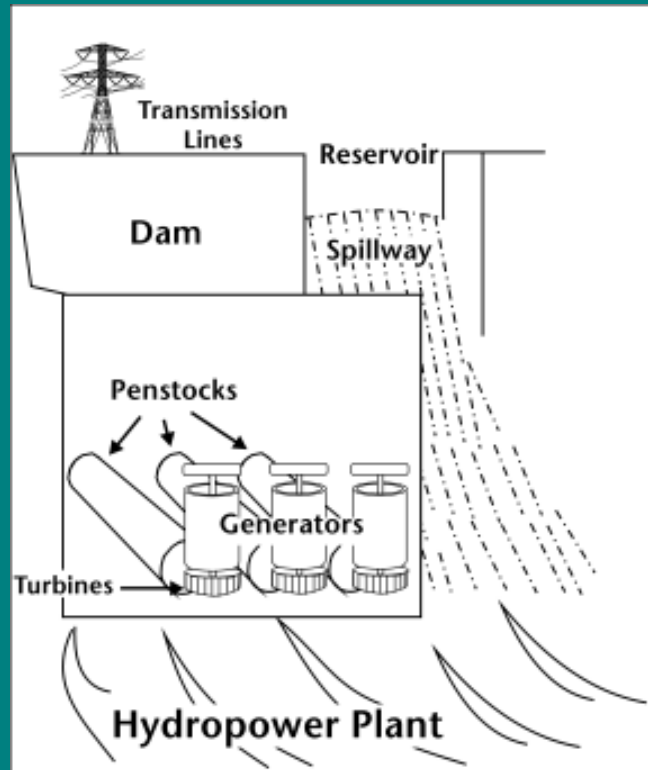


Nuclear power



- Nuclear reactor to create energy it is necessary for nuclear fission to take place.
- Occurs when an atom is split into smaller particles and an enormous amount of energy is released in the process.
- Uranium used as fuel for the reaction- is radioactive, and is unstable enough to be broken down into smaller parts.
- Uranium atom absorbs a neutron and splits into two equal parts and energy is created.
- Kinetic energy becomes heat energy as the particles slow down, and it is this heat energy, which is used to produce electricity.
- Heat is moved through a transfer medium, such as water, and is used to turn water into steam.
- Steam turns a turbine, which is connected to a generator.
- Turbine turns the generator creates electricity, which is transferred to the consumers.

HYDROPOWER



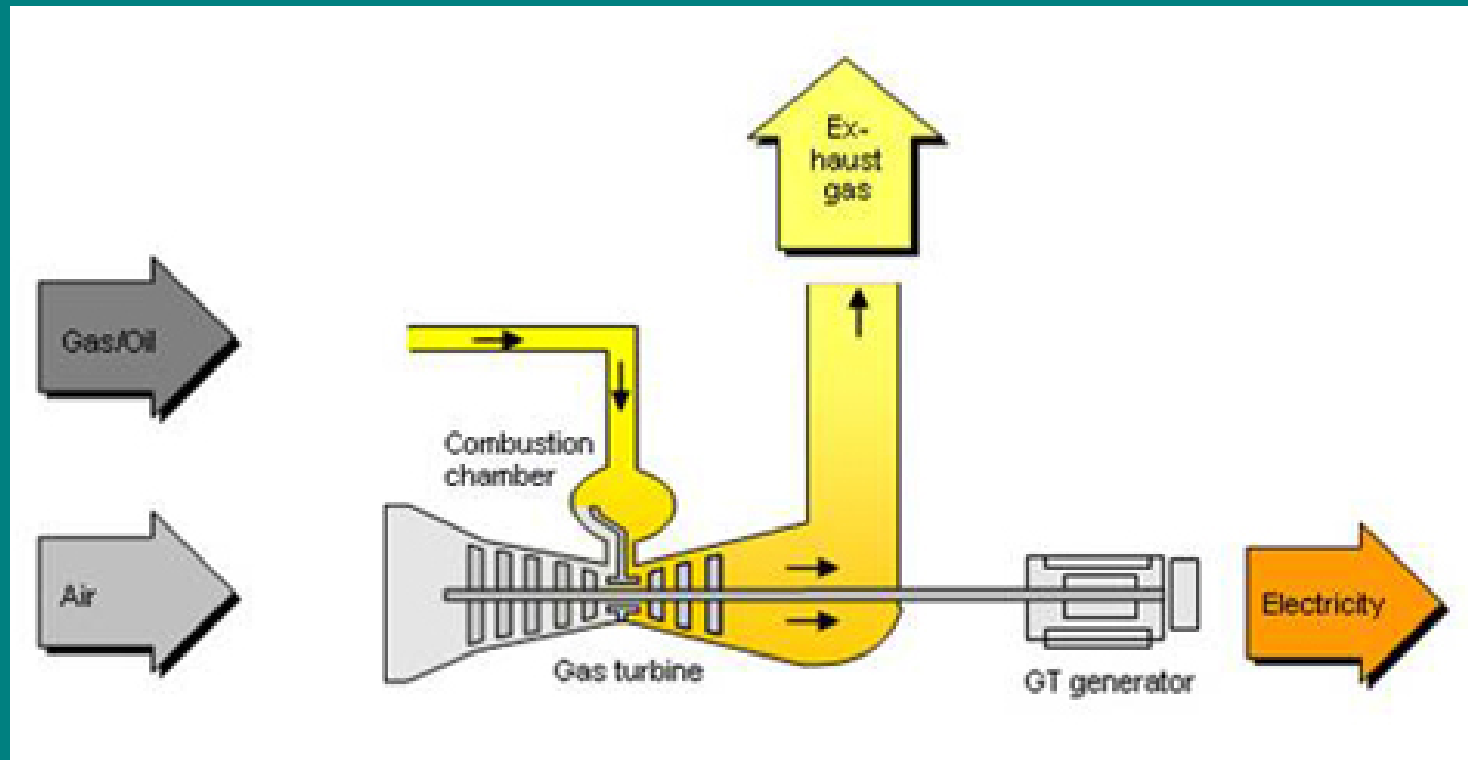
HYDRO POWER

- Dam is built where there is a natural lake/large river in a valley.
- Dam contains the water and creates pressure in order that the water can be utilized to produce electrical power.
- Gravitational potential energy is stored in the water and this is used to turn generators and create electricity.
- Turbines are within tunnels in the dam wall.
- Electrical generators are turned by these massive turbines and create electricity.
- Water flows through the tunnels with great pressure and turn these turbines.
- Water has immense pressure due to the great height at which is kept in the dam.
- Greater volume of water, very large difference between the water level and where it flows out more power out of the water as it has greater potential energy.
- Difference in height of the water is called the head.

(<http://library.thinkquest.org/06aug/01335/hydroelectric.htm>)



GAS OCGT



GAS/OCGT

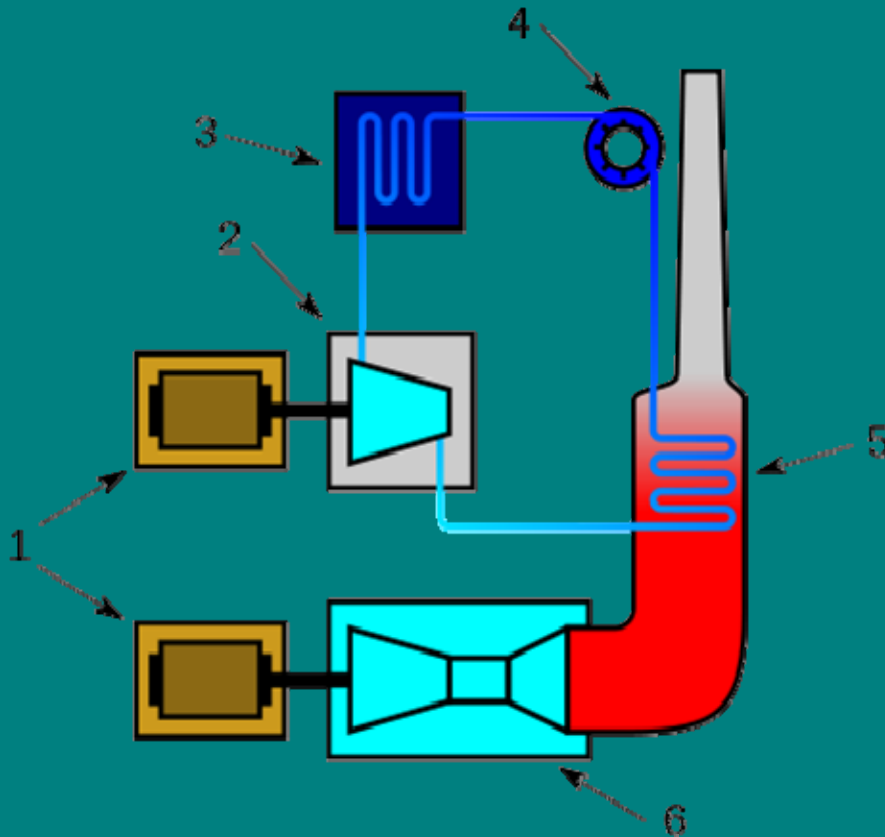
- In a gas turbine, large volumes of filtered air are fed in the compressor section of the engine. In an OCGT the multistage compressor squeezes the air to from normal pressure up to 40 times atmospheric pressure depending on the type of turbine.
- Fuel is distributed to the various combustion chambers surrounding the gas turbine. This then mixes with the compressed air and ignition and combustion takes place.
- The combustion gasses expand rapidly and this energy is transmitted to the axial turbine blades which drive the rotor shaft.
- The rotor torque is transmitted to both the compressor section of the gas turbine and the external electrical generator

GAS/CCGT

- In electric power generation a **combined cycle** is an assembly of heat engines that work in tandem off the same source of heat, converting it into mechanical energy, which in turn usually drives electrical generators.
- The principle is that the exhaust of one heat engine is used as the heat source for another, thus extracting more useful energy from the heat, increasing the system's overall efficiency.
- This works because heat engines are only able to use a portion of the energy their fuel generates (usually less than 50%)

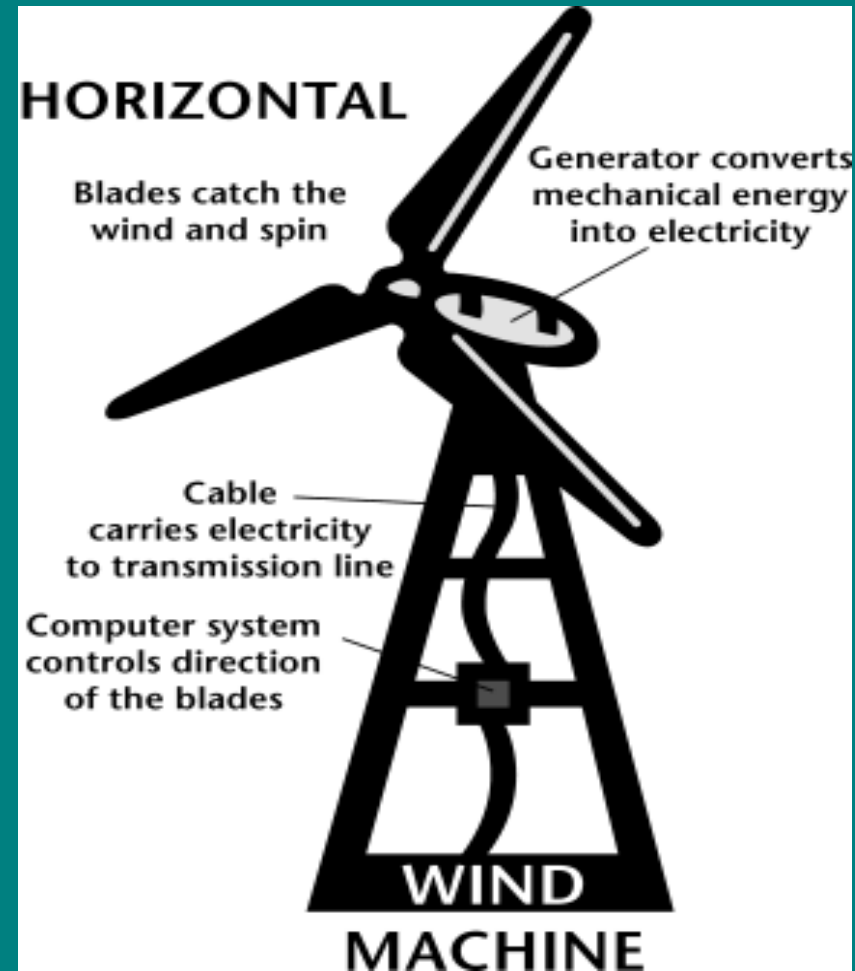
(http://en.wikipedia.org/wiki/Combined_cycle)

GAS/CCGT



- Working principle of CCGT power plant
- 1-Electric generators,
- 2-Steam turbine,
- 3-Condenser,
- 4-Pump,
- 5-Boiler/heat exchanger,
- 6-Gas turbine

WIND POWER





WIND POWER

- Wind power is when we convert the power of the wind, physical energy, to more useful types of energy. The most common type of energy it is converted to is electricity.
- A wind farm is a large area of land on which there are a number of wind turbines generating electricity, as a power plant does. When creating a wind farm one must make sure that the spacing between the turbine is sufficient as not to cause energy/wind loss.
- Energy generated from wind is electrical energy. This is by making the use of an electrical generator which is turned by turbine blades which are turned by the wind and thereby turning the turbine, creating electricity.

SOLAR POWER



Solar Energy

so-lar en-er-gy

Energy from the sun which is
converted into thermal or
electrical energy

SOLAR POWER



- There are two types of solar power – photovoltaic and thermal.
- **Photovoltaic** converts light directly into electricity using semiconductor technology.
- **Thermal** solar uses the sun's radiation to heat water for buildings and swimming pools.

PHOTOVOLTAIC

- Use treated crystalline silicon operating as a semiconductor to generate a flow of direct current electricity when exposed to light. PV technologies are evolving, allowing PV use in products such as flexible roofing applications and using other materials such as thin-film polymer
- Convert sunlight directly into electricity, which enables the generation of some or all of the daily electrical energy demand

THERMAL SOLAR

- Thermal solar systems involve direct utilization of solar energy for space heating, space cooling and/or water heating systems.

BIOFUEL/BIOGAS



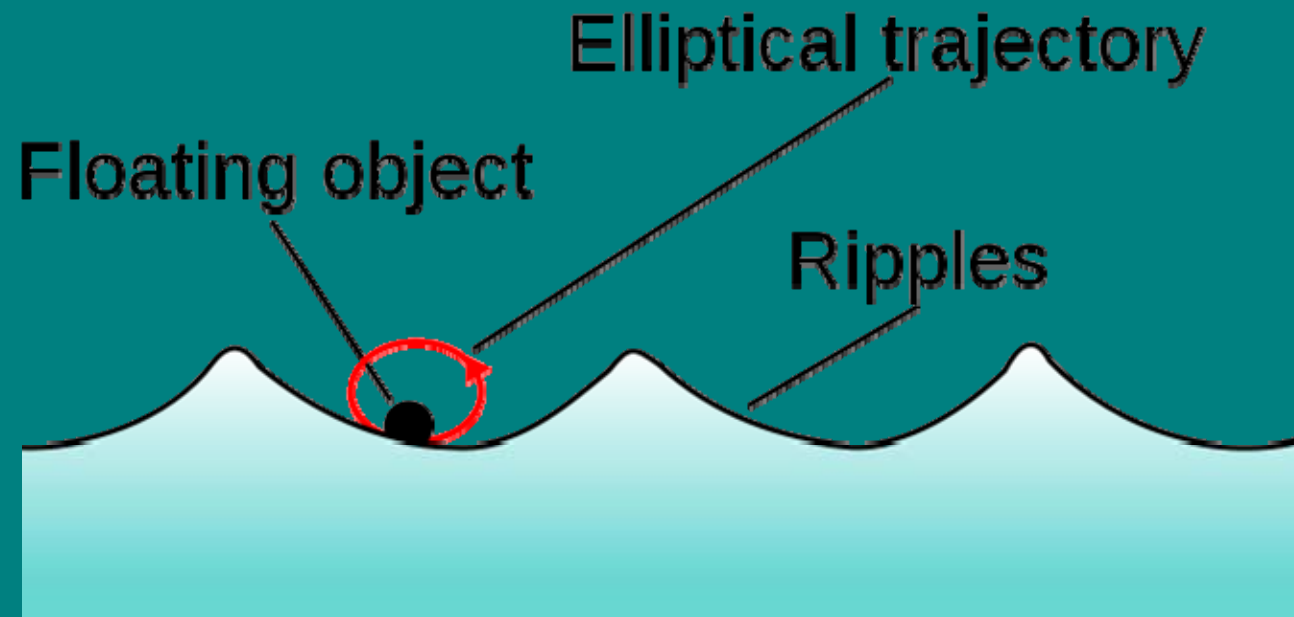
- **Biofuel** is a type of fuel whose energy is derived from biological carbon fixation. Biofuels include fuels derived from biomass conversion, as well as solid biomass, liquid fuels and various biogases (<http://en.wikipedia.org/wiki/Biofuel>)



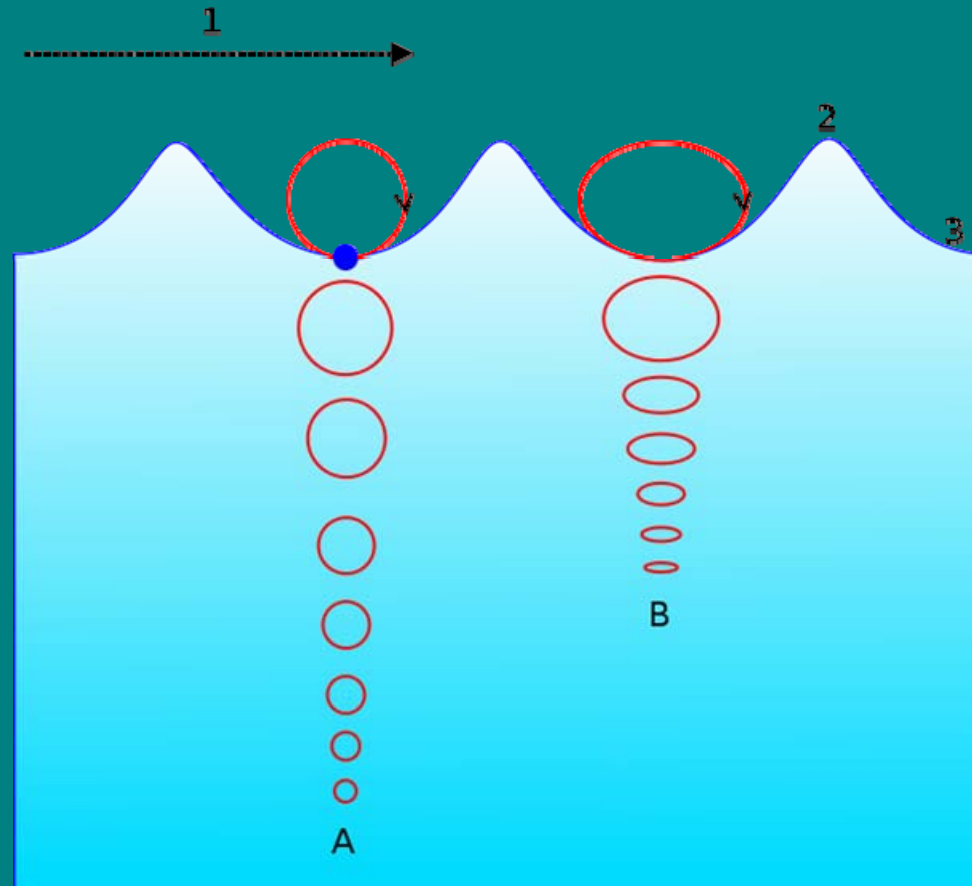
BIOGAS GENERATION

- **Biogas** typically refers to a [gas](#) produced by the biological breakdown of [organic matter](#) in the absence of [oxygen](#). Organic waste such as dead plant and animal material, animal dung, and kitchen waste can be converted into a [gaseous](#) fuel called biogas. Biogas originates from biogenic material and is a type of [biofuel](#).
- Biogas is produced by the [anaerobic digestion](#) or [fermentation](#) of biodegradable materials such as [biomass](#), [manure](#), [sewage](#), [municipal waste](#), [green waste](#), [plant material](#), and crops.[1] Biogas comprises primarily [methane](#) (CH₄) and [carbon dioxide](#) (CO₂) and may have small amounts of [hydrogen sulphide](#) (H₂S), moisture and [siloxanes](#).
- The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat.[2] Biogas can be compressed, much like [natural gas](#), and used to power [motor vehicles](#). In the UK, for example, biogas is estimated to have the potential to replace around 17% of vehicle fuel.[3] Biogas is a [renewable fuel](#), so it qualifies for renewable [energy subsidies](#) in some parts of the world. Biogas can also be cleaned and upgraded to natural gas standards when it becomes [biomethane](#).

WAVE GENERATION



WAVE POWER



Motion of a particle in an ocean wave.

A = At deep water. The [orbital](#) motion of fluid particles decreases rapidly with increasing depth below the surface.

B = At shallow water (ocean floor is now at B). The elliptical movement of a fluid particle flattens with decreasing depth.

1 = Propagation direction.

2 = Wave crest.

3 = Wave trough

WAVE POWER

- **Wave power** is the transport of energy by ocean surface waves, and the capture of that energy to do useful work — for example, 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 is distinct from the diurnal flux of tidal power and the steady gyre of ocean currents. Wave power generation is not currently a widely employed commercial technology although there have been attempts at using it since at least 1890.^[1] In 2008, the first experimental wave farm was opened in Portugal, at the Aguçadoura Wave Park.^[2]

RENEWABLE ENERGY SOURCES FOR SOUTH AFRICA

- South Africa is a unique country with access to many reliable renewable energy sources including wind, solar and tidal.
- There are already a number of Biogas generators producing electricity from waste and sewerage farms.
- Biofuels are being investigated for viability.

RENEWABLE ENERGY PROJECTS FOR SOUTH AFRICA

- Eskom - 3.2 MW demonstration wind farm at Klipheuwel Western Cape.
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- 4-turbine,5.2MW Darling wind farm in the Western Cape started producing electricity in 2008 and remains the country's only commercial wind farm.
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- Irish company Mainstream Renewable Energy,in partnership with local outfit Genesis Eco-Energy,are planning to build some 18 wind farms in the Eastern,Western and Northern Cape,including 30 and 40 MW projects near Jeffrey's Bay and Colesberg respectively.
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- Eskom has proposed a 100 MW wind farm at Koekenaap near Vredendal Western Cape.
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- Belgian company Electrawinds recently announced a partnership deal for a 25-turbine wind farm at Coega in the Eastern Cape.
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- The Nelson Mandela Bay municipality plans to build a wind farm with at least 10 turbines.
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RENEWABLE ENERGY PROJECTS FOR SOUTH AFRICA

- UK-based Renewable Energy Systems proposed to install around 300 MW of wind energy projects - Western and Eastern Cape.
- St Helena Bay wind farm on the West Coast is expected to produce 50 to 80 MW of electricity.
- 300 MW wind farm project near Caledon in the Western Cape announced earlier this year.
- Tsitsikamma Community Wind Farm project Eastern Cape aims to produce about 40 MW by 2013.
- In October last year, government and the Clinton Foundation signed an agreement to establish the country's first "solar park", which is to deliver up to 5 000 MW of solar electricity to the national grid.
- Cape Town start-up Aurora Power Solutions is developing a 200 MW portfolio of solar power projects.
- Eskom is planning a 100 MW concentrated solar power demonstration plant near Upington.
- A factory for thin-film solar panels is to be built in Paarl.
- A number of PV Solar farms are in early stages of feasibility (Fluor)

QUESTIONS

