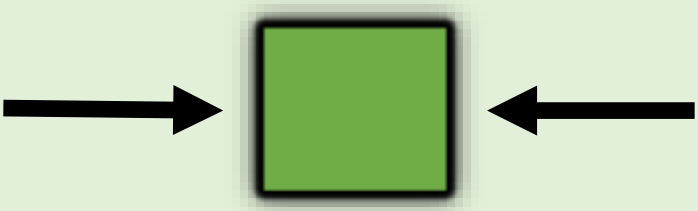
TECHNOLOGYSTUDENT

MOBILE REVISION

ENERGY SYSTEMS AND ENERGY PRODUCTION

This mobile revision pdf is based on detailed work found in the 'Technology and the Environment ' section.
Tap on the green link button below to go to the complete website section



Tap the blue button to view all energy systems covered by this Revision PDF

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ENERGY SYSTEMS AND ENERGY PRODUCTION

1. COAL

2. OIL AND NATURAL GAS

3. HYDRAULIC FRACTURING "FRACKING"

4. SOLAR POWER

5. WIND POWER

6. SEA / TIDAL POWER

7. WAVE POWER AND RIVERS

8. DAMS / HYDRO ELECTRICITY

9. GEOTHERMAL ENERGY

10. BIO-FUELS

11. NUCLEAR POWER

12. THE ARCHIMEDEAN SCREW

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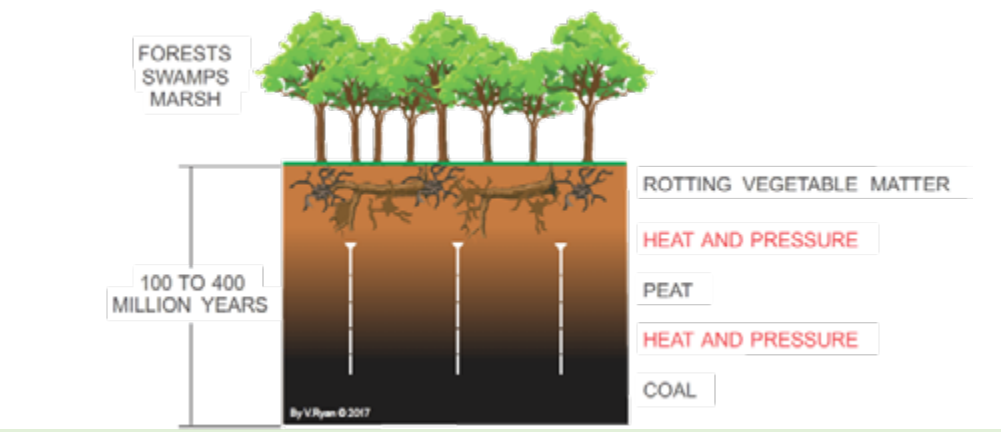
HOW IS COAL FORMED?

Coal is mined from deep underground, although sometimes it is found relatively near the surface. It originates from plants, in swampy / tropical regions, that lived millions of years ago. As the plants died year after year, they began to be compacted through the pressure of other dead plant matter, rocks and debris. Due to hundreds of millions of years, of pressure and the earth's heat, peat and coal formed. **Tap on the image** for more detail



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HOW IS COAL MINED?

Coal is usually mined from deep underground. Mine shafts are ‘sunk’ and the workforce is lowered by a lift to the coal level. Much of the coal is removed from a ‘seam’ of coal, using mechanised equipment. Even today, mining is regarded as a dangerous occupation.

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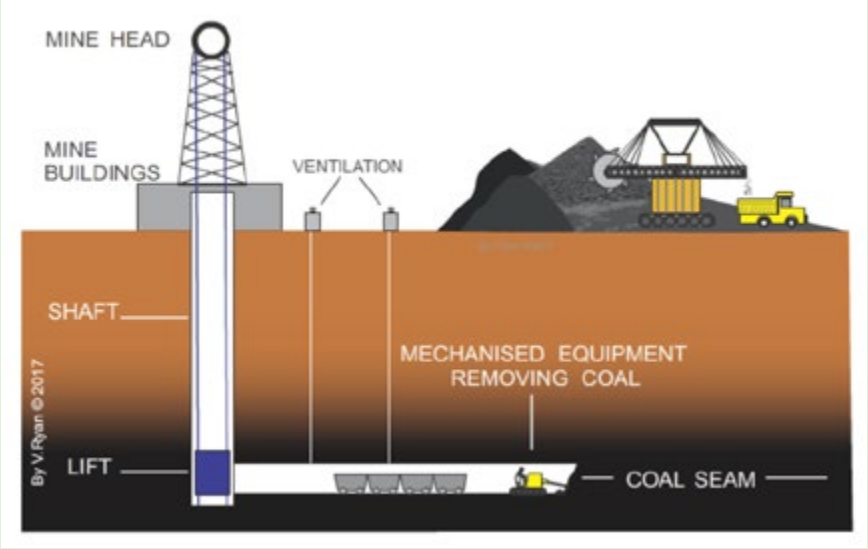

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PRODUCING ELECTRICITY FROM COAL

Coal is dropped into a hopper. The hopper feeds the furnace.
As the coal burns, it heats a water tank creating high pressure steam. The steam is used to turn turbines, producing electricity.
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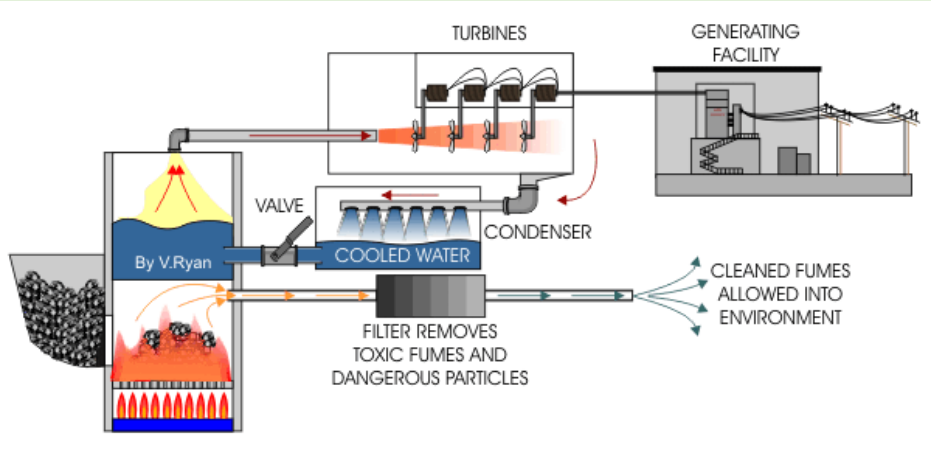

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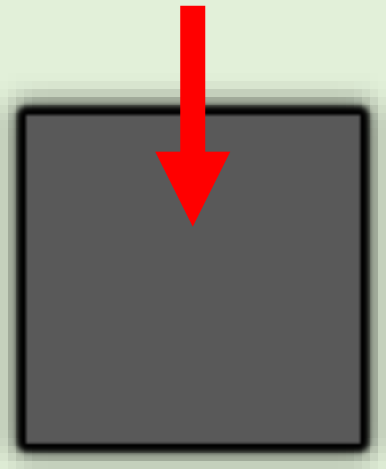
Tap on the link button below, for disadvantages and advantages of using **coal** to produce electricity.

DISADVANTAGES AND ADVANTAGES



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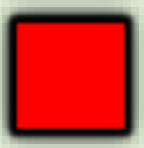

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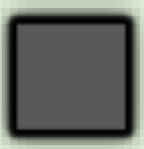

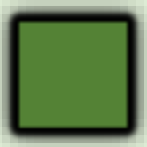

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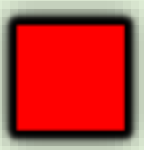

FINITE RESOURCES
CRUDE OIL AND NATURAL GAS

Oil and natural gas have a very important role in our lives and the plays an equally important role in industry and the world economy. Oil and natural gas, provide us with a range of essential fuels and materials. However, crude oil and natural gas are finite resources, as they will eventually run out, they are sustainable and some regard them as being environmentally damaging.

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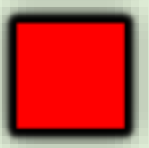
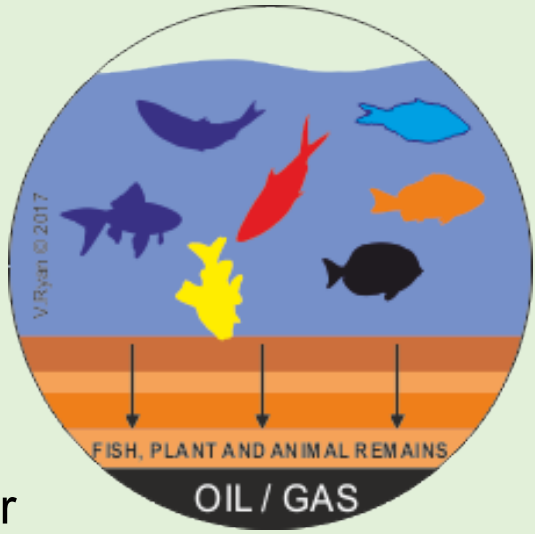


BUT WHERE DOES OIL AND NATURAL GAS COME FROM?

Three to four hundred million years ago, marine plants, fish and animals died and their remains dropped to the bottom of the sea. Over time more remains built up and were covered by sand and silt. Over the following hundreds of millions of years, the compacting pressure from the build up of further sand and heat, transformed the fish, plant and animal remains into oil and natural gas.



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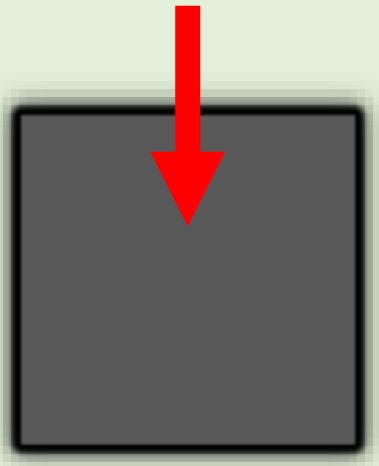
Tap on the link button below, for disadvantages and advantages of using **GAS**.

DISADVANTAGES AND ADVANTAGES



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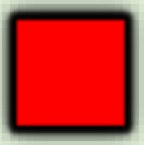

EXTRACTION OF GAS AND CRUDE OIL

Generally, when an oil / gas well is drilled, the pressure of the oil trapped in the rock structure (reservoir), is enough to drive it to the well head. **Tap on the image** for more detail.

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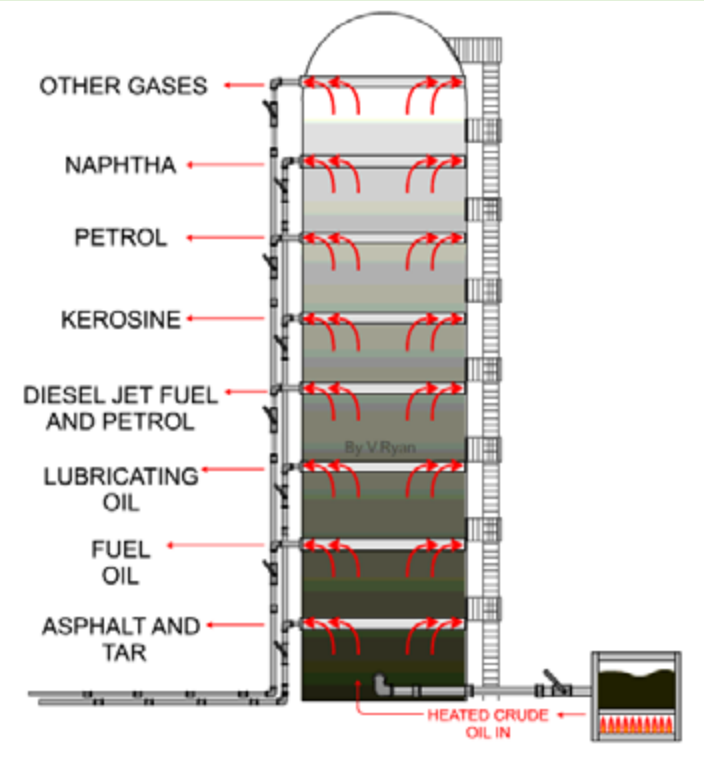
DISTILLATION OF CRUDE OIL

Crude oil needs refining, before it can be used. This takes place in a distillation tower. Crude oil is heated to over 370 degrees Celsius and vaporises and rises up the tower, forming different fuels. **Tap on the image** below for more detail



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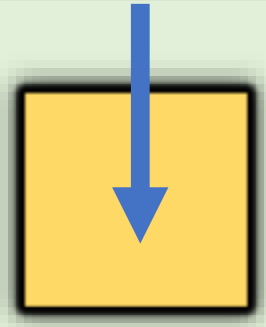
TAP HERE FOR HOW PLASTICS ARE MANUFACTURED FROM OIL



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HYDRAULIC FRACTURING "FRACKING"

Fracking (called hydraulic fracturing) is the drilling of shale rocks to liberate gas and oil. Shale gas is usually the main output from the wellhead. Fracking normally involves drilling straight down to a shale layer of rock and then drilling horizontally into the seam. Water, sand and chemicals (90% water, 9.5% sand and 0.5% chemicals) are injected at very high pressure, causing the shale to fracture, releasing the gas, which is returned to the surface for processing. It is the sand particles that keep the fractures open, allowing the gas to continue to escape back up the pipe. One fracking site can support a number of wells, because horizontal drilling allows the wells to spread outwards, from a central production facility.

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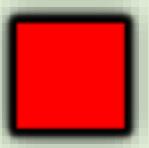
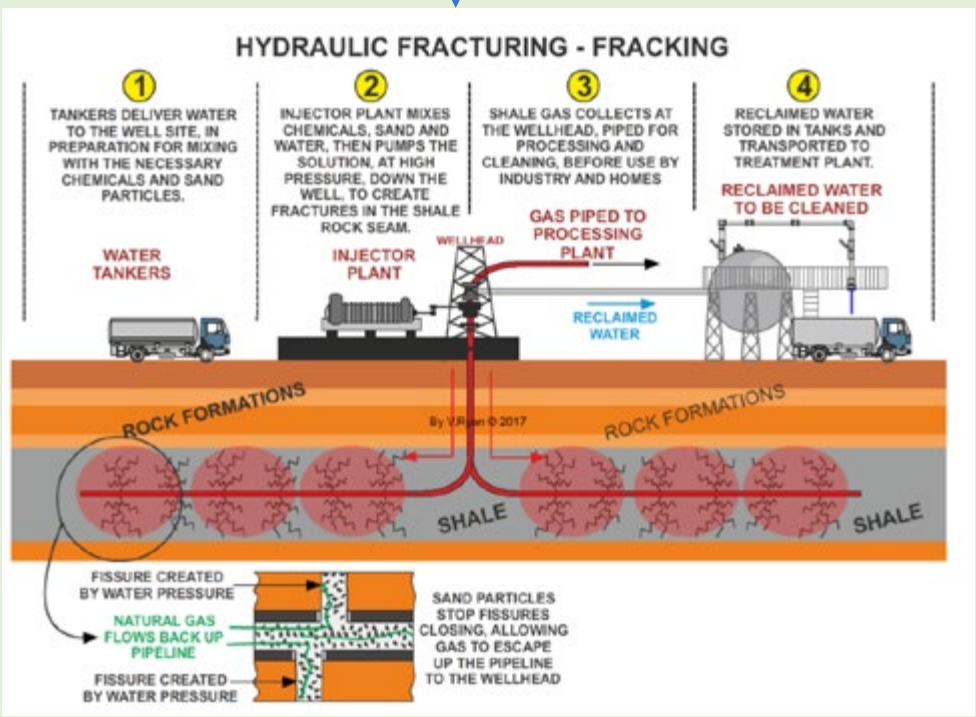


<u>Tap the image</u> below for more detail on the fracking process. Arguments for and against



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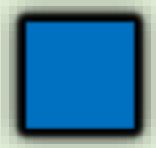

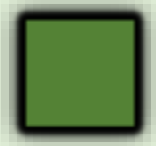

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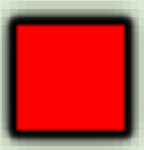

WHAT IS SOLAR POWER?
SOLAR PANELS – HEATING WATER

Solar power is energy from the sun and has been looked upon as a serious source of energy , through solar panels, photovoltaic cells and parabolic reflectors.
The sun can be used to heat water. A typical solar panel for heating water, is a combination of magnifying lenses and fluid filled pipes. The fluid in the pipes is warmed by the sun. In turn, the fluid in the pipes heat up a tank of water. Hot water is the result.

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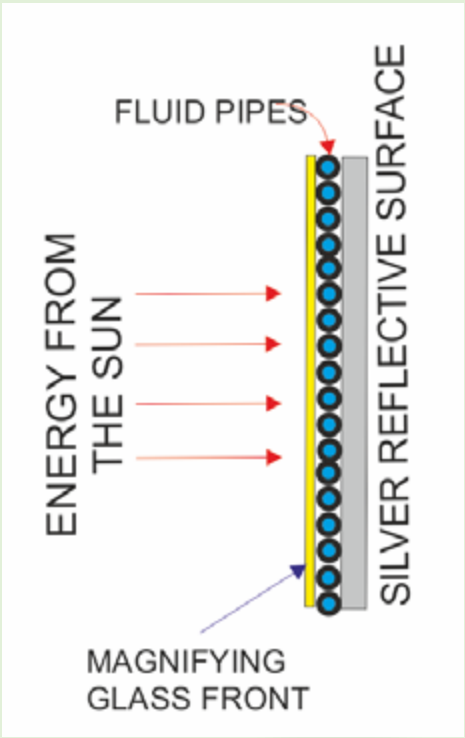
For more information



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PARABOLIC REFLECTORS AND ELECTRICITY PRODUCTION

Large numbers of parabolic mirrors can be used to focus the power of the sun, heating a solution of potassium nitrate, in a series of pipes, which in turn converts water to steam. The steam drives turbines producing electricity.

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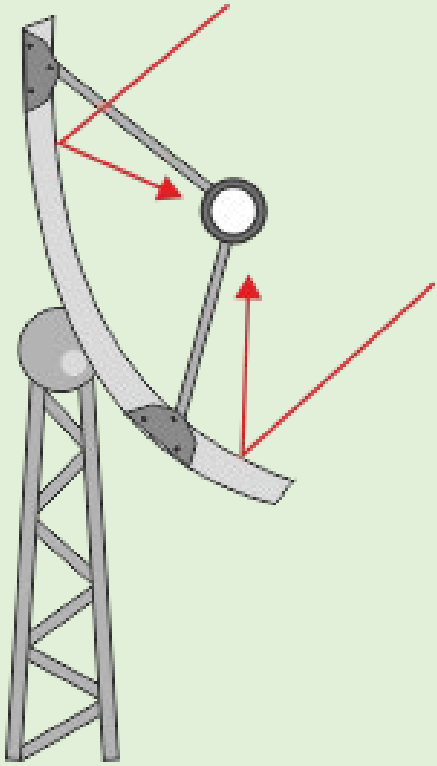

A Solar Electric Power Generation Plant in Andalucía (Spain), has the capacity to produce 50 MW of electricity, using parabolic mirrors that track the sun.

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PHOTOVOLTAIC CELLS
ELECTRICITY PRODUCTION

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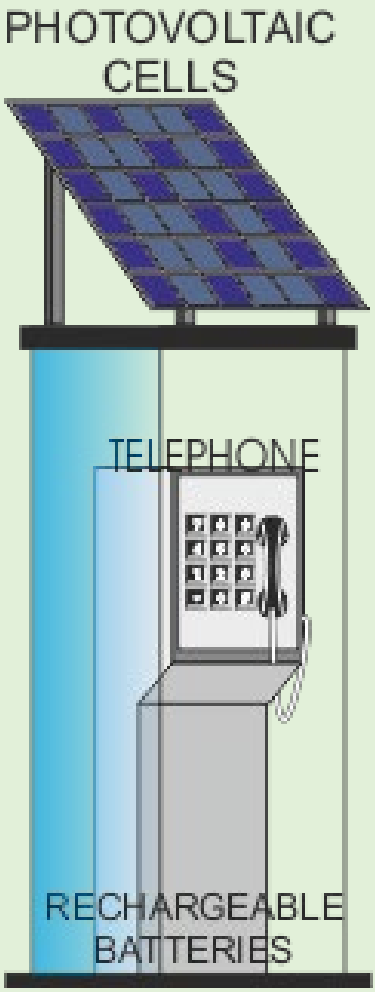

Silicon is a ‘semiconductor’ that conducts electricity efficiently. It is the main material of photovoltaic cells. The phone box seen opposite is powered directly by photovoltaic cells during the day. Batteries are charged during sunlight hours, for use at night. Many houses have photovoltaic cells on the roof, producing electricity for the National Grid.

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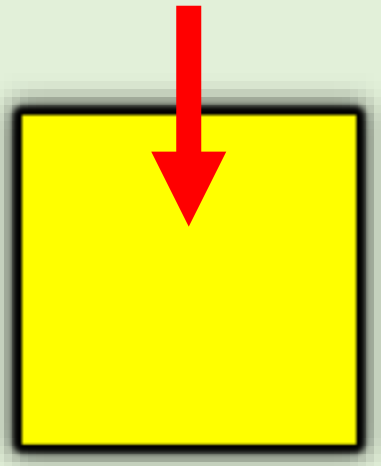
Tap on the link button below, for disadvantages and advantages of **SOLAR POWER**.

DISADVANTAGES AND ADVANTAGES



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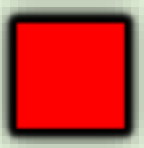

Tap on the link buttons below, to go to detailed information and exercises on **SOLAR POWER.** Ideal for revision.

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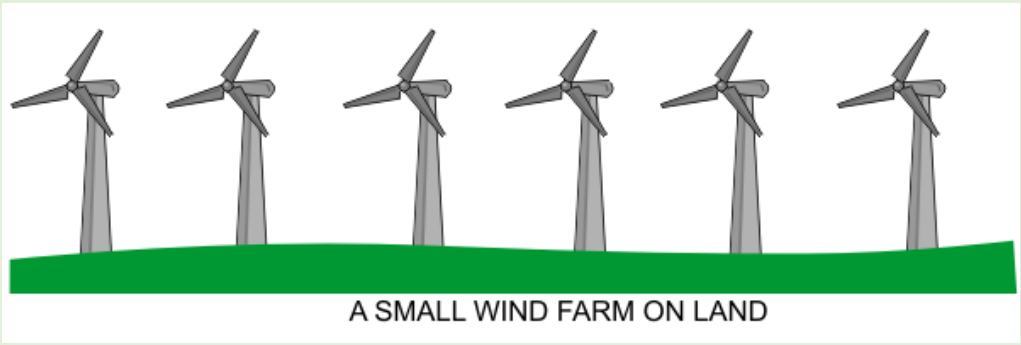
WIND POWER ON LAND

Wind power generators are rarely seen in isolation as they are normally put together in groups forming wind farms. This is the most efficient way of producing electricity from the wind and feeding it into the national power grid. Single generators are normally much smaller and used on farms or in remote areas where it is not possible to cable electricity from the national grid. **Tap on the image** below for more detail.



A SMALL WIND FARM ON LAND

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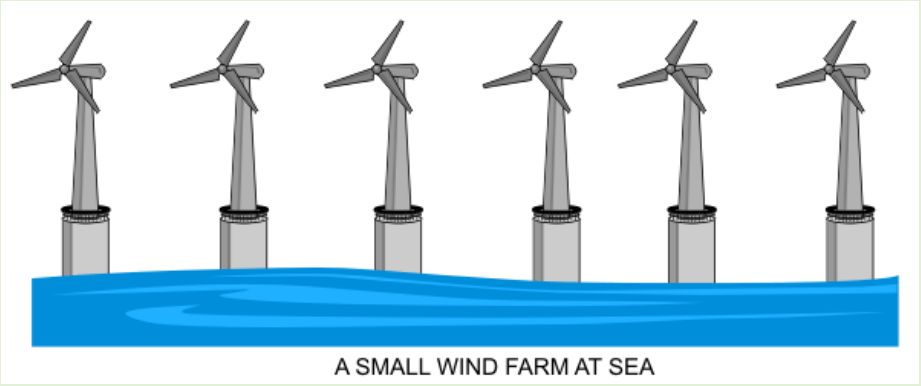
WIND POWER AT SEA

Some technologists and scientists believe the answer is to site large wind generators at sea. The noise they produce will not be heard and if sited miles way from the coast they will not even be seen. However, they are much more costly to locate and maintain in the sea. Also, the salt in sea water means that the materials used to make them have to be specially treated so that they are protected. This increases there overall cost of manufacture and installation significantly. **Tap on the image** for more detail.



A SMALL WIND FARM AT SEA

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THE SCALE OF MODERN WIND TURBINES

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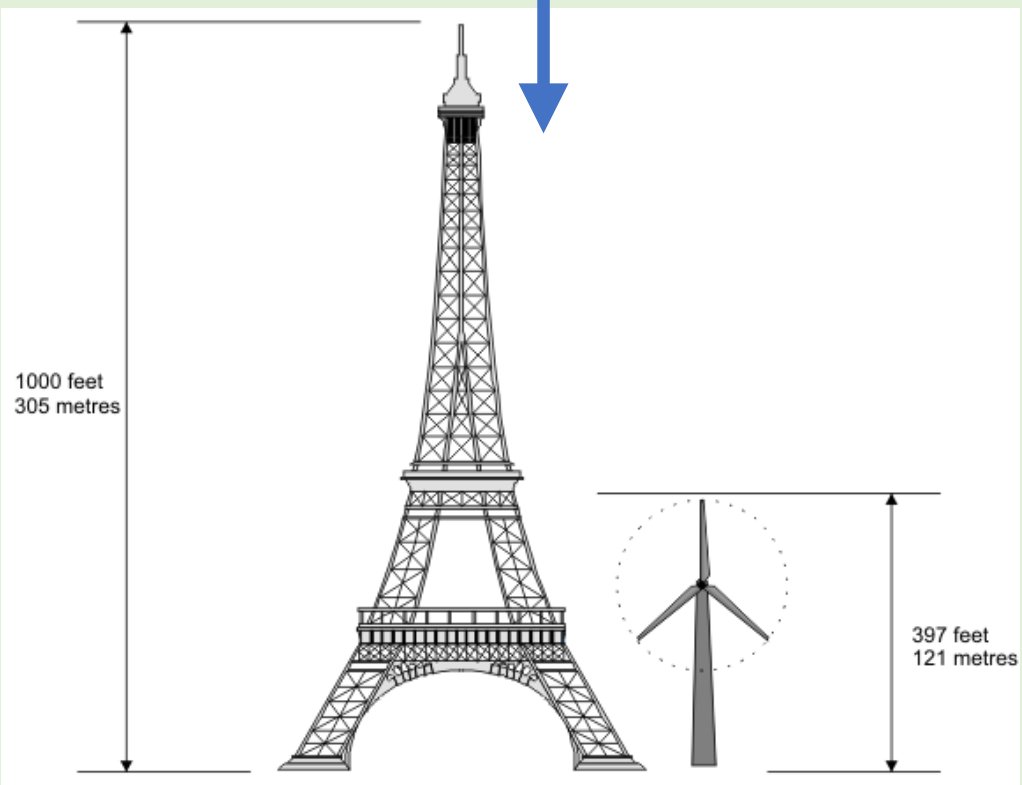

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HOW A TURBINE WORKS AND GENERATES ELECTRICITY FROM THE WIND

The aerodynamic blades catch the wind, rotating the main shaft. The gear box is an arrangement of individual gears, that are set to keep the rotation of the main shaft under control. The Rotor Generator converts the rotation of the shaft into electricity.

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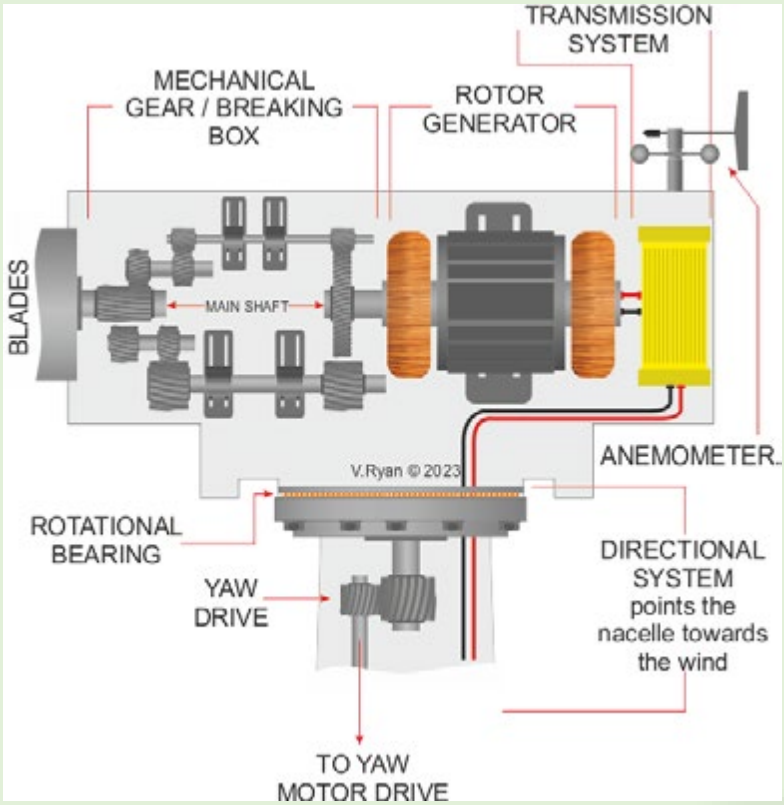

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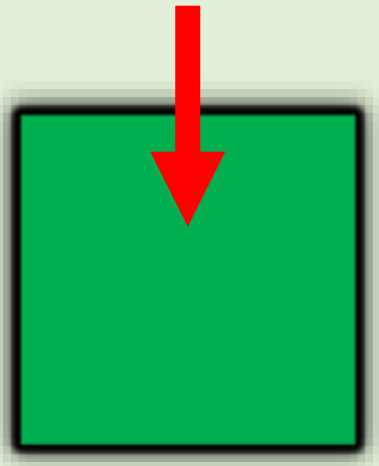
Tap on the link button below, for disadvantages and advantages of **WIND POWER**.

DISADVANTAGES AND ADVANTAGES



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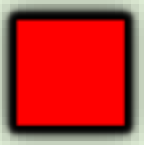

Tap on the link buttons below, to go to detailed information and exercises on **WIND POWER.**
Ideal for revision.

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SEA / TIDAL POWER

The incoming and outgoing tides of the sea can be harnessed to produce electrical power. Tides are often very powerful and the sea can move very quickly when the tide is coming into land.

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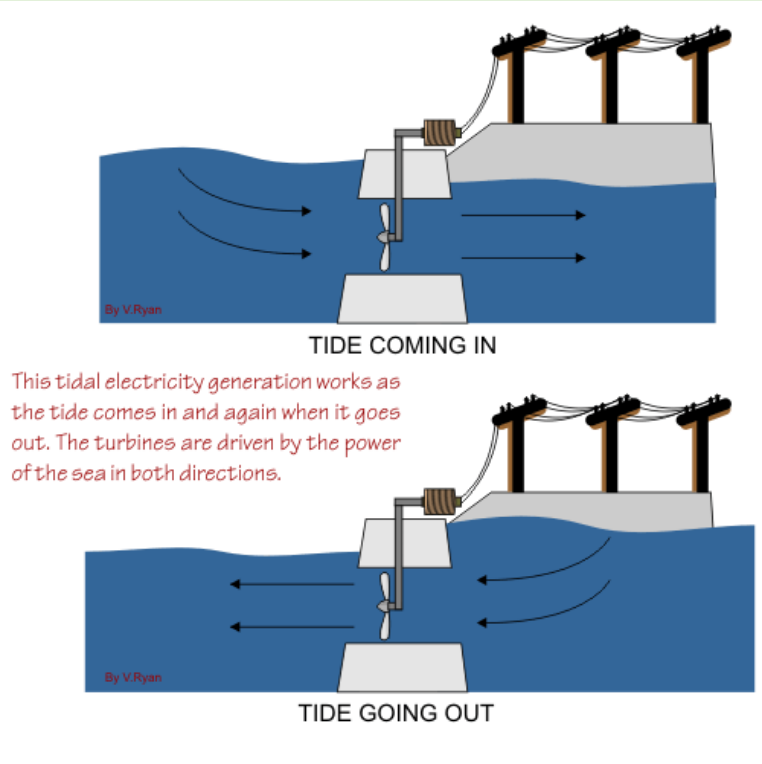

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THE PROPOSED BRISTOL CHANNEL TIDAL POWER SCHEME

The power is obtained through the flow of the tide, when filling and emptying partially closed sea basins. A proposed scheme exists for the Bristol Channel (UK). As the tide runs into the 'low' basin it drives turbines and as the tide retreats, again turbines are turned - producing large amounts of electricity. Unfortunately this scheme has been 'shelved' due to cost and possible damage to the local ecology.
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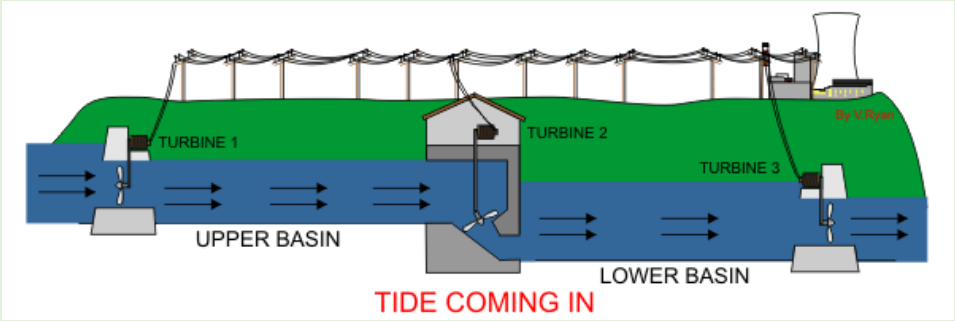

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THE RANCE TIDAL POWER SCHEME

An alternative way of using the tide to generate electricity is seen below. As the tide comes in, sea water is allowed to enter the dammed area behind the sea wall. This drives turbines that produce electricity. The sluice gates are then shut to hold the sea water behind the dam wall. When the tide goes out, the sea water from inside the dam wall is allowed to flow back out by reopening the sluice gates. As water flows through the slices, it drives the same turbines which produce electricity a second time.

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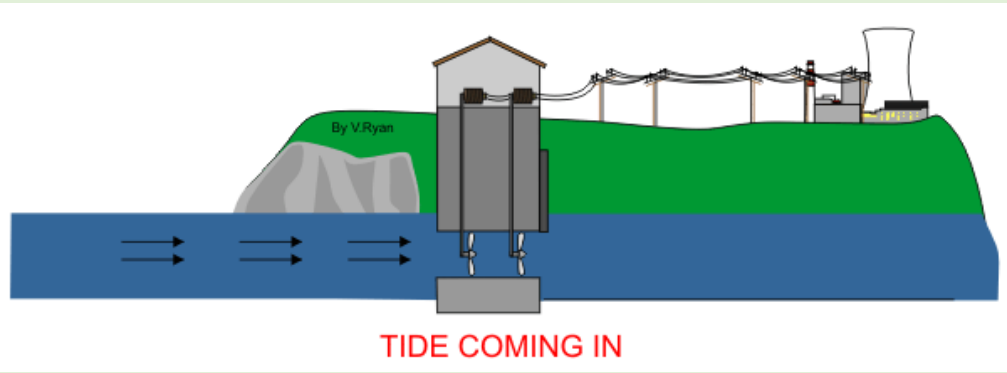

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OFFSHORE TURBINES

Research is being carried out on the possibility of using off shore turbines, driven by the power of the tides. The powerful tides could be used drive under water turbines. The turbines could rotate in either a clockwise or anticlockwise direction and as the tide is always moving, electricity production would be continuous.
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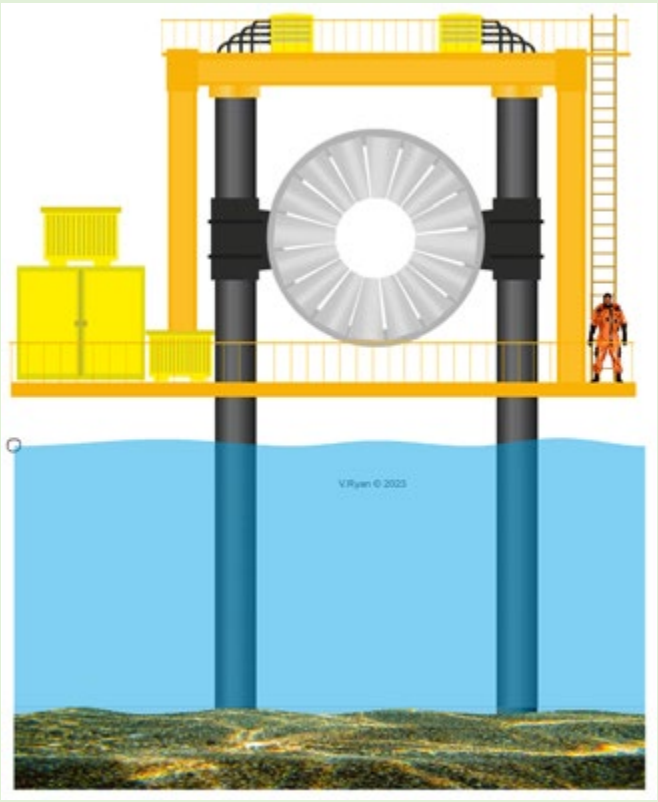

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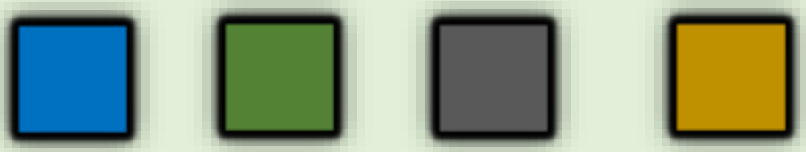

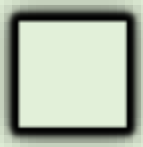

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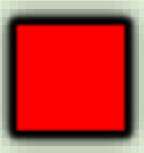
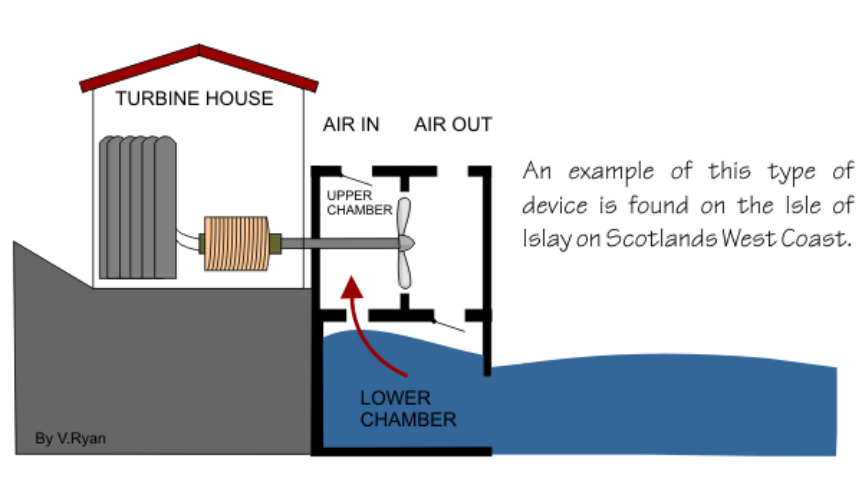


WAVE POWER

This is called an ‘Oscillating Water Column’. As the wave enters the lower chamber, it forces air into the upper chamber and this causes the turbines to rotate.
The advantage of this type of system is that the propellers are out of the sea water which means they are not affected by the salty water.
Tap the image for more detail.



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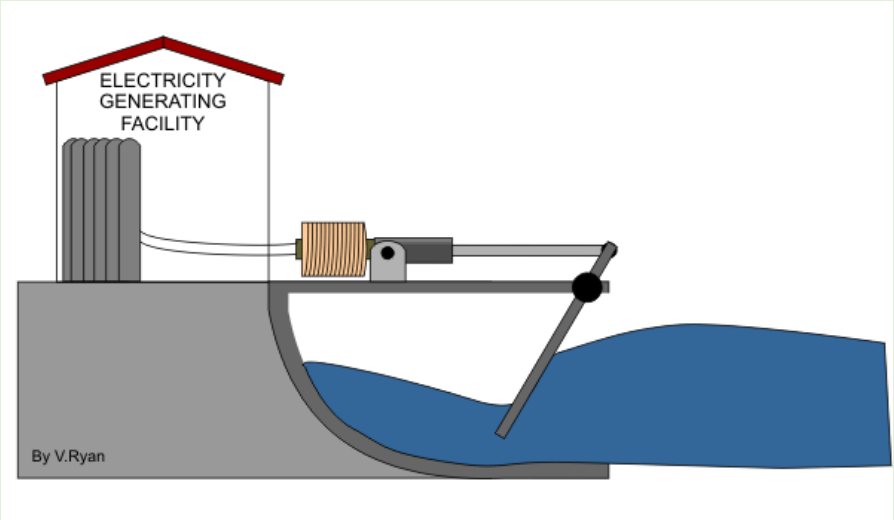
WAVE POWER

The PENDULUM device seen below is another electricity generating device that utilises the power of waves. As the wave hits the pendulum it is forced backwards and then returns to its original position until the next wave hits. This movement forces hydraulic ramps backwards and forwards which drive special turbines and produces electricity.

Tap the image for more detail



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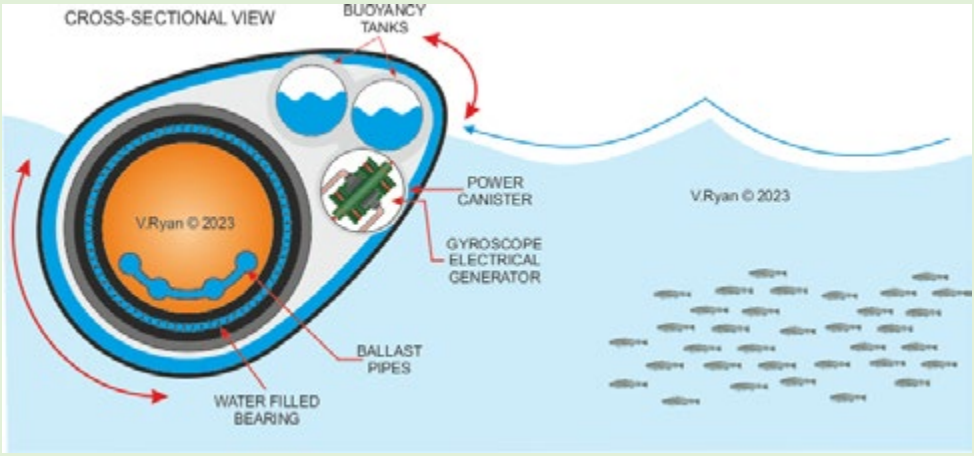
THE SALTER DUCK

The ‘Salter Duck’, ‘bobs’ up and down on waves and a special turbine inside converts this movement into electricity. It is as large as a Double Decker bus. They are arranged in set patterns in the sea, to take advantage of wave formations.
Tap the image for detail.



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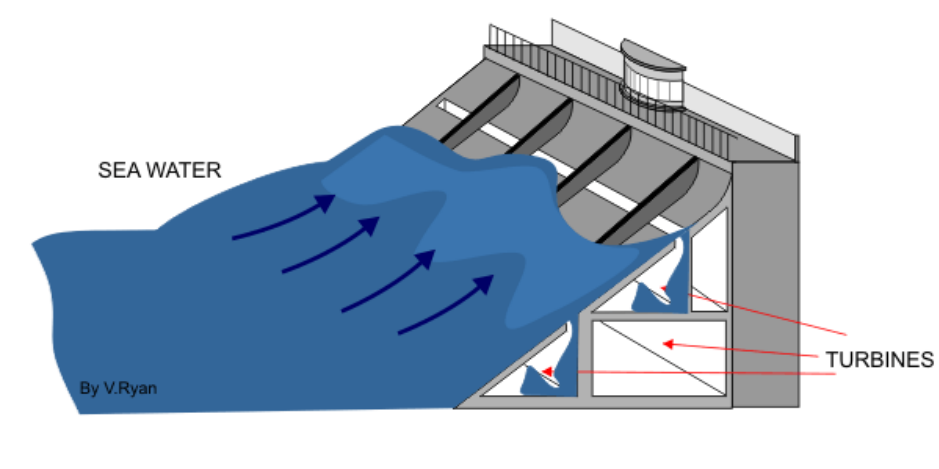
COASTAL DEFENCES AND ELECTRICITY GENERATION

A Norwegian company has developed a potentially effective way of harnessing wave power. The sea wall is part of an electrical generating system. As the wave hits the sea wall, the sea water falls into mini reservoirs. The sea water then cascades down through turbine blades, generating electricity.
Tap the image for detail.



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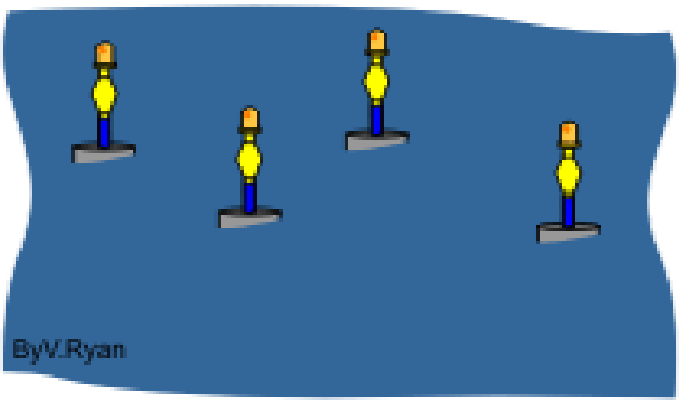
THE ELECTRICITY GENERATING SEA BUOY

A electricity generating buoy has been developed in the USA. As the buoy 'bobs' up and down in the sea a electricity generating system inside produces electricity. It is estimated that these system have low maintenance costs and a life time of at least twenty years.
Tap the image for further detail



POWER GENERATING BUOYS ARRANGED IN THE SEA

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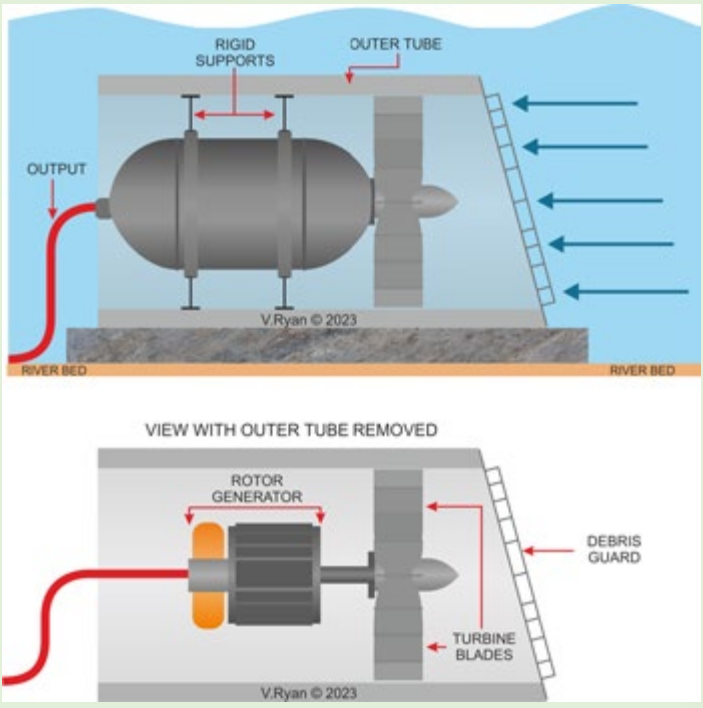
HYDROKINETIC HYDROELECTRIC TURBINES

Hydrokinetic Hydroelectric Turbines are designed to generate electricity from the flow of rivers and canals. They are small scale and usually backup or complement existing localised power systems, such as a diesel generator. They are ideal for charging batteries, in the same way as solar power is often used.

Tap the image for further detail



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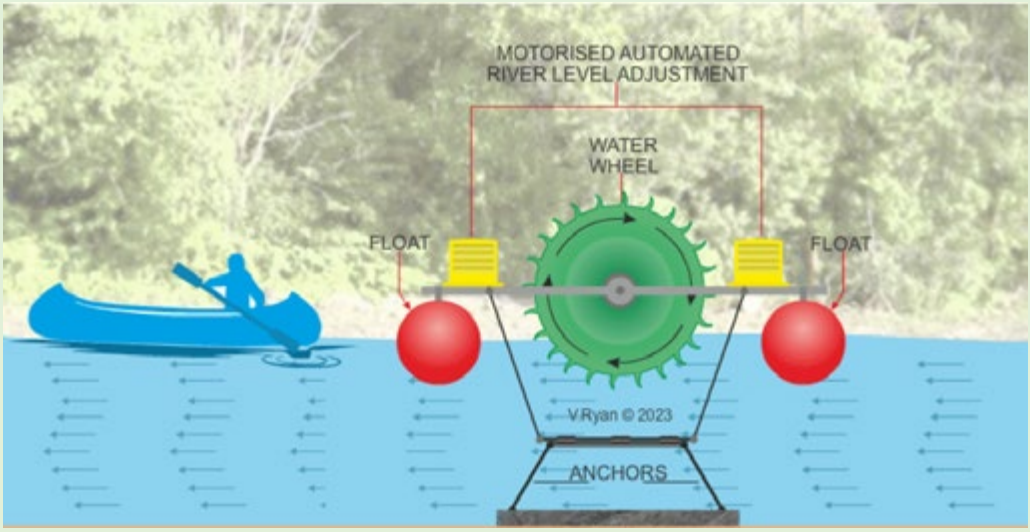
FLOATING HYDRO UNDERFLOW WATER WHEEL

Water wheels have been in use for centuries. A modern version is the floating Hydro Underflow Water Wheel. The most efficient designs are based on a rotating ‘barrel’, with hydrodynamic blades. The blades have been developed to catch the water current. They are the equivalent of turbine blades, designed to take advantage of hydrodynamic drag (the resistance that an object meets, when a liquid moves across its surface).

Tap the image for further detail



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Tap on the link buttons below, to go to detailed information and exercises on **WAVE POWER** Ideal for revision.

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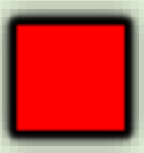
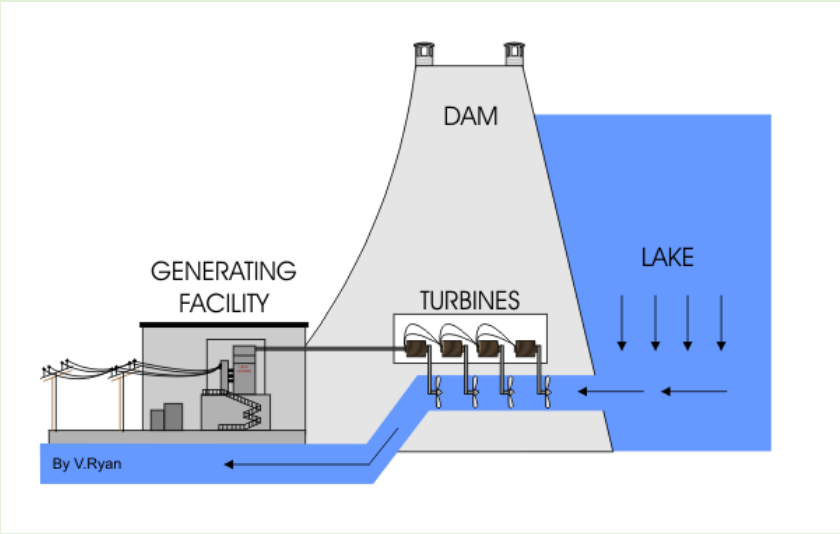


DAMS / HYDRO ELECTRICITY

A typical setup requires the construction of a dam. Behind the dam, water is allowed to build up forming a large, deep lake. A typical dam may take years to construct and cost millions of Dollars / Euros and consequently a dam must stay producing electricity for many years (perhaps even decades) - in order to produce electricity profitably. **Tap on the image** for further detail.



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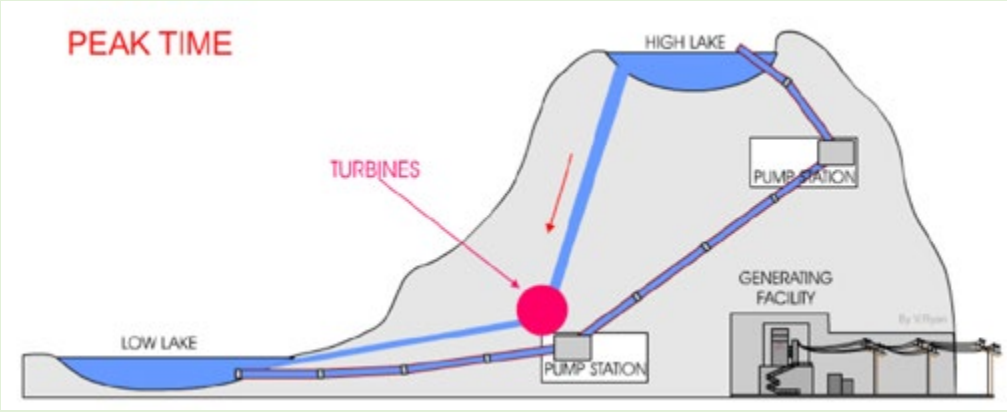
PUMP STORAGE SYSTEMS

The system is generally used to support the National Power Grid at peak times, when demand for electricity is at its greatest. Water is released from the high lake when electricity is needed. At night time the water in the low lake is pumped back up the mountain to the high lake, for use again.
Tap the image for further detail



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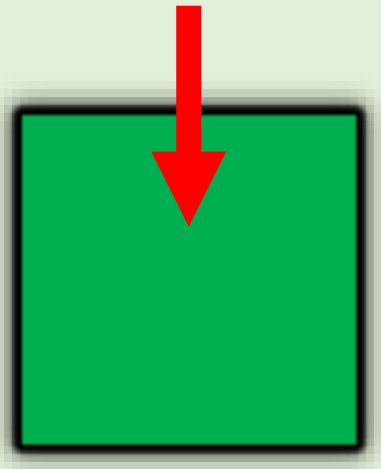
Tap on the link button below, for disadvantages and advantages of **HYDROELECTRICITY**.

DISADVANTAGES AND ADVANTAGES



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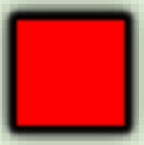
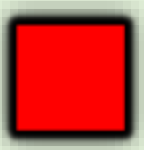


Tap on the link buttons below, to go to detailed information and exercises on **HYDROELECTRICITY** Ideal for revision.

Tap the red button to return to the Contents page



WHAT IS GEOTHERMAL ENERGY?

Geothermal energy is energy derived from the heat of the earth. The earth's centre is a distance of approximately 4000 miles and is so hot that it is molten. Temperatures are understood to be at least 5000 degrees centigrade. Heat from the centre of the earth conducts outwards and heats up the outer layers of rock called the mantle. Rain water sometimes seeps down through geological fault lines and cracks becoming super heated by the hot rocks below. Some of this super heated water rises back to the surface of the earth where it emerges as hot springs or even geysers. Sometimes the hot water becomes trapped below the surface as a geothermal reservoir.

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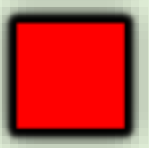
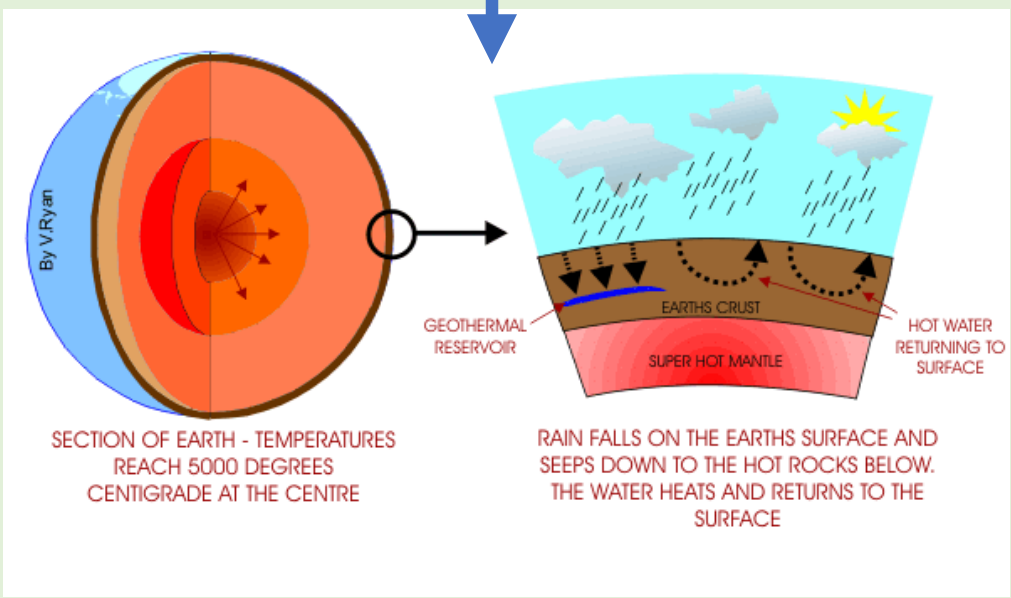


ADVANTAGES OF GEOTHERMAL POWER

Tap on the image below for the advantages of Geothermal Power and more detail about this type of energy



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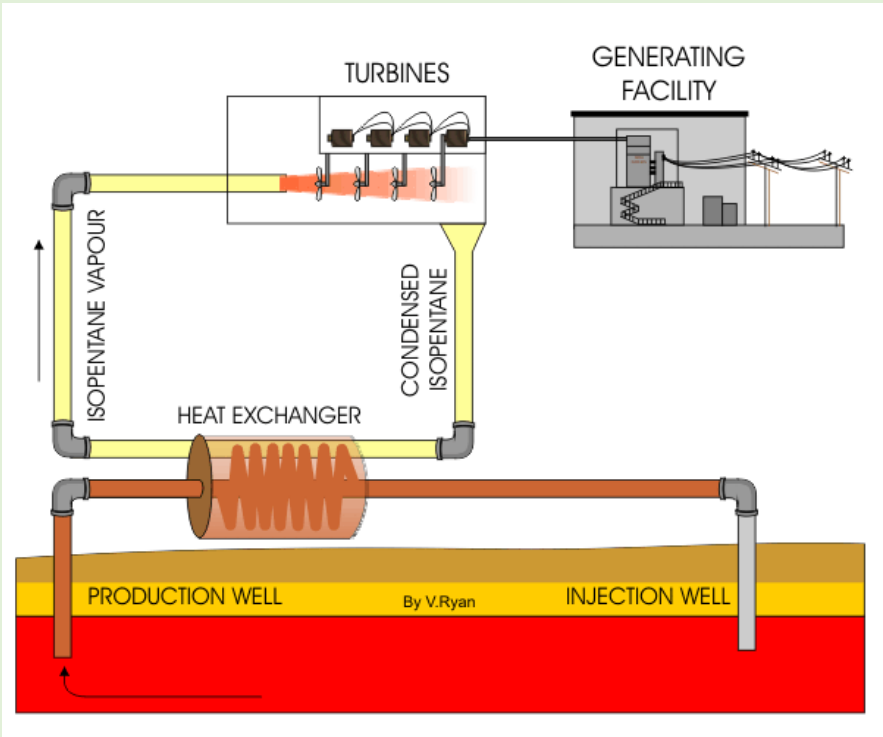
BINARY CYCLE POWER PLANT

Tap on the image for information about this type of Geothermal Power Plant



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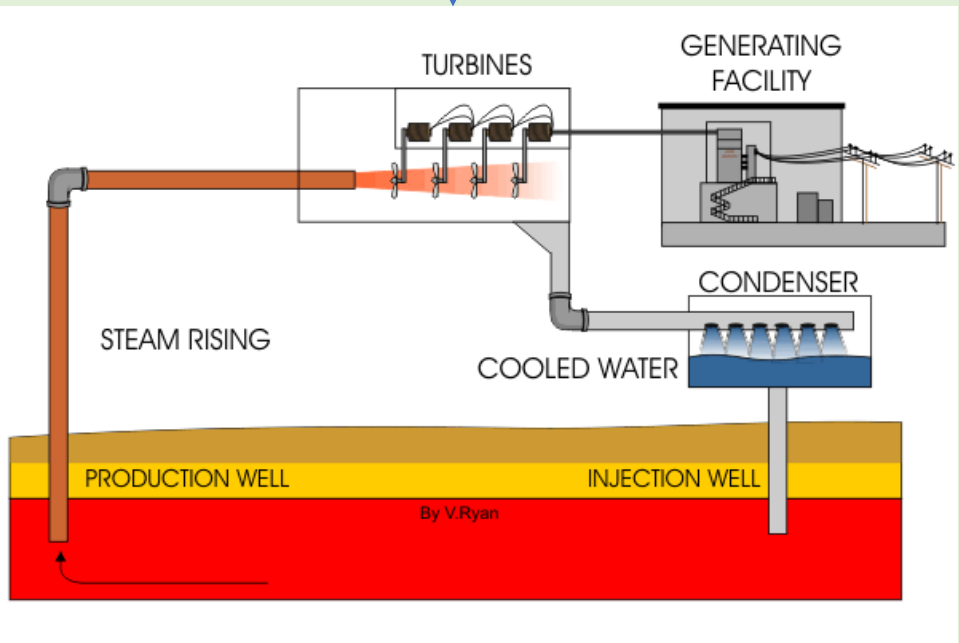
DRY STEAM POWER PLANT

Tap on the image for information about this type of Geothermal Power Plant



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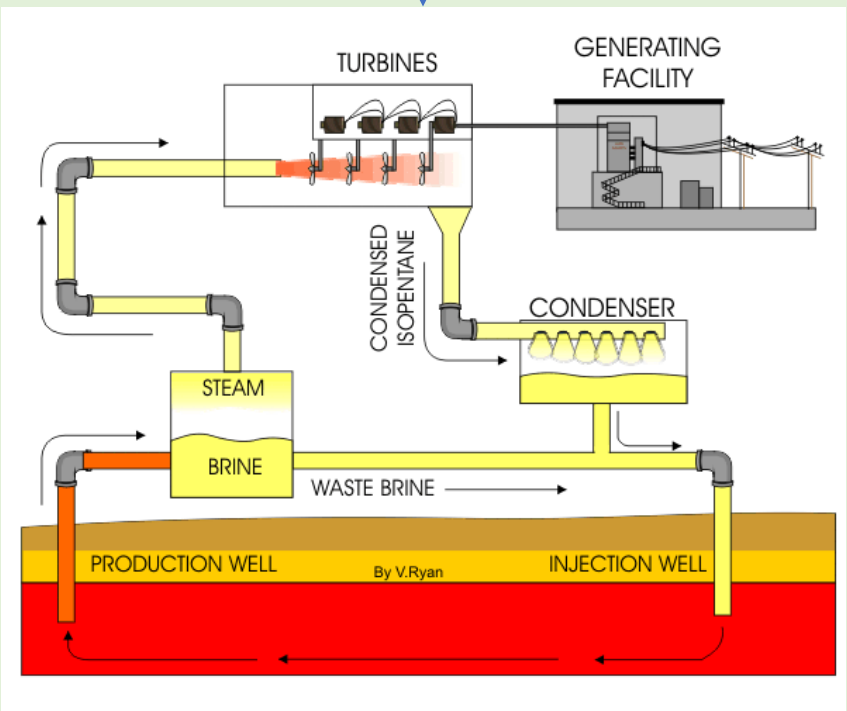
FLASH STEAM POWER PLANT

Tap on the image for information about this type of Geothermal Power Plant



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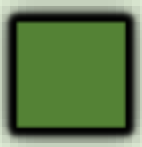
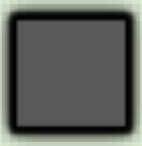
Tap on the link buttons below, to go to detailed information and exercises on

GEOTHERMAL ENERGY

Ideal for revision.





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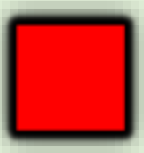
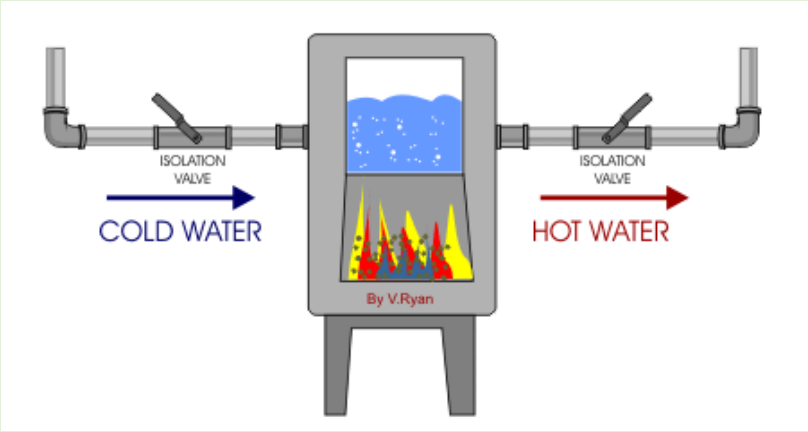


BIO-FUELS
USING FAST GROWING WILLOW

Willow grows quickly and is harvested. The wood is stored until transported to a processing plant for ‘chipping’. Each trunk is fed through a ‘chipping’ machine - the chippings are collected and packaged for distribution. The willow chippings are fed into a boiler and burned to produce heat. On a large scale, it can be used to produce electricity.

Tap the image for further detail.



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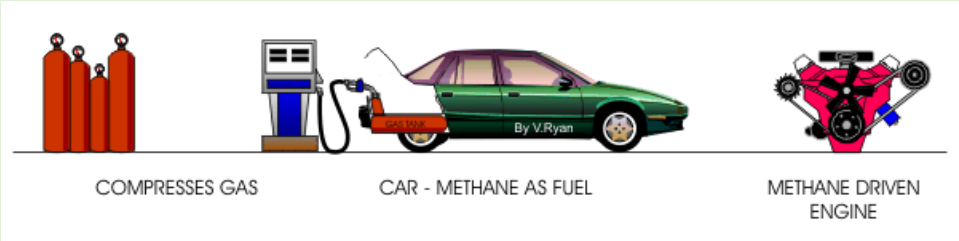
BIO-FUELS
METHANE FROM ANIMAL WASTE

Methane is a gas that can be collected and burned as a fuel. This gas is produced by animal waste, as it decays. Some farms collect animal waste and store it in tanks, processing the collected gas. The resulting methane gas is then compressed in tanks/containers and distributed to customers. It can be used to heat cookers, houses and even to power car engines.
Tap the image for further detail.



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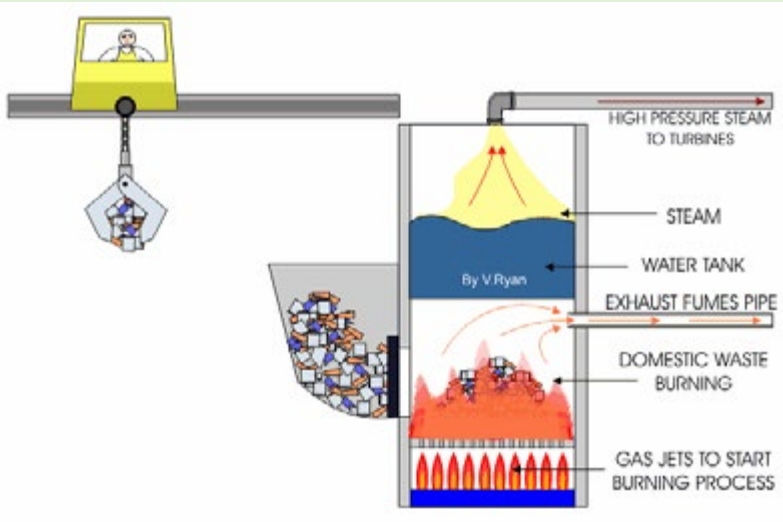
BIO-FUELS
BURNING DOMESTIC WASTE

The domestic waste is burned to produce electricity. Today, the technology exists to remove almost all the pollutants from the fumes produced during the energy production cycle. Special filters remove dangerous chemicals and particles that would normally be found in the fumes.
Tab on the image for further detail



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BIOFUELS - ETHANOL

Ethanol (ethyl alcohol) often known as alcohol can be used as an environmentally friendly fuel. Brazil uses ethanol as a replacement fuel for petrol and diesel. Brazil has reduced its reliance on fossil fuels such oil through its enthusiastic use of ethanol. In Brazil, ethanol is processed from sugar cane.
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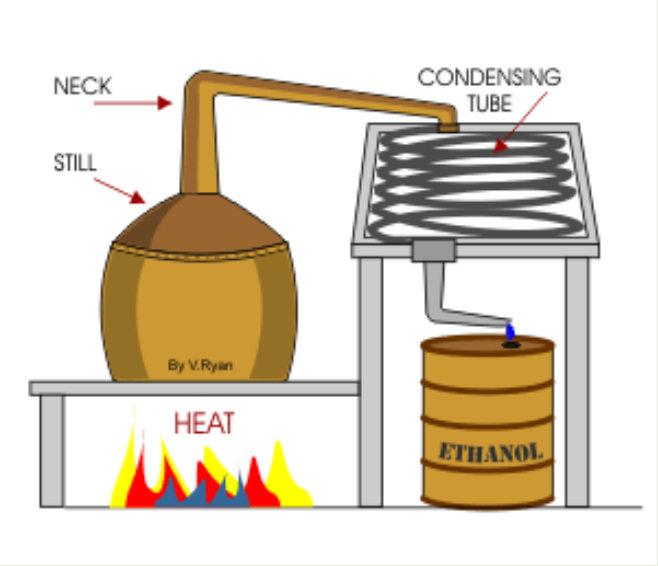

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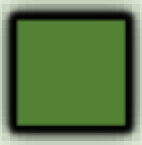
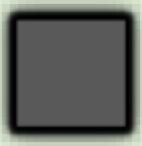
Tap on the link buttons below, to go to detailed information and exercises on

BIOFUELS

Ideal for revision.





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NUCLEAR POWER GENERATION

Nuclear Power Stations use a fuel called uranium, a relatively common material. Energy is released from uranium when an atom is split by a neutron. The uranium atom is split into two and as this happens energy is released in the form of radiation and heat. This nuclear reaction is called the fission process.

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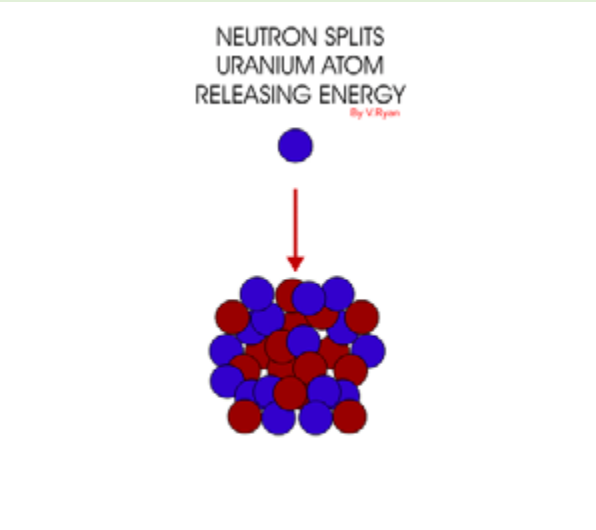

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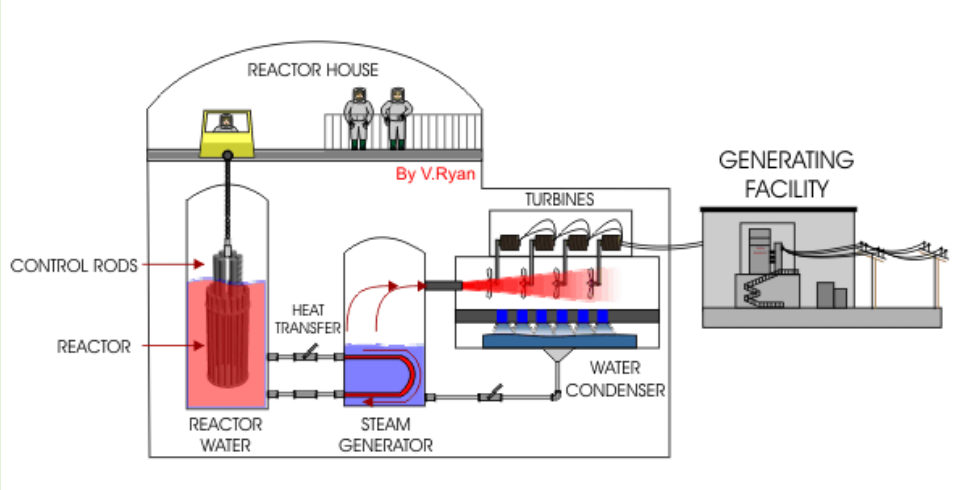
NUCLEAR POWER GENERATION

The uranium rods are kept cool by submerging them in water. When they are removed from the water a nuclear reaction takes place causing heat. The amount of heat required is controlled by raising and lowering the rods. The heat produces steam, driving turbines creating electricity. **Tap the image** for further detail.



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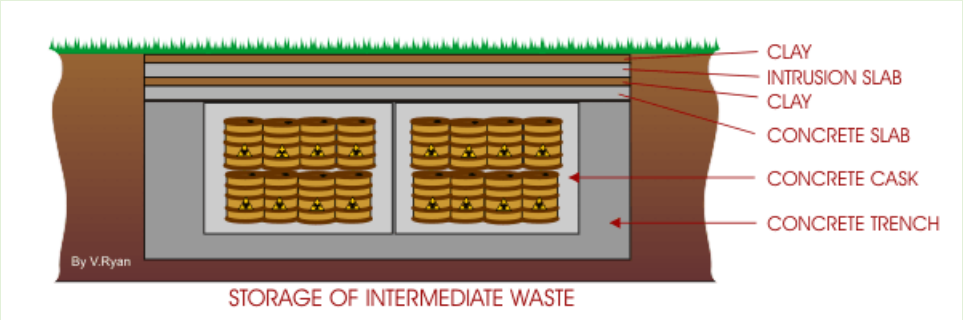
THE STORAGE / DISPOSAL OF RADIOACTIVE WASTE

The production of waste by nuclear power, its storage and handling are of great concern to the public. There are three levels of nuclear waste, low activity or low level, intermediate activity or intermediate level and high activity or high level wastes. Radioactive waste can be extremely dangerous.

Tap on the image for further detail.



STORAGE OF INTERMEDIATE WASTE

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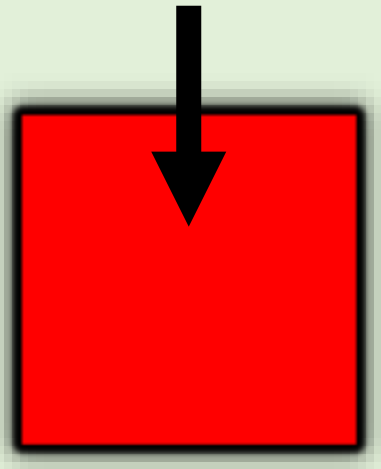
Tap on the link button below, for disadvantages and advantages of **NUCLEAR POWER**.

DISADVANTAGES AND ADVANTAGES



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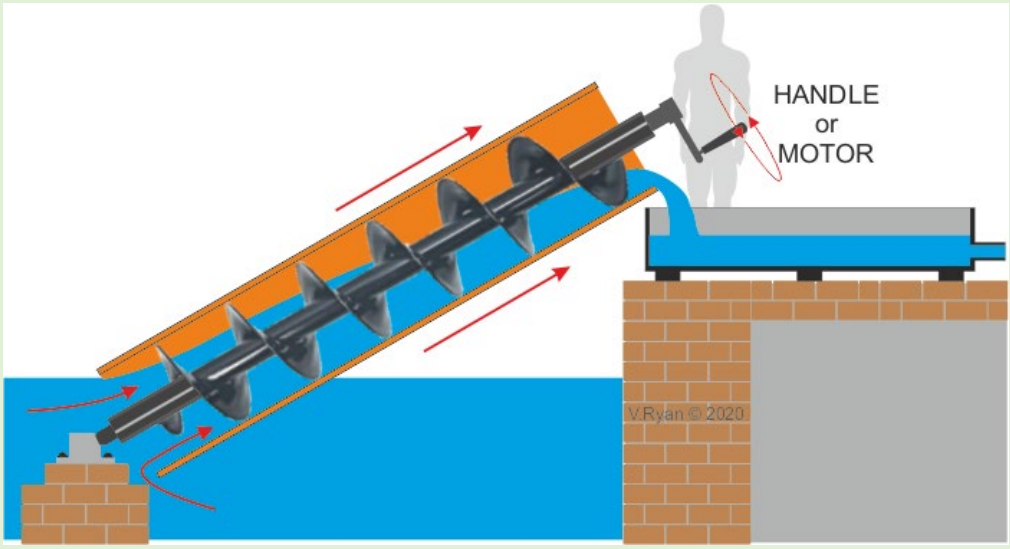
THE ARCHIMEDEAN SCREW
BASIC WORKING PRINCIPLE

The Archimedean Screw seen below, is enclosed within a cylinder. As the screw is turned by hand or by a motor (in modern times), the water moves upwards, until it spills from the top. This supplies water efficiently.

Tap on the image for further detail.



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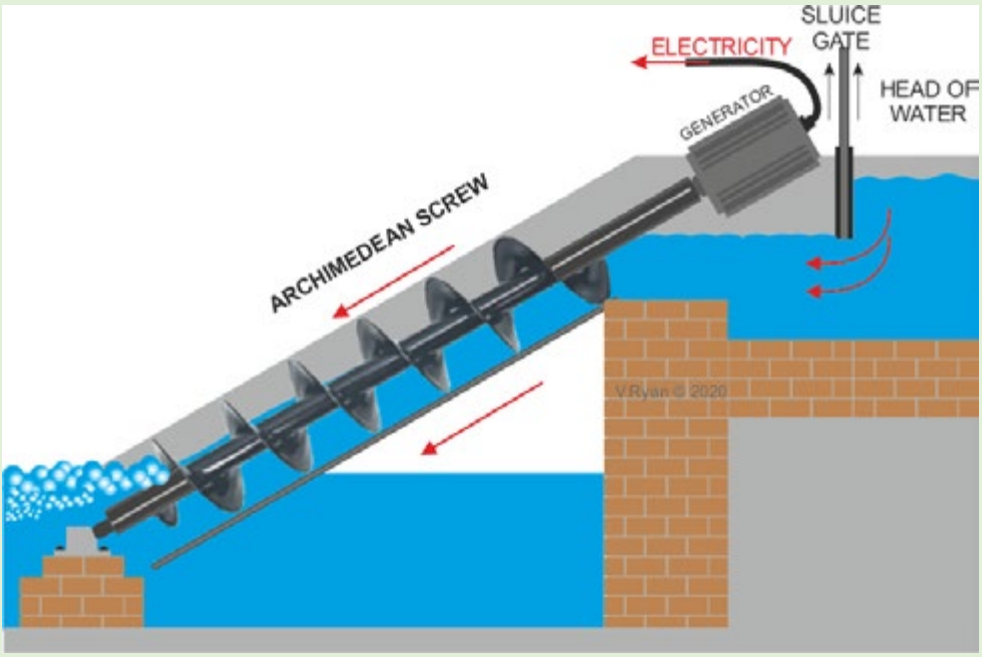
THE ARCHIMEDEAN SCREW ENERGY PRODUCTION

Modern Archimedean Screw systems can generate between 1Kw to 350Kw. Normally, Archimedean Screw systems are used to lift water up hill. However, to generate electricity, the water flows down hill, turning the screw. As the screw turns, a generator converts the movement to electricity.

Tap on the image for further detail.



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HYDROGEN IN PLACE OF PETROL AND DIESEL

1. Hydrogen is converted to electricity by a hydrogen fuel cell, which powers the vehicle.
2. Burning hydrogen in an engine in place of petrol and diesel.

A major advantage of the hydrogen powered vehicles, is that the only by-product is **water.**

Tap on the image for further detail.

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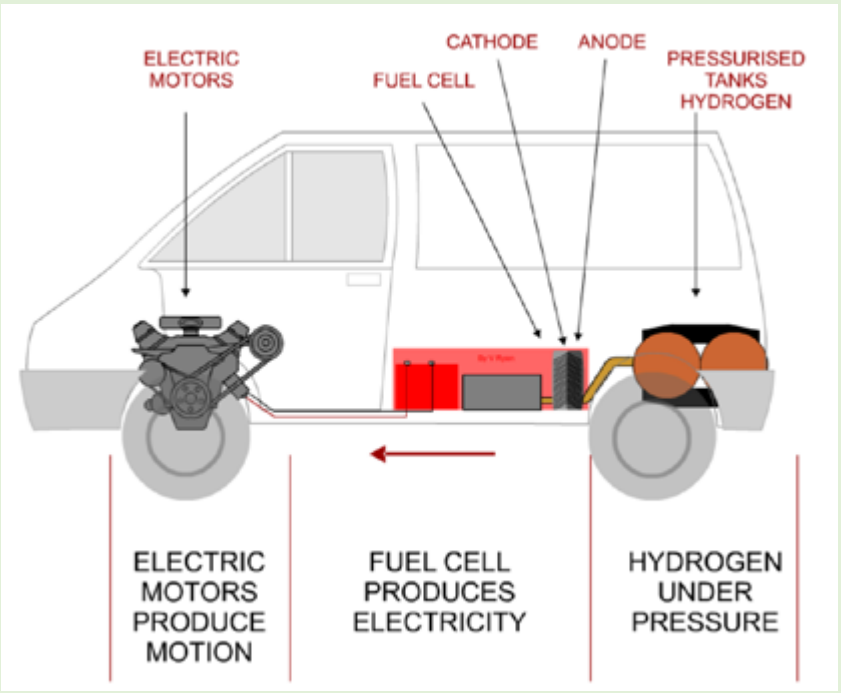
THE HYDROGEN FUEL CELL

A fuel cell is an essential part of a hydrogen car, producing electricity to drive motors. It consists of three parts - the ANODE, CATHODE and CATALYST.
Hydrogen is fed into the ANODE where it produces electrons and they are conducted through the ANODE and around the external circuit driving the motors..

Tap on the image for further detail.



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RENEWABLE HYDROGEN CYCLE

Hydrogen is the most abundant element in the universe. Hydrogen is all around us, for instance in water (H_2O). Hydrogen is used in fuel cells to produce electricity, with only water as waste. Although an economy can run on hydrogen (called the Hydrogen Economy), the world still uses polluting fossil fuels, for the vast majority of its energy production.

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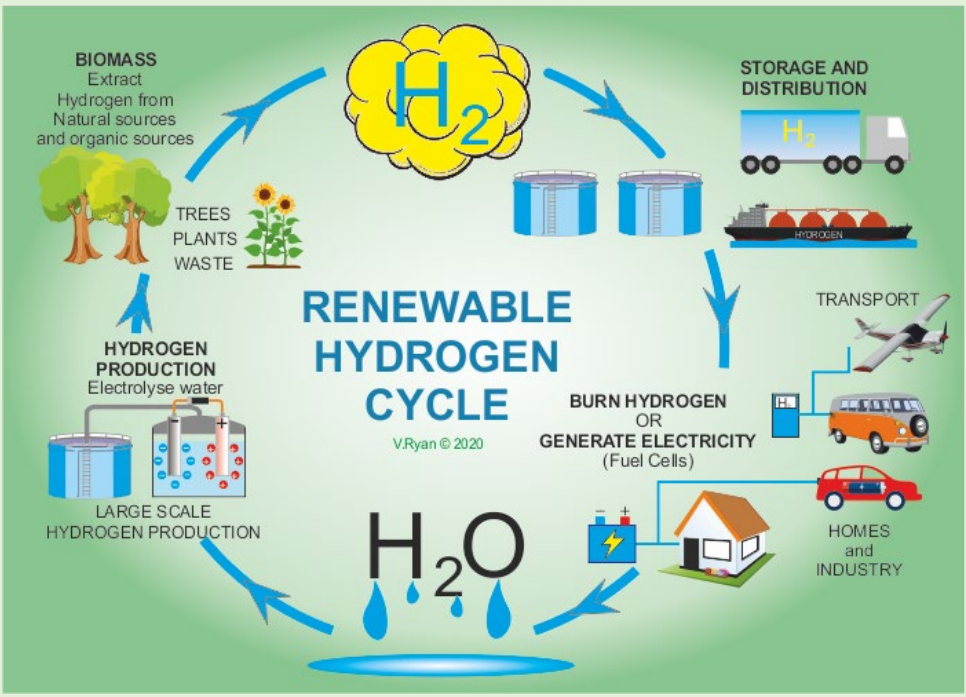

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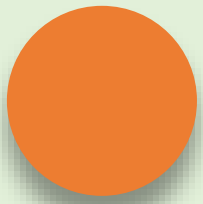
ADVANTAGES OF HYDROGEN

1. Hydrogen can be stored as liquid gas.
2. Hydrogen fuel cells are efficient, operating at an efficiency of 80%.
3. The emissions from hydrogen fuel cells, are in the form of water / water vapour.
4. Fuel cells have a wide range of applications. They can be used to 'power' vehicles, houses and businesses.

DISADVANTAGESOF HYDROGEN

1. Hydrogen is difficult to store as a gas and when liquified.
2. Fuels cells are most efficient within a specific temperature range.
3. In order to establish an hydrogen economy, there is a need to invest heavily in infrastructure, so that hydrogen can be moved as a gas and liquid.

Tap on the image button for further detail.



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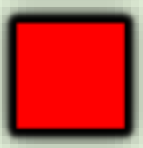
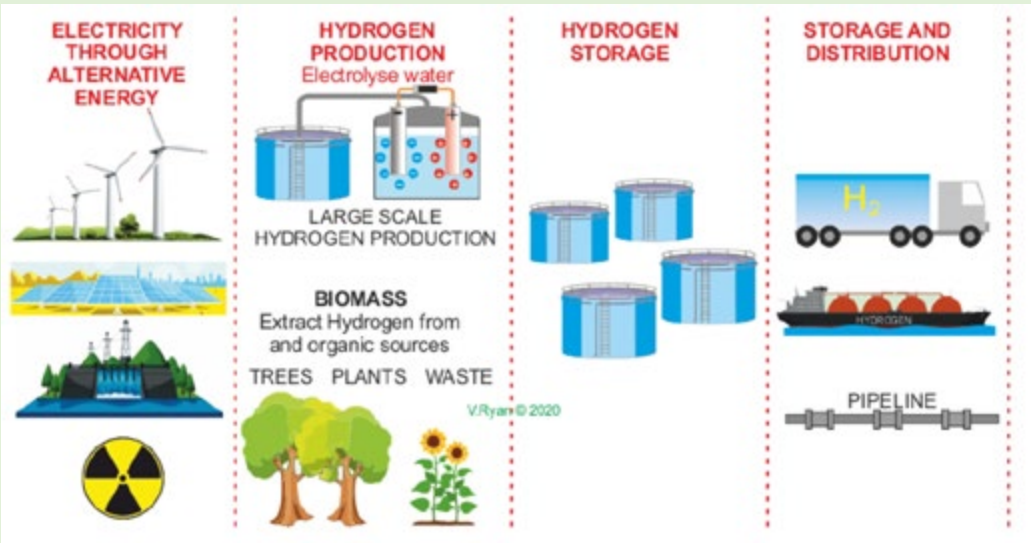


THE HYDROGEN ECONOMY

The world economy is currently based on the large scale use of fossil fuels, to produce the fuels and energy. This drives the economy, from transport to domestic heating. However, the downside is massive environmental damage, global warming, climate change and atmospheric pollution.

The change to an hydrogen based economy, provides the possibility of a future, based on a fuels and energy, that does little damage to the environment.

Tap on the image for further detail.



Tap the blue button for the next page on this energy.

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Tap on the link buttons for information and exercises on a range of energy storage systems.

MECHANICAL SYSTEMS
SPRINGS

PNEUMATICS

HYDRAULICS

FLYWHEELS

BATTERIES - DISPOSABLE AND RECHARGEABLE
AND WIND-UP DEVICES

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