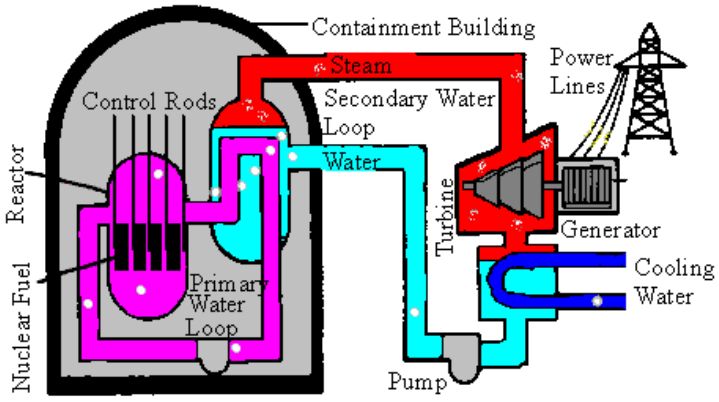
Nuclear Power

Nuclear power plants create electricity using the energy released by splitting atoms to boil water and create steam which turns a steam turbine driving a generator. Since no fuel is burned, there are no gases or pollutants released into the air. The water used to create steam is isolated from radiation and any hot water to be discharged is cooled down in ponds or in tall cooling towers. Nuclear waste is the only byproduct of nuclear power and is packaged and stored rather than released into the environment. Unlike other fossil fuels, nuclear power plants release almost no emissions into the environment.

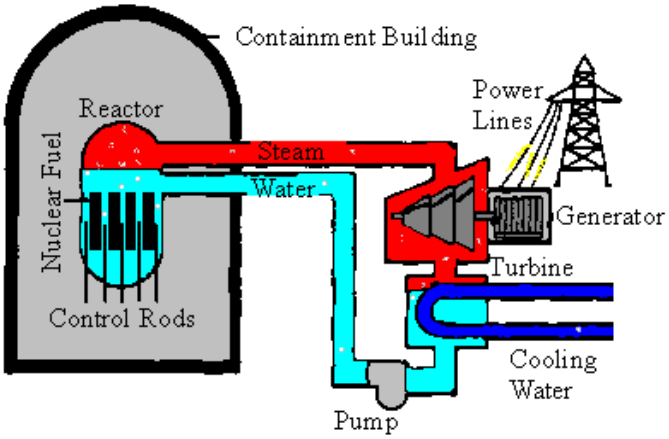
Two different light-water reactor designs are currently in use, the Pressurised Water Reactor (PWR) and the Boiling Water Reactor (BWR).

Diagram **of a PWR**

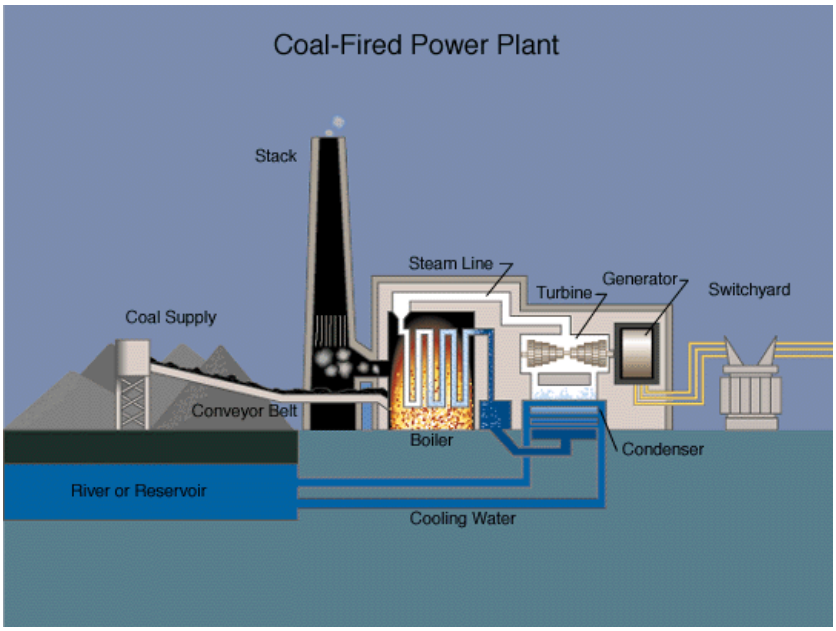


In a PWR, the heat is removed from the reactor by water flowing in a closed pressurized loop. The heat is transferred to a second water loop through a heat exchanger. The second loop is kept at a lower pressure, allowing the water to boil and create steam, which is used to turn the turbine-generator and produce electricity. Afterward, the steam is condensed into water and returned to the heat exchanger.

Diagram of a BWR



In a BWR, water boils inside the reactor itself, and the steam goes directly to the turbine-generator to produce electricity. Here, too, the steam is condensed and reused.



How a coal-fired power plant works

Electricity is produced at a coal-fired fossil plant by the process of heating water in a boiler to produce steam. The steam, under tremendous pressure, flows into a turbine, which spins a generator to produce electricity. Crude oil (called "petroleum") is easier to get out of the ground than coal, as it can flow along pipes. This also makes it cheaper to transport.

Advantages

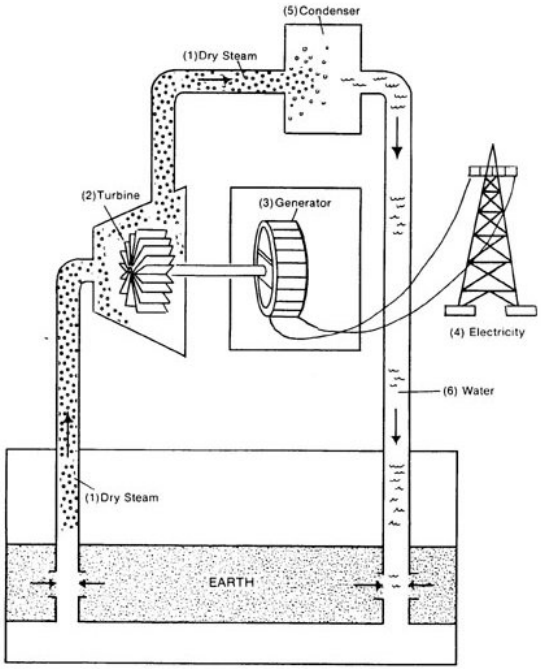
- Very large amounts of electricity can be generated in one place using coal, fairly cheaply.
- Transporting oil to the power stations is easy.
- A fossil-fuelled power station can be built almost anywhere, so long as you can get large quantities of fuel to it.

Disadvantages

- Basically, the main drawback of fossil fuels is pollution.
  Burning any fossil fuel produces carbon dioxide, which contributes to the "greenhouse effect", warming the Earth.
- Burning coal produces more carbon dioxide than burning oil or gas.
  It also produces sulphur dioxide, a gas that contributes to acid rain.
- Mining coal can be difficult and dangerous. Strip mining destroys large areas of the landscape.
- Coal-fired power stations need huge amounts of fuel. In order to cope with changing demands for power, the station has to cover a large area of countryside next to the power station with piles of coal.

Geothermal Energy

Sometimes there is natural groundwater in the hot rocks anyway, or we may need to drill more holes and pump water down to them.Water is pumped down an "injection well", filters through the cracks in the rocks in the hot region, and comes back up the "recovery well" under pressure. It "flashes" into steam when it reaches the surface.



The steam may be used to drive a turbo generator, or passed through a heat exchanger to heat water to warm houses.The steam must be purified before it is used to drive a turbine, or the turbine blades will get form lime scale and be ruined.

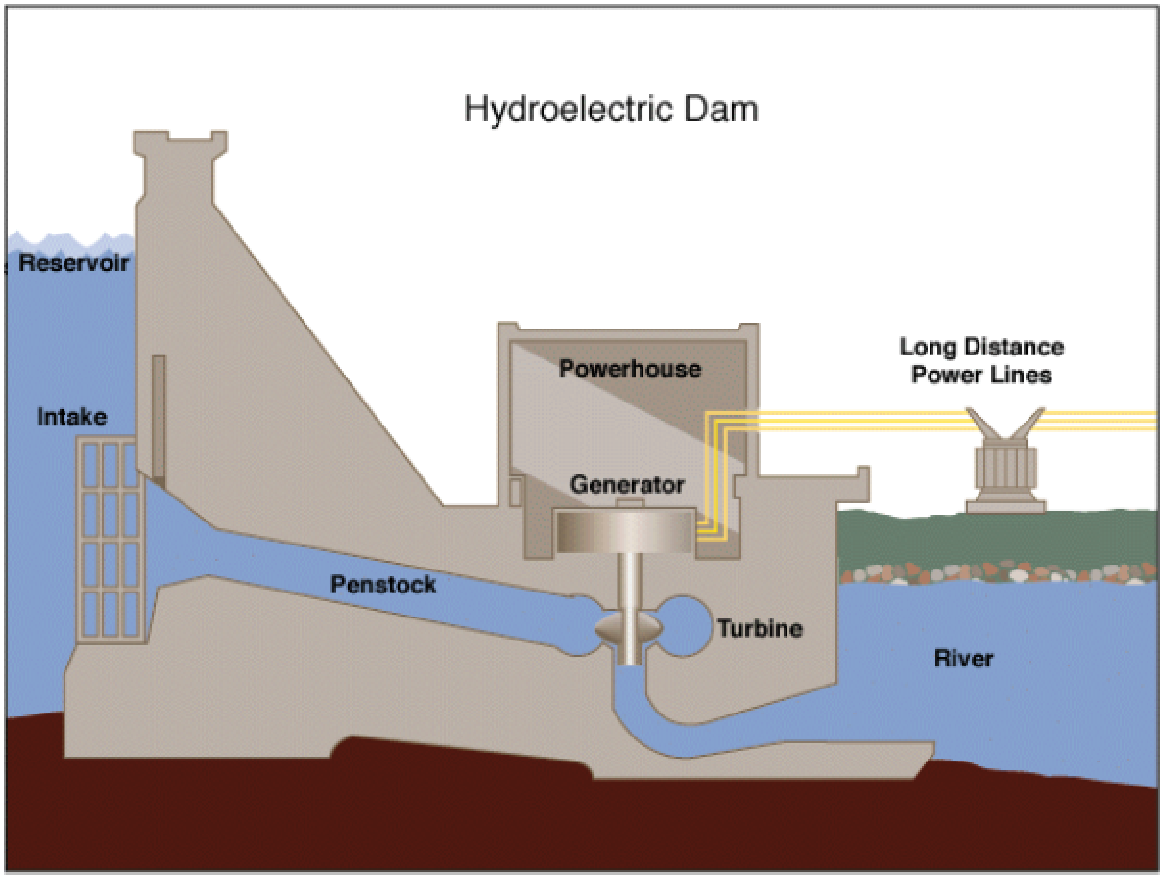
Advantages

- Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.
- The power stations do not take up much room, so there is not much impact on the environment.
- No fuel is needed.
- Once you've built a geothermal power station, the energy is almost free.
  It may need a little energy to run a pump, but this can be taken from the energy being generated.

Disadvantages

- The big problem is that there are not many places where you can build a geothermal power station.
  You need hot rocks of a suitable type, at a depth where we can drill down to them.
  The type of rock above is also important, it must be of a type that we can easily drill through.
- Sometimes a geothermal site may "run out of steam", perhaps for decades.
- Hazardous gases and minerals may come up from underground, and can be difficult to safely dispose of.

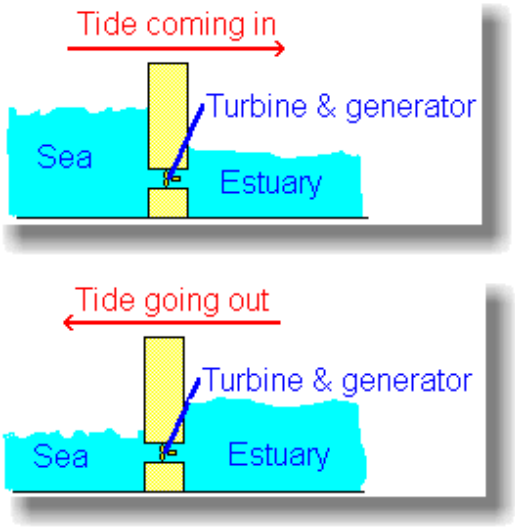
. Hydroelectric Power



What is hydroelectric power?

Water is needed to run a hydroelectric generating unit. It's held in a reservoir or lake behind the dam , and the force of the water being released from the reservoir through the dam spins the blades of a turbine. The turbine is connected to the generator that produces electricity. After passing through the turbine, the water reenters the river on the downstream side of the dam.

Tidal Energy



Tidal power works rather like a hydroelectric scheme, except that the dam is much bigger.

A huge dam (called a "barrage") is built across a river estuary. When the tide goes in and out, the water flows through tunnels in the dam.

The ebb and flow of the tides can be used to turn a turbine, or it can be used to push air through a pipe, which then turns a turbine. Large lock gates, like the ones used on canals, allow ships to pass.

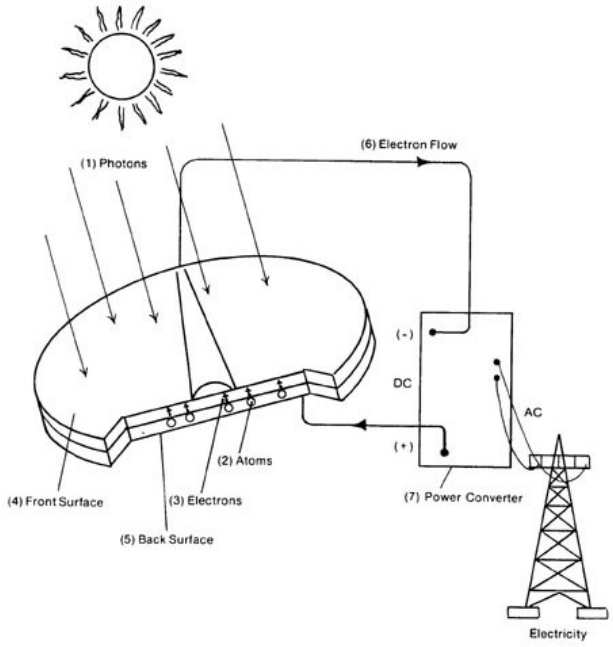
Advantages

- Once you've built it, tidal power is free.
- It produces no greenhouse gases or other waste.
- It needs no fuel.
- It produces electricity reliably.
- Not expensive to maintain.
- Tides are totally predictable.
- Offshore turbines and vertical-axis turbines are not ruinously expensive to build and do not have a large environmental impact.

Disadvantages

- A barrage across an estuary is very expensive to build, and affects a very wide area - the environment is changed for many miles upstream and downstream. Many birds rely on the tide uncovering the mud flats so that they can feed. there are few suitable sites for tidal barrages.
- Only provides power for around 10 hours each day, when the tide is actually moving in or out.

Solar Power



The photovoltaic solar cell is a semiconductor that converts light into electricity. As light strikes the surface of the cell it is absorbed and frees electrons in the top layer which are then trapped in the bottom layer. When the top and bottom layers are connected by an electric circuit, the electrons travel back to the top layer through the circuit creating an electric current.In this form of cell there are two layers of semiconductor material, one negative and the other positive. The layers are made mostly of silicon crystal with some impurities added (doping). In the top layer some of the silicon atoms (orange dots) have been replaced by an element that has one more electron such as phosphorous (green dots) which makes the layer negative (n-type layer) due to the extra electrons. In the bottom layer, some of the silicon atoms have been replaced by an element that has one less electron such as boron (red dots) which makes the layer positive (p-type layer) due to the lack of electrons. When the layers are sandwiched together, the area where they meet (junction) develops an electric charge as nearby extra electrons from the n-type layer fill nearby spaces in the p-type layer until they balance out. When a light ray (photon) hits the cell, it creates a new electron which upsets the balance as it tries to find a space to fill. The junction only lets electrons through one way, forcing them to travel out to the electric circuit in order to get back to the layer where it can find a space to fill.

Advantages

- Solar energy is free - it needs no fuel and produces no waste or pollution.
- In sunny countries, solar power can be used where there is no easy way to get electricity to a remote place.
- Handy for low-power uses such as solar powered garden lights and battery chargers

Disadvantages

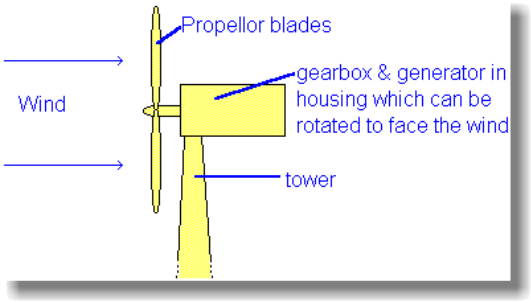
- Doesn't work at night.
- Very expensive to build solar power stations.
- Can be unreliable unless you're in a very sunny climate. In the United Kingdom, solar power isn't much use except for low-power applications, as you need a very large area of solar panels to get a decent amount of power.

Wind Energy

The Sun heats our atmosphere unevenly, so some patches become warmer than others.

These warm patches of air rise, other air blows in to replace them - and we feel a wind blowing.

We can use the energy in the wind by building a tall tower, with a large propellor on the top.



The wind blows the propellor round, which turns a generator to produce electricity.

We tend to build many of these towers together, to make a "wind farm" and produce more electricity.

The more towers, the more wind, and the larger the propellors, the more electricity we can make.

It's only worth building wind farms in places that have strong, steady winds, although boats and caravans increasingly have small wind generators to help keep their batteries charged.

Advantages

- Wind is free, wind farms need no fuel.
- Produces no waste or greenhouse gases.
- The land beneath can usually still be used for farming.
- Wind farms can be tourist attractions.
- A good method of supplying energy to remote areas.

Disadvantages

- The wind is not always predictable - some days have no wind.
- Suitable areas for wind farms are often near the coast, where land is expensive.
- Some people feel that covering the landscape with these towers is unsightly.
- Can kill birds - migrating flocks tend to like strong winds. Splat!
- Can affect television reception if you live nearby.
- Noisy. A wind generator makes a constant, low, "swooshing" noise day and night, which can drive you nuts. An entire wind farm makes quite a racket!

Natural Gas

Natural gas combined cycle power plants generate electricity using two methods, the steam cycle and the gas cycle. In the steam cycle, fuel is burned to boil water and create steam which turns a steam turbine driving a generator to create electricity. In the gas cycle, gas is burned in a gas turbine which directly turns a generator to create electricity. Combined cycle power plants operate by combining the gas cycle and the steam cycle for higher efficiency. The hot exhaust gases exiting the gas turbine are routed to the steam cycle and are used to heat or boil water. These exhaust gases typically carry away up to 70% of the energy in the fuel before it was burned, so capturing what otherwise would be wasted can double overall efficiency from 30% for a gas cycle only plant to 60% using the newest combined cycle technology.

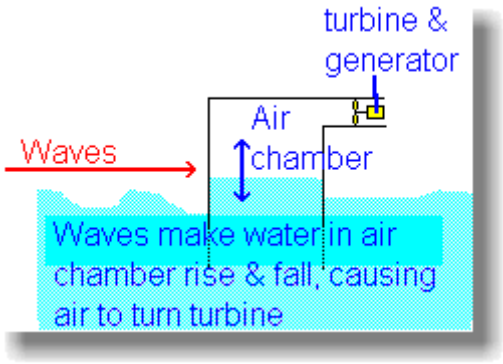
Advantages

The gas cycle has another advantage in that it can provide power within minutes after startup whereas the steam cycle takes several hours to create enough steam to drive the steam turbine. The gas turbine is useful during times of peak electricity demand when extra power must be added for a short period during the day. It can be turned on during peak demand periods to quickly add electricity to the grid and turned off when the demand drops to normal levels. The combined cycle plant takes advantage of the efficiencies of running both cycles simultaneously to produce power very cost effectively during those peak periods thereby saving the utility from having to purchase power to meet spikes in demand.

Disadvantages

Even though air pollution concerns are much lower with gas fired plants, there are other environmental concerns including water use and water pollution. Combined cycle plants use about 10 million gallons of water per day, consuming 7 million and putting 3 million gallons back into nearby rivers.

Wave Energy



There are several methods of getting energy from waves, but one of the most effective works like a swimming pool wave machine in reverse. At a wave power station, the waves arriving cause the water in the chamber to rise and fall, which means that air is forced in and out of the hole in the top of the chamber. We place a turbine in this hole, which is turned by the air rushing in and out. The turbine turns a generator. A problem with this design is that the rushing air can be very noisy, unless a silencer is fitted to the turbine. The noise is not a huge problem anyway, as the waves make quite a bit of noise themselves.

Advantages

- The energy is free - no fuel needed, no waste produced.
- Not expensive to operate and maintain.
- Can produce a great deal of energy.

Disadvantages

- Depends on the waves - sometimes you'll get loads of energy, sometimes nothing.
- Needs a suitable site, where waves are consistently strong.
- Some designs are noisy.
- Must be able to withstand very rough weather.