Fission

Conventional power stations burn coal, oil or gas to produce steam which drives turbines which in turn drive generators to produce electricity. British Energy's power stations work on the same principle, but use the heat from a nuclear reaction known as 'fission'.

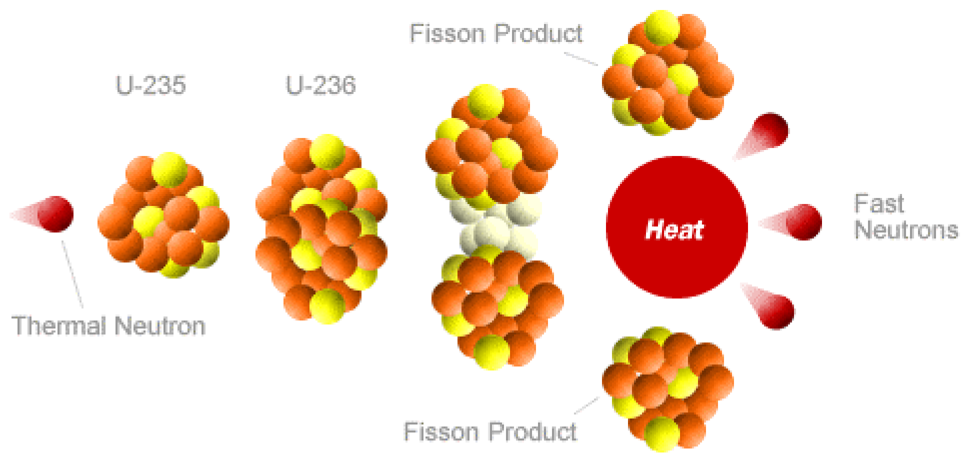
During the 1930s, scientists all over the world were experimenting with nuclear particles. However, nuclear fission wasn't discovered until 1938 by the German scientist Otto Hahn, working in Berlin with his colleagues Fritz Strassman and Lise Meitner.

Hahn had concentrated his experiments on uranium and it was his discovery of the peculiar behaviour of one of the isotopes, uranium-235 (U-235), which led to him being the first person to split the atom – an achievement which earned him the 1944 Nobel Prize in Chemistry.

Uranium 235 is, by atomic standards, a huge atom. Its name comes from the fact its nucleus consists of 235 particles – 92 protons and 143 neutrons. Atoms at the top end of the atomic scale, such as uranium, are so large that their nuclear forces can only just hold them together. As they break up they emit radioactivity including neutrons.

Uranium in its natural form gives off neutrons slowly, but adding another slow moving neutron into the nucleus of the atom can speed up the process. The extra particle overwhelms the nuclear forces holding the original particles together and causes fission. For this reason uranium is said to be a 'fissile' material.

Nuclear **Fisson**



During fission the uranium atom splits into two roughly equal parts, known as 'fission products'. Spare neutrons are also released, along with heat from the energy holding the atom together. In isolation this process isn't very helpful as the heat released is very small and the spare neutrons move too quickly to be useful.

Using a moderator such as water or graphite slows the neutrons so they're more likely to interact with other uranium atoms. This means the fission process can go on indefinitely in what is called a chain reaction. This is maintained by choosing the correct the amount of moderator so that the number of neutrons generated by fission is greater than the number lost.

However, the chain reaction can only be sustained if 'criticality' can be achieved. This means that the quantity of uranium must be large enough to maintain the chain reaction within itself. The amount of fissile material that must be assembled to achieve criticality is known as the 'critical mass.'

If the amount of uranium is greater than the critical mass, the chain reaction can progressively increase. This is obviously no use for a reactor where we need a steady, controlled chain reaction to produce a constant heat and a consistent electrical output. To achieve this control rods made from materials like boron, which can absorb excess neutrons without becoming radioactive, are used to control the chain reaction.

So, to achieve a controlled chain reaction, you need a 'core' containing more than the critical mass of fissile material, surrounded by a moderator, with a neutron absorber present for control.

In a nuclear reactor the chain reaction is started by gradually withdrawing the control rods, increasing the number of free neutrons. When the number of neutrons lost is slightly less than the average number of neutrons produced, a chain reaction is established. The position of the control rods is then varied to maintain a steady reaction, which controls the heat output of the reactor and, therefore, the electrical output of the station.

Controlling the reactor is not solely dependant on the control rods. A reactor must be able to shut down immediately if a fault develops which threatens its safety. This is achieved by introducing other neutron absorbing material in the form of a gas or liquid, which provides a diverse means to reduce the number of free neutrons so that the chain reaction stops.

This is what takes place in a modern nuclear reactor. It's fascinating to learn that naturally-formed reactors – created over two billion years ago when ground water collected within rock containing uranium – were discovered in 1972 in Oklo in Gabon, West Africa by French physicist Francis Perrin. Sixteen of these so-called 'Fossil Reactors' have been found so far.