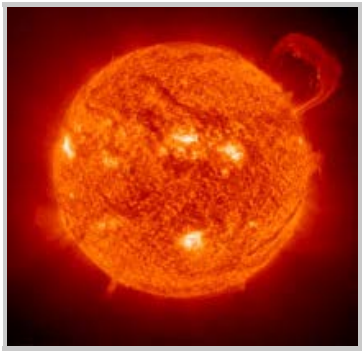
UNDERSTANDING FUSION

- What is Fusion?
- Technology
- Merits
- Fusion in Culture
- ITER
- Broader Approach
- DEMO
- Glossary of Terms

What is Fusion?

The greatest increase in demand for energy is envisaged to come from developing countries where, with rapid urbanisation, large-scale electricity generation will be required. With environmental requirements for zero or low CO_2 emission sources and the need to invest in a sustainable energy mix, new energy sources must be developed. Fusion will be available as a future energy option by the middle of this century, and should be able to acquire a significant role in providing a sustainable, secure and safe solution to tackle European and global energy needs.

Fusion is the process which powers the sun and the stars. It is energy that makes all life on earth possible. It is called 'fusion' because the energy is produced by fusing together light atoms, such as hydrogen, at the extremely high pressures and temperatures which exist at the centre of the sun (15 million ºC). At the high temperatures experienced in the sun any gas becomes plasma, the fourth state of matter (solid, liquid and gas being the other three).



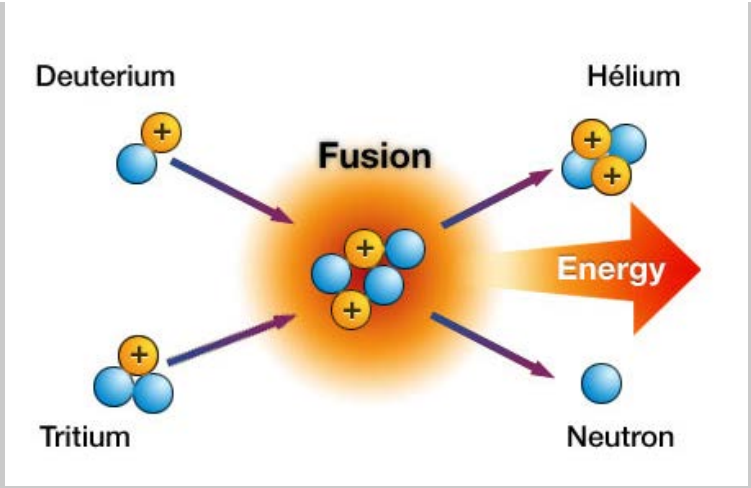
Inside the sun, fusion reactions take place at very high temperatures and enormous gravitational pressures

Plasma can be described as an 'electrically-charged gas' in which the negatively charged electrons in atoms are completely separated from the positively charged atomic nuclei (or ions). Although plasma is rarely found on earth, it is estimated that more than 99% of the universe exists as plasma.

In order to replicate this process on earth, gases need to be heated to extremely high temperatures of about 150 million degrees ºC whereby atoms become completely ionised. The fusion reaction that is easiest to accomplish is the reaction between two hydrogen isotopes: deuterium, extracted from water and tritium, produced during the fusion reaction through contact with lithium. When deuterium and tritium nuclei fuse, they form a helium nucleus, a neutron and a lot of energy.

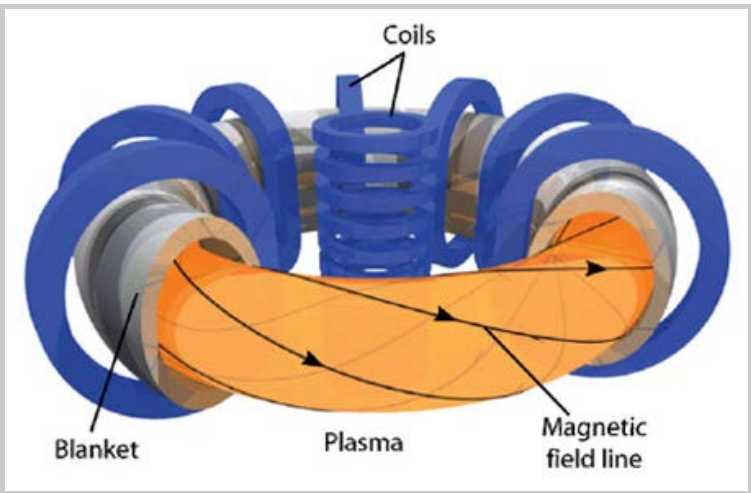
FACT SHEETS

- Towards a sustainable energy mix
- What is Fusion?
- The European Fusion Programme
- JET
- What is ITER?
- What is Fusion for Energy?
- What is the European contribution to ITER?
- The Broader Approach
- DEMO

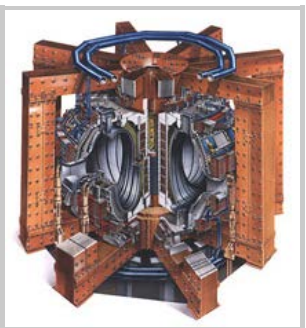


Two atoms, deuterium and tritium, fuse together, forming a helium nucleus, a neutron and lots of energy

Scientists have built devices able to produce temperatures more than ten times higher than those in the sun. To reach these temperatures there must first be powerful heating, and thermal losses must be minimised by keeping the hot fuel particles away from the walls of the container. This is achieved by creating a magnetic “cage” made by strong magnetic fields which prevent the particles from escaping. For energy production this plasma has to be confined for a sufficiently long period for fusion to occur.



In a tokamak the plasma is held in a doughnut-shaped vessel. Using special coils, a magnetic field is generated, which causes the plasma particles to run around in spirals, without touching the wall of the chamber. (Image courtesy of EFDA).



Jet - Assembly (source EFDA-JET)

The most developed configuration at present is the tokamak , a Russian word for a torus shaped magnetic chamber. Scientists have succeeded in producing gas with temperatures ten times higher in fusion devices. Megawatts of power have been produced for a few seconds. In Europe, this has been achieved in the Joint European Torus (JET), the world's largest fusion device which currently holds the world record for fusion power.

Nearly 2000 scientists and engineers are currently working on a broad range of fusion R&D projects in more than 20 laboratories, including JET.

Fusion energy has the potential to provide a sustainable solution to European and global energy needs. ITER, which means the way in Latin, is an international collaboration on an experimental facility. It is the world’s greatest energy project which aims to demonstrate that fusion can be part of the solution by improving our energy mix to

meet the global energy needs.