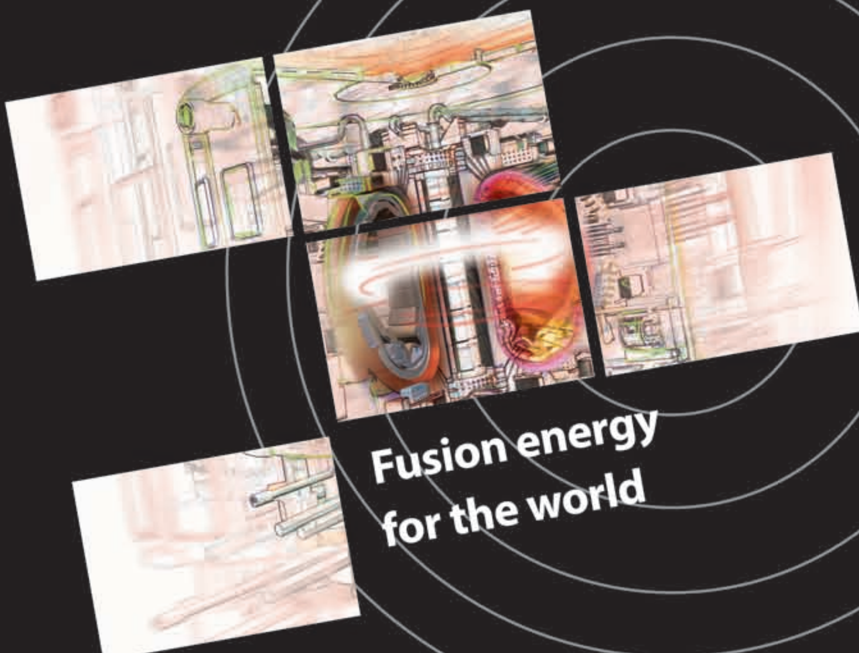
European research in action

ITER



Fusion energy for the world

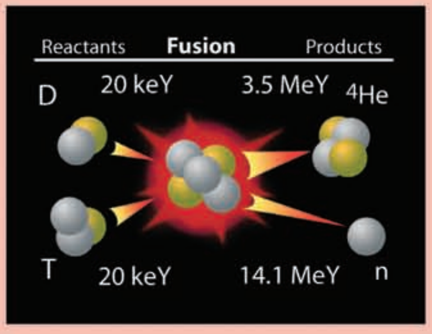
Energy – securing a safe supply for the future

Securing future energy supply is the major challenge for Europe and the world. Today's society depends on a constant and reliable supply of energy. But our main sources of fuel, such as oil and gas, are becoming scarcer, more expensive and are contributing to greenhouse gas emissions – the chief cause of global warming.

Global energy demand may double over the next 50 years as people in developing countries become wealthier. Where will we find the clean, safe and secure energy that future generations will need around the world? A balanced energy mix, including renewable technologies, will be necessary to satisfy future needs. We must develop new sustainable energy sources that can deliver continuous, large-scale power for the long term without harming the environment.

Fusion: towards an international energy solution

Fusion energy has the potential to provide a sustainable solution to European and global energy needs. Scientists have embarked on the next step towards realising this potential in an international collaboration for an experimental fusion facility called ITER. This is the biggest scientific project for energy research in the world and is being built in Europe.



Fusion is the process that powers the sun – it is fusion energy that makes all life on earth possible. Fusion releases energy as a result of two light atoms such as hydrogen joining together to form a helium atom. Unlike nuclear fission, which involves splitting very heavy atoms to release energy.
Inside the sun hydrogen collides and fuses together at extremely high temperatures (about 15 million °C) and enormous gravitational pressures: 600 million tonnes of hydrogen is fused to helium every second.

On earth, fusion will be reproduced on a smaller scale than the sun! But the smaller scale also means that the temperatures involved must be ten times higher to make it an energy source. This is a significant challenge and will involve scientists and engineers from all over the world working together.



Advantages of fusion

On earth, the fuel for fusion reactors will be two forms (isotopes) of hydrogen gas: deuterium and tritium. There are around 33 milligrammes of deuterium in every litre of water. If all the deuterium in a litre of water was fused with tritium it would provide energy equivalent to 340 litres of petrol! The natural resources of tritium on earth are extremely low, therefore it will be produced inside the fusion reactor from lithium, an abundant metal.

As well as using an almost limitless fuel supply, no transport of radioactive materials would be needed for the day-to-day running of a fusion power plant. The plant will be inherently safe, with runaway or meltdown accidents impossible.
The fusion process will not create greenhouse gases or long-lasting radioactive waste. Fusion power will offer a continuous base-load power supply that is sustainable and large scale.

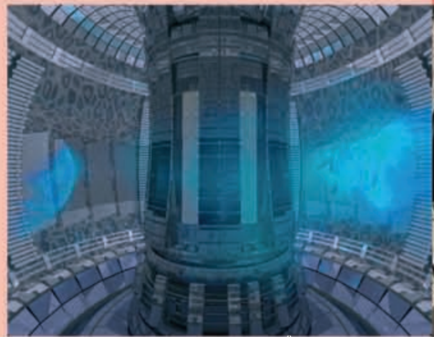
Tokamak technology

To produce fusion, the tritium and deuterium must be heated to 150 million ºC. This results in a high-temperature, electrically charged gas called plasma. For continuous fusion power, the plasma must be controlled, heated and contained using powerful magnetic fields.

At the heart of the ITER experiment will be the world's largest tokamak. A tokamak is a torus or doughnut-shaped device, essentially a continuous tube. The first tokamak was conceived in Moscow in the 1960s and was designed specifically to create an intricate but ingenious magnetic cage to confine the high-energy plasma.

European expertise

*Europe has been a leader in fusion research for over 50 years.
All of Europe's fusion research is coordinated by the European Commission. Funding comes from the Community's Euratom Research Framework Programme and national funds from the EU Member States and Switzerland. The coordination and the long-term continuity is ensured by contracts between Euratom and the national partners. This joint approach has allowed all European countries to participate and contribute to the largest and currently most successful fusion experiment in the world – JET (the Joint European Torus). The basic design of ITER follows on from that of the JET device.*




ITER

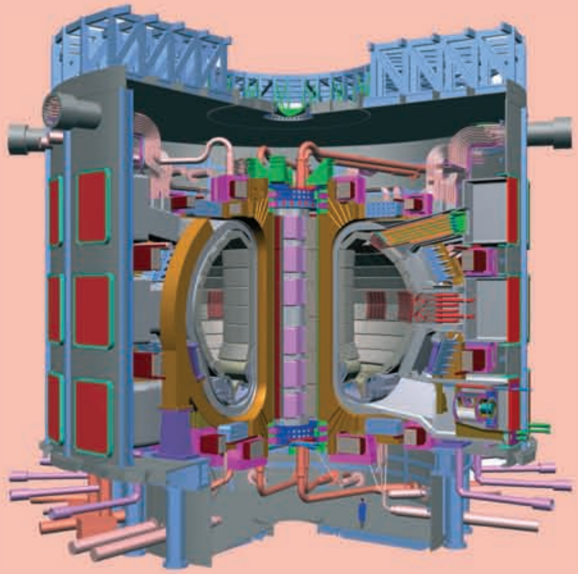
ITER will have a tokamak capable of generating 500 million watts (MW) of fusion power continuously for up to 10 minutes. It will be 30 times more powerful than JET, and very close to the size of future commercial reactors. The ITER project will, for the first time, allow scientists to study the physics of a burning plasma – a plasma that is heated by internal fusion reactions rather than external heating. It will demonstrate and refine the key technologies for developing fusion as a safe and environmentally benign energy source.

ITER will provide the basis for constructing a demonstration electricity-generating power plant. It is the crucial next step to achieving the goal of fusion energy.

The ITER experiment will generate ten times more power than is required to produce and heat the hydrogen plasma. It will test the heating, control, diagnostic and remote maintenance systems that will be needed in a real power station. ITER will also test systems to refuel the plasma and extract impurities.

DEMO

Many of the components tested in ITER will be used in a future demonstration power plant (DEMO). In parallel with the realisation of ITER, advanced fusion materials research will contribute to the technology solutions needed for DEMO and the first commercial fusion power plants.



ITER – an international venture

The ITER project has a 35 year experimental lifetime. It is a massive undertaking on the road to fusion power. Its results are of critical international interest and it is, therefore, a truly global project.

The idea of ITER as an international experiment was first proposed in 1985 and started as a collaboration between the former Soviet Union, the United States, the European Union and Japan under the auspices of the International Atomic Energy Agency (IAEA).

Today, the international consortium consists of the People's Republic of China, the European Union, India, Japan, the Republic of Korea, the Russian Federation and the United States.

Collaboration

ITER is a multinational collaboration between countries involved in fusion research worldwide. It operates by consensus among the participants. In a way, it extends the European research and development model that has enjoyed success in the Euratom fusion programme with JET to the whole world.

Conceptual and engineering studies for ITER led to a detailed design which was underpinned by a large research programme that has established the feasibility of ITER and involved industry for the construction of full-scale prototypes of key ITER components. Collaboration between the ITER parties is progressing well and construction of the ITER site is well under way.

The ITER project requires a wide range of highly skilled staff such as fusion scientists and engineers, administrators, lawyers and procurement officers.

The challenges

Building and operating ITER is a huge international challenge for science, engineering and technology . This has built on the leading fusion experiments, such as Euratom's JET, JT-60 in Japan and TFTR in the US, and the fusion experiments in the Euratom programme: all have provided expertise and data in fusion physics and technology in preparation for ITER.

The scientific challenge is great, but the global need for such a clean and sustainable energy source is even greater!

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ITER at Cadarache

ITER is being built in Cadarache, Southern France. The location was chosen from a shortlist of four possible sites around the world.

The construction site covers a total surface area of about 40 hectares with another 30 hectares available temporarily for use during building.

Key requirements for the ITER site included thermal cooling capacity of around 450 MW and an electrical power supply of up to 120 MW.

The headquarters of Fusion for Energy (F4E), the European Union's organisation responsible for providing Europe's contribution to ITER, are located in Barcelona, Spain.

More information

- **ITER**: www.iter.org
- **European Commission (energy section)**:
  www.ec.europa.eu/research/energy/
- **F4E**: www.fusionforenergy.europa.eu
- **EFDA**: www.efda.org
- **JET** : www.jet.efda.org

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