Frequently Asked Questions

What is fusion?

Fusion is the process which powers the sun and the stars. When light atomic nuclei fuse together to form heavier ones, a large amount of energy is released. This is a very difficult process to recreate on earth - gases need to be heated to extremely high temperatures (about 100 millions degrees C) to produce a plasma which then needs to be contained for a sufficiently long period for fusion to occur. 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. Harnessing fusion would provide an environmentally friendly and almost limitless source of energy.

Is fusion a reliable energy source?

Energy will become a major issue in the 21st century to ensure the development of humankind. All options that preserve our environment need to be considered and should be placed at the disposal of succeeding generations. Fusion presents several advantages (intrinsic safety, abundance and geographical availability of fuel, no emission of greenhouse gas, no high activity nuclear waste) that must be considered for the energy mix of tomorrow. One should therefore keep the fusion option open.

What are the attractions of fusion as an energy source?

The key advantages are:

- It could provide a large-scale energy source with basic fuels which are abundant and available everywhere;
- Very low global impact on the environment – no CO2 greenhouse gas emissions;
- Day-to-day-operation of a fusion power station would not require the transport of radioactive materials;
- Power Stations would be inherently safe, with no possibility of “meltdown” or “runaway reactions”;
- There is no long-lasting radioactive waste to create a burden on future generations.

Is fusion safe?

A fusion reactor is like a gas burner – the fuel which is injected into the system is burnt off. There is very little fuel in the reaction chamber at any given moment (about 1g in a volume of 1000 cubic metres) and if the fuel supply is interrupted, the reactions only continue for a few seconds. Any malfunction of the device would cause the reactor to cool and the reactions would stop. In fact the difficulty to create fusion reactions has been the challenge facing researchers since the 1950's.

The basic fuels - deuterium and lithium – and the reaction product - helium - are not radioactive. The intermediate fuel – tritium – is radioactive and decays very quickly, producing a very low energy electron (Beta radiation). In air, this electron can only travel a few millimetres and cannot even penetrate a piece of paper. Nevertheless, tritium would be harmful if it entered the body, so the facility will have very thorough safety systems and procedures for the handling and storage of tritium. As the tritium is produced in the reactor chamber itself, there are no issues regarding the transport of radio-active materials.

Extensive safety and environmental studies have led to the conclusion that a fusion reactor could be designed in such a way to ensure that any in-plant incident would not require the evacuation of the local population.

What will be the environmental impact of fusion energy?

The energy generated by the fusion reactions will be used for the same purposes as current sources of energy, such as generation of electricity, heat for industrial use or the production of hydrogen.

The fuel consumption of a fusion power station will be extremely low. A 1 GW fusion plant will need about 100 Kg of deuterium and 3 tons of natural lithium to operate for a whole year, generating about 7 billion kWh, with no greenhouse gas or other polluting emissions. To generate the same energy, a coal-fired power plant (without carbon sequestration) requires about 1.5 million tons of fuel and produces about 4-5 million tons of CO_2.

The neutrons generated by the fusion reaction cause radioactivity in the materials surrounding the reaction – such as the walls of the container etc. A careful choice of the materials for these components will allow them to be released from regulatory control and possibly recycled about 100 years after the power plant stops operating. Waste from fusion plants will not be a burden for future generations.

What is Euratom?

Fusion research in Europe is organised through a coordinated programme which makes effective use of all the knowledge and resources. This programme is managed by the European Commission under the auspices of the Euratom Treaty – one of the founding Treaties of the European Communities signed in 1957. This joint approach has allowed the development of the largest and most successful fusion experiment in the world – JET (the Joint European Torus) which has formed the basis for the design of ITER and started out as a Joint Undertaking similar to 'Fusion for Energy'.

What is ITER?

ITER, meaning “the way” in latin, is a major international experiment with the aim of demonstrating the scientific and technical feasibility of fusion as an energy source. It will be 30 times more powerful than the Joint European Torus (JET) which is currently the largest comparable experiment operating in the world. ITER will allow scientists and engineers to develop the knowledge and technologies needed to develop demonstration electricity producing fusion power stations.

Who are the Seven Parties to ITER?

The seven international Parties that are co-operating to develop ITER are: China, EU, India, Japan, Russia, South Korea, and the United States. Collectively the parties taking part in the ITER Project represent over one half of the world’s population and a diverse range of economies. The ITER Agreement is open for accession by or co-operation with other countries that have demonstrated a capacity for specific technologies and knowledge and are ready to contribute to the project.

Why is it important to undertake this project with seven international Parties?

It is a very important step to bring together the most advanced nations in the world to co-operate in the development of a major potential new technology. The challenges of the ITER project require the best technological and scientific expertise, which can best be harnessed by pooling resources globally. By working together, the seven parties are committing themselves to a global response to a global challenge – assuring sustainable energy resources. By ensuring the best possible knowledge is put into ITER, it will be all the more likely that a viable energy source will emerge at the end of the project. In view of the importance of sustainable energy supply for the world’s economic development, it is fitting that the ITER Parties now represent more than half of the world’s population.

How will ITER be financed?

The ITER project will be undertaken by the ITER Organisation established by the ITER Agreement. The members of the Organisation will be the Parties to the Agreement; who will together bear the costs of ITER. For the construction of the ITER device, most of the components will be contributed by the members “in kind” (i.e. by providing directly the components themselves, rather than the financing for them). The EU as host Party will contribute up to about 50% of the construction costs and the other parties will each contribute up to 10%.

Is ITER a good investment?

ITER is financed by seven parties, including the EU with its 27 member states. The cost of the project, spread over more than 30 years between these seven partners, is modest with respect to research expenditure in each party. In the EU for example, it is less than the budget for the effort in the renewable energies. It is a drop in the ocean compared to the market of the energy in the world, which is today about 3000 billion dollars per year. ITER is a research programme and so by definition its results cannot be guaranteed. But the progress made in fusion in recent years and the wide-ranging studies made for ITER offer high confidence in its success. For instance, extrapolations of ITER performance are based on observations over more than three orders of magnitude and prototypes of the main components for ITER have been successfully built and tested to validate the main technologies involved in ITER.

What are “in kind” contributions used for ITER and how will it work?

The idea behind the “in kind” contributions is that each of the parties to the ITER project will make contracts with their industries and research organisations to build parts of the ITER experiment. Europe, for example, will have to develop some of the largest parts such as the superconducting magnets. The parts will then be transported to France and the machine assembled. The advantage of the in kind contributions rather than in cash is that the contributions do not depend upon the value of the currency in the respective countries.

Where is ITER being built and what is happening there now?

In June 2005, after long negotiations, the ITER Parties decided to select the EU’s proposal of Cadarache in the south of France as the site for ITER. Cadarache already hosts the world’s largest super-conducting fusion experiment "Tore-Supra" at the CEA's Research Centre, one of the biggest civil nuclear research centres in Europe. The site therefore has technical support facilities and expertise to support the construction of the ITER project.

The ITER Agreement was signed in Paris on the 21st November 2006 and at the time of writing (July 2007) has been ratified (or approved depending on local requirements) by the governments of six of the parties (EU, Japan, Korea, India, the US and Russia).

The Nominee Director-General of the Project, Kaname Ikeda, and his principal deputy, Norbert Holtkamp are assembling the international team that will take responsibility for managing the ITER construction in Cadarache. Six Deputy Director Generals have also been appointed including Carlos Alejaldre from Spain who has responsibility for safety and security.

The preparation of the ITER site started at the end of January 2007. Until October 2007, a site of 180 hectares next to the Cadarache site will be prepared for the construction of ITER, under the supervision of the Agence ITER France. The first stage is the clearing of a forested zone of 90 hectares. The aim is to keep as much of the ITER site wooded as possible and to minimize the environmental impact of this work, which is overseen by the Office National des Forêts.

What does hosting ITER mean for Europe?

By hosting ITER, the EU will maintain its position at the forefront of fusion research. The existence of such a high technology, cutting edge research facility in the EU will have considerable benefits for EU industry. We have seen from past experiments in this field and in other areas (e.g. CERN for particle physics) that participation in such projects has kept the best and brightest scientists in Europe, who have gone on to develop highly innovative projects that bring considerable value for the companies for which they work and EU industry in general.

The EU has established a new European organisation in Barcelona known as 'Fusion for Energy', in the form of a Joint Undertaking which is responsible for providing all of Europe's contributions to the ITER Organisation, including the procurement and transfer of contributions in kind, the assignment of qualified staff and financial contributions to the budget of the ITER Organisation. This existence of Fusion for Energy will further enhance Europe's position in fusion, in particular, to position industry in view of realising the first demonstration fusion power plants.

What are the opportunities for people to work in the Joint Undertaking?

Many opportunities are expected for highly qualified engineers and scientists as well as administrative and other support staff employed under attractive and stable conditions. In the beginning a staff of about 100 professionals is anticipated but this is expected to grow as the organisation's workload increases. Interested profiles should regularly check our job opportunities.

How can we make sure that all these different parts of the fusion programme: Associations, EDFA, JET and the Joint Undertaking work together?

Thanks to the Euratom Treaty and the support of successive Research Framework Programmes, a very integrated system of fusion research has been created in Europe. By virtue of this system, it is possible to examine the work that is being planned by the different players and make sure that they are in harmony with one other. In that sense the Joint Undertaking will be another "instrument" of the fusion programme albeit a very important one.