**MEMO/06/216**

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# ITER and fusion energy research – your questions answered

***ITER, a project to demonstrate the potential of fusion as an energy source, will be the world's biggest scientific collaboration of its kind and involve countries representing over half the world's population. The 7 Parties engaged in the project met in Brussels on 24 May 2006 to confirm the agreements negotiated over the past year, following the decision to select the site for the construction and operation of ITER in Europe at Cadarache in southern France. This background note aims to answer major questions on the agreement, and the project in general.***

## What is ITER?

ITER is an experimental reactor which will reproduce the physical reaction - fusion - that occurs in the sun and stars. Existing experiments have already shown that it is possible to replicate this process on Earth. ITER aims to do this at a scale and in conditions that will demonstrate the scientific and technological feasibility of fusion as an energy source.

## What is fusion?

When the nuclei of light atoms come together at very high temperatures, they fuse and this produces enormous amounts of energy. In the core of the sun or a star, the huge gravitational pressure allows this to happen at temperatures of around 10 million degrees Celsius.

At the much lower pressures that we can produce on Earth, temperatures to produce fusion need to be much higher – above 100 million degrees Celsius. 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 "cage" made by strong magnetic fields, which prevent the particles from escaping. The development of the science and technology involved in this process is the basis of the European fusion programme.

## 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 radio-active 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 m3) 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.

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 facilities 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 plan (without carbon sequestration) requires about 1.5 million tons of fuel and produces about 4-5million tons of $CO_2$.

The neutrons generated by the fusion reaction cause radio-activity 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 stop operating. Waste from fusion plants will not be a burden for future generations.

## 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. The negotiations take place under the auspices of the International Atomic Energy Agency (IAEA). Canada was earlier a party to the negotiations, but withdrew in December 2003.

## What was done in Brussels on 24 May and what happens next?

At the Brussels meeting the representatives of the seven Parties undertook the final act of the Negotiations that have been in progress since November 2001, by initialling the Texts that they have developed jointly. With this major milestone passed, each of the Parties will submit the Agreement and related documents to their respective authorities in order to secure the authorisation to sign the Agreement. It is hoped that it will be possible for all Parties to complete this procedure before the end of this year.

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

It is clearly 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.

## Will other countries be able to participate?

Since its very beginning, development of ITER has taken place under the auspices of the United Nations International Atomic Energy Authority. The ITER Agreement, once finalised, will be open for accession by or co-operation with other countries who have demonstrated a capacity for specific technologies and knowledge and are ready to contribute to the project.

## How much will ITER cost?

ITER construction costs are estimated at 4.57B€ (at 2000 prices), to be spread over about ten years. Estimated total operating costs over the expected operational lifetime of about twenty years are of a similar order.

## 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%.

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

In June 2005, after long negotiations, the ITER Parties decided to designate 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 Cadarache Research Centre, one of the biggest civil nuclear research centres in Europe and so the site has existing technical support facilities and expertise, which may be used to support the construction of the ITER project.

A special site for joint technical work has already been set up at Cadarache. The Nominee Director-General of the Project, Kaname Ikeda, and his principal deputy, Norbert Holtkamp have been selected by the Parties and are starting to assemble the international team that will take responsibility for managing ITER Construction one the Agreement enters into force.

In accordance with French planning regulations, an extensive Public Debate on the project has taken place over recent months. The public hearings have been completed and the responsible Committee is preparing its conclusions.

## 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 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 is establishing a new European organisation in Barcelona, in the form of a Joint Undertaking which will be 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.

See also: IP/06/676