



EUROPEAN
COMMISSION

Community Research

FUSION ENERGY

TOWARDS A SUSTAINABLE, LARGE-SCALE ENERGY SOURCE

European research on fusion is leading the way to a new source of energy for large-scale electricity production free from emissions of greenhouse gases. The European Union, in an international collaboration, is preparing for the demonstration of the scientific and technological feasibility of fusion in conditions comparable to those in a real power plant.

Joint efforts are being made towards the possible construction of this "Next Step" experiment. Coordination and integration among European fusion laboratories is being strengthened. Power plant oriented research and development and socio-economic evaluations are being advanced.

European fusion research is based on a well-established network of centres of excellence and demonstrates just how a European Research Area can provide scientific world leadership.



Background

The growth of the world's population and rising living standards in many developing countries mean that worldwide energy demand is set to increase in the coming decades. Europe needs to develop its own energy supply in order to limit dependence on energy imports. The role of energy R&D is to ensure that future generations will have a balanced choice of energy supply technologies to satisfy their needs in a sustainable manner. Fusion offers the possibility of an environmentally friendly, secure, long-term energy option.

Fusion offers some important advantages:

- The basic fuels (deuterium and lithium) are abundant everywhere;
- No greenhouse gas emissions;
- Day-to-day operation of a fusion power station does not require the transport of radioactive materials;
- Fusion power stations can be made inherently safe. "Runaway" or "meltdown" accidents are impossible; and
- Waste will not prove to be a long-term burden on future generations.

State of the art

Building on the success of the *Joint European Torus* (JET), Europe and its international partners are ready to build the next generation device. *ITER* is an international research and development project for the demonstration of the feasibility of fusion. It is the next major step in the development of fusion energy. The completion of the *ITER* design already represents a remarkable scientific achievement made possible by close collaboration between hundreds of leading scientists from research centres, universities and industries all around the world. Experiments in many fusion devices worldwide have provided a solid physics base for extrapolation to the *ITER* scale. Key high-tech components (such as large superconducting coils) have been developed by industry and tested to the point of readiness for production. The first complete design of a fusion device of power station dimensions is therefore based on well-established physics and proven technology.

The *ITER* design provides a detailed plan ready for implementation. As well as meeting demanding technical challenges, this global collaboration has broken new ground by demonstrating that the work of geographically spread, multicultural teams can be coordinated on such a large scale.

Rationale and objectives for future research and development

To guarantee a long-term, safe, environmentally friendly energy supply in a scenario with a growing world population is the driver for Europe and its global partners to pursue the development of fusion as a future energy option.

A European long-term policy on energy and energy research must ensure the availability of a sufficient range of large-scale options for commercially viable energy supply, in a 30- to 50-year time frame.

The results from the major "Next Step" experiment will form the basis for the construction of a demonstration device, producing significant amounts of electricity and demonstrating safe and reliable fusion power production. Fusion could then become a significant energy source for the second half of this century.



Research and development priorities for the Sixth Framework Programme (FP6)

The priority in FP6 is to make progress towards demonstrating the scientific and technological feasibility of fusion energy and assessing its sustainable qualities.

In line with the reactor orientation of Community activities in fusion research, worldwide collaboration has progressed to the design of a Next Step device, ITER, with the objectives of operating at conditions relevant to energy production. Its construction could start during FP6.

The joint exploitation of JET and the specialised fusion devices in the Fusion Associations will aim at preparing ITER operation and consolidating its scientific basis. Work in the Associations will include fusion physics and technology (mainly in support of ITER) and studies of the economics and social acceptability of fusion energy.

European added value

Europe is at the forefront of international fusion research. This has been achieved thanks to wide-ranging coordinated efforts in all the EU countries within a single and well-integrated European programme, ensuring that research activities are synergetic and complementary. Projects too large for any individual Member State, such as JET, have been undertaken jointly.

All the EU Member States, plus Switzerland and the EU candidate countries which have associated to FP6-Euratom (Bulgaria, the Czech Republic, Hungary, Latvia, Romania, the Slovak Republic and Slovenia), participate in the European fusion programme. Fusion research carried out in laboratories in the Member States is partly financed at the Community level. The budget for fusion research in the Sixth Framework Programme is €750 million, including up to €200 million for the possible construction of ITER. Close to 2000 scientists and engineers are working on a broad range of fusion R&D projects in more than 20 laboratories, including JET.

Implementation modalities

The European Commission manages the programme through two mechanisms:

- 21 Contracts of Association with Member States (or institutions therein), Switzerland and some of the countries that are candidates for EU membership and are associated to the Euratom Framework Programme;
- the European Fusion Development Agreement (EFDA) which is responsible for the exploitation of the JET facilities, international collaboration in support of ITER and technology RTD.

The Contracts of Association are the principal means of implementing the fusion programme. They provide funding to fusion for defined research work packages within the overall European R&D programme. Contracts also promote mutual access to major facilities and mobility of researchers to and from large and small experimental facilities. Specific support encourages the smaller Associations to participate in the larger experiments; for example by developing, installing and exploiting auxiliary hardware on large facilities.

Collaboration is further promoted by support for the exchange of personnel. In addition, the training and mobility of the young researchers is supported by Marie-Curie fellowships.

Countries participating in the European fusion programme



Examples of fusion projects

ITER – the way ahead

The ITER (meaning “the way” in Latin) project is a unique model for effective international collaboration in science and technology. Its goal is to demonstrate the feasibility of fusion for the development of an attractive energy source for our planet.

Fusion physics at JET

Since coming into operation in 1983, JET has established itself as the world’s largest and highest performance fusion experiment. In 1997, it set the world record for fusion power production of 17 megawatts, a record which will stand until ITER is built!



(Courtesy of EFDA)

High-tech component for ITER

The major components of ITER have been successfully tested. An example is a model one of the Toroidal Field Coils needed for plasma magnetic confinement. These coils, based on a niobium tin alloy, represent a significant step in superconducting technology. Manufacturing feasibility at the required tolerances has been demonstrated by a consortium of European industries. The test of the model coil at the Toska facility (Forschungszentrum Karlsruhe, Germany) has shown that all the specifications have been reached.

More information is available at:

http://europa.eu.int/comm/research/energy/index_en.html

<http://www.efda.org>

<http://www.iter.org>



Cut-away drawing of the ITER tokamak showing the D-shaped vacuum vessel, surrounding structures, and the cylindrical cryostat which forms one of several safety barriers.

(Courtesy of ITER)

What is fusion?

Fusion is the process which powers the sun and other stars. It is called ‘fusion’ because the energy is produced by fusing together light atoms such as hydrogen.

On earth, fusion offers the potential of an almost limitless source of energy for future generations. However, effective energy production requires a fuel combination of isotopes of hydrogen – deuterium and tritium – which must be heated to very high temperature (150 million °C, ten times higher than in the centre of the sun) and isolated from contact with the reactor walls by so-called magnetic confinement. The most developed configuration at present is the tokamak (a Russian word for a torus-shaped magnetic chamber). Scientists have produced 17 megawatts of fusion power for up to a few seconds.



(Courtesy of EFDA JET)



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