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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 fusing together to form a helium atom. Unlike nuclear fission, which involves splitting very heavy atoms to release energy, fusion is the process that powers the sun. To produce fusion, the tritium and deuterium must be heated to 150 million °C. 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.

Tokamak technology

To produce fusion, the tritium and deuterium must be heated to 150 million °C. 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 intrinsically safe, but ingenious magnetic cage to confine the high-energy plasma.

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 milligrams 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.

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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.

European research in action

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 Euroatom 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 Euroatom 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.

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Inside the sun, hydrogen collides and fuses together at enormous gravitational pressures: 600 million tonnes of hydrogen is fused to helium every second. On earth, fusion will be reproduced on a smaller scale.

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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.

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