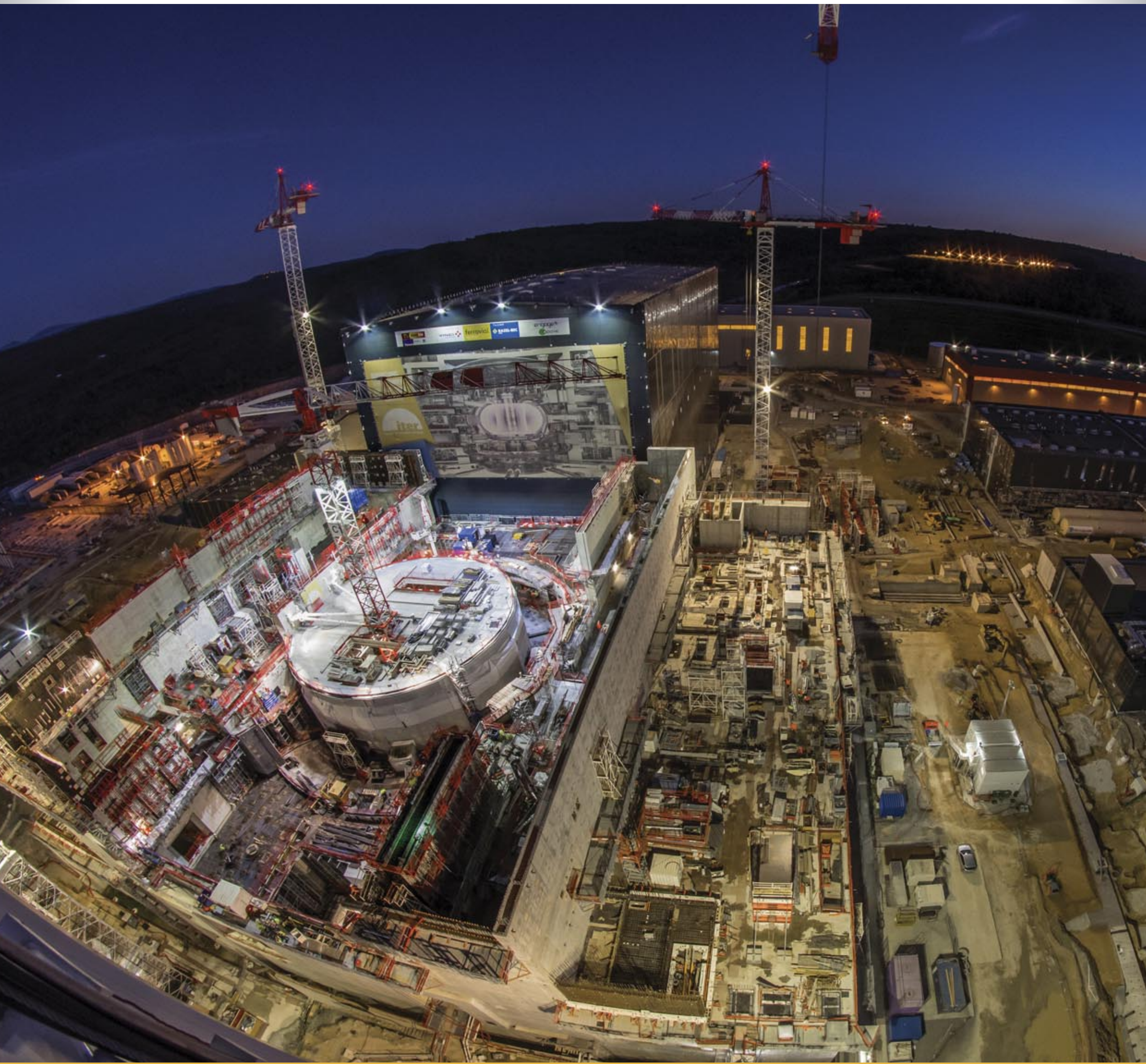
ITER,
THE WAY TO NEW ENERGY



China, European Union, India, Japan, Korea, Russia, United States

www.iter.org

ITER ("The Way" in Latin) is designed to demonstrate the scientific and technological feasibility of fusion energy.

WHAT IS FUSION?

Fusion is the process that occurs in the core of the Sun and stars. What we see as light and feel as warmth is the result of fusion reactions: hydrogen nuclei collide, fuse into heavier helium atoms, and release considerable amounts of energy in the process. Fusion is the source of life in the Universe.

In the Sun and stars, gravitational forces create the necessary conditions for fusion. On Earth, fusion can be achieved through "magnetic confinement" – a technique that involves high temperature plasmas and intense magnetic fields.

ITER is a large-scale scientific experiment that aims to demonstrate that it is possible to produce commercial energy from fusion. It is the culmination of sixty years of fusion research, carried out on hundreds of devices throughout the world. Experiments run on ITER – the largest fusion device ever built – will provide the data necessary for the design and subsequent operation of the first electricity-producing fusion power plants.

ITER is also a unique international collaboration that brings together China, the European Union, India, Japan, Korea, Russia and the United States – seven Members (35 nations) that represent 80% of the world's GDP and half the planet's population. The ITER Members are sharing the responsibility for designing, building and operating the ITER installation.

By unanimous decision in 2005, the ITER Members chose a site proposed by the European Union in southern France. Following the establishment of the ITER Organization and preparatory site works, construction of the buildings began in August 2010.

The ITER experimental facility will be operational in 2025. Manufacturing is underway now in ITER Member factories on three continents, and the first completed components have already reached ITER.

Cover page: At the heart of the Tokamak Complex the concrete bioshield is now complete. Major machine assembly activities begin in 2020.

WELCOME TO THE MACHINE

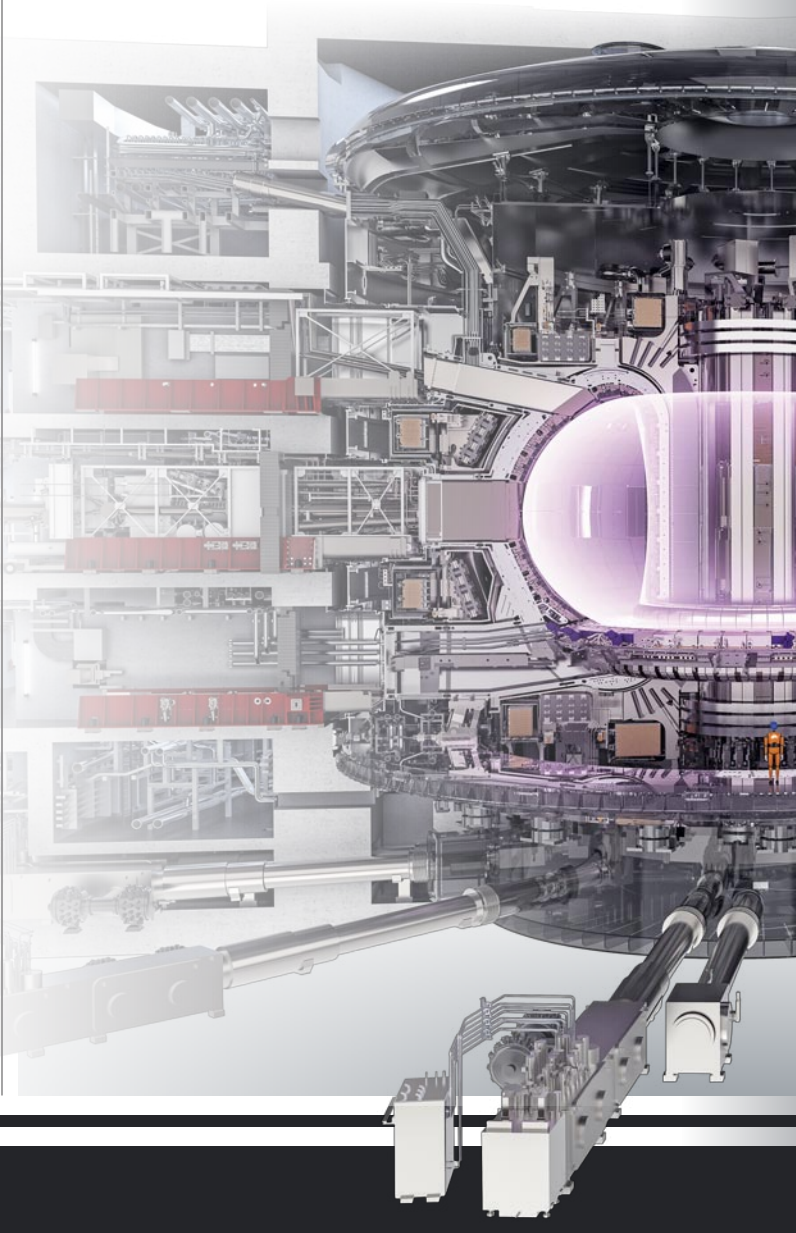
The ITER device is a tokamak – a Russian acronym meaning "toroidal chamber with magnetic coils." Tokamaks are torus-shaped fusion devices that were developed in the late 1950s and 1960s in the Soviet Union and quickly adopted by most fusion laboratories throughout the world.

In the past 50 years, progress in tokamaks has been as steady and as spectacular as the growth in the performance of microprocessors – indeed slightly better. Key fusion parameters have increased by a factor of 10 million.

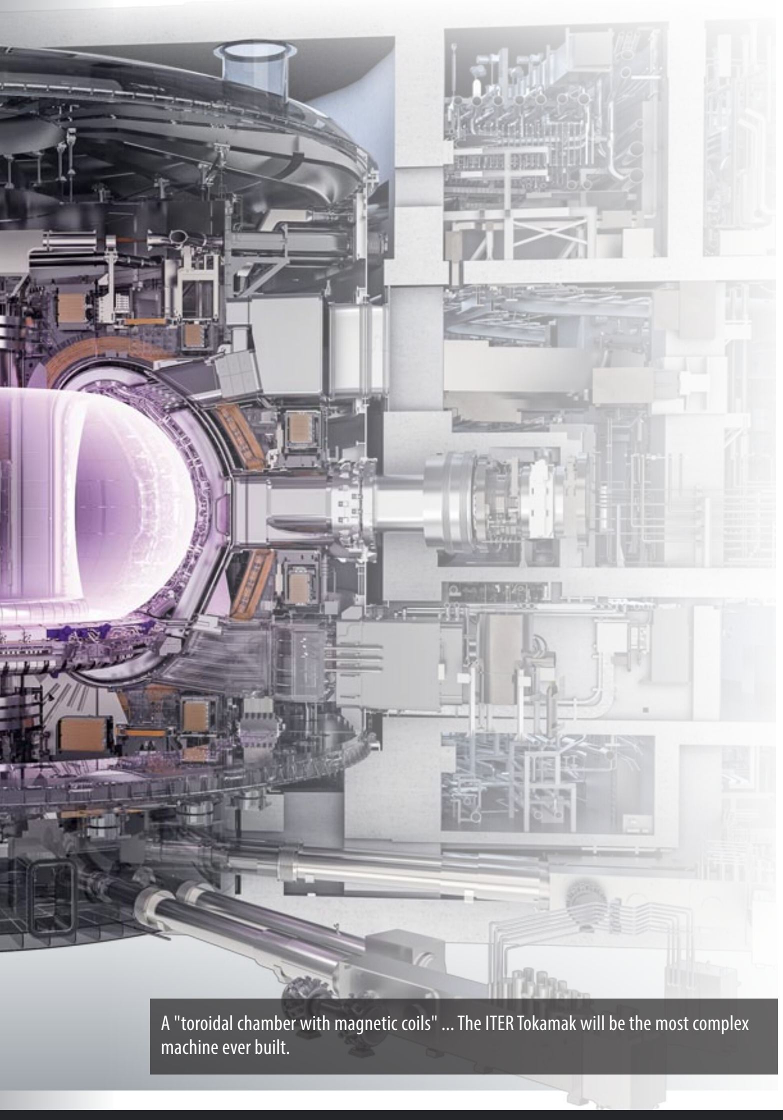
In the ITER Tokamak, a 50/50 gaseous mixture of hydrogen isotopes deuterium and tritium will be heated to temperatures in excess of 150 million °C to form a hot plasma. The fusion reactions produced will release four million times more energy than the chemical reactions obtained through the burning of oil or gas.

Magnetic fields created by an array of giant superconducting coils and a strong electrical current will shape and confine the plasma, keeping it away from the vessel walls.

The 23,000-tonne ITER Tokamak will be the largest and most powerful fusion machine ever built, capable of generating at least 10 times more energy than it takes to heat the plasma ($Q \geq 10$). ITER will test key technologies for future fusion power plants at reactor scale.



The ITER site in southern France – 42 hectares to host the Tokamak and its plant systems.



A "toroidal chamber with magnetic coils" ... The ITER Tokamak will be the most complex machine ever built.

WE ARE BUILDING

In the south of France close to 2,000 workers are participating in the construction of the ITER scientific facility – a concentrated grouping of 39 buildings and technical areas that will house the Tokamak and its plant systems. Work is financed and supervised by the European Domestic Agency as part of Europe's contributions to the ITER Project.

At the centre is the Tokamak Complex, where experiments will be carried out from 2025 on. After a four-year campaign to create the building's seismic foundations (2010-2014), construction is underway now on the seven-storey structure. Sixty-metres tall, 400,000 tonnes … it will take another four years to complete the Complex and install all electrical and mechanical equipment.

Nearby, in the Assembly Building, teams are installing a set of sophisticated bespoke tools for the pre-assembly of machine components. Forty metres overhead, heavy lift cranes will run the full length of the Assembly and Tokamak buildings during the machine installation phase, carrying component loads of up to 1,500 tonnes.

Completed components are already arriving from the ITER Members. But for two of the largest systems – the poloidal field magnets and the cryostat – international transport is out of the question. Fabrication activities for these important contributions are ongoing in dedicated on-site manufacturing facilities supplied by Europe and India.

In other areas of the construction platform, equipment installation is underway in the auxiliary buildings housing the many plant systems (cooling water, cryogenics, power supply, heating …) that are necessary for ITER operation.

As major assembly activities kick off in 2020 the number of workers at ITER is expected to climb to 3,000, with assembly teams joining construction teams on site.

ITER Organization Headquarters
Route de Vinon-sur-Verdon
CS 90 046
13067 St. Paul-lez-Durance Cedex
France

Publications Director
Laban Coblentz

Seven Members – China, the European Union, India, Japan, Korea, Russia and the United States – are sharing the responsibility for designing, building and operating the ITER installation in southern France. First Plasma is planned for December 2025.

"I do believe that the development of fusion for the future world energy supply is not negotiable. If we want to quit our dependence on burning fossil fuels, which leads to ever-rising CO2 emissions, we have to deliver fusion energy to the grid as soon as we can. Fusion's energetic potential is unparalleled. It is within our grasp to change the energy future of generations to come."

Bernard Bigot, ITER Director-General since March 2015, ITER website (www.iter.org)

"Nuclear fusion holds the promise of an inexhaustible, clean and safe source of energy – one of the dreams of humankind. If this dream can be realized, it will have dramatic implications for the future on many levels, from economic growth to climate change and fighting poverty."

Yukiya Amano, Director General of the International Atomic Energy Agency (IAEA), official visit to ITER, 6 July 2012

"Europe is proud to believe in ITER. The future of our continent is in science and innovation."

José-Manuel Barroso, President of the European Commission, official visit to ITER, 11 July 2014

"ITER is a very good example of long-term vision and international cooperation. The project truly shows that securing tomorrow's energy demands vision and investment now."

Pierre Gadonneix, president of the World Energy Council, Monaco ITER International Fusion Energy Days (MIIFED), 4 December 2013

"I would like nuclear fusion to become a practical power source. It would provide an inexhaustible supply of energy, without pollution or global warming."

Stephen Hawking, physicist, cosmologist, *Time Magazine*, 15 November 2010

WHY WE NEED FUSION

By the end of the century, demand for energy will have tripled under the combined pressure of population growth, increased urbanization and expanding access to energy in developing countries. A new large-scale, sustainable and carbon-free form of energy is urgently needed. The following advantages make fusion worth pursuing.

Abundant energy: Fusing atoms together releases nearly four million times more energy than a chemical reaction such as the burning of coal, oil or gas and four times as much as nuclear fission reactions (at equal mass). Fusion has the potential to provide the kind of baseload energy needed to supply electricity to our cities and our industries.

Sustainability: Fusion fuels are widely available and nearly inexhaustible. Deuterium can be distilled from all forms of water. Tritium can be produced during the fusion reaction as fusion neutrons interact with lithium – and lithium from proven, easily extractable land-based resources would be enough to operate fusion power plants for more than 1,000 years.

No greenhouse gases: Fusion doesn't release carbon dioxide or other greenhouse gases into the atmosphere.

No long-lived radioactive waste: Unlike fission reactors, nuclear fusion reactors produce no high activity, long-lived nuclear waste.

No proliferation: Fusion doesn't employ fissile materials that could be exploited to make nuclear weapons.

No risk of meltdown: A Fukushima-type nuclear catastrophe is not possible in a tokamak fusion device. If any disturbance occurs, the plasma cools within seconds and the reaction stops.