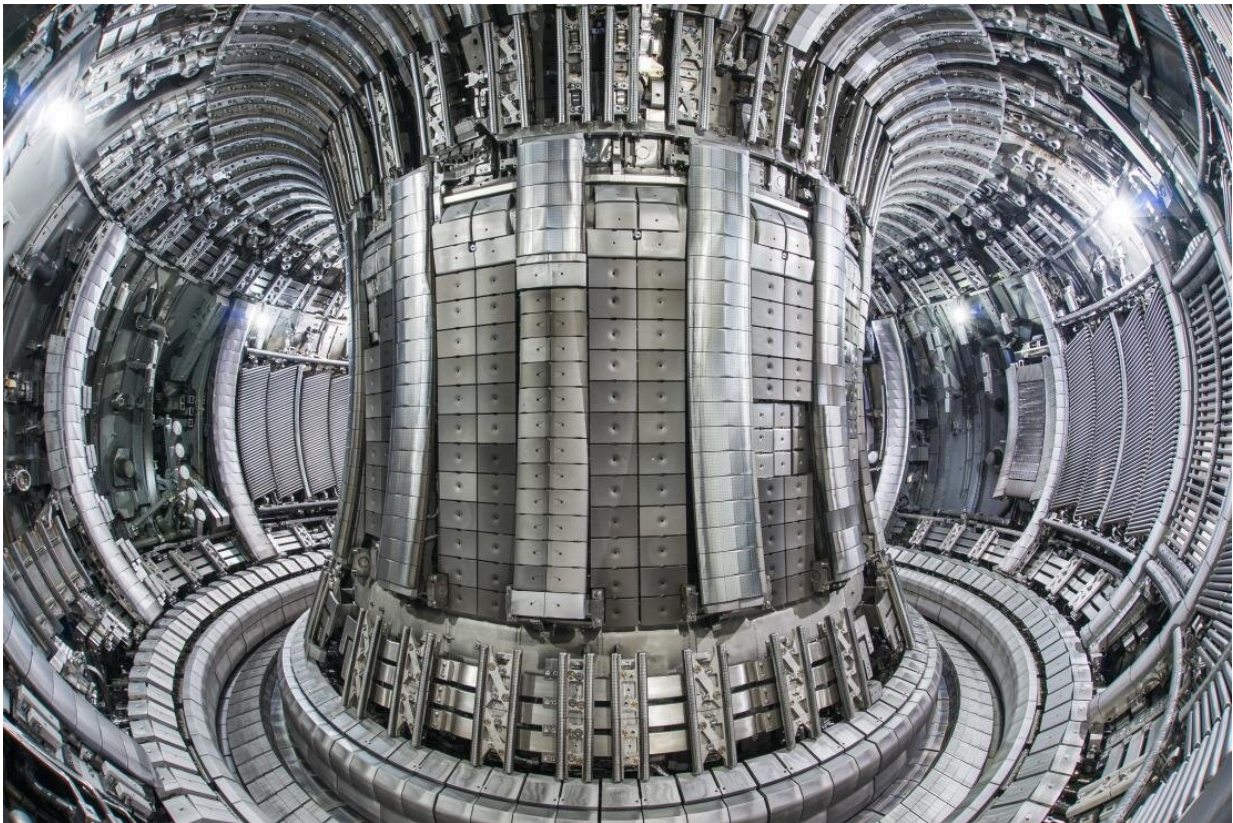


# Dream of unlimited, clean nuclear fusion energy within reach

June 28 2022, by Gareth Willmer

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Nuclear fusion energy could be a pivotal sustainable energy source to complement renewables. The world's largest fusion experiment, ITER, is being built in France. Credit: © ITER Organization, [www.iter.org/](http://www.iter.org/)

The old joke is that nuclear fusion is always 30 years away. Yet the

dream of abundant clean energy is no laughing matter as we meet an ITER researcher to catch up on progress at the reactor facility.

The sun has fueled life on Earth for billions of years, creating light and heat through [nuclear fusion](#). Given that incredible power and longevity, it seems there can hardly be a better way to generate energy than by harnessing the same nuclear processes that occur in our own and other stars.

Nuclear [fusion](#) reactors aim to replicate this process by fusing hydrogen atoms to create helium, releasing energy in the form of heat. Sustaining this at scale has the potential to produce a safe, clean, almost inexhaustible power source.

The quest began decades ago, but could a long-running joke that nuclear fusion is always 30 years away soon start to look old?

Some hope so, following a major breakthrough during [a nuclear-fusion experiment in late 2021](#). This came at the Joint European Torus (JET) research facility in Oxfordshire, U.K., in a giant, doughnut-shaped machine called a tokamak.

Inside, superheated gases called plasmas are generated in which the [fusion reactions](#) take place, containing charged particles that are held in place by powerful magnetic fields. Such plasmas can reach temperatures of 150 million degrees Celsius, an unfathomable 10 times hotter than the sun's core.

In a sustained five-second burst, researchers in the EUROfusion consortium released a record-breaking 59 megajoules (MJ) of fusion energy. This was almost triple the previous 21.7 MJ record set at the same facility in 1997, with the results touted as "the clearest demonstration in a quarter of a century of the potential for fusion energy

to deliver safe and sustainable low-carbon energy."

The results provided a major boost ahead of the next phase of nuclear fusion's development. A larger and more advanced version of JET known as [ITER](#) (meaning "the way" in Latin) is under construction on a 180-hectare site in Saint-Paul-lès-Durance, southern France.

ITER, which is being built as a collaboration between 35 nations, including those in the EU, is aimed at further firming up the concept of fusion. One of the most complicated machines ever to be created, it was scheduled to start generating its first plasma in 2025 before entering into high-power operation around 2035—although researchers on the project expect some delays because of the pandemic.

## Major milestone

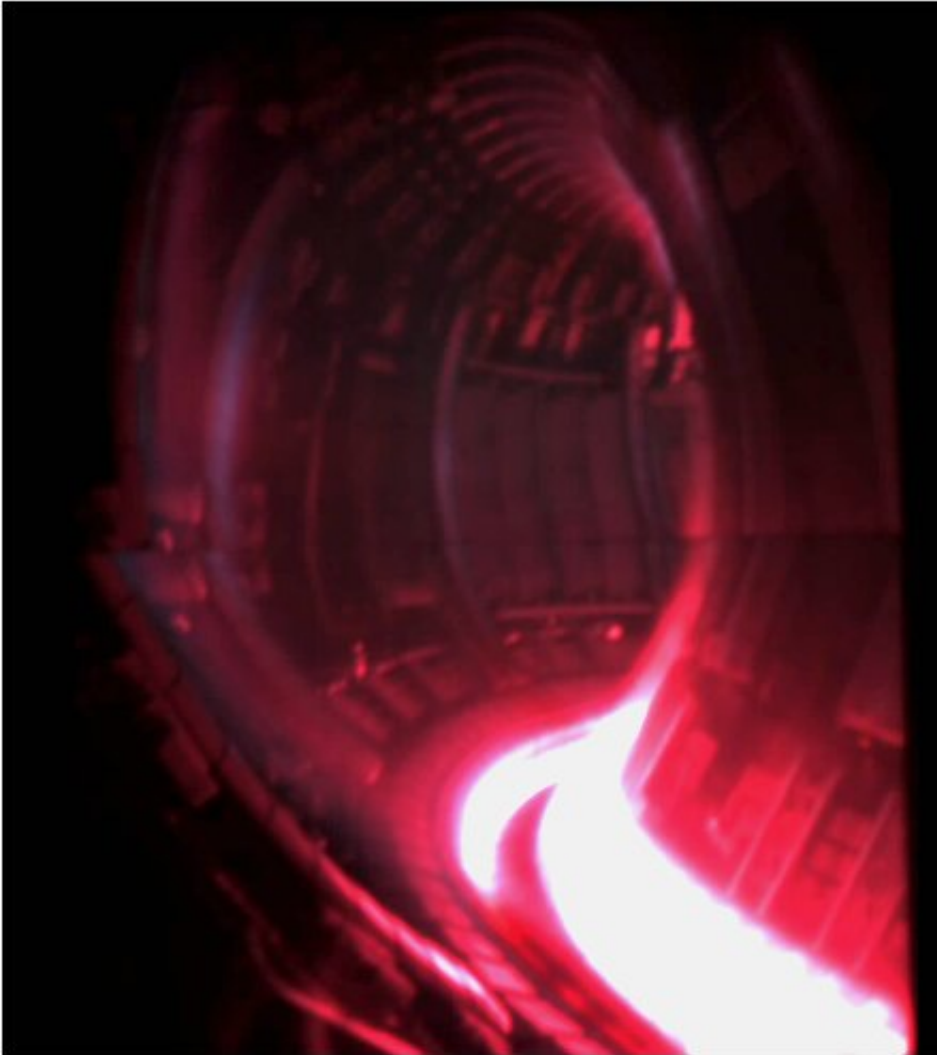
The results at JET represent a major landmark, said Professor Tony Donn , program manager of [the EUROfusion project](#), a major consortium of 4,800 experts, students and facilities across Europe. "It's a huge milestone—the biggest for a long time," he said.

"It's confirmed all the modeling, so it has really increased confidence that ITER will work and do what it's meant to do." While the energy generated at JET lasted just a few seconds, the aim is to ramp this up to a sustained reaction that produces energy.

The results were the culmination of years of preparation, with Prof Donn  explaining that one of the key developments since 1997 involved changing the inner wall of the JET vessel.

Previously, the wall was made of carbon, but this proved too reactive with the fuel mix of deuterium and tritium, two heavier isotopes—or variants—of hydrogen used in the fusion reaction. This resulted in the

formation of hydrocarbons, locking up the tritium fuel in the wall.



View of JET experimental fusion reactor plasma. Credit: © EUROfusion consortium (2022)

In the rebuild, which involved 16,000 components and 4,000 tons of metal, the carbon was replaced with beryllium and tungsten to reduce tritium retention. Ultimately, the team was able to cut the amount of trapped fuel by a large multiple, contributing to the success of the recent

fusion shot.

## **DEMO run**

In preparation for the next stage of fusion's epic journey, upgrades to JET ensured that its configuration aligns with the plans for ITER. Further in the future, the next step beyond ITER will be a demonstration power plant known as DEMO, designed to send electricity into the grid—leading on to fusion plants becoming a commercial and industrial reality.

"ITER is a device which will create 10 times more fusion energy than the energy delivered to the plasma," said Prof Donné. "But as it is an experimental facility, it will not deliver electricity to the grid. For that, we need another device, which we call DEMO. This will really bring us to the foundations for the first generation of fusion power plants."

Prof Donné added: "JET has shown now that fusion is plausible. ITER has to show that it's further feasible, and DEMO will need to demonstrate that it really works."

Planned to provide up to 500 megawatts (MW) to the grid, he thinks it is realistic for DEMO to come into operation around 2050. "We hope to build DEMO much faster than we built ITER, making (use of the) lessons learned," he said.

Yet there are other key challenges to overcome on the way to getting nuclear fusion up and running. Not least is that while deuterium is abundant in seawater, tritium is extremely scarce and difficult to produce.

The researchers therefore plan to develop a way of generating it inside the tokamak, using a "breeding blanket" containing lithium. The idea is

that high-energy neutrons from the fusion reactions will interact with the lithium to create tritium.

## Essential energy

Prof Donné said nuclear fusion could prove a pivotal green and sustainable energy source for the future. "I would say it's essential," he said. "I'm not convinced that by 2050 we can make the carbon dioxide transition with only renewables, and we need other things."

And although he says the current method of creating nuclear energy through fission is becoming safer and safer, fusion has key advantages. Proponents for ITER talk of [benefits such as an absence of meltdown risk](#), adding that nuclear fusion does not produce long-lived radioactive waste and that reactor materials can be recycled or reused within 100 to 300 years.

"It's definitely much safer," said Prof Donné. Referencing the stigma carried by nuclear energy, he said, "What we see when we interact with the public is that people very often haven't heard about nuclear fusion. But when we explain the pros and cons, then I think people get positive."

Referring to Lev Artsimovich, dubbed the "father of the tokamak," he said, "Artsimovich always said fusion will be there when society really needs it. If we get fusion up and running, then really we have a very safe and clean energy source which can give us [energy](#) for thousands of years."

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