Text 1

## European scientists say they have made a major breakthrough in their quest to develop practical nuclear fusion - the energy process that powers the stars.

The UK-based JET laboratory has smashed its own world record for the amount of energy it can extract by squeezing together two forms of hydrogen. If nuclear fusion can be successfully recreated on Earth it holds out the potential of virtually unlimited supplies of low-carbon, low-radiation energy. The experiments produced 59 megajoules of energy over five seconds (11 megawatts of power). This is more than double what was achieved in similar tests back in 1997. It's not a massive energy output - only enough to boil about 60 kettles' worth of water. But the significance is that it validates design choices that have been made for an even bigger fusion reactor now being constructed in France. "The JET experiments put us a step closer to fusion power," said Dr Joe Milnes, the head of operations at the reactor lab. "We've demonstrated that we can create a mini star inside of our machine and hold it there for five seconds and get high performance, which really takes us into a new realm."

(…)

Fusion works on the principle that energy can be released by forcing together atomic nuclei rather than by splitting them, as in the case of the fission reactions that drive existing nuclear power stations. In the core of the Sun, huge gravitational pressures allow this to happen at temperatures of around 10 million Celsius. At the much lower pressures that are possible on Earth, temperatures to produce fusion need to be much higher - above 100 million Celsius. No materials exist that can withstand direct contact with such heat. So, to achieve fusion in a lab, scientists have devised a solution in which a super-heated gas, or plasma, is held inside a doughnut-shaped magnetic field. The Joint European Torus (JET), sited at Culham in Oxfordshire, has been pioneering this fusion approach for nearly 40 years. And for the past 10 years, it has been configured to replicate the anticipated ITER set-up *[ITER ("The Way" in Latin) is one of the most ambitious energy projects in the world today. In southern France, 35 nations are collaborating to build the world's largest tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars.].*

The fusion announcement is great news but sadly it won't help in our battle to lessen the effects of climate change. There's huge uncertainty about when fusion power will be ready for commercialisation. One estimate suggests maybe 20 years. Then fusion would need to scale up, which would mean a delay of perhaps another few decades. And here's the problem: the need for carbon-free energy is urgent - and the government has pledged that all electricity in the UK must be zero emissions by 2035. That means nuclear, renewables and energy storage. In the words of my colleague Jon Amos: "Fusion is not a solution to get us to 2050 net zero. This is a solution to power society in the second half of this century."

The French lab's preferred "fuel" to make the plasma will be a mix of two forms, or isotopes, of hydrogen called deuterium and tritium. JET was asked to demonstrate a lining for the 80-cubic-metre toroidal vessel enclosing the magnetic field that would work efficiently with these isotopes. For its record-breaking experiments in 1997, JET had used carbon, but carbon absorbs tritium, which is radioactive. So for the latest tests, new walls for the vessel were constructed out of the metals beryllium and tungsten. These are 10 times less absorbent. The JET science team then had to tune their plasma to work effectively in this new environment. "This is a stunning result because they managed to demonstrate the greatest amount of energy output from the fusion reactions of any device in history," commented Dr Arthur Turrell, the author of The Star Builders: Nuclear Fusion And The Race To Power The Planet. "It's a landmark because they demonstrated stability of the plasma over five seconds. That doesn't sound very long, but on a nuclear timescale, it's a very, very long time indeed. And it's very easy then to go from five seconds to five minutes, or five hours, or even longer." JET can't actually run any longer because its copper electromagnets get too hot. For ITER, internally cooled superconducting magnets will be used. Fusion reactions in the lab famously consume more energy to initiate than they can output. At Jet, two 500 megawatt flywheels are used to run the experiments. But there is solid evidence that this deficit can be overcome in the future as the plasmas are scaled up. ITER's toroidal vessel volume will be 10 times that of JET. It's hoped the French lab will get to breakeven. The commercial power plants that come after should then show a net gain that could be fed into electricity grids.

This is a long game and it's significant that of the 300 or so scientists working as JET, a quarter are in the early part of their careers. They will have to carry the baton of research forward. "Fusion takes a long time, it is complex, it is difficult," said Dr Athina Kappatou, who's in her thirties. "This is why we have to ensure that from one generation to the next, there are the scientists, there are the engineers and the technical staff who can take things forward." Many technical challenges remain, however. In Europe, these challenges are being worked on by the Eurofusion consortium, which comprises some 5,000 science and engineering experts from across the EU, Switzerland and Ukraine. The UK is a participant, too. Its full involvement in ITER, however, will require first for Britain to "associate" to certain EU science programmes, something that so far has been held up by disagreements over post-Brexit trading arrangements, particularly in relation to Northern Ireland. JET is likely to be decommissioned after 2023 with ITER beginning plasma experiments in 2025, or soon after.

Fonte: https://www.bbc.com

1. **According to the author, the major breakthrough achieved from this project at this time was:**
    a. To confirm a correct selection of materials and methodologies that will help in future larger scale projects.
    b. To produce a small compact commercial device capable of a small scale energy production of 11 MW of power.
    c. To demonstrate the fusion reaction is achievable on Earth.
    d. To demonstrate that the fusion reaction can only occur at or above 100 million Celsius.

2. **Which of the following is NOT according to the text:**
    a. There are no materials on Earth that can withstand the temperatures needed for fusion.
    b. The fusion principle is to use energy released from low atomic number, driven by fission energy from heavy nuclei splitting reactions.
    c. Experiments in the JET Lab are meant to anticipate and contribute to the larger ITER project.
    d. Fusion in the Sun occurs at lower temperatures than on Earth.

3. **According to the text, it is correct to say that fusion technology:**
    a. will not help lessen climate change effects, because it is not a clean source.
    b. will be commercially available for home users within 20 years.
    c. will strongly contribute to meet UK zero emissions by 2035.
    d. is still more than 30 years away from an industrial scale production.

4. **Regarding the experiment done in the JET laboratory, it is correct to say that:**
    a. In 1997, the walls of the vessel were constructed out of beryllium and tungsten metals.
    b. Carbon is the best material for the vessel.
    c. The "new environment" (in line 38) that the author refers to is related the materials chosen for the wall of the toroidal vessel.
    d. Carbon is less tritium absorbent than beryllium.

5. **How will the ITER project benefit from the Joint European Torus (JET) experiment?**

I – Construction materials were successfully validated by JET.
II – A part of ITER, JET will be part of the energy grid necessary for its operation.
III – JET is a small-scale experiment that demonstrated the stability of the plasma over five seconds.

a. Only II is true.
b. Only I and II are true.
c. I and III are true.
d. None are true.

6. **"JET can't actually run any longer" in line 43 means that:**
    a. JET is to be decommissioned after 2023.
    b. JET produces radioactive materials from tritium absorption and is dangerous.
    c. JET is too small.
    d. JET doesn't have superconducting magnets to run for more than 5 minutes.

7. **Regarding the energy needed to operate fusion reactions, the authors state that:**
    a. It is expected that ITER will produce an amount of energy equivalent to that if consumes to initiate the fusion reaction.
    b. JET produced more electricity than is needed to start the fusion reaction.
    c. ITER will produce more electricity than it needs to operate.
    d. Only the commercially available fusion plants that are in current operation can produce net gain to the electricity grid.

8. **Regarding fusion research, it is correct to say that:**

a. Is three quarters researched by very young scientists in their early stage of careers.
b. Technical challenges will remain for many generations.
c. Britain participates with more than 5,000 science and engineering experts.
d. Is complex, but the current working engineers and the technical staff are sufficient to ensure operation within a few years.

**9. The "fuel" used to produce fusion at the UK-based Joint European Torus (JET) laboratory is:**
a. carbon.
b. a mix of beryllium and tungsten.
c. a mix of two forms, or isotopes, of hydrogen called deuterium and tritium.
d. Isotopes of copper.

**10. The current solution to overcome problems related to the high temperature in production of fusion is to:**
a. Use a super-heated gas, or plasma, held inside a doughnut-shaped magnetic field.
b. To use beryllium instead of carbon in the tokamak walls.
c. To use cooled superconducting magnets.
d. To use larger toroidal chambers.