Comment and Analysis

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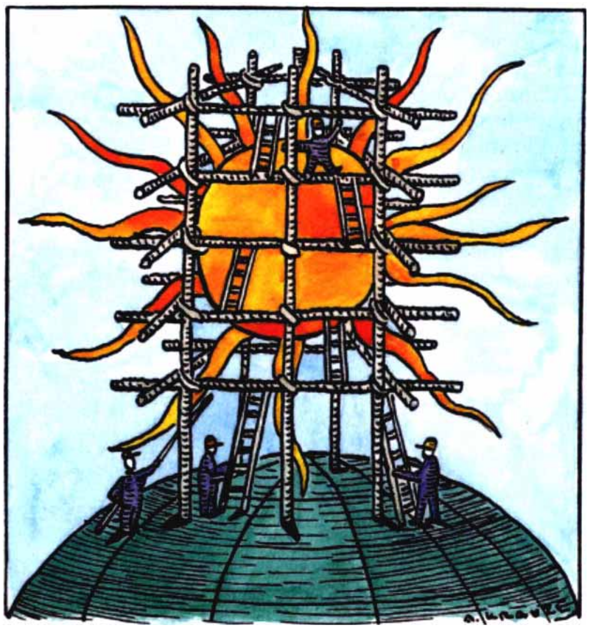
Fast forward to fusion

Critics say the search for fusion power is a wild goose chase that wastes billions. David King, the UK government's chief scientific adviser, sees it differently



UNLIMITED clean energy produced by the reaction that powers the sun: that has always been the goal of fusion research. But will it ever happen?

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Since the 1960s scientists have been saying that fusion power could be achieved here on Earth within a 40 to 50-year time frame. Some say it is still 40 years away - and that it will always be just out of reach. When I joined the UK government as chief scientific adviser in 2000, I too was a sceptic. But after making a detailed investigation, I have changed my mind.

The concept of fusion power is simple. Heat a mix of hydrogen isotopes to temperatures in excess of 100 million degrees and their nuclei will fuse, producing helium and colossal amounts of energy. Scientists discovered decades ago that powerful electromagnetic rings, or tokamaks, could be used to contain such hot plasmas. The trouble until recently was that experimental fusion reactors always consumed more energy than they gave out: it took more energy to heat the gas to fusion temperature, and keep it there, than was produced by any fusion.

That has changed. Experiments at JET, Europe's leading fusion facility based in Culham, Oxfordshire, have now shown that it really is possible to create the temperatures needed for fusion, and hang on to them. The key breakthrough involves manipulating the tokamak's magnetic fields to generate special regions of the plasma capable of slowing heat escape from the reactor. Conditions in JET have reached the point where the power output is equal to the power input. A Japanese tokamak, JT60, has produced similar results. The next stage is to build a bigger tokamak to simulate the conditions in a power station and confirm the feasibility of fusion.

This is the main reason why I believe the time is now right to press ahead with ITER, the International Tokamak Experimental Reactor. The consortium designing this next-generation reactor - from the European Union, Japan and Russia - has done an impressive job. Each major piece of this very large instrument has been built and tested, including the huge superconducting electro-magnet that will contain and control the hot plasma. Based on the output from JET, it should produce at least 10 times as much power as it consumes. That is the ratio required for a power plant.

Another crucial reason for investing in ITER is the need to reduce fossil fuel emissions. The problem of climate change means we must look to carbon-free technologies to meet our energy needs. Fusion power is one such potential energy source. The fuel for the reaction can be derived from seawater and lithium, both of which are abundant. The lithium from one laptop battery and deuterium from a bath of water would generate enough energy to cover the needs of a UK citizen for seven years. The waste product from fusion is helium, and it is carbon-free, non-radioactive and harmless. And while the required temperatures for fusion are high, the reactors would not be unduly dangerous. Any disruption to the energy source immediately lowers the temperature of the plasma and so terminates the production of energy.

There is one potential problem. Fusion plasma produces a high flux of neutrons which, over time, will make the walls of the machine radioactive. This will have to be dealt with when any future fusion power station reaches the end of its life and is decommissioned. However, work is under way to produce resistant wall materials whose radioactivity will decay quickly. Fusion is potentially a clean, safe and sustainable source of electricity.

ITER will be an experimental device. The question that follows is how to turn the technology into an actual power station. In a report to the European Commission, a group of experts that I chaired proposed building a facility for developing and testing materials for the walls of a power station. That way, if ITER fulfils its promise, work could begin immediately on the construction of the world's first fusion power station. This fast-track approach is capable of delivering fusion power within 30 years. Our report was accepted by the Commission and has reinvigorated the international community. I am pleased to say that the ITER partnership has recently expanded to include China, the US and South Korea.

A decision now needs to be reached on where ITER is to be built. Two sites have been short listed: an EU site in Cadarache, France, and Rokkasho in Japan. We are currently discussing an arrangement in which one of these partners will house ITER while the second hosts a materials-testing facility, a computer-simulated version of ITER and a centre to design the first power station. I am optimistic that a good outcome, steered by the EU and Japan and acceptable to all parties, will emerge.

When ITER is up and running, it will be the world's largest fully international science and technology project. If successful, it will deliver what could be the world's most important energy source over the next millennium. Its impact will be bigger than landing the first man on the moon.

David King
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