Fusion power faces big crunch

Europe poised to decide whether to go it alone on £3bn trial reactor

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It is the power source for every star in the universe - something that scientists have longed to bring to Earth. Success would mean huge rewards: cheap, clean and almost limitless electricity for an increasingly energy-hungry planet.

But, in more than half a century of hard scientific slog, nuclear fusion has been a tough nut to crack.

On Friday, decades of research, argument, false dawns and political wrangling over one of the world's most expensive scientific projects will reach a decisive stage.

European Union ministers will meet in Brussels to decide whether to push ahead with the International Thermonuclear Experimental Reactor (Iter), an ambitious, £3bn project that aims to prove, once and for all, that fusion power offers the best solution to future energy needs.

At the meeting, EU politicians will consider whether to continue long and difficult negotiations with five international partners over where to build the vast trial reactor - or to draw a line under the talks and go-it-alone with the project. If the latter decision is made, Iter could be built by the end of the decade, and, if it is successful, commercial fusion power could come on stream by mid-century.

Iter was conceived in the 1980s as an international collaboration of the best scientific minds in the field. But nearly two decades of cooperation in designing the machine has been beset in the past year by infighting among the partners.

The shortlist for the Iter site has been whittled down to two candidates: Cadarache in France and Rokkasho in Japan. Both countries are desperate for the prestige the project would bring and neither wants to back down.

The final decision should have been made at the end of last year, but the six partners - the EU, China, Japan, South Korea, Russia, and the United States - remain divided. Russia and China favour Cadarache, while the US and South Korea want Iter built in Japan. After months of fraught negotiations, the EU in September set a deadline of November 26 for a decision.

At a meeting in Vienna last week, the EU and Japan were still at loggerheads, despite both claiming to have made significant concessions.

Iter's job is to prove that fusion can work commercially. So far, experimental reactors around the world, such as the Joint European Torus (Jet) in Culham, Oxfordshire, have proved that fusion can work in principle. But they have not been able to produce more energy than is required to get the reactions going in the first place. Iter - a towering 55 ft high - aims to produce 500 megawatts of energy, or 10 times its predicted input.

The reactor will work by fusing two isotopes of hydrogen: deuterium and tritium. The fuel is placed inside a doughnut shaped vessel and heated until to 100m degrees C. The isotopes fuse to form helium - releasing lots of energy. As well as virtually limitless fuel, proponents argue that fusion is environmentally friendly because it produces very little radioactive waste.

But creating a mini-star on Earth has, perhaps unsurprisingly, proved to be one of the biggest challenges physicists have faced since work began in the 1950s.

"People underestimated the amount of new physics they had to learn," said Sir Christopher Llewellyn Smith, director of the research facility in Culham. "There was some early optimism in the 50s, but it was misplaced."

Scientists soon realised that strong magnetic fields would be needed to contain the fuel in a reactor, but, 50 years ago, they had no reliable way of producing them. These problems, among others, led many scientists to denounce fusion research as a waste of time - a sentiment that colours the work to this day.

Iter is the fusion physicists' last chance to prove that the technology is viable.

Wherever Iter is built, British scientists are gearing up to bid for the contracts to build components for it. Sir David King, the government's chief scientific adviser, is a vocal supporter of the technology. "I believe it's got a very good chance of success or I wouldn't be backing it," he told the Guardian last year.

A senior British fusion researcher said: "We are well-positioned to contribute fully. We see no particular threat [from the political rows]."

The EU's most recent move has been to offer Japan a "privileged partner" status, whereby Tokyo would have the pick of the contracts to make the instrumentation and components of the reactor if it were built in southern France, with Europe shouldering more than half the costs.

But Japan's chief negotiator, Satoru Ohtake, told Science magazine last week that being the host would be like winning the lottery, while losing out would be like winning nothing.

On the surface, EU officials seem convinced that the Iter partners will agree to the Cadarache site, not least because of the established community of 300 fusion physicists already working there. If the European ministers come to the conclusion that the six partners cannot hammer out a deal, however, the EU seems prepared to go with whichever countries will support the French site, and that could mean it will go it alone.

"The proposed negotiation mandate is thus aimed at achieving agreement to construct Iter in Cadarache with all six parties," said a statement issued by the European Commission last week. "Should the parties fail to attain this hoped-for consensus, the EU would pursue Iter construction in the broadest possible partnership."

The fusion research community want the politicians to get on with it.

"If we had to decide, it would probably be slightly easier for us to be involved if it was in Cadarache," said the senior fusion researcher. "[But] the overriding feeling is that we want Iter to be built."