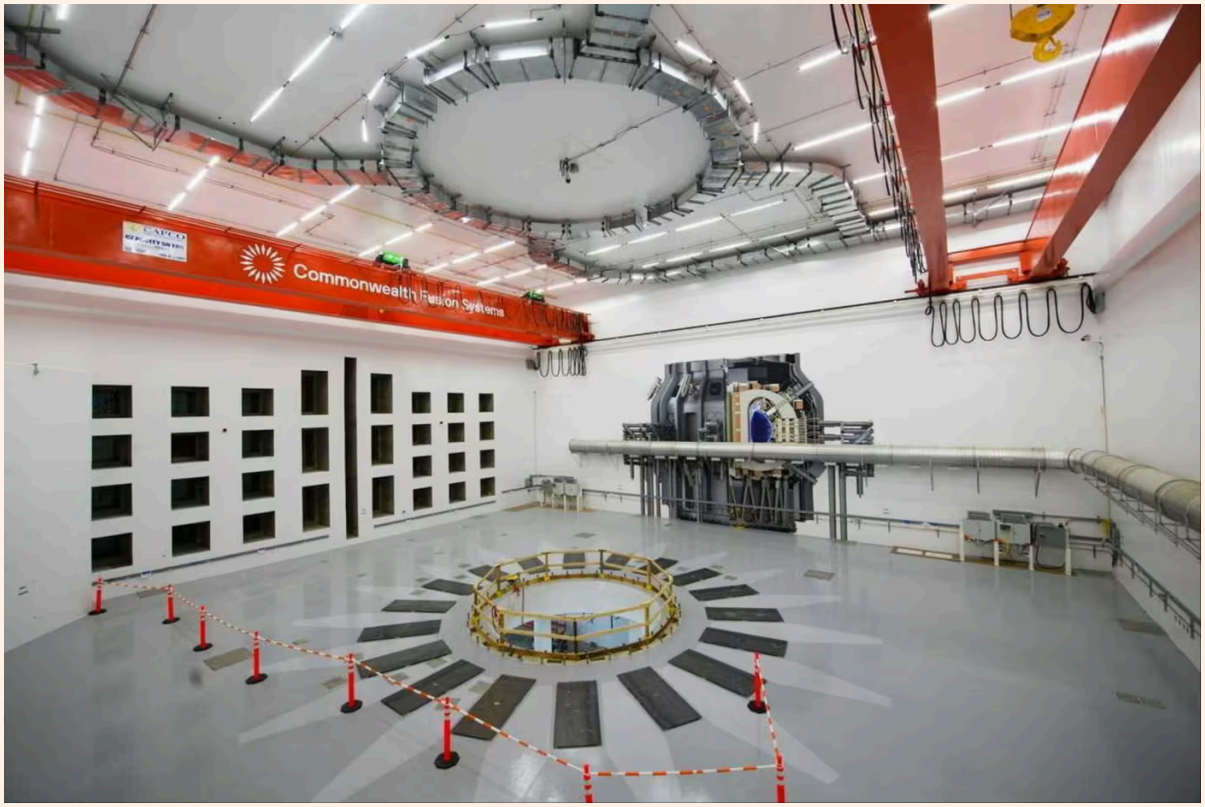
Nuclear energy

Scientists inch towards holy grail of fusion reactors

Many companies predict commercial viability next decade, but more funding is needed now



The Commonwealth Fusion Systems SPARC project in Massachusetts, which is developing the technology underlying a future fusion power plant

Tom Wilson 13 HOURS AGO

Physicists have been promising since the 1960s that fusion reactions have the potential to provide an abundant, emissions-free solution to the planet's long-term energy needs.

Now, scientists, fusion executives and investors say the foundations may finally be in place for a company, or several, to demonstrate a commercially viable fusion plant by the 2030s.

"The stage is set for a big five years in fusion," says Richard Pearson, a co-founder of Japan's Kyoto Fusioneering, which was set up in 2019 to develop fusion power plant technology. "A lot has to happen, and there is a lot to do, but the emphasis and excitement in the industry is definitely there."

The promise of fusion — in which hydrogen isotopes are heated to such extreme temperatures that they fuse, releasing energy — has tantalised researchers for decades.

Unlike fission — the process harnessed by nuclear power stations in which atoms are split — fusion

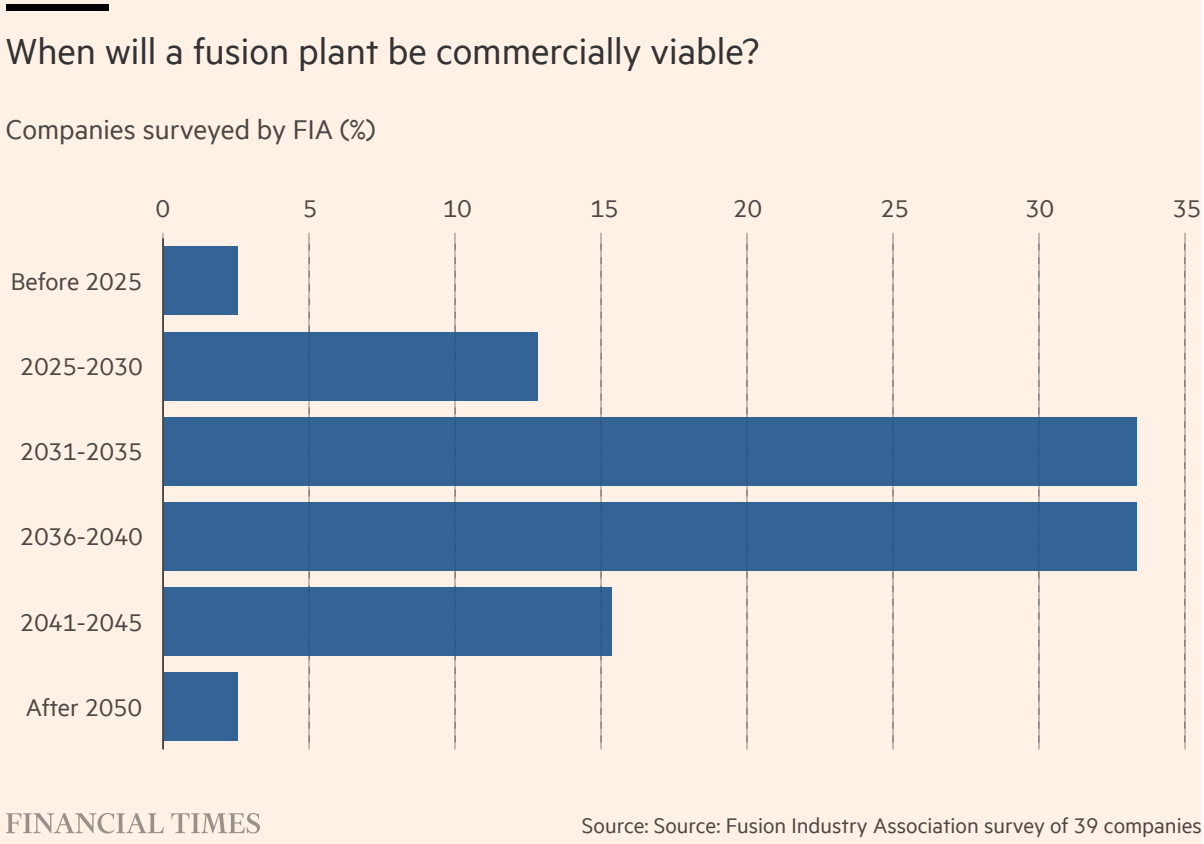
produces no long-lived nuclear waste. The only gas emitted is helium, the isotopes can be sourced in large quantities, and a small cup of the fuel has the potential to power a house for hundreds of years.

> **This could be the thing that powers the earth not 50 years but 500 years into the future**
>
> **Richard Pearson, Kyoto Fusioneering**

The challenge has been that the energy-dense reactions are hard to sustain. Until recently, no group had produced more energy from fusion than the reaction consumes — a milestone known as energy gain, or scientific break-even. US scientists achieved that landmark for the first time in December 2021 but only produced about a gain of 1.1 megajoules — about enough to boil a kettle.

To make further progress, the nascent sector must now demonstrate engineering break-even, in which the energy produced from a fusion reaction exceeds the total energy used to power the machine. Whoever succeeds must then take that design and demonstrate it can produce energy at a scale and cost that makes it commercially viable.

Out of 39 fusion companies surveyed by the Fusion Industry Association (FIA) last year, a third said commercial viability would be demonstrated between 2031 and 2035, and another third said it would happen between 2036 and 2040.



Charles Boakye, an energy transition strategist at Jefferies, one of the few investment banks

studying the sector, thinks this will happen between 2035 and 2037, but is doubtful the device will be ready to be scaled.

“I think the truth is we will see a very, very poorly designed fusion power plant connected to the grid, or at least producing some form of electricity, in the mid 2030s,” he says.

One obstacle will be the lack of readiness in supply chains to provide the engineering, materials, and expertise required to roll out a fusion solution at scale. “Suppliers are waiting in a holding pattern until they see engineering break-even,” Boakye adds.

Jefferies’ analysis found more than 45 private companies working on commercialising fusion but only two companies — Kyoto Fusioneering and the UK’s Oxford Sigma — working on technologies and solutions to support the sector.

Andrew Holland, executive director of the FIA, says the body is working with more than 80 affiliate members, most of which are supply chain companies, so that they are ready to scale with the industry.

But he is more concerned about whether adequate funding will be available to enable the sector to grow as quickly as it could.

This month, US Congress, for example, approved $790mn for fusion energy research in 2024, representing the seventh straight year of increased funding.

“It’s great that it did grow . . . but it’s not enough to meet the opportunity,” Holland says.

Private sector companies have led efforts to commercialise fusion energy in recent years, raising more than $6bn to date in private funding.

However, these companies are now looking to government support to help de-risk their projects as they seek to raise higher amounts of capital from investors.

The UK, Germany and Japan have all launched their own programmes to support fusion companies and, in November, the US and UK signed a partnership agreement to collaborate on fusion initiatives and share research and development facilities.

China has also stepped up its support of fusion research, creating a consortium in December, led by the China National Nuclear Corporation, to advance the development of fusion energy in the country.

“If you think about fusion as the ultimate energy source for humankind there are obvious geopolitical implications,” says Pearson at Kyoto Fusioneering. “This could be the thing that powers the earth not 50 years but 500 years into the future.”

Chinese fusion research has traditionally been a “few years behind” Europe and the US but made recent advancements and demonstrated an ability to “move fast once they get this in place”, says Boakye.

“Unlimited or very cheap power, it’s the whole game, if you think of the rise in computing we’re

seeing, the rise in data centres, AI, military capabilities," he says. "At the moment there is definitely a feeling . . . that it's important who gets there first."

This article has been amended to show that companies have to date raised more than $6bn in private funding to commercialise fusion energy.
