

NEWS

Japan consoled with contracts as France snares fusion project

PARIS

France has been chosen to host a billion-dollar international thermonuclear experiment. After an 18-month stalemate over whether Japan or France should host the project ITER, the Japanese finally bowed out on 28 June — in return for a hefty compensation package.

Scientists hope that, now the experiment's location has been decided, it could be up and running by 2015 (see 'Securing the funds'). If all goes well, it will be the first fusion experiment that generates more energy than it uses.

The promise of fusion is well known. Using the same reactions that power the stars, hydrogen nuclei can be fused to produce helium, releasing huge amounts of energy — and no high-level radioactive waste. But the line that usable fusion power is 40 years away, and always will be, is sadly just as familiar.

Recent progress has been promising, however, especially for tokamak reactors, in which hot plasma is confined in a floating doughnut shape by superconducting magnets. Both Europe's JET and Japan's JT-60 tokamaks have achieved short periods in which the energy released approaches the energy put in: JET holds the record, with a maximum power

output of 16 megawatts. At more than 12 metres across, the plasma ring in ITER will be about twice as big as JET's, and will hopefully generate 400–700 megawatts of power.

Negotiations over ITER's home have been deadlocked since December 2003. The United States and South Korea backed a Japanese site at Rokkasho, while China and Russia supported the European Union's bid for Cadarache in southern France. But at Tuesday's meeting of ITER's six international partners in Moscow, ministers finally agreed.

It's a deal

The European Union will now pay half of ITER's US\$5.5-billion construction costs, much of it coming from France. The other five partners will contribute 10% each, mostly in the form of equipment and components. Japan will win 20% of the manufacturing orders despite its 10% share. The European Union has also agreed to support a Japanese candidate for ITER's director-general, and Japan will provide 20% of the project's scientists, instead of the 10% to which it is entitled.

Up to 8% of the ITER construction budget will go towards partner facilities. These will

now be built in Japan, and three likely candidates are a supercomputing centre, an upgrade of the JT-60 and a materials testing facility.

Such centres would carry out research in parallel with ITER, so that if it is successful, work can start straight away on the next step — a prototype fusion reactor called DEMO. For example, the testing facility would use accelerators to find building materials that will stand the extreme conditions of a fusion power plant. Some even say that DEMO could be operational by 2030.

The Europeans are, of course, ecstatic. "There is no equivalent to this site anywhere in the world," says Jean Jacquinot, a plasma physicist who played a leading role in the Cadarache bid.

Cadarache is already home to more than 2,000 nuclear engineers and scientists, he points out. Most of them work on fission energy, but Jacquinot says ITER could still use their expertise. The site's use as a nuclear research facility means the project will have the necessary access to large amounts of electricity and water-cooling facilities, Jacquinot adds.

Meanwhile, Japan's researchers are looking for someone to blame. "Japanese scientists

Clear skies raise global-warming estimates

MUNICH

For more than a century, dust and aerosols in the atmosphere have been blocking some of the Sun's radiation, shielding us from the worst effects of global warming. The question has always been: how much? Now, as cuts in pollution allow the skies to clear, an attempt to quantify the effect on future temperatures has produced an alarming conclusion.

Even under relatively cautious assumptions about past and present aerosol cooling, the study suggests that global warming could easily exceed the upper extreme predicted by the Intergovernmental Panel on Climate Change (IPCC), as clean-air measures take effect.

"Things could get really uncomfortable," says lead author Meinrat Andreae, an atmospheric researcher at the Max Planck Institute of Chemistry in Mainz, Germany. "The climate system is much more sensitive to human per-



How much has pollution shielded us from the Sun?

turbations than has been thought. If our model is right, things could become totally uncontrollable in the second half of the century."

That is quite a big 'if', however. As cars, industries and power plants worldwide become cleaner, atmospheric concentrations of emitted aerosols are expected to drop substantially. But

how global temperatures will respond depends on how big the masking effect was in the first place — and that is the wild card in the climate game.

The problem is that different methods of estimating the cooling effect arrive at vastly different values. Trying to work it out from our understanding of how aerosol particles behave in the atmosphere suggests that the amount of solar energy reaching the ground will be reduced by anything from 0 to 4.5 watts per square metre. Working it out from a best guess of how sensitive the atmosphere is to greenhouse gases and how much warming we have seen so far gives 2 watts per square metre.

Such uncertainty has deterred researchers from estimating the effect of losing our aerosol shield. But as the skies are already starting to brighten (see *Nature* 435, 135; 2005), the question has become critical.



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Victorious: Cadarache, in southern France, has been selected to host the ITER fusion project.

think it very regrettable," says one senior fusion scientist, who asked not to be named. He says one theory about why France won is that the choice of Rokkasho, which is fairly isolated, gave the impression that Japan was not serious about the project.

Others blame Prime Minister Junichiro Koizumi for being unable to match his French counterpart's charm. "Jacques Chirac could get up and talk for 30 minutes about the value of ITER and its significance for the future," *Nature* was told. "Koizumi would just throw

out one sentence: 'We really want to get ITER!'"

Representatives from China and South Korea are said to be irked by the fact that Japan is getting so many perks despite their equal contributions. But the Americans just seem happy to have a decision. "I think the response from the community is one of relief," says Gerald Navratil, a plasma physicist from New York's Columbia University.

Declan Butler

Additional reporting by David Cyranoski in Tokyo and Geoff Brumfiel in Washington DC.

Andreae, along with German and British colleagues, used a climate model specifically designed to simulate aerosol effects. After calibrating it against a series of more complex global models, they plugged in a range of values for aerosol cooling, and ran the model to simulate future temperatures as the skies clear (see pages 1187–1190).

For a present-day cooling of 1.5 watts per square metre, which most climatologists agree is a relatively conservative value, the model implies that temperatures could rise between 6 and 10 °C by 2100. That is well in excess of the current IPCC predictions, which suggest a temperature rise of between 1.4 and 5.8 °C over the same time period.

Andreae acknowledges that there are many uncertainties about his study. But he points out that it is the best estimate we have so far. "This forces us to accept that pessimistic climate scenarios are much more

"Pessimistic climate scenarios are now much more plausible."

plausible than had been thought," he says.

Other experts are more cautious. "Climate modellers like playing around with values," says Theodore Anderson, an atmospheric scientist and aerosol researcher at the University of Washington in Seattle. "It is legitimate to engage in speculative reasoning. But I object to conclusions based on the assumption that our knowledge is better than it actually is."

Anderson points out that, for high values of aerosol cooling, Andreae's model breaks down, predicting unrealistically high or infinite temperature rises. He says this could mean that our understanding of what is driving the climate system is wrong. Or, he suggests, natural climate variability might be much larger than most scientists assume.

"The predictions may look more dramatic than what we actually expect," agrees Olivier Boucher, head of climate chemistry and ecosystems at the Hadley Centre for Climate

Securing the funds

The international fusion experiment ITER finally has a home. But don't assume there's a smooth ride ahead. Before a formal agreement is signed and construction can begin, ITER members must win the money that they have pledged from their respective governments.

Scientists hope this will happen by the end of the year, but several obstacles must be overcome. "Just because a site has been selected doesn't mean we're finished," says Gerald Navratil of the US ITER team.

The European Commission has committed money for 2006, for example, but it will need to double that in the budgets for 2007–13. There's no doubt that the commission sees ITER as a priority, but as budget negotiations for Europe's Framework 7 research programme have stalled, the way ahead is less than clear.

The situation is more hopeful in Japan, where officials say they can easily come up with the desired funds. But in the United States legislation could delay participation in ITER by almost a year: the House of Representatives passed an amendment to that effect that could become law. And in Russia, reports say the trade ministry has proposed that no new money go towards the fusion project in 2006.

After 20 years of fraught negotiations, it is crucial that governments agree on funding fast in order to keep political momentum behind the project, says David Baldwin, director of fusion programmes at General Atomics in San Diego. "Otherwise, the negotiators will die of old age."

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Prediction and Research in Exeter, UK. "But this is still an alarming hint at the upper bound of what can happen."

All agree that precise observations about the vertical distribution of aerosols are required. Calypso, a satellite funded by the United States and France, will provide such data after its launch in August, although scientists warn that it could take 20 years to get a clear picture.

In the meantime, Andreae says he hopes his results will rouse political debate, especially as the G8 summit looms. "Mankind must fight CO₂ emissions more aggressively," he says.

The uncertainty surrounding the effects of global warming has been widely used to imply that things might not be as bad as projected, says Michael Grubb, an expert on policy responses to climate change at Imperial College, London. "This study is a timely reminder that uncertainty also means things could be a lot worse," he points out. "Politically, this is a hugely important message."

Quirin Schiermeier