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Fusion power

Bouillabaisse sushi

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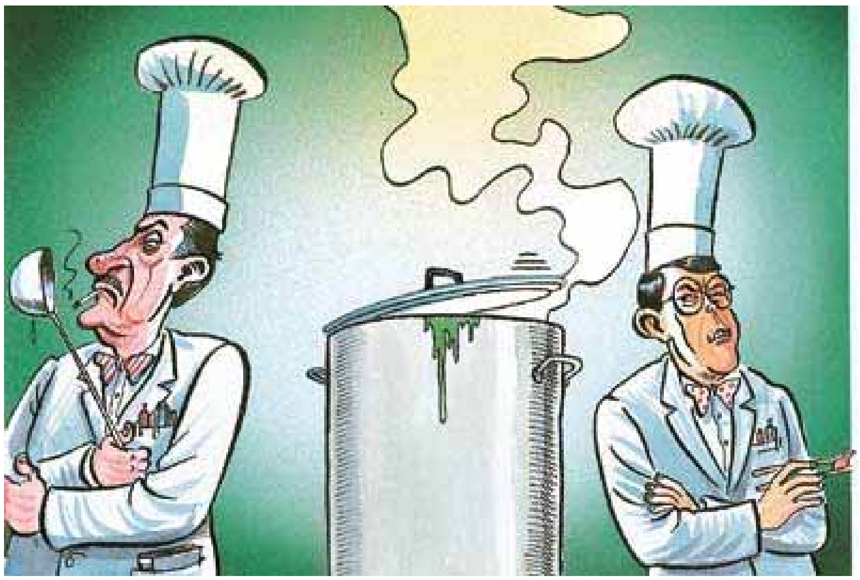

A site will soon be chosen for a new international fusion reactor. This is a pity

IF AVANT-GARDE cuisine is any guide, Japanese-French fusion does not work all that well. And the interminable discussions over the International Thermonuclear Experimental Reactor (ITER) suggest that what is true of cooking is true of physics. Japan and France (along with much of the rest of Europe, under the banner of an organisation called Euratom) are supposed to be joining America, China, Russia and South Korea in a project called ITER, which aims to build a fusion reactor.

Such a reactor would generate power by merging the nuclei of hydrogen atoms, and thus liberating the so-called binding energy whose absence, paradoxically, helps to hold complicated atomic nuclei together. This is a process similar to the one that powers the sun. Moreover, unlike previous attempts to do so, ITER would produce more energy than it consumed in getting the hydrogen nuclei hot enough to fuse in the first place.

The current imbroglio is over who gets the reactor, and with it the economic boost of a multibillion-dollar construction project. The two sites remaining in the competition are Cadarache in France and Rokkasho in Japan.

America is siding with Japan, while the French have the backing of the Chinese and the Russians. The South Koreans seem to be sitting on the fence, although leaning—if that is not stretching the metaphor too far—towards Europe. Meetings of ministers in December failed to resolve the issue (indeed, Canada withdrew from the project entirely) and the date for a decision keeps getting pushed back. According to spokesmen from the Japanese embassy in London, early March is now the target.

It is unusual for ministers to be discussing scientific projects of this nature, even ones as expensive as ITER. But the reason for all the attention is not that politicians have suddenly developed a particular interest in physics, but that the question of where to put ITER has become—so observers believe—another proxy for the debate over the war on Iraq. America is commonly thought to be supporting Rokkasho in return for Japan's support in Iraq. Meanwhile, the Russians and Chinese may be trying to spite the Americans by siding with the French. Nor are the French helping the situation by threatening (unlike the Japanese) to pull out of the project entirely if they do not get their way.

One ludicrous compromise would place the reactor in Japan and the data and control centre in France, or vice versa. Such gerrymandering recalls the worst of the International Space Station, a collaborative effort which is a scientific boondoggle, and contrasts badly with collaborations such as CERN, the European centre for particle physics, which is a model for international co-operation on big science projects. So, given ITER's price tag (about $5 billion to build, and another $5 billion in running costs for a 20-year operational lifespan and a ten-year decommissioning period), it might not be a bad outcome if the whole thing did go belly up. Although visionaries have long been lured to the idea of fusion because the fuel, being a constituent of water, is unlikely ever to run out, the economics of the process are dubious.

Boon or boondoggle?

Sceptics (including this newspaper) have pointed out that workable fusion power has seemed perpetually 30 years away since the first experiments were done in the 1950s. Even if the 30-year horizon were actually true on this occasion, the discount rate over three decades, and the opportunity cost of all those billions, would probably make it uneconomic. Nor is the world in obvious need of another way to generate electricity.

There are, of course, arguments on the other side. On the 30-year-horizon question Robert Goldston, the head of the Princeton Plasma Physics Laboratory (PPPL), America's premier fusion laboratory, points out that, although a forecast made in 1980 that an ITER-like project would be finished by now has obviously not come true, that projection relied on America's fusion budget increasing three-fold. Instead, he says, the budget was slashed by a factor of three.

In addition, Gia Tuong Hoang and Jean Jacquinot of Euratom point out in an article in the January issue of *Physics Today* that the performance of fusion reactors like those at PPPL and ITER has been doubling every 1.8 years. This, they observe, beats Moore's law, the famous observation that the number of transistors on a computer chip doubles every two years.

On the face of it, that sounds impressive. But even if this trend continues, it will take, according to a report compiled last year by Britain's Parliamentary Office of Science and Technology, until 2043 for fusion to become commercially viable. This forecast is even worse than the traditional 30-year horizon. A doubling every 1.8 years would lead to something like a 4m-fold improvement in performance over four decades. That sounds impressive but, in fact, it shows just how primitive existing fusion technology is. And the analogy with Moore's law is specious for another reason. Even the most primitive computer chips were useful, and found a market. Commercially, fusion is just money down the drain until a reactor that is powerful and reliable enough can be built.

And so fusion advocates are reduced to the last refuge of the desperate engineer—spin-offs. No doubt these would come. Reactors of the ITER design, known as tokamaks (from the Russian for "toroidal magnetic chamber"), look like giant, hollow doughnuts. They work by heating special isotopes of hydrogen contained in the hollow of the doughnut to the point where the electrons and atomic nuclei in the gas part company to create an electrically conducting mixture called a plasma. Further heating speeds the nuclei up to the point where, if they collide, they merge and release the binding energy that will eventually, so the plan goes, be harnessed to make electricity.

Some spin-offs may come from a better understanding of high-temperature plasmas, though they are hard to predict. More plausible spin-offs would be in the field of superconductivity. The electromagnets needed to "confine" the hydrogen while it is heated to fusion temperatures will rely on superconducting wire to feed electricity to them. Superconductivity (which employs a combination of special materials and low temperatures to achieve resistance-free electrical transmission) is another "nearly" technology which has been promising more than it has delivered for many decades. But it is a lot more "nearly" than fusion, and a concerted, technically demanding push in this area might, just, bring it to the point where it could break out of the specialist applications to which it is now confined and contribute to, say, long-distance power transmission.

Whether these spin-offs would justify the price-tag, though, is questionable. If they are worth pursuing, it would surely be better to invest in projects focused on them, rather than hoping they will magically emerge from something else. All in all, ITER seems more boondoggle than boon. Governments should spend their research money on other things.