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Quest for nuclear fusion in the forest

By James Kanter International Herald Tribune
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CADARACHE, France Scientists seeking to capture the power of the sun could soon stumble over one of humankind's earliest quarries - the wild boar - as they hunt for a new source of clean and abundant energy in this forest in southern France.

Chestnut-haired pigs streak among the oak trees of Cadarache, at the confluence of Verdon and Durance rivers, 40 kilometers, or 25 miles, from Aix-en-Provence. Hunters gather two or three times a year to keep the animals' numbers in check, and some residents still decorate the outsides of their houses with hooves and tails as signs of boar-hunting prowess.

But ever since President Charles de Gaulle designated Cadarache a center for atomic research in the late 1950s, the main business of the forest has been testing the nuclear reactors that supply France with 80 percent of its electricity.

Now Cadarache is to be the site of one of the most ambitious scientific quests ever undertaken.

Six partners - the European Union, the United States, China, Japan, Russia and South Korea - agreed in June to build a facility here called the International Thermonuclear Experimental Reactor, or ITER. The goal is to use nuclear fusion to reduce the world's reliance on fossil fuels and replace many existing nuclear power plants with far cleaner models powered by abundant materials found in the ocean.

The choice of Cadarache was a victory for President Jacques Chirac, who led a determined campaign to beat rival bids from Spain and Japan. The project - worth about 10 billion, or $12.2 billion, over the next 30 years - is a shot in the arm for France, where unemployment is on the rise and national pride took a beating after losing a bid to host the Olympics to Britain. But for scientists at Cadarache, a project to create a source of virtually unlimited energy transcends national interest at a time when reserves of oil and gas are dwindling even as consumption rises, fueling global warming.

"The situation today is one in which people even go to war over increasingly scarce supplies of petrol," said Pascal Garin, the ITER project leader at Cadarache. "We are modest engineers, but making the benefits of fusion available to humankind is powerful element for us to push this project forward."

Scientists like Garin already know how to make a reactor like ITER work but say they need 15 years of further experiments to learn how to keep it running and to test materials under extreme conditions.

All modern nuclear plants generate power through fission, splitting heavy uranium atoms. ITER will use a different process, fusion, which involves heating very lightweight

atoms to around 150 million degrees Celsius - or 10 times the temperature of the sun.

This process creates a "plasma" gas in which normally repelling particles combine and yield vast amounts of additional energy. By confining the hot plasma with powerful magnets, scientists aim to keep the process going in much the same way that the sun, confined by gravity, continues to burn in the shape of a ball.

On Earth, the easiest way scientists generate fusion is by combining small amounts of deuterium, which is a form of the element hydrogen extracted from sea water, and tritium, produced by bombarding with radiation the element lithium, which is also found in sea water.

Scientists say fusion could eventually be used to drive electrical turbines with steam. Fusion creates no greenhouse gases and produces far less hazardous waste than fission, although reactors do become radioactive and waste would still require special disposal.

Scientists have already heated deuterium plasma and produced fusion lasting more than six minutes in a reactor at Cadarache called Tore Supra, a sort of mini-ITER. But that experiment yielded less energy than was used to trigger the reaction in the first place.

Critics say ITER is destined to drain more power from the French electricity grid than it ever will produce. They also say it distracts from proven ways of producing power from renewable sources and discourages conservation.

"There's a hidden message behind the ITER project," said Stéphane Lhomme of the French group Sortir du Nucléaire (Get Out of Nuclear). "That message is, 'Don't change any of your consumption patterns because you'll soon have unlimited amounts of free power.' That's a big gamble."

But results from a reactor called JET, near Oxford, England, show that it is possible to extract nearly the same amount of energy used to reach fusion. With ITER, scientists aim to produce 500 megawatts, or 10 times the energy used to trigger and heat the plasma, over a period of nearly seven minutes - enough time, say scientists, to show that the burning plasma can sustain itself.

Plans for ITER show a casing 28 meters, or 92 feet, wide in the form of a doughnut, with a metal chamber inside. Eighteen D-shaped magnets, each weighing about 450 tons, hug the tube in much the same way snow chains hug a car tire. Liquid helium will course through tiny, precision-engineered pipes inside the magnets to maintain their superconductive properties.

ITER will be housed in a building 25 stories high, 18 stories above the forest floor. Massive components, including the magnets, will arrive by boat from other European countries and Japan at a port near Marseille and then move inland by barge. The final leg will be by road. The same engineering team that oversaw the shipment of parts for the new superjumbo Airbus passenger aircraft is helping to plan the required bridge and highway projects surrounding Cadarache.

Some residents see the project as a boon.

Aurore Paris, 27, works in a logistics company in Marseille but frequently helps her brother at his restaurant, the Palais de la Bière, in the town of Vinon-sur-Verdon, about seven kilometers from Cadarache. She is considering moving permanently to the area to take advantage of employment opportunities created by the influx of 1,000 scientists and their families.

Other residents are more skeptical. Stéphane Bertusi, 36, foresees years of disturbances from construction and heavy-truck traffic, and he complains about skyrocketing property prices. Bertusi, who writes software for one of the laboratories at Cadarache, owns his home in the village nearest to ITER, Saint-Paul-lez-Durance, but said he could not afford to buy a new plot of land for his growing family.

Rampant land speculation is a phenomenon that the mayor of Saint-Paul, Roger Pizot, attributes to buyers of second homes in sunny Provence rather than on ITER. Even so, the local authority has taken measures to control local land prices, steps that could help scientists from less prosperous countries like Russia afford to move in.

Odette Navarro, 61, expects a flood of new customers at the Bar de la Marie in Saint-Paul. But she warned that newcomers would probably have to wait if they wanted a table. Local zoning rules prevent her from expanding. "I won't see the benefits as I'm near retirement," Navarro said, "but this is important for the next generation."

To win the right to have the reactor in Europe, the EU authorities gave Japan the right to appoint a director general and build additional test facilities in Japan. Those details still must be finalized during talks that are scheduled to begin this autumn. All the partners are free to use the knowledge gained at ITER to push forward with their own fusion power projects.

Even then, proof that fusion will work commercially is not expected until at least 2020. Construction of power plants is unlikely to begin before 2050.

With rising energy prices and continuing turmoil in oil-producing regions, pressures could grow to accelerate the timetable. "There are a certain number of people who favor a fast track, and a lot of scientists say we only need a single step after an experimental reactor before building an actual power station," said Pascale Amenc-Antoni, the director of Cadarache. "There will be further international discussions about this and certainly Japan will be given its chance" to lead ITER-related projects, she said.

There are few obvious dangers in fusion. Reactions come in bursts and the introduction of any impurities in the plasma would stop the process immediately. But the antinuclear lobby in France has long warned of the danger of earthquakes from a fault line near Cadarache. Pizot, the mayor, who formerly worked at Cadarache as a maintenance engineer, dismissed those fears and said a nuclear reactor, because of its solid construction, would be the safest place to shelter during an earthquake.

For Garin, the ITER project leader, the only real danger at Cadarache is likely to occur early in the morning and leaving late at night - when newcomers must be careful to avoid collisions on the roads with bolting wild boars.

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