



Finland's new nuclear power plant at Olkiluoto will be home to Europe's first new reactor in 15 years.

design called a gas-pebble-bed reactor (PBMR). The new reactors are supposed to be inexpensive to build, more powerful, and safer; and they can be operated for up to 60 years, according to nuclear-power trade groups.

The international view

Late last year, officials from Bruce Power, one of Canada's largest power companies, announced a Can\$4.25 billion (US\$3.6 billion) investment to rebuild two reactors that have stood idle for nearly 10 years on the eastern shore of Lake Huron, north of Kincardine, Ontario. Last December, the Ontario Power Authority proposed plans to build 12 new nuclear plants to help phase out Ontario's coal-fired power stations.

New 1600-MW European PWRs are being built, one in Finland and one in France, with respective power-up dates of 2008 and 2012. On 5 January, France's president, Jacques Chirac, announced plans for an expansion of renewable and nuclear energy sources for France, including a PBMR by 2020. UK Prime Minister Tony Blair is expected to announce this spring six to eight new reactors in the UK.

Russia is currently constructing several reactors, including an 800-MW fast neutron reactor, but financial difficulties may delay four of them, says the London-based World Nuclear Association. Iran is building two Russian-designed reactors, the first of which should go on line later this year. The first South African PBMR is set to be completed in 2012.

Nuclear-industry officials have long said that the majority of growth would come in Asia. Japan is building five new power plants by 2010, and China plans to build 30 nuclear reactors, based on domestic designs, by 2020. China also sees nuclear technology as a major export opportunity, say industry analysts, and is building its second of four power plants for

Pakistan, which may lead to a larger order. India has nine power plants under construction, including a fast-breeder reactor that generates its own fuel.

Six countries—Argentina, Brazil, Bulgaria, Chile, the Czech Republic, and Turkey—may build two to five PWRs each, while Germany, Sweden, and Switzerland are now

reevaluating nuclear power.

US moves

The US nuclear power industry has been virtually frozen since the Three Mile Island accident in 1979, but in the US Congress 2005 energy bill, tax credits worth \$3.1 billion, along with liability protection and compensation for legislative delays, were added for the industry. On 30 December 2005, for the first time in years, the Nuclear Regulatory Commission (NRC) certified the design of a new reactor—the 1000-MW Westinghouse advanced passive (AP) reactor.

Six US power-plant operators are preparing combined construction and operating license (COL) requests to the NRC that could restart construction in the next five years. NuStart Energy, a consortium of nine nuclear energy companies, submitted plans for a General Electric simplified boiling water reactor at the Grand Gulf nuclear station near Port Gibson, Mississippi, and an AP-1000 reactor at the Bellefonte nuclear plant near Scottsboro, Alabama.

Two AP-1000 reactors may be built in the Carolinas by Duke Energy, along with another reactor by Progress Energy. "Preparing this application provides us the option to continue using a diverse fuel mix in the future," says Brew Barron, Duke Energy's chief nuclear officer.

Constellation Energy of Baltimore, Maryland, is in partnership with AREVA, a large French-German engineering firm, to submit COL requests for a European PWR at the Calvert Cliffs Nuclear Power Plant site in southern Maryland and the Nine Mile Point nuclear plant in Oswego, New York. Entergy, another NuStart member, announced it was preparing its own COL request for a new reactor at its River Bend Station power plant in St. Francisville, Louisiana. On 6 December, two electric utilities, Scana Corp and Santee Cooper, filed a letter of intent with the

Nuclear Regulatory Commission to build two new reactors north of Columbia, South Carolina, to meet growing regional power demands.

According to representatives of the electric utilities involved, the US government and the reactor technology suppliers are paying for most of the \$150 million the certification process costs. "The utilities are waiting to see if they can get any more subsidies out of the government," says Lyman, "so it's still premature to say if any of them will go ahead." A satisfactory means for disposal of their radioactive waste products has not yet been announced.

But the nuclear power industry believes the first new US order is only two years away. Says NuStart Energy president Marilyn Kray, "Our country needs these advanced nuclear plants."

Paul Guinnessy

NSF Centers to Study Societal Impact of Nanotechnology

To better understand and anticipate what one researcher calls the "risk, hope, hype, and fear" of nanotechnology, NSF is funding two new centers and two related projects to create a four-university network that will study the "societal implications" of the rapidly expanding field of science. The five-year grants, which total \$14.3 million, will fund the sixth major NSF nanotechnology research network and add yet another piece to the \$1 billion-per-year US National Nanotechnology Initiative.

The University of California, Santa Barbara, will receive \$5 million, and Arizona State University in Tempe will get \$6.2 million to establish the centers, which will research the implications of nanotechnology on everything from the equitable distribution of benefits to the convergence of biology and nanomachines. "Nanotechnology promises insights and innovations that could revolutionize whole sectors like manufacturing, energy, and health care," said David Guston, a political scientist and the principal investigator at the ASU center. But nanotechnology also raises profound questions about "identity, security, economic equity, bioconvergence of human and nanomaterials, and environmental and health risks," he said.

In addition to funding the centers, NSF is allocating \$1.4 million to a research group at the University of South Carolina to study the role of images in communicating about nanotechnology. The group will also look at

how evolving nanotechnology research is changing the scientific and engineering practices of the researchers themselves. Harvard University will receive \$1.7 million for expansion of an earlier project to create a database about nanoscience researchers, their research and patents, and organizations.

Connecting fragments

Mihail Roco, NSF's senior adviser for nanotechnology, said NSF has created 24 large centers and research networks in the field since 2000, and the foundation was looking for a way to "connect the fragments and address [societal concerns] in a systematic way." About three years ago, he said, "we realized we had the critical mass to create a new national network to look at the societal implications." Other NSF-sponsored nanotech networks are focused on research infrastructure, computer simulation, manufacturing, informal education through museums, and formal K-16 education and teaching.

In broad terms, he said, the UCSB and ASU centers will be looking at "short-term societal drivers in nanotechnology"—for example, the safety and toxicity issues involved in the creation of new materials. A near-term ethical issue is the equitable distribution of benefits from the products of nanotechnology, particularly the biomedical advances envisioned by many in the field.

"The longer-term implications are changes in the economy, and human development," Roco said. "We have to address all of these issues in a systematic way."

Guston said the large goal for the ASU center is to create a "governance frame" for the vast field of nanotechnology. A new model is needed for understanding the interactions of technology and society to improve policy choices, he said.

The complex nature of the ethical questions involved in nanotechnology is apparent in several examples Guston cited. "It is a plausible technological scenario where you will be able to walk into a room with spray paint and have, in the paint, nanosensors that can observe and transmit everything that occurs in the room," he said. "The idea that nanosensors can be imbedded in any substrate is both good and ill."

The bioconvergence issue raises questions about an individual's identity as a human, he said. Neural researchers at ASU are talking about implantable interfaces that will allow communication directly to the brain, he said. "They will also allow obser-

vation of what the brain is doing."

And soon, Guston continued, "we'll be able to have the entire contents of the Library of Congress in a nanodevice the size of a sugar cube that can be implanted in the brain. Whether that is good or bad gets to the issue of what is involved in this next generation of biological convergence of the human and non-human. It raises issues of great historical and philosophical importance."

At UCSB, W. Patrick McCray, a historian and codirector at the new center, said three working groups will look at nanotechnology in terms of its historical context, the public's perception of risk, and ongoing technological development. McCray said his interest in contemporary history will focus on the "risk, hope, hype, and fear" that is influencing society's view of the new technology.

"What is the policy that is developing for nanotechnology and how does that compare to the policy that brought about the space program?" he asked. "There is more money being spent thus far on nanotechnology than with the human genome at a comparable stage," he added. "When you're spending a billion dollars a year on it, maybe you ought to look at it."

Jim Dawson

Defense R&D Funding Sees Modest Increase

As the rest of the US government's fiscal year 2006 budget was being finalized by Congress in November and December, the Department of Defense budget was mired in congressional fights over a host of provisions that had little or nothing to do with defense—oil drilling in the Arctic, a ban on torture, hurricane relief, and preparations for a bird-flu pandemic. And although Congress added \$50 billion to the defense authorization for the wars in Iraq and Afghanistan, the Bush administration is expected to continue funding the conflicts through multi-billion-dollar supplemental requests outside the regular budget process.

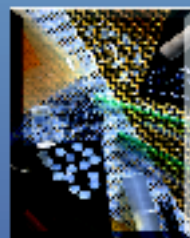
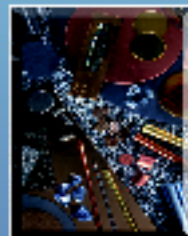
When the final DOD budget passed, the Arctic drilling provision was gone, but the other provisions remained, turning the \$453.5 billion defense authorization into something of a catchall bill that includes \$29 billion for Hurricane Katrina relief, \$2 billion to help low-income families heat their homes, and \$3.8 billion in bird-flu money.

The Katrina funding is to be paid for

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