

ties Construction program gets a \$400 million boost to work through the backlog of telescopes and other major research facilities that have been approved by the National Science Board (NSB), and \$100 million will be added to the foundation's science and math education programs.

Although Bement declined to say how the funds would be distributed among the agency's directorates, he did state that NSF, like other agencies, must have its plan vetted by the Office of Management and Budget and congressional appropriators before it can begin spending the money. But one NSB member, who did not want to be named, said Bement told the board that the plan was to spend the \$2 billion portion of the stimulus money to fund about 3000 research proposals that are in the pipeline and that received high marks from reviewers. While that's good news for investigators, new awardees could find that there's no funding for renewals when the stimulus-funded awards expire in three years, warns Amy Scott, a federal relations staffer at the Association of American Universities. Although the stimulus funds are supposed to be obligated before FY 2011, NSF has been looking into whether it could stagger award payouts to smooth the funding profile somewhat. Michael Lubell, director of public affairs at the American Physical Society, said that a portion of the funding could be used to help academic researchers purchase lower-price-tag lab equipment and to aid universities with the cost of establishing labs for newly hired faculty—an expense that typically runs \$500 000 or more. Obama's 2010 request for NSF is \$7 billion, up \$500 million from the agency's final appropriation for the current year, not counting the stimulus funds.

DOE cuts red tape

DOE also hasn't detailed how the \$1.6 billion for its Office of Science will be distributed. But Chu announced a streamlining of DOE's procedures that he said would get the ARRA money flowing by early summer. The paper-

work reductions and other reforms will enable DOE to pay out 70% of its stimulus funding by the end of FY 2010, Chu said.

In addition to its ARRA windfall, DOE's science office will receive a 19% increase to its base budget under the omnibus FY 2009 appropriations bill. Department-wide, DOE receives a \$2.5 billion increase to its base budget this year. But the agency purses would then shrink by \$600 million in FY 2010, if lawmakers follow Obama's budget proposal.

Much of ARRA will pay to begin modernizing the nation's fragmented and inefficient electricity grid (see related story below). Under ARRA, a clean-energy finance authority will be set up to coordinate the federal government's growing investments in renewable energy. Some \$6 billion in new loan guarantees is expected to stimulate tens of billions more in new private financing for renewable energy facilities, Chu told the Senate energy committee.

Chu said he is in the process of finding a director for a new DOE entity to be known as the Advanced Research Projects Agency-Energy. The stimulus act appropriated \$400 million for ARPA-E, which will fund high-risk research in energy technologies. The ARPA-E, he said, will consist of "a lean set of contracting people" to select technologies that are too risky to be financed by the private sector. The new office will be evaluated after two or three years and will be terminated if the concept doesn't look promising, Chu said.

As he sent his FY 2010 budget request to Capitol Hill, Obama reiterated his campaign pledge to invest \$15 billion a year for 10 years to develop renewable energy technologies like wind power and solar power and more efficient technologies for motor vehicles. That money would come from revenues generated by an economy-wide cap-and-trade system of controls on carbon dioxide that Obama is proposing to initiate in 2012. According to the budget document, the controls will cut US CO₂ emissions by 14% from their 2005 levels by 2020 and by 83% by 2050.

David Kramer

'Smart grid' gets big stimulus from US recovery plan

An updated electric grid will be more reliable and secure, but some warn that investments should await industry standards.

The more than \$38 billion in economic stimulus money appropriated to the US Department of Energy (DOE) from the American Recovery and Reinvestment Act (ARRA) includes \$4.5 billion to begin building a new "smart

grid," considered a prerequisite to major expansion of wind, solar, and geothermal energy facilities. A new transmission system will be needed to collect green energy generated at scattered points across sparsely populated areas

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"The investment we're making today will create a newer, smarter electric grid that will allow for broader use of alternative energy," President Obama said in remarks at the signing of ARRA on 17 February.

According to a report issued by DOE's Electricity Advisory Committee in December, smart features will enable consumers to lower their bills by programming appliances to turn on at times of the day when power is in less demand and less expensive. Such load-leveling will lessen the need for utilities to build new plants and transmission lines that are only switched on when electric demand peaks—in some cases for just a few hours each year. Fewer power outages and the capability to remotely pinpoint the cause of such problems are other smart-grid features.

The new system will be self-healing, continuously monitoring itself to detect and respond to problems that occur too quickly or are too large for human in-

tervention, according to a DOE vision plan. That will also make the grid more secure and capable of withstanding physical and cyber attacks. New generating capacity or electric storage facilities could be plugged into the smart grid with the same ease as plug-and-play peripherals for computers.

Clinton, Gore among supporters

An unusual coalition of government officials, business and labor leaders, and environmentalists convened in Washington, DC, in February to drum up political support for a new grid. Former president Bill Clinton and former vice president Al Gore attended the roundtable session organized by John Podesta, the well-connected former White House chief of staff who now heads the liberal think tank Center for American Progress. Among the other participants were Secretary of Energy Steven Chu, Senate majority leader Harry Reid (D-NV), House speaker Nancy Pelosi (D-CA), and several hundred reporters. Gore spoke of a smart-

grid-enabled future where rooftops covered by photovoltaics will feed the grid, displacing an electricity industry now dominated by carbon-belching, coal-burning stations.

Plenty of hurdles obstruct the path to a smart grid, not the least being finding someone who will pay for a system that legendary oilman-turned-energy-independence-crusader T. Boone Pickens estimates will cost \$200 billion. Utilities by and large are risk-averse, and their business model generally does not provide economic rewards for cutting-edge technologies, the DOE advisory committee noted. Determining exactly where to string the new high-voltage transmission lines will be arduous and contentious. State public utility commissions will decide whether utilities can add the cost of smart-grid technologies to their rates; it's likely that those decisions will vary from one state to the next, the committee report cautioned. As Pelosi put it, "It's always in someone's interest to not get this done."

In March DOE's electricity delivery

CERN role in thriller is boon for public outreach

A murder plot at CERN? Yes, at least in *Angels and Demons*, Dan Brown's 2000 best-selling novel. The Sony Pictures movie based on the book will be released on 15 May.

In *Angels and Demons*, a secret society wants to steal antimatter from CERN to build a bomb and destroy the Vatican. Part of the movie was filmed at CERN. The lab's actual antimatter storage apparatus is "a small and visually uninspiring facility," says CERN spokesman James Gillies, "so we took them to ATLAS," one of the main experiments at the Large Hadron Collider. In Brown's book, notes Gillies, "it's the LHC that is creating stored antimatter. That's complete nonsense." Antimatter is in fact created—but not necessarily captured and stored—in all high-energy collisions.

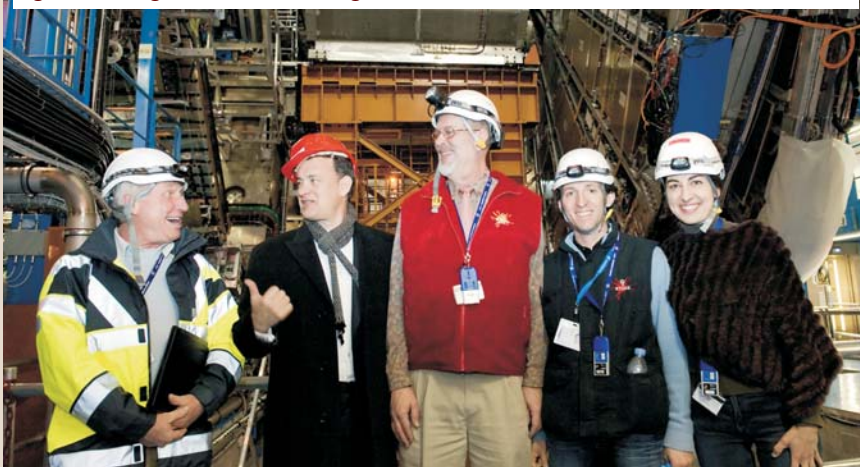
Also unrealistic is the amount of antimatter needed by the plotters in *Angels and Demons*. In fact, only tiny quantities can be made; the CERN website says it would take 2 billion years to produce the amount of antimatter needed for the fictional bomb.

Still, Gillies and others at CERN say they were impressed by film director Ron Howard's efforts to get the science and science culture right. For example, CERN scientists suggested such phrases as "resonant antiproton product" and "establish colliding beams" to the filmmakers. The CERN scenes appear before the opening credits, says Gillies. "The action is concentrated in Rome, but CERN is referred back to." And, he adds, "scientists will cringe a bit. One subtext is a perceived clash of science and religion, so [the filmmakers] couldn't avoid a God particle, which they link to antimatter."

But there is no doubt that *Angels and Demons* has been a boon to CERN. "The hits on our website went up by a factor of 10" when the book came out, says Rolf Landua, the CERN researcher

who most closely parallels the leading antimatter scientist in the book. "We are trying to hook onto the movie now and in the next few months, so we have an *Angels and Demons* exhibition here [at CERN] and an *Angels and Demons* tour. It's a fantastic opportunity to reach a lot of people." Similarly, US particle physicists are

Angels and Demons lead actor Tom Hanks (second from left) in the ATLAS cavern at CERN with members of the ATLAS experiment Rusty Boyd of the University of Oklahoma (center) and CERN's Tom Meyer (far left), William Andreazza (second from right), and Olga Beltramello (far right).



CERN/ATLAS/CLAUDIA MARCELLONI

urging their ranks to reach out to the public with lectures keyed to the film. (For preparatory materials and other information for giving or hosting a lecture, and for a link to a discussion of CERN-related facts versus fiction in *Angels and Demons*, visit http://www.uslhq.us/Angels_Demons.) But perhaps the biggest outreach event will be this fall, if *Angels and Demons* star Tom Hanks accepts CERN's invitation to return to the lab to press the on switch when the LHC is ready to restart.

Toni Feder

and reliability office, which will administer the ARRA funds, announced that it will soon solicit proposals from industry for an unspecified number of regional smart-grid demonstration projects. The agency will pay up to half the cost of the winning proposals, which will help to better pin down smart-grid costs and benefits, verify the viability of the technologies, and validate new business models. According to DOE's electricity office, the more than 3000 miles of needed new or modernized transmission lines will create jobs immediately.

Standards are needed

Among its other features, the smart grid will provide an integrated digital communications system to replace the slow and localized ones now used by the power industry. But because standards don't yet exist to ensure the interoperability of smart-grid components, there is some concern that the short-term stimulus funds could wind up paying for components that will become white elephants.

"I'm concerned about obsolescence," Senator Lisa Murkowski (R-AK), the ranking minority member of the Committee on Energy and Natural Resources, said at a hearing on 3 March. Murkowski recalled that Chu had previously described the lack of standards as the biggest impediment to modernization. She suggested that the disbursement of the ARRA grid funding be made contingent on development of the necessary standards.

"Before we can create a common language, we must assemble a common al-

phabet," agreed Evan Gaddis, president of the National Electrical Manufacturers Association, lamenting the slow pace of progress on standards. "NIST is our navigator, and the industry is ready to row."

NIST was instructed by Congress in 2007 to coordinate development of new grid standards, and ARRA provides \$10 million for the agency to do that. Patrick Gallagher, NIST's deputy director, told the Senate committee that due to the complexity of the existing US grid, suites of standards will need to be developed to cover multiple types of grid components. But Gallagher assured Murkowski that the potential for obsolescence will be minimal due to the open-architecture approach.

Utilities throughout the country are in the midst of installing smart meters in 40 million homes; the meters are expected to provide consumers with a new awareness of their energy usage at any given time. Edward Lu, advanced projects manager at Google Inc, told the Senate hearing that studies indicate that when consumers can see in real time how much energy they are using, they save 5%–15% on their usage by making simple behavioral changes.

Lu said the internet giant is developing a free software tool, PowerMeter, that will work in conjunction with the smart meters to provide consumers remote access to their home electricity consumption data from their computers or cell phones on a near-real-time basis. Other third parties also can be expected to offer energy management applications that will be smart-meter-based, he said.

David Kramer

Superconductors to boost wind power

More powerful generators are key to growing offshore wind farms.

Electricity from offshore wind farms could become cost-competitive with fossil fuels through the introduction of superconductors to wind turbines. That approach is being used by some US and European companies and government research laboratories to double the power of existing wind-turbine generators. Several groups expect to have generator prototypes ready for testing within two years.

Wind power is produced when the spinning blades of a wind turbine rotate magnets around coiled wire in a generator to induce electrical flow. More powerful generators mean that fewer turbines will need to be built to provide a given amount of electricity. That's espe-

cially important at sea, where frequent and expensive maintenance voyages have threatened to cripple the offshore expansion of wind farms. By using high-temperature superconducting (HTS) wire, which packs more than 100 times the current density of copper wire, such power increases can be achieved without the proportional size and weight gains that would accompany scaling up a conventional generator.

Super wind

"The manufacturing upper limit for conventional wind turbines is around 5 to 6 megawatts," says Daniel McGahn, a vice president at American Superconductor Corp in Massachusetts.

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