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 disbursal 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 alphabet," 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

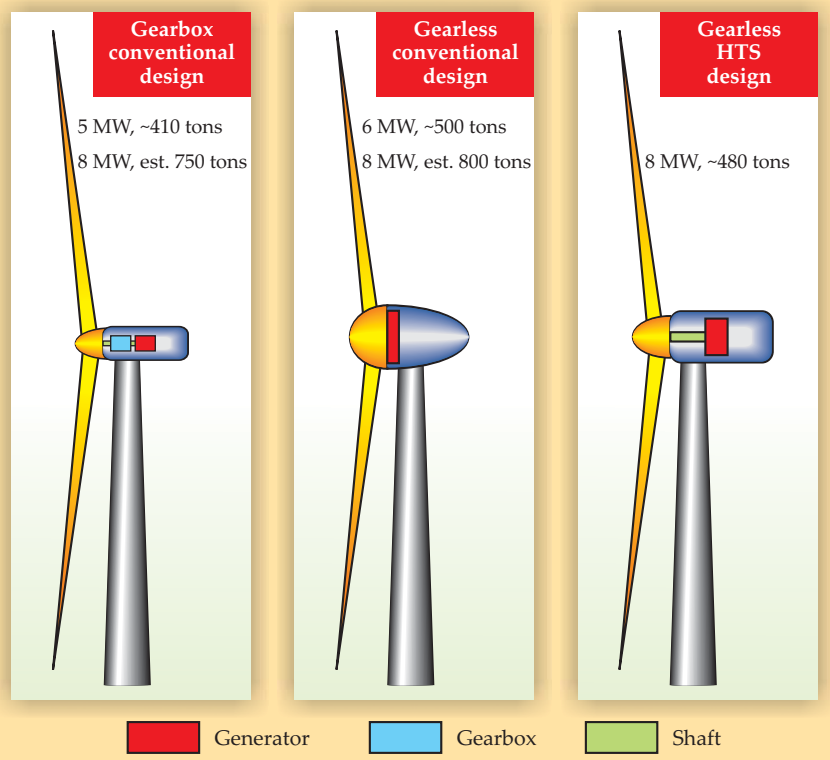
More powerful generators are key to growing offshore wind farms.

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 especially 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.



ADAPTED FROM AMERICAN SUPERCONDUCTOR CORP

Lightweight, superconducting generators will make possible 8- to 10-MW wind turbines (right) at a fraction of the weight and size that geared (left) and gearless (center) conventional copper-wire generators would have to be. (Adapted from American Superconductor Corp.)

But HTS technology is surpassing those limits: AMSC and Texas-based TECO-Westinghouse Motor Co have teamed up on an estimated $6.8 million project to design components for a 10-MW HTS generator. Another HTS device manufacturer, Germany's Zenergy Power Group, is working with Converteam Ltd in the UK to commercialize an 8-MW HTS wind-turbine generator. Because of the practical limitations to erecting large turbines, a generator's size and weight do matter, says Larry Masur, a Zenergy vice president.

A less powerful, research-grade HTS wind-turbine is near completion at Denmark's Risø DTU National Laboratory for Sustainable Energy. "We hope to use our [10-kW] prototype to model the properties of HTS generators and to learn how they would integrate with a turbine," says Risø senior scientist Asger B. Abrahamsen, who coordinates the activities of Risø's Superwind project. "We will not compete with industry," adds Abrahamsen. "We will collaborate with them." Denmark draws 20% of its electricity from wind power, more than any other nation, and is home to some of the wind industry's leading companies.

The efficiency benefits of HTS wire have been demonstrated in other applications. In 2007 AMSC designed and tested a 36.5-MW HTS ship-propulsion motor for the US Navy. And compact HTS power cables have replaced bulky copper-based ones in electrical-grid demonstrations (see PHYSICS TODAY, April 2005, page 41, and January 2008, page 30). For electrical equipment, the physics of HTS wire performance has been mostly solved, and only engineering optimization steps remain, says Bruce Gamble, AMSC's director of engineering. "We feel this is a ready-to-go technology."

But first engineers at the National Wind Technology Center in Colorado will factor performance, manufacturing, and operating costs into an evaluation of the cost of electricity from AMSC's 10-MW HTS wind turbine. The resulting model will be helpful for developing reliable offshore wind farms, says NWTC engineer Walter Musial.

Not science fiction

"Half of the Superwind project is making the wires cheaper," says Abrahamsen, whose colleagues are working on a more efficient process to deposit the layers of YBCO ($YBa_2Cu_3O_7$) superconducting cuprates that form coated conductors. "The cost of offshore wind power is about €1 million [$1.3 million] for 1 MW, and depending on the design, a 10-MW generator will require several hundred kilometers of HTS wire." To compete with the cost of copper wire, which is around $50/kA·m, Zenergy's Masur says that HTS wire manufacturing needs to ramp up, and the price of HTS wire needs to fall to $15–$30/kA·m—from values estimated by other sources to be as high as $100/kA·m at low-production volumes. That does not include the cost to maintain and operate the cryogenic equipment needed to cool the wire below its critical temperature.

The HTS generator project teams are also testing designs that eliminate the gearbox, which converts the low angular speed of a turbine's blades to a higher rotor speed to match the electrical grid's AC frequency. Gearboxes often break down, especially in the humid offshore environment, and that adds to the cost of maintenance. AMSC's Gamble says that his team has already yielded a gearless design that increases the torque on the rotor, which makes it easier to control the speed of the blades and maintain constant power flow to the grid.

The promise of HTS wind-turbine generators has the support of sectors from environmental groups to governments. Musial says it may take 10–15 years for commercial 10-MW or greater HTS generators to take off. "This is not science fiction," he adds, "but it is not a garage project either."

Jermey N. A. Matthews

New agency is proposed to run weapons labs

A new federal agency should be formed to take over and manage the nuclear weapons laboratories, an independent task force commissioned by the National Nuclear Security Administration has concluded. The panel, organized as a task force of the Henry L. Stimson Center, an arms control think tank, determined that NNSA, the semiautonomous weapons arm of the US Department of Energy (DOE), can no longer afford to maintain the labs' scientific infrastructures by itself as its budget steadily declines and with no new weapons design or manufacture on the horizon.

The proposed new agency would spread responsibility for the labs' upkeep among the various departments that use them, the task force said. The existing contracting arrangements through which the Department of Defense (DOD), Department of Homeland