

Superstation in New Mexico would unite fragmented US electrical grid

High- T_c superconductor cables would provide interregional access to renewable energy.

Texas winds could cool homes in California, and the hot Nevada sun could deliver heat to commercial buildings on the East Coast, if a proposed energy-trading hub in New Mexico sees the light of day. The Tres Amigas Superstation would physically unite the three regional US power grids—the Eastern Interconnection, Western Electricity Coordinating Council, and the Electric Reliability Council of Texas (ERCOT).

Three substations positioned to form a triangle with sides about 5 km long would each connect to a regional grid via new or existing transmission lines. The substations would be interlinked by high- T_c superconducting (HTS) ca-

bles. The hub would act as a portal through which energy—particularly solar and wind—from regionally isolated sources would flow. Tres Amigas (Spanish for “three friends”) would also be an early commercial application of high-temperature superconductivity in the grid. Technically, the hub could open for business as early as 2014, pending the go-ahead from the Federal Energy Regulatory Commission (FERC), which oversees the interstate transmission of energy.

Last September Tres Amigas LLC, the hub’s business arm, leased a 58-km² plot of government land at the eastern end of New Mexico. “The Southwest is

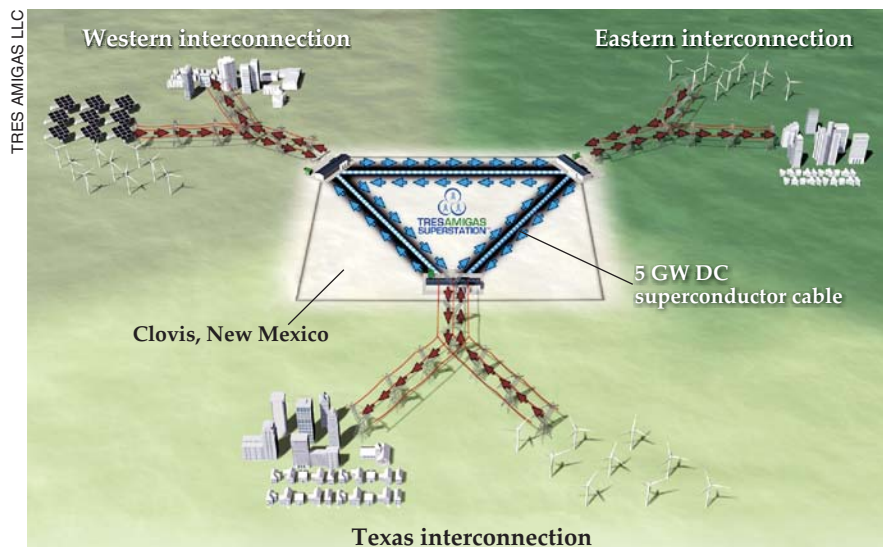
the richest region for renewable energy,” says company CEO Phil Harris, who conceived the idea for the hub. The region also holds plenty of oil and gas reserves and could host nuclear power plants in the future, but the hub, Harris says, “is engineered to meet a national need for renewable energy, and the political will and technology now exist to make this work.”

Power swap

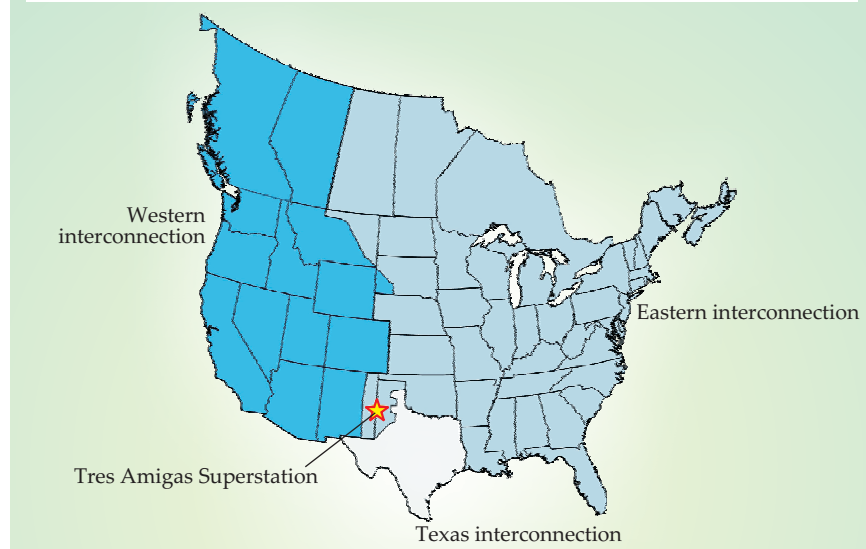
The Tres Amigas site lies about 2 km from the Texas state line and less than 150 km from existing or proposed transmission lines for all three interconnections. The site location allows the substations to be placed close to each of the regional grids, which lowers the cost to build new grid-to-substation transmission lines, if they’re needed. The HTS cables between any two substations could carry 5 GW, enough to power 3.5 million homes; the capacity could be increased to 30 GW with additional HTS cables. Even the 5-GW design is ambitious, says Steven Eckroad, underground transmission program manager for the California-based Electric Power Research Institute (EPRI). “There are a few small [links] between the Eastern and Western interconnections, but their total combined capacity is around 1 GW.”

To carry 5–30 GW of power, transmission lines could be placed underground to avoid weather-related outages, says Eckroad. HTS cables transmit the same power load in less than one-fifth the space required by copper cables, a particular advantage underground where installation costs are higher. At its core, an HTS cable is a bundling of razor-thin, flexible ceramic wires that conduct electricity below 77 K with no resistive losses. American Superconductor Corp, a part owner of Tres Amigas, will supply the HTS wire. The US Department of Energy has partially funded several in-grid demonstrations of AMSC’s technology (see PHYSICS TODAY, January 2008, page 30).

Instead of the AC transmission lines used in those demonstrations, AMSC has designed a DC cable for the Tres Amigas hub. That’s because the three grids are out of phase with each other, even though they all operate on the same 60-Hz frequency. Therefore, incoming AC power from one grid must be converted to DC before it can be synchronized with the phase of the receiving



A proposed energy-trading hub would exploit high- T_c superconducting cables to exchange 5–30 GW of power among the three US regional grids.



grid. At the hub's substations, that process will be done by voltage source converters. "The largest VSCs right now can handle around 600 MW, but VSCs allow us to grow in capacity because we can splice in as many of them as we want," says Harris. And Tres Amigas plans to store excess energy in 150-MW-capacity batteries to be installed at each substation.

Commercially viable

The project has attracted the interest of energy companies in the Southwest, including PNM Resources Inc, New Mexico's largest energy provider, which has submitted a letter expressing its desire to connect to Tres Amigas's proposed hub. Director of engineering and operations Greg Miller says that up to 20% of the company's power capacity comes from wind energy. In addition to exporting excess wind and solar energy by plugging into the hub, he says, "PNM could also see some potential reliability benefits."

Tres Amigas has received the blessing of New Mexico politicians, including Governor Bill Richardson and US Senator Jeff Bingaman (D), chairman of the Senate Committee on Energy and Natural Resources. In a statement, Bingaman said the station "will catalyze the adoption of renewable energy while . . . increasing the reliability of [the nation's] electricity network."

Political support notwithstanding, "we're not asking for stimulus funds, or guarantees, or grants," says Harris, who maintains that Tres Amigas will be a privately funded venture.

Harris would not say how much it would cost to build the hub, but EPRI estimates that its HTS DC cable will cost \$5 million per kilometer once it becomes commercially mature, says Eckroad. Whatever the costs end up being, Harris says that his experience and research convinces him that HTS cables are the only way, technologically and economically, to pull off the Tres Amigas concept. And funding it privately, he says, will "allow American Superconductor to show that their HTS technology is commercially viable and ready."

For now, though, plans are on hold as FERC considers whether to grant Tres Amigas permission to negotiate and set prices with utility companies and whether to exempt ERCOT from FERC's authority once the now-independent Texas interconnection plugs into the hub. At press time, FERC had not yet issued its decisions, and declined PHYSICS TODAY's request for an interview. But if FERC approves the first request, denies the second, and ERCOT refuses to join, Harris says that the hub will still go ahead with "dos amigas" and immediately begin to link the Eastern and Western grids.

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ferent approaches or interpretations that result in the creation of new paradigms or new scientific fields."

Globalization is a policy companion piece to the NSB's *Science and Engineering Indicators 2010*, a compilation of statistics and analysis that highlights rapid gains in foreign S&E investments, human capital, research infrastructure, and high-tech (see PHYSICS TODAY, March 2010, page 30).

Maintaining US leadership

The cabinet-level council called for in *Globalization* would determine the critical research fields in which the US should retain its world leadership. Other issues for the council's consideration are ensuring that the US economy benefits from R&D performed abroad by US-based multinational firms, developing cooperative relationships between US and foreign sponsors of R&D to secure continued US technical growth and strength, and safeguarding US intellectual property. Lanzerotti, a physics professor at the New Jersey Institute of Technology, said the benchmarking process called for in *Globalization* would help verify that federal funding for research is "wisely invested to ensure US leadership in science and technology."

Arden Bement, outgoing NSF director, noted that the postwar period of US dominance in nearly every field of science has ended. "It's quite possible that in many cases, we could be the co-leader, and in some cases we could be the fast-follower," he mused at the report's 19 February unveiling, adding, "The importance of that realization is that we have to stay connected with the rest of the world."

In the *Globalization* report, the NSB urges the Obama administration to heed a provision in the 2008 America COMPETES Act instructing the White House to establish a "council on innovation and competitiveness" to be chaired by the secretary of Commerce and comprising more than a dozen other cabinet-ranking members. The law charges that council with developing an "innovation agenda" and recommending policies for maintaining US leadership in science and technology. Although the legislation called for the new council to be organized apart from the framework of the National Science and Technology Council, President George W. Bush formally designated a committee of the NSTC to serve as the new council.

Lanzerotti said that the NSB would be happy if the Obama administration chose to follow its predecessor with regard to the placement of responsibilities

National Science Board warns of slide in US competitiveness

Board instructs NSF to select "truly transformational" research proposals and advises White House to ensure that US retains international leadership in key fields.

Following up on its January report documenting a surge of high-tech investments and competencies in China and other Asian nations, the National Science Board has issued a new report, *Globalization of Science and Engineering Research*. It recommends that a new cabinet-level council be formed to take stock of US innovation and competitiveness, and calls for the Office of Science and Technology Policy (OSTP) to lead a government-wide evaluation of US R&D programs against those of other nations. "The US government must be attentive to developments in S&E capacity around the world and take proactive steps to maintain our nation's competitive strength," said Steven Beering, NSB chairman.

In a third recommendation, the board instructs NSF to focus its funding on research that is "truly transforma-

tional" and to achieve that goal by adjusting as necessary the criteria used to rank grant proposals. As the only federal sponsor of nonmission research, says the *Globalization* report, NSF is obligated to "maintain its emphasis on the funding of basic, peer-reviewed research across the fields of science and engineering, with special attention to transformative S&E research in order to ensure that the U.S. remains a world research leader." The NSB is NSF's governing board.

Louis Lanzerotti, chair of the NSB Committee on Science and Engineering Indicators, said the board will soon establish a task force of its members to ensure that its instructions to NSF are implemented. The *Globalization* report defines transformative research as "revolutionary advancements, [made] through the application of radically dif-