# Researchers pursue re-engineering of US power grid for efficiency, renewable energy

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Imagine a modern nation that works, communicates, and entertains itself via an ever-expanding lattice of fast and efficient high-tech devices but powers this network with an electric system that dates to before many parts of the country even had electricity and leaks nearly as much energy as it transports.

This seemingly incompatible arrangement is in fact how the United States keeps itself plugged in. To bridge our high-tech lives with our early-20th-century generators, a research team in the University of Pittsburgh's Swanson School of Engineering has launched a large-scale project to integrate modern and efficient power-delivery technology into the rapidly growing American grid.

By employing the same simulation technology used to design and engineer electricity grids, the researchers will model an expanded power grid that delivers electricity from the power plant to our homes and businesses with less infrastructure and a more reliable and efficient flow of electricity. This improved infrastructure would not only conserve electricity, but also make it easier to tap into renewable resources, particularly solar and wind power, which are typically generated in remote locations far from consumers.

Lead researcher Gregory Reed, a professor of electrical and computer engineering in the Swanson School and director of the school's Power and Energy Initiative, explained that the problem with power delivery currently is one of consistency. Electricity in the United States is generated, transported, and delivered by alternating current (AC). But modern devices—from renewable power resources and electric vehicles to high-definition televisions, data centers, computers, and many other electrical devices—take a direct current (DC) input, hence the AC/DC converter most consumer electronics need.

The more practical choice before the electronic age, AC allows electricity to be delivered over long distances from a central generator such as a power plant; it also was more compatible with early industrial motors and other equipment, Reed said. But AC transmission requires more infrastructure than DC, and because electricity flows on the surface of an AC power line, it results in greater energy loss. DC delivers electricity directly via electronic circuitry without the need for AC's power-leeching transformers and iconic triple-wire steel towers. Plus, DC can be transferred over long distances with far less loss and at higher capacities, significant benefits in an increasingly spread-out society, Reed said.

Reed and his team are working to merge DC into the U.S.'s AC-dominated grid at the transport stage, he said. Only a few universities in North America—including North Carolina State University and the University of Manitoba, top institutions in electric power engineering—are investigating an upgrade of this scale, Reed said. The importance of the team's work is reflected by the significant government and industry support the Pitt project has so far received, including a recent $600,000 support grant from the Commonwealth of Pennsylvania's Ben Franklin Technology Development Authority. Industry supporters include ABB, Inc., and Eaton Corporation, among others.

"We have to expand our electric-power delivery network anyway as our nation becomes more digitized and people live and work further from power sources," Reed said. "It makes sense to take advantage of this time and upgrade to a new, better way to deliver power, instead of just building onto the infrastructure developed nearly 100 years ago. A DC infrastructure is better for taking full advantage of renewable energy resources and more compatible with the ubiquitous DC devices and systems at the consumer level."

Because Reed's research group cannot reconstruct an actual power grid, it has have acquired the same high-power simulator programs that are the industry-standard tools for designing and analyzing power transmission systems. Pitt is one of only a few universities licensed to use the full, professional version of the Power System Simulator for Engineering (PSS®E)—provided to the University by Siemens Energy, Inc., as part of a partnership between Pitt and Siemens—and one of only two with access to the commercial version of PSCAD/EMTDC, one of the most powerful electromagnetic simulators available.

"By using the same tools used for daily utility operations, long-term planning, and design and development, we can engineer a better electric power system that is realistic in both performance and implementation," Reed said.

"Like the few projects similar to ours, the work we've undertaken is very ambitious because of its scale," Reed continued, "but if we as a nation want to not only conserve energy but also get more out of the power we use, a DC-based infrastructure is an essential step forward."

Provided by University of Pittsburgh