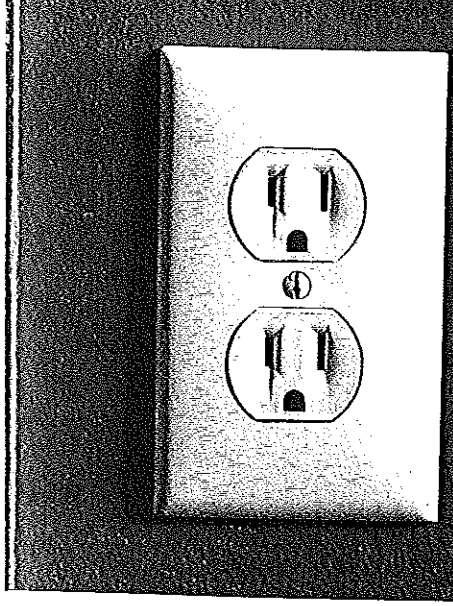


The Smart Grid

Transforming Electricity's Distribution

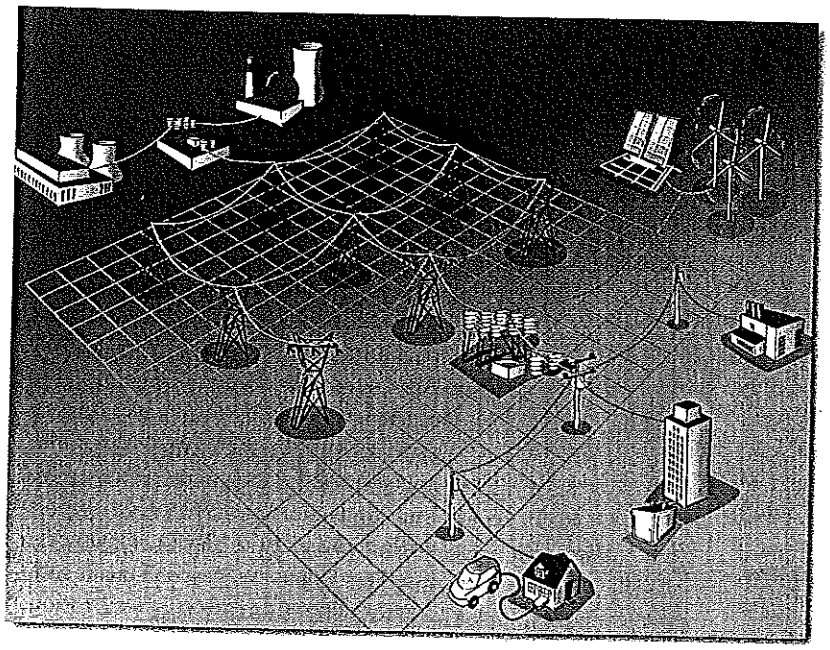
Through Smart Grid, our nation's transportation sector can be transformed by shifting toward electric vehicles that can be recharged from the grid.

BY STEVEN BOSSART

THE U.S. ELECTRICITY GRID is an aging infrastructure based mostly on designs of the 1950s and largely constructed in the 60s and 70s with periodic expansions to meet load growth. Much of the physical assets of the electricity grid are either near or beyond the end of their design life. Our nation's electricity grid is under increasing stress and being asked to perform functions it was never designed to perform, as evidenced by increases in transmission congestion; business losses from outages and power quality events up to $150 billion annually; increased frequency and duration of power outages; increased electricity prices and decreased asset utilization. Implementation of a Smart Grid can assist in reversing the stress on our electricity grid and enable a 21st century lifestyle and economy.

What Makes the Smart Grid "Smart"?

The Smart Grid uses digital sensors and two-way communications and controls to create a more intelligent electric power system that can access a greater variety of power resources including centralized generation (e.g., coal and nuclear), distributed generation (e.g., wind, solar, geothermal), storage (e.g., battery) and demand response (e.g., consumer response to price signals). The Smart Grid promises to deliver the quality of electric service demanded by consumers and society that is affordable, reliable, clean, safe and resilient and decreases our dependence on foreign sources of energy.



The components that will make up the Smart Grid.

National Energy Technology Laboratory's Role in Smart Grid

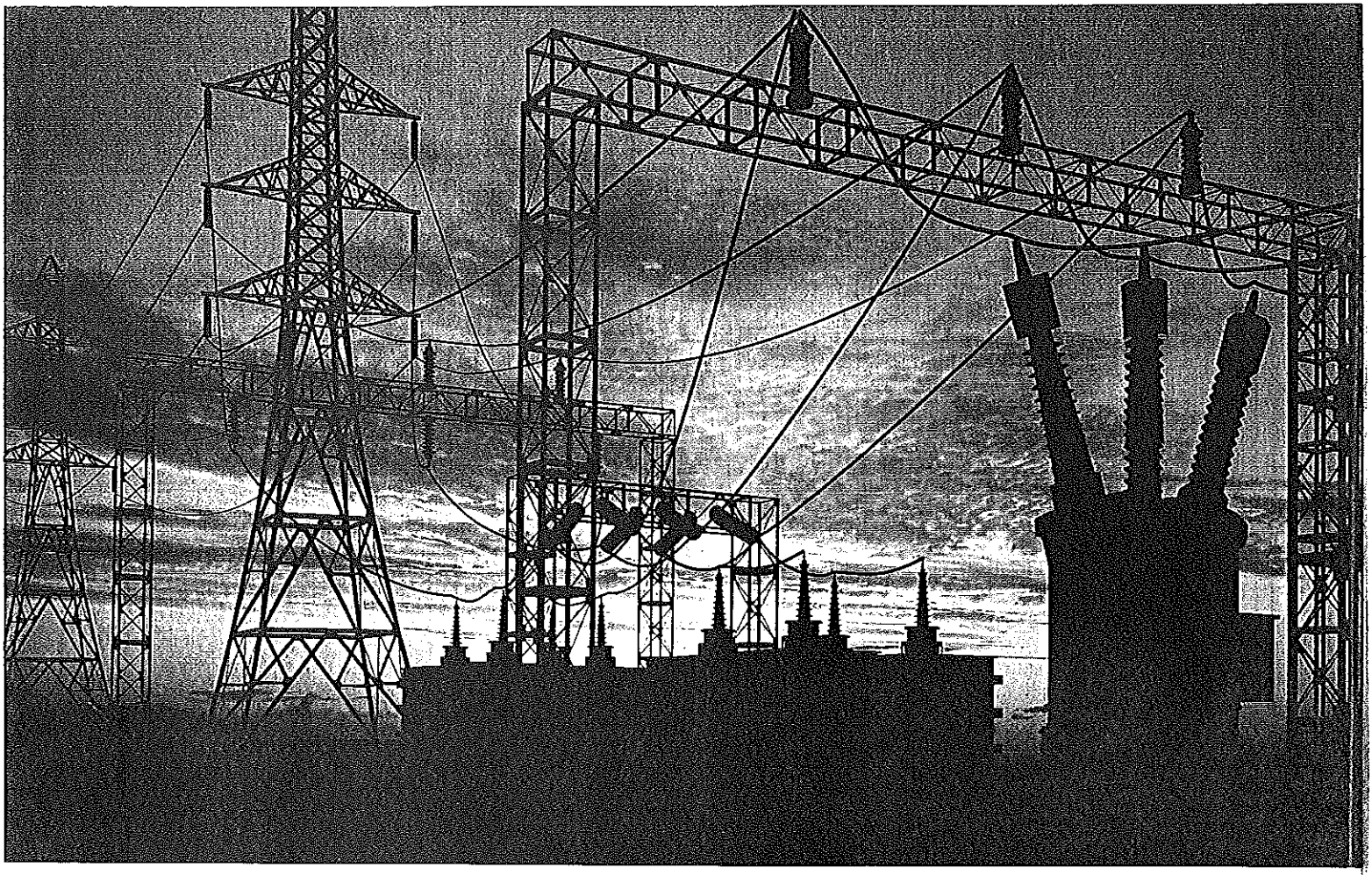
Since 2005, the U.S. Department of Energy's National Energy Technology Laboratory (NETL) has been at the forefront of facilitating and accelerating the transformation of the nation's electricity grid to a Smart Grid including major initiatives within West Virginia. The NETL Modern Grid Strategy team has facilitated the creation of a common vision for the Smart Grid that has been widely adopted by the government, electric power industry and its stakeholders. This vision is defined by its seven principal characteristics. The Smart Grid will:

1. Enable active participation by consumers in operation of the grid through demand response and consumer-owned generation and storage. The electric service provider can use these consumer resources to meet load demand, particularly during periods of peak load.
2. Accommodate all electricity generation and storage options, including the growing market of distributed generation and storage technologies.
3. Encourage new products and services, including financial markets to purchase and sell electric power.

ExEdge

The first transmission of three-phase alternating current using high voltage took place in 1891 during the international electricity exhibition in Frankfurt.

Source: http://en.wikipedia.org/wiki/Electric_power_transmission



4. Provide the quality of power demanded by an increasingly digital society.
5. Optimize the utilization of grid assets and operate efficiently by increasing load factors, reducing transmission and distribution losses and improving maintenance and planning processes.
6. Anticipate and respond to disturbances by detecting and correcting problems before they result in outages or by quickly restoring and isolating outages when they do occur (i.e., self-heal).
7. Operate resiliently against attack and natural disaster, including cyber events.

Key Smart Grid technologies that enable these seven principal characteristics include:

- Sensors to measure condition of the electricity grid in near real-time.
- Advanced controls that enable automated or manual operation of the grid.
- Advanced components that improve efficiency, reliability and power quality such as superconducting materials, energy storage and power electronics.
- Improved interfaces and decision support applications to assist operators in quickly assessing options to respond to events such as modeling, simulation, visualization and other analytical tools.

- A two-way communications system allowing sensors and controls to interact and manage the distributed generation, storage and demand response resources.

Value of Smart Grid

In 2004, the Electric Power Research Institute released a report on the cost and benefits of implementing a national Smart Grid. This report indicated that the incremental cost to implement Smart Grid was about $165 billion over 20 years and that the benefits of Smart Grid to electric service providers, consumers and society will outweigh its cost by 4:1 to 5:1. Through Smart Grid, our nation's transportation sector can be transformed by shifting toward electric vehicles that can be recharged from the grid. In the future, it may be possible for electric vehicles to store and then discharge their power to the grid, particularly during periods of peak load. The shift of the transportation sector from petroleum-fueled vehicles to electricity-driven vehicles is projected to decrease the import of crude oil by about 52 percent according to a 2007 study conducted by the Pacific Northwest National Laboratory.

NETL Smart Grid Activities in West Virginia

The West Virginia Smart Grid Implementation Plan (WVSGIP) is a collaborative project between NETL; its site-support contractor, RDS LLC; Allegheny Power; American Electric Power; West Virginia University; the State of West Virginia's Division of Energy and the DOE Office of Electricity Delivery and Energy Reliability. This project will detail the cost and benefits of a Smart Grid in West Virginia and create a roadmap with key milestones to guide its implementation. The plan will be the first statewide Smart Grid implementation plan.

In another project, Allegheny Power is leading a team of companies to develop the West Virginia Super Circuit. DOE selected the project as one of nine Smart Grid demonstration projects that will help shape the future of the nation's electricity grid.

The Super Circuit project will demonstrate how smart meters, advanced metering infrastructure and distributed generation and storage can be integrated with existing technologies to improve the electric grid performance and reliability for approximately 2,300 customers served by Allegheny's West Run Substation in Morgantown. The type of distributed generation resources will likely include biodiesel, micro-turbine and photovoltaic array while storage will likely be a sodium sulfide battery. Project goals include:

- reducing peak power consumption by at least 15 percent,
- enabling real-time pricing options and time-of-use billing,
- improving system efficiency,
- enhancing service reliability by automatic detection and diagnosis of outages coupled with automated switching to isolate problems and restore service and
- demonstrating the benefits of the integrated operation of distribution technologies, such as distributed generation, energy storage, automated load controls, advanced wireless communications and advanced system control technologies. ■

Photography by National Energy Technology Laboratory