Order Code RL34288

CRS Report for Congress

Smart Grid Provisions in H.R. 6, 110th Congress

Updated December 20, 2007

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Prepared for Members and
Committees of Congress

Congressional
Research
Service

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Summary

The term Smart Grid refers to a distribution system that allows for flow of information from a customer's meter in two directions: both inside the house to thermostats and appliances and other devices, and back to the utility. This could allow appliances to be turned off during periods of high electrical demand and cost, and give customers real-time information on constantly changing electric rates. Efforts are being made in both industry and government to modernize electric distribution to improve communications between utilities and the ultimate consumer. The goal is to use advanced, information-based technologies to increase power grid efficiency, reliability, and flexibility, and reduce the rate at which additional electric utility infrastructure needs to be built.

Both regulatory and technological barriers have limited the implementation of Smart Grid technology. At issue is whether a distinction for cost allocation purposes can be made between the impact of Smart Grid technology on the wholesale transmission system and its impact on the retail distribution system. Another issue limiting the deployment of this technology is the lack of consistent standards and protocols. There currently are no standards for these technologies. This limits the interoperability of Smart Grid technologies and limits future choices for companies that choose to install any particular type of technology.

H.R. 6, as signed by the President, contains provisions to encourage research, development, and deployment of Smart Grid technologies. Provisions include requiring the National Institute of Standards and Technology to be the lead agency to develop standards and protocols; creating a research, development, and demonstration program for Smart Grid technologies at the Department of Energy; and providing federal matching funds for portions of qualified Smart Grid investments.

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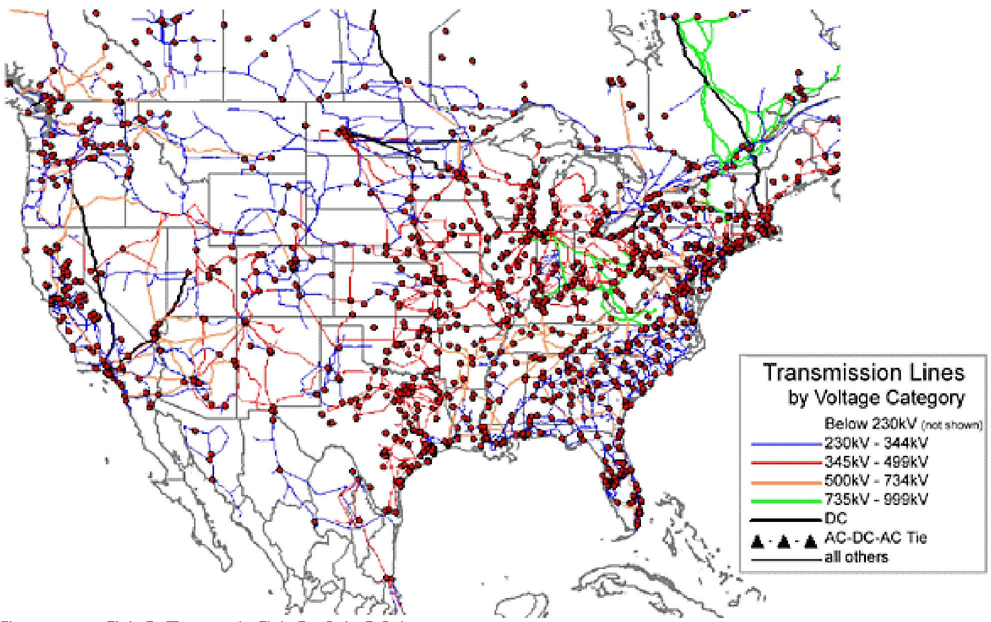
Introduction and Overview

The U.S. electric power system has historically operated at such a high level of reliability that any major outage, either caused by sabotage, weather, or operational errors, makes news headlines. As the August 14, 2003, Midwest and Northeast blackout demonstrated, a loss of electric power is very expensive and can entail considerable disruption to business, travel, government services, and daily life.

The electric utility industry operates as an integrated system of generation, transmission, and distribution facilities to deliver power to consumers. The electric power system in the United States consists of over 9,200 electric generating units with more than 950,000 megawatts of generating capacity connected to more than 300,000 miles of transmission lines; more than 210,000 miles of the transmission lines are rated at 230 kilovolts (kV) or higher (**Figure 1**).[1] In addition, approximately 150 control centers manage the flow of electricity through the system under normal operating conditions.

Figure 1. Electric Transmission Network

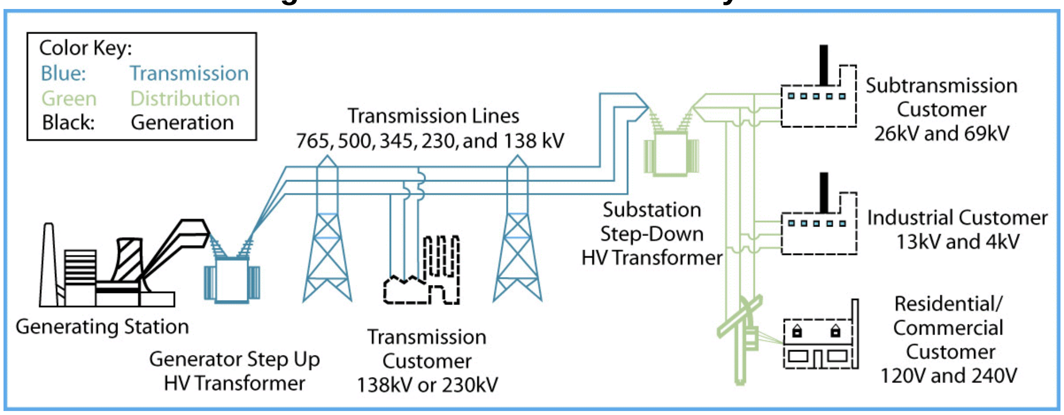


Source: GAO Report GAO-04-204

[1] North American Reliability Council. NERC 2007 Electricity Supply and Demand Database.

Most electricity in the United States is generated at power plants that use fossil fuels (oil, gas, coal), nuclear fission, or renewable energy (hydropower, geothermal, solar, wind, biomass). At the power plant, energy is converted into a set of three alternating electric currents, called three-phase power.[2] After power is generated, the first step in delivering electricity to the consumer is to transform the power from medium voltage (15-50 kilovolt (kV)) to high voltage (138-765 kV) alternating current (**Figure 2**).[3] This initial step-up of voltage occurs in a transformer located at transmission substations at the generating facilities. High voltages allow power to be moved long distances with the greatest efficiency, i.e. transmission line losses are minimized.[4] The three phases of power are carried over three wires that are connected to large transmission towers.[5] Close to the ultimate consumer, the power is stepped-down at another substation to lower voltages, typically less than 10 kV. At this point, the power is considered to have left the transmission system and entered the distribution system.

Figure 2. The Electric Power System



The transmission system continues to become more congested, and siting of transmission lines continues to be difficult. To try to maximize operation of existing infrastructure, efforts are being made in both industry and government to modernize electric distribution equipment to improve communications between utilities and the ultimate consumer. The goal is to use advanced, information-based technologies to increase power grid efficiency, reliability, and flexibility, and reduce the rate at which additional electric utility infrastructure needs to be built.

Some utilities have been using smart metering: meters that can be read remotely, primarily for billing purposes. However, these meters do not provide communication

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[2] The three currents are sinusoidal functions of time but with the same frequency (60 Hertz). In a three phase system, the phases are spaced equally, offset 120 degrees from each other. With three-phase power, one of the three phases is always nearing a peak.

[3] 1kV=1,000 volts

[4] The loss of power on the transmission system is proportional to the square of the current (flow of electricity) while the current is inversely proportional to the voltage.

[5] Transmission towers also support a fourth wire running above the other three lines. This line is intended to attract lighting, so that the flow of electricity is not disturbed.

back to the utility with information on voltage, current levels, and specific usage. Similarly, these meters have very limited ability to allow the consumer the ability to either automatically or selectively change their usage patterns based on information provided by the utility.

The term Smart Grid refers to a distribution system that allows for flow of information from a customer's meter in two directions: both inside the house to thermostats and appliances and other devices, and back to the utility. It is expected that grid reliability will increase as additional information from the distribution system is available to utility operators. This will allow for better planning and operations during peak demand. For example, new technologies such as a Programmable Communicating Thermostat (PCT) could connect with a customer's meter through a Home Area Network allowing the utility to change the settings on the thermostat based on load or other factors. PCTs are not commercially available, but are expected to be available within a year.[6] It is estimated that a 4% peak load reduction could be achieved using Smart Grid technologies.

Both regulatory and technological barriers have limited the implementation of Smart Grid technology. The Federal Energy Regulatory Commission (FERC) regulates the wholesale transmission system and the states regulate the distribution system. In general, the federal government has not interfered with state regulation of the electric distribution system. However, the Energy Policy Act of 2005 (EPACT05) required states to consider deploying smart meters for residential and small commercial customers.[7] At issue is whether a distinction for cost allocation purposes can be made between Smart Grid technologies' impact on the wholesale transmission system and retail distribution system. If FERC and the states cannot determine which costs should be considered transmission related (federally regulated) and which should be considered distribution related (state regulated) utilities may be reluctant to make large investments in Smart Grid technologies.

Another issue limiting the deployment of this technology is the lack of consistent standards and protocols. There currently are no standards for these technologies. Most systems are able to communicate only with technologies developed by the same manufacturer. This limits the interoperability of Smart Grid technologies and limits future choices for companies that choose to install any particular type of technology. The Department of Energy's (DOE's) Office of Electricity Delivery and Energy Reliability in partnership with industry is developing standards for advanced grid design and operations. In addition, DOE is funding research and development projects in this area.

Selected Utility Applications

Smart Grid technologies are currently being used by several utilities in small applications, mainly for testing purposes. However, the technologies within the

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[6] Personal Communication. Tom Casey, CEO Current Technologies. August 2, 2007.

[7] P.L. 109-58, §1252.

customer's house or business cannot allow for dynamic control of thermostats, for instance, but rather use switches to either turn an appliance on or off depending on preset criteria. The following applications of Smart Grid technologies represent some of the largest installations.

Southern California Edison Company

The California Public Utility Commission as well as the California Energy Action Plan call for smart meters as part of the overall energy policy for California.[8] On July 31, 2007, Southern California Edison Company (SCE) filed an application with the Public Utility Commission of California for approval of advanced metering infrastructure (AMI) deployment activities and a cost recovery mechanism for the $1.7 billion in estimated costs.[9] Beginning in 2009, SCE proposes to install through its SmartConnect™ program advanced meters in all households and businesses under 200 kW throughout its service territory (approximately 5.3 million meters). It is expected that demand response at peak times could save SCE as much as 1,000 megawatts of capacity additions. Dynamic rates such as Time of Use and Critical Peak Pricing should provide incentives to customers to shift some of their electricity usage to off-peak hours. According to SCE's application before the California Public Utility Commission:

> Edison SmartConnect™ includes meter and indication functionality that (I) measures interval electricity usage and voltage; (ii) supports nonproprietary, open standard communication interfaces with technologies such as programmable communicating thermostats and device switches; (iii) improves reliability through remote outage detection at customer premises; (iv) improves service and reduces costs by remote service activation; (v) is capable of remote upgrades; (vi) is compatible with broadband over powerline used by third parties; (vii) supports contract gas and water meter reads; and (viii) incorporates industry-leading security capabilities.[10]

In its filing, SCE is requesting approval to recover the operation and maintenance and capital expenditures associated with deployment of Edison SmartConnect™.

SCE is planning to use three telecommunications elements in addition to a smart meter.[11] The telecommunications system will include a Home Area Network (HAN) that is a non-proprietary open standard two-way narrowband radio frequency mesh network interface from the meter to customer-owned smart appliances, displays, and thermostats. Second, there will be a Local Area Network (LAN) consisting of a

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[8] California Energy Commission. *Energy Action Plan II*, September 21, 2005. Available at [http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF].

[9] Public Utilities Commission of the State of California. *Southern California Edison Company's (U 338-E) Application for Approval of Advanced Metering Infrastructure Deployment Activities and Cost Recovery Mechanism*. Filed July 31, 2007.

[10] Ibid., p. 7.

[11] Email communication. Paul De Martini. Director Edison SmartConnect™. August 2, 2007.

proprietary two-way narrowband radio frequency network that will connect the meter to the electricity aggregator.[12] Finally, a Wide Area Network (WAN) will be installed using a non-proprietary open standard two-way broadband network that will be used to communicate between the aggregator and the utility back office systems.[13] The meter will integrate the LAN and HAN in order to provide electric usage measurements, service voltage measurements, and interval measurements for billing purposes. These meters will have net-metering capability to support measurement of solar and other distributed generation at the customer's location. In addition, the meters will have security that has sophisticated cryptographic capabilities.

For the consumer, benefits include load reduction and energy conservation, which could result in lower electric bills. Outage information will automatically be sent to the utilities so customers won't need to report these disturbances. SCE is expecting to achieve greater reliability over time as additional information from the system is available to manage operations. For the utility, manual meter reading will be eliminated as will field service to turn power on to new customers.

Pacific Northwest GridWise™ Demonstration

The Pacific Northwest National Laboratory (PNNL) is teaming with utilities in the states of Washington and Oregon to test new energy technologies designed to improve efficiency and reliability while at the same time increasing consumer choice and control.[14] The utilities involved in the demonstration projects include the Bonneville Power Administration, PacifiCorp, Portland General Electric, Mason County PUD #3, Clallam County PUD, and the City of Port Angeles, Washington. PNNL has received in-kind contributions from industrial collaborators, including Sears Kenmore dryers, and communications and market integration software from IBM.

Two demonstration projects involve 300 homes as well as some municipal and commercial customers. The first project on the Olympic Peninsula involves 200 homes that are receiving real-time price signals over the Internet and have demand-response thermostats and hot water heaters that can be programmed to respond automatically. The goal is to relieve congestion on the transmission and distribution grid during peak periods. These 200 homes will test a "home information gateway" that will allow smart appliances such as communicating thermostats, smart water heaters, and smart clothes dryers to respond to transmission congestion due to peak demand or when prices are high. In addition, consumers will be able to see the actual cost of producing and delivering electricity, and cash incentives will be used to motivate customers to reduce peak demand. Part of the demonstration will study how existing backup generators can be used to displace demand for electricity.

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[12] An electric aggregator purchases power at wholesale for resale to retail customers.

[13] The two-way broadband network could include cellular, WiMax, or broadband over powerline.

[14] [http://gridwise.pnl.gov/]

The second demonstration involves 50 homes on the Olympic Peninsula in Washington, 50 homes in Yakima, Washington, and 50 homes in Gresham, Oregon. Clothes dryers will be installed in 150 homes and water heaters will be installed in 50 homes to test the ability of PNNL-developed appliance controllers to detect fluctuations in frequency. Fluctuations in frequency can indicate that the grid is under stress, and the appliance controllers can quickly respond to that stress by reducing demand. The appliance controllers will automatically turn off some appliances for a few seconds or minutes, allowing grid operators to rebalance the system.

TXU Electric Delivery Company

In October 2006, TXU Electric Delivery entered into an agreement to purchase 400,000 advanced meters. TXU Electric Delivery plans to have 3 million automated meters installed primarily in the Dallas-Fort Worth area by 2011. As of December 31, 2006, TXU had installed 285,000 advanced meters, 10,000 of which had broadband over powerline (BPL) capabilities.[15] This system combines advanced meters manufactured by Landis+Gyr with BPL-enabled communications technology provided by CURRENT Technologies. TXU Electric Delivery in the near-term will primarily use the advanced meters for increased network reliability and power quality and to prevent, detect, and restore customer outages more effectively. It is expected that TXU electric delivery will eventually include time-of-use options and new billing methods to its consumers.

On May 10, 2007, the Public Utility Commission of Texas issued an order allowing for the cost recovery of advanced meters.[16]

Summary of H.R. 6 Smart Grid Provisions

H.R. 6, signed by the President, contains a provision on Smart Grid technologies to address some of the regulatory and technological barriers to widespread installation.[17] This section summarizes Title XIII.

Section 1301. Statement of Policy on Modernization of Electricity Grid

It is the policy of the United States to support the modernization of the electric transmission and distribution system to maintain reliability and infrastructure protection. The Smart Grid is defined to include: increasing the use of additional information controls to improve operation of the electric grid; optimizing grid operations and resources to reflect the changing dynamics of the physical

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[15] TXU Electric Delivery Company Annual Report. Form 10-K filing to the Securities and Exchange Commission. March 7, 2007.

[16] Public Utility Commission of Texas. Project Number 31418. Rulemaking Related to Advanced Metering. May 10, 2007.

[17] H.R. 6 was signed by President Bush on December 19, 2007.

infrastructure and economic markets, while ensuring cybersecurity; using and integrating distributed resources, including renewable resources; developing and integrating demand response, demand-side resources, and energy-efficiency resources; deploying smart technologies for metering, communications of grid operations and status, and distribution automation; integrating "smart" appliances and other consumer devices; deploying and integrating advanced electricity storage and peak-shaving technologies; transferring information to consumers in a timely manner to allow control decisions; developing standards for the communication and the interoperability of appliances and equipment connected to the electric grid; identifying and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Section 1302. Smart Grid System Report

No later than one year after enactment, and every two years thereafter, the Secretary of Energy shall issue a report to Congress on the status of the deployment of smart grid technologies and any regulatory or government barriers to continued deployment.

Section 1303. Smart Grid Advisory Committee and Smart Grid Task Force

Within 90 days of enactment, the Secretary of Energy shall establish a Smart Grid Advisory Committee, whose mission is to advise the Secretary of Energy and other relevant federal officials on the development of smart grid technologies, the deployment of such technologies, and the development of widely-accepted technical and practical standards and protocols to allow interoperability and integration among Smart Grid capable devices, and the optimal means for using federal incentive authority to encourage such programs.

In addition, a Smart Grid Task Force shall be established within 90 days of enactment. This task force will be composed of employees of the Department of Energy, Federal Energy Regulatory Commission, and the National Institute of Standards and Technology. The mission of the Smart Grid Task Force is to ensure coordination and integration of activities among the federal agencies.

Section 1304. Smart Grid Technology Research, Development, and Demonstration

The Secretary of Energy, in consultation with appropriate agencies, electric utilities, the states, and other stakeholders, is directed to carry out a program, in part, to develop advanced measurement techniques to monitor peak load reductions and energy efficiency savings from smart metering, demand response, distributed generation, and electricity storage systems; to conduct research to advance the use of wide-area measurement and control networks; to test new reliability technologies; to investigate the feasibility of a transition to time-of-use and real-time electricity pricing; to promote the use of underutilized electricity generation capacity in any substitution of electricity for liquid fuels in the transportation system of the United States; and to propose interconnection protocols to enable electric utilities to access electricity stored in hybrid vehicles to help meet peak demand loads. The Secretary of Energy shall also establish a Smart Grid regional demonstration initiative focusing on projects using advanced technologies for use in power grid sensing, communications, analysis, and power flow control.

Section 1305. Smart Grid Interoperability Framework

The Director of the National Institute of Standards and Technology is primarily responsible for coordinating the development of a framework for protocols and model standards for information management to gain interoperability of smart grid devices and systems.

Section 1306. Federal Matching Funds for Smart Grid Investment Costs

The Secretary of Energy shall establish a program to reimburse 20% of qualifying Smart Grid investments.

Section 1307. State Consideration of Smart Grid

The Public Utility Regulatory Policies Act of 1978 (16 U.S.C. 2621 (d)) is amended to require each state to consider requiring electric utilities demonstrate that prior to investing in non-advanced grid technologies, Smart Grid technology is determined not to be appropriate. States must also consider regulatory standards that allow utilities to recover Smart Grid investments through rates.

Section 1308. Study of the Effect of Private Wire Laws on the Development of Combined Heat and Power Facilities

Within one year of enactment, the Secretary of Energy shall submit a report to Congress detailing a study of the laws and regulations affecting the siting of privately owned electric distribution wires on and across public rights-of-way. This study will assess whether privately owned electric distribution wires would result in duplicative facilities and whether duplicate facilities are necessary or desirable.

Section 1309. DOE Study of Security Attributes of Smart Grid Systems

Within 18 months of enactment, the Secretary of Energy shall report to Congress the results of a study which provides a quantitative assessment and determination of the existing and potential impacts of the deployment of Smart Grid systems on the security of the electricity infrastructure and its operating capability.