The Smart Grid:
Opportunities for Industry and How IEEE Can Help

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Executive Summary

- A partnership of industry and government has begun to fund and overhaul the electrical power grid around the world and build a smart grid that is more secure and efficient, delivering power at a lower cost. The development will evolve over the next 20 years.

- The smart grid will add monitoring, analysis, control and communication capabilities to power generation and distribution. Real-time information on costs, demands and supply of power will provide control at every level of the system. Consumers will both receive and contribute power to the smart grid from ultimately anywhere in the world.

- Large appropriations are being spent around the world to advance smart grid. In the U.S., bills have been passed nationally and at the state level to mandate renewable energy standards, funded by both government and industry.

- The need for cross-industry research is immense. Smart grid queries of IEEE data resources have increased. Collaborations have begun between experts in diverse fields—electrical systems engineers with software developers, communications firms and the computer systems experts—to develop technologies for new applications in distribution, communication, analysis and control. Millions of new products and devices will be required.

- IEEE, a leader in standards and technology expertise, is working with NIST to develop smart grid standards and technologies to save firms time and money, while collaborating with other standards bodies to ensure proper coordination. IEEE has nearly 100 smart grid standards, including over 20 IEEE standards named in the NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0.

- IEEE is a provider of vital smart grid research. Over 100 smart grid technical sessions have been offered by IEEE, as well as more than 1,000 conferences around the world. IEEE offers a wealth of digital and print research resources. Trial subscriptions to IEEE Xplore® digital library are available by request at www.ieee.org/freetrial.
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About the Smart Grid and Its Impact on the World

In the next two decades, a partnership of industry and government will overhaul the electrical power grid in the United States and other countries, building toward a smart grid that is more resistant to failure, more secure, more efficient and delivers power across the system at a lower cost to producers and consumers.

Much of the existing electrical power infrastructure is worn and needs replacement, and was built when demand was significantly lower—not just for lighting and heating, but for thousands of consumer and industrial applications that did not exist when the grid was first coming into being. As the infrastructure is expanded and upgraded, it will also be made more capable: the smart grid will add monitoring, analysis, control and communication capabilities to the national power generation and distribution infrastructure.

The aptly named smart grid makes everyone smarter. Energy consumers, producers and distributors will all have real-time information on the cost, demands and supply of power across the grid, enabling an unprecedented level of control at every level of the system. The smart grid will also flatten the power distribution world: when the project is sufficiently far along, there will no longer be local energy markets. Massachusetts wind farms will be able to supply Las Vegas consumers with power at rates comparable to that of the Hoover Dam. Similar scenarios will be developed around the world. Likewise, the smart grid will enable more widespread use of distributed generation: bringing generation closer to consumers. Solar-powered homes, for example, could buy energy from the grid at night and sell it back during the day, providing a strong green incentive for consumers and contributing to a more robust grid.

An advanced metering infrastructure (AMI) will enable consumer-friendly efficiency concepts like "prices to devices," under which prices are relayed to "smart" home controllers or end-consumer devices like thermostats, washer/dryers and refrigerators (major household consumers of power), which process the information and start or stop devices based on customer preference.

By being able to monitor power distribution in real time—multiple times per second, rather than multiple times per minute (the current standard)—producers will be able to accommodate energy needs more efficiently and minimize or avoid blackouts (the Department of Energy estimates that credit card operators lose $2.5 million per hour of blackout). A network that is more tightly monitored is also less vulnerable to deliberate manipulation and attacks.

A smart grid will also help take the peak out of peak demand. By allowing producers to better anticipate demand, the smart grid can minimize or eliminate the need for
so-called “peaker plants.” As the grid operates now, without a greater ability to anticipate when demand will peak or how high it will go, producers maintain peaker plants that only operate during peak demand. The peaker plants are expensive to operate (their fuel is necessarily bought on the more expensive spot market or cash market); generate additional greenhouse gases; and drive energy prices up, since the plants must be built, maintained and staffed, but generally remain idle much of the time.

It goes without saying that national economies—and the standard of living in the United States, as well as most of the world—rests squarely upon the electrical infrastructure. Expanding and modernizing that infrastructure may be one of the most important technological efforts in the coming decades.

**An Idea Whose Time Has Come**

Around the world, smart grid programs are growing and maturing.

The government of Ontario, Canada, through the Energy and Conservation Responsibility Act in 2006, mandated the installation of Smart Meters in all Ontario businesses and households by the end of 2010.

The Australian government has committed US$100 million to smart grid and is in the initial stages of launching a study into how to increase customer awareness and engagement in energy usage.

From the Republic of Korea to China and across the European Union, smart grid is being embraced, backed by large amounts of money and major players in the industry, who are all seeking solutions.

In the United States, industry, the federal government and individual states have recognized the urgent need for a revitalized electrical grid.

In 2007, the U.S. Congress passed the Energy Independence and Security Act, which mandates greater energy independence and security, increased production of renewable fuels, increased efficiency of products, buildings and vehicles, and new research on, and deployment of, greenhouse gas capture and storage options. The law includes a $100 million appropriation for a Smart Grid Regional Demonstration Initiative.

Thirty states in the U.S. have developed and adopted renewable energy standards, which require up to 20 percent of an individual state’s energy to come exclusively from renewable sources (in some cases as early as 2010). The growth of renewable energy resources can
only come about with an expanded and more flexible electrical grid to connect them to consumers.

In May 2009, Dr. E. James Prendergast, Executive Director of IEEE, participated in the Smart Grid Leadership meeting, organized by Commerce Secretary Gary Locke and Energy Secretary Steven Chu. In October 2009, President Obama announced the US$3.4 billion Smart Grid Investment Grant awards, part of the American Reinvestment and Recovery Act, which will be matched by utility industry funding for a total public-private investment worth more than $8 billion. Overall, more than a dozen other bills that include smart grid appropriations and mandates are pending in the House and Senate.

Building the smart grid will be an ongoing process. John McDonald of GE Energy T&D, who was announced in January 2010 as head of the U.S. Commerce Department’s National Institute of Standards and Technology’s Smart Grid Interoperability Panel Governing Board, says “It’s a journey, not a destination, and it won’t happen all at once.” Nonetheless, the smart grid will realize tangible benefits, McDonald says, even if its individual components are not all built at once.

The need for cross-industry information and research is immense, and smart grid queries of IEEE data resources have increased relative to this need. Experts in many diverse fields are finding themselves collaborating and developing new smart grid solutions. Naturally, producers of electrical systems equipment are expected to play a major role in building the smart grid, but software developers, communications firms and a large segment of the computer industry will also be engaged in rebuilding the electrical infrastructure.

Though it may take decades to reach a mature version of the smart grid, the work has already begun, and there is ample and urgent need for firms to envision and develop technology for an immense variety of new applications in distribution, communications, analysis and control.

The smart grid is a critical agenda item in the United States and around the globe. The need for new products and technology to service this effort will increase dramatically, and those firms that are early innovators will have a distinct edge as the project increases in size and scope.

Where Industry Fits In

The smart grid initiative will draw on firms from around the globe in developing products and processes. In addition to traditional industrial materials like wire, plastic and steel, the project will require literally millions of new products and devices, including chipsets,
photonic packages, metering equipment, hundreds of varieties of software, control
circuitry, telecommunications equipment, solar cells, sensors and RF devices, among others.

In the long term, it is likely that all sectors of the electronics industry will be deeply involved
in the building of the smart grid, so large is the project and diverse its components.

Firms that hope to bring products to market for the smart grid will need to develop
new expertise across a broad spectrum of manufacturing techniques, technologies and
standards. While some of that knowledge has yet to exist, much of it is already available in
IEEE’s technical publications and databases.

IEEE Partnerships

IEEE is naturally positioned to guide smart grid interoperability standardization, given its
close working relationship with the National Institute of Standards and Technology (NIST).
IEEE possesses a significant and relevant breadth of technology expertise and a worldwide
technical community.

IEEE is already a leader with existing standards and standards projects in development in
fields such as digital information and controls technology, networking, security, reliability,
assessment, interconnection of distributed resources including renewable energy sources to
the grid, sensors, electric metering, broadband over power line, and systems engineering.

Working closely with NIST, IEEE is helping to develop a standards roadmap, conformance
testing and certification framework for the smart grid, and is collaborating with other stan-
dards bodies to ensure standards coordination and the success of the smart grid initiative.

More than 100 smart grid technical sessions have been offered by IEEE in the past four
years, including the first Innovative Smart Grid Technologies conference, held in the U.S.
at the NIST campus in Maryland in January 2010. Smart grid standards were covered, as
well as power and energy system applications, cyber and physical security systems, wide
area protection in energy systems, advanced metering infrastructure, and other related
topics. IEEE annually hosts more than 1,200 conferences and meetings throughout the
world where best practices and the most current and timely research inform participants
from around the world.

Many firms already have expertise in some area of smart grid architecture, but that
expertise might not be put to its most effective use without understanding where a given
component or product will fit into the larger picture. IEEE can offer potential participants a
road map of the standards and technologies that will comprise the smart grid, saving firms
from costly and time-consuming false steps.
Getting There from Here

IEEE is one of the very few organizations able to provide industry with a wide diversity of expertise, information, resources and the vision necessary to realize the smart grid’s full potential. Those resources include the IEEE Xplore digital library, which includes journal articles covering the most current research and conference proceedings, including “IEEE Innovative Smart Grid Technologies” and the new “IEEE Smart Grid World Forum.” To date, more than 2,500 papers focused on smart grid have been published in over 40 IEEE journals.

IEEE has nearly 100 standards and standards in development relevant to smart grid, including the over 20 IEEE standards named in the NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0. The NIST report describes a high-level reference model for the smart grid, identifies nearly 80 existing standards that can be used now to support its development, and identifies high priority gaps for which new or revised standards are needed.

Available standards include:

- IEEE 2030 (Released September 2011) Draft Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads
- IEEE 802 LAN/MAN Standards Series
- IEEE SCC21 1547 Standards for Interconnecting Distributed Resources with Electric Power Systems
- IEEE Standard 1159 for Monitoring Electric Power Quality
- IEEE Standard 762: Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity
- IEEE SCC 31 Automatic Meter Reading and Related Services

In addition to vast digital and print resources, IEEE draws from a global community of experts in hundreds of specialties who support the organization’s knowledge societies, technical councils and committees, working and affinity groups and virtual networks. Taken together, these bodies offer industry a deep pool of expertise and guidance in conceptualizing and developing new products for the market.

There is no doubt that the smart grid is coming, and that it will emerge to be the bedrock of the nation’s economy for the foreseeable future. In the U.S., that initiative is being
funded now by the government and the utilities industry. Firms that seek to develop smart grid products for the market will require this funding, as well as expertise in standards for interoperability and design.

If your firm wants to be a part of building a greener, more resilient, and more cost-effective electrical infrastructure, IEEE should be your partner.

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