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energy efficiency

perfect power system techniques & applications

IT HAS BEEN MY PLEASURE TO serve as the guest editor for this issue of *IEEE Power & Energy Magazine,* which is dedicated to energy efficiency and perfect power systems. The articles, in their order of presentation, and their authors are presented as follows:

- ✔ "Striving for Power Perfection" by Kurt Yeager
- ✔ "Destination: Perfection" by Alexander Flueck and Zuyi Li
- ✔ "For the Good of the Grid" by S. Massoud Amin
- ✔ "The Right Combination" by John Kelly and Greg Rouse
- ✔ "Smart Integration" by Ali Vojdani.

The article by Kurt Yeager will set the stage for introducing perfect power systems and the essence of energy efficiency, smart grid, and applications of renewable energy in power systems. He defines perfect power as a paradigm which provides the following five basic functionality advantages:

- ✔ eliminate consumer electricity service interruptions and maximize energy efficiency
- ✔ minimize the cost of electricity service by optimally integrating clean local power resources with those of the bulk power system at all times
- ✔ provide varying "octane" levels of digital-grade power to meet individualized consumer needs
- ✔ expand consumer service value in terms of demand response, metering, billing, energy management and security monitoring, among others
- ✔ enable energy-smart appliances, power-market participation, and consumer-controlled distributed generation and storage.

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The article then discusses several phases of the implementation of perfect power systems based on the Galvin Electricity Initiative. The third phase of this project has led to the implementation of a perfect power system at Illinois Institute of Technology (IIT) that is the subject of the next article.

The second article is coauthored by Alex Flueck and Zuyi Li and reviews the initial application of perfect power systems in an academic institution in the United States. The U.S. Department of Energy, IIT, and a consortium of power industries have funded this multimillion dollar project. The outcome of the project will convert the IIT campus in Chicago to a state-of-the art power system operation that includes distributed generation, smart grid, a new power distribution system configuration for increasing the reliability, more advanced automation for self-healing, and more efficient facility operations throughout IIT. The project team at IIT has separated the campus into logical groups of buildings that will be located on electric and thermal loops to maximize reliability and efficiency. Each electricity loop will be continuously energized. In the event of a loss of any one section of cable or any switch, the design concept provides for the automatic isolation of faults without interruption of power to any loads. Reclosure is not necessary, but is available. Preliminary studies of the project indicate that the implementation of energy efficiency and smart grid technology could reduce the off peak campus power consumption by over 20%, reduce peak consumption by 50%, and delay the construction of a new substation at IIT by several years. The five-year IIT project will be concluded by 2013.

Massoud Amin's contribution, which follows, examines a balanced, cost-effective approach to investments in power systems and the use of technology that can make a sizable difference in mitigating power system outages. Given economic, societal, and quality-of-life issues and the ever-increasing interdependencies among infrastructures, a key challenge before us is whether the electricity infrastructure will evolve to become the primary support for the 21st century's digital society—a smart grid with self-healing capabilities—or be left behind as an 20th century industrial relic? He points out that achieving the grid security and reliability is a profitable national investment, not a cost burden on the taxpayer. The payback starts with the completion of each sequence of grid improvement. He concludes that considering the impact of regulatory agencies, they should be capable of inducing the industry to plan and fund the implementation of perfect power systems. This may be the most efficient way to get such initiatives for enhancing the power system operation.

Our fourth article, coauthored by John Kelly and Greg Rouse, describes a rich example of combined heat and power

(CHP) application for enhancing the energy efficiency in a metropolitan area. Energy efficiency is one of the components of perfect power systems as described by previous articles in this issue. The authors point out that the office building on Fifth Avenue in New York City has managed to cut its electric usage and cooling and heating needs with a new 1.6 MW on-site CHP system. This CHP system handles 60% of the building's electric usage and 65% of its cooling and heating needs. It generates electric power during on- and mid-peak hours and provides chilled water in the summer and hot water in the winter. Though its primary function is to increase the building's efficiency, the CHP system can also be configured to provide backup power to keep the building operational during an extended power outage, such as the one experienced by tenants during the August 2003 blackout (in conjunction with the building's existing diesel generator, which powers fire and life safety systems). Whenever the system is operational, the building remains connected to the local utility, ConEd, running in parallel with the utility's grid. This CHP installation is the first of its kind to be synchronously interconnected to the critical midtown ConEd network grid.

The final article, authored by Ali Vojdani, provides a clear overview on energy efficiency issues, renewable energy applications, and smart grid integration. Such components of perfect power systems, discussed by other papers in this issue, portray the grid of the 21st century and the applications of information technology in enhancing the power system operation and control in a competitive era. The author elegantly describes the numerous studies which suggest that consumers would use less electricity if they knew how much it was costing them. The effect becomes more pronounced during peak hours when prices are higher. U.S. Department of Energy studies concluded that when consumers are given the means to track and adjust their energy usage, power consumption declines. Similar studies estimated that smart grid technology, if used nationwide, could save billions of dollars in unneeded infrastructure investments, displacing the need for the equivalent of tens of large coal-fired power plants. Such cost savings are enhanced by a large reduction in carbon dioxide emissions. The author also argues that the transition to a smart grid/metering environment will require flexible design, agility, and improvisation necessitated by frequent and dramatic changes that are ill-suited for traditional utility-style projects. In this new environment, people, systems, solutions, and business processes must be dynamic and flexible, able to bend, shrink or stretch in response to changes in technology, customer needs, prices, standards, policies or other requirements.

We hope you enjoy these articles, which review several nationwide projects on energy efficiency, renewable and distributed generation, and applications of smart grid in the United States. We look forward to receiving your comments. p&e