

# Power of Two

## Illinois and South Korea: A Model Partnership for Smart Grid Collaboration

**Bruce Hamilton,  
Yeoung Jin Chae,  
Matthew Summy,  
Jordan Cutler,  
and David Kolata**

Digital Object Identifier 10.1109/MPE.2010.939160  
Date of publication: 21 December 2010

©PHOTODISC





**U**S. PRESIDENT BARACK OBAMA CAME to office with a commitment to act quickly and boldly in charting a new energy future that embraces alternative and renewable energy, ending the country's addiction to foreign oil, addressing the global climate crisis, and creating millions of new jobs in the clean-energy economy. Concurrently, on the other side of the globe South Korea President Lee Myung-bak unveiled what he called a "national strategy for green growth"—a new paradigm built on energy security, economic efficiency, and environmental protection. A common desire to provide leadership amid the global push to decarbonize has fostered the formation of partnerships and mutually beneficial cooperation between the two countries.

### **International Collaboration on Distributed Energy**

Several economic, reliability, and environmental factors make distributed energy resources (DER) an important option for managing energy prices, ensuring secure and reliable power, and reducing the need for additional power generation, transmission, and distribution equipment and infrastructure. DER have the ability to serve or manage on-site load and encompass distributed generation, demand response, and energy efficiency. In July 2008, the Korean government funded a three-year program of international collaboration on DER to be conducted by ADICA, LLC, in partnership with the Korea Power Exchange (KPX). ADICA is a global energy software and consulting company committed to empowering individuals, companies, and nations in the pursuit of sustainable development. Consistent with this goal, ADICA has organized projects to address energy-planning needs in Africa, Asia, the Caribbean, Europe, Latin America, and North America. The major objectives of the international collaboration program on DER are to:

- ✓ develop human resources in Korea for power planning and policy-making support in the area of DER
- ✓ facilitate KPX's cooperation and business relations with federal and regional organizations, research institutes, and universities renowned for the planning, analysis, and implementation of DER.

The activities carried out under the international collaboration program include arranging for Korean collaboration with the U.S. Federal Energy Regulatory Commission (FERC), Mid-Atlantic Distributed Resources Initiative (MADRI), PJM Interconnection, and Illinois Citizens Utility Board (CUB); reporting on the integration of DER

This globally connected public-private partnership between Illinois and Korea combines industry innovators, visionary government leadership, and sophisticated nongovernmental organizations.

into U.S. energy markets; and assessing demand response business models and the role of the independent system operator (ISO) in a smart grid environment. ADICA's Smart Market software was also applied to assess the impact of smart grid-enabled programs in Korea and the U.S. state of Illinois on consumer behavior, electricity prices, plant operations, generating company profits, and carbon emissions.

### **A United States–South Korea Smart Grid Collaboration**

In April 2009, ADICA facilitated the visit of a delegation led by the Korean Ministry of Knowledge Economy (MKE) to U.S. Department of Energy (DOE) headquarters, with the goal of discussing opportunities for smart grid collaboration. On this occasion, the Korean delegation presented a letter from Minister Choi Kyunghwan of the MKE to Secretary Stephen Chu of the DOE. The letter expressed Korea's desire to expand and promote bilateral cooperation in the areas of smart grid-related policy, technology standards, and R&D, along with enhanced cooperation in the private sector, including universities, research institutes, and companies. Two months later, during a summit meeting between Presidents Lee and Obama in Washington, D.C., Minister Choi and Secretary Chu signed a statement of intent for smart grid collaboration.

### **The Illinois-Korea Smart Grid Partnership**

The DOE-MKE agreement was a catalyst for focusing high-level government attention on the establishment of international public- and private-sector partnerships for the development, testing, and implementation of smart grid technologies. In November 2009, ADICA prepared a feasibility report titled "A Smart Grid and Green Technology Development Initiative Between the State of Illinois and Korea." In recommending Illinois as an ideal location and partner for smart grid development and deployment, ADICA noted the following key considerations:

- ✓ cutting-edge work being done at Illinois's world-class universities and federal laboratories
- ✓ Illinois's collaborative approach to the smart grid, which involves and engages communities across the state
- ✓ a wide array of smart grid and renewable-energy projects under way in the state
- ✓ supportive public policy, state and local governments, utilities, and consumers

- ✓ well-developed proposals for innovative smart grid implementation projects prepared for consideration of federal stimulus grant funding.

### **Cutting-Edge Smart Grid Research in Illinois**

The Argonne National Laboratory (ANL) is one of the DOE's largest national laboratories for science and engineering research. With more than 3,000 employees and an annual operating budget of around US\$630 million, ANL conducts cutting-edge research that seeks solutions to pressing national problems in the areas of energy, environmental systems, and national security. ANL is a recognized global leader in the development of transformational energy storage systems, alternative energy sources, and advanced power systems analytics. As the smart grid moves from concept to reality, ANL is helping to ensure this technology will interact seamlessly with the emergence of plug-in hybrid electric vehicles (PHEVs) through R&D in battery technology, "open" charging stations, vehicle instrumentation, data communication, customer behavior, and grid impacts.

Illinois Institute of Technology (IIT) is focused on enhancing the performance and security of the U.S. electric power infrastructure through a groundbreaking smart grid initiative known as the "perfect power" project. IIT partnered with the Galvin Electricity Initiative and the DOE, in collaboration with S&C Electric, Endurant Energy, and ComEd (Commonwealth Edison), to develop a perfect power system design for IIT's main campus. IIT wants this project to establish the institute as the undisputed leader in microgrid demonstration. In addition, IIT has signed a memorandum of understanding (MOU) with KPX regarding collaboration on graduate-level training on electricity markets.

Northwestern University (NU), with more than US\$475 million in sponsored research, often partners with ANL, Fermilab, and local universities to solve society's problems and facilitate commercial use of their innovations. In the university's economics department, research focuses on regulation, restructuring, retail competition, and technological change in the electricity industry. Experimental economic research in electricity markets investigates the impact of market design and regulatory policy. Research results are communicated to policy makers to enhance their understanding of market processes in energy industries.

The University of Chicago (UC) is one of the world's preeminent research universities. It is home to internationally renowned scholars, researchers, and intellectual pioneers. In

## The Korean and Illinois PMOs have communicated weekly since January and have held a number of face-to-face meetings.

the last century, UC produced more than 70 Nobel laureates. As one of six professional schools at UC, the Harris School of Public Policy Studies strives to understand and influence public policies by conducting policy-relevant research and preparing talented individuals to become leaders and agents of social change.

The University of Illinois at Urbana-Champaign (UIUC) is one of the largest research institutions in the world. Researchers in UIUC's Department of Electrical and Computer Engineering (ECE) collaborate with industry, government, and peer institutions in the search for solutions on a broad array of projects. Specific areas of interest include the dynamics and stability of power systems, energy and power system economics, and power system computational and visualization techniques. The Information Trust Institute (ITI), also based at UIUC, provides international leadership combining research and education with industrial outreach in trustworthy and secure information systems, including the electrical grid. ITI is home to the DOE-funded Trustworthy Cyber Infrastructure for the Power Grid project.

### Illinois's Collaborative Approach to the Smart Grid

Smart grid development efforts in Illinois began in 2008 when the Center for Neighborhood Technologies (CNT) formed the Illinois Smart Grid Initiative (ISGI), a public-private working group chaired by Chicago Mayor Richard M. Daley and former speaker of the U.S. House of Representatives J. Dennis Hastert. The purpose of the ISGI was to engage Illinoisans in an examination of the nature and potential benefits of a modernized electric grid and to map a policy path for achieving those benefits for consumers and the economy. The ISGI held a series of roundtable meetings featuring presentations and discussions about the smart grid concept and subsequently focused on public policy formulation. A final report was issued in April 2009.

The utility regulator, the Illinois Commerce Commission (ICC), then ordered the establishment of collaborative smart grid efforts in Illinois. The ICC evaluated a smart grid deployment proposal made by ComEd and based on a proposal made by the CUB and determined that the public interest could best be served by developing pilots and strategic plans for smart grid deployment in Illinois collaboratively. Two specific efforts were initiated. The first was a series of workshops evaluating advanced metering infrastructure (AMI) and tasked with developing AMI project goals, timelines, and evaluation criteria. The workshops resulted in an AMI pilot project with approximately 131,000 smart meters

operating in ComEd's service territory during 2010. The second effort was the more comprehensive Illinois State-wide Smart Grid Collaborative (SSGC), whose purpose was to consider the potential costs and benefits of smart grid implementation and develop a strategic plan for such implementation. The ICC developed the following policy objectives for the SSGC to evaluate and report on before the end of 2010:

- ✓ definition of a smart grid and its functionalities
- ✓ principles Illinois should use to guide smart grid planning and deployment—for example, interoperability, open architecture, and nondiscriminatory access
- ✓ uniform standards
- ✓ methods of estimating, calculating, and assessing benefits and costs, including evaluation of nonquantifiable benefits (and costs), and implications of smart grid technology for future policies regarding rate design, consumer protection, and customer choice
- ✓ the effect of statutory renewable resource, demand response, and energy efficiency goals on smart grid planning and implementation
- ✓ consumer education and dissemination of information about smart grid technologies, demand response programs, and alternative rate structures
- ✓ access by electricity market participants to smart grid functionalities
- ✓ data collection, storage, management, security, and availability to third parties
- ✓ standards for interconnection of third-party equipment
- ✓ mechanisms for flowing any utility smart grid revenues through to customers
- ✓ adoption of new demand response programs
- ✓ open architecture and interoperability standards for technological connectivity to the regional transmission organization (RTO) and/or independent system operator (ISO) to which a utility may belong.

### Federal Stimulus Funding

The American Recovery and Reinvestment Act of 2009 (ARRA) included two DOE grant programs directed to stimulate the deployment of smart grid development and deployment in the United States. A US\$3.375 billion Smart Grid Investment Grant program (SGIG) provides matching grants of up to 50% for investments planned by electric utilities and other entities to deploy smart grid technologies. In addition, a US\$615 million smart grid

demonstration grant program provides funding for smart grid demonstration projects that demonstrate regional benefits, utility-scale energy storage technologies, and grid-monitoring capabilities. Some of the grant project proposals submitted by organizations in Illinois following the enactment of ARRA are discussed below.

### **ComEd**

ComEd submitted a proposal for US\$175 million to support a comprehensive project involving customer systems, AMI, electric distribution systems, and electric transmission systems. The proposed project would complement the ComEd AMI pilot with the following additional investments:

- ✓ the installation of an additional 120,000 AMI meters to complete deployment of meters throughout the Maywood operating center
- ✓ the installation of 19,000 advanced two-way air conditioning control switches capable of communicating with the AMI meters
- ✓ the installation of 2,000 advanced meters as part of a joint project with the Building Owners and Managers Association of Chicago (BOMA/Chicago) to test the ability of large office buildings to aggregate demand response
- ✓ the installation of 59,000 AMI meters in two Chicago communities that would be integrated with available energy-efficiency services and associated environmental initiatives in those communities permitting the demonstration of the smart grid's ability to advance community climate action and economic development strategies
- ✓ the deployment of up to 50,000 in-home devices in residences in these two Chicago communities
- ✓ the deployment of a full suite of smart grid technologies, including 700 distribution automation switches, four intelligent substations, the installation of dynamic voltage management and conservation voltage reduction (CVR) technology in two of the substations, a fiber ring, and a supervisory control and

data acquisition (SCADA) core network upgrade to provide a template for the future rollout of the smart grid throughout the ComEd service territory.

### **BOMA/Chicago**

BOMA/Chicago, a trade association for the commercial real estate industry in Chicago, proposed the first commercial office building smart grid program in the United States. BOMA/Chicago applied for US\$92.7 million in SGIG matching funds for a 30-month, US\$185.4 million project designed to retrofit buildings to participate fully in energy markets. The installation of devices such as variable-frequency drives, the updating of building automation systems, and the creation of a network operations center would let buildings optimize their operations by means of price signals in the capacity, energy, and ancillary services markets operated by PJM interconnection, the RTO for the Chicago area. The initial proposal was for 50 buildings in downtown Chicago, including the Hancock Center, the Aon building, and the Willis Tower (formerly the Sears Tower).

### **IIT and UIUC**

IIT and UIUC jointly applied for a US\$60 million demonstration project grant to help finance a proposed US\$120 million statewide project. Their joint plan was (and remains) making Illinois an international center for innovation, validation, deployment, and evaluation of new smart grid technologies. IIT led the initial proposal effort with UIUC; other participants included the State of Illinois, the City of Chicago, the Village of Oak Park, the Galvin Electricity Initiative, ComEd, Ameren, and more than 50 private companies. The four primary components of the project are:

- ✓ IIT's perfect power system, which is to be a complete, reproducible, and scalable demonstration of a reliable microgrid



**figure 1.** The Korean delegation visit to Illinois in January 2010 with executives from industry giants KEPCO, KT, LG Electronics, SK, and LG Chemical along with senior officials from MKE, KOTRA, KSGA, KSGI, KDN, and KERI.



figure 2. Signing of the MOU in Seoul, Korea, on 20 January 2010.

- ✓ Oak Park's community demonstration project, which would showcase the technological, financial, and policy investments communities can make right now, including smart metering infrastructure
- ✓ IIT's Smart Grid Demonstration Center, a comprehensive technology development, demonstration, and evaluation program for smart grid technologies that would let companies hook up to an existing smart grid and accelerate development of their own technologies and services
- ✓ UIUC's Smart Grid Validation Facility, which would be an incubator, research center, and test bed for companies that want to evaluate their smart grid technologies in terms of cybersecurity and interoperability standards before implementation.

On 27 October 2009, the IIT/UIUC projects were denied funding under ARRA, creating an opportunity for supplemental funding from alternative sources within the United States and abroad. However, each university has since been able to advance elements of its proposals through other funding sources, including support from the State of Illinois.

### Illinois: A Growing Center for Smart Grid Development and Deployment

Over the last two years, more than US\$500 million has been captured in the state for energy efficiency or green development, including nearly US\$120 million in smart grid R&D and demonstration projects in 2009 and 2010, highlighted by:

- ✓ US\$25 million to the Chicago Metropolitan Agency for Planning and the City of Chicago for design and execution of an energy-efficiency retrofit program
- ✓ US\$24 million in ARRA funds awarded to Beacon Power Corporation to construct a 20-MW flywheel energy storage plant in Chicago
- ✓ US\$18.8 million over five years to the ITI at UIUC by the DOE to extend its Trustworthy Cyber Infrastructure for the Power Grid initiative

- ✓ US\$12.6 million including US\$5 million in ARRA funds and US\$2.5 million in state funds, to IIT to establish a Smart Grid Education and Workforce Training Center (the largest university award in the ARRA project category)
- ✓ US\$11 million in ARRA funds to Naperville, Illinois, for AMI installation
- ✓ US\$8.8 million to ANL for advanced battery and energy storage R&D, setting the stage for mass electric vehicle adoption
- ✓ US\$5.1 million in ARRA funds to S&C Electric for a distributed generation project.

### Illinois-Korea Smart Grid Collaboration MOU

In December 2009, Minister Choi of the MKE and Governor Pat Quinn of Illinois entered into a dialogue concerning opportunities for mutually beneficial collaboration on smart grid and green technology. While noting that Korea is on the leading edge of smart grid technology development and Illinois is a top-tier state in making advancements in smart grid implementation, Minister Choi proposed that the two form a sustainable business alliance for the developing, testing, and deploying of smart grid and green technology to establish a world model for collaborative practices.

Governor Quinn noted that Illinois and Korea have a long history of collaboration and are united by a strong desire to solve the problems of the 21st century. Illinois's renowned universities—in partnership with the state, local governments, and utilities—have already launched innovative projects to demonstrate, test, and improve smart grid technologies. Implementing a smart grid throughout the state would help create jobs and ensure that Illinois families and businesses have access to technology that can lower their energy consumption and energy costs while yielding significant environmental benefits. Governor Quinn proposed a meeting of representatives from Korea and Illinois to



**figure 3.** MOU signing in Chicago, on 21 July 2010, by ISTC CEO Matthew Summy and KETEP President Jung Hyun Lee.

discuss how to move forward with a partnership on these important issues.

In early January 2010, a delegation of approximately 20 Korean business leaders and government officials met with officials in Illinois to explore opportunities for collaboration (see Figure 1). Based on the success of these meetings, a delegation from Illinois, led by Illinois Department of Commerce and Economic Opportunity (DCEO) Director Warren Ribley, attended the World Smart Grid Forum in Seoul where, on 20 January 2010, a memorandum of understanding was signed between Korea and Illinois agreeing to cooperate on smart grid and green technology development and deployment (see Figure 2). Minister Choi Kyunghwan of the MKE and DCEO Director Warren Ribley signed the MOU, pledging to take actions to deploy smart grid–tested business models and technologies, conduct joint R&D in the development of smart grid and green technologies, and foster information, technology, and human resource exchanges among government agencies, businesses, and research institutions.

Korean and Illinois businesses are expected to develop effective partnerships for pursuing emerging markets that include demand response, electric vehicles, energy management, and advanced battery technology. “With the MOU, South Korea gained a foothold in the giant U.S. energy grid sector, while giving Illinois a chance to attract business investments and create jobs,” a ministry official was quoted as saying by Korea’s Yonhap News Agency.

## Collaboration Counterparts and Timeline

A Smart Grid and Green Economy Committee (SGGEC) has been established to direct and supervise the cooperation, with Korea and Illinois each designating representatives to serve in a program management office (PMO) capacity. MKE appointed the Korea Smart Grid Institute (KSGI) to lead the Korean PMO, and DCEO appointed the Illinois Science & Technology Coalition (ISTC) to lead the Illinois PMO. KSGI is a government agency, established in 2009 to contribute to the implementation of Korea’s green-growth, low-carbon initiative by comprehensively managing the government’s smart grid road map, operating a smart grid test bed, and extending other policy support for smart grid–related issues. ISTC is a nonprofit organization committed to cultivating economic development in Illinois by fostering public-private partnerships to develop and execute R&D projects, advocating for R&D funding initiatives, and collaborating with public and private partners to attract and retain R&D resources and talent in Illinois. Other Korean partners in the collaboration include the Korea Smart Grid Association (KSGA), Korea Business Center Chicago of the Korea Trade-Investment Promotion Agency (KOTRA), and Deloitte-Korea. In Illinois, partners include the State of Illinois, Illinois DCEO, Chicago Department of Environment, CUB, ADICA, University of Illinois, IIT, Illinois Commerce Commission, BOMA/Chicago, Metropolitan Energy, Holland & Knight LLP, and TechAmerica Midwest, among others.

## Collaboration Activities

The Korean and Illinois PMOs have communicated weekly since January and have held a number of face-to-face meetings. Face-to-face meetings were held in April, May, and June of 2010. These meetings gave partners from Korea and Illinois the opportunity to develop a set of initial, or phase 1, collaborative projects that will further the goals established by the MOU.

In July 2010, Minister Kyunghwan Choi of the MKE led a delegation of nearly 50 Korean business and government leaders to Illinois. Meetings were held with leaders from multiple Illinois smart grid–related industries, including utilities and electric vehicles, as well as with Illinois Governor Pat Quinn and Chicago Mayor Richard Daley. The purpose of the visit was to announce MOUs to formalize several phase 1 projects (see Figures 3 and



**figure 4.** Illinois DCEO Director Ribley presents memento of productive collaboration to Minister Choi of the MKE on 21 July 2010.

4). Four of the initial projects are expected to provide more than US\$20 million to improve grid cybersecurity, develop technological infrastructure, deploy energy optimization solutions, and create a workforce ready to develop next-generation energy solutions. At a networking dinner with more than 120 government and industry leaders (see Figure 5), the following projects were announced:



**figure 5.** Illinois governor Pat Quinn addresses more than 120 government and industry leaders involved in the Illinois-Korea Smart Grid Initiative.

- ✓ **Cybersecurity and grid trustworthiness:** UIUC's ITI will partner with the Korean National Security Research Institute on R&D initiatives to improve cyber- and grid security and network resiliency.
- ✓ **Global workforce training and development:** IIT and ADICA will build out professional training and development programs in this sector to solidify Illinois as a hotbed for education and training opportunities in the smart grid sector. Through a global partnership with the Korea Electrical Engineering and Science Research Institute, this center will bring industry professionals from around the world to IIT to develop new strategies and techniques for business innovations that will result from the deployment of a smart grid.
- ✓ **Illinois Smart Buildings Initiative (ISBI):** Supported by BOMA/Chicago and CUB, this project will include deep energy audits on Loop-area high-rises in order to set up a multibuilding regulation services and energy-efficiency project. By installing new technologies to network buildings and enable smart grid strategies—such as demand response and variable operations of building systems—large properties like the AON Center can optimize their energy usage to reduce costs by hundreds of thousands of U.S. dollars per year and decrease their carbon footprint. This project has support from the KSGA, Korea Telecom, and LG Electronics.
- ✓ **Building energy management systems and DER integration:** IIT will sign two agreements to conduct R&D to improve building energy management systems, develop distribution automation strategies, integrate renewable energy sources and energy storage technologies into the smart grid, and increase power systems reliability. KSGI and the Korea Electrotechnology Research Institute are supporting these projects.

Following these announcements and MOU signings, partners from Korea and Illinois have worked to develop contractual business arrangements that will formalize their

relationships and create lasting partnerships. To date this work is still ongoing, and project teams and engineers from Korea visited Chicago during the months of August and September 2010. The purpose of these visits was to continue the process of refining project scopes and to gather further information about the collaborative opportunities the partners are developing. In addition, as the phase 1 projects are being initiated, the partners have begun the identification and development of potential phase 2 projects.

### Illinois-Korea Collaboration Results

This globally connected public-private partnership between Illinois and Korea combines industry innovators, visionary government leadership, and sophisticated nongovernmental organizations working together to produce smart grid clusters in Illinois and South Korea that will yield economic development, create jobs, and accelerate product development.

In November 2010, during the G-20 summit in Korea, an event titled Korea Smart Grid Week was held on Jeju Island to execute documents to transition MOUs into contracts and establish a sister-state agreement between the Jeju Special Self-Governing Province and the State of Illinois.

In addition, the development and execution of phase 1 projects represent an important milestone in this unique collaboration. Discussions are ongoing, and the partners have begun to identify a number of other opportunities for future collaboration. Additional project opportunities are being evaluated in the areas of smart buildings, smart transportation, smart communities, and R&D. Dignitaries in Illinois and South Korea affirm the mutual benefits of this model partnership for smart grid collaboration. Additional information is available at [www.smartgrid.or.kr](http://www.smartgrid.or.kr) and [www.adica.com](http://www.adica.com).

### Acknowledgments

The authors would like to express their appreciation to the KSGA, ISTC, and IIT for granting permission for the use of their photographs.

### Biographies

*Bruce Hamilton* is with ADICA, LLC.

*Yeoung Jin Chae* is with KPX.

*Matthew Summy* is with the ISTC.

*Jordan Berman-Cutler* is with the ISTC.

*David Kolata* is with CUB.

