Illinois Regional Smart Grid Demonstration

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1. Project Objectives

Illinois Institute of Technology (IIT), University of Illinois at Urbana-Champaign (UIUC), Argonne National Laboratory (Argonne), State of Illinois (State), PowerWorld Corporation (PowerWorld), West Monroe Partners (WMP), and Village of Oak Park (Oak Park), in collaboration with the Galvin Electricity Initiative (GEI), and other key partners (Illinois team) are leading an effort to develop and validate innovative smart grid technologies, and demonstrate smart grid applications, community outreach, and renewed policies for better serving the consumers. The demonstration will assist utilities and companies implementing new smart grid technologies, and consumers with the integration of home automation technology in order to leverage smart meters. The results will be replicable to communities and campus-type settings across the nation.

Illinois team's objectives include 1) Demonstrate complete, replicable, and scalable Perfect Power and Smart Grid implementations; 2) Provide a comprehensive technology-based demonstration, validation, research and development platform for Smart Grid technologies, products, systems and protocols; 3) Pursue comprehensive research and demonstration platforms for promoting energy and public policies that will accelerate the U.S. transition to a world-leader on smart grid in the most cost effective and innovative fashion; 4) Position the state of Illinois and the region as the hub for Smart Grid and Perfect Power technology development and demonstration.

Proposed tasks will address three of the four domain/technology areas including 1) Distributed Energy Resources, 2) T&D Infrastructure, and 3) Information Networks and Finance. This will be achieved by building the IIT Perfect Power System (IPPS) and the IIT Smart Grid Demonstration Center (ISGDC), establishing the Illinois Smart Grid Validation Facility (ISGVF) at UIUC, and enhancing the Oak Park Virtual Microgrid (OPVM) Implementation project at Oak Park, IL.

The proposed project will **demonstrate that communities and campuses in Illinois provide the strategic leverage to achieve solicitation objectives** by addressing the major barriers to smart grid utilization. The proposed **replicable community and campus microgrid approach** will produce the following results for residential customers, businesses and factories, and campus settings: 1) Lowering electricity costs; 2) Lowering peak demand; 3) Reducing carbon emissions; 4) Lowering T&D costs by delaying system expansions; and 5) Improving the response time to unscheduled outages.

The proposed project will include an extensive public outreach and education. The Illinois team will establish a **community wide education and outreach program** that would educate consumers on applications of home automation devices, energy efficiency, demand response, and distributed generation including on-site renewables. The education and outreach program will be combined with **innovative financing programs** to allow communities to jointly bond funds needed to deploy the smart grid technology and pay for the technology by utilizing monthly savings in energy costs. In addition, Oak Park in collaboration with Argonne and WMP will monitor and record costs and benefits of smart grid applications. The results will be utilized to strengthen the education and outreach program for smart grid.

IIT: T&D Infrastructure, Distributed Generation, Cyber Security, Technology Demonstration, and Education. IIT is focused on enhancing the performance and the security of the Nation's electric power infrastructure through its groundbreaking project on Smart Grid, which is known as the Perfect Power project. The IIT members of the Illinois team propose to fully implement the IPPS and provide for a world-class demonstration facility in Chicago. The purpose is to establish IIT, which is an urban campus with all the features of a small community, as the undisputed leader in microgrid demonstration. The proposed project will contribute to furthering the development of smart grid functions

at IIT by introducing energy savings which are due to efficiency, replacement of obsolete equipment, increased demand response, comprehensive cyber security, island operating mode capability and expanded market opportunities, expanded use of renewables, and education and outreach for smart grid activities. IIT is also focused on establishing a 125,000 sq. ft. Smart Grid Demonstration Center in the IIT's Technology Park. ISGDC will provide laboratory facilities, office space, and small manufacturing demonstration opportunities for independent entrepreneurs, research faculty, and start-up companies to plug into IPPS their developed new technologies and test new ideas on a real world smart grid system. The ISGDC facility will help speed up the adoption of smart grid by creating a platform for promoting innovations. The IIT's planned investments on ISGDC and IPPS as part of the Regional Demonstration will 1) allow IIT to build a world renowned demonstration system that will provide a dynamic, large scale demonstration laboratory for researchers and innovators; and 2) build a national demonstration center to attract to Illinois researchers, innovators, and entrepreneurs with interests in smart grid .

UIUC: Interoperability, Cyber Security, Technology Validation, and Education. UIUC in collaboration with PowerWorld is focused on a regional demonstration and the validation of distributed smart grid systems, including microgrids and distributed energy resources. The key objective is to demonstrate within a new laboratory setting at UIUC (ISGVF). ISGVF will demonstrate how new and more cost-effective smart grid technologies, tools, techniques, and system configurations can be used in trustworthy configurations that will significantly improve upon the ones that are either in common use today or likely to be proposed by the DOE Smart Grid Investment Grant Program. ISGVF activities will demonstrate how these results can be validated in a laboratory setting to provide extensive calibration using results from actual installations. ISGVF will be a resource center both for smart grid equipment suppliers and integrators and for electric utilities to allow validation of system designs before deployment. ISGVF will develop validation methodologies that can be replicated across the country.

Oak Park: Community Smart Home/Business Deployment, Innovative Financing, Education, and Outreach. Oak Park is focused on home/small business empowerment in its community by actively participating in the proposed Illinois Regional Smart Grid Demonstration project. The overall goal of this project is to educate the community residents and businesses to leverage smart meters in Oak Park and to achieve financial and social benefits which would reduce energy consumption costs, carbon footprints, unscheduled outage times, and power system reliability.

Industry Partners including Argonne, GEI, PowerWorld, and WMP will engage in specific tasks on Smart Grid analyses, polices, simulation, and optimization, respectively.

Industry Affiliates representing over 60 companies, which are mostly within Illinois, will support the Illinois team to establish a Smart Grid Regional Demonstration in Illinois. The statewide nature of this initiative and its collaborative approach will be an excellent strategy for ensuring that public, private, corporate and philanthropic interests can efficiently partner to develop and implement regional smart grid initiatives, while striving to overcome obstacles for the smart grid implementation at the national level. **This regional collaborative approach** will generate market opportunities for new smart grid technologies and, most notably, **create new jobs** in the United States**. The State**, in addition to providing a valuable financial support to the proposed initiative, will monitor and promote Smart Grid activities within the State, which will position the State to be a **hub for the efficient incubation, ongoing innovation, critical validation, and essential community implementation and evaluation of Smart Grid technologies.**

2. Project Scope

- The scope of the IIT Perfect Power System (IPPS) project includes 1) Energy management and building efficiency Initiative; 2) Key subsystem re-commissioning; 3) Expanding master controller capability and functionality; 4) Integrating advanced cyber security features into all Perfect Power devices; 5) Expanding backup generation capacity to provide for local power redundancy, automated start, and faster response times; 6) Expanding solar system and electricity storage capacity; 7)

Developing Perfect Power small scale model; and 8) Perfect power education, training, and workshops.

- The scope of the IIT Smart Grid Demonstration Center (ISCDC) includes building a dedicated technology development, demonstration and evaluation facility that is integrated with an existing smart microgrid allowing the many researchers and engineers to test smart grid technologies in a "real world" environment, as well as evaluate the Smart Grid system as a whole.
- The ISGVF at UIUC will focus on providing convincing evidence that a smart grid design or configuration, when deployed, will perform satisfactorily under real use scenarios and in the face of accidental failures and cyber attacks. It will be available to smart grid industrial participants, such as electric utilities, equipment suppliers, and system integrators. While there exist many standardized methods for testing both cyber and power equipment, currently there are no standard methods, tools, or facilities to undertake a more comprehensive validation of an interconnected and interdependent system composed of both kinds of equipment. In practice, a smart grid technology today is typically deemed mature when enough utilities deploy the technology on a trial basis, report success, and migrate it to actual operations. However, this approach is not only quite expensive, due to sunk costs when a trial deployment fails, but also not foolproof, because a failed trial does not necessarily mean failed technology, and a "successful" demonstration does not necessarily mean that the technology will function as expected under all likely circumstances. The purpose of the Validation Facility is to demonstrate that smart grid technology can be validated, at least to a large extent, within a laboratory setting, leading to a more rapid implementation of the Smart Grid.
- The scope of OPVM implementation project includes 1) Program Management; 2) Community and Local Government Outreach; 3) Develop Village Aggregation and Financing Programs; 4) Develop Local Energy Manager; and 5) Develop Village Energy Manager.
- The Argonne's decision analysis team will use the data collected by the IIT monitoring and the AMI meters to conduct a variety of advanced analyses to assess the economic, financial, and power system benefits of the proposed project. The analytical process is divided into several stages. First, Argonne will review the data streams and filter them for errors and flag anomalies. Data stream analysis will be performed on real-time information, including the electricity prices, consumer loads, and system (feeder) loads. The data and analysis will be separated into different study groups based on the customer type, household demographic information collected by other team members, and other criteria. The relationship (if any) between variables, such as household income, education, size, composition and consumer/household behavior, will be quantified. The Argonne team will also evaluate correlations between consumer loads and temperature obtained from local weather stations. Argonne will leverage its expertise in consumer research and behavioral modeling to analyze how consumers adapt to real-time pricing, real-time information available through the AMI infrastructure, and the use of smart devices and technologies. The analysis will be done for the household samples in Oak Park, but the analysis results and data may be used in combination with one of Argonne's power market analysis tools to scale up results to the a larger balancing area.

3. Tasks to be Performed

Phase I – Project Definition and NEPA Compliance
- Task 1.0 – Update Project Management Plan
- Task 2.0 – National Environmental Protection Act (NEPA) Compliance
- Task 3.0 – Baseline for Evaluating Project Performance
- Decision Point 1

Phase II – Design & Implementation
- Task 0.0 – Update Project Management Plan
- Task 1.0 – IIT Perfect Power System Project
  - Subtask 1.1 – Modern Energy Management and Efficiency Initiative
  - Subtask 1.2 – Upgrade Key Smart Grid Subsystem Components

- Subtask 1.3 – Master Controller Advancements
- Subtask 1.4 – Advanced Cyber Security Features
- Subtask 1.5 – Expanded Site Generation
- Subtask 1.6 – Solar PV, Storage, Vehicle Charging and Plug-in Vehicle Capability
- Subtask 1.7 – Communications and Education Tools - Small Scale Model and Prototype
- Subtask 1.8 – Education, Training, and Outreach

Task 2.0 – IIT Smart Grid Demonstration Center

- Subtask 2.1 – Initial Setup
- Subtask 2.2 – Test Beds Hardware and Software Design
- Subtask 2.3 – Test Beds Set Up
- Subtask 2.4 – Test Beds Operation and Demonstration
- Subtask 2.5 – Test Beds Demonstration Data Collection and Reporting

Task 3.0 – Illinois Smart Grid Validation Facility (ISGVF)

- Subtask 3.1 – ISGVF Administration and Operations
- Subtask 3.2 – Facility Fit-Out
- Subtask 3.3 – Equipment Procurement, Assembly, Test Integration
- Subtask 3.4 – Software Development
- Subtask 3.5 – Micro-Grid(s) Setup, Test, Calibration
- Subtask 3.6 – Validation Methodologies and Process
- Subtask 3.7 – Validation Lab Calibration and Operational Readiness
- Subtask 3.8 – ISGVF Startup and Operations
- Subtask 3.9 – Cost Benefit Analysis (CBA)

Task 4.0 – Oak Park Home/Small Business Empowerment Demonstration

- Subtask 4.1 – Program Management
- Subtask 4.2 – Community and Local Government Outreach
- Subtask 4.3 – Develop Village Aggregation and Financing Programs
- Subtask 4.4 – Local Energy Manager
- Subtask 4.5 – Village Energy Manager
- Subtask 4.6 – Reporting

Decision Point 2

Phase III – Commissioning & Operations

Task 0.0 – Update Project Management Plan

Task 1.0 – Data Collection

Phase IV – Final Reporting

Task 0.0 – Update Project Management Plan

Task 1.0 – Prepare the Final Report of the Project