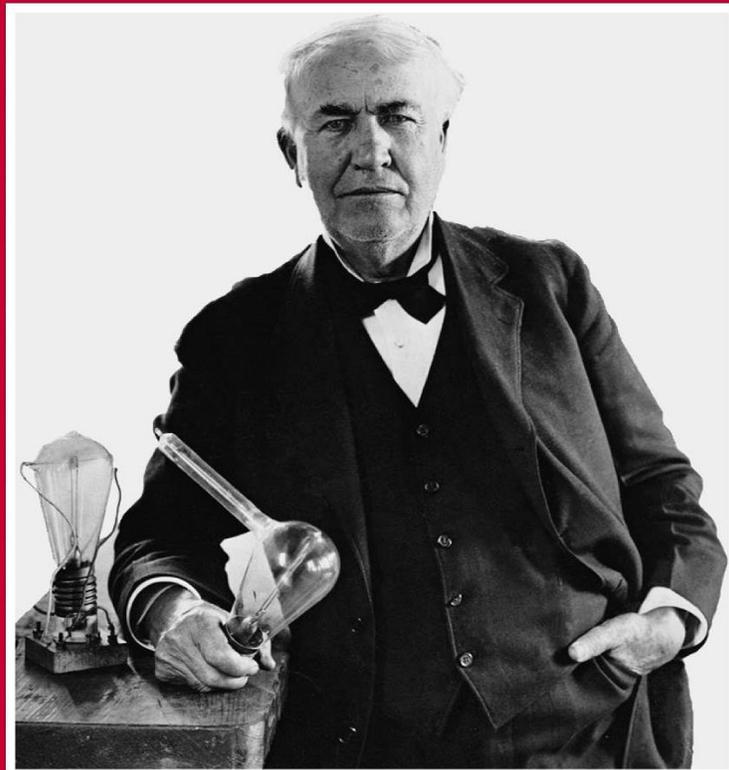


Commonwealth Edison Company's Quarterly Smart Grid Test Bed Report

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**THE POWER OF
AN IDEA**
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November 14, 2016

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I. Introduction

ComEd's Test Bed mission is to facilitate and provide open and unbiased live-grid opportunities for testing, demonstration, and promotion of innovative smart grid programs, technologies, business models, services, products, and other smart grid-related activities that may benefit ComEd's customers. ComEd created its Smart Grid Test Bed ("Test Bed") and associated objectives pursuant to subsection 16-108.8 of the Public Utilities Act ("Act"). ComEd protects the safety and security of its distribution grid and grid operations through the Test Bed Idea ("Idea") selection process and through management of Test Bed Demonstration ("Demonstration") projects.

ComEd's Test Bed vision is focused on providing innovative ways to demonstrate, in an open and unbiased manner, how working technology actually operates in a live utility scale environment. The Test Bed is not intended to provide a lab where investigational ideas are tested out; those facilities exist and such tests are not appropriate for a live environment. The Test Bed allows approved Idea Submitters ("Submitters"), subject to appropriate protections, to connect technology to the utility grid for the purpose of demonstrating that the technology functions as designed. The Test Bed is designed to help validate business models or services by permitting demonstration of specific functional aspects of the technology and/or verification that services/business models provide the intended results.

The Test Bed is open to all qualified Idea Submitters. ComEd envisions a diverse group of qualified Idea Submitters that may consist of scientific, technical, entrepreneurial, innovative, and non-technical Idea stakeholders. Ideas may come

from a variety of sources including, but not limited to: the Illinois Science and Energy Innovation Foundation (“Energy Foundry”), ComEd’s own employees, professional organizations, universities, entrepreneurs, technology partners, and other ComEd stakeholders. By opening the Test Bed to a diverse group of stakeholders, ComEd will provide live-grid opportunities to as many Test Bed Demonstrations as reasonably feasible.

Accordingly, this report summarizes the Test Bed activities, discoveries, and other information deemed mutually relevant from July 1, 2016 through September 30, 2016 (“Reporting Period”) as described in subsection (i) of Section 16-108.8 of the Act.

II. Test Bed Ideas

ComEd has led existing and new Test Bed Idea coordination activities during the current Reporting Period. Test Bed Idea status updates are provided in the following three categories: Potential Test Bed Idea Submissions, Recently Submitted Test Bed Ideas, and Previously Submitted Test Bed Ideas.

Stage of Development Symbols



New Idea Stage: Ideas are received and an initial review is conducted to seek clarification on the Idea and to determine applicability of the technology for the Test Bed and for the ComEd system.



Analysis/Planning Stage: Internal subject matter experts work closely with the Idea Submitter to develop a Demonstration Plan, which includes the Demonstration objectives and key functions of the technology to be tested, as well as the scope of work (“SOW”), associated costs, and success metrics.



Demonstration Stage: The technology is installed/constructed, and demonstrated on ComEd’s grid in accordance with the Demonstration Plan and/or Test Bed Agreement.

Potential Test Bed Idea Submissions



Carbon Cash

Carbon Cash is proposing a customer energy usage tracking mobile application that engages residential customers in energy saving behaviors through personalized

messaging, gamification and rewards. This application allows consumers to track their electricity usage and emissions footprint from their iOS or Android device. As users meet consumption benchmarks they earn points “Carbon Cash” that they can redeem for discounts, gift cards and merchandise on their smart phone. Carbon Cash will be demonstrating their application’s potential for achieving behavioral demand response through an emissions-centric call-to-action. This demonstration will also include the collection and analysis of psychometric data, which will be used to tailor engagement strategies for individual users. Carbon Cash is currently planning to begin its demonstration Jan 1, 2017 and for it to last 6 months.



General Electric Lighting

General Electric had proposed to install Smart LED Lighting with embedded sensors (cameras, primarily) to improve light quality and enhance security using applied analytics in a ComEd substation. General Electric has since withdrawn its application from the Test Bed.



Semtive

Semtive proposed a Test Bed Idea Submittal for a renewable energy technology, the Nemoi, a vertical wind turbine. The turbines can be installed on street light structures or upon rooftops. Semtive currently has three 3-phase models: XS (12V; 100W nominal power; average 200KWh/year); S (24/48V; 200W; 350KWh/yr); and M (24/48V; 1KW; 2,5MWh/yr). Semtive is proposing a Test Bed Demonstration for its S-model and M-model, targeting Q4 2016 for US manufacturing of existing models and Q1 2017 for development of new L and XL models. Semtive has expressed interest in

the Test Bed and has initiated discussions for a potential Test Bed Demonstration. As discussions continue, further evaluation will be conducted to determine if Semtive's renewable energy technology meets the criteria and spirit or intent of the Test Bed.



Southwire

Southwire has been working with Electric Power Research Institute ("EPRI") to develop a suite of substation sensors. The proposed technologies pose an integrated solution using a base station, i.e., a Southwire Gateway, to collect weather data and data from multiple sensors and to communicate that data to the local utility. The communication uses a process control network ("PCN") to transmit via a cellular network or direct wire to SCADA. The family of sensing technologies Southwire is proposing includes a Line Monitor, a Connector Monitor, and an Insulator Monitor. For example, the Insulator Monitor (porcelain, glass and polymer) senses contaminate deposit and build-up, and records temperature, humidity, rain, and wind speed and direction data. The sensor will send an alarm/notification (via 2.4 GHz RF) when the equipment requires maintenance before a flashover due to leakage current caused by moisture or contamination. Southwire has expressed interest in the Test Bed and has initiated discussions for a potential Test Bed Demonstration. As discussions continue, further evaluation will be conducted to determine if Southwire's substation sensor technologies meet the criteria and spirit or intent of the Test Bed. Southwire is targeting a potential Test Bed Demonstration for late 2016.



RIOK

RIOK has submitted an idea for their Aluminum Guide Wire Adjustment Assembly (GWAA), which is designed to help minimize damages to lines caused by harsh environmental conditions, typically related to all kinds of storms. The GWAA is a mechanical fitting that addresses both hardening and modernization of the grid in efforts to make the infrastructure more resilient. It is comprised of an elongated electrically conductive device that has two point of attachments, a built in safety turnbuckle mechanism to help with lateral moves within the line to address sagging or taut distribution lines, and a spring to aid in the deflection of debris and to provide flexibility in the service lines due to high winds. The Aluminum Guide Wire Adjustment Assembly has been designed to work with the electrical overhead service conductor or cable that is brought from a utility pole or other main source of electricity, to a point of attachment on or near the structure to bring electrical power. The GWAA is currently under Technical Review to determine if it meets the spirit and criteria of the Test Bed.

Recently Submitted Test Bed Ideas



DNV GL

DNV GL has submitted an Idea for their Smart Cable Guard system, which is designed to continuously monitor underground medium voltage cables and detect and locate full and intermittent faults and partial discharges (“PDs”). DNV GL’s submitted Idea has been reviewed. As further discussions continue, ComEd will work with DNV GL to determine how the proposed technology can be demonstrated in the Test Bed.

DNV GL has committed to delivering the hardware for two complete systems, providing expert supervision of the installation, and training of ComEd personnel on the operation of the systems.

Previously Submitted Test Bed Ideas



Kerite High Voltage and Specialty Cable Systems

Kerite is the new brand now handling the SafeGuard System, which had been previously submitted as a Test Bed idea by Aetna Insulated Wire. Kerite will resubmit its application for the SafeGuard System under the Kerite name. The Idea is for a modular cable protection system that is customizable for various electric power distribution and fiber optic cables. Kerite's SafeGuard System offers critical circuit protection against a variety of threats; products include insulated, cut-resistant cable, high frequency EMP shielding (natural and man-made) and signal security, protection against small-scale intentional electromagnetic interference ("IEMI") devices, and ballistic deterrence. The SafeGuard technology has been reviewed and Kerite has agreed to provide a section of cable to be tested in ComEd's laboratory. As further evaluations continue, ComEd will work with Kerite to determine how the proposed technology can be demonstrated in the Test Bed.



Athena Power, Inc.

Athena Power, Inc. proposed an Idea on a next generation sensor for real-time underground remote monitoring and fault detection. The sensor is self-powered, weather-proof, wireless, and can communicate to an external radio via DNP3 protocol.

The sensor can be used for subsurface or pad-mounted transformers or switchgear, sectionalizing cabinets, junction boxes, and splices. Athena's submitted Idea has been reviewed. It has been determined Athena's Test Bed Idea is a potential Test Bed Demonstration project, pending execution of a Test Bed Agreement. As ComEd is evaluating potential locations to install Athena's equipment, ComEd is coordinating with Athena to provide additional technical information.

eluminocity US Inc.

In collaboration with the Illinois Institute of Technology ("IIT") and Silver Spring Networks ("SSN"), eluminocity will be piloting their Light & Charge system, a combined smart LED streetlight and electric vehicle charging unit, which eluminocity developed in cooperation with automaker BMW. A smart wireless connectivity platform is integrated to allow for sensor-based applications such as lighting control based on occupancy or real-time parking space monitoring. The proposed unit for IIT, which was on display at CES 2016 in Las Vegas, will be a new installation in a parking lot at IIT. However, further applications can ideally be retrofitted to existing streetlights, thereby significantly lowering the costs of installation when compared to conventional EV charging stations. The luminaires are compatible with existing infrastructure and can be sized accordingly, with up to four LED modules per luminaire, further reducing energy consumption. A prototype system was installed in August 2016 at the Illinois Institute of Technology, and displayed at a Department of Energy event shortly thereafter. A complete, UL listed system is expected to be installed in Q4 2016.



EnSync Energy Systems

EnSync Energy Systems, formerly known as ZBB Energy, proposed an Idea demonstrating its matrix product. EnSync intends to verify the matrix product functions in a live-grid environment with full communication. The matrix product regulates bi-directional energy flow to the grid by charging and discharging energy storage devices. For this Demonstration, EnSync proposes to connect the matrix product to a building and a communication network.

Multiple functions of the matrix proposed to be demonstrated will include: active energy synchronization of all DC and AC inputs and outputs, energy storage application management, bulk energy storage, peak shaving, frequency regulation, renewable integration, renewable firming, power factor correction, conservation voltage regulation, smart export between building and utility distribution, microgrid operation, islanding, back-up power, and utility communication and control. In addition, EnSync proposed to demonstrate the Matrix performing several of these active and reactive power functions simultaneously through the use of their patented AutoSync DC bus concept.

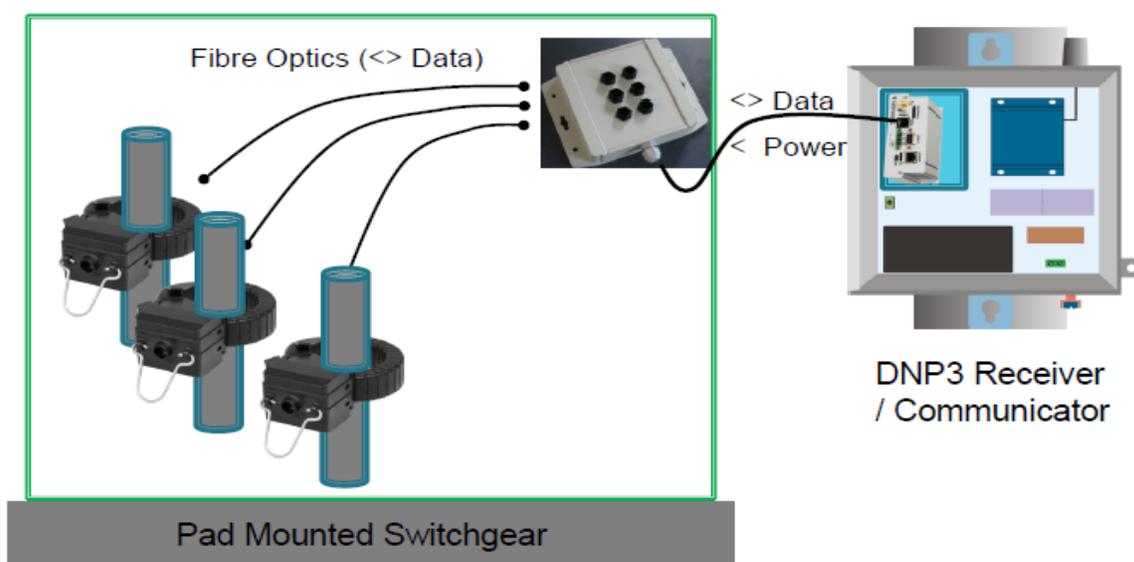
This development would incorporate primarily photovoltaics (“PV”) generation and energy storage, with the potential to add other energy sources. EnSync will provide all generation assets and controls. ComEd and EnSync are currently evaluating locations for an effective Demonstration.

As a result of this pilot, EnSync plans to be able to demonstrate supply response on demand and learn to facilitate and create an interface from an electric utility’s perspective. ComEd and EnSync would co-author a white paper based on a

successful Demonstration of the listed active and reactive power functions and applications. EnSync's Idea is currently under review and coordination for the Test Bed is ongoing.

Power Delivery Products ("PDP")

PDP proposed a Demonstration of a "Smart Load Tracker" fault detection solution that PDP is currently developing for underground pad-mount applications.



A key feature of this technology is its capability to provide remote notification via ComEd's two-way wireless mesh network. The solution is designed to cost-effectively reduce customer outage response times and is particularly applicable for underground direct buried cable "loop schemes", which can include up to pad-mount transformers and cable sections. The Smart Load Tracker solution provides intelligent identification and real-time reporting of underground cable faults, as well as information to improve ongoing monitoring of distribution lines. A key capability proposed to be demonstrated in the Test Bed is real-time notification of cable faults and communications via the

Silver Spring communications network or other communications backhauls. After scoping discussions were held in Q1 of 2015, PDP is exploring further innovations to better align the Smart Load Tracker solution with the application scenarios discussed for single-phase underground residential distribution (“URD”) loops to utilize single-phase and three phase pad-mounted transformers for commercial applications. PDP is finalizing their design which will offer a better fit for and easier integration with ComEd’s desired application. PDP is targeting Q4 2016 to have single-phase communication units available for pad-mounted transformers. The Demonstration Plan is expected to be finalized once PDP has single-phase communication units available.



QinetiQ

QinetiQ proposed an Idea for its “bird on a wire” voltage and current sensor technology. The bird on a wire is a grid sensing and monitoring technology that measures line current and voltage up to 36kV. Some of the applications for which it can be used include theft detection, grid automation, voltage and power measurements, fault detection and outage management, asset management, and green energy/renewable integration. QinetiQ’s submitted Idea has been reviewed. ComEd has identified a potentially new application for QinetiQ’s line sensing technology. The technology is being evaluated for a potential voltage optimization pilot. It has been determined QinetiQ’s Test Bed Idea is a potential Test Bed Demonstration project, pending agreement execution of a Test Bed Agreement. As ComEd is evaluating potential locations to install QinetiQ’s equipment, ComEd is coordinating with QinetiQ to finalize next steps for implementation.



Micator Inc.

Qualitrol Corp had previously submitted an Idea for a smart sensing technology that monitors pole tilt with battery-powered and wireless communications, monitors optical vibrations, vectors and displacement for transformer and circuit breakers, and monitors optical voltage and current. Qualitrol has informed ComEd that Micator would be the company providing the sensors and asked if Micator could lead this demonstration project going forward. Micator has communicated that they intend to resubmit the application for this technology under their name. As further discussions continue, ComEd will work with Micator to determine how the proposed technology can be demonstrated in the Test Bed.



Rabine Group

The Rabine Group has proposed an Idea to demonstrate its Maximum Power Transfer Solution (“MPTS”). The MPTS decreases overall electrical power consumption and improves electrical power quality using dynamic impedance matching technology. Rabine uses an independent monitoring system with its MPTS technology. The MPTS precisely senses the supply input and demand output, matches the impedance parameters, adjusts the resonance of the resulting network loop and synchronizes and optimizes the output. This occurs at very high speeds in the device eliminating nearly all the wasted electrical power in the system thereby decreasing the carbon footprint and improving energy availability at the facility. This reduces total electrical consumption by significant levels and enhances electrical efficiency (power factor) of the network to near unity. Rabine’s MPTS technology Idea is currently being

considered for implementation at ComEd's Tech Center in Maywood, pending execution of a Test Bed Demonstration Agreement.

III. Test Bed Demonstration Projects

Below is a summary of current technology Demonstration projects underway at ComEd. Previously completed Demonstration projects are not included within this report. Demonstration projects can come from a variety of sources, spanning multiple technology areas.



G&W Electric Company

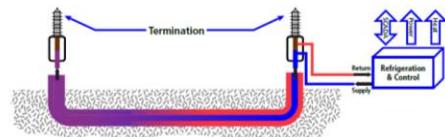
ComEd contractors have installed G&W's AccuSense voltage sensing solution. This device enables users to collect critical voltage data for optimizing grid power delivery and reliability. It serves as a smaller, light-weight alternative to traditional voltage transformers and can thus be integrated throughout the grid as metering points. The objective of this project is to evaluate performance of the AccuSense voltage sensor in a field installation. Metering grade, 0.3 class voltage transformers are being used as a reference when monitoring the AccuSense voltage sensors. The AccuSense voltage sensors and voltage transformers were integrated with an SEL651R control for monitoring purposes. The SEL control serves as the data collection point and will be accessed in intervals to evaluate the performance of the devices. ComEd and G&W will retrieve data from the devices for approximately one year. G&W is currently in the process of evaluating the results from the first prototype. A second generation of the prototype is being considered for a future installation.

IV. Other Innovative Projects

ComEd’s commitment to innovation is not limited to the Test Bed program. ComEd and its employees continue to develop new ideas, new products and customer offerings. ComEd has several partnerships with cutting edge companies and organizations. This section focuses on smart grid-related pilots and new technologies spurred by innovation.

Superconductor Development

ComEd and American Superconductor (“AMSC”) agreed to participate with the Department of Homeland Security (“DHS”) in its Resilient Electric Grid Program. Developing plans to deploy high temperature superconductor cable in Chicago’s central business district (“CBD”). This DHS program is designed to provide protection against the catastrophic effects resulting from the loss of critical substation facilities by allowing the sharing of capacity of nearby substations that cannot typically be accomplished through conventional means.



The superconductor cable would interconnect three key electrical substations in the city and provide enhanced security and redundancy to critical infrastructure. Given the significant level of external funding and the size and scale of the project, one of the project goals is to significantly reduce the cost of manufacturing the superconductor cable.

In addition to providing reliable power and increased security, this installation of nearly one and one-half miles of superconductor cable would create the most extensive superconductor technology infrastructure in the world.



ComEd's transformation of its business relies heavily on technology and innovation. In this era of increasingly intense weather events and other potential catastrophic occurrences, this project will not only support the City of Chicago but can serve as a model to enable widespread implementation of the superconductor technology nationally and globally.

ComEd and AMSC are currently in the midst of a feasibility study to determine operation and deployment viability. The preliminary engineering phase has been extended to align the design with the original approved cost estimate. The new target completion of the feasibility study is Q1 2017.

Fuel Cell Demonstration

ComEd is working with Toshiba to showcase the first implementation of a 700 Watt Toshiba fuel cell in the United States. The initial Toshiba Ene-Farm unit, originally designed for residential applications in Japan, is being planned for installation at Brookfield Zoo, to provide supplemental power to



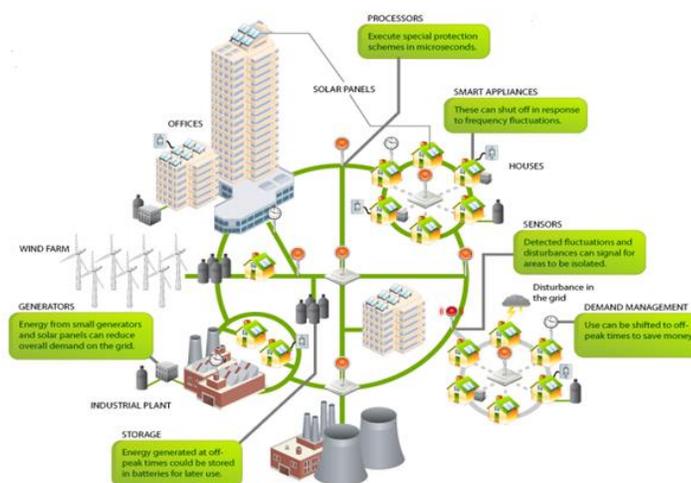
the Zoo's grid and hot water to a new hand-washing station complimenting the nearby food court. The demonstration will help ComEd and Toshiba to better understand the operation and applicability of the technology in the U.S., and the exhibit will serve to educate the public on fuel cell technology and energy efficiency. ComEd is managing the installation of the fuel cell, its display kiosk with fencing, and all associated utility and civil work. Pending receipt of Cook County's Building and Zoning permit, the fuel cell is expected to be energized in early spring 2017.

Microgrid Development

In support of President Obama's Climate Action Plan and the Administration's commitment to improve national power grid resiliency, the U.S. Department of Energy ("DOE") awarded more than \$8 million for microgrid controller related R&D

projects to help cities and towns better prepare for extreme weather events and other potential electricity disruptions.

In September 2014, ComEd was selected by the DOE to develop and test a commercial grade master controller that could drive the operations of clusters of two or more microgrids. ComEd's project was the only



utility-led effort to receive DOE funding. ComEd has assembled a group of leading science and technology partners, including Argonne National Laboratory, Illinois Institute of Technology (“IIT”), OSISOFT, Quanta Technologies, S&C Electric, and University of Denver. With its partners, ComEd kicked-off the controller development effort in November 2014.

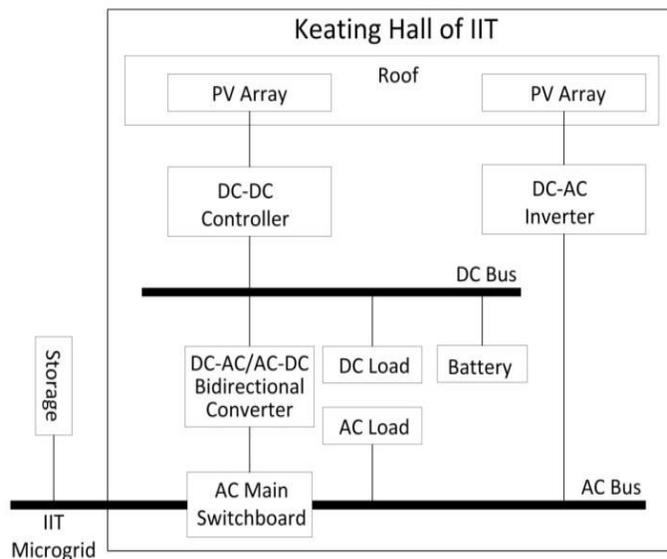
Since then, ComEd has completed six sub-task reports for the DOE as part of the grant deliverables. The reports have concentrated on evaluating the Bronzeville neighborhood in terms of loading and potential for generation installation for purposes of a microgrid. Additionally, ComEd submitted a comprehensive test plan report to the DOE and conducted a briefing for the DOE Technical Advisory Group (“TAG”), which has responsibility for reviewing the technical aspects of the project. The briefing was held in April of 2016. At the conclusion of the review process ComEd was given the go ahead to start the testing phase of the project. The first phase of the testing will require that the control algorithms be tested in a real time simulation environment which simulates various scenarios of microgrid operation. The equipment has been received and testing activities will be underway through the first quarter of 2017.

As part of the controller R&D effort, ComEd is in the midst of evaluating Chicago’s Bronzeville neighborhood, adjacent to IIT’s existing microgrid, potentially for its first microgrid installation. The microgrid would also demonstrate all the capabilities of the clustered microgrid controller and is currently under development by ComEd. ComEd’s proposed microgrid at Bronzeville includes a diverse mix of facilities and critical loads, including police headquarters, major transportation infrastructure, healthcare facilities, educational facilities, and private residences.

In January 2016, the DOE announced that ComEd received a grant under the sustainable and holistic integration of energy storage and solar PV (“SHINES”) funding. This grant allows ComEd the opportunity to research, develop, and test microgrid integrated solar and storage technology (“MISST”) within the footprint of the proposed Bronzeville Community Microgrid. The grant will be a total of \$4M from the DOE to develop and demonstrate the MISST technology.

Nanogrids: AC/DC Hybrid Systems

ComEd, IIT, Argonne National Lab, DOE, Emerge Alliance, and Starline DC Solutions are partnering to develop a hybrid nanogrid for IIT’s Keating Hall. This effort is funded through a U.S. DOE grant. Nanogrids are a sub-category of microgrids, generally supplying power to a single building or load. Hybrid nanogrids include both



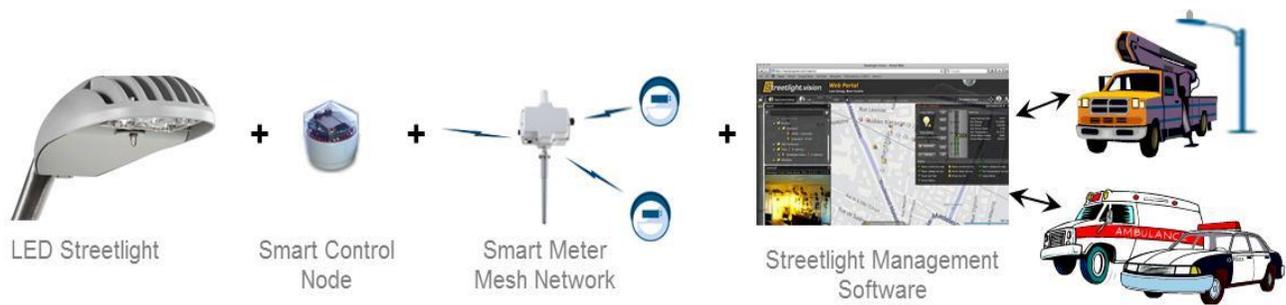
alternating current (“AC”) and direct current (“DC”) circuitry. As the name suggests, nanogrids are generally much smaller than conventional microgrids. DC loads, such as data centers, electric vehicle charging stations, and LED lighting, together with the proliferation of DC-based distributed generation and energy storage are likely to reshape power distribution.

The Keating Hall nanogrid will incorporate PV generation, energy storage, LED lighting, and power electronic based conversion equipment. The main drivers for hybrid nanogrid development are: 1) DC based PV assets installed on the rooftop; 2) reduced conversion losses, through centralized energy conversion; and 3) LED lighting solutions for more efficient and controllable lighting for the building.

The overall goal of the project is to learn about integrating the AC and DC systems for a building-scale nanogrid solution. The learnings from this small demonstration could enable ComEd to apply these technologies in future microgrid and nanogrid deployments. The project not only included installation of new technology, but applied that technology to robust integration of renewables and improved energy efficiency. Some of the Controller Algorithms that were developed under the microgrid controller grant were also applied to this project. The project was deployed in August of 2016. A ribbon cutting was held to commemorate the event.

Smart LED Streetlights

ComEd is evaluating opportunities to offer smart LED streetlight service to communities within its service territory. The solution would leverage the wireless mesh communications network that is currently being built as part of ComEd's smart meter deployment. The ubiquitous nature of the network allows ComEd to reach all areas within its territory, extracting additional value from the smart grid investments ComEd is already making.



This service would include a smart streetlight control node installed on each light fixture. The control node includes the same wireless radio found in ComEd’s smart meters, allowing it to communicate on the same mesh radio network of the smart meters.

In Q4 2014, ComEd initiated a proof of concept (“POC”) project for smart LED streetlights in two communities it serves – Bensenville and Lombard. During Q1 2015, approximately 750 smart LED fixtures were installed, collectively, between the two municipalities. The POC also included the provisioning of streetlight management software to the two municipalities, equipping them with direct control over and monitoring capability of the streetlights. By late April 2015, all POC hardware and software had been deployed and authorized personnel from the POC municipalities were subsequently trained on use of the systems. Between this time and the end of 2015, ComEd staff members monitored these streetlights, performed detailed functionality testing, identified technical issues, and made improvements to the systems.

Through POC deployment, monitoring of operations, identifying and triaging of issues, and developing system enhancements with vendors, ComEd developed a thorough understanding of the technical capabilities of this technology. ComEd also evaluated

customer preferences with respect to this potential new service offering. The results of the POC are being used to make informed decisions about the potential to deploy the technology on a broader scale.

Smart FAA Warning Lights

Three new poles equipped with new LED FAA warning lights were installed in downtown Dixon, due to the close proximity of a nearby hospital heliport. The new lights are equipped with a communication panel that leverages the capability of ComEd's wireless mesh communications network to provide real-time status of the lights. When a failure is indicated, the communications panel communicates this to ComEd's SCADA system and sends texts and emails



to the appropriate personnel so issues can be addressed promptly. Additionally, loss of power to the system, or a communications failure will trigger an alarm. ComEd is currently exploring opportunities to streamline the design of the smart FAA warning lights by integrating the same control node being used in its smart streetlight pilot to reduce equipment and installation costs. The hardware and monitoring is currently undergoing testing in one of ComEd's labs prior to deployment. If testing proves successful, and the solution is found to be cost effective, integration with the monitoring software will be the next step in demonstrating the end-to-end FAA warning light monitoring solution.

Smart Meter Connected Devices

The ComEd Smart Meter Connected Devices (“SMCD”) service is offered to ComEd residential customers who have smart meters installed at their homes. This service enables customers to receive electricity usage and estimated electricity cost information from ComEd through a smart device that is wirelessly connected to their smart meter. With access to more information, customers can make educated decisions that help them better control their electricity use and save on electric bills.

A ComEd customer can enroll in the service by purchasing a compatible smart device in retail and registering the smart device on the ComEd.com website. Once the registration is complete, ComEd will connect their device wirelessly over the Silver Spring Networks. There are a variety of smart devices available to customers with varying capabilities. They generally fall into the following categories:

In-Home Displays (“IHDs”)

IHDs are user-friendly tabletop, smart devices that provide customers with the ability to monitor their costs and energy usage patterns that are streamed to the IHD from the ComEd smart meter. IHDs display estimated electricity costs (Price * Usage) based on the fixed-price electricity supply rate from ComEd or other electric suppliers.

Energy Gateway

The Energy Gateway is a smart device that connects the ComEd smart meter to the Internet (Ethernet LAN), communicating wirelessly using an Ethernet cable or Wi-Fi.

Depending on the device, you can view your real-time and historical energy usage from wherever you are through a website associated with the smart device, or stream your usage to any supported third-party cloud service.

Smart Thermostat

More than just a thermostat, these smart devices feature Wi-Fi connectivity to the Internet. Features for these devices may include programmability to adjust temperature, display of energy usage, interactive mobile apps, web portal and live weather updates. This controllable thermostat communicates wirelessly with a ComEd smart meter and the Internet.

As of October 2016, Smart Meter Connected Devices has 400 devices that have been enrolled in the service by ComEd customers. Since early in the inception of the SMCD service ComEd has partnered with the Illinois Science and Energy Innovation Foundation (“ISEIF”) to study the usage patterns of ComEd customers in behavioral studies that show the effectiveness of using a smart device. ComEd also keeps in close contact with the manufactures of the smart devices to provide feedback and ensure ComEd customers who contact the manufacturer have their needs met or exceeded. These manufactures currently include Ambient, AzTech, EnerGate, and Rainforest Automation.

ComEd continues to look for ways to expand the device offering as well as looking for ways to improve the SMCD service. Currently, ComEd is working to automate the enrollment into the SMCD service. If this automation is completed it will allow ComEd customers to self-enroll 7 days a week, 24 hours a day.

Bidgely HomeBeat™ Pilot

ComEd is conducting a pilot with Bidgely, a leading energy analytics Software as a Service (“SaaS”) provider serving utility customers, to test Bidgely’s new HomeBeat™ Energy



Monitor and Web & Mobile engagement solution with ComEd customers. ComEd is one of the first utilities to offer to customers this technology, which will provide them with personalized energy reports detailing how and when they use energy in their homes. The first phase of the pilot targeted the participation of 30 employees. However, 6 employees were unable to complete the program due to connectivity issues or personal reasons.

In Q3 2015, ComEd completed the pilot’s first phase: 24 ComEd employee participants received the HomeBeat Energy Monitor, which connected directly to their ComEd smart meter and provided real-time energy usage data to the Bidgely cloud. Via a process known as disaggregation, the information is analyzed in near-real-time to provide appliance-level energy use to the participant through the Bidgely Web and Mobile platform.

In September 2016, an additional 45,000 participants were contacted to participate in this program, each of whom were given access to Bidgely’s HomeBeat Web & Mobile platform. As of the writing of this report, there are 800 customers who have opted-in to take advantage of this opportunity, and who have enrolled with Bidgely and will have access to the service for one year.

On a parallel path, ComEd is investigating using the SilverLink and SensoriQ applications to send data to Bidgely in near real-time through the smart meter

network. This capability is expected to be available for testing in November, allowing ComEd to study any impacts to the meters and network as data traffic increases. Bidgely's HomeBeat platform will provide personalized appliance-level insights through the company's disaggregation-based solution. This technology will empower customers to take specific actions that will help them save energy. The inclusion of Bidgely's HomeBeat Energy Monitor enables ComEd to offer real-time energy insights, such as high-usage alerts via mobile push notifications within minutes of use. ComEd is one of the first utilities to offer Bidgely's new suite of HomeBeat products, which include:

- **HomeBeat Web & Mobile app:** Enhanced mobile app that provides real-time notifications and insights around energy use and puts the ability to make smarter decisions about energy in the palm of the customer's hand.



- **HomeBeat Energy Monitor:** Simple and affordable in-home gateway that syncs smart meter data with Bidgely's cloud to enable real-time energy insights.



MeterGenius Pilot



MeterGenius is a local Illinois start-up launched by Northwestern University students in 2013. The MeterGenius platform allows residential consumers to view their electricity consumption data via web and mobile applications, set an energy budget, receive tips on reducing usage, and earn rewards. ComEd worked with MeterGenius to develop a 6-month pilot for select ComEd customers with smart meters to determine the amount of electricity MeterGenius' platform can save, along with impacts on customer satisfaction and engagement in other ComEd efficiency programs.

The MeterGenius pilot launched in December 2015 and ran through May 2016. The pilot included nearly 6,500 randomly selected residential ComEd smart meter customers. MeterGenius leveraged the smart meter network to show participants 30-minute intervals of their usage data, which was updated the next day. The customers had unlimited access to MeterGenius' web and mobile applications, which allowed them to budget and track their energy usage on a granular level by the hour, day, week or month. Participants also received monthly communications with customizable tips on how to lower their electricity bills, and with energy-efficient habit reminders such as closing the blinds during the day to reduce cooling costs and defrosting the freezer on a regular basis in order to increase its efficiency. By using MeterGenius' tools, participating customers earned points that could be redeemed for gift cards and energy efficient products. Additionally, they were able to register for

weekly contests to compete against neighbors to see who lowered their electricity consumption the most compared to the previous week.

Results of the pilot were shared with relevant stakeholders within Smart Grid Exchange and Energy Efficiency groups, as well as across EU. Some highlights from the program include: average savings of 1% for participants that enrolled; enrolled users spent 15 minutes/month on the website learning about their energy use; customer satisfaction with energy efficiency programs increased 88%; 44% of enrollees answered over 100 questions about their home; and millennials showed the highest engagement and had the highest percent savings. Currently, the results of the pilot are being reviewed by Navigant and they are preparing their M&V report.

Smart Thermostat Program

ComEd submitted a tariff to the ICC on March 25, 2016 for a program supporting smart thermostats as part of ComEd's Central Air Conditioning ("AC") Cycling Program (i.e., Rider AC). The tariff went into effect on May 9, 2016. ComEd customers in the program can earn up to \$40 during the summer (i.e., June 1, 2016 through September 30, 2016) by allowing ComEd to adjust the temperature of the customer-owned smart thermostat. Customers in the program can participate using a Nest smart thermostat. As of, October 31, 2016 there were 7,100 Nest smart thermostat customers on the program. There were 2,988 Nest Thermostat customers that participated in the 2015 pilot. Nest Thermostats schedule demand response events under their "Rush Hour Rewards Program."

The smart thermostat program allows ComEd to leverage smart thermostat products as devices for residential demand response, to enhance customer experience and engagement, and introduces a channel for customers to obtain innovative technologies that help them use less electricity when it is most in demand.

Green Button Connect My Data

In May 2015, ComEd partnered with Schneider Electric to deploy Green Button Connect My Data in northern Illinois. Green Button is an industry initiative stemming from a White House call to action for utilities to voluntarily provide customers with



easy access to their energy usage in a secure and user-friendly electronic format. ComEd is among the first utilities to introduce Green Button Connect My Data, which allows customers to authorize third-party service providers to receive direct access to their energy usage analytics via the Green Button functionality. To help customers maximize energy savings via the Green Button Connect My Data functionality, ComEd offered Energy Insights Online, a free web-based energy analysis service that interfaces with Green Button. Energy Insights Online provided ComEd's commercial customers a more detailed analysis of their building's energy usage. It, also, enabled third-party vendors, such as Schneider Electric, to provide automated monitoring based commissioning (aMBCx) technology with embedded fault detection and diagnostics ("FDD") analytics that accurately prioritize energy savings opportunities.

The ability to transfer this data more seamlessly to third-party developers will help accelerate technology applications and analytics leveraging smart meter data. ComEd integrated the Green Button Connect functionality for its Commercial & Industrial customers in spring 2015. Elmhurst Hospital is among the first of ComEd's commercial customers to take advantage of ComEd's Energy Insights Online and Green Button Connect My Data. Using the Schneider Electric utility interface, data is pulled from different sources, including three onsite ComEd smart meters, with information Schneider Electric compiles in 5-minute intervals via 13,000 sensor points within the HVAC control system. Working with ComEd and Schneider Electric, Elmhurst Hospital was able to leverage these tools and their smart meters with zero additional investments in hardware or software to reduce the energy costs of their 866,000 square feet facility. ComEd successfully deployed Green Button Connect for residential customers in two phases. The first phase allowed third-party vendor registrations and was completed in October 2015. The second phase enabled the customer facing portion of Green Button Connect and was completed in December 2015. The customer facing portion was made available to the public on May 23, 2016. ComEd currently has one third-party vendor registered and is working with 15 others including MACH Energy, Carbon Cash and Power TakeOff to expand this list throughout 2016.

Root3

ComEd has contracted with Root3 for a one-year pilot of its Balance energy management system ("EMS") at four industrial/large commercial locations. The Balance tool uses big data and predictive analytics to optimize energy operations and

enable strategic energy planning at chilled water, steam, cogeneration, and compressed air plants (also referred to as Central Plants).



Balance has a step-by-step guidance system that updates based on ambient conditions and helps operators eliminate waste and improve their productivity and dispatch consistency across shifts. Algorithms in Balance continuously track operational efficiency and effectiveness. This makes it easier to identify bottlenecks and continuously improve energy operations. Balance also brings together data from a site's existing energy management system and plant process control systems, and combines it with information on weather, energy prices, operational constraints, business constraints and goals. It uses algorithms to continuously predict the safest, most reliable, and most cost-effective way to run a plant. In this aspect, Balance is very much like a navigational system, guiding users to Lean Energy Operations.

Another advantage of Balance is that it requires no capital investment to deploy – it uses data from a plant's existing sensors and meters.

To date, ComEd has one of four locations operating with Balance installed. The information on the first site is currently being reviewed by Navigant, and based on the information uncovered during this process Root3 will be evaluated to see if the pilot should be continued in other locations.

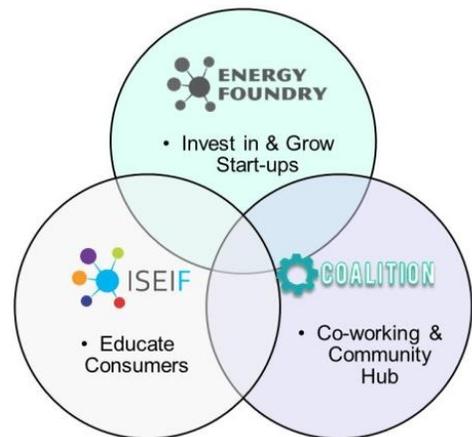
V. Smart Grid Collaboration

ComEd recognizes that great innovations come from engaging forward-thinking individuals with a broad diversity of perspectives, experiences, and expertise. That's why ComEd is forging key relationships with industry leaders, technology accelerators, universities and others, to further encourage the development of new and innovative grid-related products and services by entrepreneurs. Following are a few examples of key collaborative relationships and events that ComEd has established to seek out – and celebrate – innovation.

Energy Foundry

In addition to providing an initial funding investment, ComEd continues to support the Energy Foundry in its mission to foster innovative new grid-related and energy-related products and services. The pipeline continues to be robust, with applications received that span across a diverse range of business sectors and development stages such as gas,

water, energy storage, transportation, generation, power electronics, building technology and infrastructure. Leadership at the Energy Foundry has developed the selection criteria to help entrepreneurs achieve their highest goals and an investment model to accelerate speed to market for promising energy ideas. To date, the Energy Foundry has made nine investments and had two successful exits.



Select Investment Activities

- **Advanced Diamond Technologies:** An Argonne National Lab spin-out that developed an innovative method to manufacture a synthetic diamond coating for with end use applications including power electronics, industrial components, and power generation.
- **Bractlet:** A software sensor and analytic platform that allows large energy service companies to efficiently and continuously measure the savings of energy efficiency retrofits.
- **Intellihot:** A tank-less water heater that targets the commercial market (i.e., hotels, restaurants, etc.). Achieves savings in energy and installation costs, while enhancing reliability. They have a development path that includes combined heat and power.
- **InVekTek:** A Chicago-based company that licensed Georgia Tech motion control technology for industrial drives, improving operational efficiency, increasing useful life, and reducing energy waste.
- **RedWave Energy:** Developing an advanced technology to capture low-grade waste heat from thermal power plant and industrial processes.
- **SiNode:** An early stage advanced materials company developing the next generation of lithium-ion batteries, with a core focus on silicon-graphene anode technology.

- **Tank Utility:** A wireless monitoring solution for residential and industrial heating fuel tanks that allows small and medium sized heating fuel distributors to more efficiently serve customers and optimize deliveries

CSMART Laboratory at IIT

Built with the support of IIT, ComEd, Silver Spring Networks and West Monroe Partners, CSMART is one of the first of its kind to bring together academic, industry and utility experts to provide a fully-functional test environment for smart grid and smart city technology.



CSMART provides the platform to conduct a wide range of smart grid and smart city R&D analysis projects. Some of the initial state-of-the-art demos include:

- **AMI Water:** As part of a proof of concept program to leverage the mesh network's capabilities, inter-operability testing of the AMI Water Meter and ComEd's Electric Meter is under way at the CSMART lab. The AMI Water meter is being tested to communicate to the electric meter and transmit water usage data to ComEd's smart meter monitoring software. Testing on this technology has completed successfully and has moved onto more detailed testing at ComEd's testing facilities. Smart water meters are still being utilized in the chiller plants on campus using the similar IT and physical infrastructure used during testing in Q1 and Q2 2016.

- **Smart street lights operational testing:** Intelligent and adaptive networked street lights can reduce operating and maintenance and energy costs by 75 percent through LED lights that are controlled and connected by a network. The software helps provide scheduling, remote on/off and dimming features as well as outage detection notification for faster repairs to ensure the safety of citizens and the community. Smart street lighting networks can also establish a platform upon which additional smart city applications can be deployed. ComEd is facilitating the retrofit of a significant number of the IIT campus lights with this technology. To date, 100 lights have been donated by Cooper Lighting and around 22 have been installed in the field.
- **Street Light Smart Applications:** Exploring and developing an application integrating the campus 911 emergency call buttons with the smart streetlights that enables control of streetlights based on activation of 911 call button. The key research component is how to intelligently and precisely correlate the streetlights with an external information source. Current efforts are building on the successful pilot to implement motion sensing and “on the edge” group control.
- **Cyber-security Evaluation of the IIT Smart Streetlight Project:** Conducting a complete cyber-security evaluation of the prototype system currently installed in the CSMART lab to discover potential vulnerabilities in the smart streetlight system, and investigating means to eliminate or mitigate them.
- **Distributed Energy Resource Management – ConnectTheGrid™:** Cloud-based application that provides work-flow management and an online dashboard for

utilities to manage distributed generation application approvals, including roof top solar, as well as providing asset tracking, reporting and forecasting.

- **Data analytics and real time interactive dashboard:** Smart-grid communications networks are used to monitor operations and collect data from throughout IIT's electric microgrid in order to optimize electrical efficiency of the system and predict faults prior to their occurrence.
- **PMU Data Collection and Analytics:** Eight phasor measurement units ("PMUs") are in place at IIT. All eight of these communicate with a phasor data concentrator ("PDC") controller responsible for data collection. Current efforts are focused on integrating PMU data with the OSIsoft Asset Framework Template.
- **(GRIDCO) "Advanced Distribution Automation: In-Line Power Regulator ("IPR"):** Initially testing and demonstrating two use cases that are relevant to the utility business: Conservation Voltage Reduction ("CVR") and detection of technical and non-technical losses. If tests are successful, this will demonstrate not only the Gridco Systems product but also the concept of distributed local control for the distribution grid using Smart Meters and Bridges on the Silver Spring communications network. Other applications include distributed power factor control and distributed harmonic mitigation, which will be tested in later phases of the project.
- **IIT Single Line-diagram – mapping the IIT Micro-grid:** Utilizing OSIsoft's PI ProcessBook to create a live updating one line diagram that condenses the microgrid data into one easily accessible location for IIT facilities members and for

faculty and student research. Stores historical microgrid data at 5-second intervals in condensed and easily searchable form for analysis and adds real-time notifications to microgrid assets to inform facilities and faculty of changing statuses around the campus.

- **OSIsoft Asset Framework (“AF”) Template Project:** Creating a Common interface model (“CIM”) for the campus microgrid including solar, battery storage, Cogeneration, wind, as well as relay and protection. This model will serve as an input to a CIM translator into OSIsoft’s Hierarchical data management software. The CIM translator has the added benefit of automatically creating PI tags (data points in the PI system) which removes many man-hours of configuration.
- **UFARM Campus community garden:** Initiated by the IIT chapter of *Engineers for a Sustainable World* this facility is a test-bed for the development of urban agricultural technology. Current projects are heavily focused on networked monitoring and intelligent irrigation controls.
- **Microgrid SCADA:** Utilizing Alstom SCADA software and existing Silver Spring Networked devices this tool will be used in parallel with production controls and monitoring to establish control of edge devices (Smart Streetlights initially) and a development environment for microgrid specific SCADA.
- **IIT DC Nanogrid:** Complementing the 200 kW Photovoltaic installation on Keating Hall this project adds a DC bus, micro controller, and 8 hours of battery storage to power building loads (DC) without the losses of an inverter. The first major application is the upgrade of gymnasium lighting to controllable LEDs.

SmartGridExchange™

The mission of the SmartGridExchange™ (“SGE”) is to discover, seek out, foster, and execute pilots and innovative products and relationships. This collaborative initiative between ComEd, entrepreneurs, technology start-ups, universities and customers seeks to explore and shape new products, offers and innovative solutions that utilize the intelligence and benefits of the smart grid. Through the SmartGridExchange™, ComEd is starting the process of co-designing the future of electricity with companies interested in developing smart grid-enabled

products and services. These include enabling third parties to develop new products and services that leverage the smart grid investments ComEd is already making; working with select developers who bring demonstrated value to customers; and giving customers a convenient portal from which they can learn about new and developing energy products and services.

In addition to the Bidgely Pilot, Smart Thermostats Program, MeterGenius Pilot, Green Button Connect My Data, and other programs detailed in the previous section, some additional initiatives and demonstrations already underway through the SmartGridExchange™ include the following:

- Through ongoing market scans and ideation sessions, the SmartGridExchange™ has already become the birthplace of multiple new technology demonstrations, and collaborations, including Smart Meter Connected Devices, Bidgely, Nest Learning



Thermostat™, and Root3 described in the Current Demonstration Projects section above.

- ComEd, in partnership with Accenture and Silver Spring Networks, is hosting its third annual SmartGridExchange™ Forum in downtown Chicago in November 2016, bringing together leading technology and innovation companies with other customer and stakeholder organizations, including the City of Chicago, Citizens Utility Board and Smart Grid Consumer Collaborative, to discuss how to leverage the smart grid to deliver increased value to consumers.

The SmartGridExchange™ initiative has continued to introduce, vet, and advance new ideas and potential pilots while continuing to deploy existing in-market initiatives and programs. The SGE Team has continued biweekly market assessments of industry developments and to identify products and solutions with potential for piloting or collaboration under SGE. New technologies that have been vetted are continuously added to the SGE initiative pipeline to monitor, evaluate, and charter new initiatives and pilots. The SGE team has been meeting with vendors and program managers to explore, discuss, and structure potential pilot program design. The SGE Team is currently working on securing which projects will be developed and implemented in 2017.

EPRI Smart Thermostats Collaboration

Advances in technology have led to the development of a new generation of programmable communicating thermostats that hold the potential



for energy and demand savings at a relatively low cost to electric and gas utility customers.

Known as “smart thermostats”, these control devices for space conditioning systems have capabilities beyond just allowing the customer to program temperatures for different times of the day and days of the week. They allow customers to remotely program their thermostat, often via internet-enabled devices (such as a PC or mobile device) with a consumer-friendly user interface. They enable two-way communication of data outside the building premises (either built-in or expandable), including indoor temperature data, operational sequence of space conditioning equipment and so on. They can also be adapted to receive demand response event signals from utilities.

Industry experience has shown that customer acceptance and usability can be key drivers to a thermostat’s energy or demand reduction potential. Given that smart thermostats may offer better customer usability due to their remote programming capability, the objective of this project is to evaluate their energy and demand savings impacts, as well as how customers perceive and use them.

In 2014, Exelon Utilities joined the Electric Power Research Institute’s (“EPRI”) Evaluating Smart Thermostats' Impact on Energy Efficiency and Demand Response project which is being executed under EPRI’s program 182, Understanding Electric Utility Customer. During the summer of 2015, ComEd had two thermostat pilots underway and joining the EPRI effort will provide the opportunity to not only share the learnings from ComEd’s own pilots, but to learn from the pilots that are being conducted by nine other utilities participating in this project. EPRI’s research activities cover pilot design as well as technology scouting and review. Additionally, EPRI will

serve as a third party for evaluation, measurement and verification (“EM&V”) of each member pilot’s ability to achieve established objectives. New learnings for the industry and the public will come about through collaboration and conducting pilot projects to evaluate the capabilities of various vendors and technology. During Q2 and Q3 2015, the EPRI Smart Thermostats Collaborative conducted several workshops and webcasts on topics related to the project. Two studies conducted by EPRI have recently been completed. In each study, one type of smart thermostat helped reduce customer costs while the other actually increased costs.