NRECA – DOE Smart Grid Demonstration Project (DE-OE0000222)
Interim Technology Performance Report

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1.0 Introduction

The coordination, procurement and delivery of Smart Grid technologies for the 23 co-ops that are part of this study has taken significantly longer than anticipated. Partly this was a matter of having 23 sub-recipients to coordinate with, but vendors were also much slower to respond than anticipated. In addition, many vendors had long lead times due to the large numbers of ARRA funded orders placed with a rather limited field of suppliers for Smart Grid products. As a result, NRECA and the co-ops that are participants in this study are still in the midst of installing much of the equipment procured under this project.

Fully 80% of the currently installed equipment has been installed within the last six months and it is still too early to be able to give detailed information on how well the equipment is performing and what measurable benefits have been gained through its implementation. Therefore, this report primarily focuses on the procurement and installation aspects of technology performance.

For the purposes of performing the studies of SmartGrid Technologies, this project has chosen to classify the technologies deployed into one of three major sub-classes, each consisting of four technology types. These are:

Enabling Technologies:	Advanced Metering Infrastructure Meter Data Management Systems Telecommunications Supervisory Control and Data Acquisition
Demand Response:	In-Home Displays & Web Portals Demand Response Over AMI Pre-Paid Metering Interactive Thermal Storage
Distribution Automation:	Renewables Integration Smart Feeder Switching Advanced Volt/VAR Control Conservation Voltage Reduction

Thus, the balance of this report provides a status update on all the major items installed to-date (over 257,000 items), and then addresses each technology area in turn and describes what progress and issues have been experienced at the various co-op participant sites.

2.0 Technology Installed

As part of this project the following types of technology have been deployed:

Advance Metering Infrastructure (AMI) - differs from traditional automatic meter reading (AMR) in that it enables two-way communications with the meter. This equipment consists of the smart meters and their connection to a means of communicating back to the electric utility. A smart meter is usually a digital electrical meter that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily, but frequently hourly or even at 15-minute intervals, back to the utility for monitoring and billing purposes.

Meter Data Management (MDM) systems - refers to a key component in the Smart Grid infrastructure that performs long term data storage and management for the vast quantities of data delivered by smart metering systems. This data consists primarily of usage data and events that are read from the meters. The MDM system will typically import the data, then validate, cleanse and process it before making it available for billing and analysis. The MDM system usually also provides the data interface to the customer billing system, outage management systems and may also control the remote connect/disconnect of service depending on meter types installed. Furthermore, an MDM system may provide reporting capabilities for load and demand forecasting, management reports, and customer service metrics.

Telecommunications – are the backbone of and modern Smart grid system. This is the main area where these modern systems differ significantly from previous systems. Not only is there two-way communications between the devices in the field and the utility offices, but the quantities of information are also orders of magnitude higher than they were before. This, most utilities face the need to upgrade their communications infrastructure. The equipment installed to do this ranges from radio links and towers, to fiber optic cable and routers, to power line carrier head end systems and supporting equipment. In addition, post substation aggregated data may also be carried under a service agreement by commercial data carriers using fiber optic or microwave high speed data links.

Supervisory Control and Data Acquisition (SCADA) systems are computer control systems that provide exactly what their name implies. Most utilities already have some form of SCADA system in place at their command center to monitor the state of their distribution system and control reclosers, voltage regulators and other equipment at substations, but frequently the newer Smart Grid equipment requires either upgrades or replacement of existing systems.

In-Home Displays (IHDs) and Web Portals - refer to two different technologies that provide consumer facing display of electric power usage and event notification from the electric utility. IHDs are typically dedicated LCD display units that can be set on a counter or shelf and provide up-to-date electricity usage information to the consumer. For utilities implementing Time Of Use (TOU) or other tiered pricing strategies, the IHDs also can display the current rates that consumers are paying for the power. Several studies have shown that such information can effect consumer behaviors and reduce power consumption. Web Portals provide much the same information through access to a secure webpage, but have the advantage of being able to display a richer range of information and graphical representations. They also have the advantage of being more easily modified as the needs of the utility change. The downside is that they require consumers to log in and display the information, though some systems are being developed that allow consumers to enable push notifications to mobile devices.

Demand Response over AMI – utilizes the two-way communications implicit in AMI to turn on and off large load devices at the consumer premises. Typically these consist of HVAC and water heater loads. Participation in these DR activities is a voluntary enrollment by the consumer wherein they receive some discount on their electric bill. While earlier AMR based system could also control switches in the consumer's house, there was no feedback mechanism to let the utility know if the switch had actually operated correctly. The ability to shed load during peak times is a critical cost reduction strategy for many electric distribution utilities

Pre-Paid Metering – is another new capability made possible by the computer control of the new Smart meters and their supporting systems. Consumers pre-purchase their electricity for the month, and the system has the ability to turn off the electricity to the house when that amount has been consumed. There have been several studies that have shown a change in consumer behavior towards reduced electricity usage based on pre-paying for their electricity. This technology also reduced the costs for utilities associated with activating and deactivating accounts, and is particularly useful in transient and multi-tenant dwellings where frequent account changes are common. There are many options and variations being tried with this technology, from split power systems where essential electrical services would not be disconnected (ie. for furnace control in northern Alaska) to kiosks for pre-payment in local convenience stores, to notification of low-balance and payment authorization by mobile device.

Interactive Thermal Storage – refers to a specific type of water heater that has been developed for use in Smart Grid systems. This type of water heater stores energy by heating water to very high heats (185F+) during times when grid electricity usage is low and therefor cheaper and then mixes the hot water with cold water from the supply to the desired usage temperature. In this manner the energy is stored from the time it is available cheaply to the time it is needed which would otherwise typically be a peak usage time. Shifting loads from peak times is another critical element in reducing the electricity purchase costs of electric distribution utilities.

Renewables Integration – refers to a number of technologies that make it easier for utilities to reliably integrate solar and wind electricity generation sources into the distribution system. The active flow of information between the utility command center and the distributed renewable energy generation source allows these devices to be monitored and controlled, and for energy storage devices in the form of large battery arrays to be switched in and out to help level the supply as the sun and wind varies.

Smart Feeder Switching – is a critical component of many distribution utilities outage management systems. The capability to monitor the state of their distribution grid and determine outages caused by damage or equipment failure, isolate the damaged section and then switch power supply around the damaged sections to quickly restore power to the majority of their consumers. The equipment utilized for this activity are large computer controlled recloser switches typically installed in substations or smaller units that are pole mounted for neighborhood distribution control. Control schemes for switch management may be centralized at the command center for the utility, or be distributed where each switch “talks” to its neighbors and acts locally and reports back to command center.

Advanced Volt/VAR control – refers to the process of managing voltage levels and reactive power (VAR) throughout the power distribution system through the utilization of computer controlled voltage regulators and capacitor banks. Volt-VAR control can both help to reduce the over-voltage and under-voltage violations that can occur when large inductive and capacitive loads are switched on and off. Increasingly, Volt-VAR control is also being used to manage distribution system voltages in order to reduce demand and energy consumption and achieve significant energy savings.

Conservation Voltage Reduction (CVR) – is similar to Advanced Volt-VAR control in that it uses the computer controlled voltage regulators in order to achieve energy savings. The idea behind CVR is old, if you reduce the voltage to an induction motor from 120VAC to 114VAC you can save some energy. The problem has always been that the voltage on an electric distribution system decreases naturally the farther you get from the substation and if you provide a little too little voltage then the energy saving is lost and damage may occur to motors and other consumer devices. The Smart Grid offers the ability to precisely monitor the voltage all the way to the meter and allows the ability to set substation and neighborhood voltage regulators to achieve optimal energy savings, up to 3% in some cases.

3.0 Technology Evaluation

3.1 Advanced Metering Infrastructure (AMI)

Calhoun Co. ECA, IA - In working with Cooper Power Systems (Cooper) Calhoun’s vendor for this project the procurement of materials and scheduled deliveries were prompt. The value of their project management and training however seemed to be lacking. As a small cooperative with staff of limited experience in the IT department, the integration of Cooper’s software with the existing billing software (Professional Computer Systems, Co.), was difficult for Calhoun. During the selection process Cooper indicated that they would be “partners” and the integration was to be seamless however this has yet to be completed to full functionality.

That said, the meter readings can now be collected within an 18 hour reading period verse a 2-3 day convention meter read allowance. This system allows for information on kW load at targeted accounts to ensure transformer sizing and member requests of load information. Stored meter data has allowed Calhoun to follow up on several concerns with high bill complaints as well. As a side benefit, the install of these metering devices did result in the discovery of some faulty meter sockets that may have led to outage situations.

Clarke Electric Co-op, Inc., IA – The AMI system selected at Clarke was the Power Line Carrier model AMI system as developed by Cooper/Cannon. Clarke experienced significant issues with the installations of this equipment. Initially there were problems with large numbers of the meter modules being shipped with the incorrect communications and address settings, then even more problems getting the meters to actually communicate back to the collectors and returned to the co-op offices. Cooper eventually sent field engineers out to Clarke to diagnose the issues and found that the solution was to include significantly more signal repeaters in the deployment to get the reporting rates up. While significantly increasing the cost of the system (more than $100K), this has been mostly successful, but it has still not been possible to get the read rate up to even 98% and the delays caused by these problems have significantly delayed the overall deployment of the smart grid systems at Clarke Electric Co-operative. Knowing what they know now, Clarke would probably have chosen to go with a different vendor for their AMI equipment.

Delaware County Electric Co-op, NY – DCEC selected Landis & Gyr meters for their compatibility with the rest of their meter system. The installations of the meters went smoothly and the installation of the sub-station equipment was well-executed by DCEC personnel, mostly during the cold-weather months. Minor items were discovered during the process all of which were resolved to allow for successful operation. Processes improved as the work advanced and DCEC personnel became more familiar with the equipment. Adequate support was received from Landis & Gyr to resolve any issues. The integration between DCEC legacy SCADA system and the Landis & Gyr hosted server has required more developmental work than planned. However, this is truly developmental as it is the first of its kind to require this type of functionality to our knowledge. Functionality for meter reading, outage management system applications and voltage monitoring has been judged as very good. However, extracting data from the PLC AMI system to use in other may only be accomplished with manual intervention, which is less than desirable.

EnergyUnited, NC – Even though EnergyUnited did not deploy its AMI system under the terms of this agreement, this effort was ongoing contemporaneously with the Pre-paid metering activity in the Smart Grid project, and the deployment of the AMI system is directly relevant to their implementation of Pre-Paid metering. Thus their experience with deploying a large scale system is included here. EnergyUnited deployed a hybrid AMI solution – both PLC and RF metering using the Cooper Technologies AMI system. The RF technology has proven to be a much more reliable means of communications providing the bandwidth to obtain hourly readings at a very high percentage rate. In contrast, the noise over the power lines as well as bandwidth limitations makes power line carrier a much less desirable solution, but one that is necessary in the more remote and rugged sections of the service territory. Given the bandwidth constraints and noise and substation signal cross-talk issues EnergyUnited does not anticipate that it will be able to use the PLC AMI system for hourly data for all customers. This limits the use of the analytics that are possible when reviewing transformer loading and other engineering applications.

Flint EMC, GA – Flint selected the Aclara TWACS system to complete their AMI system. TWACS was chosen mainly because they already had several thousand meters of this type installed. Under this activity they installed over 51,000 more meters. In this scenario it was necessary to purchase the meters from one are distributor (GE meters from Stuart C Irby, Co.) and the Aclara communications modules from a separate distributer (HD Supply). This required that each meter be configured with the appropriate comm. module prior to use. The two vendors coordinated this work seamlessly at the factory level so that Flint EMC received the end product ready to install. There were no significant issues with the procurement or deployment of these meters.

At this point Flint has seen a significant reduction in metering operations cost as all meters can now be read remotely. They anticipate integrating the TWACS system more fully into their Outage Management suite to aid in identifying outages and confirming power restoration.

As a part of the TWACS deployment, they also installed 6,000 meters with remote disconnect feature. These units have proven to be particularly valuable in reducing costs to the co-op and to the members. They save the trip cost to disconnect and later reconnect and the customer saves the trip charge normally added to the bill to partially reimburse those costs. It also allows Flint EMC to restore service immediately upon payment.

Humboldt County REC, IA – Humboldt Co. REC purchased their AMI equipment from Cooper Industries. At that time they felt that was the best product to meet their needs that included two way communications with their meters and also supported a load management system as well. The next closest bid received was twice as much as the Cooper bid. In all the Cooper system suffices for getting the meter readings once a day, but has fallen short in terms of gathering load profile information on a 60 minute interval. Humboldt chose to install the equipment ourselves, however looking back, they feel Cooper could better serve its customers by providing an installation team to install all the software, server hardware and even the meters for the first substation, including all integration to the billing and CIS systems.

Kaua'i Island Utility Co-op, HI – Overall KIUC is very pleased with the decision to go with Landis & Gyr for their AMI metering system. While they did encounter "bumps in the road" throughout the installation process L&G was very prompt and competent in addressing the issues. The equipment is working as expected and KIUC is excited to be the leader in the State of Hawaii in Smart Meter deployment.

Prairie Energy Co-op, IA – In general the procurement and installation of the PLC-based AMI meters went smoothly at Prairie Energy Co-op. Meters arrived ready to install, by the supporting electronic files for integration into the existing back-office billing systems were another story. One vendor sent a complete file and the other sent two files because they did not install the AMI module on-site but rather sent their meter to a second party who did the installation. Combining these two files manually was time consuming and tedious.

The big advantage of the new meters is the ability to get a reading from any meter at any time requested. However, they do have a problem with meters that they are unable to read because of interference on the Power Line. The number of signal repeaters that we were told we would need when the system was designed and quoted probably should have been double. The co-op tried to set the system up to do hourly reads on every meter but this did not work reliably enough to make it worthwhile. The PLC-based system is only capable of providing hourly reads from a certain number of meters on each substation and even then is very limited in the number of intervals it will actually download on a daily basis.

3.2 Meter Data Management (MDM)

Adams Electric Co-op, IL – Adams EC selected an MDM system provided by NISC. The integration of this software into their system has taken significantly longer than anticipated which has held up both the web portal activity and the demand reduction/ time-of-use rate activity.

Blue Ridge Electric, NC – Selected an Aclara MDM system based on their need to integrate with their existing equipment. Aclara was supposed to begin work on the project 3/12 but due to personnel issues was unable to begin. Aclara did not reassign the project to a new project manager until 12/12 and the installation is now significantly behind schedule. Aclara has also been trying to get out of some of the system customizations that they contractually agreed to. In general, Blue Ridge has found Aclara to be difficult to deal with on this project.

Delta Montrose EA, CO – DMEA selected the NISC MDM software system for its mix of functionality and attractive pricing. The NISC system will be replacing the previous Aclara Energy Vision software. The software for this part of the project at DMEA has been installed and tested and is now working correctly. Integrating the software with the existing billing and back-office systems went smoothly and NISC offered superior support and service to DMEA. DMEA plans to begin integration of the MDM with the NISC SmartHub module for integration with In-Home displays within the week. Additional integration with Master Station software and power usage software will enable a pilot of Pre-paid metering in 1Q13.

EnergyUnited, NC – Due to issues and delays experienced in the Prepaid Metering Activity, EnergyUnited has made the decision to postpone the MDM install until later in 2013.

Great River Energy, MN – After a lot of careful specification of requirements and determination of a make vs. buy decision for this novel multi-tenant MDM and DR management system, the vendor selected to the was NISC. Things have not gone as smoothly with this system development as hoped, and GRE has had to fail the NISC system during two of the milestone checks. That said, it is hoped that the system development will be completed by 8/13 and final acceptance testing can begin then.

Lake Region Electric Co-op., MN – LRE is one of distribution co-ops associated with the GRE multi-tenant MDM system. They will be using the system to provide consumers real-time insight into their energy usage.

Minnesota Valley EC, MN – MVE is the third member of the GRE multi-tenant MDM system and will be using the system to not only provide the real-time customer information, but also to control the Demand Reduction switches on members' water heaters and air conditioners.

3.3 Telecommunications

Adams Electric Co-op, IL – Adams EC installed new S&C MDS radios as part of their distribution automation upgrades. The radios were straight-forward to install and have worked well.

Clarke Electric Co-op, Inc., IA – Clarke EC installed 450 MHz radio backhaul equipment and associated communication equipment to link Clarke's control center with twenty-one (21) field switch locations and eleven (11) substations. The vendor selected for this was RFIP and, in general, their work was done correctly, but on frequent occasions they were not organized and behind schedule. Clarke was able to work with them when these issues arose with the equipment and service they received during the installation phase of the project and the equipment was brought online in a timely fashion. However, Clarke is currently experiencing some issues with dropped packets which is preventing the correct functioning of the Smart Feeder system equipment. Right now Clarke is working with their engineering vendor, PSE, to see how they can address that issue. It looks like the problem may be in how the gear was configured by RFIP and a hopefully solution should be forthcoming shortly.

Corn Belt Power Co-op, IA – Corn Belt acts as an intermediary between generation and supply and a group of local rural electric co-operatives. The wireless communications system installed was purchased through Larson Digital Communications, consists of 53 radio transmitter/receivers and relays and was installed by Corn Belt employees and contractors. The system provides a WAN between Corn Belt HQ and its member cooperatives and the distributions substations, enabling Load management Control. The equipment installation went smoothly and all aspects work as specified and as required to initiate a load control condition, pass this information to the RECs and then through their PLC networks down to load control devices at the member level. It is estimated that Corn Belt's Members saved over $400,000 in 2012 and they expect larger savings next year as more load management switches are installed.

Delaware County Electric Co-op, NY – DCEC was constrained by their geographical (topographical) constraints to use power line carrier (PLC) communications for the project. For base functionality, PLC is stable and reliable, however, it is very limited in its communications capability. DCEC reports that they are experiencing reasonable performance from our PLC system, however, they would not characterize its performance as being equivalent to that of other AMI systems which use a different medium for the communications. They see the key for the future of Smart Grid system will be judged mostly on its communications capability and the PLC system has significant limitations.

Owen Electric Co-op, Inc., KY – OEC has added significantly to their telecommunications network over the course of this project. In conjunction with the fiber portion of this project, the new equipment allows for a loop design of the OEC WAN to utilize OSP routing. A new communications control room and microwave dish were added at an existing tower, with the equipment being installed by MobilComm and integrated into OEC's WAN with the assistance of the OEC staff and another vendor PTS. After the actual field study was completed, it became clear that the microwave dish needed to be mounted higher on the tower and MobilComm quickly corrected the issue.

In addition to the microwave equipment, OEC has added a significant amount of fiber lines to its network. Almost all of the fiber has been installed and the system is functioning as design on the Ethernet portion (OEC). There are some issues however on the T1 side (connection to Eastern Kentucky Power Cooperative) that are a result of the equipment used to partition the fiber optic line. EKPC and OEC have been working with the vendor on a solution, but thus far have not been able to come up with one that fully satisfies EKPC.

Finally, OEC incorporated Adtran switches and routers that are compatible with the existing routers and switches in OEC's WAN. The OEC staff along with PTS, which is OEC's maintenance contractor for OEC's phone and network hardware, completed the project without any additional equipment or programming.

Washington-St. Tammany EC, LA – WSST has originally planned to use microwave communications on concrete poles to link their system of smart feeder switches. They were fairly sure that this would work, however, attenuation from vegetation and other factors drove a need for towers twice the height originally planned. This would have increased the cost of the system unacceptably and the system had to be re-engineered. It was eventually determined that fiber optics provided the best combination of speed, cost and durability and the equipment and supplies were ordered and this system is being installed. They are currently installing and terminating 120 miles of fiber and they expected to be complete by September 2013.

3.4 Supervisory Control and Data Acquisition (SCADA)

Adams Electric Co-op, IL – Adams EC selected OSI for their SCADA system upgrade and have found OSI support to be excellent. They report that the SCADA software is excellent and is consistently exceeding their expectations. As they learn the software, they keep finding more and better ways to monitor their distribution system. The active load control functionality of the software is still being implemented and should be online around April, 2013.

Adams-Columbia Electric Co-op, WI – ACEC has and existing Survailent SCADA system, but the addition of the Smart Feeder Switching activity necessitated same feature upgrades in their system. Procurement installation and configuration went off without a hitch.

Clarke Electric Co-op, Inc., IA – Clarke selected the Open Systems International (OSI) SCADA system for its SCADA and Smart Feeder control systems. This system is installed and functional and operating correctly at several data points but they are still programming some of the equipment in the field as well as adjusting the SCADA software. Initially there were significant issues with integration with the rest of Clarke's systems, however after changing to a different engineer who is familiar with the OSI system things are progressing well.

Owen Electric Co-op, Inc., KY –Very few technical issues arose during this project and the most significant issue was a firmware upgrade that was required to resolve an intermittent communication problem to the co-ops remote terminal units (RTUs). The technical benefits are already being realized by increased situational awareness of events in the field as a result of the increased data being retrieved from the field devices. For example, fault current magnitudes and fault targets have been used to identify fault locations and dispatch crews to the source of the problem and thus reduce outage durations for our membership. Additional cost savings will be realized this year, through eliminated trips, as we will be able to remotely reprogram our RTUs as part of a project to implement a “hot line” tagging for substation oil circuit reclosers.

Washington-St. Tammany EC, LA – Due to the issues related to their communications backbone, WSTT is significantly behind where they planned to be installing their SCADA system. They will be installing the Cooper Yukon in October and Cooper will be coming out then to help them configure the setup.

3.5 In-Home Displays (IHD) / Web Portal Pilots

Adams Electric Co-op, IL – Adams will be providing a web portal pilot program to its members. To accomplish this, there needs to be integrations between their Customer Information System (CIS, from Daffron) and the Meter Data management software (MDM, from NISC). The interfaces between these two pieces of software has taken significantly more work than anticipated, but should be completed in the next couple of months. Some of Adams EC’s auxiliary meters are causing extra problems for the e-business and the MDM software. E-billing is in the testing phase right now and the necessary web-page enhancements are completed and are awaiting the MDM and e-billing components.

Delaware County Electric Co-op, NY - All of DCEC’s deployed IHDs link to their respective endpoint/metering device via the Zigbee wireless radio link. Fifty of the IHDs are included in the study portion of this project. The Zigbee link allows the IHD to display selected energy measurements derived from the endpoint metering instruments. The study group of fifty is complete and operational. With the exception of three locations, all IHDs were successfully deployed using Landis & Gyr’s hosted Command Center control system. Three devices required remedial addressing in the field to correctly provision the Zigbee wireless radio link.

Flint EMC, GA – One aspect of their project was to deploy a web portal for customer use in viewing and analyzing their usage. This task was accomplished fairly easily by deploying a pre-built module on their Customer Information System (Southeastern Data Corporation). This allowed them to make the portal available to their entire customer base and provides near real-time usage data.

The most frustrating portion of the project for the co-op was sourcing and deploying an In-Home Display system to a portion of our customers for peak demand notification and general usage information. When the project was conceived it was with the intent to use one of the commercially available IHDs which utilize the Zigbee communications protocol to gather information from the meter. At the time Aclara was advertising their modules available with the Zigbee chip. After Flint began the project and tried to procure these, Aclara informed them that they had no Zigbee equipped modules ready to ship. After some time passed they informed Flint that they had discontinued development on the Zigbee chip, citing range and wall penetration issues. Flint EMC was forced to come up with another way to communicate to an in-home display device. As a last resort they bought and repurposed Aclara's IHD designed for pre-ay metering and purchased the Utilsales pre-pay software to send messages to the IHDs even though they are not using Aclara's prepay system. This device communicates to the system head end server through the TWACS protocol, not directly with the co-located meter as had originally been intended. The work-around allows Flint to send peak notifications but provides no real-time meter data reporting for the customer.

Kaua'i Island Utility Co-op, HI – From KIUC's members standpoint the IHD's has been the most exciting aspect about KIUC 's Smart Grid project. They estimate that it has raised the level of awareness on individual consumer usage to a whole new level. So much so, that their Board of Directors approved an additional 500 IHD above the original procurement of 500. Demand Reduction through the action on the part of individual consumes is important on a truly "islanded" power system and can save members significant amounts as Hawaii has some of the highest energy prices in the US.

Lake Region Electric Co-op., MN Lake Region will be providing a web portal interface for their consumers to get real-time data on their energy usage through the multi-tenant MDM system being developed with Great River Energy. This application is being developed by NISC and is significantly delayed. GRE is optimistic that the system will be complete and correct by 08/13.

Menard Electric Co-op, IL Menard plans to implement web portals to provide customer facing information from the meter data management system on members' electric consumption. NISC is providing the MDM system and is late in getting the system developed and deployed. At this point Menard EC belives they will have the system completely deployed and tested by 11/13.

Minnesota Valley EC, MN – MVE will be providing a web portal interface for their consumers to get real-time data on their energy usage through the multi-tenant MDM system being developed with Great River Energy. This application is being developed by NISC and is significantly delayed. GRE is optimistic that the system will be complete and correct by 08/13.

Owen Electric Co-op, Inc., KY – Owen EC combines their web portal pilot program with a demand reduction (DR) effort in what they call their Smart Home project. For this effort, Tendril was selected as the vendor based on all around capability, product, marketing, experience and software. The decision at the time was correct, but with new knowledge and developments in the industry Owen would do it differently now. The project has been much more difficult than anticipated. All areas involved significant learning issues; hardware, software, marketing and products. Other unanticipated challenges included addressing 400 amp meters, ERT installations, etc. However, these sorts of challenges are the very reasons Owen chose to approach is effort in a small scale pilot to begin with.

The software involved is Software as a Service (SaaS) from Tendril via the member's internet; it provides the member with control of their thermostat and hot water heater via their PC or smart phone. It also provides them with historic usage and billing data. It asks them to fill out a home profile so that they can be compared with other similar homes. And there is also a place to set energy saving goals, receive energy savings ideas, and a place to share ideas with other enrollees. The major concern with the software is that it is all geared toward energy savings and not peak demand savings, which is the real saving value for the co-op. Owen EC is working with Tendril to develop peak savings tools that will be deployed over the monitoring period.

3.6 Demand Reduction (DR) over AMI

Adams Electric Co-op, IL – While the Aclara software has been installed and Aclara support has been excellent, the active control of load control switches and disconnect meters has not begun as the required integration between the CIS and MDM systems is still underway. Adams EC is waiting to make sure the infrastructure systems are installed and working correctly before promoting the new RTP rate.

Delaware County Electric Co-op, NY - DCEC's demand reduction program centers on the control of member/customer electric water heating equipment. The deployed load management switches or load control switches (LCS), operate as a controlled endpoint of the L&G PLC based AMI system. The newly installed LCS devices control electric water heating equipment on a timed based schedule controlled by the AMI system. However, DCEC has been working with their SCADA system provider (Survalent) and AMI system provider (L&G) to integrate their respective systems using MultiSpeak. This integration will allow the command sequence programs in SCADA, which measure and predict the DCEC system load, to control LCS devices in an optimal manner that minimizes purchased energy costs with respect to DCEC's power supplier's rate structure. DCEC's power supplier is the New York Power Authority (NYPA). An additional component of our Project is to investigate the qualification of their controlled water heating system as a Demand Response resource in the New York Independent System Operator's (NYISO) Demand Response program. It is not known at this time if the system will qualify. The LCS devices installed with this Project replace a set of load control relays (LCR) which were no longer supported. The "legacy" LCR system required the use of a separate power line carrier system which also was no longer supported. DCEC has successfully deployed 425 new LCS devices. Deployment continues. Additionally, DCEC has advertised the controlled water heating option to its member/customers in an effort to solicit additional controlled water heating participants. Returns to that solicitation indicate that approximately 290 additional LCS devices will be deployed to interested members/customers.

Humboldt Co. REC – At this time the co-op has approximately 20% of the planned DR system installed. They have found the equipment easy to install and have had very few issues with this system. Humboldt Co. REC recently merged with Midland Power Cooperative so the installation rate slowed down some with the added work load of the merger, but the majority of the remaining load control switches should be operational by the end of 2Q13.

Iowa Lakes EC – Iowa Lakes EC's vendor experience has been less than stellar. They purchased their system from Cooper Power Systems. The co-op reports that they had significant difficulties getting a satisfactory system configuration and controller programming from the vendor. ILEC reports that the design and programming of the system performed by Cooper would have, in time, compromised the functionality of the system. Eventually Corn Belt & Iowa Lakes discarded Cooper's programming and developed their own programs that meet their present needs and their expectations for the future. To Cooper's credit, from a hardware perspective, failures were under the expected one percent. The actual failure rate in a one year period was 0.45% for the direct load management device and 0.31% for the IHD device. That said, actual repair of the failed items has been a drawn out process, and all of these items sent back for repair and still awaiting return. The program has been beneficial however and DR efforts have resulted in a savings of approximately $287K last year alone.

Kaua'i Island Utility Co-op, HI – From KIUC's members standpoint the IHD's has been the most exciting aspect about the Smart Grid project. Hawaii has some of the highest energy prices in the nation, and the In-Home displays have raise the level of awareness on individual consumer usage to another level. So much so, that the KIUC Board of Directors approved an additional 500 IHDs above the original 500.

Minnesota Valley EC, MN – The load control management switches selected are those from Aclara and are deemed to be of excellent quality. The installations have been straight forward with no significant technical issues. The co-op is already seeing the benefits of having two-way communications to the load management switches. Their best estimate is that they were not controlling about 15-20 percent of the previous receivers for a variety of reasons. The two way communications of the Aclara device ensure the load is controlled by allowing us to confirm the switch status and address any issues.

Prairie Energy Co-op, IA – At this time the co-op has installed over 500 Load Control devices on numerous Water Heaters. The LCR's seem to work fine when they actually get a signal. Getting information to them or back from them is dependent on the signal strength available from the device, distance back to the substation, amount of interference on the power lines and electromagnetic interference inside the customers site. That said, the current system has already resulted in over $48K in savings in the few short months is has been installed.

3.7 Prepaid Metering

EnergyUnited, NC – EnergyUnited's pre-paid metering system was developed as an integrated solution with existing core systems – Cayenta CIS system and

Cooper AMI system. The use of multispeak protocol made this a quick development turnaround which worked out well and has been a solid interface since implementation. EnergyUnited ran into some challenges with deployment when the disconnect collars were recalled by Cooper Technologies. The firmware in the collars required an update to ensure that the collar would validate all incoming signals and not disarm unless it received and verified a signal directly from the utility.

Once the technology bugs were resolved, the pre-paid metering program has been a widely accepted offering for EnergyUnited's membership upon initial service connection in lieu of deposits. It has also proven useful in high turnover locations. They have found that prepaid metering has made members more aware of their daily usage and they are gaining a better understanding of what drives electric use.

Kotzebue Electric Assn., AK – KEA experienced significant problems finding any vendor to bid on a pre-paid metering solution to fit their needs. The primary issue seemed to be that they were simply too small and too remote and the procurement process too cumbersome to make it attractive to the vendors. Finally they were able to get their existing meter management software supplier to agree to build out the pre-paid metering capabilities. The significant delays in finding a vendor means that this development effort is just getting underway now.

3.8 Interactive Thermal Storage

Delaware County Electric Co-op, NY – The heat pump water heating component of the Project is a demonstration component which is funded with matching funding by the New York State Energy Research and Development Authority (NYSERDA). This portion of the Project calls for the installation of 45 heat pump water heating devices at member/ customer locations. The objective t is to demonstrate the operation of these devices in the Northeastern U.S. The instrumentation packages, data gathering and analyses services and technical guidance are being provided by EPRI under. As of now, eighteen "Generation I" heat pump water heaters and related instrumentation packages have been deployed. Seven more "Generation I" units will be deployed over the next several weeks. Additionally, DCEC plans to deploy ten "Generation II" units at the time when they become available from the manufacturer. ("Generation II" units are expected to have better performance characteristics than the "Generation I" units.) While there is no significant thermal storage of energy associated with these devices, the controlled electric water heating project relies on "stored energy" in the heated water to allow for effective control of the water heating devices using energy in off-peak hours without inconveniencing the member/customers.

Great River Energy, MN – GRE procured and installed Steffes grid interactive thermal storage water heaters. These units are addressable over an IP address and can be used to store energy created by wind power. GRE owns several large wind installations and wanted to prove out the ability to use the water heaters like batteries to store the excess wind generated power when the wholesale market price drops below a threshold. This typically happens in the middle of the night when wind energy peaks, but demand for energy is low. The units have worked well and the initial result are promising.

3.9 Renewables Integration

Kotzebue Electric Assn., AK – KEA restructured all their plans with respect to Smart grid projects after they got into the real engineering phase of the project. They realized that they had over-committed themselves in terms of the number of Activities that they could pursue due to the complexities involved in specifying and installing the complex smart grid gear. This process significantly set the project back. In addition, determining what form of VAr compensation device would best integrate with their existing large diesel and new large-scale wind generation systems took significantly longer than anticipated. Add in the complexities of heavy equipment delivery and installation to one of the farthest north towns in the entire US (30 miles north of the arctic circle and free water ports only open 4-5 months of the year) and the equipment for this part of the project will only be arriving in Kotzebue, AK in June, 2013.

Minnesota Valley EC, MN – MVEC has installed 5 battery storage devices to date. The project was delayed to begin with because the vendor's equipment did not perform the required and advertized functionality of powering a critical services sub-panel during a power outage. In addition, the battery storage device locked up after a period of inactivity. The vendor (SilentPower) worked diligently to resolve, and the project was able to resume.

The next hurdle with the project was the metering. At locations with only a general service meter, the installations are straight forward and relatively simple. Installations get more complex when the location has a sub-metered off-peak load. The most complex installation includes multiple off-peak loads and solar. This has taken a while to figure out how best to integrate the devices, but the co-op is beginning to control the devices in a manner to reduce our wholesale power costs. February is their first live test in which they are actively trying to discharge the batteries to offset a billing peak while still limiting them to only five discharge events per month. The good news is that co-op members are very interested in the technology and have been supportive.

3.10 Smart Feeder Switching

Adams Electric Co-op, IL – The co-op reports that the S&C SCADA Mate overhead switches were a good choice for their installation. S&C makes a good switch and are designed for easy installation and seems to be built more robust than the competing Omni Ruptor switch. The S&C automatic controllers are working great now, though during the start-up process they had some difficulty programming the controllers due to manufacturing problems. The wrong firmware was installed in the controllers and S&C was difficult to get onsite to correct the problems. Once here, S&C worked diligently to correct the problems. The controllers have been fitted with Speed Net radios for peer-to-peer communication which are faster and are reported to have fewer errors than the S&C's Utili-Net Radios. Also as part of the Smart Feeder switching project, Adams EC has installed a number of overhead and underground fault indicators. They have reported that HD Supply is a great vendor and easy to work with. The fault indicators are a great product, easy to install, met their needs and will definitely help with trouble-shooting distribution system faults.

Adams-Columbia Electric Co-op, WI – ACEC installed one overhead and 5 underground distribution switches as well as 4 sub-station reclosers. The equipment was procured through Cooper Power Systems and the delivery and installation was completed without incident.

Clarke Electric Co-op, Inc., IA – All twenty-two switches were purchased from S&C and the circuit vacuum reclosers were purchased from Cooper Power Systems. These are all installed and functioning properly under manual control. Most can be operated through the new SCADA system but until Clarke can get better reliability through their 450 MHz radios the self-healing automation will not work properly due to dropped packets of information. OSI does have to do some additional sequencing programming in the SCADA system as well for the self-healing.

Owen Electric Co-op, Inc., KY – All four Cooper Nova Reclosers (with F6 Controls) have been installed; Two at the Western Regional Waste Water Treatment Plant and two the Narrows Waste Water Treatment Plan.

Working with Cooper Power was quite easy due to the fact that a previous State-Funded self-healing project proved successful; but only after a series of failures that resulted in significant hours of work and thought along with the Cooper Power staff. The current four installations were relatively routine as Owen's crew had experience with this type of installation during the State project.

Owen is generally pleased with the Cooper System as it can support a very complex self-healing network. That is not to say the system is perfect though, the co-op would like to see Cooper make modifications in the YFA software that will allow AND/OR logic and some other basic changes. Currently, the Cooper system has minimal options for user-based modifications to the standard software. If Cooper doesn't develop user-based modifications in the near future, Owen will look to its own SCADA system and communications network to develop additional self-healing projects.

The first set of reclosers tested and commissioned on March 15, 2012. There have been no interruptions in normal power as of yet. The second set of reclosers has twice failed pre-commissioning tests. Based upon the review of the failed test data logs and some real-time analysis, the probable cause of failure points to excessive harmonic distortion inside the new treatment plant. Owen will be performing a harmonic analysis during the week of February 11, 2013. The self-healing problem has shifted to a potential customer-induced, power quality issue. This is definitely not what was expected, but is a "learning point" for both the vendor and for the industry. Something to look out for when deploying this type of technology. Owen should know if harmonic distortion is at unacceptable levels within the week and develop a mitigation strategy.

Salt River Electric Co-op Corp., KY – The co-op purchased 29 Intellirupters from S&C Electric. The switches were delivered and the installation has been as expected. There was a minor problem with incorrect radios installed in the switches delivered; the frequency range was not compatible with Salt River's existing system. While it is unclear how the incorrect model radios were installed, S&C was very prompt in responding to the problem and correcting it. Thus far the co-op has been very pleased with the installation, and the switches have much greater capabilities than previous systems. To date the switches have been called upon to respond 4 times affecting 1178 total customers, and reducing outage times on average by 44 minutes.

Snapping Shoals EMC, GA – SSEMC purchased recloser equipment from Cooper and S&C as well as communication equipment from RuggedCom and Microhard. They chose these vendors in part because they were familiar with the performance of their products and were comfortable with their technical expertise. SSEMC is now at well over half way done with the installations and this selection of equipment has worked very well. Of course there are always challenges. For example, establishing effective radio communication to support the automated switching was difficult. It took over a year, multiple trials, and multiple vendors before finding Microhard radios that work reliably on their system and in their environment. Developing procedures and training employees to take advantage of the new technology has proven to be challenging. At the end of the day we expect our 'Smart Feeder Switching' solution will prove to be very reliable and effective creating significantly more reliable service and a much more resilient power delivery system.

Washington-St. Tammany EC, LA – WSTT has installed 24 69kV air break switches with Cooper ITP relays. These relays are programed to monitor the switches upstream and downstream of their location to isolate faults from storm damage or hardware failure and then notify office of state changes. The entire 69kV distribution system is being set up in a loop configuration to be able to be fed from either direction.

3.11 Advanced Volt/VAR Control

Adams-Columbia Electric Co-op, WI ACEC had planned on installing conventional distribution capacitor banks with controls, and even went so far as to go through the entire RFQ process. However, the opportunity arose for them to procure new solid-state devices from Varentec that provide distributed voltage control on a neighborhood level. Due to the change of plans the units were only installed in June on branches of a single substation and initial findings are hopeful. The units do cycle in and out rapidly and perform well. Unfortunately they have experienced a 10% failure rate in the first month, though the units have been replaced under warranty. Varentec has cited a known component issue and believes that there will not be further issues.

Menard Electric Co-op, IL – All of the major material for the Volt/VAR project was sourced from Cooper Power Systems as they had the lowest bid. Menard Electric Cooperative has used other Cooper equipment in the past and had satisfactory results. However, within the first few months of taking delivery of the equipment they have had several problems; from programming the controller to a high percentage of failures in the field. Since then Cooper has come out with a new controller that corrects many of the programming difficulties. To date Menard has experienced 3 controllers that have quit working and 4 oil switch failures. One controller has been replaced by Cooper, but the remainder of the faulty equipment is still in the RMA process. Because of this high failure rate the co-op is concerned about whether Cooper will stand behind their equipment. The installation of the equipment has required more time than anticipated, partly due to inadequate planning, and partly due to extra time to replace faulty equipment on the new banks, and inspections of the new banks. When working, the capacitor banks seem to perform well and the features work as expected. Menard is pleased to have many of these banks installed before last summer, because they hit the highest peak load they have ever seen. Recently their G&T has announced that they are expecting all of their member cooperatives to meet a higher power factor going forward, and this project allowed Menard to get to this level before it is mandatory.

Owen Electric Co-op, Inc., KY – Owen has taken a very detailed and methodical approach to developing their Volt/VAR program; phase 1, the only one that could be completed in the timeframe of this project involved the GPS collection and field inventory of two Substation distribution service areas and the installation of (6) three-phase grid monitors. Davey Resource Group (DRG) was selected for the GPS/field inventory portion, which consisted of a total of 6 distribution feeders on the two substations.

The field work that DRG provided was satisfactory. However, there were issues with the data integration between DRG and Owen’s GIS database. Owen’s datum was developed from an older set of standards that conflicted with DRG’s third-party software they used for the GPS collection. The issues have been resolved, Owen has developed a better understanding of disconnected editing of an ESRI database, and the final feeder inventory was completed in January 2013. The integration issues delayed completion of this portion by approximately 7 months.

This GPS pilot proved valuable not only in helping to develop a very accurate distribution analysis model for the upcoming Volt/VAR optimization portion of the project; but it also shed light on the complex details and unforeseen issues of a system-wide GPS collection project. Owen plans to GPS the remainder of its system beginning in 2013. From lessons learned in this pilot, Owen will be able to better schedule, manage and utilize its resources during this major undertaking.

Four of the six grid monitor units for the Volt/VAR project are installed and communicating, with the final two awaiting a safety verification. Once these remaining monitors are installed, Owen anticipates that Volt/VAR data will be available after a series of field-to-control checkouts. This is the downline data that Owen plans to utilize to measure and verify Volt/VAR optimization results going into Phase 2 of the project.

3.12 Conservation Voltage Reduction (CVR)

Adams-Columbia Electric Co-op, WI The new Varentec units that ACEC has installed allow the operator to dial in a CVR target voltage and will maintain that value. See Volt-VAR listing for details on the Varentec installation issues.

Iowa Lakes EC – ILEC worked with their partner co-op, Corn Belt, on this activity. Corn Belt did all the hardware installation and programming in the substations. There have been no problems reported as to low voltage or any other issues. At this point it is still early to determine savings from this technology implementation, but initial results indicate a savings in 2012 of $18K.

4.0 Summary

The experiences gained on the DOE Smart Grid Demonstration Project have served to highlight the fact that this truly is an emergent technology field. At this time, the vendors are supplying equipment that is often the first of its type that the company has offered. At best it is the Mark II model. As such there are often bugs to be worked out, integration issues with other equipment are common and real-world field conditions often prove to be significantly different than anticipated by either the distribution providers or the equipment vendors. As is common for emerging technology fields, it is not uncommon for system costs to wind up being even 30% higher than vendor quotes, and installation and integration timelines two to three times longer than pre-project planning estimates.

There also seems to be a significant difference in the technology readiness levels of the Distribution Automation (DA) equipment and the consumer focused equipment like the AMI meters and In-Home displays. The DA equipment generally involves a relatively straight forward upgrade of the controllers used to monitor and control large switches, reclosers, line capacitors and voltage regulators. These large pieces of equipment are all mature technologies, well understood and proven, and it is simply the control computers that are new. Further, these control computers are fairly large and expensive devices vis-à-vis the consumer and meter level equipment, and it would appear that the industry has been able to benefit from the experience and development efforts of other industries control modernization efforts. Most of the pain and development headaches have been on the meter level; either literally with AMI meters and communications modules, individual in-home display units, or with the broader communications and data collection systems.

That said, there have been significant strides forward even in the few short years of this project. The equipment being delivered towards the end of this project more often has been arriving correctly configured for immediate deployment. Vendors have significantly improved their understanding of the issues around cybersecurity, and many have improved their product offerings to make them much more resistant to cyber attack.

This TPR is largely qualitative as we do not yet have sufficient quantitative data for more formal studies. However, work is underway on a set of single-topic studies, as listed below and in the revised MBRP. Together, these will comprise an improved, supplemental TPR this fall. These will be revised and updated for the final, end of project TPR.

- Conservation impact of Prepaid Metering – 30 October 2013
- AMI-Based Load Research – KIUC Demonstration – 30 October 2013
- Multi-tenant MDM– 30 October 2013
- Advanced Volt/VAR – 30 October 2013
- Demand Response, Critical Peak Pricing and Consumer Presentment – 15 November 2013
- Smart Feeder Switching – 15 November 2013
- Storage – 15 November 2013
- Communications– 15 November 2013
- Consumer Acceptance– 15 November 2013

Appendix A –List of Installed Equipment

As of 1/31/2013 the following major equipment was listed as having been installed

Major Equipment Installations

By Co-op as of 1/31/2013

Adams

Act.	Equipment Description	Installed
AMI TEST EQUIPMENT AND TOOLS		
	Test board	1
SCADA & DA SYSTEM MASTER STATION COMPUTERS AND SOFTWARE		
	Master Station Software (Enterprise)	0.5
DA EQUIPMENT		
	Distribution Switches Controllers	2
	Distribution Fault Detectors (Overhead)	12
	Distribution Fault Detectors (Underground)	6
	Radio Communication Equipment	1
	Overhead Switches	2

Adams Columbia

Act.	Equipment Description	Installed
SCADA & DA SYSTEM MASTER STATION COMPUTERS AND SOFTWARE		
	Enterprise SCADA Hardware (Communications, Servers& Switches)	1
	OH Distribution Switches w/ Controls	4
	Distribution Switches Controllers	5
	Distribution Reclosers w/ Controls	4
	Radio Communication Equipment	52
	Distribution Capacitor Banks with Controllers	31
	RTU	1
	Underground Switches	7

Calhoun

Act.	Equipment Description	Installed
Master Station Computers and Software		
	Master Station Software, servers, etc.	1
Substations / Tower / Repeater Equipment		
	PLC Substation Equipment	
	Signal Coupling Unit Type SCU-810	5
	H-Field Coupler to Enhance Reception for 2-way	9
	Carrier Control Unit Type CCU-711 Single Bus	5
	Primary Coupling Type PCC Rated 125KV BIL, 50 KVAR	15
	Ethernet Module for CCU	5
	Repeater, Type 902	4
	Capaciformer Single Phase Coupler	4
AMI Meters & Modules		
	1S	5
	2S (CL200)	883
	3S (CL410)	728
	4S (CL410)	11

Clarke

Act.	Equipment Description	Installed
MASTER STATION COMPUTERS AND SOFTWARE		
	Master Station Software	1
	Hardware (Servers, Switches)	1
	MDM Software	1
SUBSTATIONS / TOWER / REPEATER EQUIPMENT		
	PLC Substation Equipment	11
	Poles for Repeaters / Collectors or Radio Backhaul	1
	Radio Backbone Communications Equipment (six Microwave links)	1
	Repeater 902 Assembly For Single/Three Phase Coupling At 7.2/7.62 kV	14
	Repeater 801 Assembly	4
	Repeater 850 Assembly	3
AMI - MODULES		
	2S (CL200)	2827
	(CL20), 3S	1479
	Poly Phase (Multiphase) 9S	23
	Single Phase Disconnect Collar	3
	Poly Phase (Multiphase) 16S	2
SOLID STATE METERS		
	2S (CL200)	2827
	(CL20), 3S,	1482
	Poly Phase (Multiphase) 9S	23
	Poly Phase (Multiphase) 16S	2
SCADA & DA SYSTEM MASTER STATION COMPUTERS AND SOFTWARE		
	Master Station Software (Enterprise)	0.6
	Enterprise SCADA Hardware (Communications, Servers& Switches)	0.6
	Vendor Implementation & Project Management (Enterprise SCADA)	0.6
	DA eqpt vendor Implementation & PM	0.6
DA Equipment		
	Distribution Switches	20
	Distribution Switches Controlers	20
	Distribution Reclosers	32
	Distribution Regulator Panels	30
	Radio Communication Equipment	23

Corn Belt

Act.	Equipment Description	Installed
Substations / Tower / Repeater Equipment		
	Radio Backhaul Communications Equipment	53
SCADA and DA System Master Station Software and Computers		
	Yukon Load Management Controller (Small SCADA)	1

Delaware Co. Electric Co-op

Act.	Equipment Description	Installed
SUBSTATIONS / TOWER / REPEATER EQUIPMENT		
	Backhaul Communications Equipment	1
	PLC Substation Equipment	5
	PLC Injection Transformers	5
	Substation AMI/Equipment/Backhaul Communication Network interface (ER) (Router & Firewall)	5
AMI - MODULES FOR THE QUANTITIES INDICATED		
	2S (CL20)	5044
	PolyPhase module	6
SOLID STATE METERS FOR THE QUANTITIES INDICATED		

	2S (CL20)	5044
	3S Meter w/Module	73
	4S Meter	5
	8S Meter	2
	15/16S Meter	4
IHD / WEB PORTAL PILOT (Activity 54)		
	IHD /Ecometer	59
	Zigbee/WiFi/other Module	50
	Remote Service switch Adaptor	20
	Focus AX-SD meter w/ Service diconnect module	132
DEMAND RESPONSE OVER AMI (Activity 55)		
	LM Switches	400

Delta-Montrose

Act.	Equipment Description	Installed
MDM (Activity 99)		
	Meter Data Management (MDM) Software	1
Pre-Paid Metering (Activity 94)		
	Master Station Software (Enterprise)	1
IHD Pilot (Activity 3)		
	Power Usage Software	1

EnergyUnited

Act.	Equipment Description	Installed
MDM (Activity 112)		
	Meter Data Management (MDM) Software	1
Pre-Paid Metering (Activity 96)		
	Single Phase Disconnect Collar	790
	Locking Ring	
	Disconnect compatible meters, Landis & Gyr	179

Flint

Act.	Equipment Description	Installed
MASTER STATION COMPUTERS AND SOFTWARE		
	ENTERPRISE UTILISALES MS SOFTWRE	1
SUBSTATIONS / TOWER / REPEATER EQUIPMENT		
	Item Number Y86700-627, Control and Receiving Unit	1
	Item Number Y83760-1, Inbound Pik-Up Unit	1
	Item Number Y88300-301-Set, Outbound Modulation Unit	1
	Item Number Y86914-309, Mira Boards	36
	Item Number ACLARA SCPA-G2, UPGRADE BOARDS	45
AMI - MODULES		
	Item Number 1S-CL100, 120V Meter Modules	105
	Item Number 2S-CL200, 240v, Meter Modules	41268
	Item Number 3S-CL20, 240v, Meter Modules	41
	Item Number 4S-CL20, 240v, Meter Modules	1172
	Item Number 8S/9S-CL20, 277v, Meter Modules	632
	Item Number 12S-CL200, 120v, Meter Modules	100
	Item Number 16S-CL200, 277v, Meter Module	151
SOLID STATE METERS		
	Item Number 1S, CL100, 120v, KWH only, Basic Function Meter	105
	Item Number 2S-CL200, 240v, KWH, & KW Basic Function Meter	41268
	Item Number 3S-CL20, 240v, KWH & KW Basic Function Meter	41
	Item Number 4S-CL20, 240V, KWH & KW, Basic Function Switch	1172

	Item Number 8S/9S CL20, 277v, KWH & KW advanced Function Meter	632
	Item Number 12S-CL200, 120v, KWH & KW Basic Function Meter	100
	Item Number 16S, CL200, 277v, advanced Function Meter	151
	Item Number 10-90990, Screw-type, stanless steel meter sealing rings	10000
	Item Number 6060013-5, Endura Acrlic Meter Seal, Grey	58000
	Item Number V167-P45129-002RCB, Meter Locking Ring	3000
	Item Number V167-P45129-0970-PL, Jiffy Lock-Universal	3000
	Item Number V-167-P45129-950-PL, Jiffy Lock-Standard	3000
	Item Number U2030W-FE, Decal, Uticom	6000
	ITEM NUMBER 2S, CL200, Y72990-1, UMT-R-G+, RD - FOR I2100+METER MODULES	6000
	GE ITEM NUMBER I-210+, FORM 2S, 240V, CLASS 200 METER INCLUDING S-2 DEMAN SOFT SWITCH INSTALLED AND ENABLED	6000
	ITEM NUMBER 727X230091, 2S, CL200, 240V, KWH & KW, BASIC FUNCTION METER WTIH S2, V2 AND O SWITCHES	2070
	ITEM NUMBER 2S-CL200, 240V, UMT, METER MODULES	2070
LM - IHD - OTHER		
	ITEM NUMBER Y92500-1, IN-HOME-DISPLAYS	150

Great River Energy

Act.	Equipment Description	Installed
MDM/DRM (Activity 107)		
	Meter Data Management (MDM) Software	0.6
Interactive Thermal Storage (Activity 113)		
	Steffes Water Heater Controls	10

Humboldt

Act.	Equipment Description	Installed
Master Station Computers and Software		
	Master Station Software	1
Substations / Tower / Repeater Equipment		
	PLC Substation Ancillary Equipment	1
	Carrier Control Unit Type CCU-711 Single Bus	8
	Signal Coupling Unit Type SCU-810	12
	Primary Coupling Capacitors Type PCC Rted 125KV BIL, 50KVA	36
	H-Field Coupler to Enhance Recetption For 2-way	17
	Repeater Type RPT-902	7
	Repeater Type RPT-801	4
	Capaciformer Single Phase Coupler (Specify Primary Voltage = 7620Volt)	2
Solid State Meters w/ integrated AMI Modules		
	2S (CL200)	1508
	3S	500
	5S,6S,8S,12S, 15S	105
LM / IHD		
	LM Switches	89

Iowa Lakes

Act.	Equipment Description	Installed
LM / IHD		
	Peak Alert Monitors	1657
	LM Switches	2952

Kaua'i

Act.	Equipment Description	Installed
SUBSTATIONS / TOWER / REPEATER EQUIPMENT		
	Wireless Collectors	2
	Substation AMI/Equipment/Backhaul Communication Network interface (ER) (Router & Firewall)	81
SOLID STATE METERS w/ AMI - MODULES FOR THE QUANTITIES INDICATED		
	2S (CL200)	16859
	2S (CL320)	4
	4S (FOCUS AX)	15
	5S (S4e)	74
	6S (S4e)	268
	8S	3
	9S - (S4e-KYZ)	1
	9S	99
	12S (120V Network)	1964
	12S - S4e	17
	14S/15S/16S	651
LM - IHD - OTHER FOR THE QUANTITIES INDICATED		
	IHD units	569

Lake Region

Act.	Equipment Description	Installed
MDM/DRM (Activity 108)		
	MDM/DRM Software (in cooperation with GRE)	0.6
IHD Pilot (Activity 109)		
	Utilisales Software	1

Menard

Act.	Equipment Description	Installed
Advanced Volt/VAR Control (Activity 29)		
	Distribution Capacitor Banks with Controllers	9
	Distribution Capacitor Banks with Controllers	40

MVE

Act.	Equipment Description	Installed
Renewable/DG Integration (Activity 104)		
	Silent Power	5
DR Over AMI (Activity 110)		
	DR Software (shared project with GRE & LRE)	1
LM - IHD - OTHER		
	LM Switches	9432

Owen

Act.	Equipment Description	Installed
MASTER STATION COMPUTERS AND SOFTWARE		
	HAN installation	44
	HAN installation w/ Thermo & hot water	55
	Tendril Transport	95
	Tendril Translate (ERT to Zigbee)	95
LM - IHD - OTHER FOR THE QUANTITIES INDICATED		
	LM Switches-water heater	45
	Smart Plugs - Controllable Wall Plugs	3
	Smart Thermostats	45

DA Equipment		
	Nove 3-phase OCR Switches w/ F6 controls	4
	Distribution Switches Control software	4
	Automation Software	1
	Distribution Regulator Panels	54
	Fiber Buildout Equipment	1
	DEMICO Weather Station	10
	Three phase monitors	4
	On-site commisioning	1
	CG Automation STN-9150	18
	Fiber/Microwave Communication Equipment	1

Prairie

Act.	Equipment Description	Installed
Master Station Computers and Software		
	Master Station Software	1
	Hardware Server Switches	1
Substations / Tower / Repeater Equipment		
	PLC Substation Equipment	
	Repeater, type 801	10
	Repeater, type 902	19
	Repeater, type 850	8
	Capaciformer	2
	Signal Coupler	27
	Carrier Control Unit	17
	Ethernet switching gear	17
	Coupling Capacitors	81
	H-field couplers	56
AMI Modules		
	2S (CL20)	4000
	(CL320), 3S, 4S	900
	Poly Phase (Multiphase)	140
Solid State Meters		
	2S (CL20)	4000
	(CL320), 3S, 4S	900
	Poly Phase (Multiphase)	140
LM / IHD		
	LM Switches	515

Salt River

Act.	Equipment Description	Installed
DA Equipment		
	Distribution Switches w/ controllers	26

Snapping Shoals

Act.	Equipment Description	Installed
INSTALLATION OF SMART FEEDER SWITCHING SYSTEM (Activity 78)		
	Enterprise SCADA Hardware (Communications, Servers& Switches)	3
	SCADA hardware (switches)	22
DA Equipment		
	Intelliruptor pulse closer	3
	Distribution Reclosers	61

Washington St. Tammany

Act.	Equipment Description	Installed
DA Equipment		
	Control House, Box Structure 30' X 30' Steel	9