Smart Grid Applications at AmerenUE

Definition of the Smart Grid

For AmerenUE, the Smart Grid is defined as the implementation of technology and intelligent devices across the electrical grid that will provide for enhanced reliability, customer information, better asset management, and allow for sustainable options to customers. Current and future intelligent systems will allow engineers and dispatchers access to real-time data to identify problems and quickly respond. Customers will have access to data for better decision-making concerning their power usage and its associated costs. And the system will be prepared for future technologies like small-scale renewable generation and electric vehicles.

Smart Grid applications in place today

For several decades, AmerenUE has been employing technologies now being labeled as Smart Grid. In the 1970's, AmerenUE began installing Substation Control And Data Acquisition (SCADA) equipment in substations to provide dispatchers with information regarding load on the transformers and circuits, voltage, equipment status, and alarm points. SCADA also allows for the manipulation of load tap changing equipment on transformers which allows the company to reduce the voltage on the system to effect load reduction during periods of high demand. SCADA is now employed on all substations throughout the system with capacity over 10 MVA, the size of a typical distribution substation.

Also in the 1970's, AmerenUE developed a transformer load management system with customer connectivity which allows the company to monitor individual transformer loads and in addition, to identify each and every customer affected by an outage. This provides AmerenUE with the information to identify overloaded distribution transformers for timely replacement as well as provide specific customer outage information for proactive remediation. We also developed a Geographic Information System (mapping) that provides us with accurate circuit maps for outage location, load flow calculations and system analysis for improved planning and system build-out.

In the 1980's, AmerenUE installed a radio-based capacitor control system across Missouri. Through information provided by SCADA, the software determines when capacitors are necessary for var/voltage control, and opens or closes the capacitor switch through a radio signal as necessary. This capability helps reduce losses on the distribution system and maintain a better voltage to the customer connection.

Full scale Automated Meter Reading (AMR) was introduced across Missouri in the 1990's. At the time, this 1 million meter project was the largest implementation of network meter reading in the U.S. AMR provides for remote meter reading through a network radio system which allows customers to see their usage on a daily basis through the Ameren web site. AMR also provides outage detection from each meter which is fed directly into our Outage Analysis System for processing along with regular customer outages calls. Using this system, AmerenUE and CellNet also developed the System Load Snapshot application, which provides the ability to get specific loading on each distribution transformer during the hottest days of the year.

In the 1990's to today, AmerenUE has been strategically placing radio-controlled line switches on our 34kv and 12kv systems. To date, approximately 280 switches have been installed across the state in places where reliability will be enhanced due to the remote location of the switch (eliminate the operator drive time) or where criticality of the load necessitates automatic switching.

Expansion of Smart Grid Functions in Next 2-5 Years

The current design of protection systems in distribution substations across the AmerenUE system utilizes state-of-the-art solid-state relay equipment. As we continue the task of updating our substation plant, all new substations will be equipped with these new relays. These relay devices have the ability to perform functions such as estimating the location of system faults out on the distribution circuits. That function, along with the expansion of radio-controlled switches, will allow for the quicker restoration of customers on unaffected portions of the circuit and faster identification of the damage location on the affected portion. These concepts form the core of the "self-healing grid". AmerenUE is planning on adding to the inventory of automated switches systematically each year.

In addition to the updating of relay equipment in substations, AmerenUE is looking at on-line equipment monitoring. Previous uses of dissolved-gas analysis, bushing testing, and battery monitoring have proven the value of these technologies. AmerenUE will be moving ahead to install the necessary equipment in substations to employ this monitoring on an ongoing basis to capture data that will help prevent future outages. Through current periodic transformer testing, AmerenUE now removes more substation transformers prior to failure that actually fail in service, greatly reducing outages.

AmerenUE is currently working with Tendril and CellNet on the implementation of an in-home device that will provide the customer with up-to-date usage and cost information from their meter. The Tendril module will intercept the CellNet signal containing the latest usage information and present that in an easy-to-read format to the customer. This will provide the customer with enhanced knowledge about their appliance electricity usage and give them an opportunity to better control their bills. Rollout is expected to begin with an employee-based pilot program this summer. Rate options enabled by the system will also be designed and tested in the coming months, subject to Commission approval of supporting tariffs to be filed later this year.

AmerenUE is studying plug-in hybrid electric vehicles, with an eye towards the effect on the distribution system. A number of different charging systems are under development, and the final disposition of charging technology will ultimately effect whether load from the vehicles is an issue. Some use of PHEV's is anticipated in the near term, but large scale use is not anticipated for some time. AmerenUE is a participant in the research on PHEV's being performed by the Electric Power Research Institute (EPRI).

A trial installation of a large energy storage battery (2-5 MW) is being reviewed. The battery could be used for capital expense deferment (deferring a new substation) or for storing off-peak supply for use during on-peak periods.

All of the above will be studied together in an overall plan for the circuit of the future, looking at how all of these technologies can work together to improve reliability and customer satisfaction. Lying over the top of these technologies, AmerenUE is currently in the process of obtaining proposals from vendors on a Distribution Management System (DMS). The DMS will collect the data from all these systems and provide it in a usable fashion to system dispatchers, allowing them to react to system alarms, quickly utilize remote switching capabilities, and dispatch personnel accurately.

Beyond 2-5 years, new technologies will enable full-scale implementation of self-healing grid concepts, more accurate data from across the system, higher penetration of customer renewable generation and PHEV's and the implementation of customer devices such as home area networks. AmerenUE is actively studying all of these issues in order to be prepared for the impact on our system. The following chart summarizes many of the items discussed above.

AmerenUE SmartGrid Vision

Today

- AMR (one-way)
- Distribution Automation
- Higher transformer efficiencies
- SCADA
- Voltage reduction
- OMS
- System Load Snapshot
- GIS Upgrade
- Radio-controlled Capacitors

2-5 Years

- AMR (2-way customer communication)
- Self-healing circuits
- Dynamic voltage reduction
- Online monitoring
- Plug-in Hybrid Electric Vehicles (some)
- Energy Storage (trial)
- Circuit of the Future (Advanced system planning)
- Distribution Management System
- Pricing and demand response options

Beyond

- AMI
- Electric vehicle energy storage
- Small-scale renewable distributed generation
- Home area networks
- Larger PHEV deployments
- Larger scale energy storage deployment
- Increasing demand response automation