Duke Energy Progress

2015 Smart Grid Technology Plan Update

DUKE ENERGY PROGRESS

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Overview

As required by the North Carolina Utilities Commission (NCUC) Rule R8-60.1(b), Duke Energy Progress (DEP or Company) submits its 2015 Smart Grid Technology Plan update (Plan Update). The 2015 Plan Update represents the significant amendments or revisions to the 2014 Smart Grid Technology Plan, and is the best projection of how the Company is making smart grid investments in the near term and leveraging leading edge technologies for the future.

Duke Energy has many grid modernization projects currently underway, and many more technologies that are being evaluated for the future. Some of these ideas and technologies may or may not meet the requirements of each gate in the project lifecycle to become a full-scale project. Similar to the 2014 Plan, the projects included in the 2015 Plan Update have progressed within the project lifecycle and installation is scheduled to begin in the next five years.

1. Technology Description

Reference	Requirement
NC R8-60.1 (c) 1	A description of the technology for which installation is scheduled to begin in the next five years, including the goal and objective of that technology, options for ensuring interoperability of that technology with different technologies and the legacy system, and the life of the technology.

Self-Healing Networks

This project expands on the original project listed in the 2014 Plan and will design, install, test and commission approximately 90 new self-healing networks (55 planned in NC and 35 planned in SC), approximately 95 new DSCADA-controlled feeder reclosers and all necessary communications equipment for the networks. Self-healing technology provides an immediate benefit of increased system reliability, using distribution switches, programmable reclosers, and circuit breakers, that are automated and communicate via an intelligent control system. The control system, communications system, and power line devices all work together to identify and isolate the portion of the system affected by a fault, and minimize the extent of the outage by restoring power to as many customers as possible. The project will consist of deployments which began in 2015 and extend through the first quarter of 2018.

Recloser equipment is modeled for a 20-year useful life, communications equipment for a 10-year useful life, and IT equipment for an 8-year useful life. This project expands on the Feeder Segmentation and Self-Healing Network projects included in the 2014 Plan and integrates with the existing Distribution Management System and Distribution SCADA system. As of August 31, there are a total of 50 self-healing networks deployed across the DEP service territory.

2. SGMM Roadmap

Reference	Requirement
NC R8-60.1 (c) 2	A smart grid maturity model "roadmap," if applicable, or roadmap from a comparable industry accepted resource suitable for the developments of smart grid technology.

No significant amendments or revisions were made to the 2014 Smart Grid Technology Plan for this section.

3. Capital Expenditures

Reference	Requirement
NC R8-60.1 (c) 3	Approximate timing and amount of capital expenditures.

Self-Healing Networks
Total capital costs are planned to be approximately $9.3 million, with $3.6 million planned through the end of 2015, $2.4 million planned for 2016, and $3.3 million planned for 2017.

4. Cost-Benefit Analyses

Reference	Requirement
NC R8-60.1 (c) 4	Cost-benefit analyses for installations that are planned to begin within the next five years, including an explanation of the methodology and inputs used to perform the cost-benefit analyses.

Self-Healing Networks

Project Costs [BEGIN CONFIDENTIAL]	
Hardware and Materials	[redacted]
Labor	[redacted]
Project Team Support & Contingency	[redacted]
Project Total	**[END CONFIDENTIAL]** **$9,347,000**
Benefits	
Customer interruptions avoided annually (total for 90 self-healing networks)	96,000
Reduced truck rolls for routine switching and during outage identification and restoration	
Improved safety for field crews	

As of September 2015, DEP experienced nine self-healing operations, resulting in over 10,000 customer interruptions avoided and approximately 575,000 customer minutes of interruption saved to date.

5. Existing Equipment Book/Salvage Value

Reference	Requirement
NC R8-60.1 (c) 5	A description of existing equipment, if any, to be rendered obsolete by the new technology, its anticipated book value at time of retirement, alternative uses of the existing equipment, and the expected salvage value of the existing equipment.

Self-Healing Networks

This project is installing primarily new equipment across the distribution network. Any small amount of old equipment removed is returned to inventory for appropriate disposition.

6. Project and Pilot Status Update

Reference	Requirement
NC R8-60.1 (c) 6	Status of pilot projects and projects, including a description of whether and to what extent these projects are or will be funded by government grants.

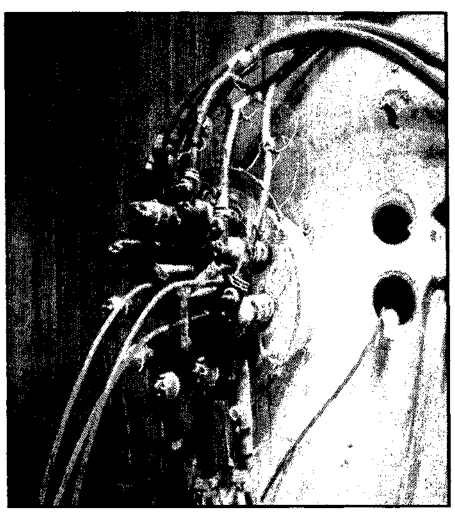
The information provided below includes new pilot projects that have begun since the 2014 Plan.

Urban Underground Automation – Raleigh

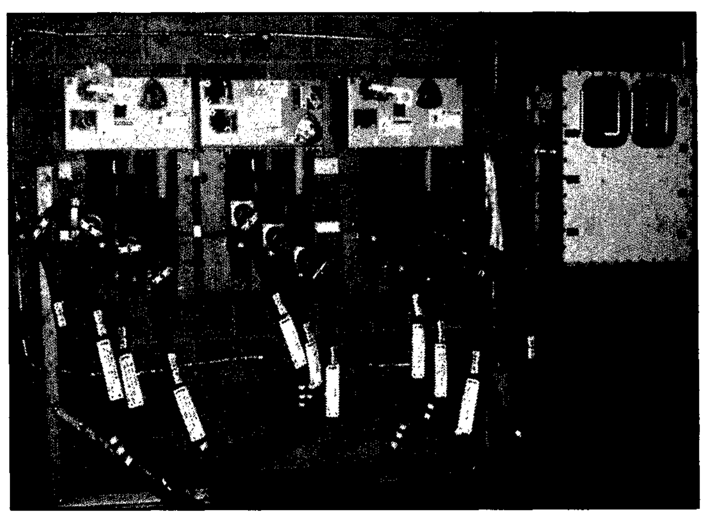
The Urban Underground Automation – Raleigh pilot project is Duke Energy's first Carolinas installation of an underground distributed intelligence loop distribution automation system. This type of system is installed in locations where load reliability can have a direct impact on safety, such as a downtown or dense multi-use location, or other places with high electricity use, like airports. Restoration times for this system allow isolation of events in less than seconds, with the system not dependent on communications to a head-end solution, but instead, able to make independent decisions and control actions within the distributed loop.

This project will provide visibility and automation to nine underground vaults in downtown Raleigh by integrating the distributed automation control system into the existing DSCADA and Distribution Management System through a fiber optic communication network. This pilot has unique challenges because the equipment is housed in underground vaults and not on the overhead distribution system.

Current Vault



Future-state Vault



Similar to Self-Healing Networks, this technology responds to a loss of power by utilizing real time data from intelligent sensors to isolate faults, reroute the power supply around the fault, and return power to as many customers as possible until the problem area is repaired. In most cases, this entire process occurs in seconds. In fact, most of the customers who would have lost power for at least 45 minutes with the current system, will only experience a blinking of the lights, or an outage of less than one minute.

Total capital costs are planned to be approximately $5.5 million, with $3.6 million planned through the end of 2015 and $1.9 million planned for 2016. This project will not be funded by government grants.

Benefits of this technology that could potentially be quantified by future projects with greater area coverage include the following:

- Reduced power interruptions: Minimizing the number of impacted customers to only those on the affected segment of the underground circuit.
- Reduced restoration time due to self-healing scheme / elimination of recordable outages. All customers would be restored for interruption of a single electrical source in seconds vs. a 45-minute minimum outage for responding crews.
- Improved Asset Utilization: Provide real time data and control of system, a functionality which does not exist today.
    - Enable ability to do planned switching
    - Flexibility: Additional switching points can be added to system with proposed relay scheme to handle continued rapid growth in high density zones
    - Enhanced monitoring and maintenance of assets, including enablement of monitoring and control of auxiliary systems (sump pumps, transformer oil level and fan operation, static infrared cameras)
    - Power quality: Enables planning and load growth data.

Key intangible benefits of providing vital information for future projects of this kind and the safety aspect of minimizing the need for workers inside of the underground vaults.

DMS Pre-scale Deployment

This project is an evaluation of a common enterprise Distribution Management System (DMS). This small-scale deployment (approximately 4 substations) will provide data for a future, larger scale alignment across the Company to a single DMS vendor and platform to provide operational efficiencies and enhanced functionality. This project will not be funded by government grants.

Trip Savers Pre-Scale Deployment

This project explores potential methods of reliability and operational improvements through the use of TripSavers II Reclosers. In the Fall of 2015, approximately 125 TripSavers will be installed across Duke Energy jurisdictions, 62 of these will be in North Carolina, with the balance in Florida and Ohio. These units will be monitored through December 2016, to capture operational data to quantify the benefits and assess the feasibility of full-scale deployment in the future. Potential benefits will vary across jurisdictions and are expected to include: reduced sustained interruptions through improved fuse save, reduced momentary interruptions through improved coordination, and reduced interruption risk through improved Hot Line Tag (i.e. non-reclosing) capability. This project will not be funded by government grants.

Emerging Technology Trends

The Emerging Technology Office's (ETO) mission is to lead Duke Energy in the identification, evaluation, development, and application of emerging technologies - technologies that may not be ready for wide-scale deployment for another 3-10 years; to identify related business opportunities and risks; and to transfer technologies to the business units to optimize value in a dynamic technology, customer, and regulatory environment. The ETO is continuing to evaluate emerging technologies such as battery storage, microgrids, and other grid-related technologies with significant updates listed below.

Microgrids

The US Department of Energy defines a microgrid as a group of interconnected loads and distributed energy resources (DER) within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid is able to connect and disconnect from the grid to enable it to operate in both grid-connected or island-modes. Microgrids owned and operated by Duke Energy enhance resiliency, improve reliability, and deliver economic and environmental benefits to participating and non-participating customers. Non-participating customers will benefit from increased reliability to critical service facilities, emergency services, and/or other public purposes served by a microgrid. In addition, to the extent a microgrid is able to provide support to the grid, all customers benefit. This represents a potential value stream for the microgrid that may be supported by non-participating customers, as determined by the appropriate authorities.

Integrating advanced protection and control technologies with DER in a microgrid supports the rapid operation of automated devices in response to an outage or power quality issue. Ultimately, this enhances the resiliency and reliability of customer electric supply. During a regional outage event, power generated by renewable technologies cannot be transmitted to the grid; the standard operating procedure is to isolate the assets. Microgrid technologies, however, allow the renewable assets and other DER within the microgrid to continue generating power for participating customers. Through multiple pilot projects and partnerships, Duke Energy is testing various microgrid control modes to evaluate and demonstrate how microgrids will automatically respond to and re-synch to the grid following outages. Current pilot projects include the McAlpine microgrid in South Charlotte and the Coalition of the Willing microgrid in Mount Holly.

As successfully demonstrated in the summer of 2015, the McAlpine microgrid enables one of the city of Charlotte-owned fire stations to remain fully operational during periods of prolonged grid outages. Off-the-shelf microgrid islanding switches paired with distributed generation (DG), such as solar arrays and battery storage, allow for the testing and planning of various outage scenarios in order to improve grid resiliency. This project is unique in that all of the microgrid assets are installed on the distribution circuit. The project demonstrates a solution for meeting energy security needs for public sector critical service facilities with microgrid technologies. The McAlpine microgrid is also expected to inform innovative business models for future customer products and services.

The Coalition of the Willing effort was developed as a result of the needs identified from the rapid adoption of DER. DER requires faster response times, reduced costs, better safety, and improved reliability. The Coalition of the Willing effort is a non-proprietary, multi-phased project to break down proprietary and operational "siloes" and to prove that enhanced operation can be achieved economically through use of a distributed intelligence platform. Phase II of this effort includes the installation and operation of a lab scale microgrid system at the Mount Holly facility. This microgrid will utilize renewable resources – solar and battery energy storage – and will operate it with an Open Field Message Bus distributed intelligence platform with wireless communications to devices. Mt. Holly will provide a dynamic use case – an islandable operational microgrid – to test true interoperability across devices and applications. Duke Energy is partnering with multiple vendors to successfully install and demonstrate this inverter-based microgrid. Following the Mt. Holly lab testing, a field test of the same concept will be conducted at the Marshall site with an additional Li-ion battery solution added to the current DER mix.

Energy Storage

Distributed energy storage continues to gain momentum as a viable solution as the price of batteries continues to drop and utility operators experience more installations on the system. Nationwide, Duke Energy owns nearly 15% of the grid-connected operating battery storage, and the Company is continuing to evaluate additional opportunities.

Batteries offer flexibility by being able to perform a multitude of functions. Distributed batteries have the ability to offer capacity, spinning reserves, solar and wind smoothing, loss reduction, outage ride-through and other system benefits. In addition to the projects discussed in previous filings, Duke continues to evaluate and demonstrate these many capabilities at different points on the grid.

Distributed Energy Storage Projects in the Carolinas

Three projects are in the planning and development stages at present, and field installations are expected to be completed by the end of 2016, as listed below:

Rankin Battery Storage - Repowering

Located at the Rankin substation in North Carolina, the project originally tested a 402-kilowatt (kW) battery linked with a commercial solar installation located 3 miles away. The original solution testing was completed earlier in the year, and a new hybrid distributed storage solution is being designed for future testing. This novel solution will pair two storage technologies - a high energy battery solution with a high power capacitor solution. Total system rating is expected to be in the 300 kW range.

Marshall Energy Storage

The currently installed 1.2 MW solar and 250 kW Energy Storage System at this site are being utilized to develop algorithms to manage distribution-tied DER integration. The work is being developed and tested in partnership with UNCC EPIC Center. Self-learning forecasting routines will incorporate weather, circuit and usage data to best determine how to operate DER at different times of the day and seasons to offset voltage rises on the circuit and fluctuations due to solar intermittency and to reduce voltage regulator operations.

Marshall site project is planned to be expanded to include development of a method for remotely determining when DER is out of synchronism with central generation or central grid signals for voltage and frequency. The test plan is to (1) prevent the DER from sustaining an unintentional island with the local distribution feeder in an improved way from current methods and (2) allow the DER to control an orderly disconnection and connection of an intentional island to the larger grid, based on these signals. Current methods are effective at low DER penetration levels, but are expected to perform crudely at higher penetration levels. These methods have high potential to enable higher DER penetration levels that can allow DER to operate much more smoothly on the grid.

Home Energy Storage

Robust battery solutions are emerging for residential applications. A technology test is currently being designed to install multiple units to validate technical and performance capabilities.

These field tests continue to inform Duke Energy's infrastructure strategy. Previous field test observations have also emphasized the need for a slightly larger penetration of distributed energy storage solutions to properly capture the stacked value benefits these solutions may offer. This insight coupled with the need for developing a seamless system integration process is expected to lead to a larger integration focused battery project in the near future.

Low Voltage Power Electronics (LVPE)

LVPE systems are a collection of semiconductor components, capacitors, telecommunications, and control circuitry used to provide a high level of flexible control to power distribution networks. These units autonomously and rapidly react to changing grid conditions via the distributed and dynamic control of power flow. Voltage levels can be kept constant, in real time, to adjust for voltage drop across the distribution transformers and changing loading conditions on circuits where these systems are installed.

Initial beta field testing for an LVPE system was recently concluded, and validated many of the applications and use cases. Field tests evaluated the use of these systems to manage power flow and peak demand, provide volt-VAr optimization, enhance power quality, provide outage and fault detection capabilities, and smooth solar PV intermittency. Additionally, providing voltage control from LVPE on the secondary side of the distribution transformer can have multiple effects on service to the customer, such as consistent voltage, improved VAr support for customer loads, and identification of low voltage areas on a circuit. While not confirmed in the limited scale beta test, multiple units installed on a circuit could also have the ability to eliminate VAr flow and influence overall primary voltage, leading to a flatter voltage profile from substation to the end of the circuit. These additional use cases as well as other LVPE solutions will continue to be evaluated in lab and field tests. Due to the benefits demonstrated, Duke Energy is currently evaluating the need for a larger pre-scaled field test of LVPE prior to committing to deployment.

7. Customer Information Transfer

Reference	Requirement
NC R8-60.1 (c) 7	A description, if applicable, of how the utility intends the technology to transfer information between it and the customer while maintaining the security of that information.

Self-Healing Networks

This section is not applicable as this project does not involve the transfer of customer information.

8. Third-Party Utilization and Information Transfer

Reference	Requirement
NC R8-60.1 (c) 8	A description, if applicable, of how third parties will implement or utilize any portion of the technology, including transfers of customer-specific information from the utility to third parties, and how customers will authorize that information for release by the utility to third parties.

Self-Healing Networks

This section is not applicable as this project does not currently involve the transfer of customer information to any third parties.

9. Reliability & Security

Reference	Requirement
NC R8-60.1 (c) 9	A description of how the proposed smart grid technology plan will improve reliability and security of the grid.

The description for each new technology project listed under Section 1, and the benefits described in Section 4, outline the specific impact each project will have on the reliability and security of the grid. Additionally, the investments as a whole will provide synergies resulting in greater overall value in improving grid security, reliability and resiliency, while also creating greater efficiencies and improving safety and sustainability. While some investments clearly add new capabilities, others capitalize on opportunities to upgrade the grid with automated and intelligent systems that will work together and optimize the electric grid. As articulated, many of these new devices are integrating into the command and control systems, such as the DMS described earlier. This integration of grid equipment and information technology systems begins to posture Duke Energy's electric grid for the challenges and opportunities of the future.

Grid modernization investments will continue to be driven in partnership with customer needs and desires, as well as grid reliability and resiliency improvements. New products and services will also drive new technologies on the electric grid, and transform the way customers interact with the Company.