

PPL Electric Utilities  
Summer Readiness Overview  
May 2015

SUMMARY

For PPL Electric Utilities (PPL Electric), summer readiness means the company must be up to the task to respond effectively to summer storms as well as provide reliable electricity every day for 1.4 million customers. Detailed below are various actions undertaken or plans for future enhancements to the system.

A. RELIABILITY ENHANCEMENT PROGRAMS

a. Enhanced Vegetation Management

PPL Electric's vegetation management program utilizes industry best practices and seeks to improve the reliability of the electric transmission and distribution systems by preventing outages from vegetation located on easements and rights-of-way (ROW), and minimizing outages from vegetation located adjacent to ROW. Trees are generally the most common cause of power outages, so vegetation management is critical to keeping our system reliable.

In 2013, PPL Electric launched ground to sky trimming on multi-phase circuits, and accelerated its efforts to identify and remove trees outside of the ROW that have the potential to cause outages. These efforts, combined with several years of more aggressive tree trimming on higher voltage lines, have resulted in an 18% reduction in the number of tree-related outages in 2014, when compared to the average of the previous ten years. In 2015, these initiatives continue with the expectation of further reductions in vegetation related service interruptions.

b. Storm Hardening

PPL Electric has implemented several new initiatives to improve system resiliency in 2015. These initiatives include construction specification changes to increase the reliability of the system during storms, such as decreasing the risk of broken poles to improve restoration times. For example, if an area is identified as having significant tree threats that cannot be mitigated through tree trimming, taller and thicker poles may be installed that provide a higher strength design. The overall intent is to reduce pole breaks due to vegetation, which can lead to extended outage time to make repairs. Storm hardening also includes designing stronger overhead components.

In 2014, a pilot project was completed in a heavily wooded area where spacer cable was installed along a 2.5 mile section of conductor. Several days after construction, the cable prevented two heavy trees from causing an outage. In 2015, PPL Electric plans to pilot another such project.

PPL Electric is also partnering with a national research and development consortium and several large utilities on a storm hardening study. Previously, this study included physical destructive testing at an outdoor laboratory. In 2014, testing was done onsite at several participating utilities, including at a location in PPL Electric territory. Information gleaned from this testing on sections of de-energized lines, which were scheduled for removal, is helping the company enhance its storm hardening and post storm inspection programs.

c. Fuses/Reclosers/Automatic Switches

In 2013, PPL Electric initiated a program for mass installation of fuses on single phase taps that were previously unprotected to limit the number of customers who experience a service interruption due to an outage. This resulted in substantial reliability improvements on long single-phase taps by limiting the number of customers impacted during an outage. Currently, PPL Electric is examining additional potential fusing locations as well as utilizing series and three phase fusing.

In 2015, PPL Electric began full implementation of a ten year plan to replace existing three-phase hydraulic reclosers with communication-enabled vacuum circuit reclosers. The strategy allows for remote operation of these devices, in addition to remote monitoring to facilitate the move toward condition based maintenance. These devices play a crucial role in reducing the number of customers interrupted by an outage and allow a majority of customers to be back in service before the permanent repairs can be made.

One hundred sixty-eight Motor Operated Load-Break Air Breaks (MOLBABs) will be installed at strategic locations on PPL Electric's 69kV transmission system prior to the start of summer 2015. MOLBABs will replace manually controlled switches on the majority of PPL Electric's 69kV transmission lines, and will give PPL Electric the ability to quickly open and close transmission switches remotely from the operations center instead of dispatching crews to a field location. This effort will also include the installation of fault indicators at MOLBAB locations, thus enabling personnel to more quickly identify fault locations, ultimately leading to shorter outage durations.

d. Smart Grid

The company continues to invest in its Smart Grid initiatives, which were initiated in 2012. Results from these investments have been impressive. For a pilot program conducted in Dauphin and Cumberland counties, a 35% to 50% reduction in customer minutes interrupted versus non automated circuits in the same geographic area was realized. Another project conducted in the Pocono region saw outage durations reduced by an average of 30%. As of the beginning of May, 558 of 715 communicating vacuum circuit reclosers have been installed on PPL Electric's system, with the remaining planned for installation by mid-summer. These devices will allow for automatic sectionalizing and reclosing, in addition to identifying fault locations helping to reduce outage duration times.

PPL Electric recently implemented an advanced Distribution Management System (DMS), which is a software solution that provides system operators real-time situational awareness of how the system is performing. One of its groundbreaking features is the ability for the software to detect a fault from smart sensors on the distribution system and quickly develop an optimized restoration plan that an operator can execute quickly and remotely. This new technology is dramatically improving the ability to quickly restore customers. Later this year a number of circuits will be selected to conduct a pilot which will allow the advanced

software to not only detect outages, but automatically execute remote restoration plans to restore most customers in a few minutes.

e. Conservation Voltage Reduction (CVR) activity

PPL Electric currently does not utilize voltage conservation technology. However, the company is investigating if it is feasible to implement the technology on a subset of distribution circuits. To effectively deploy a CVR program, large distribution power transformers must have devices called a Load Tap Change (LTC) that allows voltage to be changed automatically at the substation. PPL Electric's system does not currently contain TLCs, although the company recently modified substation design specifications to ensure this technology is added to all future transformer purchases.

PPL Electric has launched an effort to deploy smart sensors and communication technology to all of its three-phase capacitor banks. This enhancement will allow a more precise visibility and control of voltage along all sections of the company's circuits. It is anticipated this technology will play an important role in future initiatives to optimize voltage. PPL Electric expects to pilot an effort to allow the advanced DMS to autonomously switch capacitor banks off and on in order to maintain optimal power quality performance.

f. Lightning Performance Improvement

Although lightning strikes and lightning activity cannot be eliminated, the company has efforts to minimize the impact that lightning has to the reliability of our system. In 2014, PPL Electric initiated a program to substantially improve the lightning performance of several 69kV transmission lines by installing lightning arresters. They are designed to protect against the majority of the lightning strikes a line could see in a given year. Transmission lines targeted were those most prone to lightning-related outages and have seen the most lightning activity over the last several years. Lightning arresters were installed by June 2015, prior to the start of the summer and in time for the peak of "lightning season."

g. Any other relevant continual improvement activity

PPL Electric has several other noteworthy reliability improvements activities including a pilot program to identify and remediate situations for customers experiencing "momentary" interruptions, a more strategic approach to installing animal guards, projects and communications targeting customers experiencing multiple service interruptions, replacing aging sections of circuits, and building new substations.

Of note, the company has an initiative to anticipate, mitigate, and communicate with customers who have experienced multiple interruptions within a rolling 12-month basis. Upcoming projects include line relocation and/or reconductoring, installing additional fuses, or hot spot tree trimming of single phase lines. In the past year, PPL Electric has seen significant improvement in the number of customers experiencing more than three interruptions and a reduction in the total number of outages experienced by any one customer.

## B. PREVENTIVE MAINTENANCE PROGRAMS

### a. Capacitor Inspections

PPL Electric continues transitioning to condition based inspections of its multi-phase capacitors by installing automated controls and sensors. This allows PPL Electric to target maintenance in a more effective and cost-efficient way, and alert operators of potential issues in a timely manner. PPL Electric has installed automated controllers and sensors on 200 capacitor banks so far in 2015.

These automated controls and sensors allow for real-time monitoring and remote operation of switched capacitor banks, improving power quality. This program precludes the need to conduct physical inspections.

### b. Vegetation Management

As previously stated, the company continues to see the reduction of tree-related outages due to a more aggressive vegetation management program initiated several years ago. It is anticipated further improvements for customer reliability will occur.

**Distribution System Maintenance** - PPL Electric continues regular tree-trimming cycles for all aerial distribution lines. Lines are trimmed every four years in the southern half of the service territory, and every five years in the more rural northern service territory. Some lines are trimmed more frequently based on need. The company also refined its prioritization tool to more effectively rank the order of circuits trimmed throughout the year, to maximize the impact of the trimming program and minimize tree related outages. In addition, PPL Electric has increased the removal of hazard trees from outside transmission and distribution corridors and ground to sky trimming and clearing is performed on multi-phase distribution lines wherever possible.

**Bulk Electric System Maintenance (BES)** – PPL Electric maintains more than 1,500 miles of BES transmission lines over a recurring three-year period. Line clearances are maintained between overhead power lines and any vegetation.

**138kV Electric System Maintenance** – PPL Electric maintains 385 miles of 138kV transmission lines over a recurring three-year period. In residential areas, non-compatible vegetation is removed from the PPL Electric ROW on customer property. Whenever feasible, trees and other vegetation that is compatible with high-voltage transmission lines are not disturbed.

**69kV Electric System Maintenance** – PPL Electric maintain 3,144 miles of 69kV transmission lines over a recurring three-year period. In 2013, PPL Electric began implementing a new standard of clearing ROW on 69kV transmission lines to improve reliability. The new standard requires clearing to the full extent of the ROW on all 69kV lines and is expected to be completed by the end of 2015.

c. Substation Inspections

Distribution substations have a monthly visual inspection and an annual infrared inspection. Transmission substations have a quarterly visual inspection and an annual infrared inspection, the exception being the 500kV substations which have a quarterly infrared inspection.

d. Aerial Patrols

Helicopter patrols on the transmission line include routine patrols, comprehensive patrols, and annual infrared inspections. The routine patrols occur during early summer to look for larger potential issues on the transmission system. In addition, a forester typically participates to identify potential danger trees. These flights give a once-a-year look at the entire system. The comprehensive patrols are flown on one quarter of the system every year thus every line is inspected every four years. Comprehensive patrols typically take place after the routine patrol and the object of these patrols is to look for damaged equipment. Infrared patrols are performed in the early winter to scan all splices and connectors on the transmission line and corrective action is taken if any hot spots are found. For the summer of 2015, PPL Electric has commissioned an additional helicopter to run patrols on the transmission system so the company can aggressively identify and address any potential reliability concerns prior to the start of the storm season.

e. Infrared Inspections

PPL Electric's infrared (IR) line inspections are a routine part of maintenance to find potential equipment failures that cannot be detected from visual inspections. PPL Electric's IR inspection process is programmatically applied to all multi-phase lines adjacent to roadways on a two year cycle. Inspections are conducted in the winter months to take advantage of the relatively high and consistent loads associated with heating demands and the colder weather also results in a lower ambient temperature for greater contrast. Consequently, repairs associated with the results of infrared scanning are generally completed before summer creating conditions for greater reliability.

Supplementary infrared scanning may be conducted throughout the year. Circuits planned for load transfer may be scanned based on circuit performance indicators. Additionally, specific areas may be scanned to augment condition-based visual inspections

f. Any other relevant continual improvement activity

PPL Electric has a wide portfolio of maintenance activities and continuously seeks to optimize maintenance cycles to maintain reliability of service with cost.

### C. CAPACITY PLANNING

PPL Electric regularly reviews reliability performance on a system-wide, regional, local and circuit basis to identify needed improvements due to load or performance. PPL Electric's system planning process works to strike a balance between service reliability and cost of service.

In 2014, the summer peak on the PPL Electric system was 6,714 MWh, well below the all-time summer peak of 7,554 MWh recorded in July 2006. PPL Electric experienced no issues during the

2014 peak. The 2015 winter peak of 7,884 MWh, which occurred in February 2015, slightly exceeded the all-time system peak of 7,816 MWh. Forecasted load for this summer is not projected to exceed the all-time peak.

PPL Electric does not foresee concerns with the system's delivery capacity during the upcoming summer based on its performance during previous winter cold spells, prior summer heat waves, the ongoing investments in reliability, capacity upgrades and customer adoption of energy efficiency and conservation opportunities.

#### D. 2014/2015 STORM UPDATE AND LESSONS LEARNED

PPL Electric experienced a higher than average number of storm events in 2014 when compared to the benchmark period of 1994-1998. Five storms in 2014 were PUC-reportable. Currently, there are no PUC-reportable storms on record for 2015. One of the five PUC-reportable storm events referenced above was a storm event where all outages were restored within 24-36 hours.

PPL Electric remains committed to enhancing its storm response with continued collaboration to improve communications with state agencies, emergency organizations, other utilities and customers as well as working to more effectively manage estimated restoration times (ERTs) and operations. PPL Electric collaborates with other Pennsylvania Electric Distribution Companies (EDCs) and benchmarks with industry leaders to improve its emergency response processes.

Emergency preparedness highlights include:

- Increased Storm Drill Participation – The company invited representatives from local emergency management agencies to observe and provide feedback regarding PPL Electric's storm response during drills conducted in the fall of 2015 and the spring of 2015.
- De-Centralized Operations – PPL Electric completed development of a new process to more effectively manage outages within a hard-hit region during major storm events. Support personnel from less impacted regional command centers will remotely dispatch crews to areas within the affected region to accommodate the influx of resources. These resources include restoration crews, work expeditors, damage assessors, and wire guards.
- Incident Action Plans – PPL Electric has developed and conducted a drill utilizing a process where the Emergency Command Center has developed, documented and communicated clear priorities for the next 24-hours of a multi-day event.
- Enhanced Resource Tracking – Managing resources is a key component to a successful restoration effort. PPL Electric has increased the functionality of its resource tracking database to streamline roster uploads of contractor and foreign crews. In addition, PPL Electric has enhanced its housing and feeding tracking mechanisms, including visibility of reserved hotel room blocks across the entire service territory, and the ability to assign blocks to field resources.

## E. 2015 SUMMER READINESS

### a/b. Capacity Additions and Transmission Preparedness

PPL Electric is spending a significant amount to maintain and improve reliability and meet increased demand on its transmission and distribution systems – continuing a trend of increased investment in system reliability. Additionally, substantial capital is being deployed for various large transmission expansion projects such as the Northeast/Pocono Reliability Project.

PPL Electric crews and contractors are building new substations and transmission lines, upgrading existing facilities, replacing older transmission lines and poles, improving distribution circuits, and upgrading technology for better, more efficient operation. These improvements will strengthen the system to effectively handle summer peak loads and improve overall reliability.

More than 68 load-based and reliability projects on the transmission and distribution systems are planned for 2015, strengthening the network in time for peak summer demand. Additional system modernization work is underway, as well as dozens of system improvements that will be completed through the remainder of the year.

Examples of key projects include:

- Rebuilding and reconductoring several older transmission lines.
- Completion of long-planned 69-kV transmission upgrades.
- Improved lightning protection on targeted transmission facilities.
- Helicopter patrols for transmission line inspections (comprehensive and routine).
- Expansion and upgrades to bulk power substations (circuit breakers, transformers, capacitor bank replacements).
- Construction of new transmission substations and lines to relieve load on existing facilities and improve operational flexibility.
- Modification of transmission substations to improve reliability.
- Right-of-way line clearance along approximately 1,950 miles of the transmission system.
- Expanded right-of-way and clearance on targeted transmission lines where reliability improvement is needed.
- Replacement of circuit breakers and transformers at distribution substations.
- Installation of remote monitoring and control equipment at certain substations.
- Construction of five new distribution substations.
- Construction of new distribution lines to relieve load and improve operational flexibility.
- Rebuilding existing distribution lines with upgraded conductors to better handle load in certain growing areas and improve reliability.

c. Event Preparedness

PPL Electric is committed to the effectiveness of emergency preparedness and will continue to take steps toward improvements based on recent experience and industry best practices. There are currently 92 defined storm support roles, six more than last year at this time. Recently added roles include ERT lead, damage assessment lead, and construction supervisor. A process is in place to assign all PPL Electric employees a storm role within their first few months of joining PPL Electric. To ensure personnel are familiar with their storm role and responsibilities, and that the processes which they perform are repeatable, storm role-related documents and drills are developed and maintained.

Each of the six operating regions conduct monthly drills in their regional command centers to ensure the facility and support personnel are ready to respond based on established procedures and checklists. To ensure a repeatable, consistent process across all operating regions, a regional command center best practices team was established in 2013. In 2015, this concept evolved into two distinct teams, one to focus on strategic direction and another on tactics and operations.

In addition to the annual system-wide and regional drills, PPL Electric has instituted weekly small-focus drills that target specific topic and storm role(s). Performance is evaluated to identify additional training needs as well as process and document clarification.

d. Training

Training is a key part of storm drills as new concepts are introduced and tested during these sessions. In support of this, a dedicated trainer was assigned to the emergency preparedness team in 2015.

e. Personnel sufficient- Any plans to hire in next 6 months

Currently there are no plans to hire additional personnel.

F. STORM RESPONSE

a. Outage Restoration Strategy

First priority is given to public health and safety facilities, such as hospitals and 911 call centers. After those facilities are restored, focus is then on restoring trouble cases that will bring the most customers back on line as quickly and safely as possible. Improvement opportunities continue to be identified.

b. Communications and Outreach

Although PPL Electric's efforts are extensive and generally well received, the company recognizes the need for continuous improvement related to public communications. PPL Electric routinely evaluates its processes to provide accurate, timely, and frequent status updates to all stakeholders. Processes are refined to work more closely with the county emergency management agencies to assess priorities and establish a communication path between PPL Electric and affected communities.

PPL Electric has established processes to develop and disseminate information in a consistent and timely manner to various audiences, including periodic daily conference calls with public officials, proactive media outreach, direct contact with customers using PPL Alerts, automated telephone messages and broadcast e-mails, the utility's mobile-ready web site, and social media. Employees have been trained and designated to monitor social media and provide online customer engagement.

In 2014 and 2015, PPL Electric developed new tools for customer communications during storms and other emergencies. They will complement traditional outreach, which includes news releases, media interviews, website and social media messaging, and emails to local and state officials. The new tools include radio advertisements, online digital display advertisements and customer emails with video, and can be rolled out quickly to provide outage and safety information, such as the hazards of downed wires.

PPL Electric also began advertising on search engines such as Google.com. When customers use search engines, such as Google.com, to look for outage information, they will see a safety messaging about downed power lines. In addition, a wide range of emergency graphics for the company's social media channels, webpage, and blog have been developed. During major events, the company can use an alternate version of its webpage, as well as a power restoration blog where photos, videos, and updates can be posted. The company is also planning upgrades to its outage center website that will provide customers with additional outage, restoration and safety information.

In addition, PPL Electric has expanded the outage alerts program. Since 2011, PPL Electric has offered customers the option to receive outage alerts, which notify customers when they are out of power, and to provide information about expected restoration times. Customers have the option to receive their alerts via email, voice, or SMS text. More than 317,000 customers have signed up for the service, and customer survey results show satisfaction with the program consistently at or above 80%.

Following the positive results of two outage alert pilot programs in the fall of 2014, PPL Electric implemented an opt-out outage alerts program for residential customers in May of 2015 by automatically enrolling almost all existing and new residential customers. As part of the expanded program, significant changes were made to operations protocols for Estimated Restore Times (ERTs), updating business rules for when and how alerts are issued and improving messaging. Customers are informed about a variety of ways in which they can opt-out of receiving outage alerts.

c. Outage restoration and storm response best practices implemented and/or identified for future implementation

Key personnel collaborate with the Pennsylvania Public Utility Commission (PUC), national, state, regional and local emergency agencies and other utilities to share best practices and seek ways to improve emergency response. PPL Electric is engaged in the PUC's Critical Infrastructure Interdependency Working Group and is an active participant in the commission's emergency preparedness best practices initiative.

PPL Electric also continues to refine the process to work more closely with the county emergency management agencies to assess priorities and establish a communication path between PPL Electric and affected communities.

To expedite response to reported road closures involving electric facilities, new, high-priority trouble order types have been created and added to the Outage Management System (OMS). The County 911 centers will have the ability to select these report types when entering information directly into the portal to our OMS. These order types are part of a process to raise awareness of the incidents and improve response times.

To enable PPL Electric to quickly relieve county, township, and other public emergency responders from wire down incidents, an enhanced, scalable process has been developed to make additional trained resources available by using third party contractors to supplement the company's workforce.

PPL Electric also plans to develop and incorporate a smart-device application into its processes to facilitate communication and coordination with contractors and foreign crews. PPL Electric envisions this application will enable a more efficient crew registration process, work assignment and status, ERT update, and damage assessment.

d. Any other relevant continual improvement activity

Enhancement of an all-hazards response is a key focus in 2015. The initiative will ensure that PPL Electric has a more robust process to respond to critical situations other than weather events. PPL Electric is expanding procedures for all roles that are involved in the activation of the emergency response organization beyond storms.

## CONCLUSION

PPL Electric Utilities appreciates the opportunity to outline its programs, projects and activities in preparation for the peak demand and storms of the summer season.

Executing seasonal maintenance programs, along with strategic investments and system improvements, enables the company to deliver the safe, reliable power that customers expect.

Based on planning, execution of work plans, and storm response improvement initiatives, PPL Electric Utilities believes it is operationally ready for summer to meet customer needs and expectations.