

PPL Electric Utilities  
Summer Readiness Overview  
June 2019

SUMMARY

PPL Electric Utilities (PPL Electric), in preparation for summer readiness continues to implement and perform a number of activities to ensure the company will respond effectively to summer storms as well as provide reliable electricity every day for 1.4 million customers.

In addition to traditional preparation activities, such as vegetation management and equipment inspections, PPL Electric is taking innovative steps to strengthen its system and improve service for customers. These include the installation of smart grid devices, the use of automated power restoration, and more proactive sharing of outage and restoration information with customers.

Detailed below are various actions undertaken or plans for enhancements to ensure summer readiness.

A. RELIABILITY ENHANCEMENT PROGRAMS

a. Enhanced Vegetation Management

PPL Electric's vegetation management program uses industry best practices 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 adjacent to ROW. Trees are a leading cause of storm-related power outages, so vegetation management is critical to keeping the system reliable.

Trees falling from outside the ROW are a leading cause of permanent outages. Following PPL Electric's comprehensive trimming of multi-phase distribution circuits from 2013-2018, the company is using data analytics to guide the prioritization of schedule and scope for annual maintenance to maximize reliability benefits. This strategic approach to trimming allows the company to increase the volume of hazard trees being removed. Ash trees account for 25-33% of removals on the transmission and distribution systems. By aggressively targeting Ash trees for removal as part of our comprehensive hazard tree program, we are mitigating the impact of emerald ash borer.

PPL Electric continues to employ helicopters with LiDAR sensors to monitor and evaluate the clearance of vegetation from the transmission system and guide our maintenance program. We are using this experience with remote sensing as we begin a new program where drones with LiDAR sensors will capture 3D data on a sample of distribution lines in 2019. This industry leading approach will help vegetation management to identify and prioritize trimming scope more quickly, and to automate existing processes as this data integrates with our current vegetation work management software.

The company is currently working on data analytics initiatives to better understand risk and to predict where future vegetation outages are most likely to occur. The objective of

the these initiatives is to understand what variables have the most influence on failures so trees with those observed conditions can be removed before they cause outages.

b. Storm Hardening

The overall intent of storm hardening is to minimize customer impact due to storms. PPL Electric's storm hardening focus continues to be around vegetation management, asset and line reliability performance and smart grid technology. For 2019, implementing Trip Saver reclosers on single-phase taps is expected to reduce permanent and momentary outages for transient faults. These devices will be installed on targeted lines with higher permanent and momentary outage histories. In addition, we continue to address distribution pole performance through pole replacement and remediation programs along with changes to our pole sizes and crossarm attachments such as with the use of fiber crossarms. PPL Electric also using steel poles at highway and railroad crossings to harden these critical locations. Larger poles are now used in locations where heavier equipment is installed, and remote service kits are installed to improve restoration times for residential customers in rural areas. In addition, spacer cable is being specified in areas with high tree exposure.

c. Fuses/Reclosers/Automatic Switches

PPL Electric continues to replace existing three-phase hydraulic reclosers with communication-enabled vacuum circuit reclosers. This allows for remote operation of these devices, as well as 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 permanent repairs are made.

In 2019, PPL introduced two new single-phase reclosing devices onto the system in order to enhance sectionalizing on single phase taps where previously reclosing coordination or sectionalizing could not be achieved. One of these reclosing devices is remote communicating and will be fully integrable in PPL's centralized Distribution Management System (DMS). The other is a low-cost device that is quick to install and commission, whose cost-value benefit opens more locations to reclosing and sectionalizing than ever before.

d. Smart Grid

The company continues to invest in its Smart Grid initiative. For 2019, an additional 140 communicating vacuum circuit reclosers are planned for installation by June. These devices will allow for automatic sectionalizing and reclosing, in addition to identifying fault locations, all of which help to reduce outage duration times.

PPL Electric implemented a DMS in 2014, 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 to detect a fault from smart sensors on the distribution system and quickly develop and execute an optimized restoration plan. This technology is dramatically improving the ability to quickly restore customers, particularly

in conjunction with our Fault Isolation and Service Restoration (FISR) technology, which is now in use on all circuits.

PPL Electric continues to monitor and refine its usage of FISR technology. FISR identifies faulted sections and quickly develops an optimized restoration plan, then automatically executes that plan. Customers typically can be restored within five minutes from the start of the outage.

In addition, enhancements to our Smart Grid device relay programming have led to more consistent results, and further improvements have been made in the technology that analyzes the severity and location of a fault, enabling field staff to more rapidly respond to the trouble location.

e. Conservation Voltage Reduction (CVR) activity

PPL Electric does not currently engage in voltage conservation reduction activity.

f. Any Other Relevant Continual Improvement Activity

PPL Electric has several other noteworthy reliability improvement activities. For example, PPL Electric pioneered a momentary outage task force and program to investigate and mitigate the causes of multiple momentary outages. This program leverages Advanced Metering Infrastructure (AMI) data to help identify and reduce momentary outages for customers and should also reduce permanent outages that may have eventually been caused by the conditions that producing the momentary outages. Projects under this program include replacing deteriorated/defective equipment, hot spot tree trimming, protection evaluation, and animal guarding.

PPL Electric implemented a program that analyzes long-term (10 year) circuit performance and identifies those circuits which have most frequently had higher numbers of permanent and momentary outages. Plans to prioritize and remediate those circuits are developed under this program.

PPL Electric continues to expand the use of advanced data analytics to identify and remediate potentially failing equipment before it causes an outage. The use of health scores and development of predictive models is a focus area for 2019.

Additionally, PPL Electric has a program to address customers experiencing multiple interruptions (CEMI). Under this program all customers have their interruption count monitored on a rolling 12-month basis and appropriate remediation strategies are developed.

g. New programs/new technology implementations

In 2018, PPL Electric began adding smart sensors to motor operated air break switches. This allows programmatic determination of whether the device saw a fault. While these switches were already remotely operable, the addition of the smart sensor allows the FISIR system to control the switches, leading to faster customer restoration.

In 2019, PPL introduced two new single-phase reclosing devices onto the system in order to enhance sectionalizing on single phase taps where previously reclosing coordination or sectionalizing could not be achieved. One of these reclosing devices is remote communicating and will be fully integrable in PPL Electric's centralized DMS. The other is a low-cost device that is quick to install and commission whose cost opens more locations to the benefits of reclosing than ever before.

In 2019, PPL Electric installed its first Battery Energy Storage System (BESS). This project provides improved reliability to customers on a section of remote single-phase conductor that have seen a significant number of outages over a rolling twelve months. The battery storage system is anticipated to resolve the reliability concern.

PPL Electric is using signals from the new AMI meters to identify exactly when customer outages occur without relying on customers calling in. This permits us to respond more quickly than ever before to outages.

High impedance fault detection – a technology that helps identify downed, energized wires - continues to be rolled out to all new communicating reclosers in 2019. This year PPL Electric had its first successful automatic trip on a downed wire.

B. PREVENTATIVE MAINTENANCE PROGRAMS

a. Capacitor Inspections

PPL Electric uses analytics to identify blown fuses on capacitor banks. In addition, the company is monitoring voltage for all substation buses and investigates issues in near real-time. This monitoring catches capacitor banks that are not operating as expected. PPL Electric is in the process of automating switched capacitor banks. With this automation, the capacitors can be monitored for failure and controlled remotely from the operations center and have been part of voltage level and reactive power (Volt-VAR) control which began in 2018.

b. Vegetation Management

Information about PPL Electric's vegetation management program can be found in section A.a. above.

c. Substation Inspections

Distribution and transmission substations are inspected based on our program requirements to ensure safe and reliable operation. In addition, remote monitoring is in place for key substation equipment. Our substation equipment receives preventative

testing and maintenance to ensure facilities are fully operable to deliver peak demands reliably. PPL EU continues to use new technology and data analytics to refine our inspection and preventative maintenance programs.

d. Aerial Patrols

Helicopter or unmanned aerial vehicle patrols on the transmission line include routine patrols and comprehensive visual inspections. The routine patrols occur during early summer or prior to high-risk outages to look for imminent potential issues on the transmission system. A forester may participate to identify potential danger or hazard trees that could impact our system. These flights give a once-a-year look at the entire system. The comprehensive visual inspections are flown based on a risk-based schedule, with most lines receiving a comprehensive inspection once every four years on average. Comprehensive inspections typically take place after the routine patrol, and the object of these patrols is to look for damaged equipment through a detailed review.

PPL Electric received Federal Aviation Administration approval in early 2015 to use drones, or unmanned aerial vehicles, for power line inspections. They have been integrated into the overall transmission inspection program, and their use is being expanded on distribution overhead lines. The drone program will not replace all storm damage assessment or line inspection by other methods.

e. Infrared Inspections

PPL Electric's infrared (IR) line inspections are a routine part of maintenance to identify 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; the colder weather also results in a lower ambient temperature for greater contrast. Consequently, repairs associated with the results of infrared scanning are 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 and improve reliability of service. Capturing inspection data is critical to effective asset management. PPL Electric has digitized airbreak and voltage regulator inspections and now records data in a mobile web app that is accessible by all crew mobile units. Examples of airbreak condition data include health of operating rods, insulators, loadbreak contacts, linkage, and other components. Voltage regulator condition focuses on number of tap changes and proper control settings.

The resultant data from these forms provide asset condition data to make data-driven maintenance and replacement decisions on airbreak switches and voltage regulators. The

company continues collecting condition data for additional distribution assets and building health indices for each asset class.

g. New programs / new technology implementation

PPL Electric is taking further actions to improve the electric reliability for its customers with the innovative use of drones to patrol distribution overhead lines. These patrols will improve the company's ability to identify vulnerabilities along the infrastructure.

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 issues.

In 2018, the summer peak on the PPL Electric system was 7,224 MWh, below the all-time summer peak of 7,554 MWh recorded in July 2006. PPL Electric experienced no issues during the 2018 peak. The 2018 winter<sup>1</sup> peak of 7,467 MWh was below the all-time winter peak of 7,884 MWh, which occurred in February 2015. 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 and summer heat waves, ongoing investments in reliability, capacity upgrades, and customer adoption of energy efficiency and conservation opportunities.

D. 2018 STORM UPDATE AND LESSONS LEARNED

PPL Electric experienced 23 storm events in 2018, compared to an average of 14 during the benchmark period of 1994-1998. PUC Major Event Riley occurred in 2018. Another five storms in 2018 were PUC-reportable, while 17 were not reportable but required the opening of one or more area emergency centers to manage restoration efforts.

Currently, there are two PUC-reportable storms on record for 2019. Additionally, there have been five storms which were not reportable but required the opening of one or more area emergency centers to manage restoration efforts.

PPL Electric is committed to restoring customers as safely and as quickly as possible. The company continues to improve its storm and emergency response through the use of emergency exercises, after-action reviews, and best practices and benchmarking with other electric distribution companies (EDCs) and industry leaders. The company is focused on improving communications with its customers, state agencies, emergency organizations, other utilities and the media. PPL Electric is also refining the management of estimated restoration times (ERTs) and operations.

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<sup>1</sup> Defined as December of 2018 through February of 2019.

PPL Electric instituted or strengthened the following enhancements to its storm and emergency preparations:

- Execution of its annual emergency exercise plans.
- Exercises focused on targeted processes.
- Consolidation of primary command centers within regions.
- Strengthening of processes to acquire external resources.
- Consolidation of all logistics services within the logistics branch.
- More proactive and frequent event planning conference calls.
- More frequent and proactive activation of our regional command centers.

#### E. 2019 SUMMER READINESS

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

PPL Electric is making significant investments to maintain and improve reliability on its transmission and distribution systems – continuing a trend of increased investment in system reliability. Company 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.

Approximately 91 load-based and reliability projects on the transmission and distribution systems are planned to strengthen 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:

- Expansions and upgrades to existing bulk power, regional and distribution area supply substations.
- Rebuilding and reconductoring transmission and distribution lines.
- Upgrading power transformers at distribution substations for more capacity.
- Installing new distribution tie lines to improve reliability.
- Replacement of high-risk wood assets with steel.
- Avian interference and lightning protection on targeted transmission facilities.
- Helicopter and drone patrols for transmission line inspections (comprehensive and routine).
- Expanded right-of-way and clearance on targeted transmission lines to improve reliability.

##### c. Event Preparedness

PPL Electric continues to strengthen its event exercise regimen through the implementation of a systematic approach to instruction, exercise, and knowledge retention. New concepts or changes are communicated through orientation sessions, followed by tabletop or functional exercises to help employees put what they learn into

practice. In addition, small-focus drills are done to ensure understanding, knowledge retention, and effectiveness. Small-focus drills are repeated for processes not frequently used in order to keep skills sharp.

We continuously improve our process by incorporating process improvements identified in after-action reviews after events and exercises.

During our annual meeting with county emergency management groups, we review applicable processes and feedback.

d. Training

Training is a key part of PPL Electric's storm readiness planning. In 2019 PPL Electric will continue to conduct orientations and exercises to strengthen storm event processes.

e. Personnel Sufficient

PPL Electric will have sufficient personnel to address any summer event.

g. Any other relevant continual improvement activity

PPL Electric is active in numerous best-practice sharing organizations, including the American Edison Illuminating Companies (AEIC) teams (Operations, Execution, Technology, Logistics, and Unmanned Aircraft Systems (UAS)), Southeastern Electric Exchange (SEE) Mutual Assistance and Logistics teams, Edison Electric Institute (EEI) Mutual Assistance and National Response Event teams, North Atlantic Mutual Assistance Group, and PA EDC Best Practices team.

h. New programs / new technology implementation

PPL Electric continues to refine its outage prediction model to drive appropriate event preparedness, has acquired mobile command centers to provide a centralized command for restoration areas where there is a large amount of localized damage, and enhanced the damage assessment process.



## F. STORM RESPONSE

### a. Outage Restoration Strategy

PPL Electric's restoration strategy has remained consistent throughout its history. The utmost priority is given to public health and safety facilities, such as hospitals, 911 call centers, and other vital facilities and critical operations and the buildings associated with them. Once those crucial services are restored, the focus shifts to restoring trouble cases that will lead to the restoration of the most customers as quickly and as safely as possible. Priority is also given to incidents involving downed electrical wires and blocked roads.

### b. Communications and Outreach

PPL Electric recognizes the need to provide accurate, timely and frequent status updates and other helpful information about storms to everyone affected. The company is driven to develop and deliver that information in a consistent and timely manner. That includes providing periodic updates to customers, media, lawmakers, the Pennsylvania Public Utility Commission, and other stakeholders before and during events.

Customers access PPL Electric's outage map on our website to obtain outage information. Customers are also provided with information through outage alerts which provide proactive information about outages, their causes and the estimated restoration times. Alerts can be customized by customers and delivered by text, email, and recorded phone message.

In addition, regular status updates about storm damage and restoration efforts are provided via press releases and multiple social media outlets, including Facebook and Twitter. Company personnel work closely with county emergency management agencies to assess priorities and establish communication between PPL Electric and affected communities. For larger events, the company hosts conference calls with public officials.

### c. Outage Restoration and Storm Response Best Practices Implemented and/or Identified for Future Implementation

After-action reviews from 2018 and this year's active winter storm season yielded improvement opportunities summarized below:

- Acquisition of mobile command centers to provide centralized command for restoration of areas with excessive localized damage.
- Enhanced damage assessment process.
- Streamlining the US/Canada border crossing process for efficient entry of Canadian resources.
- Improved process for lodging and feeding arrangements.
- Enhanced process for activation and management of base camps to support large numbers of restoration resources in remote areas.

- Increased activation of our remote dispatch process during periods of significant outages
- Enhanced automated incident action plans (daily work plans)
- Streamlining the process to address scenarios of concentrated significant damage

d. Any Other Relevant Continual Improvement Activity

In 2019 PPL Electric will continue to focus on refining our all-hazards response to ensure that PPL Electric is ready to respond to all types of emergency events, not just those caused by the weather. Action plans for all roles associated with the activation of the Emergency Response Organization beyond storms have been expanded and the company will continue to update its business continuity plans to support all-hazard responses.

G. Average Service Availability Index (ASAI) for the 5% Worst Performing Circuits (Period starting Jan 1, 2019 and ending Mar 31, 2019) and Customer Minutes of Interruption (CMI).

b. ASAI / CMI for the ten worst circuits on the 5% WPC list, using IEEE methodology<sup>2</sup>.

Line	ASAI	CMI
Line 1	0.9985	1,287,202
Line 2	0.9992	1,017,041
Line 3	0.9992	954,926
Line 4	0.9994	831,259
Line 5	0.9990	821,539
Line 6	0.9991	774,626
Line 7	0.9993	672,444
Line 8	0.9993	670,989
Line 9	0.9991	646,829
Line 10	0.9995	615,755

## CONCLUSION

PPL Electric 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.

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<sup>2</sup> IEEE 1366 Standard was used for both ASAI and CMI.

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