

PPL Electric Utilities
Summer Readiness Overview
June 2021

SUMMARY

PPL Electric Utilities (PPL Electric) “Company”, in preparation for summer readiness continues to implement and perform 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 continues taking innovative steps to strengthen its system and improve service for customers. These include the use of data analytics, enhanced vegetation management program, smart grid device deployment, and automated system power restoration.

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

I. RELIABILITY ENHANCEMENT PROGRAMS

a. Enhanced Vegetation Management

PPL Electric’s vegetation management program uses industry best practices and data analytics 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.

PPL Electric implemented an approach to maintenance work around new and more robust data sets. The company has improved upon a risk model that quantifies vegetation risks across the system and identifies areas most likely to cause outages. The objective of this model is to direct investments in a targeted maintenance program that will improve circuit reliability.

This strategic approach to trimming allows the company to increase the volume of hazard trees being removed. In 2020 this equated to 34,500 trees, which was about four times more than the historical average. Ash trees account for 33% of removals on the transmission and distribution systems. By aggressively targeting ash trees for removal as part of our comprehensive hazard tree program, PPL Electric is mitigating the impact of emerald ash borer.

PPL Electric continues to perform an annual aerial LiDAR inspection to monitor and evaluate the clearance of vegetation from the transmission system and guide its maintenance program. The company is beginning its third year capturing aerial LiDAR information on a selection of distribution lines in 2021. This industry leading approach will help to rapidly identify and prioritize trimming scope. It is also a foundational element for future efforts to automate existing processes as this data integrates with the company's current vegetation work management software.

In addition to our core maintenance programs, the company has continued working on initiatives to better understand risk and to predict where future vegetation outages are most prevalent. The objective of these initiatives is to understand what variables have the most influence on failures, so that trees with those observed conditions can be removed before they cause outages. In 2020, we removed about 1,000 trees on 69kV lines guided by analytical data.

In phase two of our updated distribution risk model approach, work will be executed in grids on approximately 40 different distribution circuits. These lines were selected based on the probability of experiencing a vegetation caused outage. Circuit performance will be monitored, and results will guide future decisions on optimization of cost and scope to achieve reliability goals. This targeted hazard tree removal program is above and beyond our cycle-based maintenance program. Post project, we will track and analyze results to strategize future risk modeling implementation into our vegetation management programs.

b. Storm Hardening

PPL Electric's storm hardening focus continues to be around vegetation management, asset and line reliability performance, and smart grid deployment technology. Beginning

in 2019, PPL Electric began installing TripSaver reclosers on single-phase taps which have begun to reduce permanent and momentary outages for transient faults. These devices are being installed on targeted lines with higher permanent and momentary outage histories. To date, 632 TripSaver reclosers have been installed, with 182 scheduled for 2021. In addition, we continue to address distribution pole performance through pole replacement and remediation programs along with changes to our pole sizes, with a minimum of class 3 on Distribution facilities, and steel construction on Transmission, and crossarm attachments such as with the use of fiber crossarms. PPL Electric is also using steel poles at NESC Grade B crossings (highway, railroad, and river crossings) to harden these critical locations. Stronger 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. Stronger poles are also installed for communicating protective/switching devices to fortify our remote capabilities. Between the substation and the first protective device, poles are being replaced rather than being reinforced in order to strengthen the most impactful areas of the system. In addition, spacer cable is being specified in areas with high tree exposure on both single and multi-phase circuits.

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.

PPL continues to utilize the single-phase reclosing devices introduced to the system in 2021 and has begun a programmatic rollout for their installation (refer to section 1.d. Smart Grid for details).

d. Smart Grid

The company continues to invest in its Smart Grid initiative. These devices allow for automatic sectionalizing and reclosing, in addition to identifying fault locations, all of which help to reduce outage duration times. The focus of the Smart Grid initiative has begun a transition to single-phase outages for 2021, while completing the remaining locations for three-phase devices. For 2021, an additional 65 Smart Grid devices are planned for installation by June.

The company's investment in technologies such as its DMS, which is a software solution that provides system operators real-time situational awareness of how the system is performing, Fault Isolation and Service Restoration (FISR) technology that identifies faulted sections and quickly develops an optimized restoration plan and automatically executes that plan, combined with Smart Grid devices has dramatically improved the ability to quickly restore customers. As a result, there have been approximately 14 million minutes of avoided permanent interruptions from January 1, 2021 – April 30, 2021.

PPL Electric continues to monitor and refine its usage of FISR technology and identify enhancements to its Smart Grid device relay programming.

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 is programmatically reducing momentary interruptions through single-phase smart sectionalizing and responding to commercial and industrial customers with particular momentary sensitivity by targeting momentary reduction efforts to improve their quality of service. This program leverages Advanced Metering Infrastructure (AMI) data to help identify and reduce momentary outages for customers and will also reduce permanent outages that may have eventually been caused by the

conditions that were producing the momentary outages. Projects under this program include replacing deteriorated/defective equipment, hot spot tree trimming, protection evaluation, animal guarding, and single-phase reclosing device installation.

PPL Electric revised its Worst Performing Circuit program to be more indicative of the customer experience, and to focus on outage frequency and long duration outages. Plans to prioritize and remediate those circuits are developed under this program. Additionally, PPL Electric has implemented a new focus on worst performing single-phase circuits and taps.

The company continues to expand the use of advanced data analytics to identify and remediate potentially failing equipment before it causes an outage.

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 Electric installed its first Battery Energy Storage System (BESS). This project provides improved reliability to customers on sections 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 and has been used three times since its inception to power the customers while restoration was in process.

In 2019, PPL Electric deployed a Distributed Energy Resource Management System (DERMS) platform, which enables the company's DMS to identify fault locations more accurately, restore power with consideration of hidden load, and provides the capability to manage voltage utilizing inverter based Distributed Energy Resources (DER).

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.

PPL Electric is increasing the use of single-phase reclosers to reduce customer outages by installing reclosers at the head of a tap where previously a fuse was used and adding at least one additional automatic sectionalizing point downstream. Additionally, these reclosers will reduce customer blinks by allowing a more local single-phase recloser to operate instead of the upstream three-phase device, which would impact more customers.

PPL Electric is installing monitoring devices on major equipment in Transmission Substations, like transformers, circuit breakers and batteries. These monitors provide real-time data logging of critical asset information that will be used to feed health and risk index algorithms. The asset data and index scores will be used to shift from time-based to predictive maintenance and will help guide decisions for end-of-life replacements.

PPL Electric continues its program to replace vintage electromechanical relays with microprocessor relays, which can be remotely accessed to obtain fault information. High impedance fault detection – a technology that helps identify downed, energized wires - continues to be rolled out on all new communicating reclosers. We anticipate by June of 2021 45% of our Distribution substations will be upgraded to new microprocessor-based relays, and on the transmission system 58% of our substations will be upgraded to new microprocessor relays and controls.

PPL Electric is piloting Dynamic Line Rating (DLR) equipment on several congested transmission lines. The DLR sensors monitor real-time conductor sag as well as ambient temperature and wind speed. This real-time data in conjunction with forecasted weather data allows for higher utilization of existing assets. The increased dynamic ratings will reduce congestion on the transmission system which results in cost savings for customers.

PPL Electric initiated a program to address the 1,200 lattice structures constructed of weathering (Corten) steel on its 230 kV and 500 kV Bulk Transmission System. These towers were primarily installed in the 1960s and 1970s and inspections have revealed that the towers are in poor condition. It was determined that the most cost-effective solution would be to rebuild the Corten line sections to the current standards. Without this program, PPL Electric would face severe future outage and maintenance exposure on the lines constructed with Corten towers.

II. PREVENTATIVE MAINTENANCE PROGRAMS

a. Capacitor Inspections

PPL Electric uses analytics to identify blown fuses on capacitor banks. In addition, the company is remotely monitoring voltage for all substation buses and investigates any irregularities in near real-time. This monitoring identifies capacitor banks that are not operating as expected. As of 2020, PPL Electric has automated all switched capacitor banks. With this automation, the capacitors can be monitored for failure and controlled remotely from the operations center and are 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) above.

c. Substation Inspections

Distribution and transmission substations are inspected on a regular basis to ensure safe and reliable operation. In addition, remote monitoring is in place for key substation equipment. The company's substation equipment receives preventative testing and maintenance to ensure facilities are fully operable to deliver peak demands reliably. PPL Electric continues to use new technology and data analytics to refine its inspection and preventative maintenance programs.

d. Aerial Patrols

The use of helicopters or unmanned aerial vehicle (drones) has been integrated into the overall transmission inspection program and the distribution overhead lines inspection and data gathering program. In addition, the drones are used for storm assessment on a limited basis. The distribution line inspections conducted by drones are particularly efficient at finding pole top and cross arm conditions that are not visible from the ground and which, when replaced, strengthen the distribution system from incidents which could impact large numbers of customers.

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 the system. These flights give a once-a-year look at the entire system.

A more comprehensive visual inspection is conducted on a risk-based schedule, with most lines receiving this more in-depth inspection approximately every four years. 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.

e. Infrared Inspections

PPL Electric's infrared (IR) line inspections continue to be 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. Concurrent with the unmanned aerial vehicle visual inspections of the distribution system, an infrared inspection via UAV is conducted, with specific summer peaking problem areas targeted on the multiphase distribution system. Repairs identified during the UAV based infrared inspections are completed within an accelerated timeframe, improving reliability during the summer months.

- g. 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 air-break and voltage regulator inspections and now records data in a mobile web app that is accessible by all crew mobile units. Examples of air-break condition data include health of operating rods, insulators, load-break 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 air-break switches and voltage regulators. The company continues collecting condition data for additional distribution assets and building health indices for each asset class.

- h. 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 have improved the company's ability to identify vulnerabilities along the infrastructure.

PPL Electric is using resistance drill technology to inspect the wooden utility poles on the distribution system. This technology provides objective measurements of the health and strength of the utility poles, while limiting destructive bore holes and labor-intensive excavation. These data points gathered through the resistance drill measurements will enable time-based health tracking and conditioned based maintenance for the pole population.

III. 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 2020, the summer peak on the PPL Electric system was 7,395 MW, which was below the all-time summer peak of 7,554 MW recorded in July 2006. PPL Electric experienced no issues during the 2020 peak. The 2020 winter¹ peak of 6,100 MW was below the all-time winter peak of 7,884 MW, 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.

¹ Defined as December of 2020 through February of 2021.

IV. 2020 STORM UPDATE AND LESSONS LEARNED

2020 reliability results (all metrics below PUC benchmark and IEEE SAIFI in the top industry decile performance) were achieved in a year of continued storm frequency and intensity. 2020 saw a recent peak of 27 total storms, which is second only to the 28 events of 2006. There were also less IEEE excludable days than during the prior two years. NOAA average severe wind gust magnitude for Pennsylvania was at the highest level since 2010.

Through April, there are five PUC-reportable storms in 2020, the most ever through the month of April.

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 continues to improve the management and communication of estimated restoration times (ERTs) and operations.

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

- Execution of its annual emergency exercise plans.
- Exercise plans that are focused on seasonal risks to certify response teams.
- Consolidating existing response plans into simplified workflows and procedures.
- Introduced event metrics to support data driven operational improvements.
- Deliberate command center strategies to optimize storm response.

V. 2020 SUMMER READINESS

a/b. Capacity Additions and Transmission Preparedness

PPL Electric continues making significant investments to maintain and improve reliability on its transmission and distribution systems. The company is 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 have strengthened the system to effectively handle summer peak loads and improve overall reliability.

Approximately 150 load-based and reliability projects on the transmission and distribution systems are planned to prepare the network for peak summer demand, as well as dozens of system improvements that will either be completed or continue 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.
- Upgrade of our Low-Tension Networks (LTN).
- 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 ROW and clearance on targeted transmission lines to improve reliability.

c. Event Preparedness

PPL Electric strives to maintain the highest level of emergency readiness. Data driven performance indicators have been implemented to ensure readiness of our personnel, procedures, and functional support areas. Performance indicators are being utilized to identify areas for improvement and support high-risk scenario planning in real-time during training and execution of emergency preparedness plan execution.

d. Training

Training is a key part of PPL Electric's storm readiness planning. In 2020 PPL Electric will continue to conduct drills and exercises to improve storm event processes. These drills and simulations have the additional aim of enhancing the performance of the existing storm teams as well as training those new to the role.

e. Personnel Sufficient

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

f. Any other relevant continual improvement activity

A key component to continuous improvement is utilizing data driven decisions within all event workflows and procedures. Introduction of performance indicators will enable timely and effective response at all levels of our Emergency Response Organization. Additionally, simplified workflows and procedures will enable the use of mobile technology to further improve our restoration plans.

g. New programs / new technology implementation

PPL Electric continues leveraging data to strengthen our decision-making process in all stages of event response. Operational metrics allow for proactive and informed decision making, measuring of storm strategy effectiveness, tracking lessons learned, and updating drill and training plans.

Our digital transformation has enabled real-time collaboration across multiple technology platforms, which has improved overall storm planning and response.

VI. 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 can 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 2020 yielded improvement opportunities summarized below:

- Focused command center strategies to best support restoration efforts.
- Improved resource and logistics management.
- Optimized resource strategy during the 24-hour operational cycle to improve restoration durations.
- Improved procedure ownership and structure to better support timely and effective storm response.
- Proactive assessor strategy development has improved assessment quality and completion supporting overall restoration.

d. Any Other Relevant Continual Improvement Activity

PPL Electric Utilities has updated storm response plans due to supporting the COVID-19 environment. A comprehensive COVID-19 Storm Guideline was developed to ensure our storm response supported governmental and industry guidelines and best practices. Additionally, these guidelines ensure the protection of our restoration teams, while maintaining the highest level of response for our customers.

e. New programs/new technology implementation

Beyond what is mentioned in section (d) above, no new programs or technologies were introduced to Storm Response in 2020.

I. COVID-19

a. Impact on operations/capital projects in 2020

We saw minimal impact to capital projects and operations in 2020. Customer work continued to be a watchpoint with the uncertainty around shutdowns in Q2 of last year, however, customer work aligned with our original predictions and overall annual plan. There were minimal miscellaneous costs identified during the beginning of the pandemic that were specific to operating safely in the field. These were not substantial enough to impact original capital or operation plans for 2020.

COVID-19 shifted our storm response organization to operate in a remote setting, but our work in the digital space allowed PPL Electric to transition and become more effective executing storms in a remote posture.

b. Overview of 2021 operations and capital projects and COVID-19 protocols

PPL Electric anticipates our shift to remote operations, including the additional training and exercises completed over that last year to drive continued success in 2021. We expect no significant impact to capital projects.

c. Lessons learned and best practices captured for future operations

COVID-19 shifted a large portion of our existing operational practices into a remote response. PPL Electric quickly adapted and not only maintained existing capabilities but in most cases improved upon them. We saw significant improvement in remote execution of command centers, on-boarding mutual assistance crews, resource and logistics management, and assessor deployment. PPL Electric continues to evaluate these lessons to find more efficiencies and learnings to continue driving success for our customers.

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.

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.