

PPL Electric Utilities

Summer Readiness Overview

May 2023

SUMMARY

PPL Electric Utilities (PPL Electric), in preparation for summer readiness, continues to implement and perform activities to ensure the company will respond effectively to summer storms, as well as to provide reliable electricity every day for our 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 steps include the use of data analytics, smart grid devices, and automated power restoration.

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

I. RELIABILITY ENHANCEMENT PROGRAMS

a. Data Driven Vegetation Management

PPL Electric's vegetation management program leverages industry best practices and advanced analytical techniques to monitor and mitigate vegetation induced outages within and adjacent to transmission and distribution easements and rights-of-way (ROW). The primary objective of the vegetation management program is to minimize vegetation induced outages by (1) proactively maintaining vegetation encroachment and (2) removing trees that are hazardous to PPL EU facilities.

Recently, PPL leveraged remotely sensed data sources, including satellite imagery, to perform vegetation presence mapping adjacent to PPL Electric's facilities. This technology has enabled PPL to capture the population and density of vegetation located adjacent to PPL Electric's facilities across PPL commonwealth territory. This vegetation model has been

combined with vegetation risk models to prioritize vegetation activities at both circuit and sub-circuit level resolutions.

The adoption of a system wide vegetation presence/risk model enables the company to better understand vegetation impacts relative to the vegetation conditions associated with each circuit. This is enhancing cycle-based circuit selection for vegetation maintenance and identifying hazardous vegetation areas, at finer resolutions, for inspection and removal prioritization.

In addition to vegetation maintenance program enhancements, system wide vegetation presence mapping, in the form of tree canopy polygons, will support the in-situ collection of vegetation mitigations (trimming, removals, and brush management), site specific work details and methods (bucket, manual), with the collection of corresponding vegetation outage information. This data set is being created to strengthen future predictions of work and to inform outage models with robust on-site vegetation classification details.

As data sets are enhanced with greater levels of detail, models to predict both the vegetation presence and outage risk/impact will allow for improved prioritization of annual circuit selection relative to cycle-based management alone. This is made possible through greater understanding of circuit performance considering vegetation outages relative to conditions. PPL Electric aims to achieve a cost-effective Vegetation Management program to improve reliability by harnessing the power of new technology to inform data driven decision making.

b. Storm Hardening

PPL Electric's storm hardening efforts continue to be focused on vegetation management, asset and line reliability performance, and smart grid technology. Beginning in 2019, PPL Electric began installing Trip Saver reclosers on single-phase taps. These reclosers reduce permanent and momentary outages for transient faults. These devices are installed on targeted lines with higher permanent and momentary outage histories. PPL Electric plans to continue the addition of single-phase reclosing devices in 2023.

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 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 to strengthen the most impactful areas of the system. In addition, storm resistant space cable and undergrounding are 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 most customers to be back in service before permanent repairs are made.

d. Smart Grid

The company continues to invest in its Smart Grid initiative. These devices allow for identifying fault locations and automatically performing sectionalizing and reclosing, which help to reduce outage duration times. The focus of the Smart Grid initiative transitioned to single-phase outages in 2022, while completing the remaining locations for three-phase devices. For 2023, an additional one hundred Smart Grid devices are planned for installation by June.

The company's investment in technologies has dramatically improved the ability to quickly restore customers. These technologies include the Smart Grid devices; the Distribution Management System (DMS), a software solution that provides system operators real-time situational awareness of how the system is performing; and Fault Isolation and Service Restoration (FISR) technology that identifies faulted sections and quickly develops and executes an optimized restoration plan. As a result, there have been approximately 1.7 million avoided permanent outages through mid-May of 2023.

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 is programmatically reducing momentary interruptions through single-phase smart sectionalizing and applying targeted efforts to commercial and industrial customers with heightened sensitivity to momentary interruptions. 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's Worst Performing Circuit program focuses 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 FISR 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. PPL Electric plans to continue to install BESSs on the system in 2023.

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 outages occur without relying on customers calling in. This permits us to respond to outages more quickly than ever before.

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 momentary outages 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, such as 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 the program to replace vintage 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.

PPL Electric integrated Dynamic Line Rating (DLR) equipment on several congested transmission lines into TMS and PJM day-ahead markets. 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. In 2023, PPL Electric will pilot the use of DLR equipment on two distribution circuits.

PPL Electric initiated a program to install reclosers on the 69kV transmission system. These reclosers are an industry first at the 69kV level. A major benefit of 69kV reclosers is reducing customer impact due to transmission line faults. Only customers downstream of the recloser will see an interruption of power, opposed to all customers on the circuit, which would have previously been the case. When strategically placed on circuits, reclosers can have a significant impact on overall system reliability. Circuits identified to yield the greatest reliability benefits from reclosers were selected based on their operational history and analytics.

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 would have faced severe future outage and maintenance exposure on the lines constructed with Corten towers.

PPL Electric has applied for two topics totaling \$150M under the Infrastructure Investment and Jobs Act (IIJA). If approved, this funding will be applied to numerous projects involving resiliency and Smart Grid, including:

- Breaker / recloser replacement
- Energy storage
- Flooded substation relocation
- Undergrounding / storm hardening
- Predictive failure modeling
- Dynamic line rating
- LTN automation
- Single-phase reclosers
- Distribution management systems
- Digital twin modeling
- Advanced asset management

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 (I.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 innovative technology and data analytics to refine its inspection and preventative maintenance programs.

d. Aerial Patrols

The use of helicopters or unmanned aerial vehicles (drones) has been integrated into the overall transmission inspection program and the distribution overhead line inspection and data gathering program. 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 remediated, strengthen the distribution system against 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, and check for 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 lines qualifying for inspection 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 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.

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.

f. UAV (drone) use

Please refer to section (d) above.

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 provides asset condition information 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.

h. New programs / new technology implementation

PPL Electric is taking further actions to improve reliability for its customers with the innovative use of drones to patrol distribution overhead lines. The vantage point provided by the drone over a ground-based view has improved the company's ability to identify vulnerabilities along the infrastructure.

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 2022, the summer peak on the PPL Electric system was 7,065 MW, below the all-time summer peak of 7,554 MW recorded in July 2006. PPL Electric experienced no issues during the 2022 peak. The 2022 winter peak of 7,303 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.

IV. 2022 STORM UPDATE AND LESSONS LEARNED

2022 saw thirty-six total storms, the second most record on record behind the forty-two total storms of 2021. The PUC reportable storm count was 9 versus the prior ten-year average of 6.9.

Through the end of April, PPL Electric has seen 14 total storms in 2023, the highest on record through April, with the next highest year being 2022.

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 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 elements of its storm and emergency preparations:

- Execution of its annual emergency exercise plans.
- Focusing exercise plans on seasonal risks to validate readiness of response teams.
- Consolidating existing response plans into simplified workflows and procedures.
- Introducing event metrics to support data driven operational improvements.
- Optimizing storm response with deliberate command center strategies.

V. 2023 SUMMER READINESS

a/b. Capacity Additions and Transmission Preparedness

PPL Electric continues to make 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 manage summer peak loads and improve overall reliability.

Approximately 122 load-based and reliability projects on the transmission and distribution systems are planned for 2023.

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.
- Installation of 69kV reclosers to reduce the customer impact of outages.
- Installation of a new 69-12kV distribution substation.
- 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 strives to maintain the highest level of emergency readiness. Data driven performance indicators have been implemented to ensure the readiness of our personnel, procedures, and functional support areas. These 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 plans.

d. Training

Training is a key part of PPL Electric's storm readiness planning. In 2023 PPL Electric will continue to conduct drills and exercises to improve storm event processes. In addition, PPL Electric will be participating in several joint exercises with external agencies.

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 in 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 Utility 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 highest priority is given to public health and safety facilities, such as hospitals, 911 call centers, and other facilities with critical operations. Once those services are restored, the

focus shifts to 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 can be 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 2022 yielded improvement opportunities summarized below:

- 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 and other emergency responses.
- Expanded our pool of damage assessors to include retirees and improved the quality of assessments through continuous learning exercises.

d. Any Other Relevant Continual Improvement Activity

PPL Electric has implemented a streamlined approach to resource tracking and logistics based on lessons learned in 2022. The process change will assist the incident command team in making strategic resource allocation decisions.

e. New programs/new technology implementation

Beyond what is mentioned above, no new programs or technologies were introduced to Storm Response in 2023.

VII. SUPPLY CHAIN ISSUES

- a. Material shortages continue to be a challenge for all utilities. The biggest impact is seen with distribution transformers. Factories are at full capacity, and face material and labor shortages to build the transformers needed to meet unprecedented worldwide demand. This has caused lead times to grow from 12 weeks to 50+ weeks depending on the type of transformer, and prices to increase substantially.

PPL Electric has seen extended lead times for capacitor banks, capacitor cans, wire and cable, and some simple materials such as minor pole line hardware.

To assist with 2023 Summer peak demand, PPL Electric has approved new manufacturers and alternate material with the timely approvals from the Standards team, secured production slots, and increased stocking levels for critical material. PPL Electric is also using distributors to supplement our supply of material.

Large scale storms or hurricanes throughout the country could affect the ability to get replacement material because storm affected areas are given priority for material from manufacturers.

PPL Electric will continue to utilize the strong relationships we have built with our suppliers to jointly mitigate as many issues as possible, to get material when needed, and to minimize any delays in our current sourcing efforts and longer-term demand forecasts.

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, strategic investments, and system improvements enable 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 to meet customer needs and expectations in the summer of 2023.