A report by the staff of the

Public Utilities Commission of Ohio

Summer 2022 electric outages
January 3, 2023

Ohio | Public Utilities Commission

Introduction

Beginning on June 13, 2022, a line of storms moved through Ohio causing damage to a significant amount of the electric grid that resulted in numerous widespread outages across the state. All of the electric distribution utilities (EDU) in the state were affected; however, the customers and facilities of Ohio Power Company dba AEP Ohio and its affiliated transmission operating company (referenced together in this report as "AEP Ohio") were most impacted.

Subsequently, high temperatures in the area further exacerbated the problem by putting additional strain on the rest of the electric system. This resulted in a "load shed" event where AEP Ohio was required to proactively shut down parts of its distribution system in order to avoid damage to the system and further outages.

The Public Utilities Commission of Ohio (PUCO) has jurisdiction over the delivery of electricity in Ohio. Due to the impact these widespread outages had on Ohio residential and business customers, the PUCO held a public meeting on July 13, 2022, to hear from AEP Ohio and the regional grid operator, PJM Interconnection, LLC (PJM), regarding why and where the outages occurred, the impact on vulnerable populations, communications efforts, the decision-making surrounding the forced outages, the timeline of events, and what can be done to better protect or assist consumers in the future.

In addition, the PUCO directed its staff to conduct an after-action review to examine the circumstances of the event and AEP Ohio's response to determine if the company adhered to the laws and rules in the state, followed its PUCO-approved emergency plan, and responded appropriately to the event in an effort to mitigate the negative effects. This report reflects the results of that review. Staff conducted this review by examining data provided by the company and other sources, reviewing documents, and conducting interviews with company personnel.

The PUCO is aware other organizations that have shared responsibilities for the reliable operation of the grid have also conducted reviews.

Background

The PUCO regulates providers of utility services, including electric and natural gas companies, local and long-distance telephone companies, water and wastewater companies, and rail and trucking companies. Its mission is to assure all residential and business consumers access to adequate, safe, and reliable utility services at fair prices, while facilitating an environment that provides competitive choices.

Ohio Power Company dba AEP Ohio is a distribution utility providing electric service in Ohio and is under the jurisdiction of the PUCO. It serves over 1.5 million residential, commercial, and industrial customers in northwest, east, southeast, southern, and central Ohio.

The Federal Energy Regulatory Commission (FERC) is a federal agency that regulates the interstate transmission of natural gas, oil, and electricity and oversees the reliable operation of the nation's bulk power system.[1] The bulk power system can be described, in layman's terms, as the transmission system (large, high voltage wires) and associated equipment. FERC does not oversee the smaller or lower voltage wires that comprise the distribution system, which is under state jurisdiction. FERC protects the

[1] https://www.ferc.gov/what-ferc-does.

reliability of the interstate transmission system through mandatory reliability standards. Under Section 215 of the Federal Power Act, FERC is authorized to certify an entity to operate as an independent electric reliability organization to develop and enforce mandatory reliability standards that provide for reliable operation of the bulk power system. FERC has certified the North American Electric Reliability Corporation (NERC) to be this organization.

NERC is a not-for-profit regulatory authority whose mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.[2] NERC develops and enforces reliability standards and conducts other activities related to supporting reliability. The reliability standards are intended to ensure the reliable operation of the bulk power system so instability, uncontrolled separation, or cascading failures will not occur as a result of a sudden disturbance. NERC is the electric reliability organization for North America and is subject to oversight by FERC and governmental authorities in Canada. NERC's jurisdiction includes users, owners, and operators of the bulk power system.

PJM is a membership-based organization that coordinates the movement of electricity across the transmission system in a large region that includes Ohio and extends into 12 other states and the District of Columbia.[3] Because all of the transmission owners operating in Ohio are members of PJM, the state of Ohio is wholly within the PJM region. PJM directs the operation of power lines and generators for Ohio owners and continuously monitors the system across PJM's entire region for changes in demand, equipment problems, and weather conditions. In addition to ensuring reliable power throughout its region, PJM obtains generating capacity for the future and reserves for emergencies, manages generation and other resources in real time to meet consumer demand, and procures specialized services that protect the stability of the electric grid. However, PJM's primary task is to uphold the safety, reliability, and security of the bulk power system. In emergency situations where there are issues with the flow of electricity on the transmission system, PJM's directives to its members may impact operations at the distribution level since the distribution and transmission systems are connected.

Most of the electric power consumed in Ohio is generated at large scale generating facilities. Transmission lines are high voltage lines that move the power from the generation plants across the state. Some industrial and large commercial customers are served directly from the transmission lines. Distribution service is provided by transmission lines that feed distribution substations. These transmission feeds bring power to substations where it is reduced to appropriate distribution voltages and then sent out along distribution feeds to end-use customers. Residential customers as well as some smaller commercial and industrial customers are served from the lower voltage distribution system.

The amount of power being consumed on a system or part of a system at any given time is typically referred to as the "load." Load is typically measured in megawatts (MW) and tends to fluctuate throughout the day as customers' needs change. For instance, the load will generally increase to its daily peak in the evening hours when customers are arriving home from work, preparing meals, watching television, turning on lights, heating/cooling the house, etc. At other times of the day, some customers may not be using much electricity while others are using a relatively large amount. Commercial and industrial customers tend to use more electricity than a typical residence and can have a significant

[2] https://www.nerc.com/AboutNERC/Pages/default.aspx.
[3] https://www.pjm.com/about-pjm.

impact to the load in a given area. Load shedding is necessary when the amount of load on a facility exceeds its capacity. This results in forced outages.

Weather Event

On June 13, 2022, Ohio experienced a severe weather event that resulted in widespread power outages across the state. While all of Ohio's EDUs experienced high levels of customer outages, AEP Ohio territories were affected the most.

According to the National Weather Service (NWS) website,[4] the line of thunderstorms was classified as a derecho based on the American Meteorological Society definition of a derecho as "[a] widespread, convectively induced straight-line windstorm, more specifically, any family of downburst clusters produced by an extratropical mesoscale convective system."

The NWS provides the following overview of the event:

> A line of severe thunderstorms moved rapidly southeast out of Michigan and Indiana late in the evening hours of Monday June 13 and during the pre-dawn hours of Tuesday June 14, tracking along a warm front which separated very hot and humid conditions to the southwest from cooler and drier conditions to the northeast. These severe thunderstorms produced a swath of continuous wind damage from winds estimated at 60 to 70 mph from northwest Ohio through interior sections of north central and northeast Ohio. A swath from Richland, Ashland, and Morrow Counties through Wayne, Holmes, and Knox [c]ounties was particularly hard hit with widespread tree damage from winds likely around 80 mph. A large macroburst that tracked across Wayne and Holmes [c]ounties produced estimated 80 to over 90 mph winds from Wooster Township through Millersburg. Thousands of trees were downed along this path, many of which fell on homes, vehicles, and power lines causing widespread power outages. Clean-up and power restoration in Richland, Ashland, Morrow, Wayne, Holmes, and Knox [c]ounties took several days. In addition to the straight line winds, three E-F1 tornadoes touched down. The first tornado touched down 5 miles northeast of Mt. Gilead and ended 6 miles northwest of Chesterville and had maximum winds of 97 mph. The second tornado touched down in Chesterville and ended 5 miles southwest of Fredericktown and had maximum winds of 105 mph. The third tornado touched down 3 miles north of Butler and ended 4 miles south of Perrysville. These tornadoes damaged or destroyed several barns and outbuildings.

When the initial line of thunderstorms moved through the area, the high winds associated with the storms damaged numerous distribution and transmission facilities causing customer outages. Winds of that magnitude can cause outages in several ways. Typically, the winds cause outages by causing vegetation, such as trees and tree limbs, to come into contact with the electric lines (e.g., blowing entire trees over so that they fall into the lines, blowing the tree limbs or the electric lines enough that they contact each other, and causing tree limbs to break and fall into the lines). Additionally, heat can contribute to outages by causing electric lines to sag lower and contact vegetation, both because of the ambient heat as well as the increased load that typically accompanies hotter temperatures.

[4] https://www.weather.gov/cle/event_20220613_severe_weather_derecho.

This vegetation can either be within or outside of the easements where utilities are typically placed, often referred to as the right-of-way (ROW). The size of each ROW can vary greatly and depends on location (urban versus rural), capacity of the transmission or distribution line (measured in kilovolts) as well as the size of the supporting structures such as poles or towers.

On June 13, 2022 and the days following, much of Ohio, including the Columbus area, also experienced near record-high temperatures. According to the NWS website, high temperatures for June 13, 14, 15, and 16 were 92-, 93-, 94-, and 93-degrees Fahrenheit, respectively.[5]

These high temperatures contributed to the extended outage event. Initially, the storms caused outages by damaging the necessary facilities that provide electric service to customers. As AEP Ohio began restoring power to customers, the demand for power on some circuits exceeded the ability of the facilities to provide power.

Outage Summary

In response to data requests, AEP Ohio reported the total number of customers who experienced an outage between June 13 and June 19 was approximately 606,000. The company reported that the peak number of customers interrupted (CI) at one time was approximately 239,000 around 9:00 p.m. on June 14.

Customer minutes interrupted (CMI) is a metric commonly used by regulators to understand the impact of outages to customers. CMI is calculated by adding the cumulative total number of minutes all affected customers are without electric service over a period of time. In total, customers experienced 487,682,590 CMI because of this event.

The number of customers who were impacted by forced outages was approximately 283,000. Based on staff's review of information provided by the company, load shed was the leading contributor to CMI with approximately 164 million minutes. The other leading causes were trees out of right-of-way at approximately 129 million minutes and high winds at approximately 39 million minutes.

Below is a table identifying the total CI and CMI resulting from the weather event and subsequent load shed, by district as reported by AEP Ohio:

District	Total CI	Total CMI
Athens	27,374	18,201,835
Canton	80,503	99,264,808
Chillicothe	37,022	39,484,943
Columbus	351,463	195,958,792
Newark	86,562	113,490,220
Western Ohio	22,809	21,281,992
Grand Total	**605,733**	**487,682,590**

[5] https://www.weather.gov/wrh/Climate?wfo=iln.

Distribution Outages

Although distribution outages were widespread, the most heavily damaged distribution outage areas were in the Northeast Ohio area, specifically the Canton District, where total storm restorations were not completed until June 20.

This was partially because this part of the state was most impacted by the line of storms. Restoration was further hindered by access issues and rough terrain with many of the facilities travelling through long stretches of undeveloped land, rather than along roadways. Per the responses to data requests, AEP Ohio reported heavy damage and restricted access slowed the restoration progress.

Transmission Outages

During the weather event, AEP Ohio reported it had a total of 58 structures damaged across 19 transmission circuits that required either repair or total replacement of the structure or components such as crossarms, insulators, and/or wires. Total replacement was required of 38 of these structures whereas the remaining structures were repaired.

In addition, 14 circuits had outages caused by vegetation coming into contact with the lines. Seven transmission lines went down that directly contributed to the need for a load shed requirement, all but one of which had a failure that was reportedly caused by vegetation.

Restoration Process

The outage restoration process is prioritized and conducted by the EDUs. Generally, EDUs prioritize the restoration of critical facilities such as hospitals, fire stations, and nursing homes. Other restoration factors include number of customers, level of damage, type of circuit, and available resources, including workforce.

Customer Impacts

PUCO's Consumer Services Division is available for the citizens of Ohio to contact the agency via telephone, email, or the website. Staff assists residential, commercial, and industrial customers with information, answers their questions, and helps them resolve any issues that they may have with a regulated company.

A review of these contacts for June 2022 indicates that contacts related to an "out of service" condition from customers of AEP Ohio significantly increased. In fact, over the previous 11 months, there were less than 25 contacts in this category each month, whereas in June 2022 there were 223.

Over 200 of those contacts were related to the severe storm event. Customers' comments included, but were not limited to:

- Reporting an outage
- Lengthy restoration times
- Lack of communication regarding forced outages
- Location of forced outages
- Safety concerns
- Infrastructure upgrades vs. company profit
- Cost of lost food

Load Shed

Electric transmission and distribution systems are linked into what is commonly referred to as the grid. Electric facilities are constructed with the ability to handle the load for the areas they serve and, where feasible, built with redundancy to allow the grid to continue to operate with as few outages as possible when facilities fail to operate. These facilities have limits to the amount of load that they can safely sustain before they will fail. The EDUs along with the regional transmission organization, PJM, continuously monitor the grid to both ensure that power is being distributed across the grid where needed and that power is balanced across the system. The load in any given area can increase or decrease from minute to minute and the system may need to adjust accordingly.

The EDUs and PJM work together to ensure the reliable, safe operation of the grid. When there is a weather event such as what occurred in June of this year, AEP Ohio's operations personnel are in contact with PJM's operations personnel as they monitor the system because there can be significant changes in the amount and locations of the load as power is interrupted and subsequently restored. These entities make changes within the system to shift power as appropriate to maintain power and the integrity of the facilities. Under extreme circumstances, measures must be taken, up to and including disconnecting sections of the grid to reduce the amount of load on the grid.

One tool that EDUs can use to manage the load is the implementation of demand response. Some large-use customers, typically industrial, receive a type of electric service known as interruptible. In exchange for paying a discounted rate for electricity, demand response participants must be prepared to cease operations when required to do so. When there is an emergency directive issued by PJM, AEP Ohio may contact these customers to have them reduce or eliminate the amount of electricity they are using in order to reduce the load on the grid. On the morning of June 14, PJM issued load management requirements to AEP Ohio. AEP Ohio complied and contacted the interruptible customers who were in affected areas where load relief was needed. However, when the issue is isolated to specific locations as it was in this case, demand response is limited in its effectiveness because it is only beneficial if a significant amount of load responds, and it is on a circuit that requires load relief.

On June 14 and June 15, further action was required to avoid the overloading of facilities. PJM issued load shed requirements to AEP Ohio in three distinct events. The first set of directives was issued on June 14 beginning at 1:57 p.m. (Event 1), the second was on June 14 beginning at 7:30 p.m. (Event 2), and the last was on June 15 beginning at approximately 10:40 a.m. (Event 3).

Descriptions of the events are provided below. For security purposes, specific data about the lines and equipment that compose the electric grid is deemed to be critical energy infrastructure information (CEII). Therefore, for purposes of this report, labels and general location information are used to describe the infrastructure discussed below in an effort to maintain the security of the system.

Event 1 – June 14; 1:57 p.m. - June 15; 9:48 a.m.

Just before 2:00 p.m. on June 14, four 138 kV transmission lines failed in the Columbus area. Within 79 minutes of the first failure, two more transmission lines failed, totaling six. Exact times are below:

- Line 1 – 1:45 p.m.
- Line 2 – 1:51 p.m.
- Line 3 – 1:52 p.m.
- Line 4 – 1:53 p.m.
- Line 5 – 2:31 p.m.
- Line 6 – 3:04 p.m.

When the six lines went down, the load automatically shifted to other lines. The load on those lines subsequently began to increase to a point that they were functioning above safe operation conditions. As this was happening, AEP Ohio and PJM were performing analysis of the grid and it became apparent load was going to need to be reduced. PJM then directed AEP Ohio to shed load from the affected circuits.

For Event 1, PJM issued five load shed directives beginning at 1:57 p.m. that, in total, required AEP Ohio to shed 396 MW of load across several transmission lines feeding distribution substations in the Columbus area. In those areas, the amount of electricity that customers were drawing from the distribution substation exceeded the maximum capacity of the transmission feeds supplying power to the substation, putting the lines and equipment at risk. Thus, the location of the forced outages were the areas where the demand for electricity exceeded the system's ability to supply it due to the damaged facilities.

The analysis of the system conducted by PJM determined that immediately shedding 396 MW of load was necessary to reduce the load to a level where it could safely operate. When PJM issues operating orders, AEP Ohio must begin acting immediately and must fully comply within 30 minutes. Therefore, AEP Ohio must act quickly to determine which distribution circuits had to be shut down to achieve the 396 MW reduction requirement. Failure to act puts those facilities at risk of failing.

The analysis by PJM determined which transmission lines must have load reduced and by how much. This requires distribution feeds coming out of the corresponding substations shed load. Substation location is predetermined by the danger of exceeding the maximum load on transmission line feeding it. The total amount of 396 MW is an aggregate number, based on the sum of the megawatts that had to be reduced at those specific substations fed by the transmission lines determined to be overloaded.

AEP Ohio personnel began to immediately assess each substation to determine how to shed the required number of megawatts for that substation. Each substation has multiple distribution feeds leading out from the substation; each of those is monitored and shows how many megawatts of electricity are being drawn across that feed. AEP Ohio uses a combination of software and manual intervention to shed the required amount of load. In cases where manual intervention is necessary, AEP Ohio reported it selects the fewest number of distribution feeds it can shut down and still meet its load shed requirement. The number of customers, the type of customers (residential, commercial, or industrial), and the specific location of the customers are not readily available to the operations team

and are not considered. The only criterion for selecting those feeds is the amount of load they are carrying.

Event 2 – June 14; 7:30 p.m. – June 15; 9:48 a.m.

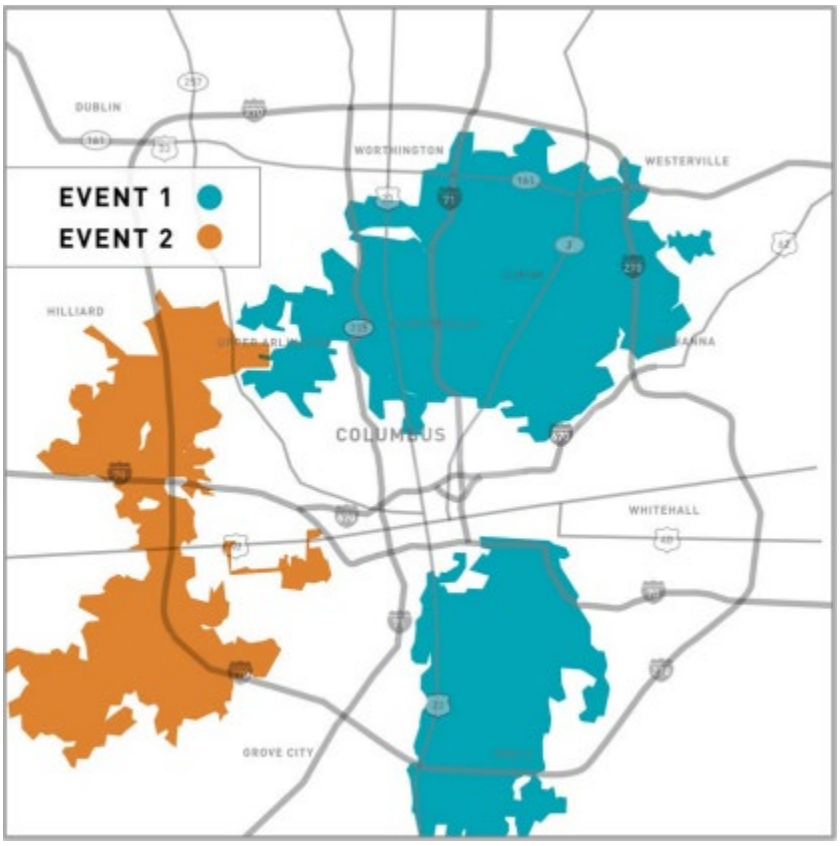
As the day progressed, the total load on the system continued to increase. There are two general reasons for this. One reason is that this is a typical result of customers' daily lives and routines. In addition to that, AEP Ohio crews continued to work to restore customers affected by the storm by repairing damaged distribution and transmission facilities. As facilities get repaired, more customers are restored, so more customers are using power. The hot weather in the area further contributed to the amount of load that customers required.

On a typical hot day, a residential customer will have their thermostat set and the air conditioning (AC) will turn on and off throughout the day. That customer's neighbor will likely have the same thing happening, but their AC unit is not necessarily turning on and off on the same schedule or at the same rate as their neighbors. So, while on hot days ACs are running throughout the area, they are not all running at the same time; it is staggered throughout the day which serves to naturally levelize the overall load. But during the restoration period following a large storm outage, on a hot day, large numbers of customers are getting their power turned back on at the same moment. Their houses are hot from not having the AC on for many hours. So, all of their AC units turn on shortly after the power comes on and they run continuously for longer-than-usual periods because it takes time to reduce the temperature down to the level set on the thermostat.

This information is important to understand the circumstances for Event 2. Although customers had already been taken off the system to reduce load, the failed transmission lines were still being repaired so there were still constraints. And then customers were starting to draw more power from the system, either through their normal routines or because they had just been restored, so the load was once again climbing to levels unsafe for maintaining the system.

Analysis performed by PJM determined that the risk of a cascading event was likely if additional load was not shed in the west and southwest areas of Columbus. A cascading event occurs when, for example, transmission lines go down causing load to shift to other transmission lines which, in turn, overloads those lines causing them to shut down, which overloads yet other lines to the point where they shut down, and so on. At 7:30 p.m., PJM began issuing additional load shed requirements to AEP Ohio. A total of 170 MW would need to be shed at various locations. AEP Ohio again went through the same process, using the same criterion, for selecting distribution feeds to shed load.

As the night of June 14 progressed into the morning of June 15, load levels began to decrease (as they typically do) and repairs to the system continued. Several transmission lines that went down initially as part of Event 1 were repaired and placed back into service. As load levels decreased and transmission facilities were brought back online, AEP Ohio was able to systematically restore the distribution feeds that were previously shut down as part of the load shed event. By 9:48 a.m. on the morning of June 15, all customers affected by load shed Events 1 and 2 were restored.



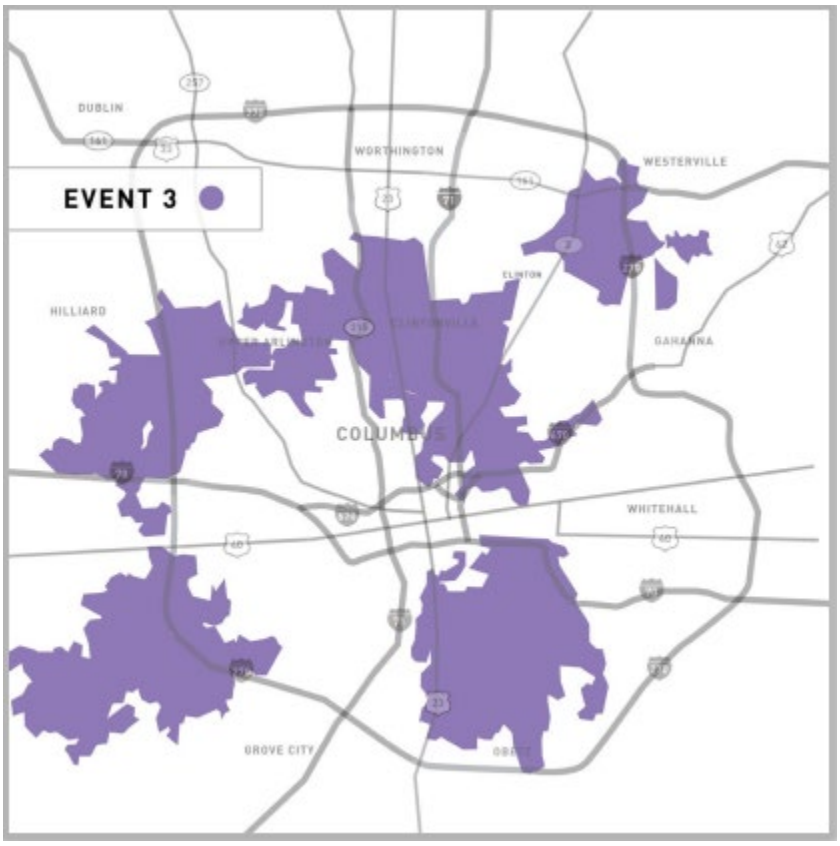
Event 3 – June 15; 10:40 a.m. - June 16; 4:51 a.m.

On the morning of June 15, four transmission lines failed. Three of these lines were lines that failed in Event 1. One was repaired and failed again a short while later due to trouble in a separate location. Equipment failure caused one of the outages, while vegetation caused the others, both grow-in (2) and fall-in (2). Exact times are below:

- Line 1 – 10:27 a.m.
- Line 3 – 10:35 a.m.
- Line 2 – 10:36 a.m.
- Line 7 – 10:50 a.m.
- Line 1 – 12:18 p.m.

Analysis of the system revealed that the load would need to be shed in some areas to avoid reaching load levels that are unsafe for operations. PJM again directed AEP Ohio to begin load shedding procedures. Although the new set of substations that required load shedding were not the same group as before, substations in Event 3 were also part of Event 1 and 2. The total required amount to be shed for this event was 479 MW.

As the day progressed and facilities were repaired, customers were restored. By 4:51 a.m. on June 16, all customers affected by the load shed were restored.



Emergency Plan

Each EDU is required to maintain an emergency plan under Ohio Administrative Code 4901:1-10-08. The plan is intended to be comprehensive and cover a wide range of potential emergency situations, including extensive power outages. It assists company personnel by providing guidance on how to proceed and sets up a command structure so there is coordination across the entire company. The company must meet all of the requirements of the rule in the preparation of its emergency plan and the PUCO inspects these plans every three years for compliance. The last inspection of AEP Ohio's emergency plan was in 2020.

As part of this after-action review, PUCO staff examined the implementation of AEP Ohio's emergency plan in response to the June weather event. Staff reviewed the company's documented protocols for the restoration of power and interviewed multiple personnel from both its distribution and transmission groups.

Overall, it was evident the company implemented its emergency plan and the plan helped leadership direct personnel properly to manage the restoration process. Staff found that AEP Ohio adhered to its emergency plan. Staff also noted that there appeared to be a high level of coordination between distribution personnel and transmission personnel. Because there was damage to both transmission and distribution infrastructure, it is essential the two groups coordinate efforts in order to restore service most efficiently.

Communications

AEP Ohio reported it attempted to maintain communications with the public throughout the event. The company also had communications with public officials as well as local and state emergency management agencies.

AEP Ohio summarized its total communications over the course of the storm event as reported below:

- Provided ongoing media updates, including on-camera interviews and information/statements for nearly 100 media inquiries
- Distributed 8 news releases to media across AEP Ohio's service territory
- Engaged with EMA contacts and community officials upon activation of the Incident Command System (ICS)
- Published 57 social media posts with 3.51 million impressions, 38k+ engagements and over 5,500 comments across Facebook, Twitter, and Instagram
- Responded to nearly 600 customer cases on social media
- Published ongoing updates to the company's website and blog
- Distributed special edition customer newsletter and pre-storm email to all customers
- Added and updated cooling center information to AEP Ohio outage maps

According to AEP Ohio, these communications included pre-storm tips, news releases, social media posts with outage updates and estimated restoration times, information on cooling centers, updates on the load shed events, newsletter articles, and information on assistance programs.

AEP Ohio reports that because of this event, it is working with community officials to gather information and best practices to develop better ways to notify communities and various customer segments should emergency forced outages occur again.

Maintenance Programs

Overview

Both distribution operators and transmission operators are required under Ohio Administrative Code 4901:1-10-27(E)(1) to "establish, maintain, and comply with written programs, policies, procedures, and schedules for the inspection, maintenance, repair, and replacement of [their] transmission and distribution circuits and equipment." There are seven required maintenance plans:

1. Poles and towers
2. Circuit and line inspections
3. Primary enclosures and secondary enclosures
4. Line reclosers
5. Line capacitors
6. Right-of-way vegetation control
7. Substations

These plans are filed with the PUCO and reviewed by its staff. AEP Ohio filed its most recent update on April 12, 2022, in Case No. 22-0367-EL-ESS. Staff performs regular field inspections and desk audits to

ensure that companies are adhering to their plans as filed and reviews annual reports submitted by EDUs as required by Ohio Administrative Code 4901:1-10-27(D)(4).

Because the majority of the outages were caused by wind, trees, or a combination of both on transmission lines, staff focused on circuit inspections and vegetation control for transmission lines in this report.

Circuit Inspections

Under Ohio Administrative Code 4901:1-10-27(D)(2), EDUs are required to perform annual inspections on all transmission circuits. AEP Ohio performs aerial inspections of its transmission circuits annually by flying qualified personnel near the transmission circuit while capturing relevant data using various sensing equipment for later analysis. Aerial inspections for the circuits where structures were damaged during the storm event were conducted on various dates, but all were inspected in the second half of 2021. The company also performs what it terms "comprehensive" inspections on a less frequent basis. These comprehensive inspections require employees or contractors to visually inspect all components of the circuit from the ground, document issues, and then prioritize any necessary repairs.

PUCO staff reviewed inspection information for the 19 circuits that had damaged structures. All had aerial inspections as required, with the latest inspections on all 19 circuits conducted in the latter half of 2021. All but two of the 19 circuits initially damaged in the storm had comprehensive inspections since 2017, with five of them in 2022. One circuit was a new circuit put in place at the end of 2018. The other circuit had not had a comprehensive inspection since 2014 and did not yet need one based on the company's risk analysis.

Vegetation Control

The goal of a company's vegetation control plan is to proactively monitor and trim vegetation in and around ROWs to prevent any reasonably anticipated contact with surrounding vegetation and avoid outages as efficiently as possible. There are several ways that this can be accomplished using various types of inspections along with varying ways of prioritizing and trimming vegetation. This can include aerial inspections and/or on-site visual inspections. Trimming can be conducted on set cycles where the entire circuit is trimmed back to where it is expected to leave enough clearance until the next cycle, or on a more risk-based approach where vegetation removal is based on the risk it poses of coming into physical contact with the lines or coming close enough for the electricity to arc, including consideration of the anticipated consequences.

Of the transmission circuits that had outages caused by vegetation, all had been trimmed in 2017 or later. All the seven transmission lines that directly contributed to the load shed event had been trimmed some time in 2021.

When companies repair transmission outages, they are required to note the cause and sub-cause of the outage using NERC's Transmission Availability Data System (TADS). NERC provides clear guidelines for the reporting of outages so that it has consistency throughout the industry for tracking purposes.

When "vegetation" is reported as the cause code, the companies must then provide sub-cause codes which indicate whether the vegetation that caused the outage by contacting the electric wires was "fall-in" or "grow-in," and whether the vegetation was inside or outside of the ROW.

Examples of a fall-in would be a tree that fully blew over during the storm and fell into the lines or it could mean that a branch from a tree broke completely off and fell into the lines, causing an outage. A grow-in sub-cause code is used when vegetation comes into contact with the lines, but it is still part of a growing plant. For example, if a branch cracked and dropped into an electric line, but was connected to a tree that is still growing out of the ground, it would be designated as a grow-in.

"Inside ROW" or "outside ROW" simply conveys whether the vegetation that ultimately caused the outage had been growing within the boundaries of the ROW or outside those boundaries.

The majority of transmission circuits that suffered outages were reported as having a cause code of vegetation. The company reported a total of 18 transmission lines suffered outages due to vegetation, with eight reported as grow-in and 10 as fall-in causes. There were 11 outages on the seven transmission lines that drove the need for the shedding of load. Of the 11 outages, 10 were listed with a vegetation cause code with the remaining circuit outage caused by equipment failure. Of those 10 caused by vegetation, seven were listed as grow-in and the other three were listed as fall-in.

After the storm event, AEP Ohio reported to staff that it is conducting detailed line analysis and has conducted additional aerial and ground patrols of lines impacted in and around the Columbus metro area and created a work plan for removing/mitigating areas of concern. It also reported it conducted further laser imaging surveys of all of the 138 kV lines serving central Ohio and repaired any identified hazards.

Transmission Investment

For the seven transmission lines that went down, the staff examined historical investment in those lines and facilities connected to those lines. The staff looked at the investments made during the last 10 years. The analysis included baseline, network, and supplemental projects in PJM's Regional Transmission Expansion Plan. Generally, baseline projects ensure compliance with national and regional reliability standards based on needs PJM identifies. Supplemental projects are enhancements or expansions to the transmission system that address local needs identified by individual transmission companies. Network projects are for new-service customers whose requests are coordinated by PJM.[6]

Line	Amount of investment (millions)	Number of projects (includes overlapping investment)	% pending	% supplemental / baseline / network
1	$113.84	7	0%	97% / 3% / 0%
2	$105.74	4	0%	100% / 0% / 0%
3	$18.48	9	22%	51% / 49% / 0%
4	$16.18	6	50%	30% / 70% / 0%
5	$21.54	6	100%	100% / 0% / 0%
6	$255.00	20	19%	47% / 53% / <1%
7	$43.88	12	24%	37% / 63% / 0%

[6] PJM, RTEP: Planning for Long-Term Transmission Needs, available at rtep-fact-sheet.ashx (pjm.com).

The data showed variability in the level of investment, the timing of investment, and the types of transmission projects. Because of this variation, and each line's involvement in the load shed event, the PJM-directed outages do not appear to have been affected by a lack of investment, by the timing of investment, or by an imbalance in the types of investments. The staff also analyzed how many of the projects were completed on time. While some of the projects historically had missed PJM's required date or AEP Ohio's projected in-service date, there were no baseline or supplemental projects that had missed one of those dates at the time of the outages. One network project had missed a deadline as of the time of the outages, but because network projects are generally for supporting new facilities, the delay may be due to delays with the new facilities.[7]

The data also shows that for more than half of the lines where investment was analyzed, the amount of investment in supplemental projects outweighs investment in baseline projects. This means that in these areas, it is AEP Ohio, rather than PJM, identifying needs and directing how those needs should be met. But it does not appear that the proportion of supplemental projects was a contributing factor to these outages. AEP Ohio should continue to ensure transmission investments in the state are being made in a holistic, balanced, and efficient manner to support long-term reliability and resilience, to protect critical facilities and vulnerable populations, and to further support continued load growth that is likely to impact the Columbus area and other parts of the state.

Conclusion and Recommendations

On June 13, 2022, NWS reported that westerly winds in central Ohio reached wind velocity exceeding 80 mph. This storm event caused significant damage to trees, poles, and other structures. However, based on a review of public information, and staff's review, AEP Ohio acted quickly in response to this derecho event by following its emergency procedures and restoration protocols, mobilizing its available workforce, and working to restore customers. The subsequent heat wave exacerbated the situation causing further outages during the load shed events. It is staff's opinion that the heat wave alone would likely not have resulted in any outages and that it was only because of the damage caused by the storm that shedding load was necessary. As evidence, according to the NWS website, the temperatures in the Columbus area on the following Tuesday and Wednesday (June 21 and 22), reached highs of 95- and 97-degrees Fahrenheit, respectively, and there were no requirements issued to shed load.

However, due to the combination of storms and heat that occurred between June 13 and June 16, the load shed directive issued by PJM and executed by AEP Ohio was necessary to avoid further extended outages. After the failure of the initial transmission lines, the load transferred to other transmission lines still in operation. As the load began to increase, those lines had the potential to damage the facilities and ultimately fail. Furthermore, the overloading and subsequent failure of lines can begin a cascading event. This would likely result in far more customers out of service than the number of customers affected by the load shed actions. After review of AEP Ohio's actions during the load shed event, it is clear to staff that the company had very little time to communicate to its customers and to react to PJM's directives in the selection of the circuits that needed a reduction in load.

[7] PJM Project Status & Cost Allocation (search Upgrade ID for n6263.2), available at https://www.pjm.com/planning/project-construction.

Staff has concerns about AEP Ohio's transmission vegetation management program, particularly those outage instances that were coded as grow-in in TADS. Most of the outages were ultimately caused by vegetation coming into contact with the power lines.

In the case of many of the grow-in related outages, AEP Ohio has asserted that although the lines came into contact with trees and limbs that were still intact, it happened only because the storm itself impacted the vegetation in and around the ROW enough that the landscape changed. And if not for that, the grow-in outage would not have occurred. Staff understands this point and can accept that this may be the case. However, it believes that if the trees were in a position that allowed the storm to alter them to the point that they caused a grow-in outage, then perhaps they had not been trimmed enough.

Although this review showed that the company adhered to its Commission-approved vegetation control plan, staff believes there is room for improvement. AEP Ohio should reevaluate its approach on its transmission vegetation management plan and move to a more cyclical trimming schedule, similar to its distribution plan. It is staff's understanding that AEP Ohio is already re-evaluating its vegetation management programs and anticipates changes. Staff recommends that AEP Ohio file an updated transmission vegetation management plan with the PUCO within 90 days of this report.

Based upon contacts in the call center, media reports, and other inquiries, staff believes that AEP Ohio needs to improve the timeliness and effectiveness of its communication with its customers. Outages can cause major disruptions to the lives of Ohioans. Although outages are not always preventable, customers can better deal with the problems associated with outages if they have accurate and timely information from the utility to rely on when making decisions.

Considering the information received after the events identified in this report, staff recommends that AEP Ohio establish a comprehensive plan to guide its communications with customers, their communities, and their government agencies, to ensure that accurate and timely information is getting to the customers who need it. AEP Ohio should work with PUCO staff to evaluate options for implementation of the provisions of the plan. For example, staff is aware that the percentage of customers who opt-in to AEP Ohio's service that allows them to receive text message information is very low. Providing that same service on an opt-out basis may be a way to improve communication. AEP Ohio should also evaluate options for communications with customers when electronic communications are difficult for those without power.

Additional emphasis should also be put forward on improving AEP Ohio's community outreach plan that incorporates the existing network of emergency responders and community leaders and their respective organizations as a means in which to supplement its communication strategy in a comprehensive manner. In both rural and urban centers, emergency responders and community organizations play a vital role in spreading valuable information and services to the communities that they serve. Efforts should be made to capitalize on this important community asset.

The events of June 13 through June 16, 2022, caused significant disruption to the daily lives of many Ohioans. Severe weather events will continue to have an impact on the utility infrastructure and delivery of these vital services. Although staff's review found that during the event the company adhered to the laws and rules in the state, followed its approved emergency plan, and responded appropriately in its recovery actions from the storm, it is the expectation of staff, and per the findings in this report, that additional diligence regarding right-of-way vegetation management and better

customer communication by the company will assist in addressing the aftereffects of these weather occurrences.