
Devin Ryan

dryan@postschell.com
717-612-6052 Direct
717-731-1985 Direct Fax
File #: 140056

February 22, 2024

VIA ELECTRONIC FILING

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street, 2nd Floor North
P.O. Box 3265
Harrisburg, PA 17105-3265

**Re: Petition of PPL Electric Utilities Corporation for Approval of Major Modifications
to its Existing Long-Term Infrastructure Improvement Plan
Docket No. P-2022-3034972**

Dear Secretary Chiavetta:

Enclosed, on behalf of PPL Electric Utilities Corporation (“PPL Electric”), is information being supplied to the Pennsylvania Public Utility Commission’s (“Commission”) Bureau of Technical Utility Services (“TUS”) in response to TUS Data Requests Set I regarding the above-captioned proceeding.

Respectfully submitted,



Devin Ryan

DR/dmc
Enclosures

cc: Harry R. Bidelspach Sr. (*via email; w/attachments*)
Certificate of Service

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the filing has been served upon the following persons, in the manner indicated, in accordance with the requirements of 52 Pa. Code § 1.54 (relating to service by a participant).

VIA E-MAIL

Aron J. Beatty, Esquire
Office of Consumer Advocate
555 Walnut Street
Forum Place, 5th Floor
Harrisburg, PA 17101-1923
Abeatty@paoca.org

Date: February 22, 2024



Devin T. Ryan

**PPL Electric Utilities Corporation
Response to Data Request Set I of the
Bureau of Technical Utility Services
P-2022-3034972
Dated February 7, 2024**

TUS I-1 Reference the Petition's page five, paragraph 19.

- a. Regarding the cost savings yielded, state if those savings factor in the installation costs, maintenance costs and operational costs of the Predictive Failure Technology (PFT).
- b. Regarding the 36 deteriorated assets identified on the test circuits, provide specific detail on each of the 36 assets identified, including the type of asset and the issue(s) identified for each asset.
- c. Regarding the 36 deteriorated assets, state if any or all of the 36 deteriorated assets were identified prior to a permanent fault or recloser operation.
- d. Regarding the identification of the 36 deteriorated assets, state whether the identified issues with the assets could have been detected by use of more frequent Overhead Line Patrols (OLP) or transformer inspections.
- e. Regarding question "c" above, provide a cost comparison between installation and use of the PFT versus the use of OLP on a routine basis of once every two years. Provide specifics on costs and the expected savings by customer minutes interrupted (CMI). Compare the results to PPL's \$2.00 per CMI threshold noted in PPL's Biennial Inspection, Maintenance, Repair and Replacement Plan for the Period January 1, 2024 – December 31, 2025, filed on October 3, 2022, at Docket No. M-2009-2094773.
- f. Regarding the three circuits within the program testing, provide details on when the deployment of PFT began on each circuit, when the last OLP occurred on each circuit, and when comprehensive vegetation management was conducted on each circuit.
- g. Regarding the testing of PFT, state if any of the three specific circuits have been identified as one of PPL's worst performing 5%

of circuits in any of PPL’s Quarterly Reliability Reports in 2022 or 2023.

- h. Regarding the 36 instances of deteriorated equipment identified by the test PFT, please provide as accurately as possible and based upon experience with actual fault conditions, the number of and types of the identified issues that were likely to result in a permanent fault which would require personnel to be dispatched to make repairs and restore service.
- i. Regarding the testing, during the year 2023, did any of the PFT technology fail or require maintenance or replacement?

PPL
Response

- a. The cost savings yielded from the test circuits do not factor in the installation, maintenance, or operational costs. The cost savings are realized by adopting a proactive approach to maintenance, which reduces operational expenses more than a reactive approach. Routine maintenance is more cost-effective than emergency repairs. Additional customer benefits like enhanced safety and reliability are recognized but not financially quantified for savings.
- b. The table below shows a detailed breakdown of assets and issues identified. Notably, at the time of the major modification filing, 36 deteriorated assets were identified; these 36 assets are numbered 1 through 36 below. Since the filing, an additional six deteriorated assets were field verified and are numbered 37-42.

Asset No.	Asset	Type of Failure
1	Conductor	Broken strands
2	Crossarm	Broken
3	Insulator	Partial discharge emittance
4	Insulator	Failing dead end insulator
5	Tie Wire	Broken
6	Covered Conductor	Partial discharge emittance
7	Fault Indicator	Failing asset
8	Insulator	Floating dead end insulator
9	Vegetation	Encroachment and extra slack in span
10	Neutral	Failing primary neutral
11	Transformer	Transformer leaking oil

12	Insulator	Broken insulator, flashed insulator, avalanche photodiode (APD) damage
13	Conductor	Frayed conductor
14	Neutral	Audible buzzing
15	Conductor	Frayed conductor
16	Vegetation	Encroachment
17	Insulator	Failing insulator
18	Switch	Failing 25kVA transformer
19	Insulator	Failing asset
20	Crossarm	Broken
21	Insulator	Failing asset
22	Insulator	Failing asset
23	Insulator	Failing asset
24	Insulator	Failing asset
25	Insulator	Partial discharge emittance
26	Insulator	Failing asset
27	Insulator	Failing asset
28	Insulator	Cracked insulator
29	Vegetation	Encroachment with partial discharge on nearby cutout
30	Vegetation	Encroachment
31	Dead End	Failing asset
32	Vegetation	Encroachment
33	Splice/Conductor	Thermal abnormality; failing
34	Insulator	Failing asset
35	Capacitor Bank	Failing cap bank switches
36	Conductor	Failed underground primary
37	Tie Wire	Loose tie wire & wearing insulative sleeve
38	Secondary	Conductor slap with communication wires
39	Insulator/Cross arm	Partial discharge emittance
40	Conductor/Hot Line Clamp	Frayed conductor & hot spot on hot line clamp
41	Tie Wire	Loose tie wire
42	Insulators/Connections	Frayed connections

- c. All 36 of the deteriorated assets were identified before a permanent fault or recloser operation.
- d. The PFT offers the ability to detect deteriorating assets that are difficult and, in many cases, impossible to detect through traditional Overhead Line Patrols (“OLPs”) or transformer inspections.

Additionally, this technology offers real time system monitoring of asset health and vegetation encroachment. In contrast, OLPs and transformer inspections offer only a snapshot in time and are not capable of identifying some of the items the PFT sensors can detect. In PPL's review of its detected deteriorated assets (see subpart (b), *supra*), some of the defects would have been caught in an OLP or transformer inspection but some would not have. The use of the PFT technology versus traditional OLPs and transformer inspections has provided PPL with a greater understanding of asset health, detected defects real time, and been able to mitigate customer outages.

- e. As stated in PPL Electric's 2024-2025 I&M Plan, "PPL Electric employs a \$2.00 per CMI saved cost threshold as a principal criterion for evaluating new projects for inclusion in the portfolio of reliability programs. Costs below that threshold are generally considered to be prudent investments, while those above typically provide less benefit for the cost." 2024-2025 I&M Plan, p. 16.

When comparing the use of OLP on a routine basis versus PFT, PFT is projected to provide a better dollar per CMI saved. In fact, as stated in the 2024-2025 I&M Plan, "PPL Electric conducted a trial of infrared inspections of multi-phase lines in 2006. The trial inspections cost \$122,500 and identified repairs costing \$100,000, saving an estimated 1,460,000-2,600,000 Customer Minutes Interrupted ('CMI'), at a cost of \$0.09 to \$0.15 per CMI saved. PPL Electric restructured the infrared service contract gaining further efficiencies in 2014. The cost benefit as calculated by the 2018 program effectiveness review suggested that the two programs, at a yearly cost of \$327,000, save an estimated 719,000 CMI, at a cost of \$0.45 per CMI saved."

In contrast, PFT is expected to provide CMI savings of significantly less than \$0.45 per CMI saved over time. Moreover, the inspections referenced in the 2024-2025 I&M Plan are a one-year investment with CMI savings, whereas the PFT is a one-time investment for a device with a 10 to 15-year life expectancy.

- f. The following table outlines the associated requested dates:

Circuit Name	PFT Install Date	Last Trim YR	Last OLP YR
Coopersburg No. 4	Oct-22	2021	2023
South Slatington No. 3	Nov-22	2022	2022
Mount Pocono No. 2 (3-Phase)	Apr-23	2021	2022
Mount Pocono No. 2 (1-Phase)	Mar-23		

As a result of the recently performed OLP inspections, no thermal or visual anomalies were reported.

- g. Through 2022 and 2023, the Coopersburg No. 4 line was identified as a worst performing circuit eight times, the South Slatington No. 3 line was identified three times, and the Mount Pocono No. 2 line was identified two times.
- h. The table below shows a historical count of outage causes and the associated failure component from 2018-2023.

Component Desc	2018	2019	2020	2021	2022	2023	Pct of Issues
No Component Entered	2	2	5	2	2	1	0.0%
OH-Capacitor Bank	4	6	2	2	8	3	0.1%
OH-Lightning Arrester	110	107	66	83	85	76	1.3%
OH-Other Equipment(explain)	128	159	111	113	96	99	1.8%
OH-Pole/Arms Attachments	364	336	368	420	489	398	6.0%
OH-PRI Splices and Connectors	53	88	60	88	61	86	1.1%
OH-Primary/Neutral	1,375	1,720	1,591	2,227	2,089	2,278	28.4%
OH-SEC Splices and Connectors	171	203	231	215	236	174	3.1%
OH-Secondaries/Services	688	781	685	811	858	750	11.5%
OH-Switch/Automatic	62	65	40	63	76	49	0.9%
OH-Switch/Manual/AB/Disc/OS/LBD	83	53	33	40	38	38	0.7%
OH-Tap Fuse/Cutout	405	440	367	387	408	364	6.0%
OH-Transformer	1,119	962	885	879	892	798	13.9%
OH-Transformer Fuse/Cutout	2,011	1,882	1,533	1,556	1,617	1,369	25.1%
OH-Transmission	38	15	13	12	13	17	0.3%

Of the 36 identified issues, data supports that 34 of those issues could have resulted in an impact to customers as an outage. The two remaining issues were issues with a capacitor bank and device. Although less likely to cause an outage, a capacitor bank’s failure could impact customers through a momentary outage depending on the nature of the failure. Specifically, when a capacitor bank fails, it is possible that the fault current generated would be great enough to trigger an upstream device to momentarily operate causing the customers to see a “blink” in service. For the other issue labelled as device, this was a fault indicator that was physically mounted on the line that had failed. This issue would not have caused an outage.

WITNESS: Preston Walker

- i. There was one instance of a malfunctioning SIM card where the device had to be replaced after installation. The vendor has since put revisions in place to mitigate this in future.

**PPL Electric Utilities Corporation
Response to Data Request Set I of the
Bureau of Technical Utility Services
P-2022-3034972
Dated February 7, 2024**

TUS I-2 Reference the Petition's page five, paragraph 20.

- a. Please clarify the statement: "PPL Electric plans to deploy Predictive Failure Technology across its service territory." What percentage and types of distribution circuits are expected to be included in this new technology?
- b. Regarding deployment, what percentage and types of circuits will not be candidates for the PFT across PPL's service territory?

PPL
Response

- a. The technology will initially be implemented on all overhead lines along the 3-phase primary backbone, extending from the substation to the end points. Due to constraints related to the existing pole infrastructure and the limited extent of short-distance three-phase taps, it is estimated that about 90% of the three-phase primary backbone, or roughly 7,000 miles out of a total of approximately 7,782 miles, can be equipped with the technology. Furthermore, based on system analysis, select radial taps will also be equipped with PFT on certain circuits. On average, each line will be equipped with approximately seven three-phase sensors along the backbone and four sensors on radial taps. The selection of taps for installation will be guided by factors such as the potential impact on customers, ease of access and historical issues.
- b. Currently, underground and Low Tension Network (LTN) circuits are not suitable for PFT implementation. The vendor offers distinct sensors designed for underground use. Prior to considering their deployment, PPL Electric is testing the technology's applicability to its underground applications through laboratory testing with the vendor.

**PPL Electric Utilities Corporation
Response to Data Request Set I of the
Bureau of Technical Utility Services
P-2022-3034972
Dated February 7, 2024**

TUS I-3 Reference the Petition's page five, paragraph 21.

- a. PPL states that over the life of the PFT technology, operations and maintenance expense will be reduced by approximately \$9 million. State if that reduction is from the result of deployment of PFT across all of the PPL distribution system and state if the \$9 million is an annual savings or a lifetime savings. State the expected lifetime of the PFT. Provide any industry data supporting the life expectancy of the devices/system.
- b. Provide data that compares the expected SAIFI improvement utilizing PFT versus the expected SAIFI improvement if PPL would return to performing distribution overhead line patrols every one to two years as required by 52 Pa. Code § 57.198(n)(4).
- c. State if PFT is susceptible to lightning damage, fault current damage or vegetation damage.

PPL
Response

- a. The \$9 million of operational expenses is expected to be realized annually after full system deployment. As referenced from the equipment manufacturer, the average life expectancy of this technology is 10-15 years, further justifying the overall savings far exceed the cost of these sensors.
- b. A reliability analysis conducted over the last year from the 36 deteriorated assets identified on the three test circuits alone showed an overall improvement in SAIFI by 0.0033 and a MAIFI improvement by 0.0237. When including the additional installations completed in 2023, reliability benefits are projected to produce SAIFI savings of 0.0275 and MAIFI savings of 0.0628, showing an increased improvement over the test circuits. Overall, these numbers show that at larger scale, PPL Electric estimates a possible savings between 10-15% for SAIFI.

Looking at the traditional line patrol program, a reliability analysis shows a smaller SAIFI improvement, or about 6,000 Customer Interruption savings. Please also see the response from TUS I-1 (e) regarding the CMI savings.

- c. PPL Electric does not see significant impact of lightning strikes on its distribution system; however, while unlikely, the PFT sensors could be susceptible to damage from lightning.

Due to the physical installation location of the PFT technology, fault current damage is not a concern.

Additionally, these sensors could see damage from vegetation should it fall on the device or resulting from a motor vehicle accident (MVA) if the pole that has PFT equipment installed on would be struck, all of which would be handled through PPL Electric's normal processes.

**PPL Electric Utilities Corporation
Response to Data Request Set I of the
Bureau of Technical Utility Services
P-2022-3034972
Dated February 7, 2024**

TUS I-4 Reference the Petition's page five, paragraph 22.

- a. State if this technology will it only be able to be used on radial line sections (taps).
- b. Describe if the technology will be used on radial two-phase and three-phase taps where delta connected transformer banks are employed. Describe if performance may be affected by back feed through delta connected transformers affect performance.
- c. Regarding the PFT, describe how monitoring of these devices and systems will be accomplished, e.g., distribution management system (DMS), supervisory control and data acquisition (SCADA), etc.
- d. Describe how the PFT will communicate its results (and status) to PPL's system, e.g. via landline telephone, wireless, fiber through power line, etc.

PPL
Response

- a. No. The PFT sensors can be used for substation and overhead line backbone applications in addition to radial line sections or taps.
- b. The technology will be used on radial two-phase and three-phase taps where delta connected transformer banks are employed. The PFT system operates by monitoring radio frequency (RF) signals, making it indifferent to the specific design, configuration, or the direction of power-flow within the electrical network. PFT's effectiveness is consistent across all network types, provided that they are powered and that the path between PFT sensors is unbroken, allowing for the uninterrupted transmission of RF signals along the power lines. Since RF signals can penetrate most utility transformers, PFT's monitoring capabilities can extend through in-line voltage regulators and transformers.

- c. The PFT system employs Internet of Things (IoT) and machine learning technologies to enhance data visualization and to identify patterns – allowing for precise detection of defects in the electric grid infrastructure (within +/- 30 feet) before they escalate into significant faults. This early detection helps prevent equipment damage, outages, and public safety hazards like fallen wires and wildfire ignition sources.

The PFT sensors monitor power lines for radio frequencies (“RF”) emanating from electrical components that deviate from standard 60 Hz operations. They conduct scans every second, identifying both immediate defects and long-term asset deterioration. Various factors can cause RF emissions that deviate from standard 60 Hz operations, including asset wear and tear, micro-arcing due to loose connections, and vegetation encroaching on live conductors.

After capturing the RF signals, the PFT units – leveraging Geospatial positioning systems (“GPS”) for location – measure the RF signal’s strength and timing, transmitting the data to a cloud server every second. In the cloud, algorithms analyze the signal’s source and characteristics.

When the PFT system identifies an unusual RF signal, the information is accessible to PPL representatives through a web interface, enabling further analysis to pinpoint potential issues, assess risks and device on the necessity of on-site inspection. Currently, there are no plans to integrate this system into the existing Advanced Distribution Management System (“ADMS”).

- d. PFT units securely send data via the PFT vendor managed 4G/LTE network to a centralized server on the vendor’s Amazon Web Services cloud. Once analyzed, the results and raw data are accessible to PPL representatives through a secure web interface.

**PPL Electric Utilities Corporation
Response to Data Request Set I of the
Bureau of Technical Utility Services
P-2022-3034972
Dated February 7, 2024**

TUS I-5 Reference the Petition's page 7, paragraph 33.

- a. Given the \$84.44 million expenditure over the course of LTIIP III, and considering expected maintenance and operational costs for the final deployed systems, state the rate of return on the investment and expected cost/benefit ratio.

PPL
Response

- a. Based on internal evaluation of project benefits and costs, PPL Electric estimates the internal rate of return ("IRR") to be 5%. A formal cost-benefit ratio is not available at this time. However, as stated in response to subparts (c) through (e) of TUS I-1, the PFT technology has outperformed traditional inspections in term of reliability improvements and is projected to produce significant reductions in annual O&M expenses over the 10 to 15-year life expectancy of the PFT assets. Moreover, the benefits of PFT include, but are not limited to, substation monitoring, reactive fault locating, vegetation encroachment identification, asset failure classification, and wildfire risk mitigation, all of which will help maintain or improve the safety and reliability of PPL Electric's distribution system. Thus, PPL Electric is confident its investment will yield long-term benefits for its customers.

VERIFICATION

I, PRESTON WALKER, being the Director – Transmission Planning & RTO Strategy at PPL Services Corporation, hereby state that the facts above set forth are true and correct to the best of my knowledge, information and belief and that I expect PPL Electric Utilities Corporation to be able to prove the same at a hearing held in this matter. I understand that the statements herein are made subject to the penalties of 18 Pa.C.S. § 4904 relating to unsworn falsification to authorities.

Date: February 22, 2024


Preston Walker (Feb 22, 2024 16:00 EST)

Preston Walker