Electric Service Reliability in Pennsylvania

2018

Pennsylvania Public Utility Commission

PENNSYLVANIA ELECTRIC RELIABILITY REPORT 2018

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Technical Utility Services

Paul T. Diskin, Director

Prepared by:

David M. Washko, Reliability Engineer

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Executive Summary

The Electricity Generation Customer Choice and Competition Act mandated the Pennsylvania Public Utility Commission (PUC or Commission) to ensure levels of reliability that existed prior to the restructuring of the electric utility industry continue in the new competitive markets.[1] In response to this mandate, the Commission adopted reporting requirements designed to ensure the continued safety, adequacy and reliability of the generation, transmission and distribution of electricity in the Commonwealth.[2] **The PUC also established reliability benchmarks and standards to measure the performance of each electric distribution company (EDC).[3]**

The benchmarks and standards established by the Commission are based on 4 reliability performance metrics adopted by the Institute of Electrical and Electronic Engineers Inc. (IEEE). Those metrics are:

- SAIFI: System average interruption frequency index or frequency of outages.
- CAIDI: Customer average interruption duration index or duration of outages.
- SAIDI: System average interruption duration index or frequency of sustained outages.
- MAIFI: Momentary average interruption frequency index or occurrences of momentary customer interruptions.

Given the uncertainty of weather and other events that affect reliability performance, the Commission has stated EDCs shall set goals **to achieve benchmark performance** in order to prepare for times when unforeseen circumstances may briefly and occasionally exceed benchmark performance.[4] In recognition of these unforeseen circumstances, the PUC set the performance standard as the threshold for those times when an EDC can briefly and occasionally exceed benchmark performance. An EDC that chronically fails to achieve benchmark performance is considered out of compliance with the performance regulations and may require a robust corrective action plan, re-organization of management objectives, and/or regulatory penalties.

As mandated, EDCs report reliability performance metrics[5] using both a rolling 12-month average and a rolling 3-year average. Tables 1A, 1B, 1C, and 1D below, provide a brief visual comparison summary of the EDCs' 12-month average performance for 2018, 2017, 2016, and 2015. More detailed analysis can be found in Section 4, *EDC Reliability Performance Data*. **Of note, the rolling 3-year average performance indices for 2016-2018 show 7 EDCs failing to meet standard in at least one performance category; and the rolling 12-month average shows 4 EDCs failing to meet standard and 9 EDCs failing to meet benchmark in at least one performance category.**

[1] Act of Dec. 3, 1996, P.L. 802, No. 138, 66 Pa.C.S. §§ 2801 et.seq.
[2] Docket No. L-00970120; 52 Pa. Code §§ 57.191-57.197.
[3] Docket No. M-00991220.
[4] Id. at 25.
[5] For an explanation of performance standards, see Section 2, page 2.

In addition to monitoring EDCs' reliability performance, the Commission established inspection and maintenance standards for electric transmission and distribution systems.[6] Biennial plans for the periodic inspection, maintenance, repair and replacement of facilities, designed to meet performance benchmarks and standards, were approved by the PUC's Bureau of Technical Utility Services (TUS).

Evaluation

Summary

In general, overall reliability performance of most EDCs regressed again in 2018. Reliability and resilience performance of the overall Pennsylvania electrical distribution system is trending more negatively than last year, and electric reliability and resilience appears to be most challenged during calendar years where there is severe storm activity. If the weather pattern experienced in the past 2 years becomes the new norm, it appears many EDCs will continue to struggle and not achieve sustained benchmark performance criterion. In the opinion of TUS staff, changes are needed by EDCs to more rapidly achieve excellence, continually improve, and develop new ideas that will achieve and sustain existing benchmark reliability performance indices and strengthen grid resilience during extreme weather events.

To address this overall negative reliability and resilience performance trend, EDCs continue to execute approved Long-Term Infrastructure Improvement Plans (LTIIPs).[7] EDCs are utilizing the LTIIPs to proactively accelerate replacement of degraded distribution system components and improve the resiliency of their distribution systems through storm hardening initiatives. There has also been an increase in tree trimming activity beyond historic levels for many EDCs, in addition to the LTIIP initiatives. A drastic change is needed to develop a Vision and Strategy in order to address how we can more efficiently and effectively reduce and eliminate the threat of off-right-of-way trees onto our modern-day electrical distribution system.

Trees are the number one cause of outages and lost customer-minutes in Pennsylvania. During major weather events trees also cause the most damage to the electrical distribution system causing about **2.7 billion customer-minutes of interruption**. The EDCs are performing the necessary vegetation management on their right-of-way corridors. However, off-right-of-way trees are causing the majority of damage and road closures that that lead to significant customer-minute interruptions and negatively impacting Pennsylvania's distribution system reliability and resilience.

Ongoing Recommendations from previous Report

As recommended in the 2017 Pennsylvania Electric Reliability Report,[8] the recommendations below are still applicable for the results of 2018:

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[6] Docket No. L-00040167.

[7] The 8 EDCs with approved LTIIPs are Met-Ed, PECO, Penelec, Penn Power, PPL, West Penn, Duquesne Light, and UGI.

[8] The 2017 Pennsylvania Electric Reliability Report is available for download here: http://www.puc.pa.gov/General/publications_reports/pdf/Electric_Service_Reliability2017.pdf.

- Possible legislative relief that will grant utility companies the authority to remove or trim danger trees that are off their existing right-of-way. Such relief could include granting EDCs the ability to trim, top-off, or remove trees that can potentially fall onto power conductors.

- Local authorities and counties could work with EDCs to be more proactive identifying and removing danger trees that are diseased or leaning toward a roadway. Road closures during a weather event, due to trees on roads, are a major hinderance during power restoration.

- EDCs and stakeholders should consider developing a long-term strategy to ensure only the "right-tree-in-the-right-place" is planted in close proximity to primary electrical conductors. The current distribution system in Pennsylvania is challenged by largely unmanaged off-right-of-way tree growth of various tree species that in many locations have grown higher and taller than adjacent power lines and could fall onto power lines during severe weather events. These types of trees would be considered the "wrong-tree-in-the-wrong-place," and a severe threat to the modern electric distribution system.

  Achieving such a strategy may involve designated funding, goals, objectives, and would need to be measured and monitored. An example of a goal would be to have, in the next 10 years, 50% of three-phase circuits will require zero tree trimming in the future using a bucket truck and future vegetation and tree growth can be effectively controlled and sustained safely by personnel on the ground. Execution of this recommendation could, in the long term, significantly increase safety, reliability, resilience, and would be a considerable future cost saving by maintaining vegetation under control in a substantial more cost-effective manner.

- Stakeholders should work together on removing dense/mature tree growth entangled in communication lines.[9]

- Landowners should be more proactive and accountable in removing diseased or leaning trees near roads.

- EDCs that belong to the North American Transmission Forum (NATF)[10] should consider utilizing and adopting NATF's continual improvement quality tools, such as the principles of excellence (POE) benchmarking program and other NATF quality management improvement methods tools NATF offers to promote excellence to ensure vegetation management programs are effective and robust to sustain our modern day electric distribution system.

[9] Per the current edition of the National Electric Safety Code, communication facility owners are not required to trim vegetation away from communication facilities.

[10] https://www.natf.net/about/about-the-natf.

Broader NATF/EDC Continual Improvement Recommendation Background

The NATF program was established by transmission operators and owners after the August 2003 Northeast blackout.[11] NATF collaborated with the Institute of Nuclear Operations (INPO), which has over 35 years of experience in applying operational performance program techniques, to improve operational excellence to sustain reliability and security of the bulk electrical system.[12]

After Superstorm Sandy in 2012, Pennsylvania EDCs implemented a collaborative group exchanging Best Practices among Pennsylvania EDCs for storm response and communications. TUS staff believes Pennsylvania EDCs are in an excellent position to voluntarily become the first distribution companies in the Nation to successfully integrate a program similar to the NATF into the electrical distribution system culture.

TUS has been in discussion beginning in 2016 with both EDCs and NATF to encourage a voluntary organic relationship to promote distribution system continual improvement and quality excellence; utilizing NATF's mature and proven quality management improvement programs and methods, that will enhance reliability and resilience of Pennsylvania's electric distribution system.

Need to Continually Improve

It has been recognized by TUS that EDCs are inconsistently achieving reliability benchmark performance and the future trend appears to be more negative. TUS staff is committed to working with EDCs to recognize and proactively make systemic changes in a way that will reduce the future impacts of climate change, aging infrastructure, grid modernization, tree/equipment failure outages, and security on the distribution system in a way that cannot be achieved by Commission rules alone.

Develop a PUC Reliability Action Item Program

TUS recommends the establishment of a formal PUC Reliability Action Item Program that includes a tracking/close-out data base system. The program would allow TUS to effectively notify EDCs of any reliability issues and concerns that TUS would want EDCs to evaluate. EDCs would provide a timely and detailed response back to TUS to better assure reliability and resilience gaps are closed, and any corrective and preventative action is completed in a timely manner.

Outage Code Standardization

TUS recommends EDCs collaborate and develop a standard set of uniform outage-cause-codes. Currently, Pennsylvania EDC outage code types and definitions vary, and are inconsistent. Some examples include the various definitions and types of "tree" outage cause code, "storm" outage codes, and "weather" outage codes. As well, the "other" outage code utilized by EDCs appears to be too nebulous of a category that should be divided into 2 categories such as "other explainable" and "unknown/unexplainable".

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[11] https://en.wikipedia.org/wiki/Northeast_blackout_of_2003#Long-term_effects.
[12] https://www.natf.net/docs/natf/documents/organization-and-programs.pdf.

Battery Storage Usage Note

In 2019, Pennsylvania EDC, PPL, installed a Battery Energy Storage System (BESS) to provide a power source to back feed customers experiencing poor electrical reliability. Battery storage energy sources are considered a promising method to minimize customer-minutes-interrupted on long radial circuits that do not have adequate redundant power feeds. Also, in the future, Pennsylvania may see an increase of battery storage systems connected to the distribution system as battery storage facility cost continues to decrease. In the long term, battery storage systems may be further utilized by EDCs to complement reliability and to adapt the distribution grid as both electrical distribution and transmission systems integrate renewable energy sources.

Table 1A

2018 EDC Performance Scorecard

Metrics achieved **GREEN** Benchmark Metrics not achieved **YELLOW** Standard Metrics not achieved **RED**

		Rolling 12-Month									
		Benchmark Score					Standard Score				
EDCs	[1]Metrics	[2]BM	Q1	Q2	Q3	Q4	[3]STD	Q1	Q2	Q3	Q4
Large EDCs											
Duquesne Light	CAIDI	108	114	103	116	106	130	114	103	116	106
	SAIDI	126	97	77	95	89	182	97	77	95	89
	SAIFI	1.17	0.85	0.75	0.82	0.84	1.40	0.85	0.75	0.82	0.84
PECO	CAIDI	112	98	96	106	110	134	98	96	106	110
	SAIDI	138	70	75	98	106	198	70	75	98	106
	SAIFI	1.23	0.72	0.78	0.93	0.97	1.48	0.72	0.78	0.93	0.97
PPL	CAIDI	145	137	185	173	168	174	137	185	173	168
	SAIDI	142	90	145	146	141	205	90	145	146	141
	SAIFI	0.98	0.65	0.78	0.85	0.84	1.18	0.65	0.78	0.85	0.84
Met-Ed (FirstEnergy)	CAIDI	117	144	147	139	130	140	144	147	139	130
	SAIDI	135	171	175	173	165	194	171	175	173	165
	SAIFI	1.15	1.19	1.19	1.25	1.27	1.38	1.19	1.19	1.25	1.27
Penelec (FirstEnergy)	CAIDI	117	132	127	116	114	141	132	127	116	114
	SAIDI	148	199	198	194	195	213	199	198	194	195
	SAIFI	1.26	1.51	1.56	1.67	1.71	1.52	1.51	1.56	1.67	1.71
Penn Power (FirstEnergy)	CAIDI	101	155	114	131	138	121	155	114	131	138
	SAIDI	113	170	124	154	152	162	170	124	154	152
	SAIFI	1.12	1.09	1.09	1.17	1.10	1.34	1.09	1.09	1.17	1.10
West Penn (FirstEnergy)	CAIDI	170	163	176	175	171	204	163	176	175	171
	SAIDI	179	191	219	219	209	257	191	219	219	209
	SAIFI	1.05	1.18	1.25	1.26	1.22	1.26	1.18	1.25	1.26	1.22
Small EDCs											
Citizens'	CAIDI	105	139	128	127	76	141	139	128	127	76
	SAIDI	21	43	36	26	16	38	43	36	26	16
	SAIFI	0.20	0.31	0.28	0.20	0.21	0.27	0.31	0.28	0.20	0.21
Pike County	CAIDI	174	135	189	235	236	235	135	189	235	236
	SAIDI	106	100	129	195	200	194	100	129	195	200
	SAIFI	0.61	0.74	0.69	0.82	0.85	0.82	0.74	0.69	0.82	0.85
UGI	CAIDI	169	208	213	183	178	228	208	213	183	178
	SAIDI	140	109	150	221	213	256	109	150	221	213
	SAIFI	0.83	0.53	0.71	1.21	1.19	1.12	0.53	0.71	1.21	1.19
Wellsboro	CAIDI	124	84	138	119	131	167	84	138	119	131
	SAIDI	153	76	162	172	178	278	76	162	172	178
	SAIFI	1.23	0.91	1.17	1.45	1.36	1.66	0.91	1.17	1.45	1.36

[1]CAIDI	(Customer Average Interruption Duration Index) - Measures average power restoration time (minutes) for every customer who lost power during this year.
SAIDI	(System Average Interruption Duration Index) - Measures average outage duration time (minutes) for every customer served during this year.
SAIFI	(System Average Interruption Frequency Index) - Measures average frequency of power interruptions for every customer served during this year.
[2]BM	(Benchmark) - EDC's attained performance baseline score prior to electric restructuring. Calculated by averaging historical performance metrics over the five-year period directly prior to electric restructuring (1994 to 1998).
[3]STD	(Standard) - EDC's upper limit performance value. CAIDI STD & SAIFI STD is calculated by multipling BM by 120% for large EDCs and 135% for small EDCs. SAIDI STD is calculated by multiplying CAIDI STD x SAIFI STD.

Table 1B

2017 EDC Performance Scorecard

Metrics achieved **GREEN** Benchmark Metrics not achieved **YELLOW** Standard Metrics not achieved **RED**

		Rolling 12-Month									
		Benchmark Score					Standard Score				
EDCs	[1]Metrics	[2]BM	Q1	Q2	Q3	Q4	[3]STD	Q1	Q2	Q3	Q4
Large EDCs											
Duquesne Light	CAIDI	108	92	113	116	115	130	92	113	116	115
	SAIDI	126	87	117	111	112	182	87	117	111	112
	SAIFI	1.17	0.95	1.04	0.96	0.98	1.40	0.95	1.04	0.96	0.98
PECO	CAIDI	112	109	99	95	99	134	109	99	95	99
	SAIDI	138	111	92	80	82	198	111	92	80	82
	SAIFI	1.23	1.02	0.93	0.85	0.83	1.48	1.02	0.93	0.85	0.83
PPL	CAIDI	145	123	127	134	146	174	123	127	134	146
	SAIDI	142	99	98	99	104	205	99	98	99	104
	SAIFI	0.98	0.81	0.78	0.74	0.71	1.18	0.81	0.78	0.74	0.71
Met-Ed (FirstEnergy)	CAIDI	117	127	121	138	147	140	127	121	138	147
	SAIDI	135	199	181	205	217	194	199	181	205	217
	SAIFI	1.15	1.57	1.50	1.48	1.47	1.38	1.57	1.50	1.48	1.47
Penelec (FirstEnergy)	CAIDI	117	125	188	137	138	141	125	188	137	138
	SAIDI	148	202	340	232	239	213	202	340	232	239
	SAIFI	1.26	1.62	1.81	1.69	1.73	1.52	1.62	1.81	1.69	1.73
Penn Power (FirstEnergy)	CAIDI	101	99	129	135	150	121	99	129	135	150
	SAIDI	113	108	173	161	160	162	108	173	161	160
	SAIFI	1.12	1.09	1.34	1.19	1.06	1.34	1.09	1.34	1.19	1.06
West Penn (FirstEnergy)	CAIDI	170	159	159	165	166	204	159	159	165	166
	SAIDI	179	191	198	211	214	257	191	198	211	214
	SAIFI	1.05	1.20	1.25	1.28	1.29	1.26	1.20	1.25	1.28	1.29
Small EDCs											
Citizens'	CAIDI	105	175	172	166	185	141	175	172	166	185
	SAIDI	21	67	70	74	84	38	67	70	74	84
	SAIFI	0.20	0.38	0.41	0.45	0.45	0.27	0.38	0.41	0.45	0.45
Pike County	CAIDI	174	251	201	167	185	235	251	201	167	185
	SAIDI	106	134	113	84	102	194	134	113	84	102
	SAIFI	0.61	0.53	0.56	0.51	0.53	0.82	0.53	0.56	0.51	0.53
UGI	CAIDI	169	127	114	134	131	228	127	114	134	131
	SAIDI	140	55	56	57	64	256	55	56	57	64
	SAIFI	0.83	0.43	0.49	0.42	0.49	1.12	0.43	0.49	0.42	0.49
Wellsboro	CAIDI	124	108	98	105	90	167	108	98	105	90
	SAIDI	153	203	175	143	97	278	203	175	143	97
	SAIFI	1.23	1.88	1.78	1.35	1.08	1.66	1.88	1.78	1.35	1.08

[1]CAIDI	(Customer Average Interruption Duration Index) - Measures average power restoration time (minutes) for every customer who lost power during this year.
SAIDI	(System Average Interruption Duration Index) - Measures average outage duration time (minutes) for every customer served during this year.
SAIFI	(System Average Interruption Frequency Index) - Measures average frequency of power interruptions for every customer served during this year.
[2]BM	(Benchmark) - EDC's attained performance baseline score prior to electric restructuring. Calculated by averaging historical performance metrics over the five-year period directly prior to electric restructuring (1994 to 1998).
[3]STD	(Standard) - EDC's upper limit performance value. CAIDI STD & SAIFI STD is calculated by multipling BM by 120% for large EDCs and 135% for small EDCs. SAIDI STD is calculated by multiplying CAIDI STD x SAIFI STD.

Table 1C

2016 EDC Performance Scorecard

Metrics achieved **GREEN** Benchmark Metrics not achieved **YELLOW** Standard Metrics not achieved **RED**

		Rolling 12-Month									
		Benchmark Score					Standard Score				
EDCs	[1]Metrics	[2]BM	Q1	Q2	Q3	Q4	[3]STD	Q1	Q2	Q3	Q4
Large EDCs											
Duquesne Light	CAIDI	108	92	70	71	100	130	92	70	71	100
	SAIDI	126	76	55	64	69	182	76	55	64	69
	SAIFI	1.17	0.83	0.79	0.90	0.69	1.40	0.83	0.79	0.90	0.69
PECO	CAIDI	112	89	102	108	106	134	89	102	108	106
	SAIDI	138	68	88	103	106	198	68	88	103	106
	SAIFI	1.23	0.77	0.86	0.97	1.00	1.48	0.77	0.86	0.97	1.00
PPL	CAIDI	145	124	118	119	121	174	124	118	119	121
	SAIDI	142	92	85	95	94	205	92	85	95	94
	SAIFI	0.98	0.75	0.72	0.80	0.78	1.18	0.75	0.72	0.80	0.78
Met-Ed (FirstEnergy)	CAIDI	117	**123**	**125**	**126**	**124**	140	123	125	126	124
	SAIDI	135	**164**	**166**	**178**	**178**	194	164	166	178	178
	SAIFI	1.15	**1.34**	**1.33**	**1.41**	**1.44**	1.38	1.34	1.33	**1.41**	**1.44**
Penelec (FirstEnergy)	CAIDI	117	**143**	**135**	**128**	**120**	141	**143**	135	128	120
	SAIDI	148	**192**	**175**	**183**	**171**	213	192	175	183	171
	SAIFI	1.26	**1.34**	**1.29**	**1.43**	**1.43**	1.52	1.34	1.29	1.43	1.43
Penn Power (FirstEnergy)	CAIDI	101	**102**	96	**111**	95	121	102	96	111	95
	SAIDI	113	**118**	95	107	104	162	118	95	107	104
	SAIFI	1.12	**1.16**	0.99	0.97	1.09	1.34	1.16	0.99	0.97	1.09
West Penn (FirstEnergy)	CAIDI	170	157	144	147	147	204	157	144	147	147
	SAIDI	179	**183**	148	163	159	257	183	148	163	159
	SAIFI	1.05	**1.16**	1.03	**1.11**	**1.08**	1.26	1.16	1.03	1.11	1.08
Small EDCs											
Citizens'	CAIDI	105	93	105	**111**	**108**	141	93	105	111	108
	SAIDI	21	19	**25**	**24**	**28**	38	19	25	24	28
	SAIFI	0.20	0.20	**0.23**	**0.22**	**0.26**	0.27	0.20	0.23	0.22	0.26
Pike County	CAIDI	174	**205**	174	**223**	**228**	235	205	174	223	228
	SAIDI	106	75	71	95	87	194	75	71	95	87
	SAIFI	0.61	0.37	0.41	0.42	0.38	0.82	0.37	0.41	0.42	0.38
UGI	CAIDI	169	109	129	119	125	228	109	129	119	125
	SAIDI	140	71	73	84	78	256	71	73	84	78
	SAIFI	0.83	0.65	0.56	0.70	0.63	1.12	0.65	0.56	0.70	0.63
Wellsboro	CAIDI	124	77	92	97	94	167	77	92	97	94
	SAIDI	153	86	96	113	**172**	278	86	96	113	172
	SAIFI	1.23	1.12	1.05	1.16	**1.84**	1.66	1.12	1.05	1.16	**1.84**

[1]CAIDI	(Customer Average Interruption Duration Index) - Measures average power restoration time (minutes) for every customer who lost power during this year.
SAIDI	(System Average Interruption Duration Index) - Measures average outage duration time (minutes) for every customer served during this year.
SAIFI	(System Average Interruption Frequency Index) - Measures average frequency of power interruptions for every customer served during this year.
[2]BM	(Benchmark) - EDC's attained performance baseline score prior to electric restructuring. Calculated by averaging historical performance metrics over the five-year period directly prior to electric restructuring (1994 to 1998).
[3]STD	(Standard) - EDC's upper limit performance value. CAIDI STD & SAIFI STD is calculated by multipling BM by 120% for large EDCs and 135% for small EDCs. SAIDI STD is calculated by multiplying CAIDI STD x SAIFI STD.

Table 1D

2015 EDC Performance Scorecard

Metrics achieved **GREEN** Benchmark Metrics not achieved **YELLOW** Standard Metrics not achieved **RED**

		Rolling 12-Month									
		Benchmark Score					Standard Score				
EDCs	[1]Metrics	[2]BM	Q1	Q2	Q3	Q4	[3]STD	Q1	Q2	Q3	Q4
Large EDCs											
Duquesne Light	CAIDI	108	103	105	107	103	130	103	105	107	103
	SAIDI	126	60	69	78	71	182	60	69	78	71
	SAIFI	1.17	0.58	0.66	0.73	0.69	1.40	0.58	0.66	0.73	0.69
PECO	CAIDI	112	92	90	86	84	134	92	90	86	84
	SAIDI	138	73	69	63	61	198	73	69	63	61
	SAIFI	1.23	0.80	0.76	0.73	0.72	1.48	0.80	0.76	0.73	0.72
PPL	CAIDI	145	142	**155**	124	118	174	142	155	124	118
	SAIDI	142	114	122	86	84	205	114	122	86	84
	SAIFI	0.98	0.80	0.79	0.69	0.72	1.18	0.80	0.79	0.69	0.72
Met-Ed (FirstEnergy)	CAIDI	117	**122**	**126**	**128**	113	140	122	126	128	113
	SAIDI	135	133	**158**	**158**	**136**	194	133	158	158	136
	SAIFI	1.15	1.09	**1.25**	**1.23**	**1.19**	1.38	1.09	1.25	1.23	1.19
Penelec (FirstEnergy)	CAIDI	117	**123**	**131**	**123**	**140**	141	123	131	123	140
	SAIDI	148	**185**	**190**	**168**	**191**	213	185	190	168	191
	SAIFI	1.26	**1.50**	**1.45**	**1.37**	**1.36**	1.52	1.50	1.45	1.37	1.36
Penn Power (FirstEnergy)	CAIDI	101	**104**	**109**	95	100	121	104	109	95	100
	SAIDI	113	103	**114**	112	**114**	162	103	114	112	114
	SAIFI	1.12	0.99	1.05	**1.18**	**1.14**	1.34	0.99	1.05	1.18	1.14
West Penn (FirstEnergy)	CAIDI	170	135	148	149	154	204	135	148	149	154
	SAIDI	179	138	168	175	179	257	138	168	175	179
	SAIFI	1.05	1.02	**1.13**	**1.17**	**1.17**	1.26	1.02	1.13	1.17	1.17
Small EDCs											
Citizens'	CAIDI	105	87	73	78	91	141	87	73	78	91
	SAIDI	21	17	17	20	18	38	17	17	20	18
	SAIFI	0.20	0.20	**0.23**	**0.25**	0.19	0.27	0.20	0.23	0.25	0.19
Pike County	CAIDI	174	104	**199**	**197**	**205**	235	104	199	197	205
	SAIDI	106	**119**	93	77	78	194	119	93	77	78
	SAIFI	0.61	**1.15**	0.47	0.39	0.38	0.82	**1.15**	0.47	0.39	0.38
UGI	CAIDI	169	153	122	113	103	228	153	122	113	103
	SAIDI	140	59	52	47	41	256	59	52	47	41
	SAIFI	0.83	0.38	0.43	0.41	0.40	1.12	0.38	0.43	0.41	0.40
Wellsboro	CAIDI	124	75	82	72	76	167	75	82	72	76
	SAIDI	153	54	80	82	81	278	54	80	82	81
	SAIFI	1.23	0.72	0.97	1.14	1.06	1.66	0.72	0.97	1.14	1.06

[1]CAIDI	(Customer Average Interruption Duration Index) - Measures average power restoration time (minutes) for every customer who lost power during this year.
SAIDI	(System Average Interruption Duration Index) - Measures average outage duration time (minutes) for every customer served during this year.
SAIFI	(System Average Interruption Frequency Index) - Measures average frequency of power interruptions for every customer served during this year.
[2]BM	(Benchmark) - EDC's attained performance baseline score prior to electric restructuring. Calculated by averaging historical performance metrics over the five-year period directly prior to electric restructuring (1994 to 1998).
[3]STD	(Standard) - EDC's upper limit performance value. CAIDI STD & SAIFI STD is calculated by multipling BM by 120% for large EDCs and 135% for small EDCs. SAIDI STD is calculated by multiplying CAIDI STD x SAIFI STD.

Section 1 – Introduction

Purpose

The report discusses the reliability performance of EDCs operating under the Commission's jurisdiction, specifically focusing on the reliability of the electric distribution system.[13]

The data presented in this report comes from the quarterly and annual reliability reports submitted by EDCs pursuant to the Commission's regulations. This data focuses on customer power restoration duration (CAIDI), average customer outage duration (SAIDI), and frequency of outages (SAIFI).[14] From these measures, this report provides an overview of the Commonwealth's electric distribution reliability as well as individual analyses of the EDCs operating within Pennsylvania.

Background

The Electricity Generation Customer Choice and Competition Act mandates the Commission ensure the level of reliability that existed prior to the restructuring of the electric utility industry is maintained in the newly restructured markets. In response to this mandate, the Commission adopted reporting requirements designed to monitor continuing safety, adequacy, and reliability of generation, transmission, and distribution of electricity in the Commonwealth.

The Commission also established reliability benchmark and standard values to measure the performance of each EDC. Given the uncertainty of weather and other events that can affect reliability performance, the Commission has stated that EDCs should set goals to achieve consistent benchmark performance in order to prepare for times when unforeseen circumstances occasionally and briefly exceed the benchmark performance threshold. As mandated, enforcement of the 3-year rolling average standard began with the utilities' filing of their 2006 annual reports. The 3-year performance standard only allows a deviation of 10% from the reliability index benchmark, as compared with the 20% or 35% deviations allowed by the 12-month performance standard.

The Commission set the performance standard as the occasional and brief maximum level an EDC can exceed the benchmark reliability performance value. Reliability performance values that are not considered in compliance require EDCs to provide an evaluation to the Commission that includes a Corrective Action Plan or a credible basis that would justify no corrective action is required. Reliability performance values that are not achieved during an assessment period will be followed up by the Commission. The inability of an EDC to achieve consistent compliance may result in an Order directing specific corrective actions.[15] Continuous noncompliance may trigger additional scrutiny and potential compliance enforcement actions by the Commission's prosecutorial staff in the Bureau of Investigation and Enforcement, including penalties and fines.[16]

[13] The high-voltage transmission system, nominally > 100 kV, is regulated by the Federal Energy Regulatory Commission (FERC). The electric distribution system is under the purview of the PUC.
[14] For more information on CAIDI and SAIFI, see Section 2.
[15] 52 Pa. Code § 57.197(a).
[16] 52 Pa. Code § 57.194(h)(1).

Section 2 –Reliability Performance Measures

Reliability Performance Metrics

The Commission's benchmarks and standards are based on 4 reliability performance metrics that have been adopted by the IEEE. The EDCs report metrics on a system-wide basis, rather than on a regional operating area basis. EDCs report the 4 reliability metrics on both a rolling 12-month average and a 3-year calendar year average:

1. **CAIDI** (Customer Average Interruption Duration Index): Measures average power restoration time (by minutes) for every customer who lost power during reporting period.
2. **SAIDI** (System Average Interruption Duration Index): Measures average outage duration time (by minutes) for every customer served during reporting period.
3. **SAIFI** (System Average Interruption Frequency Index): Measures average frequency of power interruptions for every customer served during reporting period.
4. **MAIFI** (Momentary Average Interruption Frequency Index): Measures average frequency of momentary (less than 5 minutes) interruptions for every customer served during reporting period.[17]

Additional information and data reported by EDCs:

- Average number of customers served.
- Number of sustained customer interruption minutes.
- Number of customers affected by service interruptions.
- Analysis of outage causes such as equipment failure, animal contact and contact with trees.[18]
- Reliability performance on the 5% of worst performing circuits and a corrective action plan to increase the reliability of these circuits.

[17] EDCs are required to report MAIFI data, provided the equipment capability is available to obtain relevant data. Only Met-Ed, PECO, Penelec, Penn Power and PPL report MAIFI.

[18] This information is collected and trended by EDCs to reduce customer outages and improve system reliability.

Major Events

In order to analyze and set measurable goals for electric service reliability performance, outage data is separated into either normal or abnormal periods. Only outages during normal event periods are used in calculating the reliability metrics. The term "Major Event" is used to identify an abnormal event, such as a major storm, and is defined as either of the following:[19]

- An interruption of electric service resulting from conditions beyond the control of the EDC which affects at least 10 % of the customers in the EDC's service territory during the course of the event for a duration of 5 minutes or greater; or
- An unscheduled interruption of electric service resulting from an action taken by an EDC to maintain the adequacy and security of the electrical system.

Outage data relating to Major Events are to be excluded from the calculation of reliability metrics. Prior to excluding major event data, an EDC is required to formally request to exclude those service interruptions for reporting purposes. The request must be accompanied by data that demonstrates why the service interruption qualifies as a major event exclusion.

Definitions: benchmark, standard, 12-month average, & 3-year average

The **benchmark** performance value represents the statistical average of the EDC's annual, system-wide, reliability performance index values for the 5 years from 1994-98. The benchmark value serves as an upper limit that EDCs should be consistently achieving to ensure reliability performance is considered satisfactory and acceptable.

The **standard** performance value represents an EDC's performance upper control limit established to allow EDCs to occasionally and briefly exceed the benchmark performance value. Both long-term (rolling 3-year) and short-term (rolling 12-month) performance standards have been established for each EDC based on individual EDC historical performance benchmarks. The performance standard limit allows an EDC to occasionally and briefly exceed a benchmark limit. However, chronically exceeding benchmark performance, or exceeding the standard limit is an indication that the EDC's performance is not satisfactory and requires additional scrutiny by the Commission.

The performance rolling **12-month average** is 120% of the benchmark for the large EDCs and 135% for the small EDCs.[20] A greater degree of short-term latitude for small EDCs recognizes that small EDCs have fewer customers and fewer circuits than large EDCs, potentially allowing a single event to have a more significant impact on the reliability performance of the small EDCs' distribution systems.

The performance rolling **3-year average** is 110% of the benchmark for all EDCs. This performance standard was set at 10% above the historical benchmark to ensure that the standard is no higher than the worst annual performance experienced during the years prior to the restructuring of the electric industry. The 3-year average performance is measured against the

[19] *See* 52 Pa. Code § 57.192.

[20] Large EDCs currently include Duquesne Light, Met-Ed, Penelec, Penn Power, PECO, PPL and West Penn. Small EDCs include: UGI, Citizens', Pike County and Wellsboro.

standard at the end of each calendar year. The rolling 3-year standard analysis contained in this report uses 2016, 2017 and 2018 calendar year data.
It is noted that a lower number for any index indicates better reliability performance; i.e., a lower frequency of outages or shorter outage duration. A higher number indicates worse performance.

Example: A large EDC's rolling 12-month **CAIDI benchmark** performance metric is 100 and associated **CAIDI standard** performance metric is 120 (which is 120% of benchmark). Evaluate an EDC's quarterly CAIDI score of 110, 90, and 140:

CAIDI of 110 evaluation: Performance is above **benchmark**, but below **standard**, and may require additional review and action if the EDC is chronically above **benchmark** score and trending toward exceeding **standard**. Upon Commission review, the EDC may be required to develop a Corrective Action Plan (CAP) and **additional PUC oversight will be taken to monitor effectiveness until performance is below benchmark**. In addition, this may result in a referral to Investigation & Enforcement Bureau for further action.

CAIDI of 90 evaluation: Performance is considered excellent since CAIDI is below both **benchmark and standard**.

CAIDI of 140 evaluation: Performance is considered unacceptable since CAIDI is greater than both **benchmark and standard**. The EDC will be required to develop a Corrective Action Plan (CAP) and additional PUC oversight will be taken to monitor effectiveness until benchmark performance is achieved. In addition, may result in a referral to Investigation & Enforcement Bureau for further action.

If any EDC's reliability performance does not meet Commission regulations, the Commission may require a report discussing the reasons for not meeting the regulation and the corrective measures the company is taking to improve performance.[21] In addition, Commission staff may initiate an investigation to determine whether an EDC is providing reliable service.[22]

Benchmarks and standards for EDC reliability performance and actual reliability metrics for 2018 are located in Appendix A.

Inspection and Maintenance

EDCs are required to have a plan for periodic inspection and maintenance of poles, overhead conductors and cables, wires, transformers, switching devices, protective devices, regulators, capacitors, substations, and other facilities critical to maintaining an acceptable level of reliability.[23] The time intervals for such inspections are detailed in Table 2, below. The regulation also sets forth minimum inspection and maintenance intervals for vegetation management, poles, overhead lines and substations.

[21] *See* 52 Pa. Code § 57.195(g).
[22] *See* 52 Pa. Code § 57.197(a).
[23] *See* 52 Pa. Code § 57.198.

Listed below are the most recently filed biennial inspection and maintenance (I&M) plans for the periodic inspection, maintenance, repair and replacement of facilities:

- Filed in October 2018 (effective January 2020 through December 2021) for Duquesne Light, PECO, PPL, Citizens', Pike County and Wellsboro.

- Filed in October 2017 (effective January 2019 through December 2020) for FirstEnergy (Met-Ed, Penelec, Penn Power and West Penn Power) and UGI.

The plans are subject to acceptance or rejection by the Commission. Most EDCs proposed modifications to the standards for some programs or parts of programs. Appendix B describes the exemptions that were requested by the EDCs and provides a summary of the explained justification for said exemptions.[24]

Table 2 - Inspection and Maintenance Intervals

Program	Interval
Vegetation Management	**4-6 years**
Pole Inspections	**10-12 years**
Overhead Distribution Line Inspections	**1-2 years**
Overhead Transformer Inspections	**1-2 years**
Above-Ground Pad-Mounted Transformer Inspections	**5 years**
Below-Ground Transformer Inspections	**8 years**
Recloser Inspections	**8 years**
Substation Inspections	**5 weeks**

Section 3 – 2018 Outage Response Review

Overview

Tables 3A and 3B, below, present a breakdown of reportable outage events summarized chronologically for 2018 (35 events) as compared to 2017 (50 events). All Pennsylvania EDCs had at least 1 PUC Reportable Outage Event (ROE) in 2018[25] except for Citizens', UGI, and Wellsboro. In 2018 there were 35 events, as compared to 50 events in 2017[26] and 20 events in 2016.

Table 3C, details the number of ROEs from 1993 through 2018. Note the number of ROEs that occurred during the benchmark period from 1994 through 1998. This information is highlighted to show that EDCs are expected to provide service at a level equal to or better than that provided during the benchmark period, regardless of whether ROEs are increasing on an annual basis.

[24] *See* 52 Pa. Code § 57.198(c).

[25] Service outages reports are required under 52 Pa. Code § 67.1. The reporting threshold for a 67.1 reportable outage event is 5 percent of total customers or 2,500 customers, whichever is less, for six or more consecutive hours. The reporting requirements are an initial phone call to the Commission when it is believed the threshold will be reached, followed by a written report 10 days after the last customer is restored.

[26] 50 events were the highest number of 67.1 reportable outage events since data has been collected beginning in 1993.

Table 3D details the number of customers affected by ROEs from 1993 through 2018. In 2018, a total of 2,548,905 customers were affected by ROEs as compared to 1,309,960 customers in 2017, 779,512 customers in 2016, and 619,474 customers in 2015.

Note: The high level of customers affected in 2011, 2012, and 2014 are primarily due to a few high-impact events, such as Irene in 2011, Sandy in 2012, and Nika in 2014.

Table 3E, details the cumulative number of ROEs by EDC from 2010 through 2018. West Penn and PPL have the most ROEs during this time period.

Table 3A –67.1 Reportable Outage Events Summary-2018

EDC	Date	Customers Affected	Cause
Duquesne	11/15/2018	63,344	Rain, Snow, Sleet
Duquesne	7/4/2018	31,482	Thunderstorms and rain
Duquesne	9/9/2018	19,170	Heavy rain
Met-Ed	11/15/2018	30,893	Rain, Snow, Sleet
Met-Ed	3/2/2018	272,928	Heavy rain
Met-Ed	4/4/2018	13,784	Weather
Met-Ed	5/15/2018	111,902	Weather
Met-Ed	6/17/2018	2,601	Cascading trees
Met-Ed	8/17/2018	18,766	Thunderstorms and high winds
PECO	11/2/2018	44,737	Thunderstorms and high winds
PECO	3/7/2018	191,272	Weather
PECO	5/2/2018	603,697	Weather
PECO	7/22/2018	55,681	Thunderstorms and high winds
PECO	7/3/2018	59,019	Thunderstorms and high winds
PECO	11/16/2018	27,699	Thunderstorms and high winds
Penelec	3/2/2018	90,856	Snow and wind
Penelec	4/4/2018	74,192	Weather
Penelec	5/15/2018	15,307	Weather
Penelec	5/4/2018	16,369	Thunderstorms and high winds
Penn Power	3/2/2018	8,688	Weather
Penn Power	11/16/2018	43,919	Thunderstorms and high winds
Pike	3/3/2018	2,101	Snow and wind
PPL	4/5/2018	51,721	Wind
PPL	4/15/2018	13,953	Rain and wind
PPL	7/23/2018	35,402	Rain and wind
PPL	3/2/2018	261,341	Wind
PPL	5/15/2018	121,963	Rain and wind
PPL	11/15/2018	15,673	Thunderstorms and high winds
West Penn	10/20/2018	9,424	Rain and wind
West Penn	3/2/2018	21,196	Weather
West Penn	4/4/2018	35,435	Weather
West Penn	5/15/2018	23,143	Weather
West Penn	5/4/2018	7,176	Thunderstorms and high winds
West Penn	5/15/2018	23,143	Weather
West Penn	11/15/2018	75,322	Thunderstorms and high winds

Table 3B –67.1 Reportable Outage Events Summary-2017

EDC	Date	Customers Affected	Cause
Duquesne	2/12/2017	19,735	Rain and high winds
Duquesne	3/1/2017	12,406	Thunderstorms and high winds
Duquesne	5/1/2017	47,548	Thunderstorms and high winds
Duquesne	6/13/2017	25,809	Thunderstorms and high winds
Duquesne	8/4/2017	20,799	Thunderstorms and heavy rain
Duquesne	11/19/2017	11,126	High winds- mesovortices
Met-Ed	2/12/2017	29,409	High winds
Met-Ed	2/25/2017	34,202	Thunderstorms and high winds
Met-Ed	3/1/2017	12,147	Thunderstorms and high winds
Met-Ed	3/10/2017	6,686	Suspected failed insulator on 34.5 kV line
Met-Ed	6/19/2017	27,711	Thunderstorms and high winds
Met-Ed	9/5/2017	47,610	Thunderstorms and heavy rain
Met-Ed	10/29/2017	18,315	High winds
PECO	1/23/2017	76,899	Rain and high winds
PECO	3/7/2017	39,124	Substation fire
PECO	6/21/2017	42,293	Thunderstorms and high winds
Penelec	2/12/2017	25,562	High winds
Penelec	3/1/2017	29,326	Thunderstorms and high winds
Penelec	3/8/2017	34,764	Thunderstorms and high winds
Penelec	5/1/2017	102,198	Thunderstorms and high winds
Penelec	5/5/2017	12,668	NYSEG 115 kV line failure
Penelec	6/18/2017	39,736	Thunderstorms and high winds
Penelec	7/20/2017	12,268	Thunderstorms and high winds
Penelec	8/4/2017	14,163	Thunderstorms and heavy rain
Penelec	8/19/2017	25,674	Thunderstorms and heavy rain
Penelec	11/5/2017	16,641	Thunderstorms and heavy rain
Penn Power	3/8/2017	16,557	Thunderstorms and high winds
Penn Power	5/1/2071	11,249	Thunderstorms and high winds
PPL	2/12/2017	19,429	High winds
PPL	2/25/2017	22,239	High winds
PPL	3/1/2017	12,649	Thunderstorms and high winds
PPL	3/27/2017	8,972	Transmission line crossarm failed during storm
PPL	5/1/2017	25,741	Thunderstorms and high winds
PPL	5/5/2017	16,343	Thunderstorms and high winds
PPL	9/5/2017	14,895	Thunderstorms and heavy rain
PPL	10/29/2017	36,521	High winds
PPL	11/19/2017	9,613	High winds
PPL	7/20/2017	7,530	Thunderstorms and high winds
Wellsboro	5/6/2017	6,341	Failed substation bus insulator
West Penn	2/8/2017	13,802	Snow and wind
West Penn	2/12/2017	27,067	High winds
West Penn	3/1/2017	33,836	Thunderstorms and high winds
West Penn	3/8/2017	28,404	Thunderstorms and high winds
West Penn	5/1/2017	77,458	Thunderstorms and high winds
West Penn	6/23/2017	18,595	Thunderstorms and high winds
West Penn	7/28/2017	19,901	Thunderstorms and heavy rain
West Penn	8/4/2017	41,924	Thunderstorms and high winds
West Penn	8/19/2017	10,773	Thunderstorms and heavy rain
West Penn	8/22/2017	25,888	Thunderstorms and heavy rain
West Penn	11/18/2017	19,414	High winds

Table 3C – 67.1 Reportable Events 1993-2018

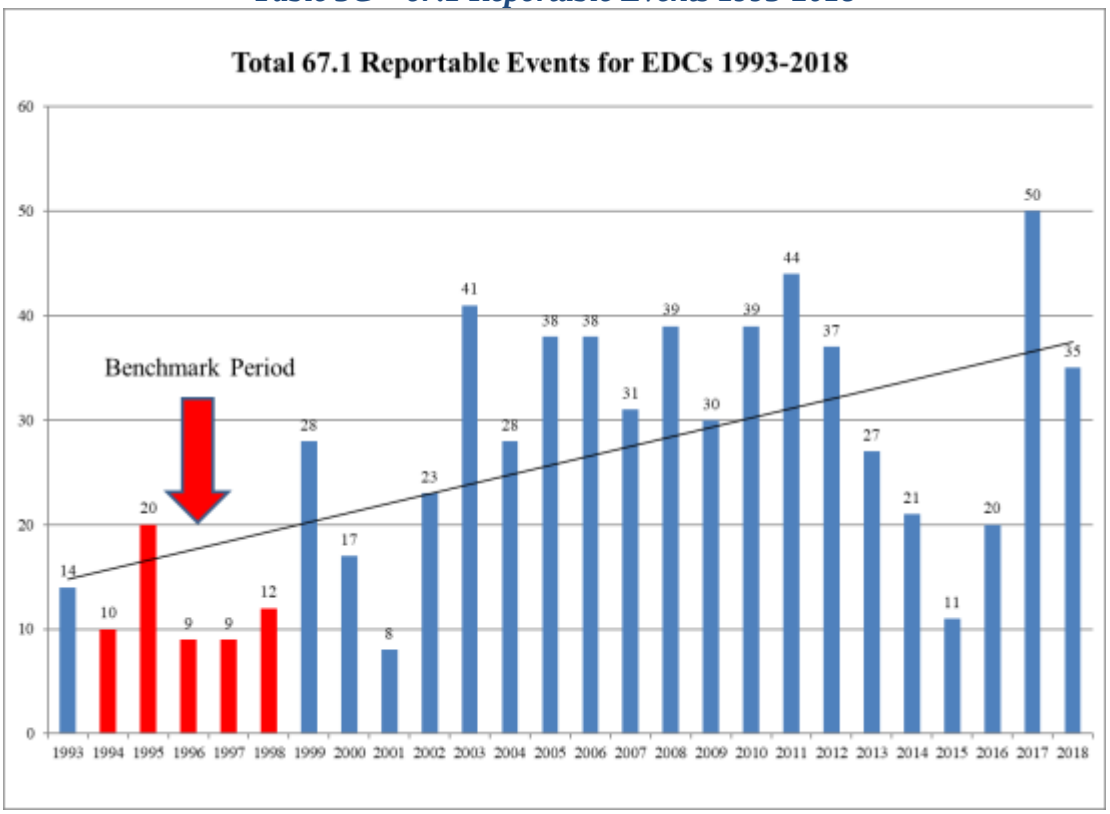


Table 3D – Total Customers Affected by 67.1 Reportable Events 1993-2018

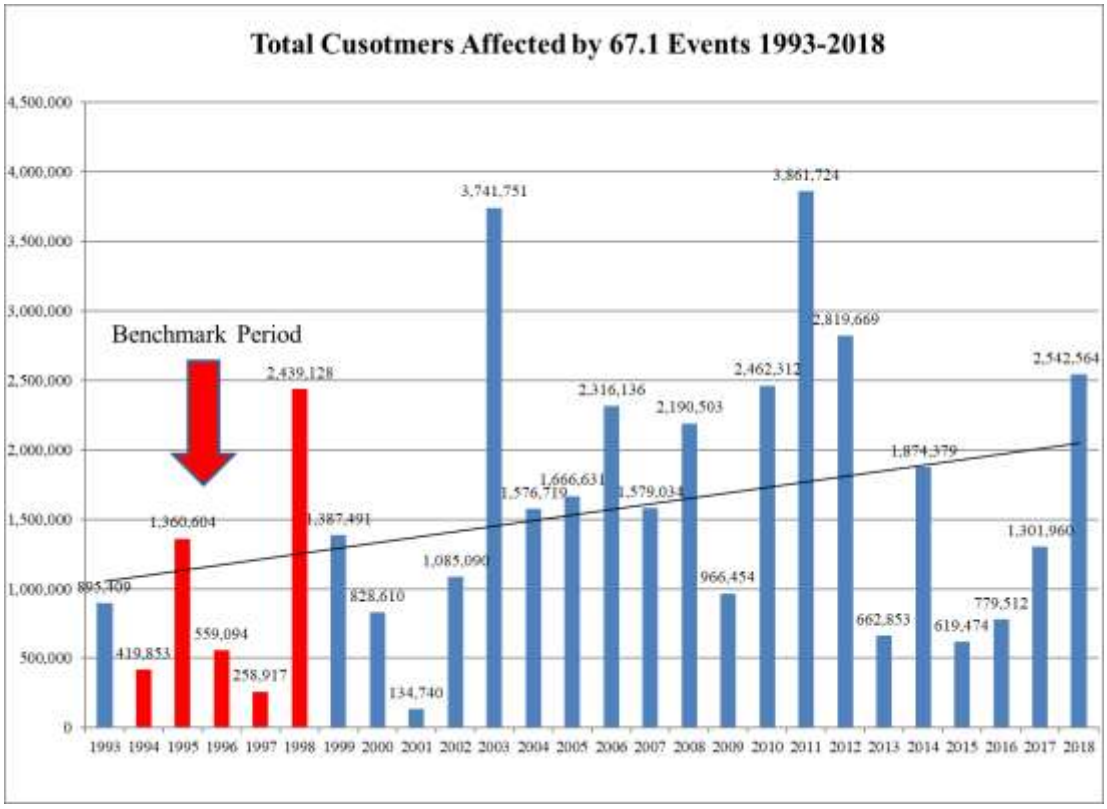
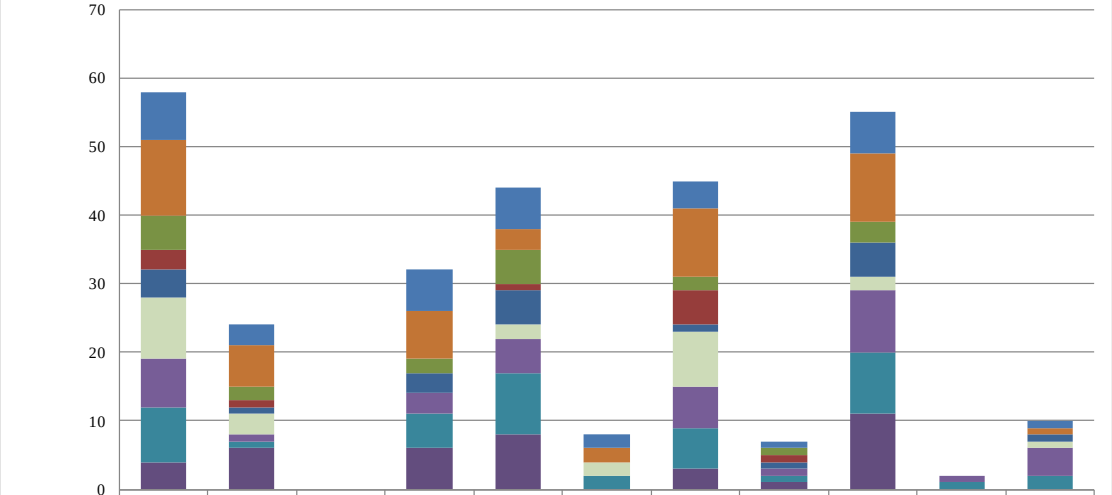


Table 3E –67.1 Reportable Events by EDC 2010-2018



	West Penn	Duquesne Light	Citizens Electric	Met Ed	PECO	Penn Power	Penelec	Pike County (O&R)	PPL	UGI Electric	Wellsboro
Total 2018	7	3	0	6	6	2	4	1	6	0	1
Total 2017	11	6	0	7	3	2	10	0	10	0	1
Total 2016	5	2	0	2	5	0	2	1	3	0	0
Total 2015	3	1	0	0	1	0	5	1	0	0	0
Total 2014	4	1	0	3	5	0	1	1	5	0	1
Total 2013	9	3	0	0	2	2	8	0	2	0	1
Total 2012	7	1	0	3	5	0	6	1	9	1	4
Total 2011	8	1		5	9	2	6	1	9	1	2
Total 2010	4	6		6	8	0	3	1	11	0	0

Major Events

The resilience of Pennsylvania's electrical system in 2018 was challenged with a substantial amount of weather storm activity. Pennsylvania customers were significantly adversely affected with almost **2.7 billion customer-minutes** lost to major storm events in 2018 that are excludable from EDC's reliability indices. In 2018, there were 29 Major Event exclusion requests filed with 27 approved (the 2 denied requests by West Penn and Met-Ed are under appeal). For comparison there were 13 Major Event exclusion requests granted in 2017, and 11 in 2016.

Major Event for 2018, 2017, and 2016 are shown below in Tables 4A, 4B, and 4C below. In 2018, there were **2,660,824,314 customers-minutes** interrupted due to Major Events. Most were caused by trees falling onto the distribution system infrastructure during storm events. In 2017, there were **135,024,798 customers-minutes** interrupted due to Major Events, and in 2016 there were only **5,988,696 customers-minutes** interrupted**.**

Table 4A – 2018 Major Events

EDC	Date	Customers Affected	Cause	Total Customer Minutes Interrupted
Citizens	3/2/2018	1,541	Winter Storm Riley	84,788
Citizens	5/15/2018	2,535	Rain and Wind	259,570
Citizens	7/21/2018	1,026	Ash Tree	94,797
Citizens	8/4/2018	1,022	Ash Tree	77,216
Citizens	9/10/2018	2,172	12 kV Bus Raccoon Fault	293,140
Citizens	11/15/2018	7,003	Snow and Ice	838,839
Duquesne	11/15/2018	63,344	Winter Storm Avery	106,227,566
Met-Ed	1/23/2018	408	Flood Waters	669,120
Met-Ed	3/2/2018	273,398	Winter Storm Riley	580,726,537
Met-Ed	5/15/2018	111,894	Thunderstorm and Winds	79,685,165
Met-Ed	7/21/2018	62,511	Excessive Rain	9,869,127
PECO	3/2/2018	603,697	Winter Storm Riley	746,216,384
PECO	3/7/2018	191,272	Winter Storm Quinn	115,649,601
Penelec	1/12/2018	187	Flood Waters	230,799
Penelec	3/1/2018	76,703	Winter Storm Riley	24,639,302
Penelec	8/13/2018	2,863	Flood Waters	3,444,136
Penelec	4/3/2018	62,262	Rain and Wind	13,104,058
Penn Power	1/18/2018	2,456	Proactive Low Voltage Interruption	2,988,702
Penn Power	6/23/2018	24,867	Conductor Fault	312,737
Penn Power	11/15/2018	43,919	Winter Storm Avery	42,702,369
Pike	3/2/2018	2,101	Winter Storm Riley/Quinn	422,777,649
Pike	9/6/2018	2,680	Orange & Rockland Lightning Strike	1,628,082
PPL	3/2/2018	261,341	Winter Storm Riley/Quinn	355,173,459
Wellsboro	7/22/2018	6,433	Fallen Tree (Penelec 34.5 issue)	1,627,549
Wellsboro	12/1/2018	947	34.5 kV FirstEnergy line disruption	143,803
West Penn	2/15/2018	2,947	Flood Waters	1,602,386
West Penn	6/20/2018	1,122	Flood Waters	4,012,943
West Penn	9/8/2018	72,408	Rain and Wind	19,429,879
West Penn	11/15/2018	75,322	Winter Storm Avery	126,314,611
	Totals	**1,960,381**	**Totals**	**2,660,824,314**

Table 4B – 2017 Major Events

EDC	Date	Customers Affected	Cause	Total Customer Minutes Interrupted
Citizens	5/27/2017	1,015	Squirrel	77,248
Citizens	7/3/2017	1,411	Squirrel	84,660
Citizens	7/4/2017	1,411	Squirrel	126,990
Citizens	9/30/2017	6,995	Wind	83,832
Penelec	5/1/2017	95,607	Rain and high winds	74,396,630
Penelec	7/23/2017	1,111	Flood waters	513,839
Penn Power	3/8/2017	16,557	Snow and wind	5,402,116
Penn Power	11/5/2017	19,298	Thunder Storm and wind	3,493,432
Pike	2/13/2017	786	Snow and wind	55,432
Wellsboro	5/6/2017	6,341	Substation bus insulator failure	1,166,744
West Penn	5/1/2017	77,458	Thunderstorms and high winds	45,309,142
West Penn	6/23/2017	1,665	Flood waters	1,745,883
West Penn	7/28/2017	3,748	Flood waters	2,568,850
	Totals	**233,403**	**Totals**	**135,024,798**

Table 4C – 2016 Major Events

EDC	Date	Customers Affected	Cause	Total Customer Minutes Interrupted
Citizens	3/30/2016	1,409	Three phase polymer insulator failed	132,895
Citizens	11/8/2016	1,008	homeowner cut down tree into line	41,468
Citizens	11/19/2016	1,833	Rain and high winds	248,388
Penelec	11/2/2016	1,794	Flash Flood near Ralston	1,804,107
Pike County	2/16/2016	1,795	Mylar baloons caught in power line	10,770
Pike County	2/24/2016	1,067	Rain and high winds	185,055
Pike County	8/13/2016	627	Rain and high winds	474,908
Pike County	9/19/2016	2,518	Motor vehicle hit utility pole	1,476,882
Wellsboro	4/3/2016	2,015	Rain and high winds	362,700
Wellsboro	8/8/2016	897	Bear in conductors	56,511
Wellsboro	12/26/2016	6,097	Transmission line failure	1,195,012
	Totals	**21,060**	**Totals**	**5,988,696**

Review of Multiple Long-Duration Outage Events

Two Nor'easter winter events during the first week of March 2018 significantly impacted the Commonwealth of Pennsylvania and EDCs. The first storm (Winter Storm Riley) began on Thursday, March 1, 2018 and lasted until Saturday, March 3, 2018. To make conditions worse, as the EDCs were continuing their restoration efforts in some areas of Pennsylvania, on March 7, 2018, a second winter storm (Winter Storm Quinn) delivered additional heavy, wet snow, and high winds into the Commonwealth.

The first storm, Riley, was a powerful storm producing high wind gusts up to 60 mph, and rain that changed into heavy, wet snow throughout Pennsylvania. The biggest impacts from Riley were experienced in the Southeastern, Eastern, and Northeastern regions of the Commonwealth (Greater Philadelphia area, Lehigh Valley, and the Pocono Mountains). The saturated soils, heavy snow, and high winds caused downed trees and power lines, infrastructure damages, and widespread

transportation issues. These conditions caused approximately 680,000 electric customer outages at the peak, which occurred at approximately 11:00 PM on March 2, 2018. When Quinn entered the Commonwealth on March 7, 2018, it produced wind gusts up to 25 mph and additional snowfall accumulations of up to 14 inches in the same areas trying to recover from the first storm. In many areas, electric restoration efforts were still occurring from Riley. While the electric outages caused by Quinn were generally much less severe than Riley, it certainly complicated and prolonged restoration efforts in most areas. Quinn was most impactful in PECO's service territory where the company experienced up to 100,000 outages.

For the detailed Commission report on these storms, including the 12 recommendations developed by TUS, please visit the below web link:

http://www.puc.pa.gov/Electric/pdf/Winter_Storm_Riley_Quinn_Report_2019.pdf

Section 4 –EDC Reliability Performance Data

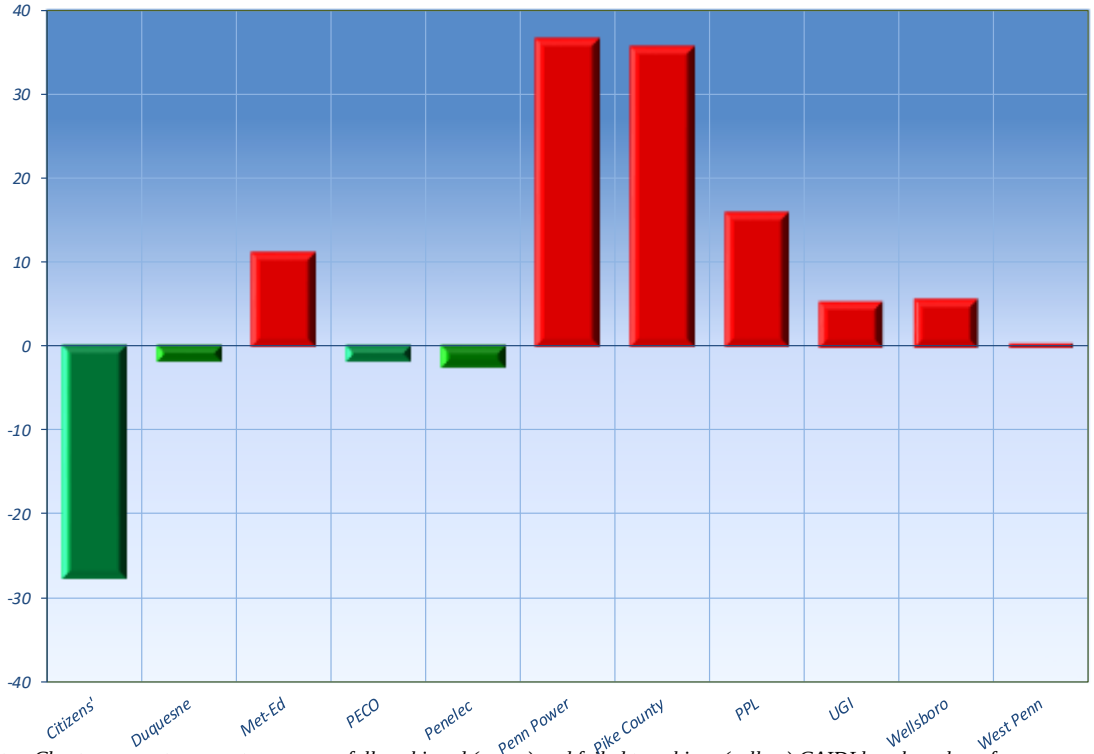
Statewide Summary

Rolling 12-month Benchmark Performance Compliance

The 2018 end of year reliability data for 12-month performance compliance submitted by the 11 EDCs indicates:

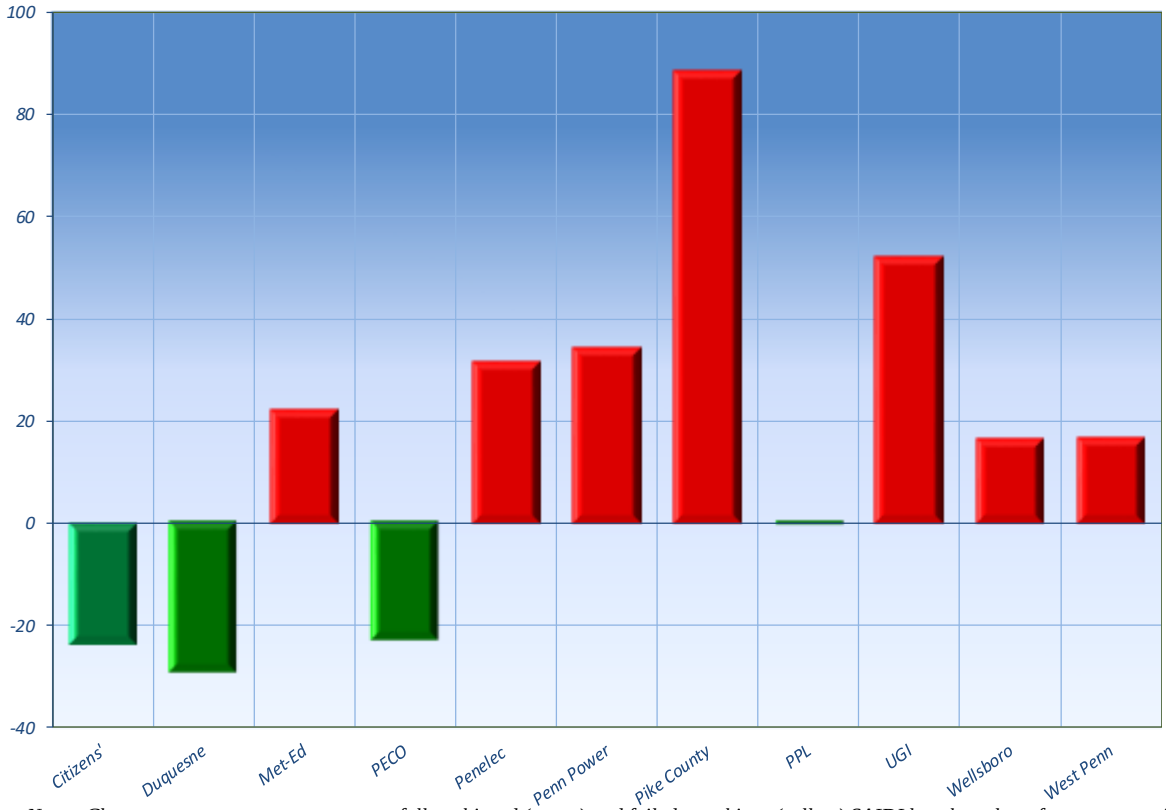
- 4 EDCs achieved the CAIDI benchmark, while 7 EDCs failed to achieve the CAIDI benchmark (Figure 1).
- 4 EDCs achieved the SAIDI benchmark, while 7 EDCs failed to achieve the SAIDI benchmark (Figure 2).
- 4 EDCs achieved the SAIFI benchmark, while 7 EDCs failed to achieve the SAIFI benchmark (Figure 3).

Figure 1 – 2018 CAIDI Comparison (percent above or below benchmark)



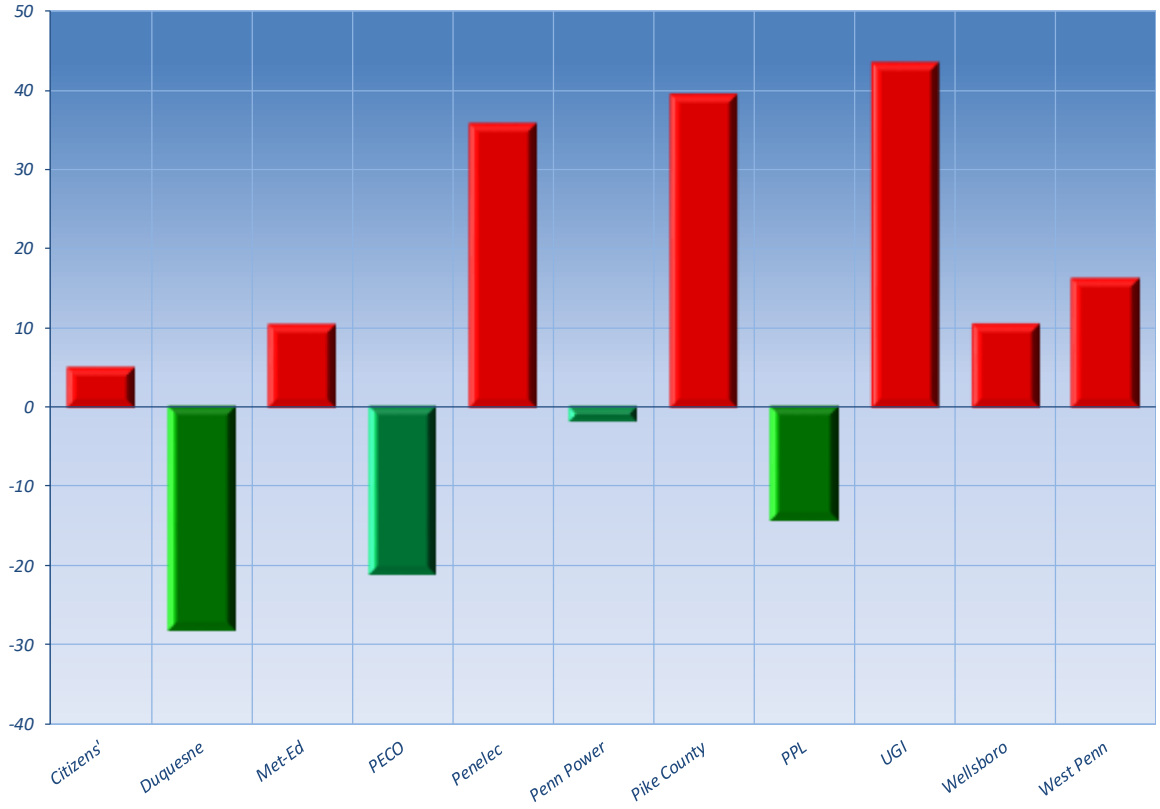
Note: Chart represents percentage successfully achieved (green) and failed to achieve (yellow) CAIDI benchmark performance metric.

Figure 2 – 2018 SAIDI Comparison (percent above or below benchmark)



Note: Chart represents percentage successfully achieved (green) and failed to achieve (yellow) SAIDI benchmark performance metric.

Figure 3 – 2018 SAIFI Comparison (percent above or below benchmark)



Note: Chart represents percentage successfully achieved (green) and failed to achieve (yellow) SAIFI benchmark performance metric.

Rolling 3-year Average (2016-2018) Performance Compliance

Appendix A provides the 2018 results for the 12-month average and 3-year average reliability performance metrics for individual EDCs.

4 EDCs (Citizens, Met-Ed, Penn Power, and Pike County) failed to meet the rolling 3-year CAIDI performance standard.

5 EDCs (Citizens, Met-Ed, Penelec, Wellsboro, and West Penn) failed to meet the rolling 3-year SAIFI performance standard.

5 EDCs (Citizens, Met-Ed, Penelec, Penn Power, and Pike County) failed to meet the rolling 3-year SAIDI performance standard.

Utility-Specific Performance Data

The Commission compares reliability metrics on a quarterly basis, using data obtained for the preceding 12 months. This periodic assessment determines the status of electric service reliability on an ongoing basis and is instrumental in identifying negative trends. The 3-year average performance is measured at the end of each calendar year, using the average of the past 3 end-year metrics, as indicated in Appendix A. The following sections provide a detailed description of the 11 EDCs' individual reliability performance on a rolling 12-month and 3-year average basis.

Duquesne Light Company

Duquesne has a service territory of about 817 square miles with a well-developed distribution system serving about 590,000 customers.

In 2018, Duquesne experienced 6.1 million kilovolt-amps (kVA) customer interruptions and 647 million kVA-minutes of customer-minutes interrupted as compared to 7.1 million kVA of customer interruptions and 813 million kVA-minutes of customer-minutes interrupted in 2017; and 5 million kVA of customer interruptions and 497 million kVA-minutes of customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Decreased from 115 minutes in 2017 to 106 minutes in 2018; achieved benchmark by 1.9%.

3-year average: Increased from 106 minutes in 2017 to 107 minutes in 2018; achieved standard by 10 %.

SAIDI

Rolling 12-month: Decreased from 112 minutes in 2017 to 89 minutes in 2018; achieved benchmark by 29%.

3-year average: Increased from 84 minutes in 2017 to 90 minutes in 2018; achieved standard by 41 %.

SAIFI

Rolling 12-month: Decreased from 0.98 outages in 2017 to 0.84 outages in 2018; achieved benchmark by 28%.

3-year average: Increased from 0.79 outages in 2017 to 0.84 outages in 2018; achieved standard by 35%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 4 and 5. During the past 3 years, Duquesne's CAIDI performance trend has been frequently negative, as seen in Figure 4. However, the December 2018 data point is below the benchmark performance upper-control-limit-line. The last 3-year CAIDI performance may be indicative that management attention is needed to address the inconsistent CAIDI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Beginning in December 2004, Duquesne's SAIFI Benchmark performance trend has been positive, as shown in Figure 5. This positive performance trend, below the benchmark performance upper-control-limit-line, has been sustained since 2004 by Duquesne, and is considered under control. Duquesne is considered an excellent SAIFI Benchmark Performer.

Outage Causes

Figure 6 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: KVA Minutes Interrupted, KVA Interrupted, and Number of Incidents. Trees were the top cause of outages and customer-minutes interrupted. Over 60% of outages are caused by trees, which includes the following: trees falling, trees in contact with distribution system, and tree damage during storms.

Figure 7 shows historical trend of the top 3 main outage causes. Trees and equipment failure are the 2 most frequent outage causes that are significantly negatively affecting Duquesne's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

Duquesne continues its reliability management work programs and resilience storm hardening activities. Duquesne has an enhanced rights-of-way vegetation management maintenance program that is designed to reduce outages and to continue targeting off right-of-way danger trees.

Duquesne installed an additional 24 automatic 3-phase sectionalizers and reclosers that divide each circuit into distinct load blocks of approximately 250-600 customers each. Also, as of May 2019, Duquesne's pulse-recloser fault protection and sectionalizing has increased to 162 circuits as compared to 104 circuits in 2018, and 98 circuits in 2017. This type of recloser reduces the stress on the circuit components during a fault event, thereby reducing component damage and outage restoration times.

Sectionalizers and reclosers used on Duquesne Light's 23kV distribution system are continuously monitored over a wireless network to its centralized Distribution Operations Center (DOC). Circuit problems are immediately annunciated at the DOC where operators quickly take action to relieve overloads or isolate faults and reroute power to customers on non-faulted load blocks. Generally, when an outage occurs, DOC operators have the actual fault isolated from the rest of the circuit and all downstream customers are restored within five minutes. This automation and remote monitoring also help operators pinpoint the actual faulted load block so field crews can be directed to the failure location more quickly in order to begin repairs.

In late spring 2018, Duquesne began utilizing a software package called CYME v8.1 CYMDIST ("CYMDIST"). With CYMDIST, planning engineers can perform several types of analysis on balanced or unbalanced 3-phase, 2-phase, and single-phase systems that are operated in radial, looped, or meshed configurations. From a reliability standpoint, it has been used to correct phase imbalance, better coordinate fusing, identify overloaded equipment, and alleviate voltage concerns across the 4 kV and 23 kV distribution systems.

Duquesne is also installing new capacitor control boxes that allow for additional information to be remotely monitored and additional setpoints to be used to better increase effectiveness.

Duquesne Light is currently in the process of updating all remotely monitored devices from a 3G network to a 4G network. This has increased the communication reliability to its remotely monitored devices.

Duquesne completed various capacity upgrades in 2018 that upgraded lines, transformers, and substation infrastructure. Duquesne has also committed to the installation of an outage management system (OMS) that in the future will provide customers with more accurate restoration information and improve storm restoration execution. Duquesne also utilizes Infrared Inspection on 20% of distribution circuits each year.

Duquesne Light is a participant in the Spare Transformer Equipment Program (STEP) program managed by Edison Electric Institute (EEI). Additionally, in 2018, Duquesne committed to participate in the Regional Equipment Sharing for Transmission Outage Restoration or RESTORE program, which establishes a proactive approach to providing critical equipment for utilities that need additional resources during disaster recovery and does not replace existing programs or agreements already in place.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to Duquesne customers. In 2018, trees and equipment failure outage causes contributed to over 60% of the total lost customer-minutes interrupted (Duquesne uses kVA-minutes interrupted) and does not include any lost customer-minutes caused by Major Events.

Duquesne experienced 1 Major Event during winter where Duquesne customers experienced a loss of **316,283,090 customer-minutes interrupted**.

CAIDI performance since the second quarter of 2017 has become erratic and needs management attention to sustain CAIDI performance below the “green” benchmark performance upper-control-limit-line. Duquesne has sustained SAIFI benchmark from 2004 through 2018 and is considered an excellent SAIFI benchmark performer

Figure 4 Duquesne CAIDI (minutes)

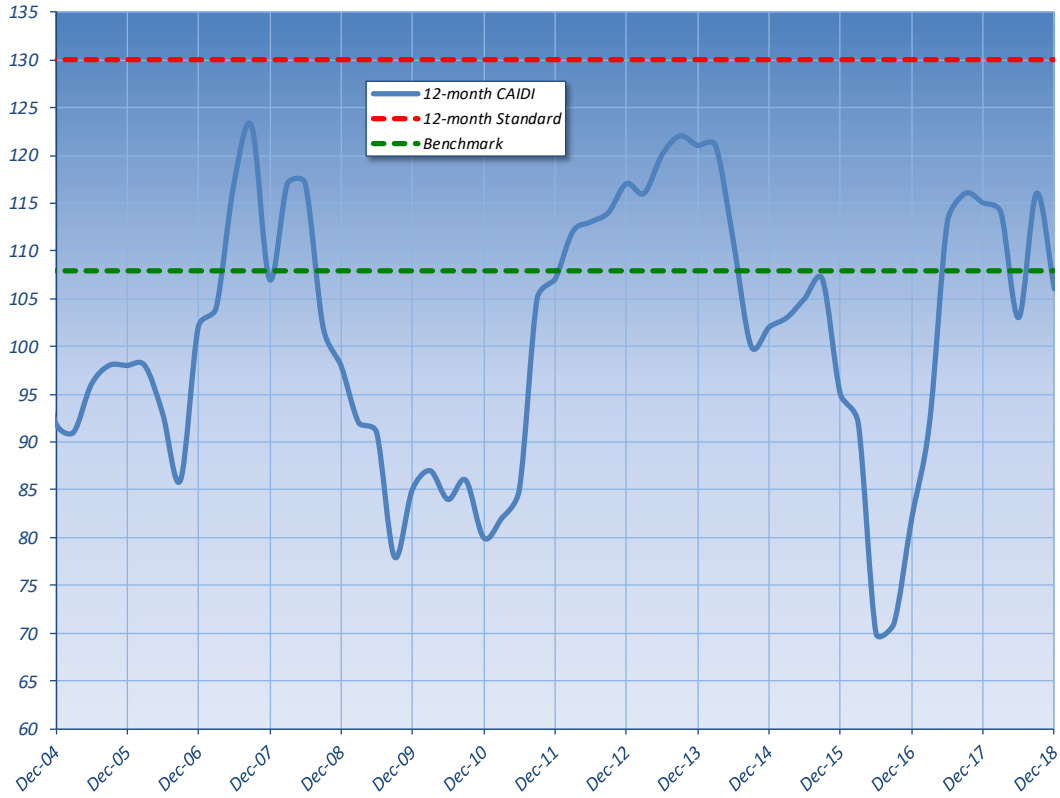


Figure 5 Duquesne SAIFI (Interruptions Per Customer)

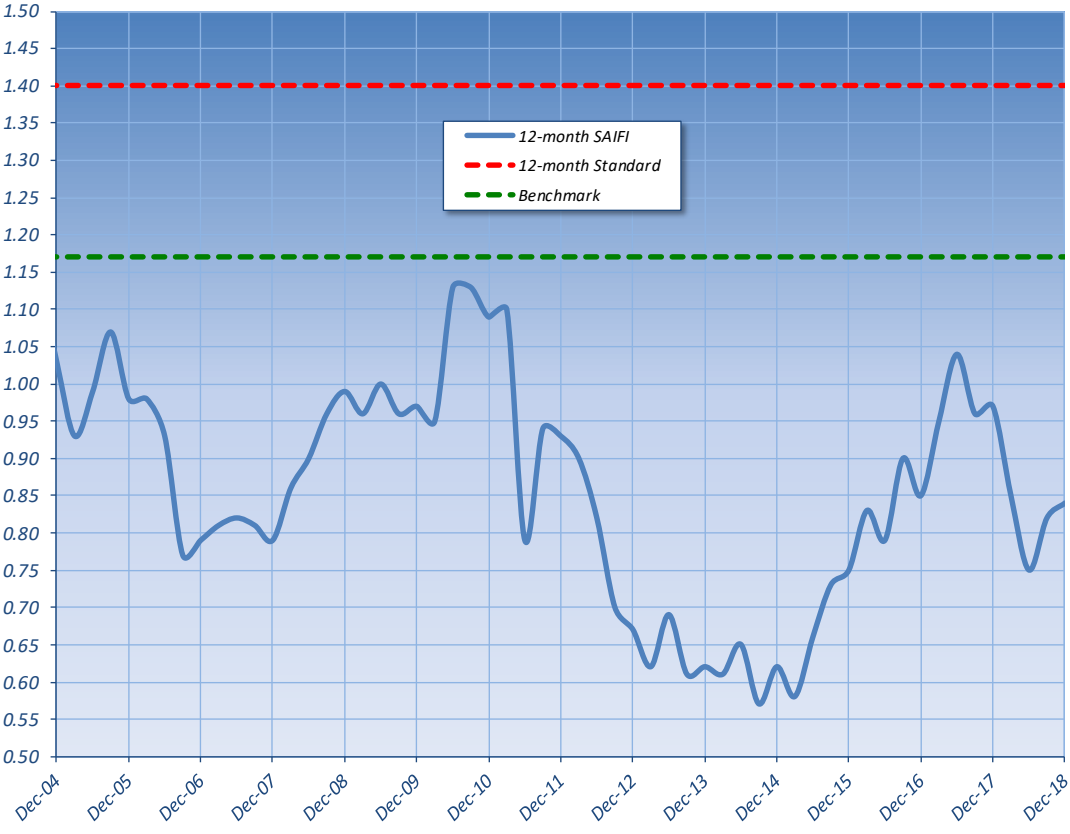


Figure 6 Duquesne Outage Causes (percent of total outages)

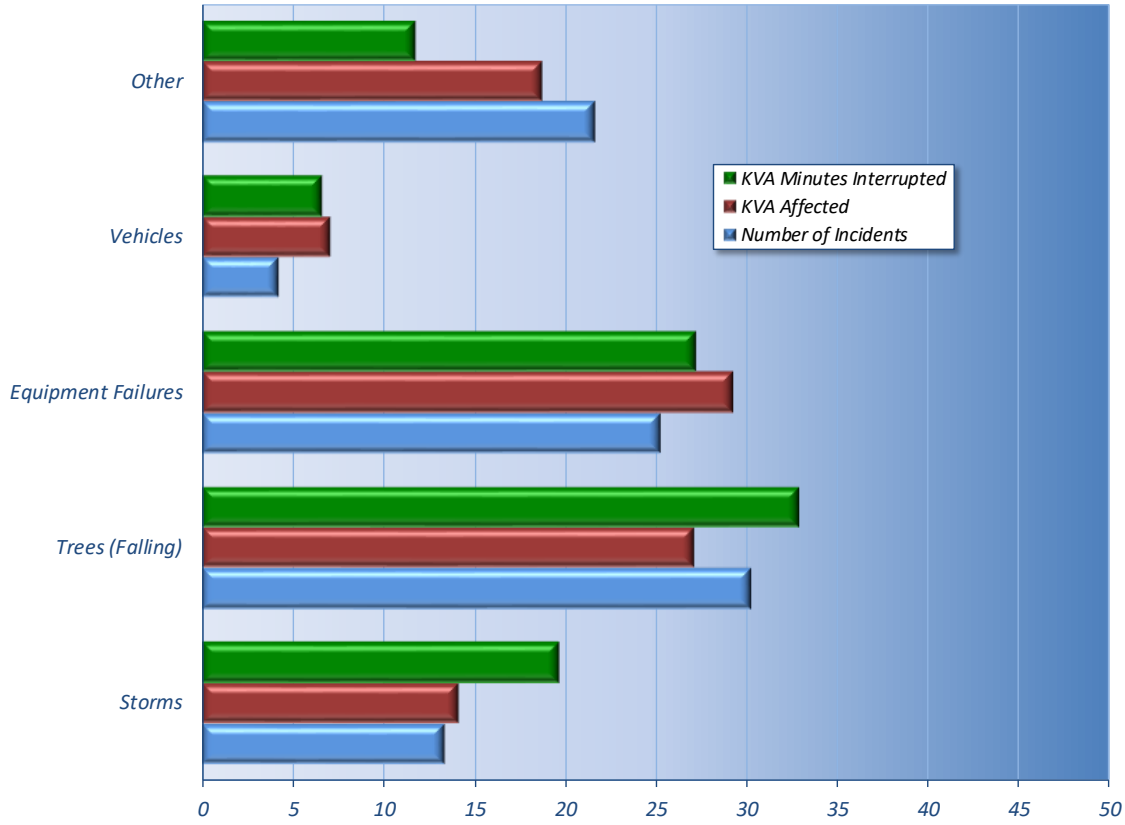
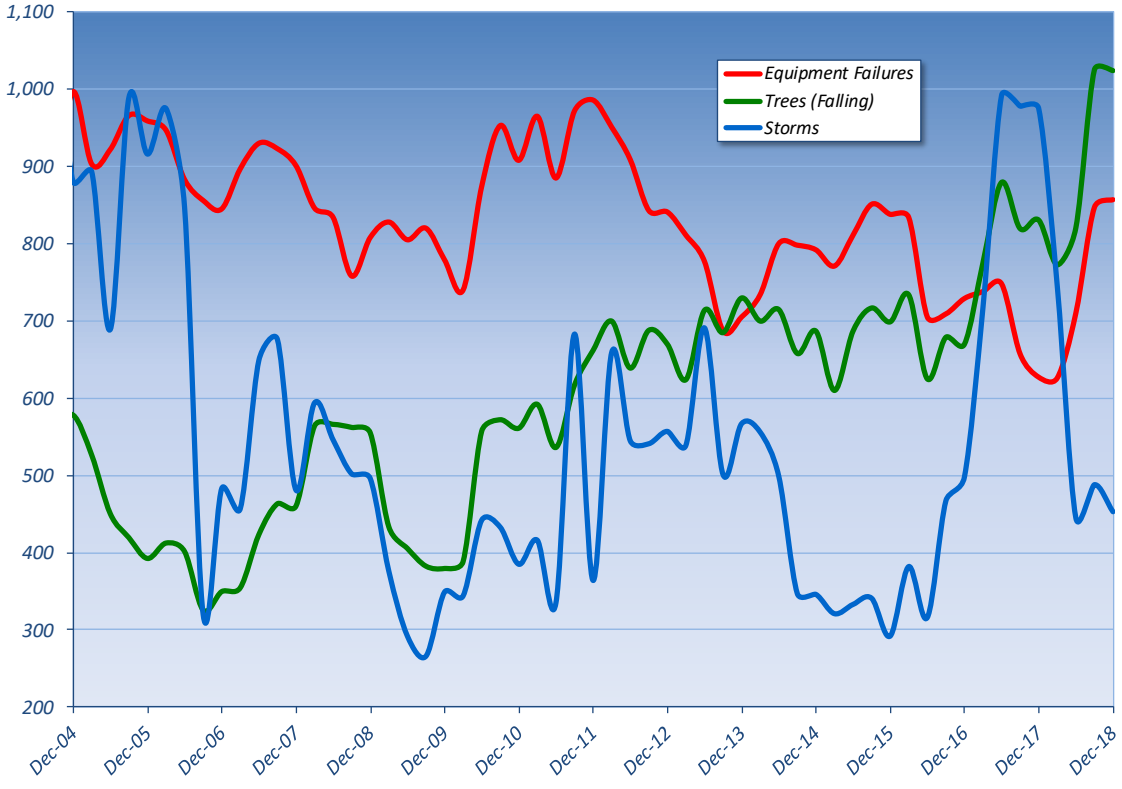


Figure 7 Duquesne Outage Tracking (number of incidents)



PECO Energy Company

PECO has a service territory of about 2,100 square miles that serves a well-developed distribution system serving about 1.7 million customers.

In 2018, PECO experienced 1.59 million customers interruptions and 174.6 million customer-minutes interrupted as compared to 1.35 million customer interruptions and 134.0 million customer-minutes interrupted in 2017, and 1.62 million customer interruptions and 171.6 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Increased from 99 minutes in 2017 to 110 minutes in 2018; achieved benchmark by 2%.

3-year average: Increased from 96 minutes in 2017 to 105 minutes in 2018; achieved standard by 15%.

SAIDI

Rolling 12-month: Increased from 82 minutes in 2017 to 106 minutes in 2018; achieved benchmark by 23%.

3-year average: Increased from 83 minutes in 2017 to 98 minutes in 2018; achieved standard by 41%.

SAIFI

Rolling 12-month: Increased from 0.83 outages in 2017 to 0.97 outages in 2018; achieved benchmark by 21%.

3-year average: Increased from 0.85 outages in 2017 to 0.93 outages in 2018; achieved standard by 31%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 8 and 9. Beginning in December 2012, PECO's CAIDI Benchmark performance trend has been positive, as shown to be below the "green" benchmark performance upper-control-limit-line. This positive performance trend, below the benchmark performance upper-control-limit-line, has been consistently sustained by PECO, and is considered under control. PECO is considered an excellent CAIDI Benchmark Performer.

Beginning with December 2012, PECO's SAIFI Benchmark performance trend has been positive, as shown on the chart to be below the "green" benchmark performance upper-control-limit-line. This positive performance trend, below the benchmark performance upper-control-limit-line, has been consistently sustained by PECO, and is considered under control. PECO is considered an excellent SAIFI Benchmark Performer.

Outage Causes

Figure 10 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Equipment failure was the top cause of outages and customer-minutes interrupted. The most frequent outage cause is equipment failure, which is about 42% of outage causes, followed by tree related (includes vegetation in-growth and vegetation broken/uprooted) outages at about 25%.

Figure 11 shows historical trend of the top 3 main outage causes. Equipment failure and trees are the 2 most frequent outage causes that are significantly negatively affecting PECO's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

In 2018, PECO continued storm hardening activities through infrastructure improvements and enhanced vegetation management. PECO installed more than 52 miles of tree resistant wire in 2018 as compared to 45 miles in 2017, in areas impacted by high incidences of vegetation-related outages. PECO also removed more than 4,500 priority trees in 2018 as compared to 3,000 priority trees in 2017, which should enhance system performance and reduce service interruptions.

Winter storms Riley and Quinn in March 2018 interrupted over 790,000 customers and 861,865,985 customer-minutes were interrupted during this event. It should be noted the data from these Major Events are not counted against reliability metrics.

PECO did perform an after-major-storms-event formal "lessons learned" review to evaluate planning and response efforts to determine what worked well and what could be improved. Several initiatives have already been implemented based on recent lessons learned evaluations, including:

- In early 2017, PECO developed, installed, and tested the capability to dispatch crews "remotely," from areas other than the main dispatch locations. This improvement was meant to increase dispatch capability to effectively communicate and more timely dispatch restoration crews. The first time this system was activated was during winter storms Riley and Quinn and was considered an improvement.

- PECO acquired 3 new Mobile Command Centers, to increase the capability to set-up command and control operations and dispatch crews directly from the storm damaged areas.

- PECO implemented a new direct computer interface with Chester County and Delaware County 911 Centers to reduce the number of phone calls needed during a storm event. Also, PECO has begun working on an interface with Montgomery County; and considering similar interfaces with Bucks and Philadelphia Counties, but have not yet been pursued by the County EMAs.

- In 2018, PECO added a second Weather Service provider, to compare and contrast forecast accuracy, and enhance system damage predictions.

- In 2019, PECO acquired a new software package to assist in the management of Mutual Assistance resources.

PECO's Long-Term Infrastructure Improvement Plan (LTIIP), or "System 2020" plan, was approved by the Commission on Oct 22, 2015.[27] Under the System 2020 Plan, PECO will spend an additional $274 million through 2020 on system resiliency and storm hardening system improvements. These investments are in 3 key areas: storm hardening and resiliency measures; accelerated cable replacements; and the acceleration of a plan to retire building substations and to upgrade the distribution facilities supplied by those substations. Accelerated spending in the replacement of aging infrastructure should overtime, reduce the number of outages caused by equipment failure.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to PECO customers. In 2018, trees and equipment failure outage causes contributed to over 72% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

PECO experienced 2 Major Events during the winter of 2018 where PECO customers experienced a loss of **861,865,985 customer-minutes interrupted**. It appears the frequency of weather events are negatively affecting PECO's overall reliability and resilience performance.

PECO has sustained CAIDI and SAIFI benchmark performance since 2006 and 2011, respectively, and is considered an excellent CAIDI and SAIFI benchmark performer. However, it should also be noted that Major Events had a significant negative impact on PECO customers that is not reflected in CAIDI and SAIFI performance metrics, and the 2018 are beginning to trend in a more negative direction.

[27] Order entered on Oct 22, 2015, at Docket No. P-2015-2471423.

Figure 8 PECO CAIDI (minutes)

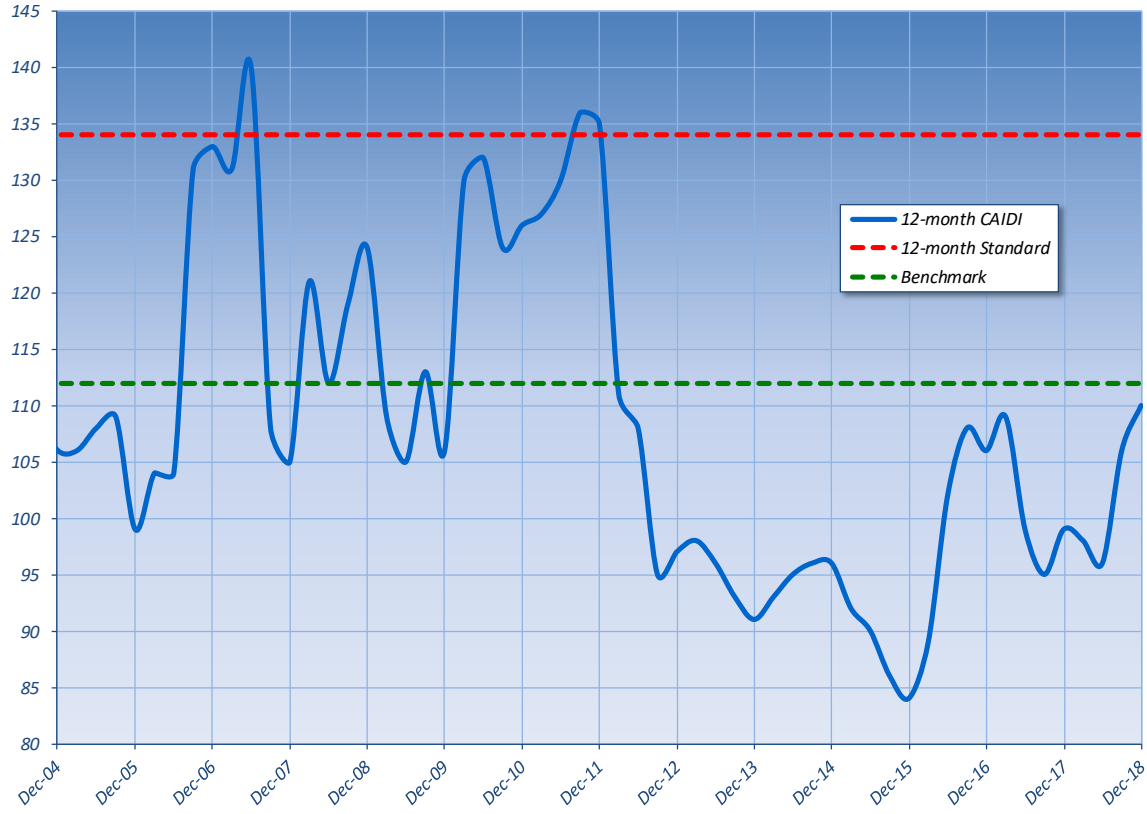


Figure 9 PECO SAIFI (interruptions per customer)

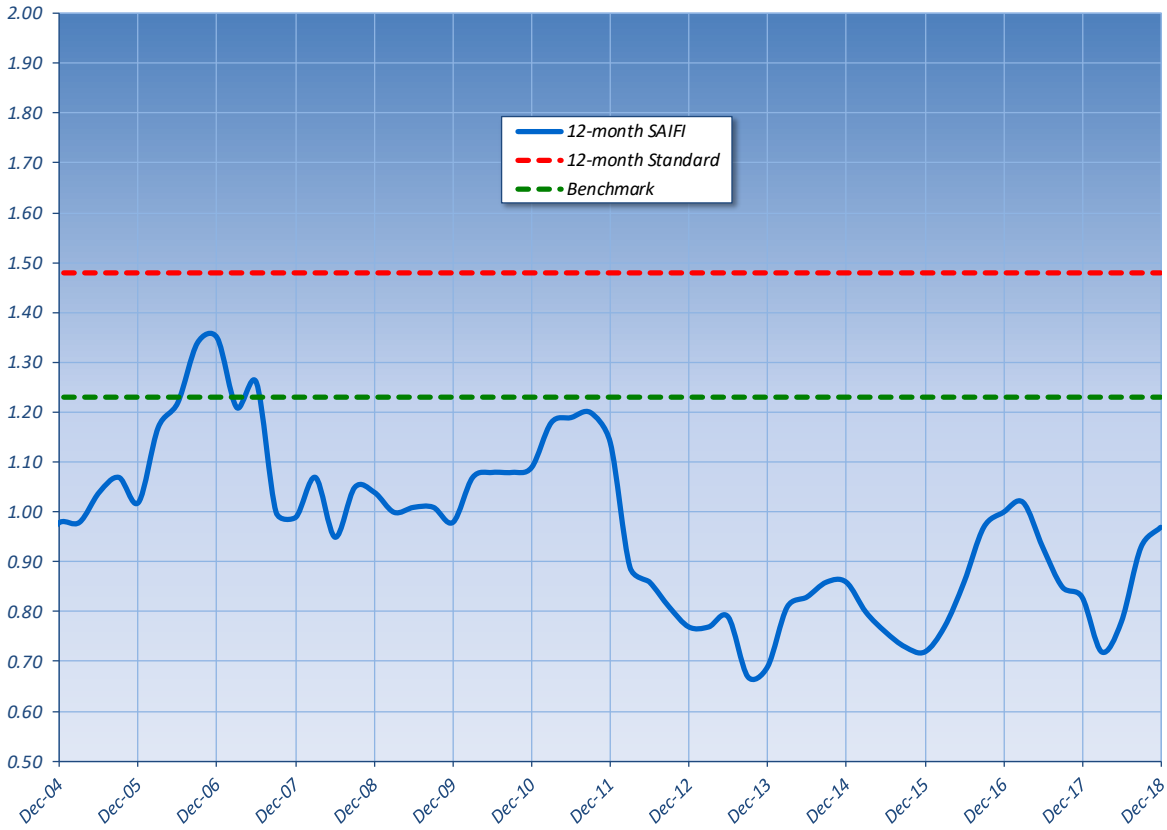


Figure 10 PECO Outage Causes (percent of total outages)

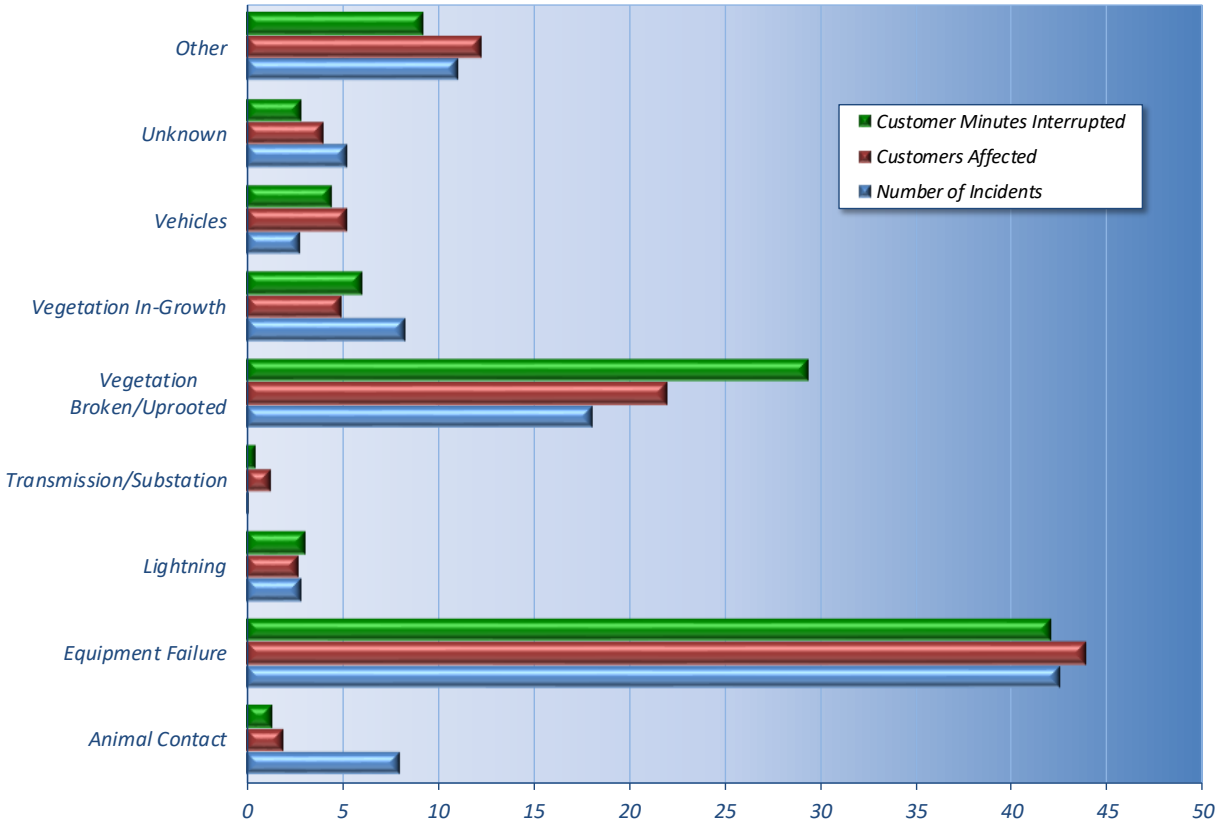
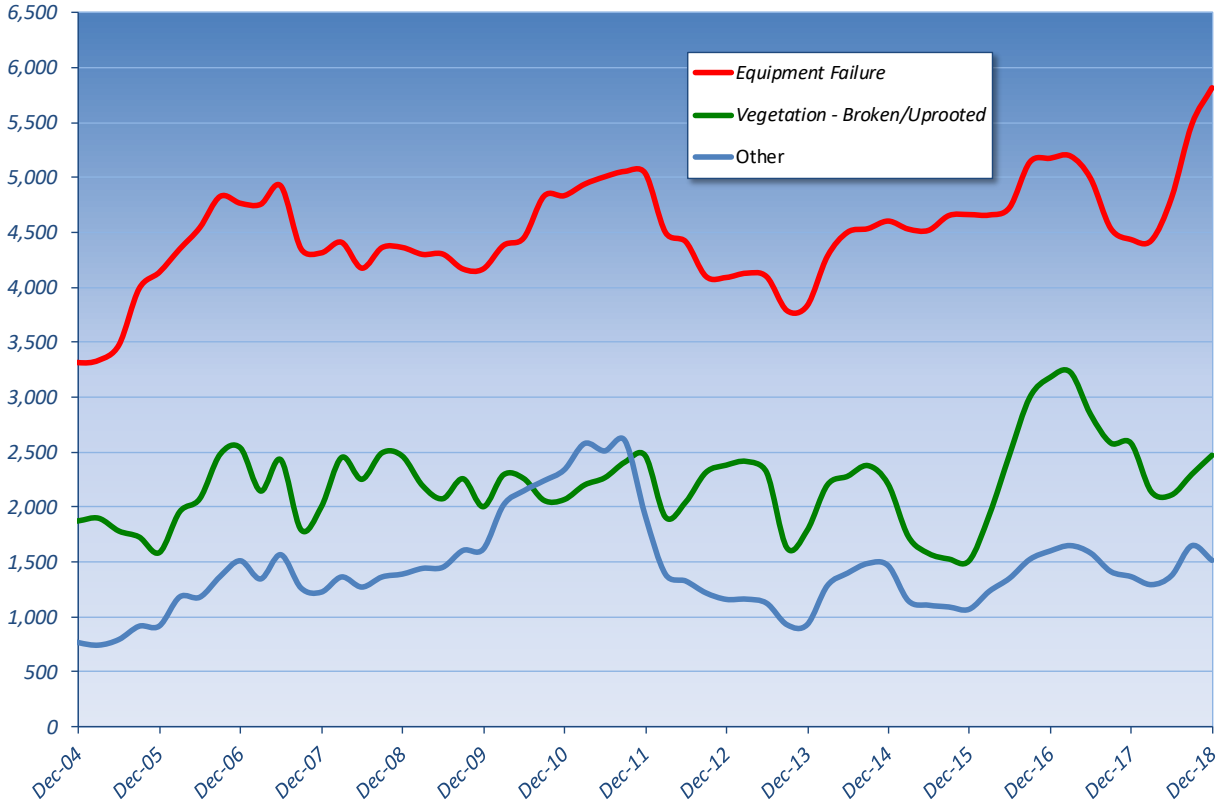


Figure 11 PECO Outage Tracking (number of incidents)



PPL Electric Utilities Corporation

PPL has a service territory of about 10,000 square miles and serves 1.4 million customers.

In 2018, PPL experienced 1.2 million customers interruptions and 201.5 million customer-minutes interrupted as compared to 1 million customer interruptions and 147.2 million customer-minutes interrupted in 2017, and 1.1 million customer interruptions and 132.9 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Increased from 146 minutes in 2017 to 168 minutes in 2018; and failed to achieve benchmark by 16%.

3-year average: Increased from 128 minutes in 2017 to 145 minutes in 2018; achieved standard by 9%.

SAIDI

Rolling 12-month: Increased from 104 minutes in 2017 to 141 minutes in 2018; achieved benchmark by 1%.

3-year average: Increased from 94 minutes in 2017 to 113 minutes in 2018; achieved standard by 34%.

SAIFI

Rolling 12-month: Increased from 0.71 outages in 2017 to 0.84 outages in 2018; achieved benchmark by 14%.

3-year average: Increased from 0.74 outages in 2017 to 0.78 outages in 2018; achieved benchmark by 28%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 12 and 13. Beginning in 2004, PPL's CAIDI performance trend has been erratic, and in the 2nd rolling 12-month quarter of 2018 has spiked above both benchmark and standard upper-control-limit-lines. Beginning in 2004, PPL's CAIDI benchmark performance was achieved less than 50% of the time. It appears more management attention is needed to address the inconsistent CAIDI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Beginning in December 2013, PPL's SAIFI Benchmark performance trend has been positive, as shown on the chart to be below the "green" benchmark performance upper-control-limit-line. This positive performance trend, below the benchmark performance upper-control-limit-line, has been consistently sustained by PPL, and is considered under control. PPL is considered an excellent SAIFI Benchmark Performer.

Outage Causes

Figure 14 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Trees were the top cause of outages and customer-minutes interrupted. Over 41% of outages are caused by trees, and 30% are caused by equipment failure.

Figure 15 shows the historical trend of the top 3 main outage causes. Trees and equipment failure are the 2 most frequent outage causes that are significantly negatively affecting PPL's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

PPL notes that its vegetation management program uses industry best practices to improve the reliability of the electric transmission and distribution systems by preventing outages from vegetation located on easements and rights-of-way (ROW) and minimizing outages from vegetation adjacent to the ROW. Trees are a leading cause of storm-related power outages, so vegetation management is critical to keeping the system reliable.

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

PPL employs helicopters with Laser imaging Detection and Ranging (LiDAR) sensors to monitor and evaluate the clearance of vegetation from the transmission system and guide its maintenance program. Also, in 2019, PPL will supplement helicopter inspection LiDAR with drone inspection LiDAR sensors to capture 3D data on a sample of distribution lines. PPL noted that this industry leading approach is expected to help vegetation management personnel identify and prioritize trimming scope more quickly, and to automatically integrate this data into current vegetation work management software.

PPL believes its data-analytics-based initiatives will improve risk assessment by predicting locations that are at most risk of a tree outage occurring. The objective is to understand what variables have the most influence on tree failures so trees with those observed conditions can be removed before they cause outages.

PPL is also continuing the storm hardening of its system. The overall intent of storm hardening is to minimize customer impact due to storms. PPL's storm hardening focus continues to be around vegetation management, asset and line reliability performance and smart grid technology. For 2019, implementing Trip Saver reclosers on single-phase taps is expected to reduce permanent and momentary outages for transient faults. These devices will be installed on targeted lines with higher permanent and momentary outage histories. In addition, PPL continues to address distribution pole performance through pole replacement and remediation programs along with changes to pole sizes and crossarm attachments such as the use of fiber crossarms. PPL is also using steel poles at highway and railroad crossings to harden these critical locations. Larger poles

are now used in locations where heavier equipment is installed, and remote service kits are installed to improve restoration times for residential customers in rural areas. In addition, spacer cable is being specified in areas with high tree exposure.

PPL continues to replace existing 3-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.

In 2019, PPL introduced 2 new single-phase reclosing devices onto the system in order to enhance sectionalizing on single-phase taps where previously reclosing coordination or sectionalizing could not be achieved. One of these reclosing devices is remote communicating and will be fully integrable in PPL's centralized Distribution Management System (DMS). The other unit does not have the communication capabilities, but can be cost effectively installed in more locations than ever before to economically provide reclosing and sectionalizing features on the distribution system.

High impedance fault detection technology continues to be rolled out to all new communicating reclosers to help identify downed energized wires in 2019. Recently, PPL had its first successful automatic trip on a downed wire.

PPL continues to invest in its Smart Grid initiative. An additional 140 communicating vacuum circuit reclosers are planned for installation by June 2019. These devices will allow for automatic sectionalizing and reclosing, in addition to identifying fault locations, all of which help to reduce outage duration times. PPL continues to expand the use of advanced data analytics to identify and remediate potentially failing equipment before it causes an outage. The use of health scores and development of predictive models is a focus area for 2019.

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

PPL experienced 23 storm events in 2018, including the Major Event winter storm Riley, as compared to an average of 14 during the benchmark period of 1994-1998. PPL continues to improve its storm and emergency response by performing emergency exercises, after-action reviews, and best practices and benchmarking initiatives with other EDCs and industry leaders. PPL notes that it is focused on improving communications with its customers, state agencies, emergency organizations, other utilities, and the media

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

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

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to PPL customers. In 2018, trees and equipment failure outage causes contributed to over 89% of the total lost customer-minutes, not including any lost customer-minutes caused by Major Events.

PPL experienced 1 Major Event during winter where PPL customers experienced a loss of **355,173,459 customer-minutes interrupted**.

PPL's CAIDI performance spiked over standard performance in 2018 and needs management attention to sustain CAIDI performance below the "green" benchmark performance upper-control-limit-line. PPL has sustained SAIFI benchmark since 2012 and is considered an excellent SAIFI benchmark performer.

It should also be noted that a Major Event had a significant negative impact on PPL customers that is not reflected in CAIDI and SAIFI performance metrics.

Figure 12 PPL CAIDI (minutes)

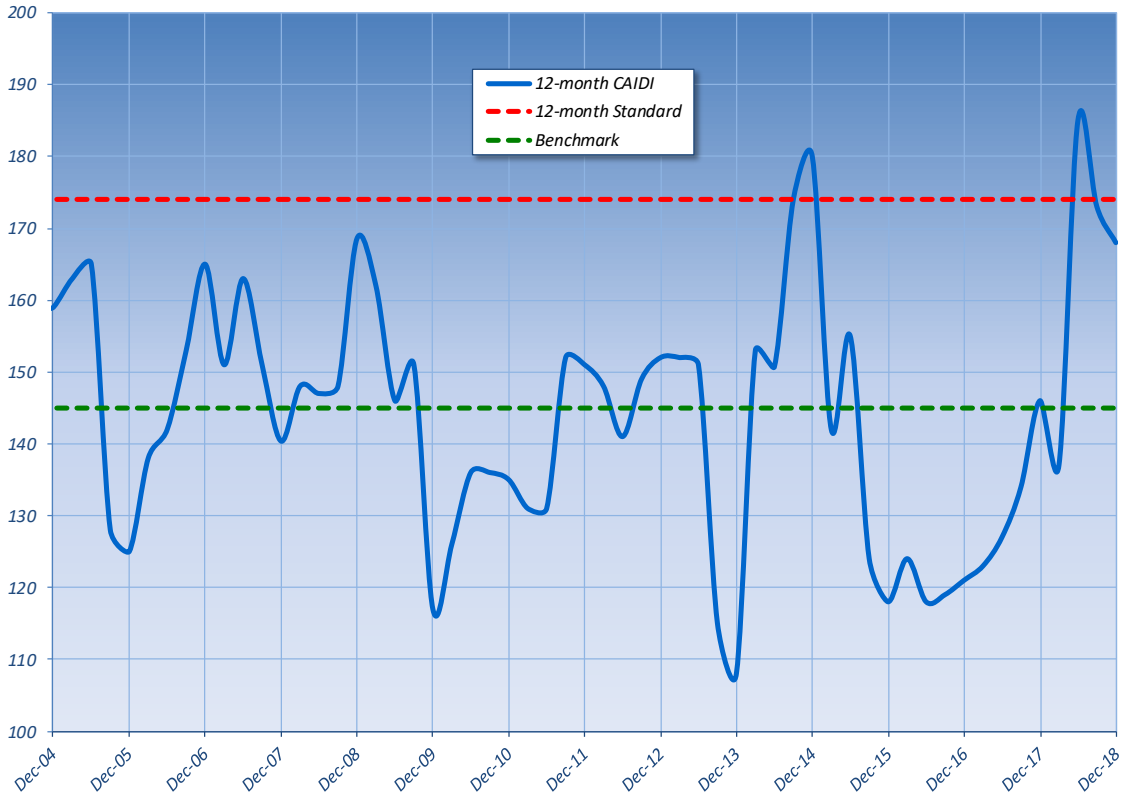


Figure 13 PPL SAIFI (interruptions per customer)

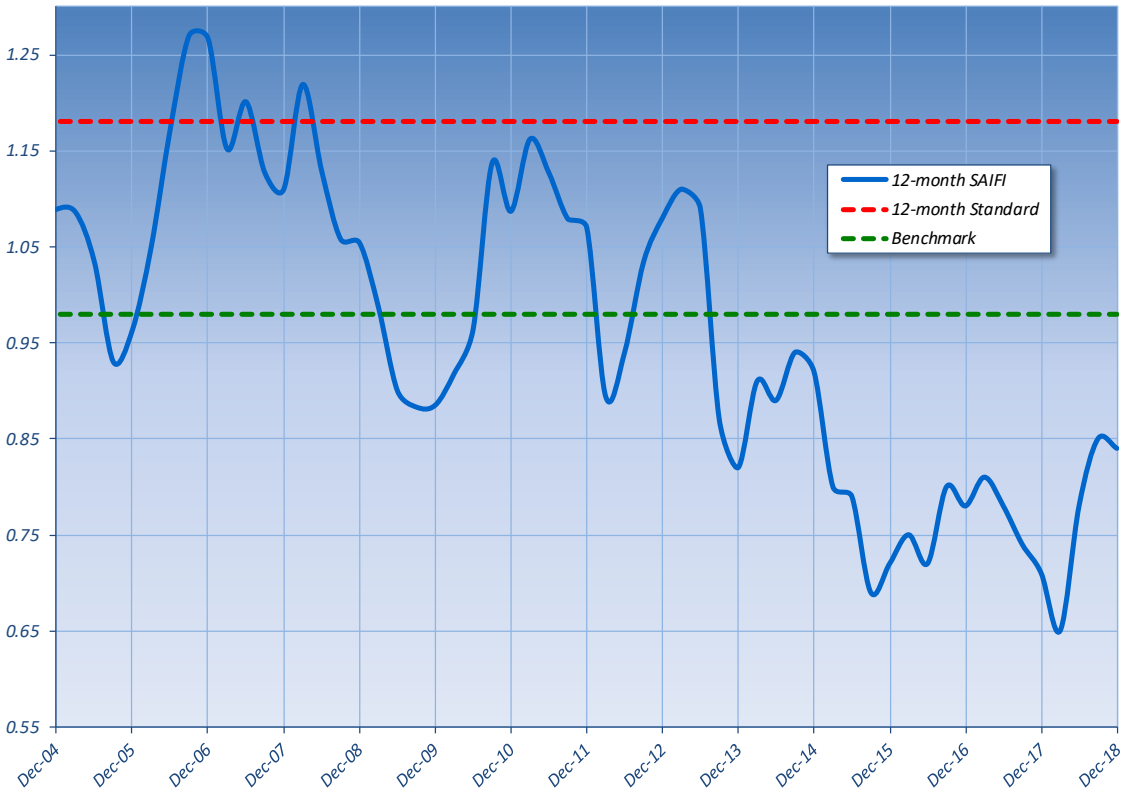


Figure 14 PPL Outage Causes (percent of total outages)

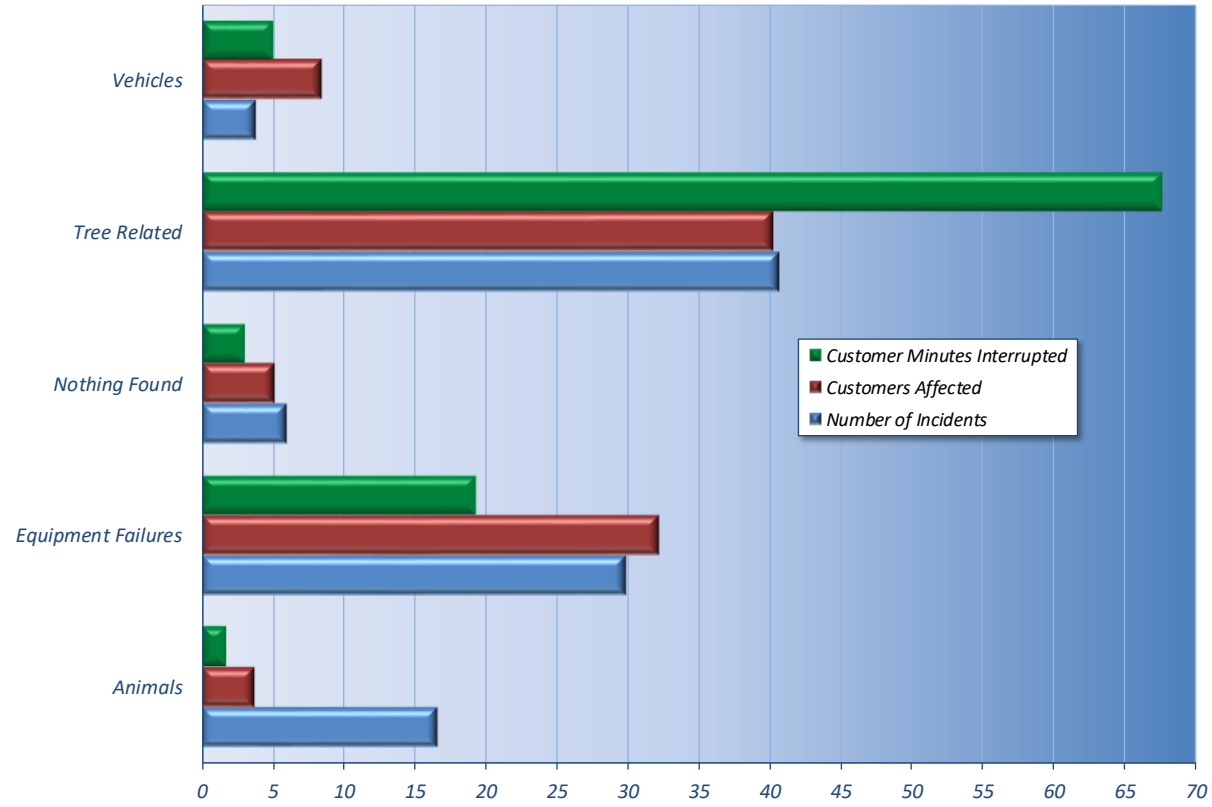
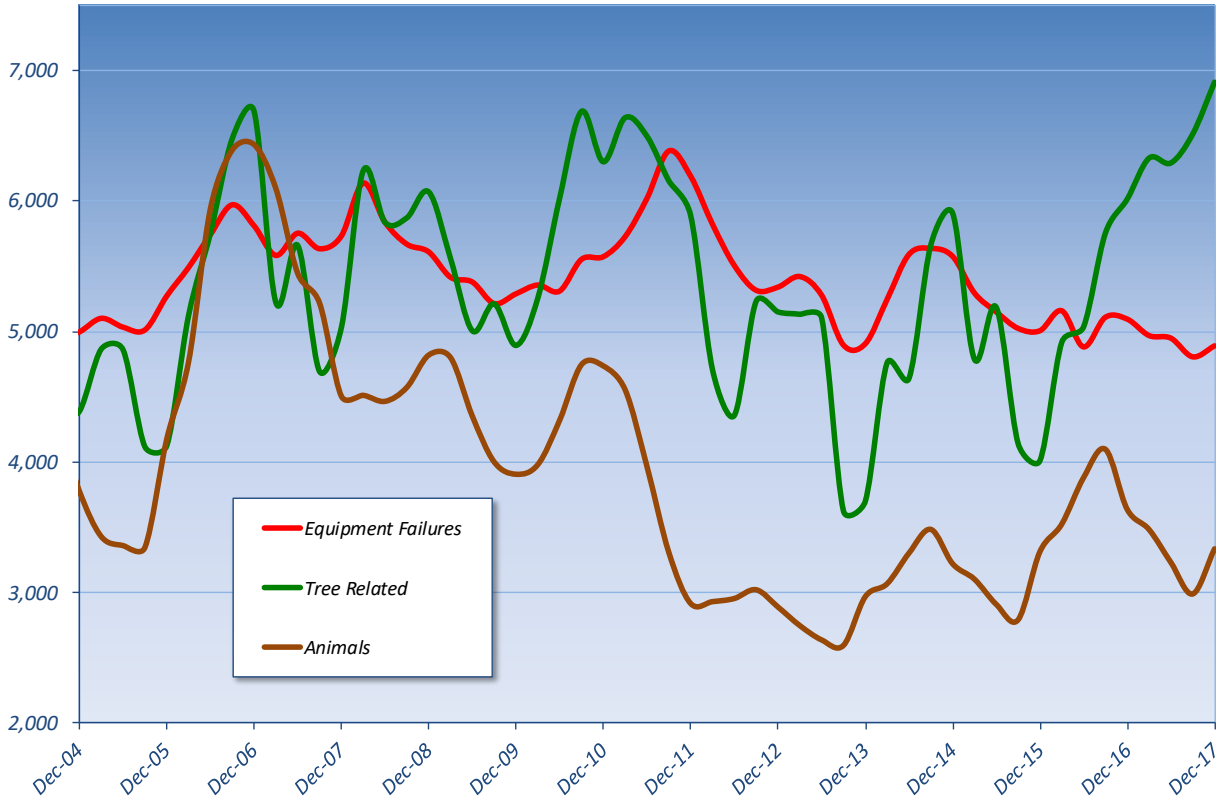


Figure 15 PPL Outage Tracking (number of incidents)



Metropolitan Edison Company

Met-Ed has a service territory of about 3,300 square miles that serves about 554,500 customers.

In 2018, Met-Ed experienced 713,881 customers interruptions and 92.8 million customer-minutes interrupted as compared to 827,461 customer interruptions and 121.9 million customer-minutes interrupted in 2017; and 804,947 customer interruptions and 99.6 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Decreased from 147 minutes in 2017 to 130 minutes in 2018; failed to achieve benchmark by 11%.

3-year average: Increased slightly from 128 minutes in 2017 to 134 minutes in 2018; failed to achieve standard by 4%.

SAIDI

Rolling 12-month: Decreased from 217 minutes in 2017 to 165 minutes in 2018; failed to achieve benchmark by 22%.

3-year average: Increased from 177 minutes in 2017 to 187 minutes in 2018; failed to achieve standard by 15%.

SAIFI

Rolling 12-month: Decreased from 1.47 outages in 2017 to 1.27 outages in 2018; failed to achieve benchmark by 10%.

3-year average: Increased from 1.37 outages in 2017 to 1.39 outages in 2018; failed to achieve standard by 10%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown on Figures 16 and 17. Beginning in 2004, Met-Ed 's CAIDI performance trend has been erratic, and from 2013 to present has been trending negative. In several 12-month rolling quarters in 2017 and 2018, CAIDI performance has spiked above both benchmark and standard upper-control-limit-lines. It appears the CAIDI performance trend is outside of acceptable tolerances, and more management attention is needed to address the inconsistent CAIDI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Beginning in 2004, Met-Ed 's SAIFI performance trend has been chronically outside of acceptable tolerances. From 2007 onward, the overall trend has been continually negative, except for a brief period in 2013-2014 when Met-Ed's performance was positive and below the "green" benchmark performance upper-control-limit-line. It appears more management attention is needed to address the inconsistent SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Outage Causes

Figure 18 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Equipment failure (includes line failure) and trees (includes all 4 tree sub-categories, and 2 are not shown) were the top cause of outages, customers affected, and customer-minutes interrupted. Over 34% of outages are caused by equipment failure (includes line failure), and 28% of outages are caused by trees (includes all 4 tree sub-categories, and 2 are not shown).

Figure 19 shows the historical trend of the top 3 main outage causes. Trees and equipment failure are the 2 most frequent causes of power outages that are significantly negatively affecting Met-Ed's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

In 2016, Met-Ed started to execute its Long-Term Infrastructure Improvement Plans (LTIIP). These plans include expenditures and programs designed to accelerate repairment, improvement or replacement of aging infrastructure in order to adequately maintain and improve the efficiency, safety, adequacy and reliability of the distribution system. On January 18, 2019, Met-Ed filed a Petition for Approval of Modification of its Long-Term Infrastructure Improvement Plan in order to increase overall spending in the 2019 program year. The Petition was approved, as filed, on May 23, 2019.[28]

The PUC has also been performing extra monitoring of Met-Ed's work management system and Reliability Improvement Plan (RIP) beginning in 2015 as a result of a Commission Motion regarding FirstEnergy's Implementation Plan to the findings of the Commission's Focused Management and Operations Audit.[29]

Met-Ed employs various programs to strengthen the durability and flexibility of the electric system. Methods to improve the efficiency, adequacy, and reliability of the distribution system are a continual focus. Met-Ed utilizes core programs to support cost-effective and reliable service. These programs include, but are not limited to:

- Routine cycle tree trimming that removes selected incompatible trees within the clearing zone corridor, removes certain defective limbs that are overhanging primary conductors, controls selected incompatible brush, and removes off right-of-way priority trees.

- Enhanced tree trimming that complements the routine cycle tree trimming by removing healthy limbs overhanging primary conductors on areas where it's determined to be beneficial.

- In response to damage caused by the Emerald Ash Borer, a program to proactively remove Ash Trees off right-of-way was implemented.

[28] Docket No. P-2015-2508942
[29] Final Order entered Nov 5, 2015, at Docket Nos. D-2013-2365991, D-2013-2365992, D-2013-2365993, and D-2013-2365994.

- Post-storm circuit patrols that target the areas with high tree-related outages. Circuit patrols identify trees damaged in a storm that may eventually lead a future outage. Once identified, the tree is removed. In addition, damaged equipment identified as part of the circuit patrol is repaired or replaced.

- After each significant storm event, Met-Ed conducts post-storm review meetings to identify and disseminate lessons learned which are used to improve the emergency response plan. From storm review action items identified as a result of 2018 and early 2019 restoration events, Met-Ed will implement the following changes:

    - Assign a Company liaison for affected Emergency Management Agencies ("EMAs") during larger restoration events and continue to reach out to EMAs during smaller events as well.

    - Implement order-based damage assessment.

- The Customers Experiencing Multiple Interruptions ("CEMI") program is aimed to reduce frequent or repeated outages for affected clusters of customers or frequently operated devices.

- Load forecasting and distribution planning is used to estimate future substation and circuit loading based upon historical load data and the planning criteria guidelines are then used to provide a consistent approach for planning the safe, reliable, orderly, and economic expansion of the distribution system.

- Circuit protection practices are aimed at achieving safety and security for the public and employees, maximizing service reliability to customers, minimizing damage to distribution equipment, and establishing a consistent process and set of application standards for distribution circuit protection.

- Fuse installation continues to reduce the scope of outages. Fuses and other protective devices are being installed on circuits selected based on overall performance as well as protection needs. Met-Ed installed 584 fuses in 2018 as compared to 433 fuses in 2017.

- Circuit ties and loops continue to be built between radial sections of circuits. When ties and loops are available, circuits can be switched during outages to enable faster service restoration. Met-Ed installed 3 circuit ties and loops in 2018 as compared to 4 circuit ties and loops in 2017.

- Line Rehabilitation continues to strengthen the electrical system. Met-Ed notes it performs targeted circuit rehabilitation in Zone 1 and Zone 2 areas, focusing on circuits having a high rate of equipment and line failure and animal-caused outages.[30] Equipment that may be replaced includes crossarms, capacitors, insulators, lightning arresters and connectors. Met-Ed completed the rehabilitation on 14 circuits in 2018.

[30] Zone 1 is defined as the portion of the circuit from the substation breaker to the first protective device. Zone 2 is defined as the three-phase conductor and devices after the first protective device.

- Supervisory control and data acquisition (SCADA) devices are replacing existing gang operated air brake switches, disconnect switches and hydraulically operated circuit reclosers on the Met-Ed distribution system. SCADA controlled switches allows for remote operation to restore service to customers when an outage occurs. Remote switching eliminates the need to dispatch crews to manually operate the switches, resulting in fewer customers affected and reduced outage duration. Met-Ed installed 106 SCADA devices in 2018 as compared to 28 SCADA devices in 2017.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to Met-Ed customers. In 2018, trees and equipment failure outage causes contributed to over 61% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

Met-Ed experienced 4 Major Events (including one event that was denied and is under appeal) where Met-Ed customers experienced a loss of **670,949,949 customer-minutes interrupted.**

Beginning in 2004, Met-Ed's CADI and SAIFI benchmark performance has been erratic and frequently outside of acceptable tolerances and Met-Ed has achieved CAIDI benchmark performance less than 40% of the time and SAIFI benchmark performance less than 20% of the time. Met-Ed's overall CAIDI and SAIFI performance trend is troubling, and Met-Ed through its RIP will need to address the inconsistent CAIDI and SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

It should also be noted that Major Events had a significant negative impact on Met-Ed's customers that is not reflected in CAIDI and SAIFI performance metrics.

Figure 16 Met-Ed CAIDI (minutes)

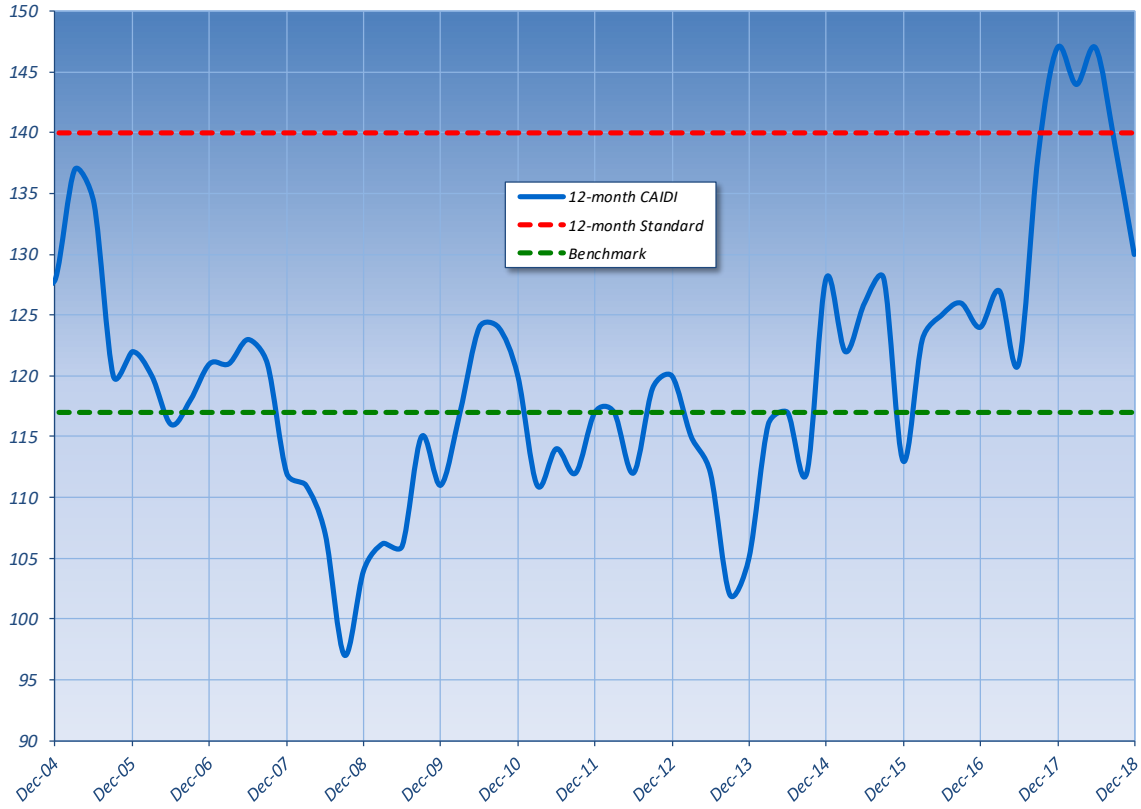


Figure 17 Met-Ed SAIFI (interruptions per customer)

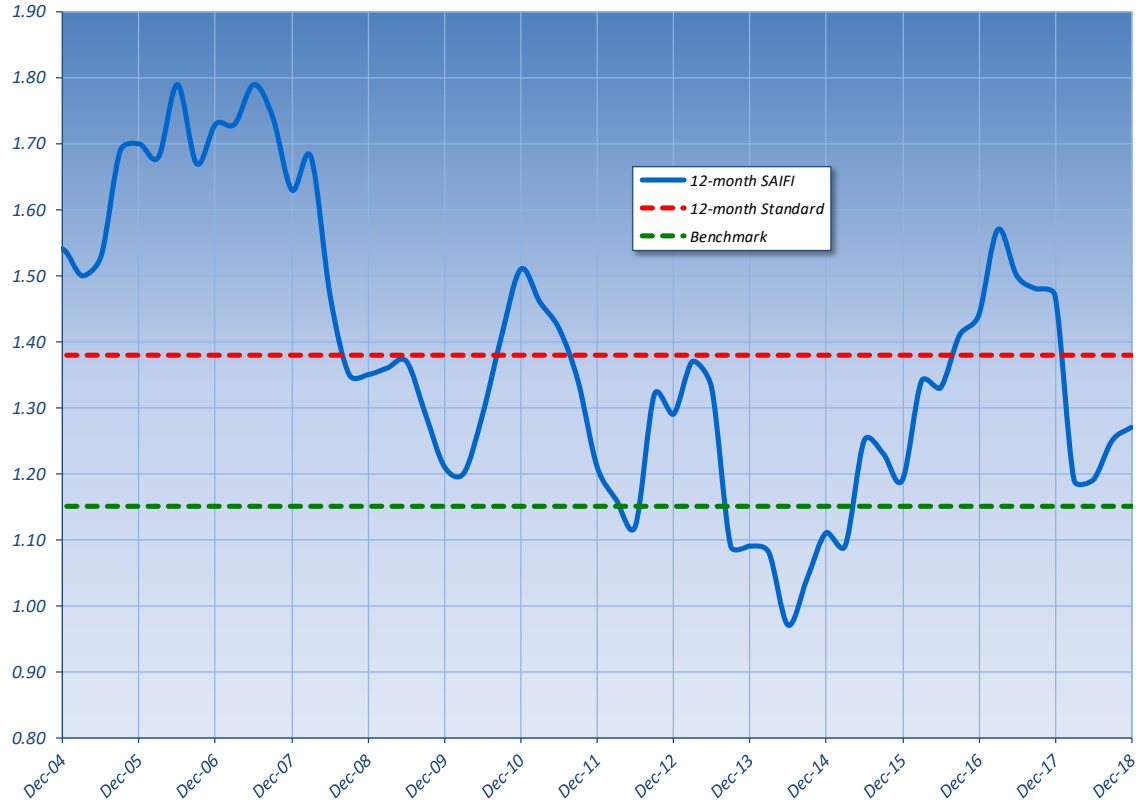


Figure 18 Met-Ed Outage Causes (percent of total outages)

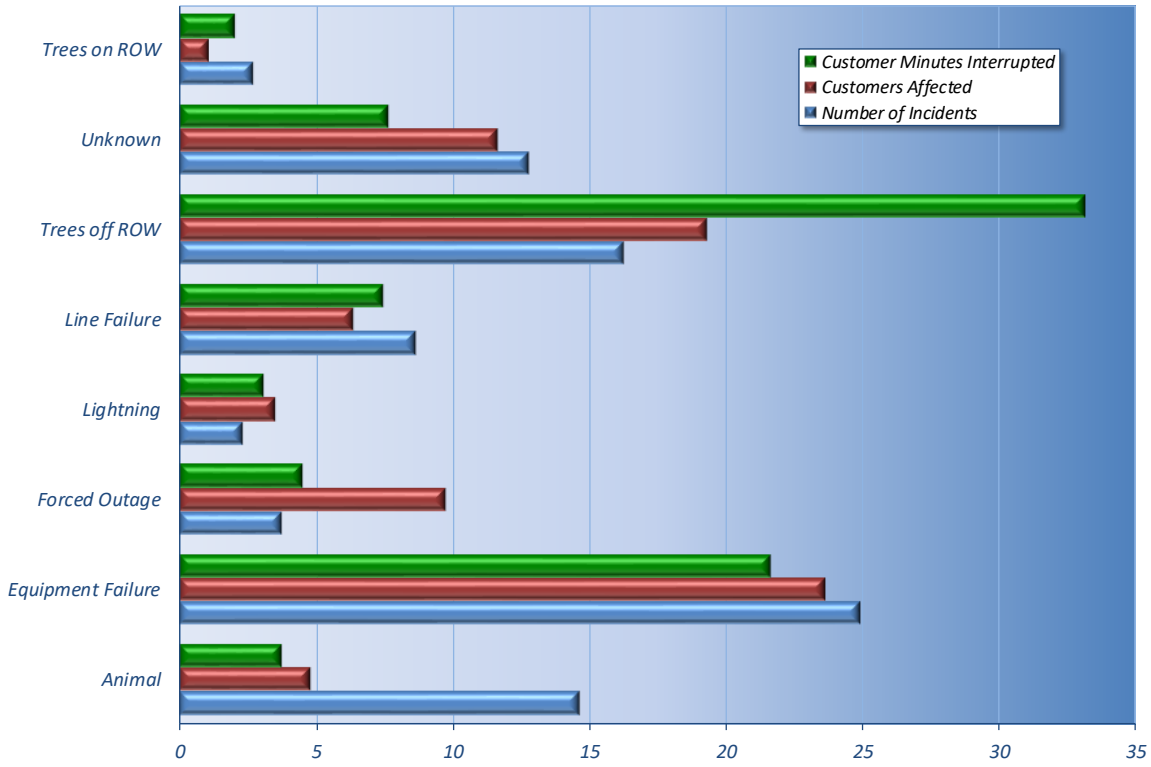
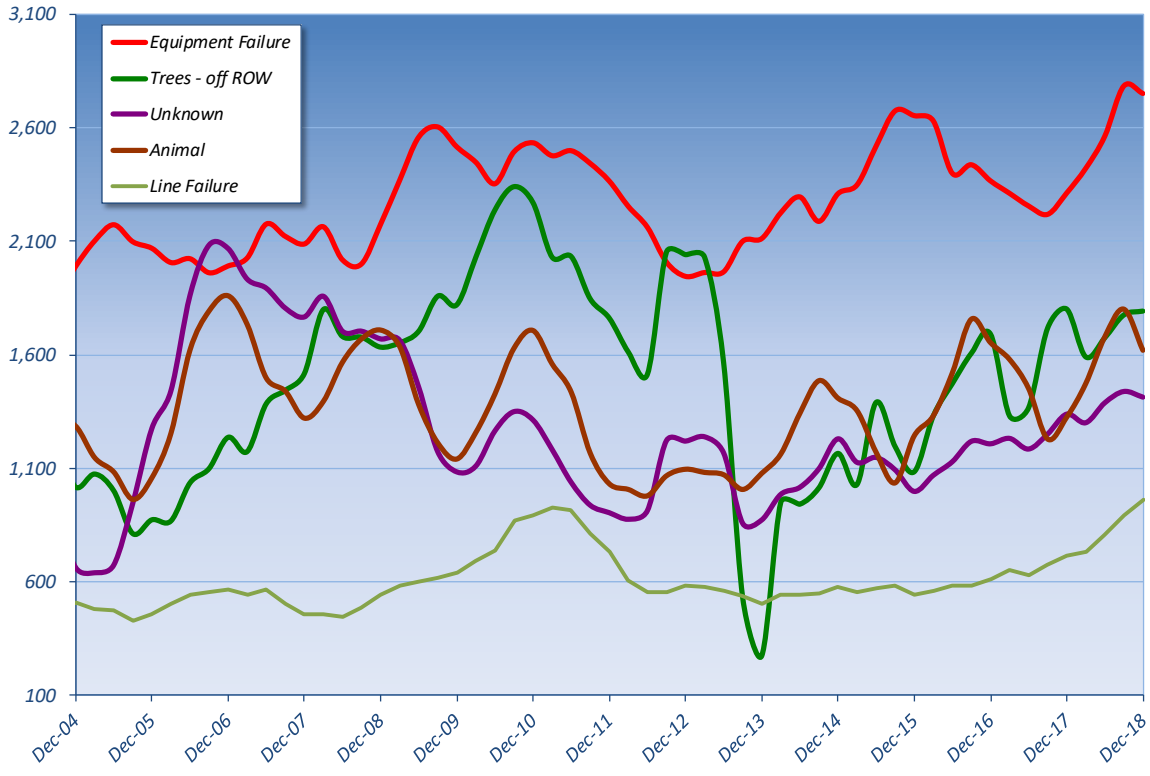


Figure 19 Met-Ed Outage Tracking (number of incidents)



Pennsylvania Electric Company

Penelec has a service territory of about 17,600 square miles serving 582,000 customers.

In 2018, Penelec experienced 992,756 customers interruptions and 113.1 million customer-minutes interrupted as compared to 1 million customer interruptions and 138.5 million customer-minutes interrupted in 2017, and 833,315 customer interruptions and 99.6 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Decreased from 138 minutes in 2017 to 114 minutes in 2018; achieved benchmark by 3%.

3-year average: Decreased from 133 minutes in 2017 to 124 minutes in 2018; achieved standard by 4%.

SAIDI

Rolling 12-month: Decreased from 239 minutes in 2017 to 195 minutes in 2018; failed to achieve benchmark by 32%

3-year average: Increased from 200 minutes in 2017 to 202 minutes in 2018; failed to achieve standard by 13%.

SAIFI

Rolling 12-month: Decreased from 1.73 outages in 2017 to 1.71 outages in 2018; failed to achieve benchmark by 36%.

3-year average: Increased from 1.51 outages in 2017 to 1.62 outages in 2018; failed to achieve standard by 17%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 20 and 21. Beginning in 2004, Penelec‘s CAIDI performance trend has been erratic and frequently chronically outside of acceptable tolerances. For the rolling 12-month quarters in 2017 and 2018, CAIDI trended toward benchmark with the 4th Quarter December 2018 data point on the positive side of the “green” benchmark performance upper-control-limit-line. It appears CAIDI performance requires more management attention to address the inconsistent performance and sustain the trend line below the “green” benchmark performance upper-control-limit-line.

Beginning in 2004, Penelec‘s SAIFI performance trend has been inconsistent and frequently outside of acceptable tolerances. From 2004 through 2018, the overall trend has been continually trending negative with the exception of one rolling 12-month quarter in 2009 when Penelec’s performance was positive, and below the “green” benchmark performance upper-control-limit-line. It appears Penelec’s overall SAIFI performance trend is chronically outside of acceptable tolerances, and more management attention is needed to address the inconsistent SAIFI performance and sustain the trend line below the “green” benchmark performance upper-control-limit-line.

Outage Causes

Figure 22 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Equipment failure (includes line failure) and trees (includes sub-categories) were the top cause of outages, customers affected, and customer-minutes interrupted. About 34% of outages are caused by equipment failure (including line failure), and 19% of outages are caused by trees.

Figure 23 shows the historical trend of the top 3 main outage causes. Equipment failure and trees and are the 2 most frequent outage-causes that are significantly negatively affecting Penelec's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

In 2016, Penelec started to execute its Long-Term Infrastructure Improvement Plan (LTIIP). These plans include expenditures and programs designed to accelerate repairment, improvement or replacement of aging infrastructure in order to adequately maintain and improve the efficiency, safety, adequacy and reliability of the distribution system. On January 18, 2019, Penelec filed a Petition for Approval of Modification of its Long-Term Infrastructure Improvement Plan in order to increase overall spending in the 2019 program year. The Petition was approved, as filed, on May 23, 2019.[31]

The PUC has also been performing extra monitoring of Penelec's work management system and Reliability Improvement Plan (RIP) beginning in 2015 as a result of a Commission Motion regarding FirstEnergy's Implementation Plan to the findings of the Commission's Focused Management and Operations Audit.[32]

Penelec employs various programs to strengthen the durability and flexibility of the electric system. Methods to improve the efficiency, adequacy, and reliability of the distribution system are a continual focus. Penelec utilizes core programs to support cost-effective and reliable service. These programs include, but are not limited to:

- Routine cycle tree trimming that removes selected incompatible trees within the clearing zone corridor, removes certain defective limbs that are overhanging primary conductors, controls selected incompatible brush, and removes off right-of-way priority trees.

- Enhanced tree trimming that complements the routine cycle tree trimming by removing healthy limbs overhanging primary conductors on areas where it's determined to be beneficial.

- In response to damage caused by the Emerald Ash Borer, a program to proactively remove Ash Trees off right-of-way was implemented.

[31] Docket No. P-2015-2508942
[32] Final Order entered Nov 5, 2015, at Docket Nos. D-2013-2365991, D-2013-2365992, D-2013-2365993, and D-2013-2365994.

- Post-storm circuit patrols that target the areas with high tree-related outages. Circuit patrols identify trees damaged in a storm that may eventually lead a future outage. Once identified, the tree is removed. In addition, damaged equipment identified as part of the circuit patrol is repaired or replaced.

- After each significant storm event, Penelec conducts post-storm review meetings to identify and disseminate lessons learned which are used to improve the emergency response plan.

- From storm review action items identified as a result of 2018 and early 2019 restoration events, Penelec will implement the following changes:

    - Implemented post storm patrols to find conditions that may cause imminent outages.

    - Begun to publish Incident Action Plans shortly after the Company is predicted to be affected by a weather event.

- Customers Experiencing Multiple Interruptions ("CEMI") program is aimed to reduce frequent or repeated outages for affected clusters of customers or frequently operated devices.

- Load forecasting and distribution planning is used to estimate future substation and circuit loading based upon historical load data and the planning criteria guidelines are then used to provide a consistent approach for planning the safe, reliable, orderly, and economic expansion of the distribution system.

- Circuit protection practices are aimed at achieving safety and security for the public and employees, maximizing service reliability to customers, minimizing damage to distribution equipment, and establishing a consistent process and set of application standards for distribution circuit protection.

- To reduce the scope of outages, fuse protection and coordination recommendations on the 34.5 kV system will be constructed and implemented based on full circuit coordination studies. Penelec implemented fuse protection coordination and recommendations on 6 circuits in 2018.

- Circuit ties and loops continue to be built between radial sections of circuits. When ties and loops are available, circuits can be switched during outages to enable faster service restoration. Penelec installed a portion of a circuit ties and loops in 2018 compared to 1 circuit ties and loops in 2017.

- Line Rehabilitation continues to strengthen the electrical system, Penelec performs targeted circuit rehabilitation in Zone 1 and Zone 2 areas, focusing on circuits having a high rate of equipment and line failure and animal-caused outages. Equipment that may be replaced includes crossarms, capacitors, insulators, lightning arresters and connectors. Penelec completed the rehabilitation on 12 circuits in 2018.

- Supervisory control and data acquisition (SCADA) devices are being installed where circuit conditions and system performance warrant. SCADA controlled switches allows for remote operation to restore service to customers when an outage occurs. Remote switching eliminates the need to dispatch crews to manually operate the switches, resulting in fewer customers affected and reduced outage duration. Penelec installed 11 SCADA devices in 2018 as compared to 21 SCADA devices in 2017.

- Advanced protective devices such as electronically controlled reclosers and switches with modernized communication are being installed to allow for additional protection coordination. Advanced protective devices were installed on 13 circuits in 2018 as compared to 2 circuits in 2017.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to Penelec customers. In 2018, trees and equipment failure outage causes contributed to over 70% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

Penelec experienced 4 Major Events where Penelec customers experienced a loss of **41,418,295 customer-minutes interrupted**.

Beginning in 2004, Penelec's CADI and SAIFI benchmark performance has been erratic and frequently outside of acceptable tolerances and Penelec has achieved CAIDI benchmark performance less than 18% of the time, and SAIFI benchmark performance less than 5% of the time. Penelec through its RIP will need to address the inconsistent CAIDI and SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

It should also be noted that Major Events had a significant negative impact on Penelec's customers that are not reflected in CAIDI and SAIFI performance metrics.

Figure 20 Penelec CAIDI (minutes)

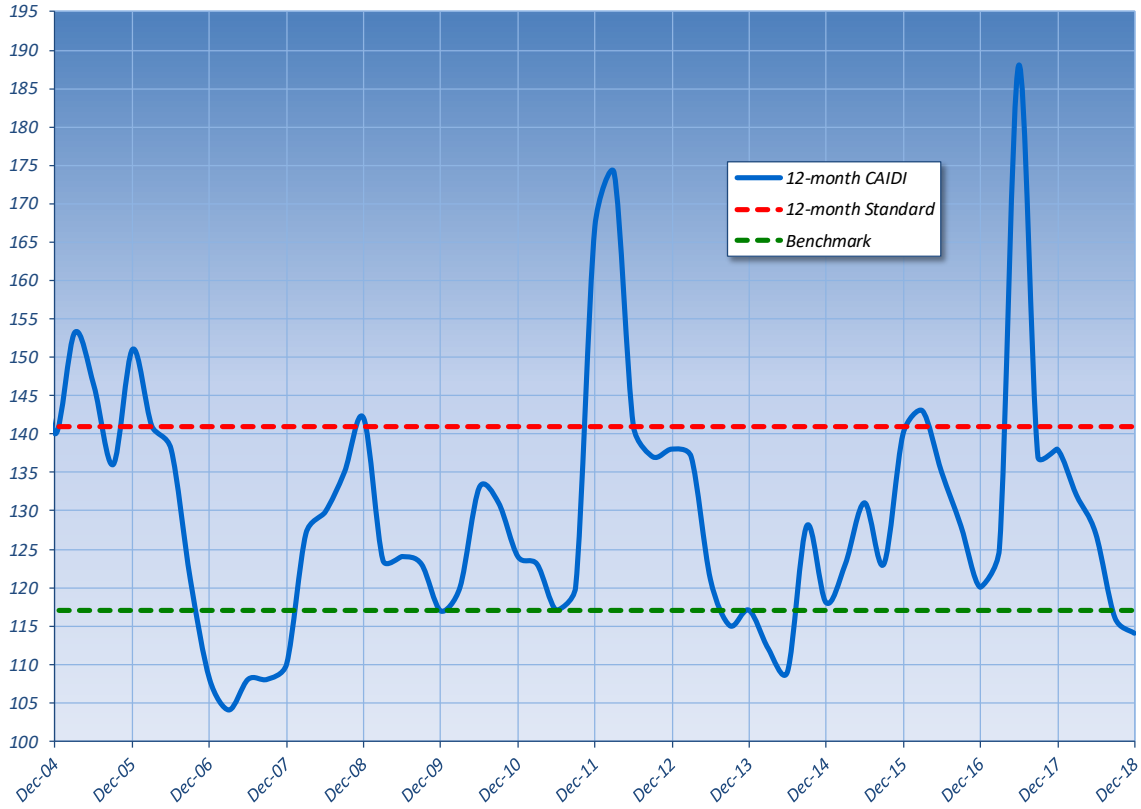


Figure 21 Penelec SAIFI (interruptions per customer)

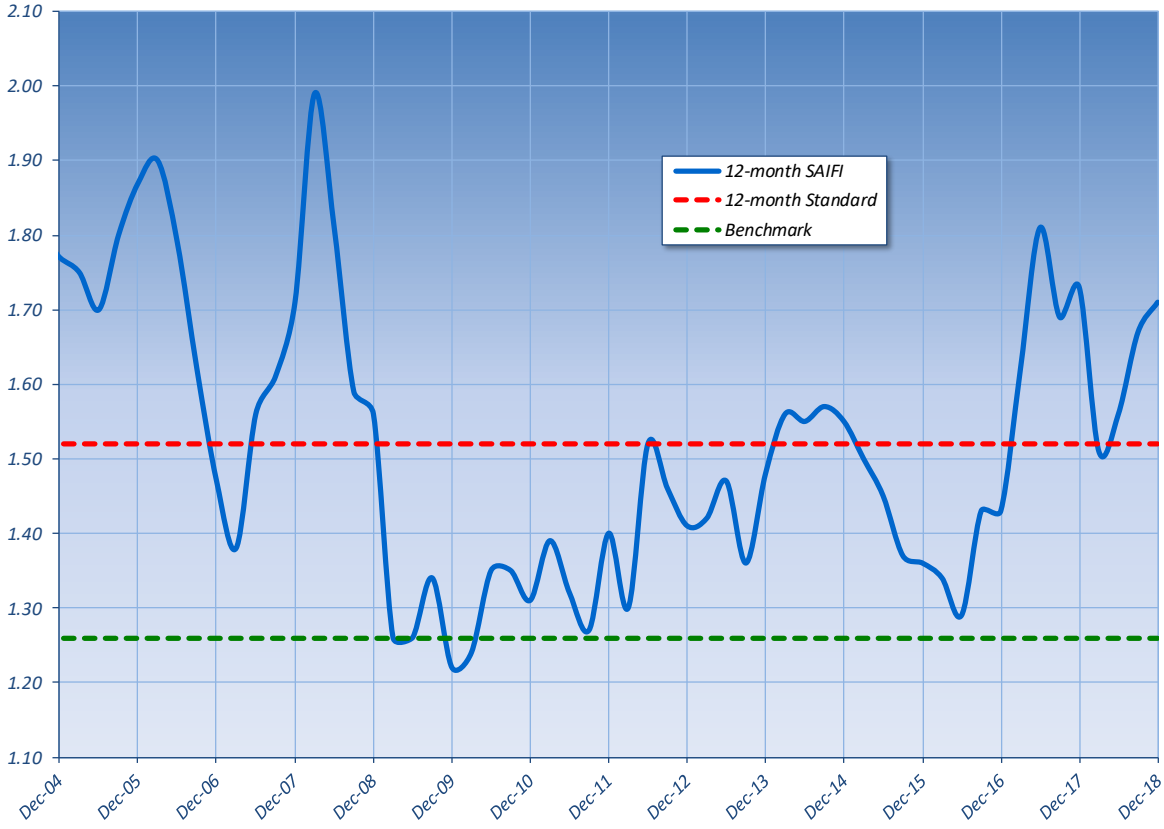


Figure 22 Penelec Outage Causes (percent of total outages)

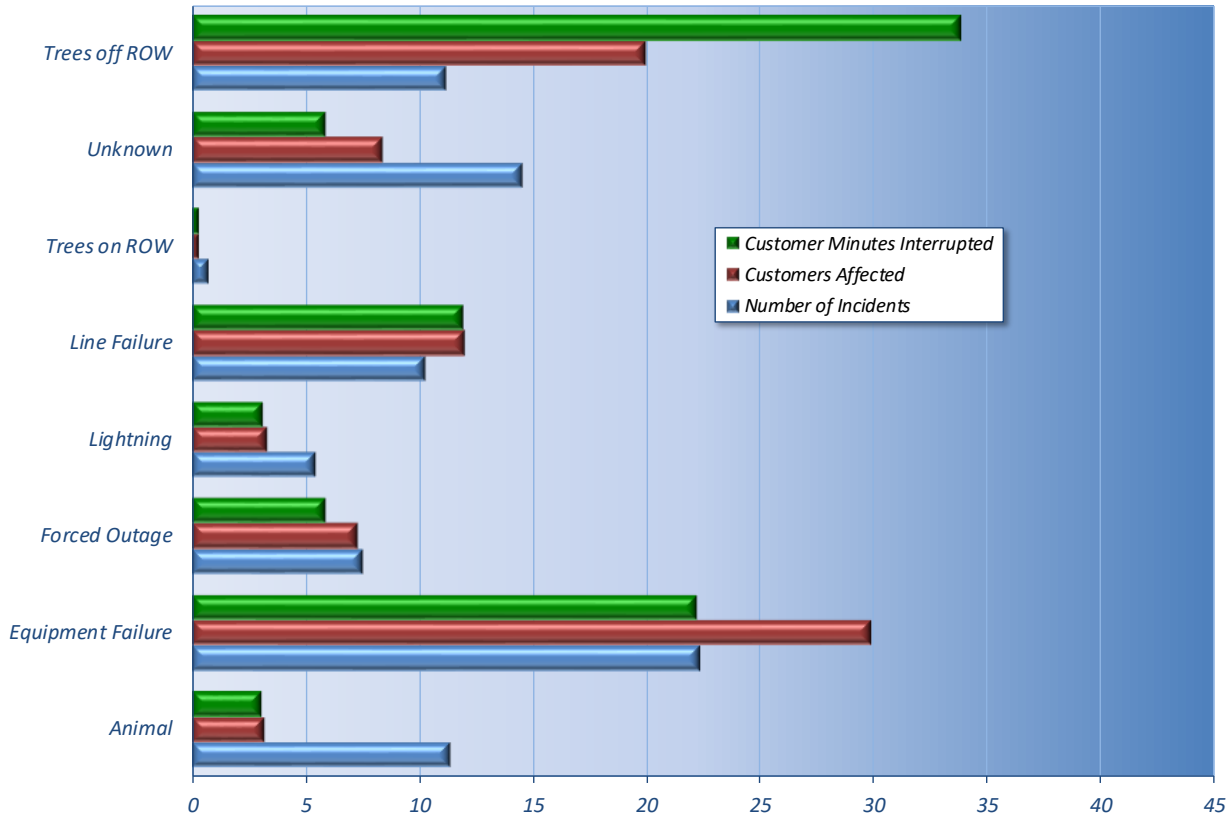
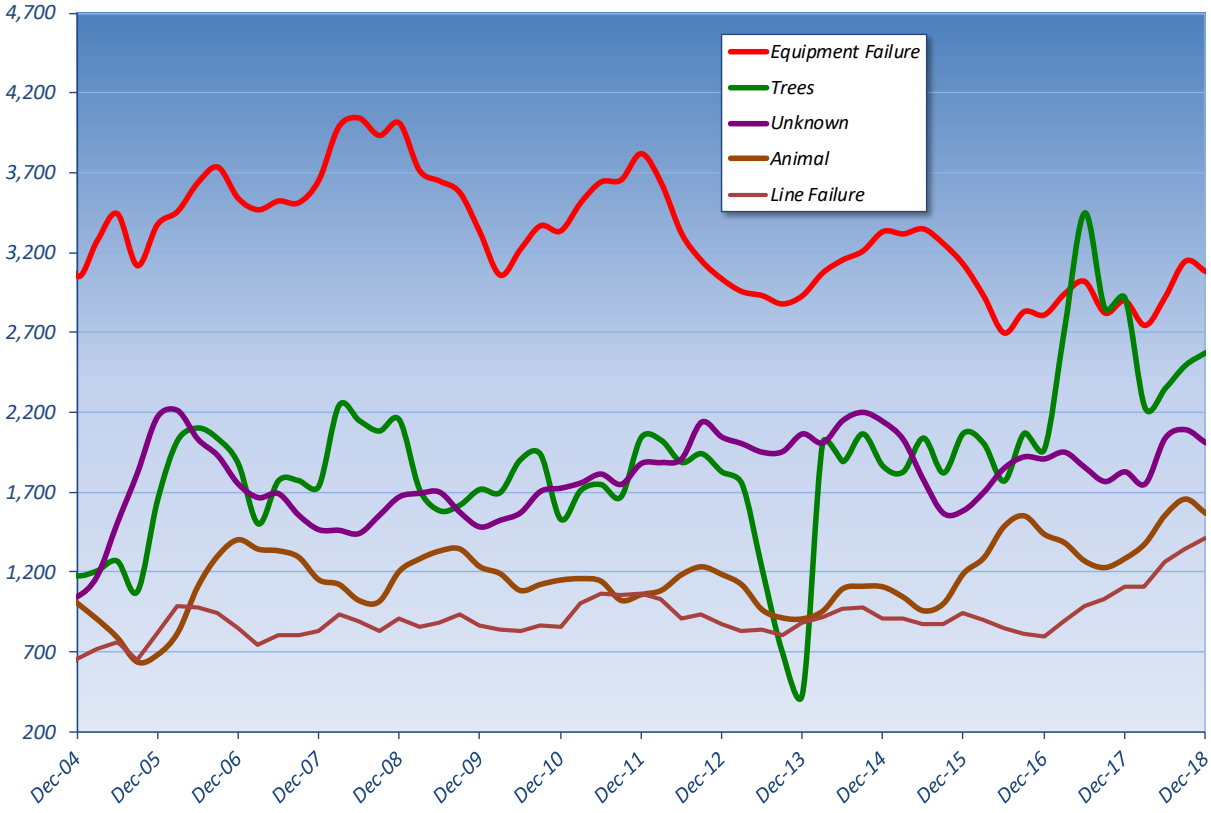


Figure 23 Penelec Outage Tracking (number of incidents)



Pennsylvania Power Company

Penn Power has a service territory of about 1,100 square miles that serves primarily 159,500 customers.

In 2018, Penn Power experienced 180,247 customers interruptions and 113.1 million customer-minutes interrupted as compared to 173,036 customer interruptions and 26 million customer-minutes interrupted in 2017, and 176,968 customer interruptions and 24.9 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Decreased from 150 minutes in 2017 to 138 minutes in 2018; and failed to achieve benchmark by 37%.

3-year average: Increased from 115 minutes in 2017 to 128 minutes in 2018; and failed to achieve standard by 1%.

SAIDI

Rolling 12-month: Decreased from 160 minutes in 2017 to 152 minutes in 2018; and failed to achieve benchmark by 35%.

3-year average: Increased from 126 minutes in 2017 to 139 minutes in 2018; and failed to achieve standard by 2%.

SAIFI

Rolling 12-month: Increased from 1.06 outages in 2017 to 1.10 outages in 2018; and achieved benchmark by 2%.

3-year average: Decreased from 1.10 outages in 2017 to 1.08 outages in 2018; and achieved standard by 12%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 24 and 25. Beginning in 2004, Penn Power's CAIDI performance trend has been erratic and frequently outside of acceptable tolerances. In the 12-month rolling quarters in 2017 and 2018, CAIDI has been exceeding the "red" standard performance upper-control-limit-line. It appears more management attention is required to address the inconsistent CAIDI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Beginning in 2012, Penn Power's SAIFI performance trend has been erratic. SAIFI has been trending slightly positive with Penn Power's 4th-quarter 2018 SAIFI data point below the "green" benchmark performance upper-control-limit-line. It appears more management attention is needed to address the inconsistent SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Outage Causes

Figure 26 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Equipment failure (includes line failure) and trees (includes all 4 tree sub-categories, and 2 are not shown) were the top cause of outages, customers affected, and customer-minutes interrupted. About 33% of outages are caused by trees (including tree sub-categories) and 20% are caused by equipment failure (includes line failure).

Figure 27 shows historical trend of the top 3 main outage causes. Trees and equipment failure are the 2 most frequent causes of power outages. Equipment failure (includes line failure) and trees (includes tree sub-categories) and are the 2 most frequent outage-causes that are significantly negatively affecting Penn Power's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

In 2016, Penn Power started to execute its Long-Term Infrastructure Improvement Plan (LTIIP). This plan included expenditures and programs designed to accelerate repairment, improvement or replacement of aging infrastructure in order to adequately maintain and improve the efficiency, safety, adequacy and reliability of the distribution system. On January 18, 2019, Penn Power filed a Petition for Approval of Modification of its Long-Term Infrastructure Improvement Plan in order to increase overall spending in the 2019 program year. The Petition was approved, as filed, on May 23, 2019.[33]

The PUC has also been performing extra monitoring of Penn Power's work management system and Reliability Improvement Plan (RIP) beginning in 2015 as a result of a Commission Motion regarding FirstEnergy's Implementation Plan to the findings of the Commission's Focused Management and Operations Audit.[34]

Penn Power employs various programs to strengthen the durability and flexibility of the electric system. Methods to improve the efficiency, adequacy, and reliability of the distribution system are a continual focus. Penn Power utilizes core programs to support cost-effective and reliable service. These programs include, but are not limited to:

- Routine cycle tree trimming that removes selected incompatible trees within the clearing zone corridor, removes certain defective limbs that are overhanging primary conductors, controls selected incompatible brush, and removes off right-of-way priority trees.

- Enhanced tree trimming that complements the routine cycle tree trimming by removing healthy limbs overhanging primary conductors on areas where it's determined to be beneficial.

[33] Docket No. P-2015-2508942

[34] Final Order entered Nov 5, 2015, at Docket Nos. D-2013-2365991, D-2013-2365992, D-2013-2365993, and D-2013-2365994.

- In response to damage caused by the Emerald Ash Borer, a program to proactively remove Ash Trees off right-of-way was implemented.

- Post-storm circuit patrols that target the areas with high tree-related outages. Circuit patrols identify trees damaged in a storm that may eventually lead a future outage. Once identified, the tree is removed. In addition, damaged equipment identified as part of the circuit patrol is repaired or replaced.

- After each significant storm event, Penn Power conducts post-storm review meetings to identify and disseminate lessons learned which are used to improve the emergency response plan.

- From storm review action items identified as a result of 2018 and early 2019 restoration events, Penn Power will implement the following changes:

    - Leveraged available reports to identify workers on property.

    - Stagger crews to prevent crews from extending past 16 hours.

    - Send severe weather notifications to crews potentially affected by inclement weather.

- Customers Experiencing Multiple Interruptions ("CEMI") program is aimed to reduce frequent or repeated outages for affected clusters of customers or frequently operated devices.

- Load forecasting and distribution planning is used to estimate future substation and circuit loading based upon historical load data and the planning criteria guidelines are then used to provide a consistent approach for planning the safe, reliable, orderly, and economic expansion of the distribution system.

- Circuit protection practices are aimed at achieving safety and security for the public and employees, maximizing service reliability to customers, minimizing damage to distribution equipment, and establishing a consistent process and set of application standards for distribution circuit protection.

- Circuit ties and loops continue to be built between radial sections of circuits. When ties and loops are available, circuits can be switched during outages to enable faster service restoration. Penn Power installed 14 circuit ties and loops in 2018 as compared to 10 circuit ties and loops in 2017.

- Smaller, aging overhead conductors are being replaced to improve energy efficiency, increase capacity and improve operational flexibility. Penn Power replaced 10 miles of overhead conductor in 2018 as compared to 4.3 miles in 2017.

- Supervisory control and data acquisition (SCADA) devices are being installed where circuit conditions and system performance warrant. SCADA controlled switches allows for remote operation to restore service to customers when an outage occurs. Remote switching eliminates the need to dispatch crews to manually operate the switches, resulting in fewer customers affected and reduced outage duration. Penn Power installed 35 SCADA switches in 2018 as compared to 14 SCADA switches in 2017.

- Advanced protective devices such as electronically controlled reclosers and switches with modernized communication are being installed to allow for additional protection coordination. Advanced protective devices were installed on 13 circuits in 2018 as compared to 2 circuits in 2017.

- Penn Power is also improving line sectionalizing capability by installing switches and fuses on unprotected overhead circuits to allow an outage fault to be more quickly isolated and power restored. In addition, poles, reclosers, cutouts, arresters, fault indicators and animal guards may be replaced or installed to ensure proper line sectionalizing. Penn Power improved line sectionalizing capability on 13 circuits in 2018 as compared to 6 circuits in 2017.

- Substation circuit breakers, station transformers, and other substation equipment, such as insulators, switches, buses, arresters and conductors that are obsolete or in poor condition are being replaced with new equipment. Proactively replacing older equipment increases substation reliability and reduces the occurrence of equipment failure. Penn Power replaced 25 pieces of equipment in 2018 as compared to 33 pieces of equipment in 2017.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to Penn Power customers. In 2018, trees and equipment failure outage causes contributed to over 64% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

Penn Power experienced 3 Major Events where Penn Power customers experienced a loss of **46,003,808 customer-minutes interrupted**.

Beginning in 2004, Penn Power's CAIDI and SAIFI benchmark performance has been inconsistent and Penn Power has achieved CAIDI benchmark performance less than 13% of the time and SAIFI benchmark performance less than 47% of the time. Penn Power through its RIP will need to address the inconsistent CAIDI and SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

It should also be noted that Major Events had a significant negative impact on Penn Power's customers that are not reflected in CAIDI and SAIFI performance metrics.

Figure 24 Penn Power CAIDI (minutes)

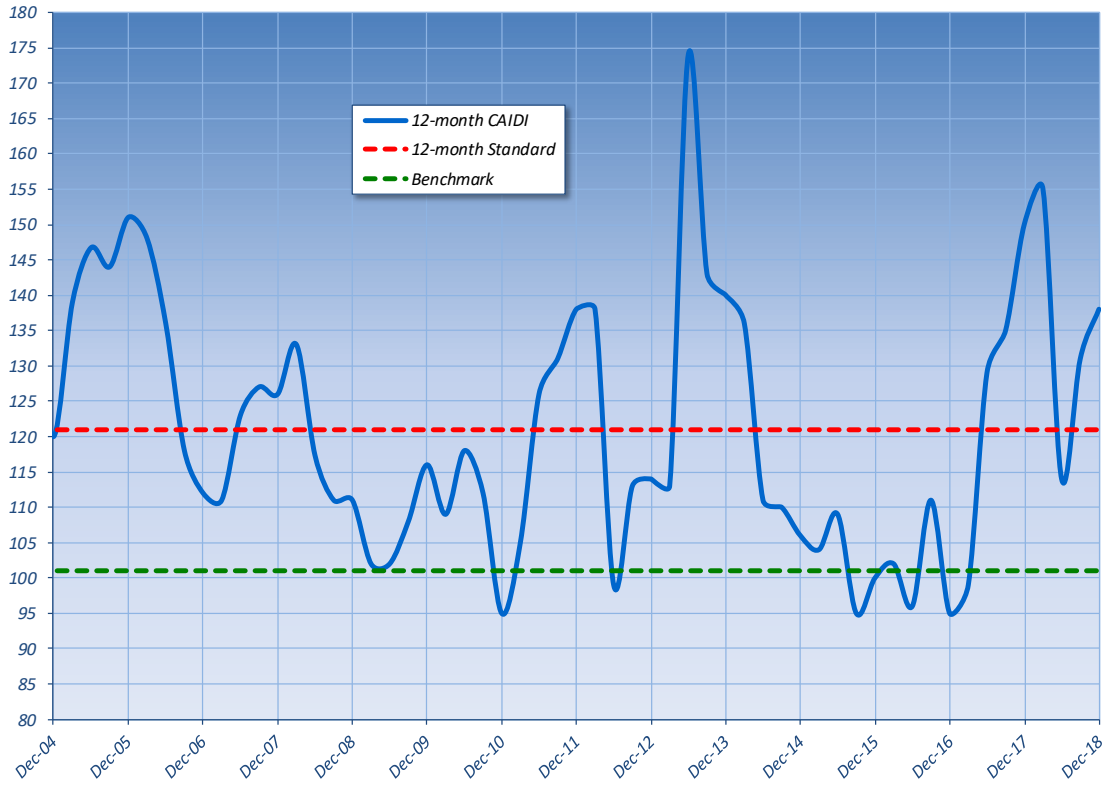


Figure 25 Penn Power SAIFI (interruptions per customer)

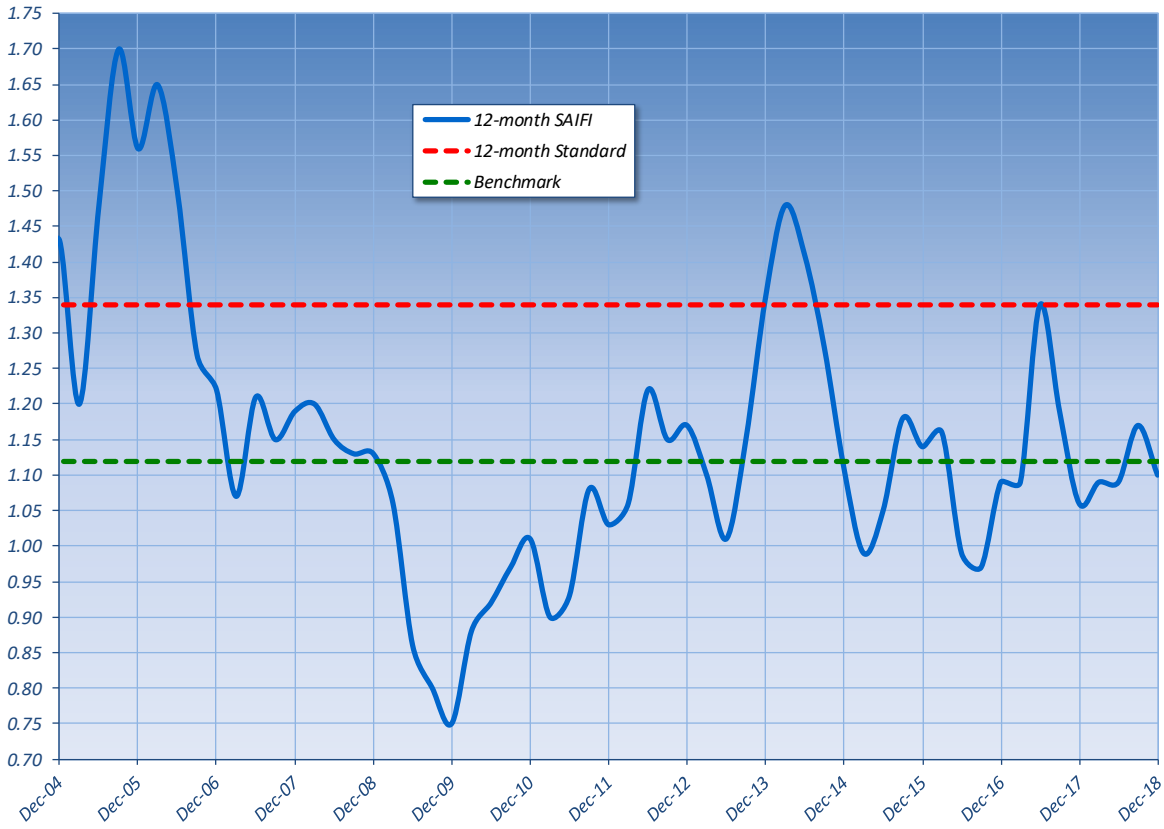


Figure 26 Penn Power Outage Causes (percent of total outages)

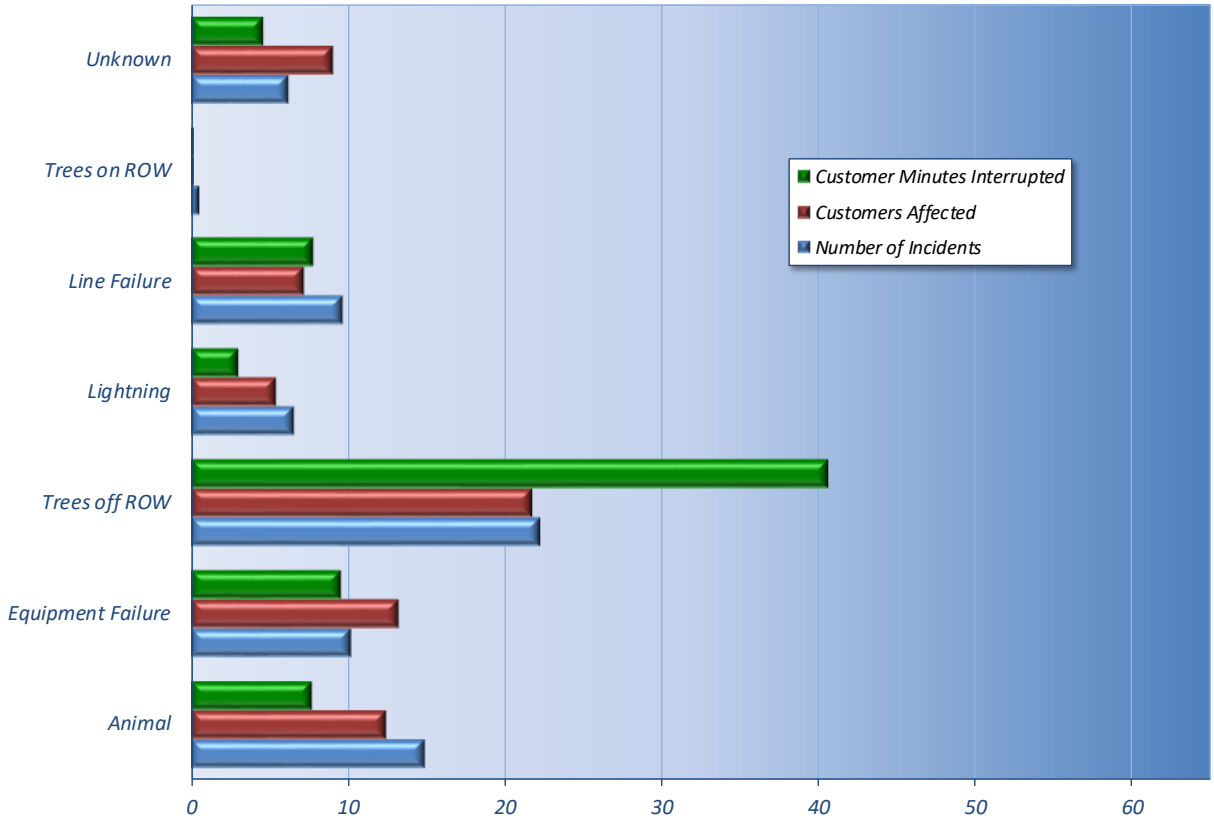
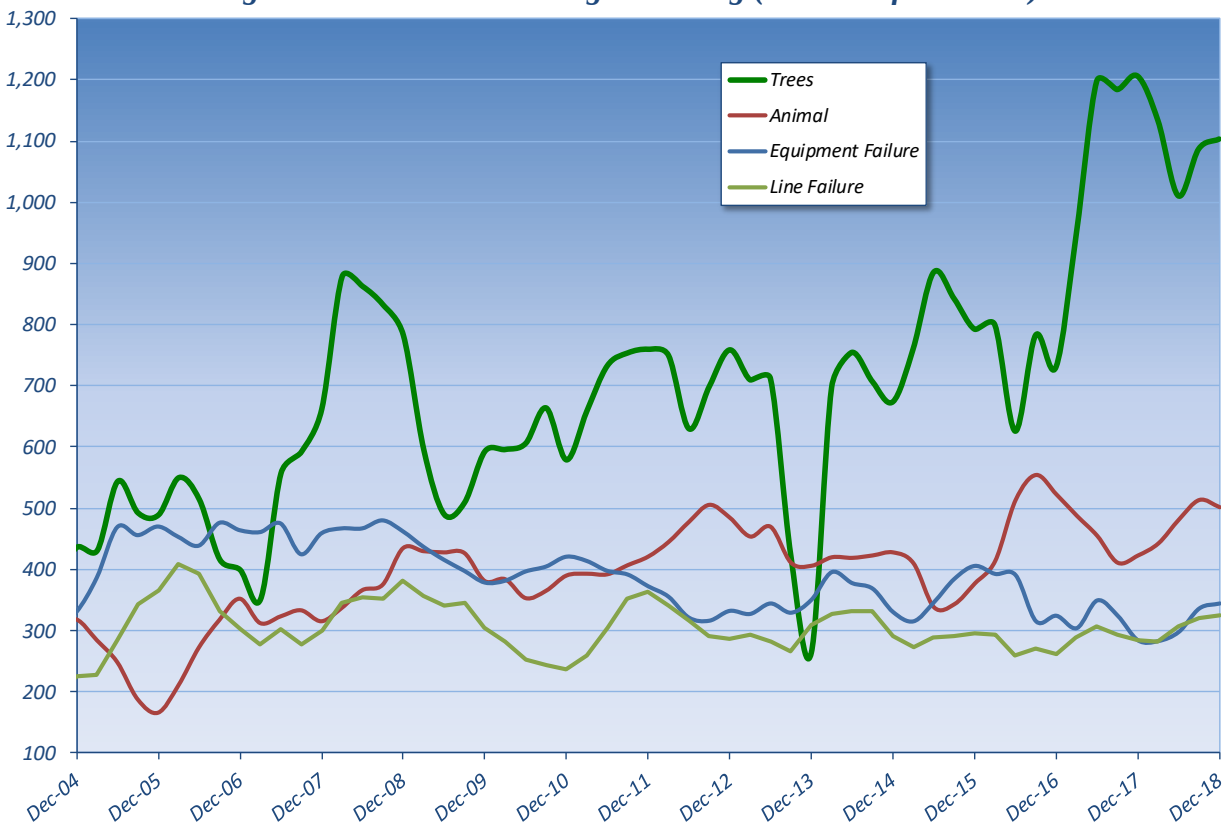


Figure 27 Penn Power Outage Tracking (number of incidents)



West Penn Power Company

West Penn has a service territory of about 10,400 square miles and serves about 710,000 customers.

In 2018, West Penn experienced 844,298 customers interruptions and 136.3 million customer-minutes interrupted as compared to 919,673 customer interruptions and 152.7 million customer-minutes interrupted in 2017, and 772,206 customer interruptions and 113.1 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Increased from 166 minutes in 2017 to 171 minutes in 2018; and failed to achieve benchmark by 1%.

3-year average: Increased from 156 minutes in 2017 to 161 minutes in 2018; and achieved standard by 14%.

SAIDI

Rolling 12-month: Decreased from 214 minutes in 2017 to 209 minutes in 2018; and failed to achieve benchmark by 17%.

3-year average: Increased from 184 minutes in 2017 to 194 minutes in 2018; and achieved standard by 11%.

SAIFI

Rolling 12-month: Decreased from 1.29 outages in 2017 to 1.22 outages in 2018; and failed to achieve benchmark by 16%.

3-year average: Increased from 1.18 outages in 2017 to 1.2 outages in 2018; and failed to achieve standard by 3%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 28 and 29. West Penn's CAIDI performance trend has historically been erratic. However, from 2014 through part of 2018, West Penn was positively below the "green" benchmark performance upper-control-limit-line. The last CAIDI data point is slightly negatively above the "green" benchmark performance upper-control-limit-line. It appears more management attention is needed to address the inconsistent CAIDI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Beginning in 2004, West Penn's SAIFI performance trend has been chronically outside of acceptable tolerances. From 2010 through 2018, the overall trend has been continually trending negative above the "green" benchmark performance upper-control-limit-line. It appears more management attention is needed to address the inconsistent SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Outage Causes

Figure 30 shows the reported 2018 outage-cause categories, as a percentage, for the following three distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Equipment failure (includes line failure) and trees (includes tree sub-categories) were the top cause of outages, customers affected, and customer-minutes interrupted. About 33% of outages are caused by trees (includes all 4 tree sub-categories, and 2 are not shown) and 32% are caused by equipment failure (includes line failure).

Figure 31 shows historical trend of the top 3 main outage causes. Trees and equipment failure are the 2 most frequent causes of power outages. Equipment failure (includes line failure) and trees (includes all 4 tree sub-categories, and 2 are not shown) and are the 2 most frequent outage-causes that are significantly negatively affecting West Penn's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

In 2016, West Penn started to execute its Long-Term Infrastructure Improvement Plan (LTIIP). This plan included expenditures and programs designed to accelerate repairment, improvement or replacement of aging infrastructure in order to adequately maintain and improve the efficiency, safety, adequacy and reliability of the distribution system. On January 18, 2019, West Penn filed a Petition for Approval of Modification of its Long-Term Infrastructure Improvement Plan in order to increase overall spending in the 2019 program year. The Petition was approved, as filed, on May 23, 2019.[35]

The PUC has also been performing extra monitoring of West Penn's work management system and Reliability Improvement Plan (RIP) beginning in 2015 as a result of a Commission Motion regarding FirstEnergy's Implementation Plan to the findings of the Commission's Focused Management and Operations Audit.[36]

West Penn employs various programs to strengthen the durability and flexibility of the electric system. Methods to improve the efficiency, adequacy, and reliability of the distribution system are a continual focus. West Penn utilizes core programs to support cost-effective and reliable service. These programs include, but are not limited to:

- Routine cycle tree trimming that removes selected incompatible trees within the clearing zone corridor, removes certain defective limbs that are overhanging primary conductors, controls selected incompatible brush, and removes off right-of-way priority trees.

- Enhanced tree trimming that complements the routine cycle tree trimming by removing healthy limbs overhanging primary conductors on areas where it's determined to be beneficial.

[35] Docket No. P-2015-2508942
[36] Final Order entered Nov 5, 2015, at Docket Nos. D-2013-2365991, D-2013-2365992, D-2013-2365993, and D-2013-2365994.

- In response to damage caused by the Emerald Ash Borer, West Penn implemented a program to proactively remove Ash Trees off right-of-way.

- Post-storm circuit patrols that target the areas with high tree-related outages. Circuit patrols identify trees damaged in a storm that may eventually lead a future outage. Once identified, the tree is removed. In addition, damaged equipment identified as part of the circuit patrol is repaired or replaced.

- After each significant storm event, West Penn conducts post-storm review meetings to identify and disseminate lessons learned which are used to improve the emergency response plan.

- From storm review action items identified as a result of 2018 and early 2019 restoration events, West Penn will implement the following changes:

    - Initiated technology readiness procedures to ensure damage assessment collection technology can fully be used for assessment information collection and transfer.

    - Improved contractor crew make-up reporting to ensure external resources are being appropriately assigned and used efficiently.

    - Developed an "in event" review processes to ensure organizational storm process adherence.

- The Customers Experiencing Multiple Interruptions ("CEMI") program is aimed to reduce frequent or repeated outages for affected clusters of customers or frequently operated devices.

- Load forecasting and distribution planning is used to estimate future substation and circuit loading based upon historical load data. The planning criteria guidelines are then used to provide a consistent approach for planning the safe, reliable, orderly, and economic expansion of the distribution system.

- Circuit protection practices are aimed at achieving safety and security for the public and employees, maximizing service reliability to customers, minimizing damage to distribution equipment, and establishing a consistent process and set of application standards for distribution circuit protection.

- Line Rehabilitation continues to strengthen the electrical system, West Penn performs targeted circuit rehabilitation in Zone 1 and Zone 2 areas, focusing on circuits having a high rate of equipment and line failure and animal-caused outages. Equipment that may be replaced includes crossarms, capacitors, insulators, lightning arresters and connectors. West Penn completed the rehabilitation on 36 circuits in 2018 as compared to 44 circuits in 2017.

- Supervisory control and data acquisition (SCADA) devices are being installed where circuit conditions and system performance warrant. SCADA controlled reclosers and switches and automatic switch modernization will provide enhanced sectionalizing for larger blocks of customers at the substation level. Remote switching eliminates the need to dispatch crews to manually operate the switches, resulting in fewer customers affected and reduced outage duration. West Penn installed 51 SCADA reclosers or switches in 2018 as compared to 72 SCADA switches in 2017.

- Substation circuit breakers, station transformers, and other substation equipment; such as insulators, switches, buses, arresters and conductors that are obsolete or in poor condition are being replaced with new equipment. West Penn notes that proactively replacing older equipment increases substation reliability and reduces the occurrence of equipment failure. West Penn replaced 62 pieces of equipment in 2018 as compared to 69 pieces of equipment in 2017.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to West Penn customers. In 2018, trees and equipment failure outage causes contributed to over 64% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

West Penn experienced 4 Major Events (including one event that was denied and is under appeal) where West Penn customers experienced a loss of **151,359,819 customer-minutes interrupted**.

Beginning with 2004, West Penn CAIDI and SAIFI benchmark performance has been erratic and frequently outside of acceptable tolerances and West Penn has achieved CAIDI benchmark performance less than 45% of the time and SAIFI benchmark performance 15% of the time. From 2014 through 2017, West Penn's CAIDI has achieved benchmark performance. However, in 2018, West Penn failed to achieve CAIDI benchmark performance. More management attention is needed in the future to sustain the trend line below the "green" benchmark performance upper-control-limit-line. West Penn through its RIP will need to address the continual poor SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

It should also be noted that Major Events had a significant negative impact on West Penn's customers that is not reflected in CAIDI and SAIFI performance metrics.

Figure 28 West Penn CAIDI (minutes)

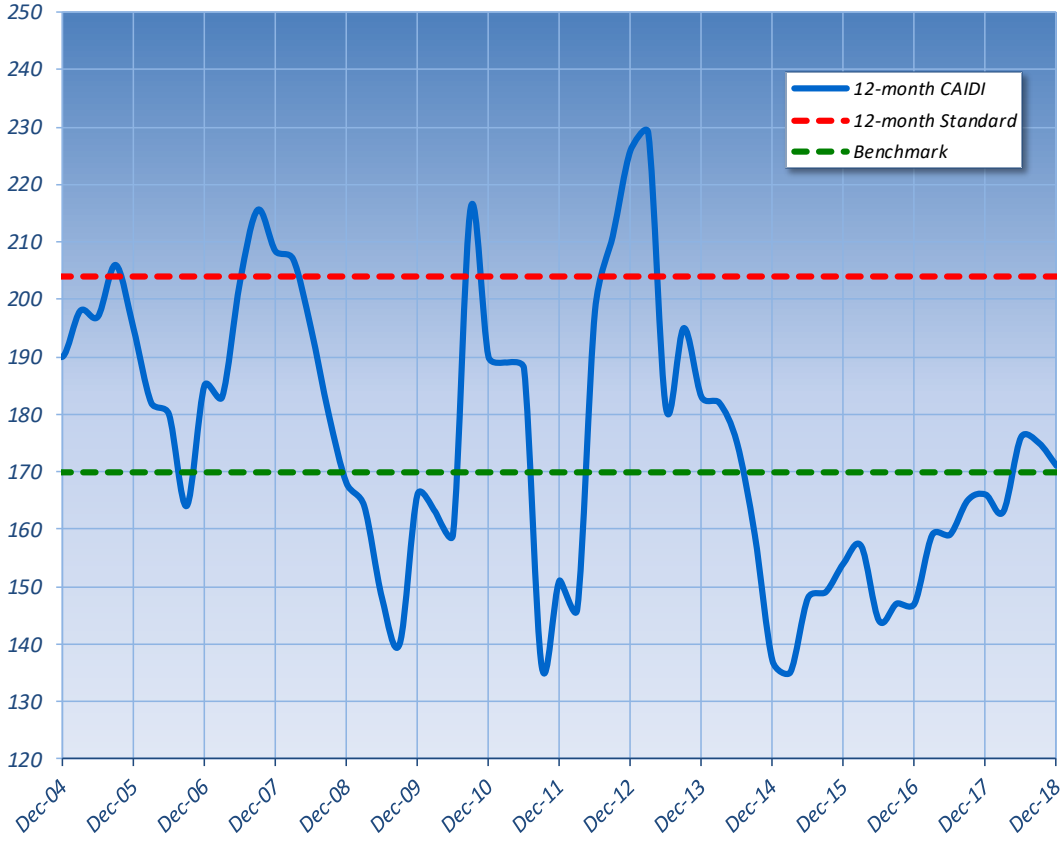


Figure 29 West Penn SAIFI (interruptions per customer)

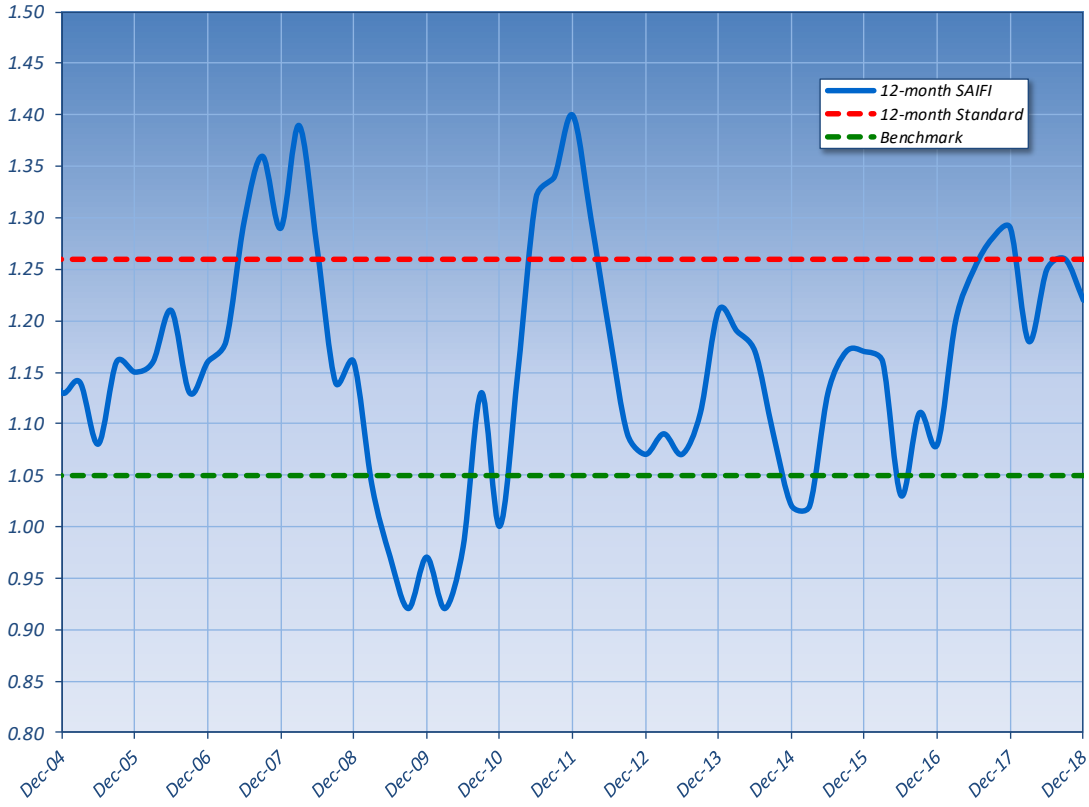


Figure 30 West Penn Outage Causes (percent of total outages)

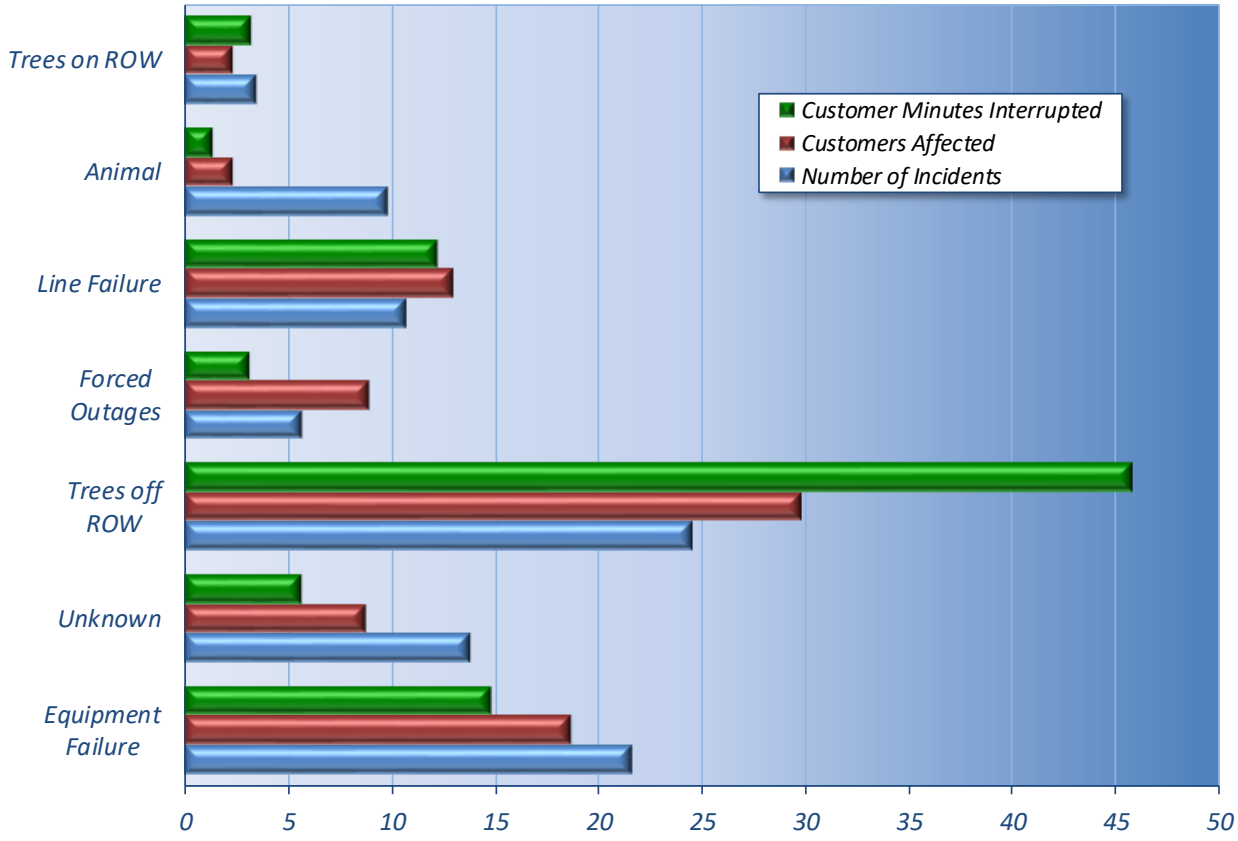
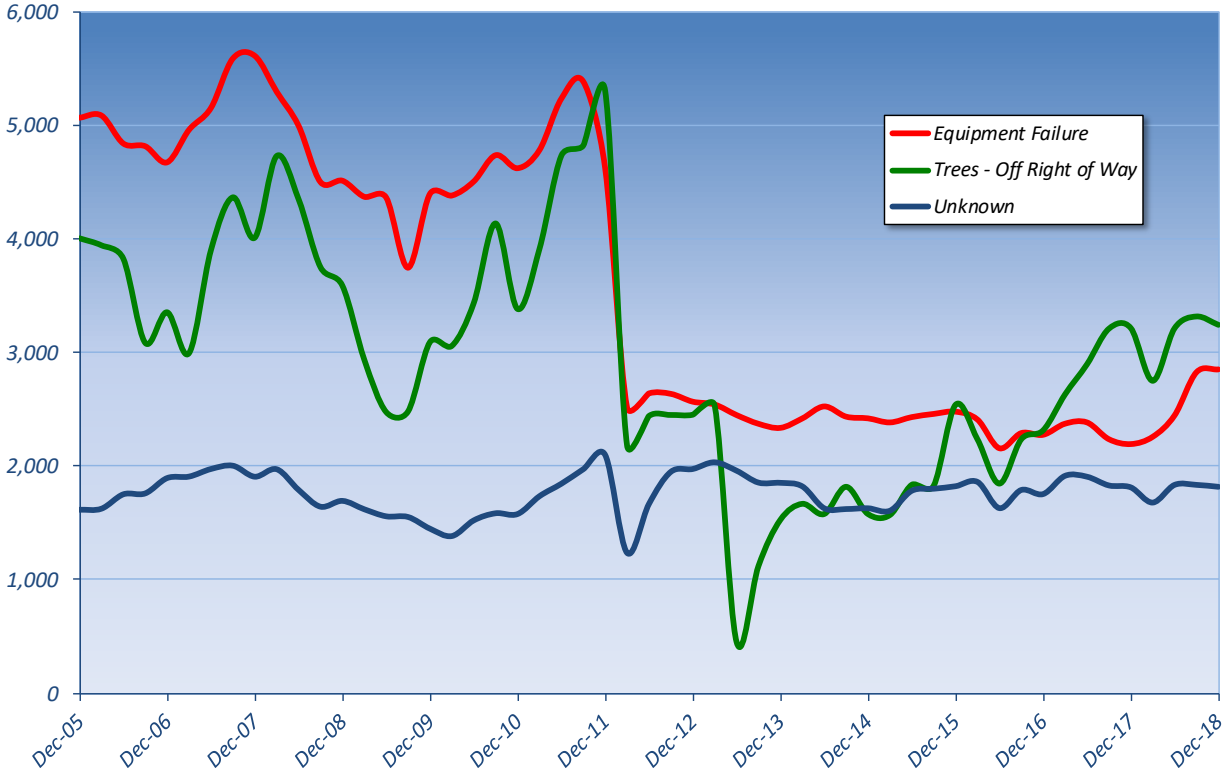


Figure 31 West Penn Outage Tracking (number of incidents)



Citizens' Electric Company

Citizens' has an operating service area of about 41 square miles with about 6,963 customers. The electric system consists of 1 distribution substation and 9 distribution feeder lines.

In 2018, Citizens' experienced 1,449 customers interruptions and 109,478 million customer-minutes interrupted as compared to 3,180 customer interruptions and 588,067 million customer-minutes interrupted in 2017, and 1,787 customer interruptions and 192,235 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Decreased from 185 minutes in 2017 to 76 minutes in 2018; achieved benchmark by 28%.

3-year average: Decreased from 128 minutes in 2017 to 123 minutes in 2018; failed to achieve standard by 7%.

SAIDI

Rolling 12-month: Decreased from 84 minutes in 2017 to 16 minutes in 2018; achieved benchmark by 24%.

3-year average: Remained the same from 43 minutes in 2017 to 43 minutes in 2018; failed to achieve standard by 70%.

SAIFI

Rolling 12-month: Decreased from 0.45 outages in 2017 to 0.21 outages in 2018; achieved benchmark by 5%.

3-year average: Increased from 0.30 outages in 2017 to 0.31 outages in 2018; failed to achieve standard by 40%.

Note: Smaller SAIFI values are typical for companies with fewer customers. Smaller systems tend to experience more variability in service outage data, which is captured in the development of historical SAIFI. This data can only be used with the historical performance of Citizens' to access reliability performance and actual values are not valid for comparisons among other EDCs.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 32 and 33. Beginning in 2004, Citizens' CAIDI performance trend has been overall positive approximately 80% of the time. However, from the 3rd quarter 2015 through the 3rd quarter 2018, Citizens' CAIDI performance has been frequently outside of acceptable tolerances. Citizens' CAIDI ended the 4th quarter 2018 positively below the "green" benchmark performance upper-control-limit-line. It appears the Citizens' CAIDI performance trend is now in a positive direction. However, more management attention is needed to ensure consistent CAIDI performance is now sustained below the "green" benchmark performance upper-control-limit-line. It should be noted that Citizens' CAIDI of 76 minutes is the best relative to any other Pennsylvania EDC.

Beginning in 2004, Citizens' SAIFI performance trend has been overall positive about 25% of the time. From the 4th quarter 2014 through the 4th quarter 2018, Citizens' SAIFI performance has been inconsistent and frequently above the "green" benchmark performance upper-control-limit-line. More management attention is needed to ensure consistent SAIFI performance is sustained below the "green" benchmark performance upper-control-limit-line. It should be noted that Citizens' 0.21 SAIFI performance is the best relative to any other Pennsylvania EDC, but based on the tighter indices calculated at the time of deregulation, Citizens' performance is still considered outside of acceptable tolerances.

Outage Causes

Figure 34 shows the reported 2018 outage-cause categories, as a percentage, for the following three distinct performance metrics: Customer-minutes Interrupted; Customers Affected; and Number of Incidents. Weather, equipment failure, and trees (includes tree sub-categories) were the top causes of customer-minutes interrupted, and number of customers affected. Equipment failure and trees (including tree sub-categories) caused the most number of incidents.

Figure 35 shows the historical trend of the top 4 main outage causes. Trees and equipment failure are the two most frequent outage-causes that are significantly negatively affecting Citizens' distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

Beginning in 2012, Citizens' Electric has been investing increasing resources to identify and remove off right-of-way hazard trees. A primary focus has been the continuing impact from the Emerald Ash Borer. Citizens' has committed additional resources to identify, prioritize and remove significant threats to reliability from hazard trees during 2019.

Citizens' notes that the exceptionally wet summer and fall of 2018 caused a significant number of hazard tree related outages, but also confirmed the value of the steps taken to date to identify and eliminate off right-of-way hazard trees. Citizens' continues to maintain its focus in this area and has begun a program to expand trimming clearances to further reduce vegetation related outages over the next trimming cycle.

Weather related outages caused the greatest impact to customers in 2018. Citizens' has budgeted a major reliability project in 2019 aimed at improved sectionalizing and isolating capabilities for a line-section that impacts over 1,000 customers (nearly 15% of total customer base). The project will allow 3 line-sections with a history of tree and weather-related outages to be completely isolated, restoring all customers prior to making repairs. Additional prescriptive tree trimming was also performed in these areas following the scheduled trimming work in 2018, further reducing the likelihood of future outages.

Citizens' experienced typical outages from spring wind, summer thunderstorms and winter snows. No significant tropical systems impacted the area. However, 2 significant weather events did occur.

- In November of 2018, a winter storm bringing a mixture of heavy, wet snow and ice caused outages on 69kV sources. Repairs were made quickly by PPL, who is the owner/operator

of the 69kV lines, and the event highlighted the value of the regular and reliable communications established between the Company and PPL's transmission operations.

- In April of 2019, an EF-1 tornado, accompanied by straight-line wind and down-draft phenomena affected Citizens' territory, with the tornado taking a path directly across the center. Based on total customers affected, this event is the second most impactful on record for the Company. Two key opportunities were gained from the event and, additionally, several earlier initiatives were proved effective.

- Lessons Learned/Key Opportunities:

    - 'No Outage' process was cumbersome in large volumes and caused temporary loss of 'No Outage' tickets. This deficiency will be explored with the outage management system (OMS) vendor and reviewed with dispatch employees resolved.

    - Foreign crews showed interest in utilizing the Company outage restoration app. The Company and its affiliates are exploring use of app when crossing company boundaries and this may be expanded to include any mutual aid crew in the future.

- Notable Successes:

    - AppSuite: Outage restoration AppSuite allowed management and crew chiefs to be immediately notified and assess an outage situation remotely, and allowed most linemen to be aware of the extent of outages prior to being called in.

    - Capacity Additions/Tie Strengthening: Projects to improve transfer capabilities were deployed. This allows Citizens' to transfer some customers to an alternate feed and isolate a line for repairs with the least number of customers impacted.

    - Affiliate Company Mutual Aid: Citizens' affiliates under C&T Enterprises have significant geographic diversity. During an April storm system, 2 of 4 affiliates were heavily damaged, however were still able to draw mutual aid from the other two affiliates.

Citizens' continues to identify and replace equipment known to be failure prone; namely specific vintages of porcelain arrestors and cutouts. All new cutouts use polymer-based insulators.

Citizens' recently began a project to replace all remaining first-generation smart meters within 5 years. The project is currently on schedule, with over 33% of the 2019-meter exchanges completed YTD. Replacing these meters will provide many benefits, including faster, more-reliable communications. This will help operations staff more quickly assess outages, dispatch repair crews, verify restorations, monitor voltage quality, and identify areas of load growth. All smart grid systems, including automated meter reading (AMR) infrastructure, OMS, GIS Mapping, and associated online and telephone customer service systems are fully operational and ready for processing outage transactions.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to Citizens' customers. In 2018, trees and equipment failure outage causes contributed to over 56% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

Citizens' experienced 6 Major Events where Citizens' customers experienced a loss of **1,648,350 customer-minutes interrupted**.

Beginning in 2004, Citizens' CAIDI and SAIFI benchmark performance has been erratic and frequently outside of acceptable tolerances and Citizens' has achieved CAIDI benchmark performance 65% of the time and SAIFI benchmark performance 32% of the time. Citizens' has failed to achieve CAIDI benchmark performance from 2016 until the last quarter in 2018. More management attention is needed in the future to sustain the trend line below the "green" benchmark performance upper-control-limit-line. Citizens' SAIFI performance trend is poor, and more management attention is needed to address the performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

It should also be noted that Major Events had a significant negative impact on Citizens' customers that is not reflected in CAIDI and SAIFI performance metrics.

Figure 32 Citizens' CAIDI (minutes)

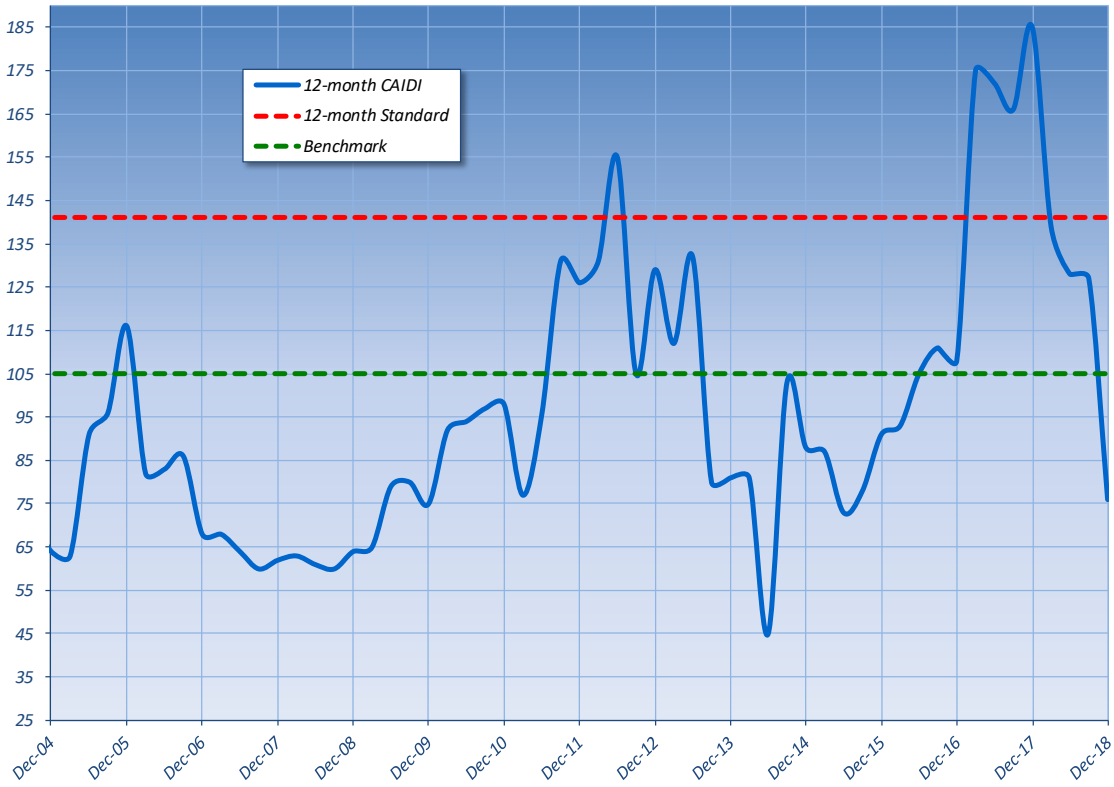


Figure 33 Citizens' SAIFI (interruptions per customer)

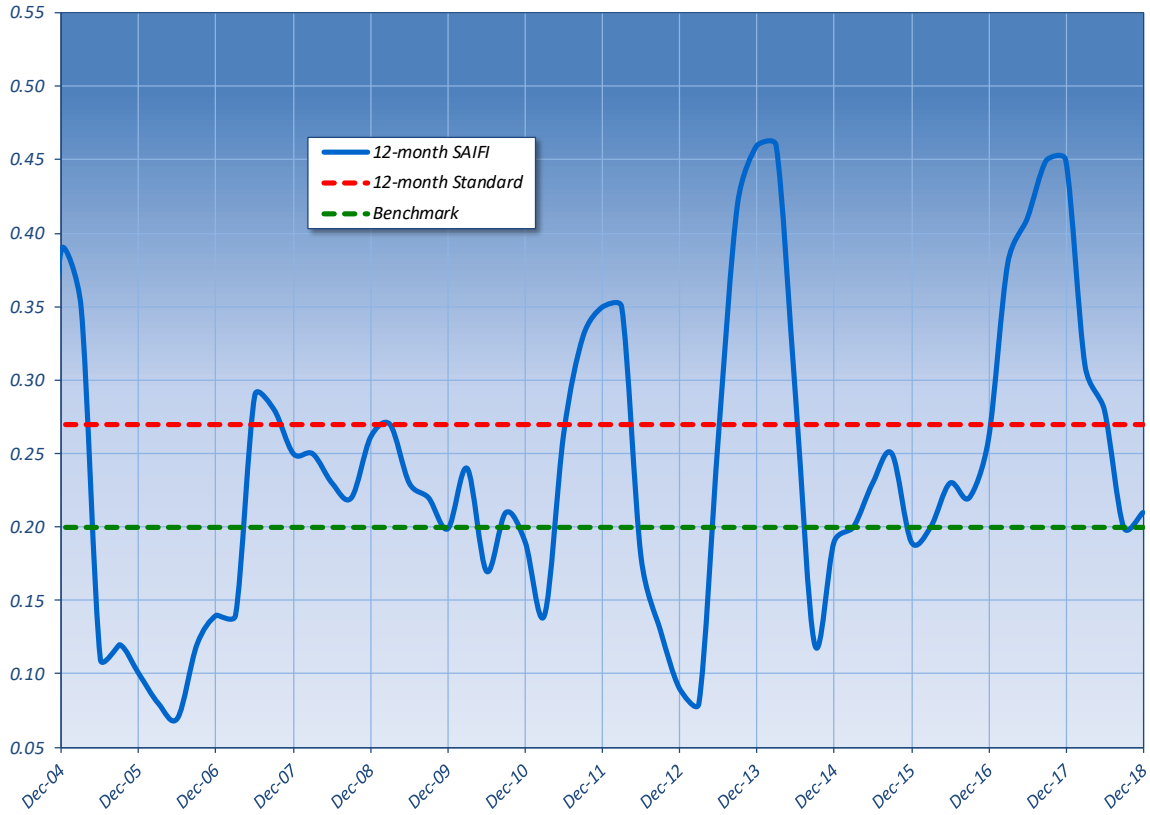


Figure 34 Citizens' Outage Causes (percent of total outages)

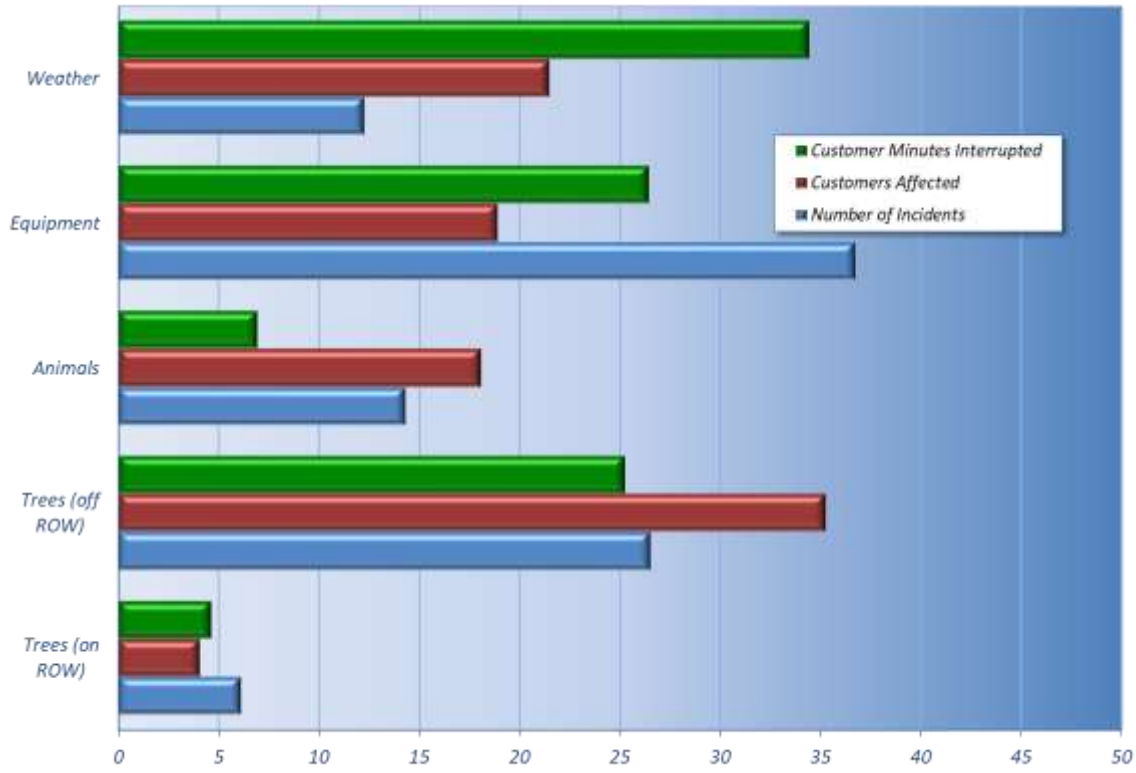
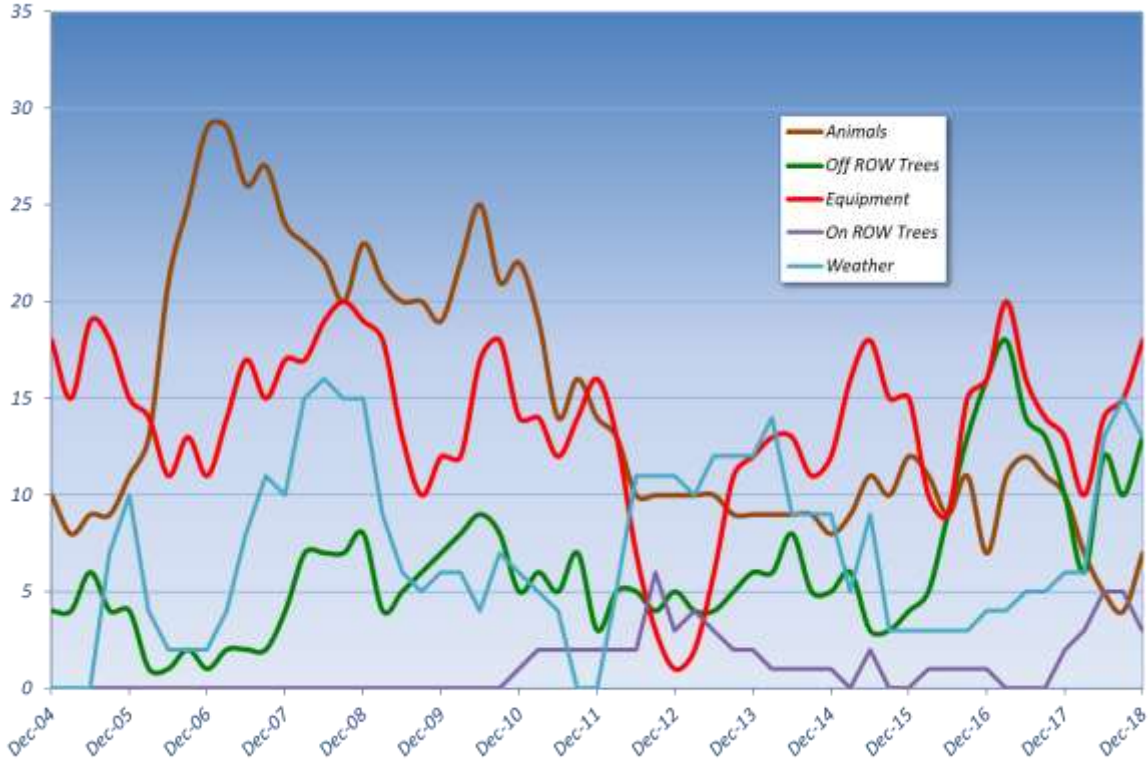


Figure 35 Citizens' Outage Tracking (number of incidents)



Pike County Light & Power Company

Pike has a relatively small operating service area of approximately 44 square miles with about 4,429 customers. Pike is primarily fed from 2 34.5-kilovolt (kV) feeders supplied from New York substations and the eastern portion of Pike service territory is fed by 2 13.2 kV feeders from the Matamoras Substation.

In 2018, Pike experienced 4,057 customers interruptions and 872,312 customer-minutes interrupted as compared to 4,648 customer interruptions and 475,003 customer-minutes interrupted in 2017, and 1,735 customer interruptions and 394,826 customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Increased from 185 minutes in 2017 to 236 minutes in 2018; and failed to achieve benchmark by 36%.

3-year average: Increased from 206 minutes in 2017 to 216 minutes in 2018; and failed to achieve standard by 13%.

SAIDI

Rolling 12-month: Increased from 102 minutes in 2017 to 200 minutes in 2018; failed to achieve benchmark by 89%.

3-year average: Increased from 89 minutes in 2017 to 130 minutes in 2018; failed to achieve standard by 0.5%.

SAIFI

Rolling 12-month: Increased from 0.53 outages in 2017 to 0.85 outages in 2018; failed to achieve benchmark by 40%.

3-year average: Increased from 0.43 outages in 2017 to 0.59 outages in 2018; achieved standard by 12%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 36 and 37. From 2004 through 2018, Pike's CAIDI performance has been positive less than 40% of the time. In general Pike's performance has been poor and frequently above the "green" benchmark performance upper-control-limit-line. More management attention is needed to ensure consistent CAIDI performance is sustained below the "green" benchmark performance upper-control-limit-line

From 2004 through 2018, Pike's SAIFI performance trend has been overall positive less than 50% of the time. Pike's 2018 SAIFI has been negatively above the "green" benchmark performance upper-control-limit-line. More management attention is needed to ensure consistent SAIFI performance is sustained below the "green" benchmark performance upper-control-limit-line.

Outage Causes

Figure 38 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Trees and equipment failure were the top cause of outages, customers affected, and customer-minutes interrupted. About 48% of outages are caused by trees and 17% are caused by equipment failure.

Figure 39 shows the historical trend of the top 3 main outage causes. Trees and Equipment failure are the two most frequent outage-causes that are significantly negatively affecting Pike's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

Pike has continued the usage of a smart fault indicators ("SFI"). In addition, Pike has pole top reclosers and substation devices that are monitored and controlled by Pike's SCADA System as of June 2018.

The defective poles identified during the 2015 (Pike was owned by Orange and Rockland Utilities at that time), 2017, and 2018 pole inspection programs are being replaced. The inspection program will result in the replacement of over 100 defective poles.

Pike utilized a drone company for infrared, pole top, and overhead transformer inspections in the fall of 2018.

Pike's vegetation management program consists of: (1) a not to exceed 5-year scheduled preventive vegetation management cycle; (2) removal of danger trees/leaders when identified or requested by a municipality/customer; and (3) a hot spot trimming program that is applied as necessary.

Scheduled preventive vegetation management work was completed in the fall of 2017 on the 13.2kv distribution circuit, which is 40% of the system. The remaining 60% on the 34.5kv system was trimmed in the fall of 2018. Hot spotting, (applying 34.5kv cycle specification) within the "Pine Tree Alley" portion of the 34.5kv feeder into Milford Borough will be performed in the summer and fall of 2019. There were some off-right-of-way removals in coordination with the Milford Borough and Pike County management. The schedule for the next preventive vegetation management cycle will commence in fall of 2020 on the 13.2kv distribution circuit.

Pike experienced 2 severe storms that qualified as Major Events in 2018. The first major storm was winter storm "Riley", and was a Pennsylvania-wide storm. The PUC Riley lesson learned report identified universal recommendations applicable to all Pennsylvania utilities and specifically suggested Pike consider utilizing an LTIIP for storm hardening and system improvements. The recommendations are under internal review as well as the Pennsylvania inter-utility reviews. Pike's General Manager participates on the "EDC Storm Best Practices" working group.

Pike will soon implement a storm response process for contractor operations response teams and will follow the general sequence for the restoration of the electric delivery system:

- Working with Municipalities, wires/trees down in heavy pedestrian areas or state or emergency service road closures and Municipally reported wires down or road closures;

- Mainline restoration of 34.5kv system which includes Critical facilities, including hospitals, police and fire stations, water supply and sewage;

- Mainline restoration of 13.2kv system including police and fire stations, water supply and sewage

- All other wires down and road closures and all distribution circuit lockouts;

- All other affected customers prioritized laterals, service transformers and individuals.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to Pike customers. In 2018, trees and equipment failure outage causes contributed to over 77% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

Pike experienced 2 Major Events where Pike customers experienced a loss of **424,405,731 customer-minutes interrupted**.

From 2004 through 2018, Pike's CAIDI and SAIFI benchmark performance has been erratic and frequently outside of acceptable tolerances. Pike has achieved CAIDI benchmark performance 38% of the time and SAIFI benchmark performance 45% of the time. Pike failed to achieve CAIDI benchmark performance in 2018. More management attention is needed in the future to sustain the trend line below the "green" benchmark performance upper-control-limit-line. Pike failed to achieve SAIFI performance in 2018. More management attention is needed to address the chronic failing performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

It should also be noted that Major Events had a significant negative impact on Pike customers that is not reflected in CAIDI and SAIFI performance metrics.

Figure 36 Pike County CAIDI (minutes)

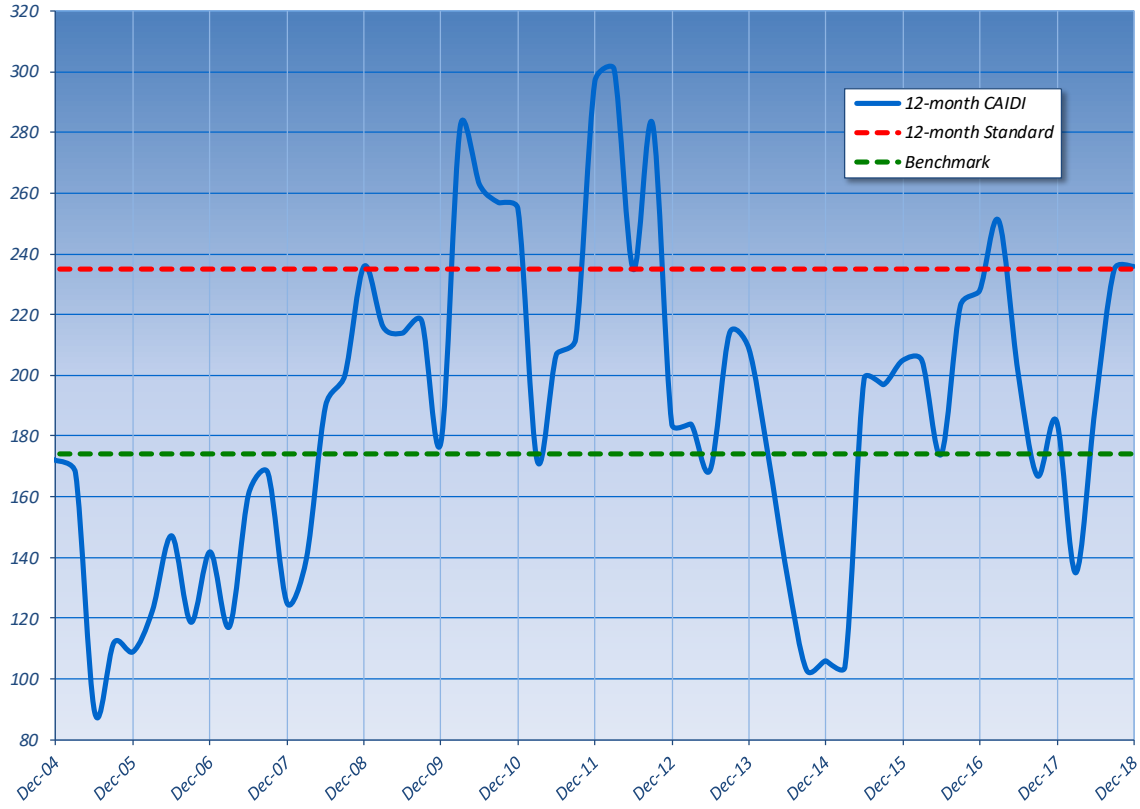


Figure 37 Pike County SAIFI (interruptions per customer)

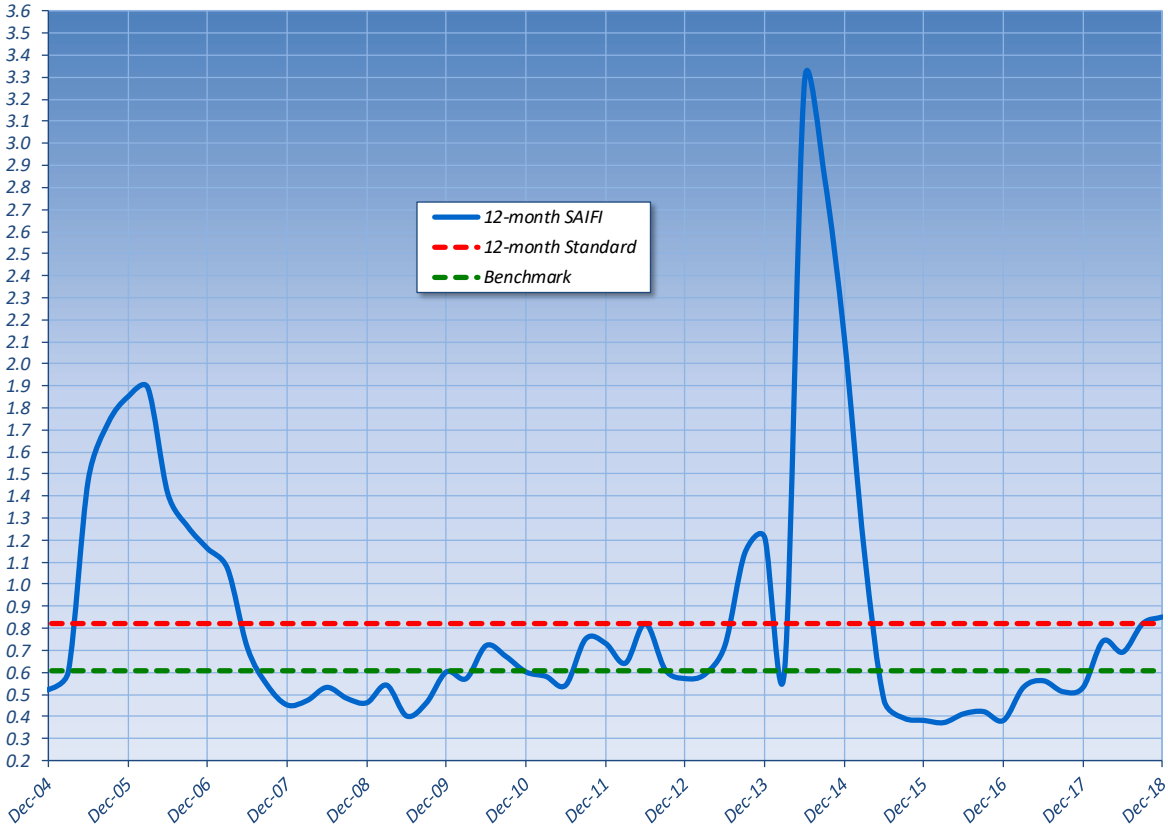


Figure 38 Pike County Outage Causes (percent of total outages)

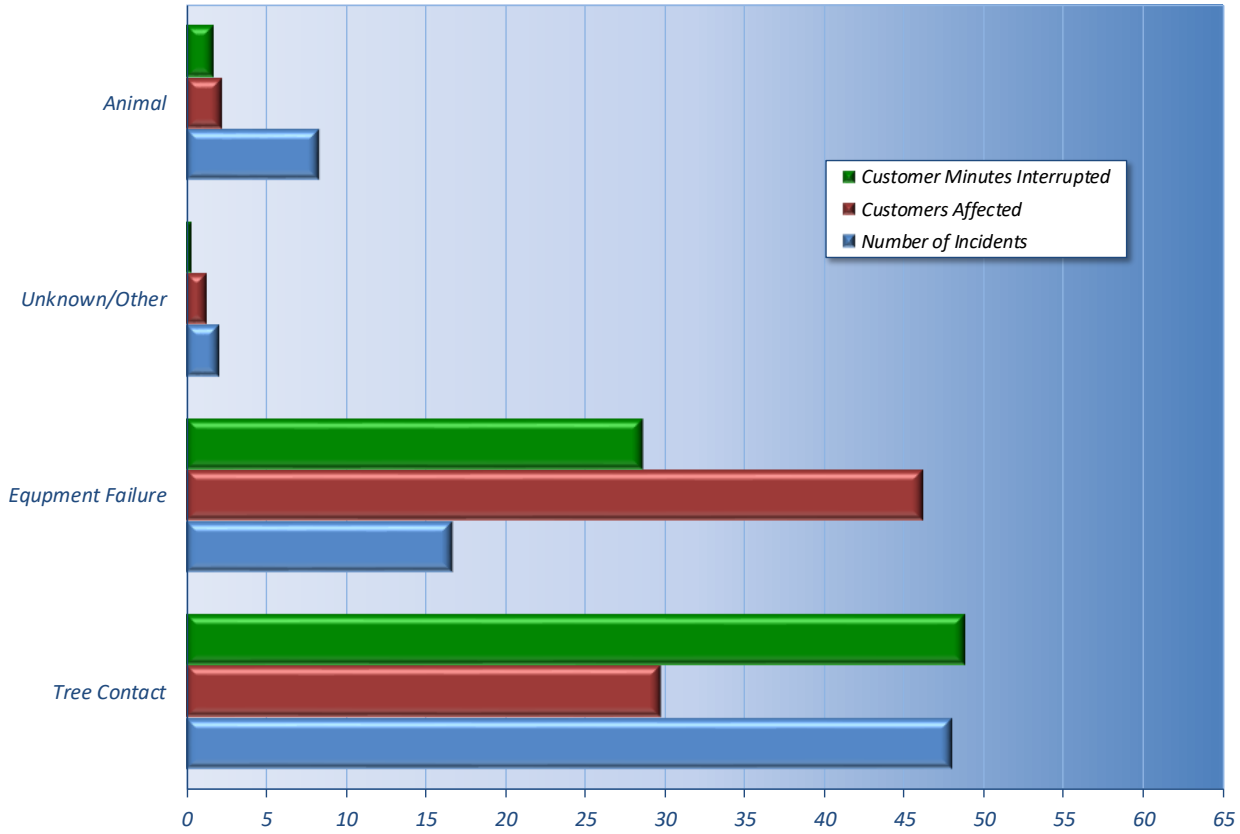
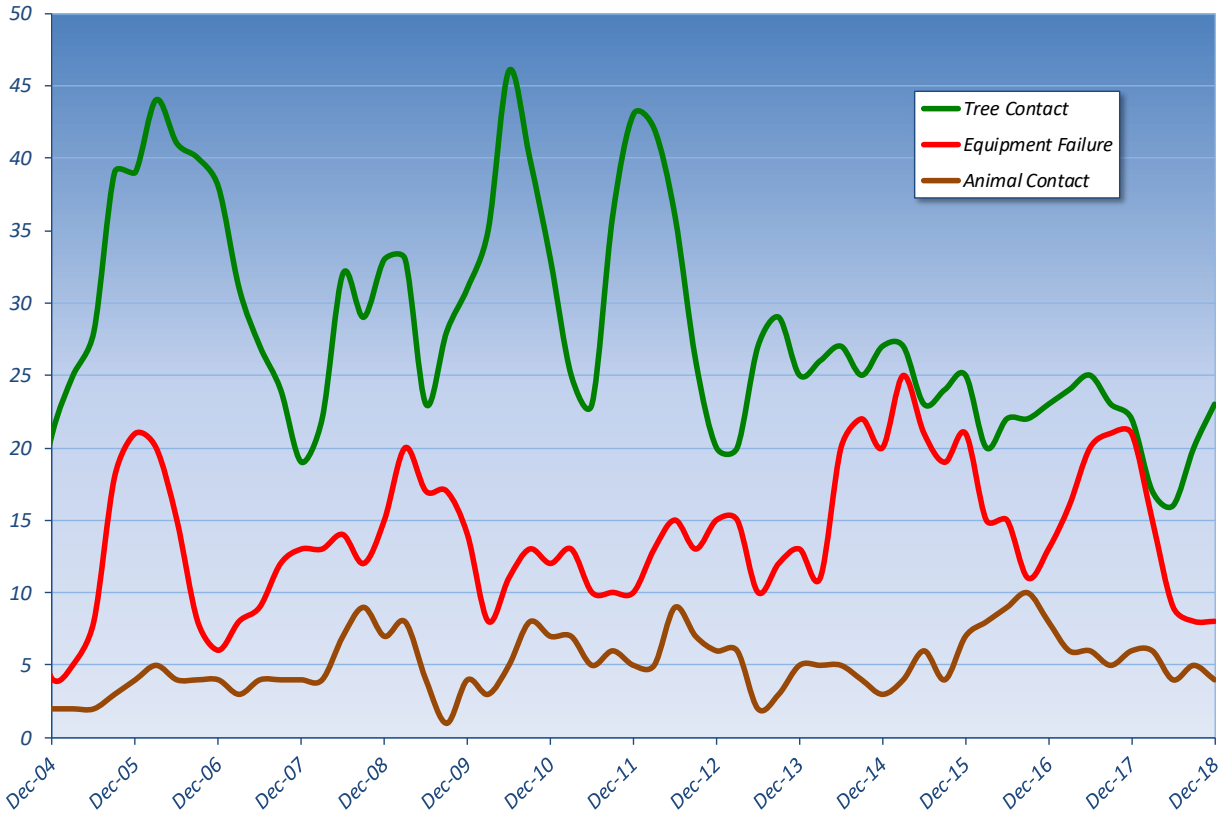


Figure 39 Pike County Outage Tracking (number of incidents)



UGI Utilities Inc.

UGI has a service territory of about 410 square miles and serves about 61,200 customers.

In 2018, UGI experienced 31,305 customers interruptions and 4.1 million customer-minutes interrupted as compared to 31,395 customer interruptions and 4.1 million customer-minutes interrupted in 2017, and 38,909 customer interruptions and 4.9 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Increased from 131 minutes in 2017 to 178 minutes in 2018; failed to achieve benchmark by 5%.

3-year average: Increased from 120 minutes in 2017 to 145 minutes in 2018; achieved standard by 22%.

SAIDI

Rolling 12-month: Increased from 64 minutes in 2017 to 213 minutes in 2018; failed to achieve benchmark by 52%.

3-year average: Increased from 61 minutes in 2017 to 118 minutes in 2018; achieved standard by 30%.

SAIFI

Rolling 12-month: Increased from 0.49 outages in 2017 to 1.19 outages in 2018; failed to achieve benchmark by 43%.

3-year average: Increased from 0.51 outages in 2017 to 0.77 outages in 2018; achieved standard by 15%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 40 and 41. During the last 2 quarters of 2018, UGI's CAIDI performance trend has been negative, as shown on the chart to be above the "green" benchmark performance upper-control-limit-line. However, CAIDI performance from 2004 up to that time was below the benchmark performance upper-control-limit-line. Prior to 2018, UGI was a consistent CAIDI Benchmark Performer. UGI appears to be recovering, but more management attention is needed to ensure CAIDI performance is again being sustained below the "green" benchmark performance upper-control-limit-line.

During the last 2 quarters of 2018, UGI's SAIFI performance trend has been negative, as shown on the chart to be above the "green" benchmark performance upper-control-limit-line. However, UGI's SAIFI performance from 2004 up to that time was below the benchmark performance upper-control-limit-line. Prior to 2018, UGI was a consistent SAIFI Benchmark Performer. More management attention is needed to ensure SAIFI performance is again being sustained below the "green" benchmark performance upper-control-limit-line.

Outage Causes

Figure 42 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Trees and equipment failure were the top cause of outages, customers affected, and customer-minutes interrupted. About 34% of outages are caused by trees and 28% are caused by equipment failure.

Figure 43 shows historical trend of the top 3 main outage causes. Trees and Equipment failure are the 2 most frequent outage-causes that are significantly negatively affecting UGI's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

To bolster UGI's existing Danger Tree Mitigation Program, UGI added an additional vegetation clearance crew in 2018 to address the Emerald Ash Borers devastation of Pennsylvania's ash trees. UGI's Danger Tree Mitigation Program identifies and addresses trees that pose an elevated threat to both transmission and distribution facilities. In calendar year 2018, UGI removed 888 Ash trees, and an additional 551 have been removed year to date in 2019. UGI performs "ground-to-sky" trimming on all multi-phase circuits and on single-phase lines as necessary.

UGI's initiatives for storm hardening are designed primarily to reduce the number of outage events caused by vegetation. Outside of its Vegetation Management Program, several initiatives are ongoing to mitigate such risks.

UGI has continued its practice of using Class 3 Wood Poles when replacing or installing new poles on its distribution system. On its transmission system, steel, Class 1 or Class 2 poles are standard for replacement or new structures.

In line with the Company's Long-Term Infrastructure Improvement Plan (LTIIP), UGI continues to complete a variety of reliability-based projects. This includes a Primary Line Relocations Program focused on moving distribution lines from troublesome off-road locations to road-side rights-of-way. Relocating the lines to roadside enables quicker patrolling as well as making repairs quicker and safer because mechanized aerial equipment can be used as opposed to climbing the poles to do repair work.

UGI continues its Porcelain Cutout and Insulator Replacement Program where a targeted number of replacements are completed each fiscal year. Although being a long time standard within the utility industry, porcelain is more likely to crack/fail during extreme cold periods due to its susceptibility to moisture. Polymer type cutouts and insulators are less susceptible to moisture and subsequent failure improving overall system reliability.

In Fiscal Year 2018, UGI completed its initial survey of every distribution feeder as part of its Line Segmentation Program. This program focuses on identifying locations to install fuses, disconnects, and other devices to limit the number of customers affected when line damage occurs and enable field personnel to restore service to customers on unaffected line segments through switching before repairs are made. UGI noted the next phase of this program will add additional feeder segmentation, targeting specific areas which have been prioritized based on current reliability performance. In Fiscal Year 2019, UGI expects to add 20 fuse installations and replace 2 fuse installations with air-breaks.

UGI initiated a Distribution Automation Pilot Project in 2015 and based on its success, a 5-year project plan was developed to extend remote monitoring and control via wireless communication links to 3-phase reclosers on select feeders through-out the system. To date, 45 reclosers have been installed with, or upgraded, to have communications. Another 11 are planned to be completed by the end of Fiscal 2019. Remote management of these devices, by UGI System Operators, will significantly reduce switching times to sectionalize and/or restore customers impacted by outages.

Due to unfavorable weather conditions, UGI had 1 reportable event in 2018 and 1 reportable event in early 2019. The UGI Restoration Team meets bi-weekly to focus on training, best practices and technology enhancements. Following UGI's latest major storm event in April 2019, UGI conducted a post storm review to identify areas for improvement and to communicate lessons learned to the entire restoration team. The review produced the following recommendations:

- A need for additional damage assessment and support personnel (Complete) – UGI contracted with Osmose Utility Services Inc. to provide additional storm restoration services such as damage assessment and wire watching. In addition, UGI has contracted with Traffic Plan to provide additional flagging resources. Finally, UGI is also exploring the use of UGI Gas personnel to provide logistical and assessment support during storm restoration events (in progress).

- UGI is in the process of better defining specific storm roles and associated training which will allow for a more efficient utilization and mobilization of storm restoration resources. To date, UGI has defined nearly all storm roles, based on its modified Incident Command System (ICS), and is assigning personnel to fill those roles.

- A need for more frequent updates from field personnel relative to device status (Complete) – Enhancements to the Partner mapping system are on a continual basis from user recommendations. In addition, based on its modified ICS, UGI has identified a role to communicate with field resources to update device status.

- UGI continues to work with its field personnel to establish a process for defining estimated time of restoration (ETR) and communicate this information to its control center.

- UGI is working with its local 911 Agency to improve communications relative to providing crew ETA's in response to "blue-sky" type emergencies such as structure fires and downed or low wires.

Conclusion

Trees and Equipment failures are the top 2 outage causes that substantially negatively affect electrical reliability to UGI customers. In 2018, trees and equipment failure outage causes contributed to over 74% of the total lost customer-minutes and does not include any lost customer-minutes caused by Major Events.

UGI experienced no Major Events in 2018.

UGI has sustained CAIDI and SAIFI benchmark performance until 2018. In 2018 UGI has negatively ramped above the "green" benchmark performance upper-control-limit-line. More management attention is needed to address the CAIDI and SAIFI performance and sustain the trend line below the "green" benchmark performance upper-control-limit-line.

Figure 40 UGI CAIDI (minutes)

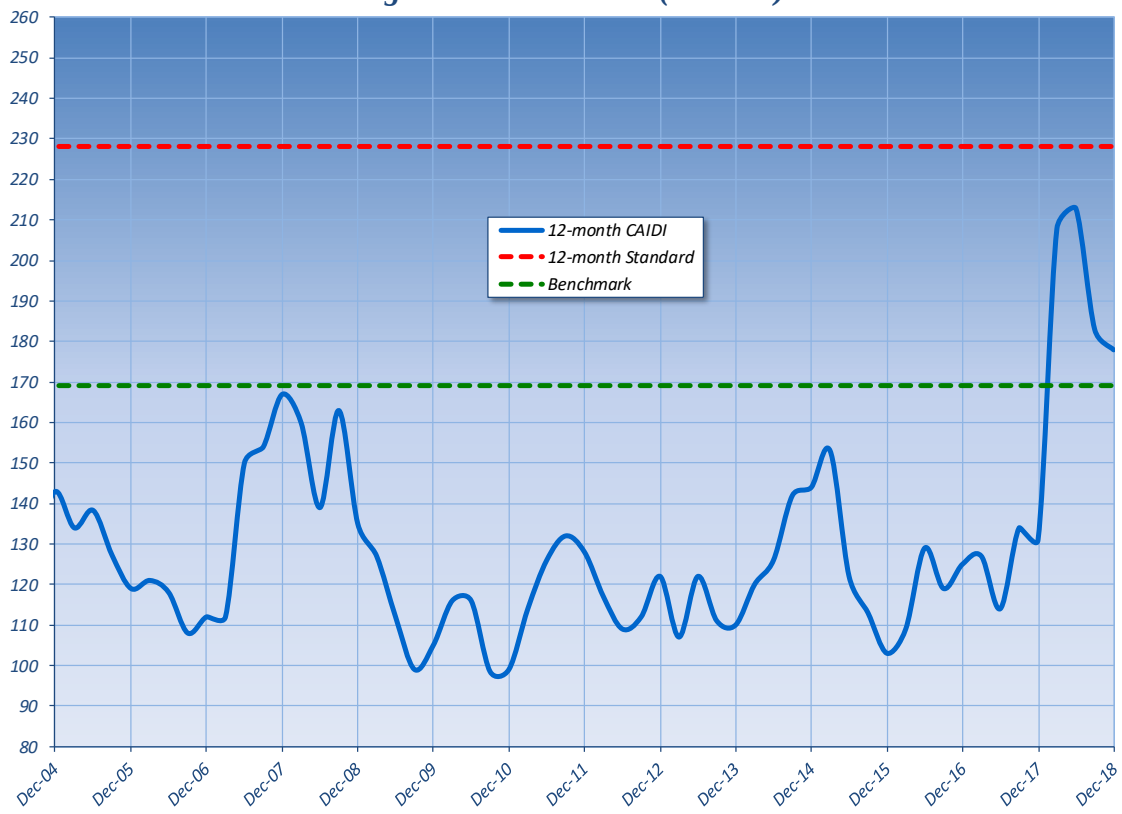


Figure 41 UGI SAIFI (interruptions per customer)

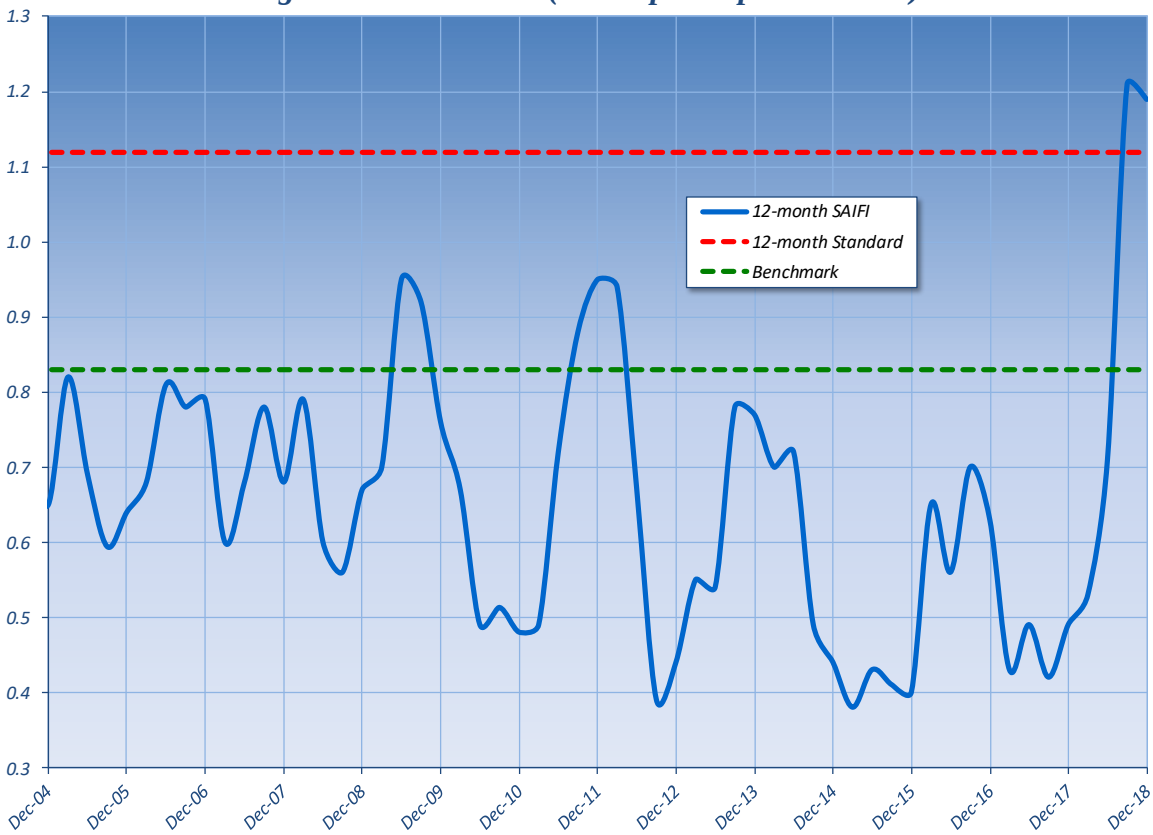


Figure 42 UGI Outage Causes (percent of total outages)

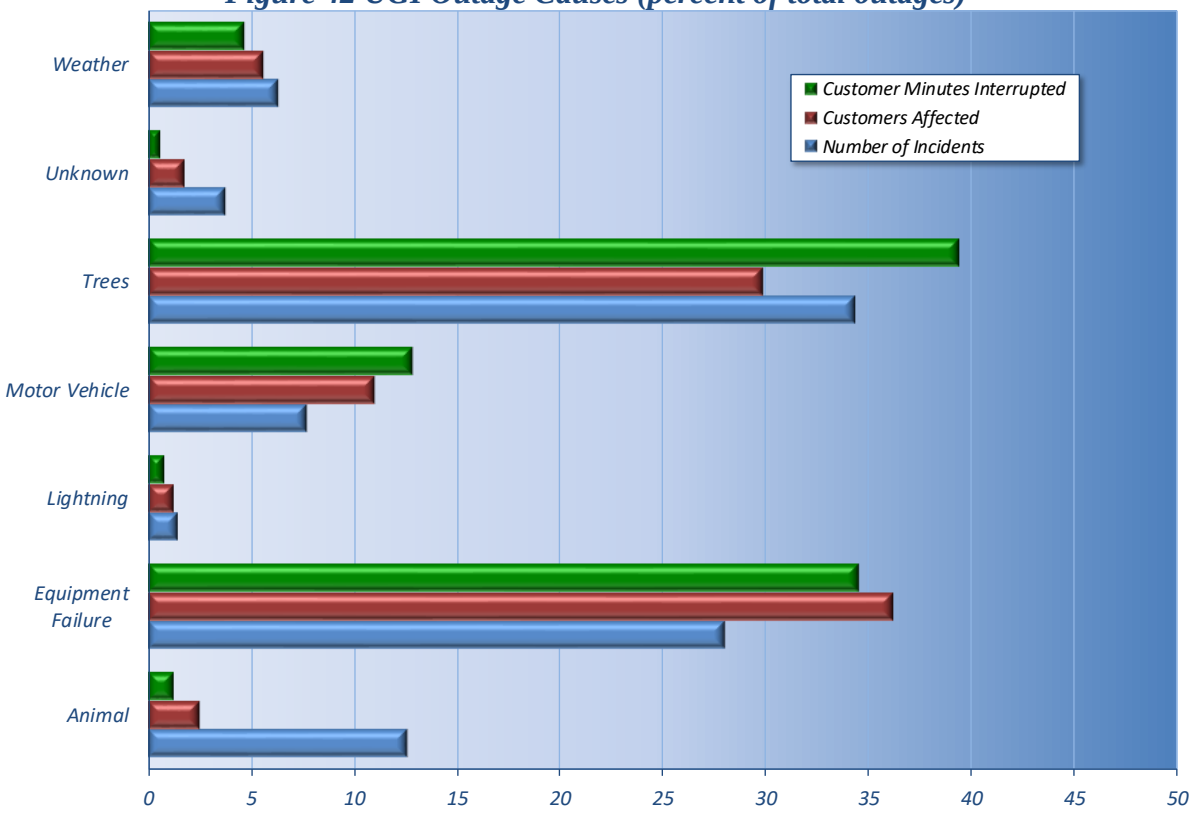
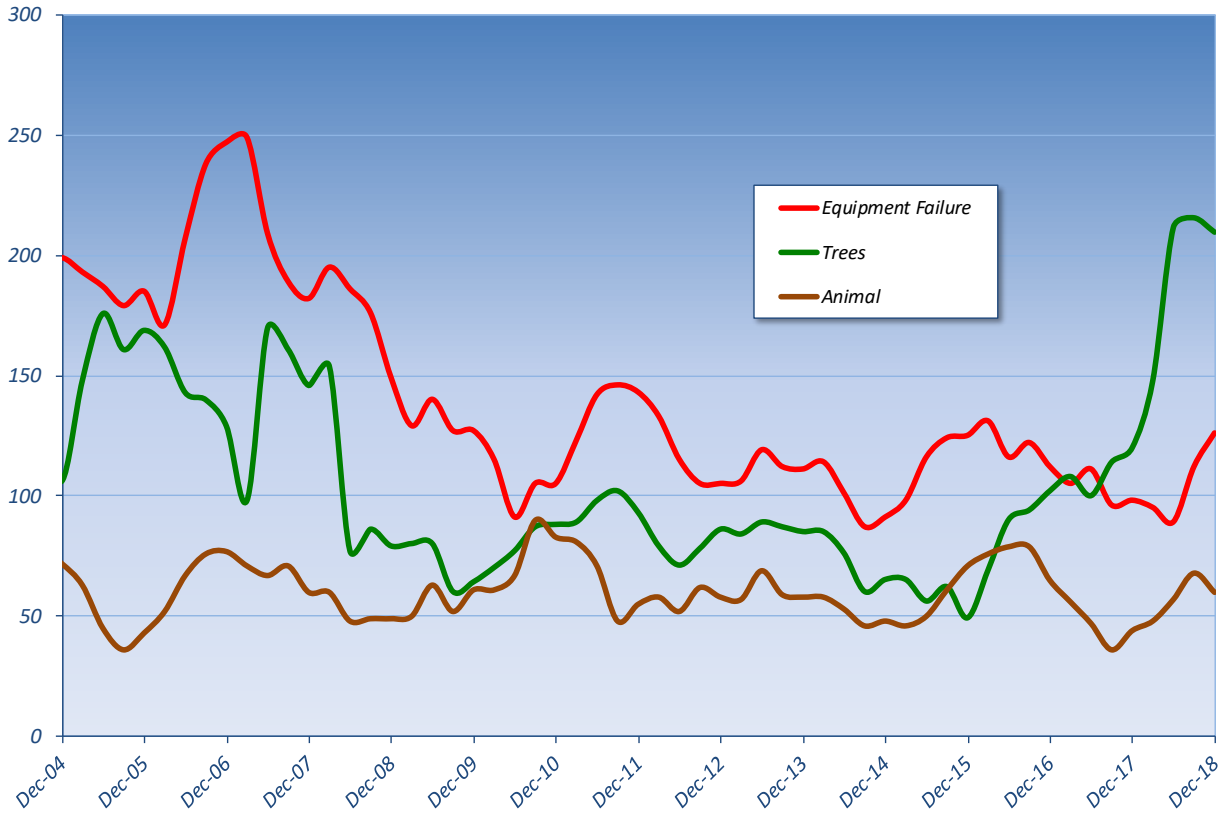


Figure 43 UGI Outage Tracking (number of incidents)



Wellsboro Electric Company

Wellsboro has a service territory of about 178 square miles and serves about 6,272 customers.

In 2018, Wellsboro experienced 8,565 customers interruptions and 1.1 million customer-minutes interrupted as compared to 6,816 customer interruptions and 0.3 million customer-minutes interrupted in 2017, and 10,138 customer interruptions and 1.1 million customer-minutes interrupted in 2016.

CAIDI/SAIDI/SAIFI Evaluation

CAIDI

Rolling 12-month: Increased from 90 minutes in 2017 to 131 minutes in 2018; failed to achieve benchmark by 6%

3-year average: Increased from 87 minutes in 2017 to 105 minutes in 2018; achieved standard by 23%.

SAIDI

Rolling 12-month: Increased from 97 minutes in 2017 to 178 minutes in 2018; failed to achieve benchmark by 16%.

3-year average: Increased from 117 minutes in 2017 to 149 minutes in 2018; achieved standard by 20%.

SAIFI

Rolling 12-month: Increased from 1.08 outages in 2017 to 1.36 outages in 2018; failed to achieve benchmark by 11%.

3-year average: Increased from 1.33 outages in 2017 to 1.43 outages in 2018; failed to achieve standard by 6%.

CAIDI and SAIFI Performance

Historical 12-month CAIDI and SAIFI benchmark reliability performance trends are shown in Figures 44 and 45. During the last 3 quarters of 2018, Wellsboro's CAIDI performance trend has been negative, as shown on the chart to be above the "green" benchmark performance upper-control-limit-line. However, prior CAIDI performance from 2004 through 2017 was below the benchmark performance upper-control-limit-line. Prior to 2018, Wellsboro was a consistent CAIDI Benchmark Performer. Wellsboro appears to be recovering, but more management attention is needed to ensure CAIDI performance is again being sustained below the "green" benchmark performance upper-control-limit-line.

Beginning in 2004, Wellsboro's SAIFI performance trend has been overall positive about 50% of the time. Recently, beginning in 2015, Wellsboro's SAIFI performance has been erratic and negatively above the "green" benchmark performance upper-control-limit-line. More management attention is needed to ensure consistent SAIFI performance is sustained below the "green" benchmark performance upper-control-limit-line.

Outage Causes

Figure 46 shows the reported 2018 outage-cause categories, as a percentage, for the following 3 distinct performance metrics: Customer-minutes Interrupted, Customers Affected, and Number of Incidents. Trees (off and on ROW) and equipment failure were the top cause of outages, customers affected, and customer-minutes interrupted. About 35% of outages are caused by trees, and 21% are caused by animals.

Figure 47 shows the historical trend of the top 3 main outage causes. Trees and Animals are the 2 most frequent outage-causes. Tree outages are significantly negatively affecting Wellsboro's distribution system reliability and resilience, as well as every EDC in Pennsylvania.

General Reliability

Wellsboro's goal of a completely automated metering system will be completed in 2019. Wellsboro's system is 100% automated and it is currently replacing the final 300 Turtle meters (daily usage data availability) with Aclara meters (hourly usage data availability). Wellsboro completed a GIS Project in the Fall of 2018 that provided a substantial improvement to the mapping detail. The mapping data was used to synchronize with Wellsboro's customer information system (CIS) data which has increased the outage management system (OMS) system accuracy and the prediction of outages.

Wellsboro's restoration strategy is to restore customers power in a safe and efficient manner. Larger storm situations will identify critical facilities (water, sewer, medical, shelters, etc.) for repair first and then 3-phase lines and finally single-phase lines using internal/external line crews for repairs.

Substations are inspected monthly in accordance with the company's inspection and maintenance program. Substations are inspected monthly with an infrared camera to identify hot spots. Any hot spots that are identified are reported and fixed immediately.

Conclusion

Trees and animals are the top 2 outage causes that substantially negatively affect electrical reliability to Wellsboro customers. In 2018, trees and animal outage causes contributed to over 71% of the total lost customer-minutes and do not include any lost customer-minutes caused by Major Events.

Wellsboro experienced 2 Major Events where Wellsboro customers experienced a loss of **1,771,352 customer-minutes interrupted**.

Wellsboro has sustained CAIDI benchmark performance from 2004 through 2017, and is considered an excellent CAIDI benchmark performer. However, Wellsboro failed to achieve CAIDI benchmark performance in 2018. More management attention is needed to sustain CAIDI performance below the "green" benchmark performance upper-control-limit-line. Beginning in 2015, Wellsboro's SAIFI performance has been inconsistent and frequently above the "green" benchmark performance upper-control-limit-line. More management attention is needed to ensure

consistent SAIFI performance is sustained below the "green" benchmark performance upper-control-limit-line.

It should also be noted that Major Events had a significant negative impact on Wellsboro customers that are not reflected in CAIDI and SAIFI performance metrics.

Figure 44 Wellsboro CAIDI (minutes)

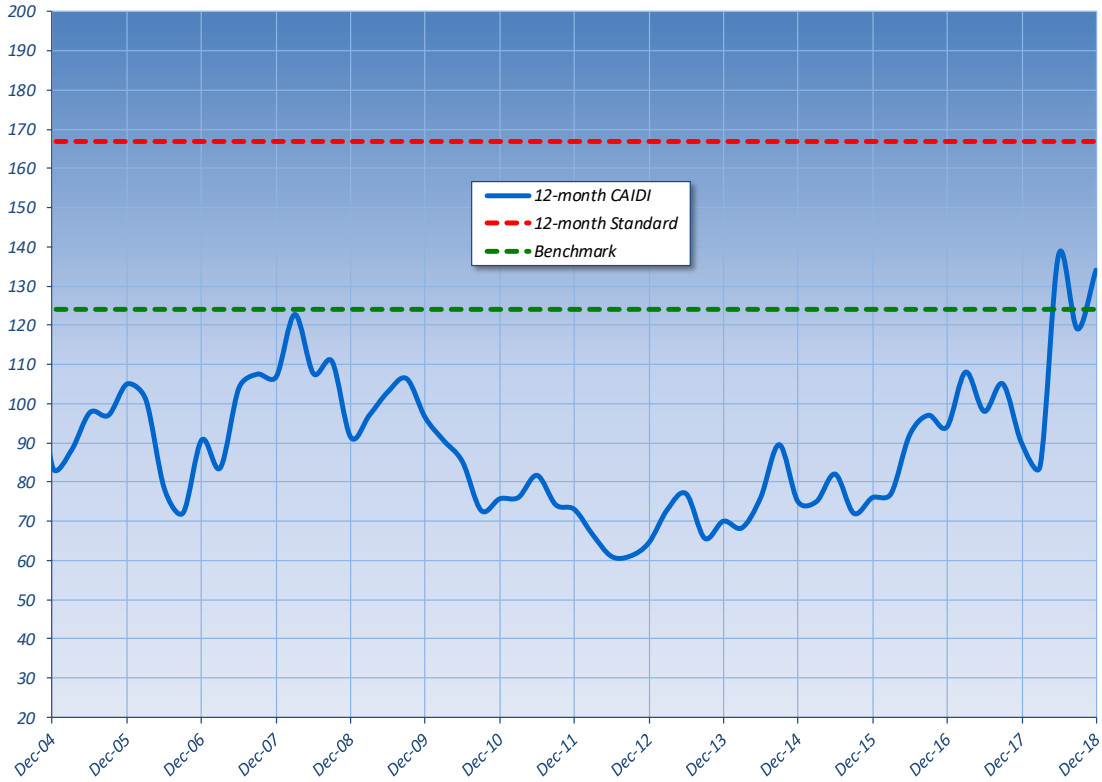


Figure 45 Wellsboro SAIFI (interruptions per customer)

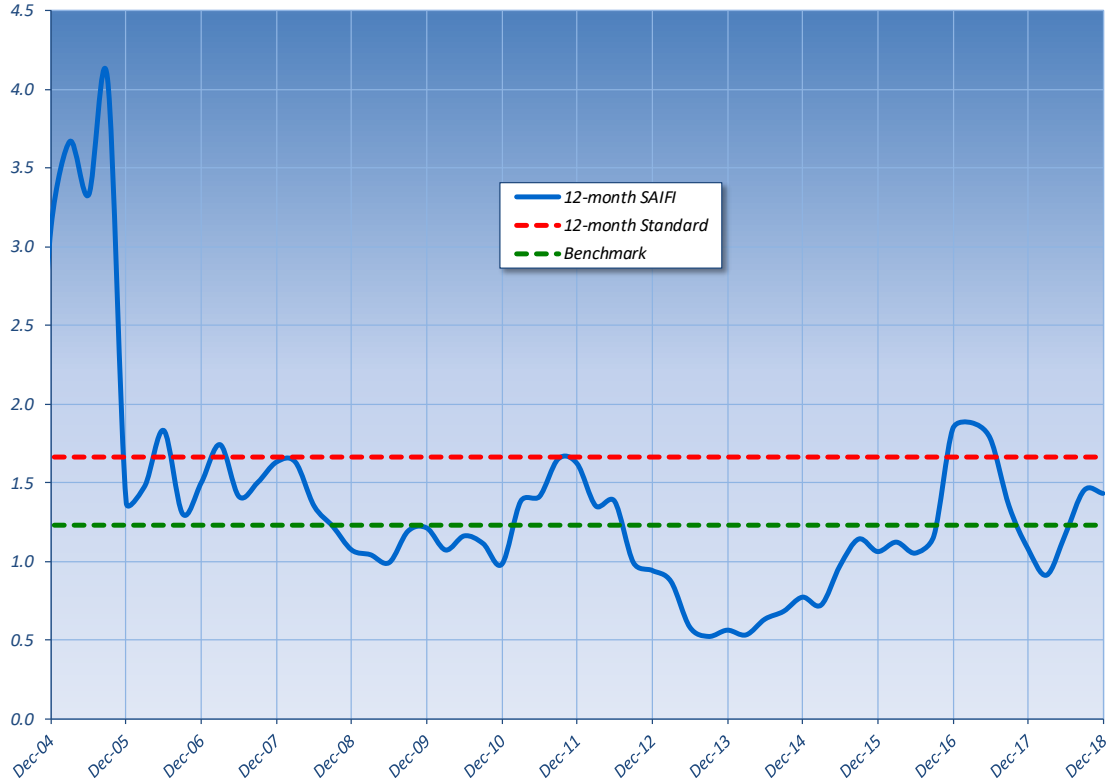


Figure 46 Wellsboro Outage Causes (percent of total outages)

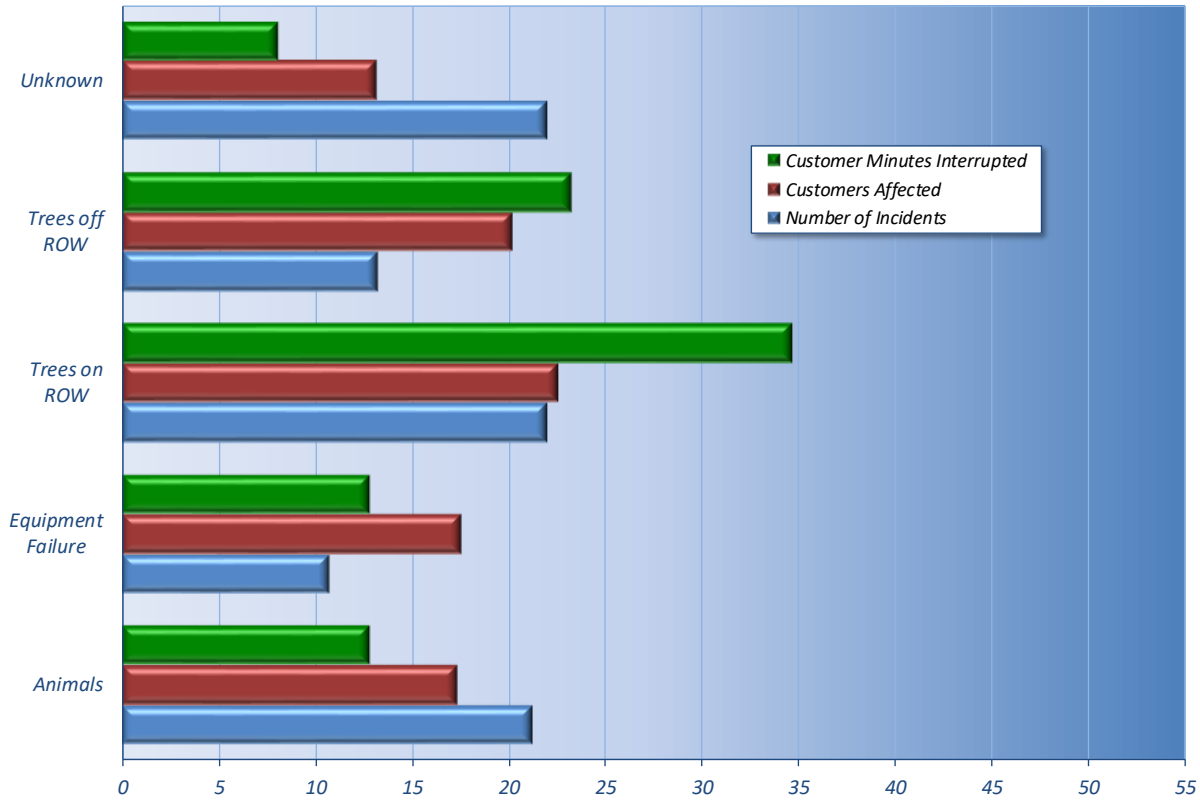
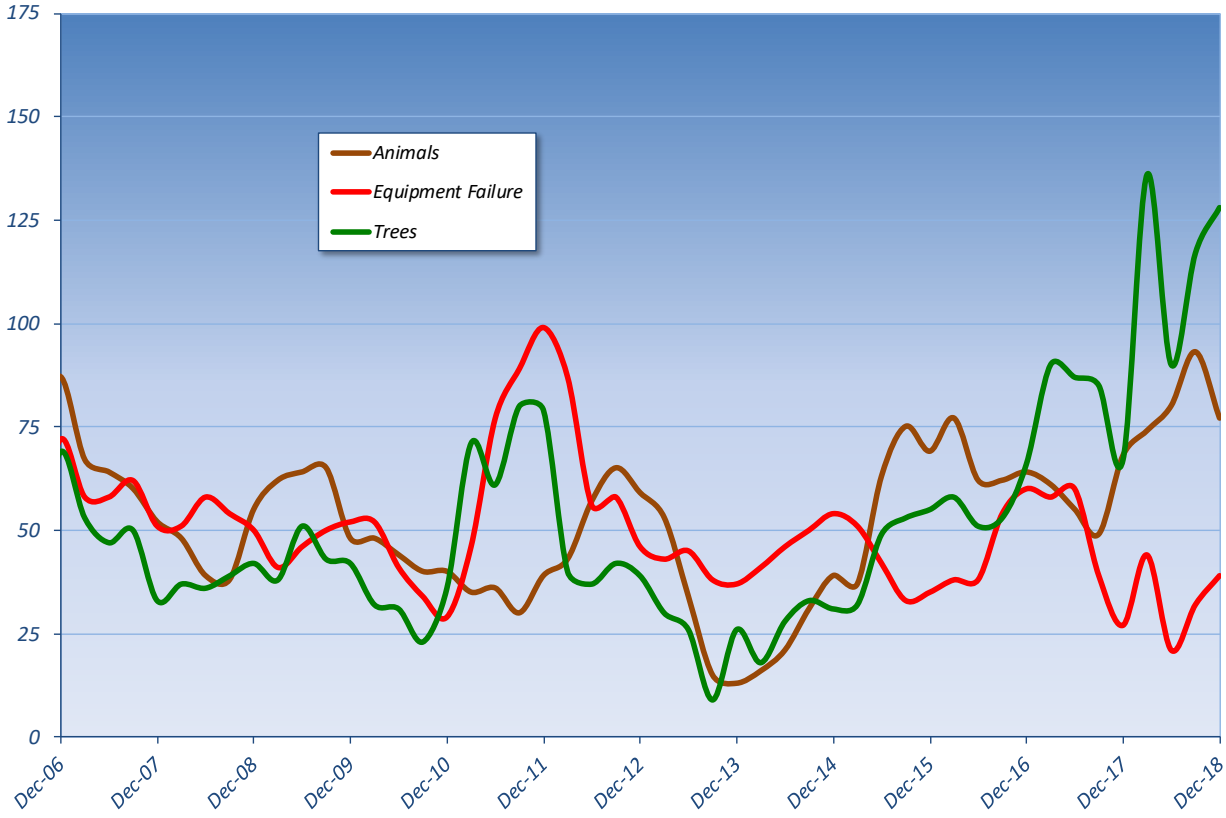


Figure 47 Wellsboro Outage Tracking (number of incidents)



Section 5 – Conclusion

Severe weather in Pennsylvania was challenging to both electrical reliability and resilience in 2018. The overall EDC reliability performance scorecards show Pennsylvania reliability performance regressing from 2015 through 2018. In addition to its normal reliability reviews with EDCs, TUS in this report has made several recommendations to help address the continuing poor reliability performance – see the **Executive Summary**.

In 2018, there were 10 of 11 EDCs who failed to achieve benchmark in all 4 rolling 12-month quarters for all performance indices. Also, only 6 of 11 EDCs managed to achieve benchmark in at least one performance metric by year-end 2018.

In 2018, there were 29 Major Events filed by EDCs that amounted to over **2.7 billion customer-minutes interrupted** as compared to only **135 million customer-minutes interrupted** in 2017. This is a remarkable number of customer-minutes interrupted in 2018. Winter Storms Riley and Quinn in March 2018 significantly challenged the resilience of Pennsylvania EDCs. Due to these

2 severe weather events, PECO, Met-Ed, Pike, and PPL accounted for 87% of the Major Event customer-minutes interrupted.[37]

In 2018, there were a total of 35 reportable events that affected approximately 2.5 million customers as compared to 2017, when there was a total of 50 reportable events that affected approximately 1.3 million customers.

The 2 biggest outage causes affecting Pennsylvania customers' electric reliability are trees and equipment failure. Also, during severe weather events when the resilience of the distribution system is challenged, the 2 outage causes (trees and equipment failure) are the biggest disrupter of electric power to customers.

In general, the ability for EDCs to achieve and sustain benchmark CAIDI and SAIFI performance has been difficult from 2004 through 2018. As shown below, Duquesne, PECO, and UGI are the only 3 Pennsylvania EDCs that have a consistent record of achieving and sustaining CAIDI and SAIFI benchmark reliability performance.[38]

Sustained CAIDI Performance

Only 2 small EDCs have achieved sustained CAIDI performance:

- Wellsboro
- UGI

Only 3 large EDCs have achieved sustained CAIDI performance:

- PECO since 2012
- West Penn since 2014
- Duquesne since 2015

Sustained SAIFI Performance

Only 1 small EDC has achieved sustained SAIFI performance:

- UGI

Only 4 large EDCs have achieved sustained SAIFI performance:

- PECO
- Duquesne
- PPL since 2013
- Penn Power since 2015

[37] Note: Major Events affect the resilience of an EDC's distribution system, and are excluded from an EDC's reliability performance metrics. The additional 2.7 billion customer-minutes interrupted had a significant negative impact on customers despite not being counted in an EDC's reliability performance metrics.

[38] TUS considers sustained performance as having a performance trend continually below the "green" benchmark performance upper-control-limit-line and only occasionally exceeding benchmark for no greater than four consecutive 12-month rolling quarters in a row

Appendix A – Electric Reliability Metrics

12-Month Average Electric Reliability Indices for 2018

Customer Average Interruption Duration Index (CAIDI)- min/yr/cust				% Above (+) or	% Above (+) or
EDC	Dec-18	Benchmark	Standard	Below (-) Benchmark	Below (-) Standard
Citizens'	76	105	141	-27.6	-46.1
Duquesne Light	106	108	130	-1.9	-18.5
Met-Ed (FE)	130	117	140	11.1	-7.1
PECO	110	112	134	-1.8	-17.9
Penelec (FE)	114	117	141	-2.6	-19.1
Penn Power (FE)	138	101	121	36.6	14.0
Pike County	236	174	235	35.6	0.4
PPL	168	145	174	15.9	-3.4
UGI	178	169	228	5.3	-21.9
Wellsboro	131	124	167	5.6	-21.6
West Penn (FE)	171	170	204	0.6	-16.2

System Average Interruption Frequency Index (SAIFI)- outages/yr/cust				% Above (+) or	% Above (+) or
EDC	Dec-18	Benchmark	Standard	Below (-) Benchmark	Below (-) Standard
Citizens'	0.21	0.20	0.27	5.0	-22.2
Duquesne Light	0.84	1.17	1.40	-28.2	-40.0
Met-Ed (FE)	1.27	1.15	1.38	10.4	-8.0
PECO	0.97	1.23	1.48	-21.1	-34.5
Penelec (FE)	1.71	1.26	1.52	35.7	12.5
Penn Power (FE)	1.10	1.12	1.34	-1.8	-17.9
Pike County	0.85	0.61	0.82	39.3	3.7
PPL	0.84	0.98	1.18	-14.3	-28.8
UGI	1.19	0.83	1.12	43.4	6.2
Wellsboro	1.36	1.23	1.66	10.6	-18.1
West Penn (FE)	1.22	1.05	1.26	16.2	-3.2

System Average Interruption Duration Index (SAIDI)- min/yr/cust				% Above (+) or	% Above (+) or
EDC	Dec-18	Benchmark	Standard	Below (-) Benchmark	Below (-) Standard
Citizens'	16	21	38	-23.8	-57.9
Duquesne Light	89	126	182	-29.4	-51.1
Met-Ed (FE)	165	135	194	22.2	-14.9
PECO	106	138	198	-23.2	-46.5
Penelec (FE)	195	148	213	31.8	-8.5
Penn Power (FE)	152	113	162	34.5	-6.2
Pike County	200	106	194	88.7	3.1
PPL	141	142	205	-0.7	-31.2
UGI	213	140	256	52.1	-16.8
Wellsboro	178	153	278	16.3	-36.0
West Penn (FE)	209	179	257	16.8	-18.7

Note: **GREEN** = better than benchmark; **RED** = worse than standard; **BLACK** = between benchmark and standard.

Three-Year Average Electric Reliability Indices for 2016-2018

Customer Average Interruption Duration Index (CAIDI)-min/yr/cust				*3-Year*	*3-Year*	*% Above (+) or*
EDC	*2016*	*2017*	*2018*	*Average*	*Standard*	*Below (-) Standard*
Citizens'	108	185	76	123	115	7.0
Duquesne Light	100	115	106	107	119	-10.1
Met-Ed (FE)	124	147	130	134	129	3.6
PECO	106	99	110	105	123	-14.6
Penelec (FE)	120	138	114	124	129	-3.9
Penn Power (FE)	95	150	138	128	111	15.0
Pike County	228	185	236	216	192	12.7
PPL	121	146	168	145	160	-9.4
UGI	125	131	178	145	186	-22.2
Wellsboro	94	90	131	105	136	-22.8
West Penn (FE)	147	166	171	161	187	-13.7
System Average Interruption Frequency Index (SAIFI)-outages/yr/cust				*3-Year*	*3-Year*	*% Above (+) or*
EDC	*2016*	*2017*	*2018*	*Average*	*Standard*	*Below (-) Standard*
Citizens'	0.26	0.45	0.21	0.31	0.22	39.4
Duquesne Light	0.69	0.98	0.84	0.84	1.29	-35.1
Met-Ed (FE)	1.44	1.47	1.27	1.39	1.27	9.7
PECO	1.00	0.83	0.97	0.93	1.35	-30.9
Penelec (FE)	1.43	1.73	1.71	1.62	1.39	16.8
Penn Power (FE)	1.09	1.06	1.10	1.08	1.23	-11.9
Pike County	0.38	0.53	0.85	0.59	0.67	-12.4
PPL	0.78	0.71	0.84	0.78	1.08	-28.1
UGI	0.63	0.49	1.19	0.77	0.91	-15.4
Wellsboro	1.84	1.08	1.36	1.43	1.35	5.7
West Penn (FE)	1.08	1.29	1.22	1.20	1.16	3.2
System Average Interruption Duration Index (SAIDI)-min/yr/cust				*3-Year*	*3-Year*	*% Above (+) or*
EDC	*2016*	*2017*	*2018*	*Average*	*Standard*	*Below (-) Standard*
Citizens'	28	84	16	43	25	70.7
Duquesne Light	69	112	89	90	153	-41.2
Met-Ed (FE)	178	217	165	187	163	14.5
PECO	106	82	106	98	167	-41.3
Penelec (FE)	171	239	195	202	179	12.7
Penn Power (FE)	104	160	152	139	136	2.0
Pike County	87	102	200	130	129	0.5
PPL	94	104	141	113	172	-34.3
UGI	78	64	213	118	170	-30.4
Wellsboro	172	97	178	149	185	-19.5
West Penn (FE)	159	214	209	194	217	-10.6

*Note: **GREEN** = better than standard; **RED** = worse than standard.*

Appendix B – Modifications to Inspection and Maintenance Intervals

Modifications to Inspection and Maintenance (I&M) Intervals (Group 1) Submitted October 2017, effective January 1, 2019- December 31, 2020

Company	Exemption Requested	Justification
FirstEnergy companies: Penelec, Penn Power, Met-Ed and West Penn Power	Pole loading calculations	Approved previously in the Jan. 1, 2013-Dec. 31, 2014 I&M Plan.
FirstEnergy companies: Penelec, Penn Power, Met-Ed and West Penn Power	Distribution overhead line inspections – 5 years rather than 1 to 2-year cycle	Approved previously in the Jan. 1, 2013-Dec. 31, 2014 I&M Plan.
FirstEnergy companies: Penelec, Penn Power, Met-Ed and West Penn Power	Overhead transformer inspections – 5 years rather than 1 to 2-year cycle	Approved previously in the Jan. 1, 2013-Dec. 31, 2014 I&M Plan.

Modifications to Inspection and Maintenance Intervals (Group 2) Submitted October 2018, effective January 1, 2020- December 31, 2021

Company	Exemption Requested	Justification
Citizens'	Pole loading calculations	Approved previously in the Jan. 1, 2012- Dec.31, 2013 I&M Plan.
Duquesne	Pole loading calculations	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
Duquesne	Overhead line inspections	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
Duquesne	Overhead transformer inspections	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
Duquesne	Above-ground pad-mounted transformers	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
PECO	Pole loading calculations	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
Pike County	Pole loading calculations	Approved previously in the Jan. 1, 2012- Dec.31, 2013 I&M Plan
PPL	Pole loading calculations	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
PPL	Overhead line inspections	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
PPL	Overhead transformer inspections	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
PPL	Pad mounted transformer inspections	Approved previously in the Jan. 1, 2012- Dec. 31, 2013 I&M Plan
PPL	Recloser inspections	Approved previously in the Jan. 1, 2014- Dec. 31, 2015 I&M Plan
PPL	Substation inspections	Provisional approved in the Jan. 1, 2017- Dec. 31, 2018 I&M Plan (docket M-2009-2094773)
Wellsboro	Pole loading calculations	Approved previously in the Jan. 1, 2012- Dec.31, 2013 I&M Plan

Pennsylvania Public Utility Commission