7.3.2 Appendix-C.2: Asset Condition Details

7.3.2.1 Appendix-C2: Substation and Electric Service Stations (ESSs) Transformers

ComEd has approximately 2,800 transformers serving substations and large customer Electric Service Stations (ESSs). At substations, transformers connect the transmission system (138kV) to the distribution system (4kV, 12kV, and 13.2kV). A transformer is an electrical device that normally changes an electrical voltage from one voltage level to another. It normally consists of a pair of windings, primary and secondary, linked by a magnetic circuit or core.

Substation transformers are the most expensive equipment installed in a substation. If the substation transformer fails, it can cause collateral damage, substation fires, environmental damage, flying porcelain fragments, oil spills, and other dangers to utility personnel and possibly to the public, and extended customer outages.

The consequences of a substation transformer failure can be significant. The main causes of transformer failures have been insulation winding breakdown – as manifested by high gassing – which is common for old transformers. including fires, extended customer interruptions, equipment damage, oil spills, and employee and public safety hazards.

ComEd defines substation transformers serving the distribution system as either power transformers, Load Tap Changing (LTC) transformers, dual LTC transformers, and distribution transformers according to their rating and application.

Transformer types:

- Power Transformers: Non-LTC transformer rated >2,500kVA, 138/69kV, 138/34kV or 138/12kV and between 34/12kV and 34/4kV
- LTC transformers: 20, 33, 50 Mega Volt Ampere (MVA) older units and 40, 60, 75 MVA newer units, 138/12kV
- Dual LTC transformers: 75 to 100MVA 138/12kV, three-phase
- Distribution transformers: Non-LTC transformer rated ≤2,500kVA, 34/4kV

In some of the older installations in the ComEd system, multiple single-phase transformers were often installed to form a three-phase “bank” and the term “transformer” and “transformer bank” have often been used interchangeably. Since approximately the 1950s, however, three-phase transformers have been the standard for all of ComEd’s transformer voltage classes and as the older banks of single-phase transformers are replaced, they are typically replaced by modern three-phase transformers.

Power transformers consist of conductors wound around a magnetic steel “core”. Current flowing in one “winding” produces a magnetic flux, which the core contains and directs to the other winding where it produces a corresponding current and voltage. The relative number of times each winding conductor encircles the core, referred to as the “turns ratio”, determines the ratio between the high voltage and low voltage windings.

The conductor in each winding must be electrically insulated between adjacent turns, as well as between the conductor and the steel core and other windings. The winding insulation in power transformers is typically comprised of a form of “paper” formed from cellulose or other material and then immersed in insulating mineral oil. In addition to serving as part of the insulation system, the oil transfers the heat, which is produced by resistive and inductive heating, away from the windings and discharges it to the surrounding air through the transformer’s “radiators” or “coolers”.

7.3.2.2 Appendix-C.2-Table 1: Transformer Type/Condition

Type	Very Poor	Poor	Fair	Good	Very Good	Grand Total
Distribution Transformer	12	3	12	129	508	664
Dual LTC Transformer			1	4	14	19
LTC Transformer	36	104	226	441	722	1529
Power Transformer	7	22	81	209	314	633
Grand Total	**55**	**129**	**320**	**783**	**1558**	**2845**

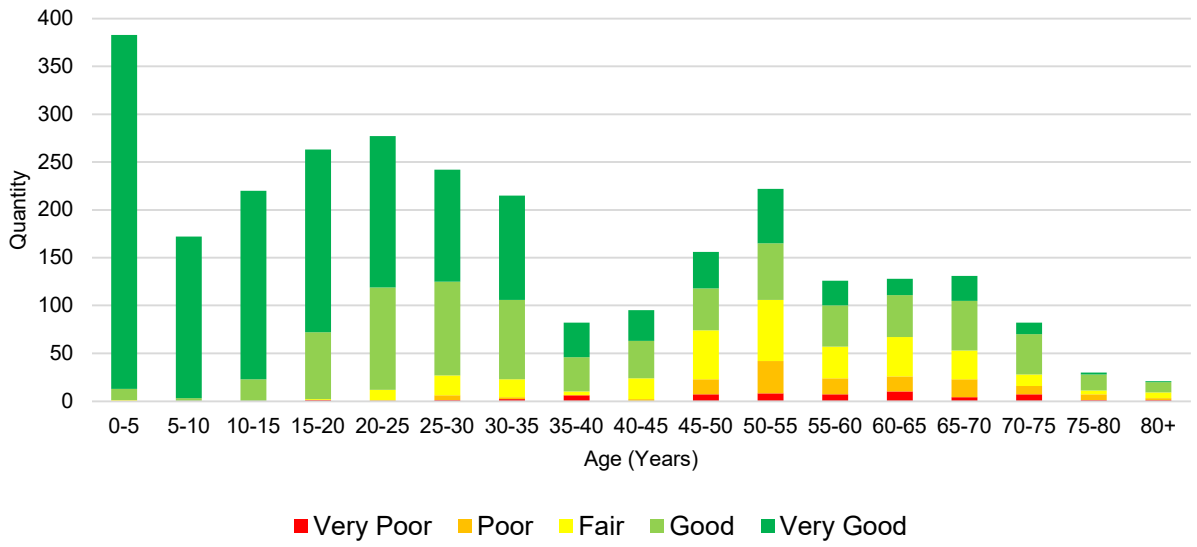
Approximately 6% of the substation transformers are currently classified as candidates for replacement based on Poor or Very Poor health index rating.

7.3.2.3 Appendix-V.2-Table 2: Transformer Age/Condition

Age Range	Very Poor	Poor	Fair	Good	Very Good	Grand Total
0-5			1	12	370	383
5-10				3	169	172
10-15				23	197	220
15-20	1		1	70	191	263
20-25		1	11	107	158	277
25-30	1	5	21	98	117	242
30-35	2	2	19	83	109	215
35-40	6		4	36	36	82
40-45		2	22	39	32	95
45-50	7	16	51	44	38	156
50-55	8	34	64	59	57	222
55-60	7	17	33	43	26	126
60-65	10	16	41	44	17	128
65-70	4	19	30	52	26	131
70-75	7	9	12	42	12	82
75-80	1	6	4	17	2	30
80+	1	2	6	11	1	21
Grand Total	**55**	**129**	**320**	**783**	**1558**	**2845**

Approximately 35% of the substation transformers are over 40 years old.

7.3.2.4 Appendix-C.2-Figure 1: Transformer Age/Condition - Graph



7.3.2.5 Appendix-C2: Load Tap Changing (LTC) Transformers

Load Tap Changing (LTC) transformers allow for maintaining a steady bus voltage with changing station load. This equipment constitutes the largest segment of transformers totaling 1,548 units.

Prior to 1970, ComEd generally purchased LTC transformers with 20, 33, and 50 MVA capacities for the 138/12 kV system. With increasing electricity demand in the 1970s, transformers with 40 MVA, 60 MVA, and 75 MVA capacities were added to the mix. ComEd no longer purchases 20 or 33 MVA transformers and existing units are replaced with larger capacities as they fail or as load growth dictates.

7.3.2.6 Appendix-C.2-Figure 2: Typical LTC transformer

Approximately 33% of the in-service LTC transformers were installed during a major expansion of the ComEd grid in the 1950s through the 1970s. Load tap changing mechanisms have been a major determinant of reliability for this

family of transformers. Transformer specifications have been updated to require transformer manufacturers to provide low maintenance LTCs and to install a standardized monitoring package that includes monitoring of the LTC mechanism.

7.3.2.7 Appendix-C2: Transformer Replacement Strategy

Over time, the winding insulation paper degrades and becomes less strong and more brittle. This is due to the polymer strands of the cellulose separating or breaking at the molecular level into shorter strands. Weaker, more brittle, insulation is less able to withstand the mechanical forces imposed by magnetic forces within the transformer and may allow the winding to deform and eventually develop an electrical short circuit between the energized conductor and the core or other grounded portions of the transformer, or between adjacent turns of the winding. Insulation failures of this type can produce very high currents and temperatures, and in extreme cases may cause the transformer tank to rupture, releasing the insulating oil and potentially catching fire.

The rate at which transformer insulation degrades is not a constant function of time, but rather is strongly influenced by the temperature of the winding conductor which the paper is in contact and can be influenced by other factors such as water moisture dissolved in the insulating oil. The conductor temperature is not constant but is governed by the electrical load that the transformer carries and the ambient air temperature in which it operates, both of which tend to vary significantly with time. Thus, transformer age alone is not an effective indicator of the optimal time to proactively replace a substation transformer.

ComEd conducts regular inspections and testing as part of its preventative maintenance (PM) plan on all substation power transformers to detect incipient transformer failures.

Testing includes both power factor testing to measure the electrical properties of the winding insulation, and dissolved gas analysis (DGA) of the insulating oil which indicates the presence of abnormal heating and moisture. Transformers which indicate excessive deterioration may be subjected to additional or more-frequent monitoring and identified for condition-based planned replacement.

The planned replacement of transformers is performed based on condition assessment and test results. ComEd's transformer testing program utilizes visual inspections, Dissolved Gas Analysis (DGA), Sweep Frequency Response Analysis, Transformer Oil Analysis, Infrared Thermography, and electrical testing to determine the health of each transformer. Replacement decisions are based on the transformer's health index.

Transformer DGA is the most valuable and important tool available for determining the condition and life expectancy of power transformers. These tests are conducted for most large and/or critical substation transformers. Substation power transformers are sometimes also replaced reactively when they fail during service and are deemed uneconomical to repair. Preventative maintenance on ancillary components of power transformers such as load tap changers or bushings also takes place.

7.3.2.8 Appendix-C2: Circuit Breakers & Reclosers

ComEd has approximately 11,000 circuit breakers serving substations and large customer Electric Service Stations (ESSs). Circuit breakers and reclosers are mechanical switching devices that electrically connect and disconnect distribution circuits and/or buses. The circuit breakers typically must carry the full operating current of the associated line or bus, remaining in this "closed" position for long periods of time, and then "open" very rapidly (typically within 50 to 100 milliseconds) when called upon to interrupt both normal operating load current and the much higher currents that flow during system fault conditions. Failure to operate fast enough to clear fault currents will cause backup protection schemes to operate, leading to a larger portion of the electrical system being de-energized.

As Circuit Breakers age and are operated repeatedly, the operating mechanisms, linkages, bearings, lubricants and other mechanical parts wear to the point that proper adjustment and alignment is difficult to achieve and maintain. Spare and replacement parts may become obsolete and no longer be available from the original equipment manufacturer ("OEM") and reconditioned, remanufactured, or "reverse engineered" parts from third party or after-market vendors might not match the OEM specifications or dimensions and/or be prohibitively expensive. These situations can lead to mis-operations and/or increased time for repairs and outage restorations, both of which can decrease system reliability.

Breaker manufacturers and designs vary greatly within these asset classes resulting in parts obsolescence issues that must be addressed as manufacturers become defunct or are consumed.

In general, the major difference lies in the interrupting or dielectric medium (i.e., air, oil, SF6 gas, or vacuum).

Circuit breakers and reclosers in ComEd substations and Electric Service Stations (ESSs) are classified as air magnetic breakers, oil breakers (oil distribution breakers for ≤ 12kV), Sulphur hexafluoride (SF6) puffer breakers, vacuum breakers (stand-alone), vacuum switchgear breakers (≤ 34kV), single- and three-phase oil reclosers, and single- and three-phase vacuum reclosers.

Oil Circuit Breakers ("OCBs") immerse the energized and current-carrying portions of the circuit breaker within a tank containing insulating mineral oil and interrupt the current by rapidly separating a moving contact from a stationary contact. The insulating oil cools and extinguishes the arc that results and thus interrupts the flow of current. This is one of the oldest types of circuit breakers.

All OCBs have been identified as an outdated technology and due to age, wear, unavailability of replacement parts, etc., are becoming increasingly difficult to maintain and keep functioning per the designed specifications. All remaining oil circuit breakers were considered for replacement.

Between the 1970s and 1980s, circuit breaker technologies transitioned from OCBs to SF6 Gas Circuit Breakers ("GCBs") for 69kV and higher applications, and Vacuum Circuit Breakers ("VCB") for 34kV and lower. Gas Circuit Breakers ("GCBs") use Sulfur-Hexafluoride (SF6) gas as an insulating medium and to cool and interrupt the arc during switching operation. The use of SF6 gas over oil resulted in various advantages in circuit breaker design including higher short circuit ratings, shorter trip times, and slightly smaller dimensions. As a result, much of the circuit breaker industry has moved to SF6.

7.3.2.9 Appendix-C.2-Table 3: Circuit Breaker/Recloser Type/Condition

Row Labels	Very Poor	Poor	Fair	Good	Very Good	Grand Total
BREAKER	**102**	**762**	**3106**	**772**	**5697**	**10439**
Air Magnetic Breaker		374	2215			2589
Oil Breaker	102	352	195	59		708
Oil Dist Breaker		36	589	683		1308
SF6 Puffer Breaker				11	937	948
Vacuum Breaker			107	7	622	736
Vacuum Swgr Breaker				12	4138	4150
RECLOSER		**17**		**20**	**839**	**876**
Oil Recloser 1-Phase		4				4
Oil Recloser 3-Phase		13				13
Vacuum Recloser 1-Phase				1	50	51
Vacuum Recloser 3-Phase				19	789	808
Grand Total	**102**	**779**	**3106**	**792**	**6536**	**11315**

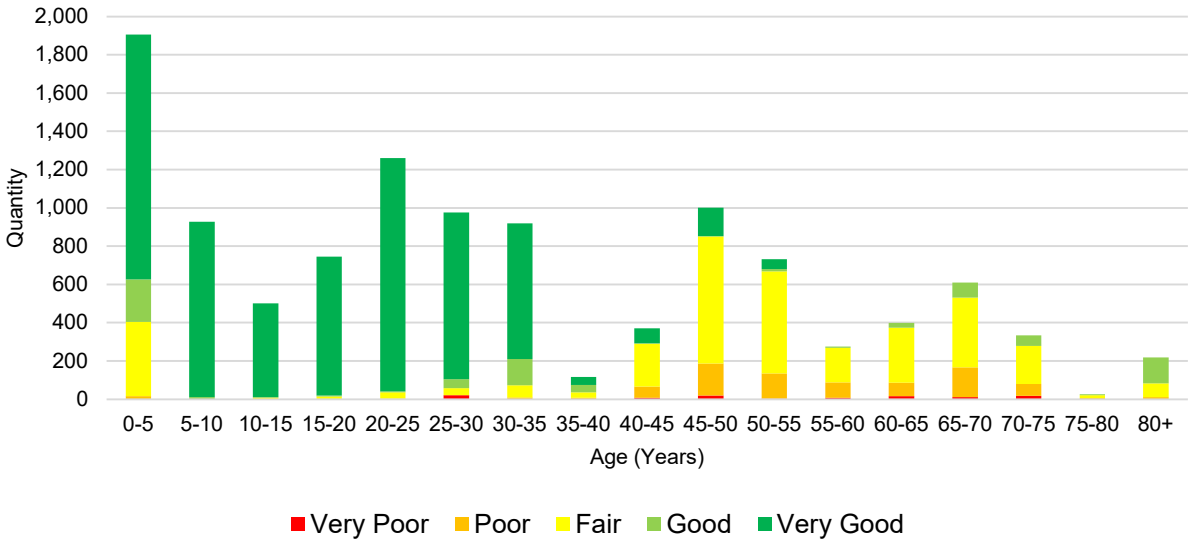
Approximately 8% of the circuit breakers are currently classified as candidates for replacement based on Poor or Very Poor health index rating.

7.3.2.10 Appendix-C.2-Table 4: Circuit Breaker/Recloser Age/Condition

Row Labels	Very Poor	Poor	Fair	Good	Very Good	Grand Total
BREAKER	**102**	**762**	**3106**	**772**	**5697**	**10439**
0-5		15	387	220	1199	1821
5-10			1	6	835	842
10-15			8	1	409	418
15-20			14	4	624	642
20-25			32	4	1008	1044
25-30	21		36	45	782	884
30-35	1	7	63	132	590	793
35-40		7	27	39	22	95
40-45	7	59	224	1	56	347
45-50	19	166	664	1	126	976
50-55	3	122	534	11	46	716
55-60	8	80	180	7		275
60-65	15	71	287	26		399
65-70	10	157	364	79		610
70-75	18	62	198	56		334
75-80		5	15	5		25
80+		11	72	135		218
RECLOSER		**17**		**20**	**839**	**876**
0-5		1		3	80	84
5-10				4	82	86
10-15				2	81	83
15-20				1	102	103
20-25		3		2	211	216
25-30				2	90	92
30-35		1		5	120	126
35-40		1			20	21
40-45				1	23	24
45-50		2			23	25
50-55		9			7	16
Grand Total	**102**	**779**	**3106**	**792**	**6536**	**11315**

Approximately 37% of the circuit breakers are over 40 years old.

7.3.2.11 Appendix-C.2-Figure 3: Circuit Breaker/Recloser Age/Condition - Graph



7.3.2.12 Appendix-C2: Oil Circuit Breakers (OCB)

Oil circuit breakers (OCBs) use oil as a dielectric or insulating medium for arc extinction. In OCBs, the contacts of the breaker are made to separate within an insulating oil. When the fault occurs in the system, the contacts of the circuit breaker are open under the insulating oil. An arc is developed between them, and the heat of the arc is evaporated in the surrounding oil.

The unavailability of replacement parts is a significant driver for OCB replacement. Oil breaker technology is no longer available for new purchases, and the existing population is shrinking due to failures or capacity-driven planned replacements.

7.3.2.13 Appendix-C.2.1-Figure 4: Typical Oil Circuit Breaker

Distribution oil breakers operating on the 4kV and 12kV systems comprise the oldest population of major equipment in ComEd substations.

7.3.2.14 Appendix-C2: Air Magnetic Circuit Breakers

Air circuit breakers use air as the medium for extinguishing the arc formed when the breaker trips. The air is usually kept in compressed form inside a cylinder and, as the breaker trips and the contacts separate, the compressed air, blown through specially designed nozzles, drives the arc into a special arc chute.

This class of breakers suffers from two common failure modes. The first is related to degraded lubrication in the operating mechanism resulting in the breaker failing to open, while the second is related to the arc chutes flashing over during an actual fault interruption event. Many vintage air magnetic breakers used synthetic grease, which deteriorates greatly compared to the preferred natural greases. Over time, the heaters used to mitigate condensation in switchgear cubicles have contributed to dry-out of the grease.

Re-lubrication of breaker bearings is necessary every 3 to 4 years to maintain reliable operation of the mechanism. The mechanisms of certain type breakers cannot be re-lubricated effectively and must be replaced.

This asset class is gradually being phased out and replaced with vacuum circuit breakers. The current maintenance program requires that breakers be exercised periodically. Operating the breaker helps redistribute available lubrication and helps confirm that bearings are free to move. Circuit breaker operations are monitored and are forced if a breaker has not operated within a 3-year period.

7.3.2.15 Appendix-C2: Circuit Braker Replacement Strategy

ComEd conducts regular inspections and testing as part of its preventative maintenance (PM) plan on all circuit breakers. Circuit breakers that do not pass inspection are either repaired (if economical to do so) or replaced.

The planned replacement of circuit breakers is performed based on condition assessment and test results. ComEd's transformer testing program utilizes visual inspections, Trip/Close Timing, Contact Resistance, etc. Replacement decisions are based on the circuit breakers health index.

Besides targeted degraded circuit breaker models, the unavailability of replacement parts is a significant driver for their replacement.

7.3.2.16 Appendix-C2: DC supply (Battery System)

Batteries are the lifeline to substations. ComEd has approximately 770 DC supply battery systems. These battery systems provide backup power for protection and relay functions. The substation DC supply is comprised of two components, a battery and a rectifier (charger). The components are connected in parallel to provide the station DC supply with dual energy sources. Under normal substation circumstances, the charger provides the power for the station DC load. If the charger cannot increase its output fast enough, the battery will provide the additional needed power when there is a momentary load. Additionally, if the charger fails and cannot provide power, the battery acts as an emergency reserve for the station DC supply.

7.3.2.17 Appendix-C.2-Figure 5: Typical DC Supply

7.3.2.18 Appendix-C.2-Table 5: Substation DC Supply Type/Condition

Type	Very Poor	Poor	Fair	Good	Very Good	Grand Total
Substation Battery	132	85	74	152	323	766
Grand Total	**132**	**85**	**74**	**152**	**323**	**766**

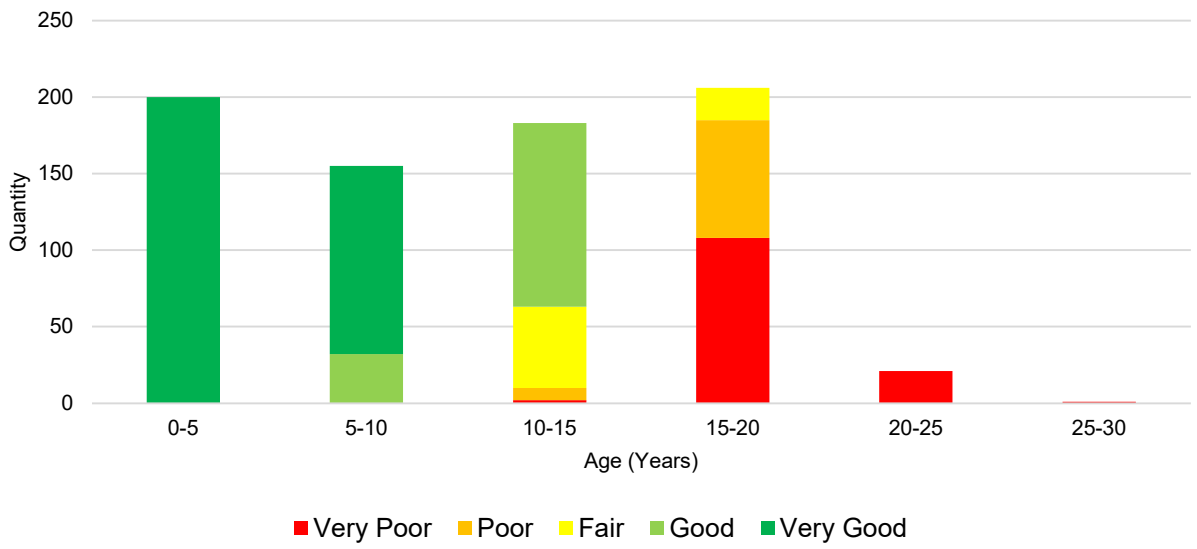
Approximately 28% of the batteries are currently classified as candidates for replacement based on Poor or Very Poor health index rating.

7.3.2.19 Appendix-C.2-Table 6: Substation DC Supply Age/Condition

Age Range	Very Poor	Poor	Fair	Good	Very Good	Grand Total
0-5					200	200
5-10				32	123	155
10-15	2	8	53	120		183
15-20	108	77	21			206
20-25	21					21
25-30	1					1
Grand Total	**132**	**85**	**74**	**152**	**323**	**766**

Approximately 3% of the batteries are over 40 years old.

7.3.2.20 Appendix-C.2-Figure 6: DC Supply Age/Condition - Graph



7.3.2.21 Appendix-C2: Vented Lead-Acid (VLA) Batteries

All the batteries are wet or flooded type batteries. These batteries utilize a liquid electrolyte solution (battery acid) that covers all the cell's internal parts. These batteries produce gas during charging. This gas should be able to escape. That is why they are referred to as vented batteries.

Of these batteries, 99% are vented lead-acid (VLA), with only 1% being NiCad. NiCad batteries are being phased out and will be from the system. VLA batteries are preferred because of their long and well-known operating history. Also, directly viewing the VLA cell internals allows for assessing battery health indicators through simple visual inspection.

7.3.2.22 Appendix-C.2-Figure 7: Battery

Unlike many equipment types, batteries are a perishable asset regardless of how much they are used or how well they are maintained.

Batteries have a designed failure mode. For VLA batteries, it is corrosion of the positive grid structure. Once the electrolyte is introduced into the battery cell, the sulfuric acid starts chemically corroding the grid over the battery's life.

This corrosion causes the positive plates to expand over the lifetime of the battery. Manufacturers size their battery jars to accommodate this growth. Once the positive plates have expanded greater than the added space, the positive terminal posts will start to raise from the jar lid. This movement is a telltale sign that the battery is reaching the end of its life and should be replaced.

ComEd's batteries are typically referenced as having a 20-year life expectancy in float service at 77 °F. Conditions such as excessive temperatures and undercharging accelerate this effect and reduce the battery's service life. If the age of ComEd's batteries were evenly distributed among the entire population, approximately 38 batteries would reach their twentieth year of service on an annual basis.

Batteries with early degradation further increase the number of batteries that should be replaced in a year. The replacement criteria will be any battery reaching its twentieth service year.

7.3.2.23 Appendix-C2: Charger

The most common cause of charger issues is a failed component on one of the internal control boards. Generally, a failed component influences the charger's operation performance but does not cause a total failure. Examples include when an alarm does not work or when the charger does not come out of equalize mode as expected. Excessive operating heat can contribute to the failures, and chargers are visually inspected internally for signs of heat damage, but most issues are found by operationally testing the charger.

Most minor charger issues can be repaired in the field with the stock of spare charger components kept by field personnel. Total charger failures, where the charger needs to be replaced, are rarer.

New T&S protection designs gravitate toward frequent implementation of intelligent electronic device-based systems, removing the older electromechanical relays, which make the IEDs increasingly dependent on the capabilities of the substation DC batteries and battery charger units. Ultimately, this means that a battery charger must maintain certain AC ripple capabilities adherent to the IEDs installed to regulate its output internally to avoid any disturbances from the battery charger to the IEDs.

7.3.2.24 Appendix-C2: DC Supply Replacement Strategy

ComEd conducts regular inspections and testing as part of its preventative maintenance (PM) plan on all battery systems.

The planned replacement of batteries is performed based on condition assessment and test results.

ComEd's battery testing program utilizes visual inspections, Trip/Close Timing, Contact Resistance, etc. Replacement decisions are based on the circuit breakers health index.

7.3.2.25 Appendix-C2: Relays

ComEd has approximately 53,000 relays which protect and monitor the distribution system.

Protective relays continuously monitor grid conditions, such as current, voltage, phase angle, power flow direction, and frequency. When an intolerable circuit condition, such as a short circuit (or "fault") is detected, a protective relay responds and closes its (output) contacts to protect the power system. It does so by opening electrical devices (typically circuit breakers) to de-energize the abnormal portion of the circuit. The goal of protective relaying is to disconnect, within its zone of protection, from a faulty circuit as quickly as possible. Relay settings such as sensitivity and selectivity are essential to validate that the proper circuit breakers are tripped at the proper speed to clear the fault, minimize equipment damage, and to reduce personnel hazard.

Relays that do not function within their designed performance parameters can either fail to trip or trip more slowly than intended, causing backup protection systems to operate and de-energize larger portions of the electric system than necessary, or trip for conditions for which they are not intended to trip, thereby causing unnecessary outages. Even if such improper operations do not directly cause power delivery to customers to be interrupted, these situations leave the electric system in a less secure configuration and increase the risk of outages or system instability.

There are three general types of relays: electro-mechanical, solid state, and micro-processor.

7.3.2.26 Appendix-C.2-Figure 8: Typical Electromechanical Relay Panel (Left) and Microprocessor Relay Panel (Right)

7.3.2.27 Appendix-C.2-Table 7: Relay Type/Risk

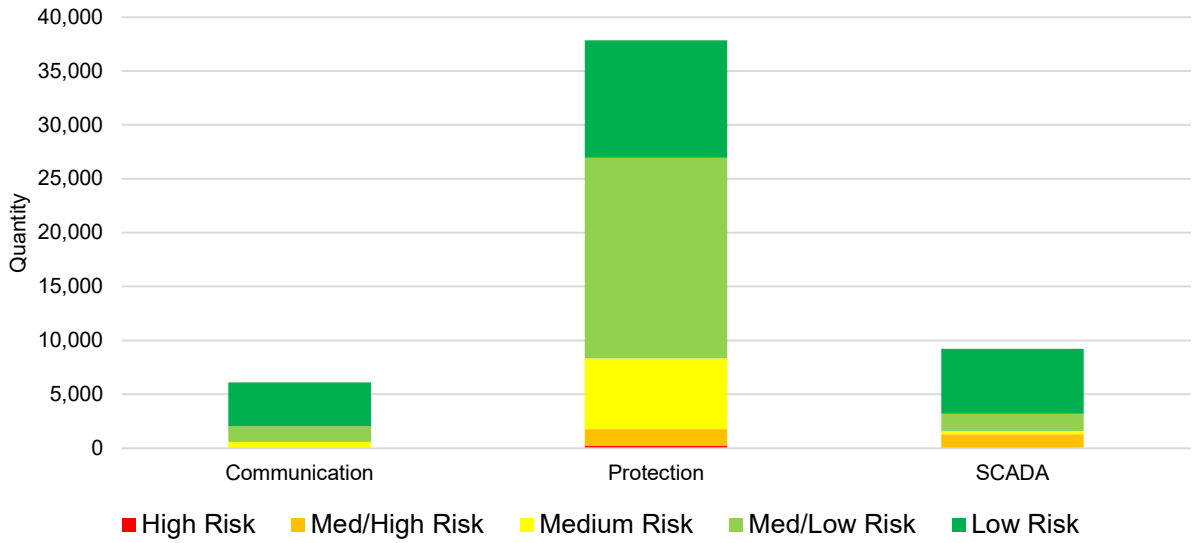
Relay Function	High Risk	Med/High Risk	Medium Risk	Med/Low Risk	Low Risk	Grand Total
Communication	0	0	593	1,433	4,070	6,096
Protection	219	1,546	6,574	18,607	10,899	37,845
SCADA	11	1,301	296	1,592	6,035	9,235
Grand Total	230	2,847	7463	21,632	21,004	53,176

Approximately 6% of the relays are currently classified as candidates for replacement (high and Med/High risk).

7.3.2.28 Appendix-C.2-Table 8: Relay Type/Voltage

Relay Function	≤480V	4kV	12kV	34kV	69kV	138kV	Other	Grand Total
Communication	194	128	6	10	407	5314	37	6096
Protection	24	3910	16416	3321	586	13588	0	37845
SCADA	211	9	1616	2795	94	4496	14	9235
Grand Total	429	4047	18038	6126	1087	23398	51	53176

7.3.2.29 Appendix-C.2-Figure 9: Relay Type/Priority



Maintenance testing helps to validate the availability of protection and control thereby minimizing the risk of undesired operations. ComEd has developed defined testing methods within appropriate intervals so that reliability operation is preserved.

Routine maintenance is necessary for all relays. Many of the older relays are electromechanical devices, which include delicate electrical and mechanical components such as bearings, springs, etc. As these relays age, these components may wear out and begin to "drift" (deviate from intended settings), increasing the likelihood of relay

mis-operation. The relays are periodically tested and adjusted to return them to the designed performance parameters. ComEd has developed rigorous testing methods within appropriate time intervals so reliable operation is preserved. If, over time, the wear or drift exceeds adjustment timeframe, the relay can no longer perform as designed and will need to be replaced.

The older styles of relay were typically single-phase, single-purpose devices, and thus the protection system for a single circuit or substation apparatus often required one or more relay "panels" containing numerous discrete relays to be installed and interconnected to provide the desired protection schemes. Such relays did not include communications capability, and thus required that someone physically visit the substation and visually determine which protection relays had tripped. These relays did not capture any history or "snapshot" of the tripping event to support post-event analysis of the system conditions and the performance of the protection system during the event. Electromechanical relays are no longer manufactured, and are generally no longer supported by the manufacturers, so new direct-replacement relays or parts are no longer available when these relays fail.

Older electromechanical relays can fail without any external indication. Typically, the only way to detect an electromechanical relay failure is either through routine maintenance or an undesired operation reported to the ComEd Operations Control Center (OCC).

Approximately 30 years ago, relay technology evolved from electromechanical relays to solid-state electronic technology. Many of the early-generation electronic relays were also single-phase, single purpose devices that did not include remote communications or event analysis capabilities. The functioning of these relays often depended on capacitors, resistors and other discrete components or circuit boards, and as the relays age, these components may fail or their performance parameters may tend to drift and negatively affect relay performance.

These early-generation solid-state or electronic relays are no longer manufactured, and many of these older styles are no longer supported by the manufacturer, and direct-replacement relays or parts are no longer available when these relays fail. Several of the older styles of electronic relays have been identified as frequently needing to be repaired or replaced, and therefore are targeted to be proactively removed from the system.

Modern relays are based on microprocessor technology and typically provide many configurable protection functions within a single physical device. This allows a single physical multi-function relay to replace numerous older single-function relays.

Digital microprocessor-based relays typically have automatic self-test functions. These self-tests verify the correct internal operation of critical device components. However, digital devices do not verify the external wires or contacts that are needed for them to perform their required zone of protection assignment. If a self-test detects an abnormal condition, the relay can close an output contact, send an alert, or provide some other indication of failure. Whenever an abnormal condition occurs, a digital relay may disable trip and control functions upon the detection of certain self-test failures based on its parameter settings.

Modern relays include remote communications and event recording capabilities that greatly improve post-event analysis and performance evaluation. These relays often include features such as line fault distance calculation to enable responders to quickly locate the fault on the physical line. This enables quick repair crew dispatch and faster fault restoration. These relays may also perform functions such as recording the accumulated fault interruption duty (I2t or similar measurement) that device has experienced, which can be used to more-efficiently determine when maintenance should be performed on that device. Because of the synergy between these new features and their significant benefit to power line protection and customers, it is much more efficient to simultaneously bundle the replacement of all older relays at a protection terminal and upgrade the entire terminal up to current design standard and capability.

Strategic, proactive replacement of obsolete or problematic relay types also avoids customer outages and/or HVD/transmission system disturbances that would occur if the relay were allowed to fail in-service, as well realizing

savings associated with efficiently replacing the relays using an optimized project schedule instead of reacting to an emergent failure.

7.3.2.30 Appendix-C2: High Voltage Wood Poles (69kV and above)

ComEd has approximately 9,000 wood poles supporting high voltage lines (69kV and 138kV) comprising approximately 7,000 wood pole structures on the ComEd system. Wood pole construction was commonly used on ComEd's overhead high-voltage distribution system due to the versatility and variety of structure types available for construction

Most high-voltage distribution wood poles were installed before 1970. ComEd's historic installation rate accelerated during the 1950s and 1960s due to spikes in population growth within ComEd's service territory.

7.3.2.31 Appendix-C.2-Figure 10: High Voltage Wood Poles

7.3.2.32 Appendix-C.2.1-Table 5: High voltage Wood Pole Type/Condition

Type	Very Poor	Poor	Fair	Good	Very Good	Grand Total
Transmission Wood Poles	18	1	351	2008	6725	9103
Grand Total	**18**	**1**	**351**	**2008**	**6725**	**9103**

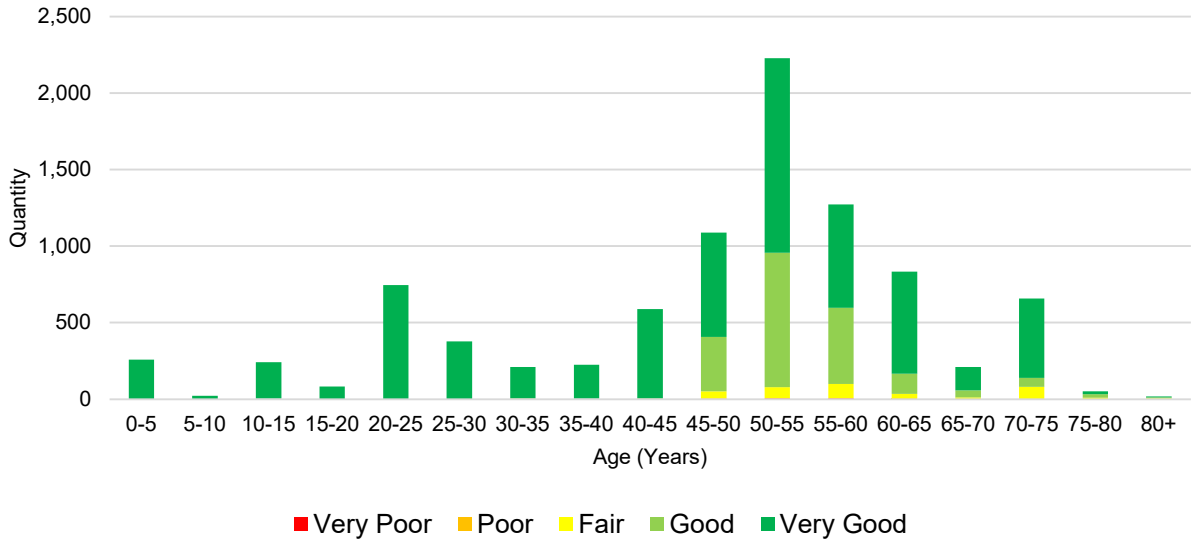
Approximately <1% of the transmission wood poles are currently classified as candidates for replacement based on Poor or Very Poor health index rating.

7.3.2.33 Appendix-C.2-Table 10: High Voltage Wood Pole Age/Condition

Age Range	Very Poor	Poor	Fair	Good	Very Good	Grand Total
0-5					257	257
5-10					22	22
10-15				2	239	241
15-20					83	83
20-25					745	745
25-30					377	377
30-35				4	205	209
35-40				2	223	225
40-45	1			5	582	588
45-50	3		49	354	683	1089
50-55	6		73	877	1271	2227
55-60	6		94	497	676	1273
60-65	2	1	31	131	668	833
65-70			11	47	151	209
70-75			80	59	518	657
75-80			9	23	19	51
80+			4	7	6	17
Grand Total	**18**	**1**	**351**	**2008**	**6725**	**9103**

Approximately 76% of the High Voltage Wood Poles are over 40 years old.

7.3.2.34 Appendix-C.2-Figure 11: HV Wood Pole Age/Condition - Graph[91]



[91] 204 poles on lines acquired from the City of Rochelle in 2020 reflect an installation date of 2020. The actual install date is undetermined.

7.3.2.35 Appendix-C2: 69 kV Construction

The 69 kV construction was installed during the late 1940s and early 1950s. These lines were built as single wood pole structures along railroads and rear lots of residential neighborhoods. Most of the 69 kV construction remains wood, but a small fraction has been replaced with steel structures.

7.3.2.36 Appendix-C2: 138 kV Construction

Typical 138 kV single circuit construction at ComEd in the late 1940s and 1950s was installing 138 kV wood H-frame structures. Several of these 138 kV H-frame lines have been rebuilt, but several wood H-frame line sections remain.

Single wood pole designs for 138 kV construction were adopted in the 1970s, especially for taps to large customers. Wood pole construction was also commonly used at tap locations in which 3-pole wood structures provided the versatility needed to change in-line direction. Wood pole switch structures consisting of 2-poles to 8-poles supporting horizontal switch frames are common.

Since 2014, ComEd's high voltage line design philosophy includes a "no new wood" policy, meaning that all high-voltage distribution wood poles and structures will be replaced with steel poles. This policy has resulted in an aging population of wood poles that continually shrinks as they are replaced.

The exclusive use of steel pole structures is a key consideration in ComEd's high voltage distribution design strategy. To date, ComEd has not experienced a failure of a steel pole structure due to a tornado or high wind conditions. Conversely, ComEd has lost hundreds of steel lattice towers and wood pole structures over the last 30 years. The significant difference in number and types of failed structures provides evidence that use of steel pole structures improves ComEd's high voltage distribution system's resilience.

Most of ComEd's steel transmission poles were purchased without galvanizing but with a factory-painted finish. That philosophy has changed. Today, nearly all tubular steel poles installed in the last 10 years have a galvanized finish or are made of self-weathering (COR-TEN®) steel, which forms its protective barrier that prevents rapid corrosion and eliminates painting costs as structures age. Since weathering steel structures require no painting to prevent strength loss, their use is expected to minimize future maintenance expenses.

ComEd's steel transmission pole strategy also includes exclusively using caisson foundations instead of direct-bury steel poles.

7.3.2.37 Appendix-C.2-Figure 12: Typical Wood to Steel Conversion

The leading cause of wood pole related failure on the ComEd system is severe weather, such as high wind or tornado events. Investigation of various severe weather wood pole failures during high wind events has found the cause of failure to be associated with overstress in the wood pole and not directly associated with ground line decay. When a wood pole breaks 10-20 feet above grade, it is likely that wind, and not decay, is the cause of failure.

Wood pole fires are caused by unbonded bolts installed through the wood poles. When these fires occur, a ground wire, carrying induced voltage to ground, becomes too close to a through-bolt. The area around the through-bolt and similar hardware give rise to a "rain shadow" effect in which the wood stays drier than the surrounding material. This drier area has a higher resistance than the surrounding moist wood surfaces and leads to arcing between the two areas when subjected to leakage current. This arcing provides an ignition source for the pole fire. The number of wood pole fires has steadily decreased as the number of aged wood pole structures has reduced, and structure grounding improvements have been completed.

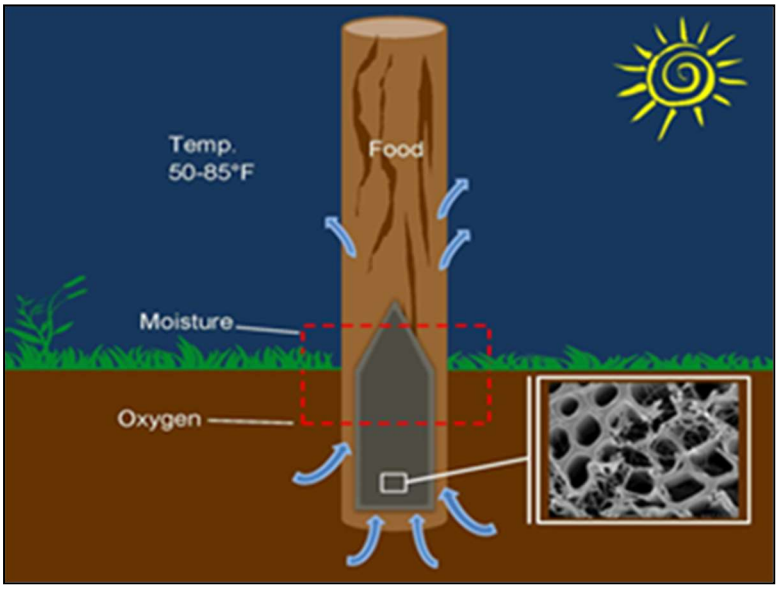
Failures related to wood pole deterioration is a concern as wood poles are susceptible to decay. Based on the review of ComEd's pole inspection data, heart rot and internal decay are the primary reject reason, with shell rot being the secondary reason. ComEd's Inspection and Treatment Program addresses each of the various types of decay.

Wood is well-suited as a structural material because it is very strong for its weight and can be easily cut into the needed dimensions. However, wood is susceptible to decay (rot) caused by water absorption into the wood, which feeds the growth of molds and fungi that literally eat away at the wood. Insect infestations accelerate the decay by reducing the wood's structural integrity through tunneling, which also provides additional water absorption routes.

Four elements are required for this process to occur which are found most commonly near groundline.

- Oxygen
- Moisture
- Temperature (50-85F)
- Food (wood)

7.3.2.38 Appendix-C.2-Figure 13: Wood Pole Decay Zone



The process of wood decay begins with no discernable change in wood and ends with wood being destroyed or consumed. The process may be continuous when conditions are favorable but may be interrupted with changes in moisture or temperature.

There are two primary types of decay

- **Heart rot:** Heart rot occurs when fungi eat away at the center of the pole leaving a hollow center. This is generally associated with thin sapwood species (firs, cedars) and characterized by soft ”punky” heartwood and/or open voids.
- **Shell rot:** Shell rot decay occurs when fungi eat away at the outer circumference of the pole. This is generally associated with thick sapwood species (pines) and is characterized by loose/fibrous shell.

7.3.2.39 Appendix-C.2-Figure 14: Typical Wood Pole Decay (Heart Rot shown Left and Shell Rot shown Right)

Both types of decay can be halted with chemical treatment and a pole restored to full strength using steel reinforcement. Treatment of poles with fumigants can make the wood undesirable and halt decay.

ComEd's current strategy for managing wood poles is composed of inspection and treatment of poles on a 10-year cycle coupled with reinforcement and replacement of rejected poles.

The US Department of Agriculture for Rural Utilities Services publishes Regional Wood Pole Decay Zones to provide guidance to utilities regarding ideal inspection and treatment cycles for in-service wood poles. The ComEd service territory resides within Decay Zone 2. Zone 2 is a relatively benign location for wood poles where humidity and ground moisture do not have a major impact on pole condition. Expected pole service life in this zone, with proper maintenance, is therefore greater than in more severe decay zones.

7.3.2.40 Appendix-C.2-Figure 15: US Dept. of Agriculture Wood Pole Decay Zones

Decay Zone	Initial Inspection (years)	Subsequent Re-inspection (years)	Percent of total poles inspected each year
1	12 to 15	12	8.3 %
2 and 3	10 to 12	10	10.0%
4 and 5	8 to 10	8	12.5%

US Dept of Agriculture
Rural Utility Service Bulletin
1730B-121

Source: US Dept of Agriculture Rural Utility Service Bulletin 1730B-121

ComEd's existing health index algorithm for HVD/transmission wood poles considers asset characteristics, inspection results, and previously identified corrective maintenance issues. This type of approach to asset health modeling is useful for identifying the wood poles with the worst condition relative to the rest of the population, which is essential for prioritizing replacements.

Given the reliability impacts of wood poles and structures during severe weather conditions, ComEd continues proactive replacement of HVD/transmission wood poles.

7.3.2.41 Appendix-C2: Medium Voltage Wood Poles (34kV and below)

ComEd has approximately 1,300,000 wood poles supporting medium voltage (4kV, 12kV, and 34kV) overhead distribution power lines with pole configuration generally including a crossarm, equipment, conductors, etc.

7.3.2.42 Appendix-C.2-Table 11: Medium Voltage Wood Poles, Condition by Age Range

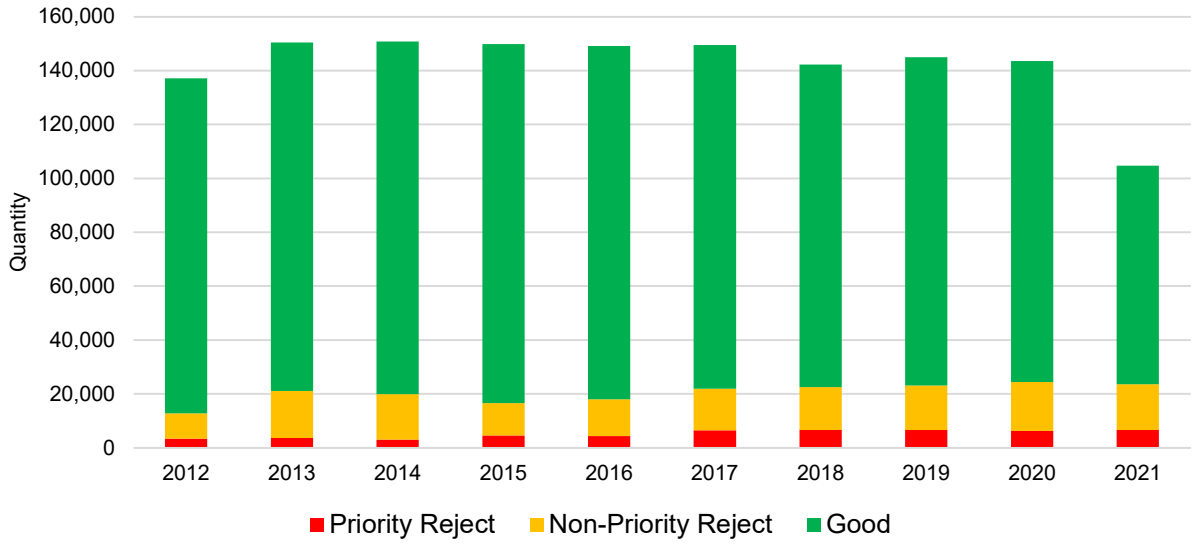
Age Range	Very Poor	Poor	Fair	Good	Very Good	Grand Total
0-5					257	257
5-10					22	22
10-15				2	239	241
15-20					83	83
20-25					745	745
25-30					377	377
30-35				4	205	209
35-40				2	223	225
40-45	1			5	582	588
45-50	3		49	354	683	1089
50-55	6		73	877	1271	2227
55-60	6		94	497	676	1273
60-65	2	1	31	131	668	833
65-70			11	47	151	209
70-75			80	59	518	657
75-80			9	23	19	51
80+			4	7	6	17
Grand Total	**18**	**1**	**351**	**2008**	**6725**	**9103**

Approximately 22% are 60 years old or greater

7.3.2.43 Appendix-C.2-Table 12: Medium Voltage Wood Poles, Accept/Reject Condition

Year	Priority Reject	Non-Priority Reject	Good	Total Poles Inspected
2012	3,425	9,417	124,310	137,152
2013	3,699	17,394	129,389	150,482
2014	2,998	16,922	130,863	150,783
2015	4,617	11,929	133,300	149,846
2016	4,389	13,583	131,109	149,081
2017	6,517	15,416	127,559	149,492
2018	6,642	15,883	119,680	142,205
2019	6,659	16,482	121,883	145,024
2020	6,265	18,201	119,057	143,523
2021	6,600	16,952	81,135	104,687
Total	51,811	152,179	1,218,285	1,422,275

7.3.2.44 Appendix-C.2-Figure 16: Medium Voltage Wood Pole Inspect/Reject Condition - Graph



At ComEd, all new poles, 65' and less are Southern Yellow Pine (SYP), while taller poles are Douglas Fir (DF) or Western Red Cedar (WRC).

Prior to 2006, Pentachlorophenol (aka Penta) was used for all wood pole treatments. However, the use of water as the solvent led to lower prices for chromated copper arsenate (CCA) treatment versus Penta, which is dissolved in oil.

The preservative treatment (Penta vs CCA) can generally be established by the color of the pole. Chromated Copper Arsenate (CCA) treated poles have green hue while Pentachlorophenol (Penta or PCP) treated poles have a brown hue.

7.3.2.45 Appendix-C.2-Figure 17: Typical CCA vs Penta Treated Wood Poles

ComEd uses CCA for SYP poles in locations that are "bucket truck accessible". The CCA treatment results in a harder shell of the pole. Line workers prefer pole treatments such as Penta which results in a softer shell if they need to climb the pole. Historically, pole locations not accessible by bucket-equipped vehicles required the use of Penta treatment poles.

7.3.2.46 Appendix-C.2-Figure 18: Truck Accessible Pole

7.3.2.47 Appendix-C.2-Figure 19: Gaff Penetration of Wood Pole

Penta will soon no longer be a treatment option for wood utility poles and crossarms.

As a restricted use pesticide, Penta hasn't been available to the general public since 1987.

In 2019, the sole supplier of Penta in North America, KMG-Bernuth, Inc., a CMC Materials company, announced that it would close its plant at the end of 2021.

Seeing an opportunity, the U.S. Environmental Protection Agency proposed in March 2021 to cancel all uses of pentachlorophenol in the U.S.

On February 4, 2022, EPA issued a final registration review decision requiring the cancellation of Penta as a preservative for utility poles. During the registration review process, EPA found that given the emergence of viable alternatives, the risks Penta poses to workers' health outweigh the benefits of its use.

Wood treatment facilities will be allowed to use their existing stocks of Penta to produce treated wood until February 28, 2027.

Wood pole and crossarm manufacturers are stocking up on Penta while they can. Wood pole and crossarm manufacturers' anticipated run-out dates vary, with some supplies potentially lasting until early 2024, depending on demand.

With the shift away from Penta as a pole treatment over the next several years, ComEd has evaluated alternate treatments such as DCOI (4,5-dichloro-2-N-octyl-4-isothiazolin-3-one) and CCA-ET for climb-ability.

Not all pole failures are the result of aging. A portion of them is due to vehicle strikes, trees, icing or wind loads above the design standard, etc. However, to identify and replace or remediate poles with deteriorating strength, ComEd performs regular pole inspections on a 10-year cycle. Any pole which upon inspection is found to present a danger to life or property is promptly repaired, disconnected, or isolated, in accordance with 2002 NESC Rule 214.A.5 in effect in Illinois. Any other pole which upon inspection is found to have deteriorated below original strength by more than 33% is "red tagged" and deemed a "reject pole," consistent with Table 261-1A of the 2002 NESC in effect in Illinois.

Poles exhibiting this deterioration or any other defect during inspection are recorded, and such records of defects are maintained until the defects are corrected, in accordance with 2002 NESC Rule 214.A.4 in effect in Illinois.

The 2002 edition of the NESC, rules 214.A.4 and .5 state:

> *214. Inspection and Tests of Lines and Equipment*
> *…*
> *4. Record of Defects*
> *Any defects affecting compliance with this code revealed by inspection or tests, if not promptly corrected, shall be recorded; such records shall be maintained until the defect is corrected.*
> *5. Remedying Defects*
> *Lines and equipment with recorded defects that could reasonably be expected to endanger life or property shall be promptly repaired, disconnected, or isolated.*

The 2017 edition of the NESC, rule 214.A.5. states:

> *214. Inspection and tests of lines and equipment*
> *…*
> *5. Corrections*
> *a. Lines and equipment with recorded conditions or defects that would reasonably be expected to endanger human life or property shall be promptly corrected, disconnected, or isolated.*
> *b. Other conditions or defects shall be* designated for correction.

To aid in the prioritization of corrective maintenance work, these red-tagged rejected poles are further classified as either a "Priority Reject" pole or a "Non-Priority Reject" pole. ComEd's designations for "Priority Reject" and "Non-Priority Reject" depend on the height of the pole.

For poles 60 feet or less in height above ground (i.e., 65-foot poles or shorter), a pole is rejected if it has a remaining strength of 67% or less.

- Poles of this height are deemed "Priority Reject" if they have 0% - 33% remaining strength.
- Poles of this height are deemed "Non-Priority Reject" if they have 34% - 67% remaining strength.

For poles greater than 60 feet in height above ground (i.e., 70-foot poles or taller), a pole is rejected if it has a remaining strength of 75% or less.

- Poles of this height are deemed "Priority Reject" if they have 0% - 33% remaining strength.
- Poles of this height are deemed "Non-Priority Reject" if they have 34% - 75% remaining strength.

For both "priority" and "non-priority" poles, there is no "industry standard" that details a timeframe for the replacement of reject structures beyond the "promptly" called for in Rule 214.A.5 for those defects "expected to endanger life or property." At ComEd any poles or other structures which are found to pose an immediate safety

hazard are mitigated with immediate resource commitment toward isolation, repair, or replacement to remove the hazard.

The pole program currently calls for the replacement of reinforceable priority reject poles 30' or less poles and 3-phase poles, along with building the pole(s) to NESC Grade B construction.

The result of an inspection will determine if a pole is to be replaced, reinforced, or will remain in the field based on the remaining strength of the pole. The following terms are used to define the reject criteria:

- Reject Pole – A pole that has deteriorated below 67% "required" strength per the National Electric Safety Code for Grade B and C construction.
- Priority Reject Pole – A pole that has less than 33% "required" remaining strength. Priority reject poles are either replaced or reinforced within a set timeframe.
- Non-Priority Reject Pole – A pole that has less than 67% remaining "required" strength but have greater than 33% required strength.

Priority Restorable poles are restored in the current inspection year and Priority Non-Restorable (Replacement) poles are scheduled for replacement the "next calendar year after inspection.

Non-priority poles are treated immediately upon inspection with a pole treatment product from Osmose to control the decay, maintain the asset, and "extend the useful life" of the pole. Once "non-priority" poles are discovered and immediately treated, ComEd does not allow anyone (including ComEd itself) to install additional facilities to that pole without first replacing it or reinforcing it. Such replacements are opportunistically reinforced or replaced as part of other routine work activities.

Pole top hardware is also inspected as part of the circuit inspection program. That hardware includes the following: cutouts, slack span sleeves, grounds, surge arresters, cross-arms, transformers, insulators, and guy wires.

7.3.2.48 Appendix-C2: Underground Residential Distribution (URD) Cable

ComEd has approximately ~23,000 miles of Underground Residential Distribution (URD) cable. The cable is primarily installed in a direct buried fashion.

Following World War II in the 1940s, activities in new residential developments increased and the design of curvilinear subdivisions with irregular sized lots, low ranch-type homes, and utility easements in place of alleys proliferated. This resulted in an increase in requests for Underground Residential Distribution (URD). The elimination of poles, overhead wires, guy wires, and anchors on almost every pole on the curved rear lot lines, greatly added to the appearance and consequently increased the value of property.

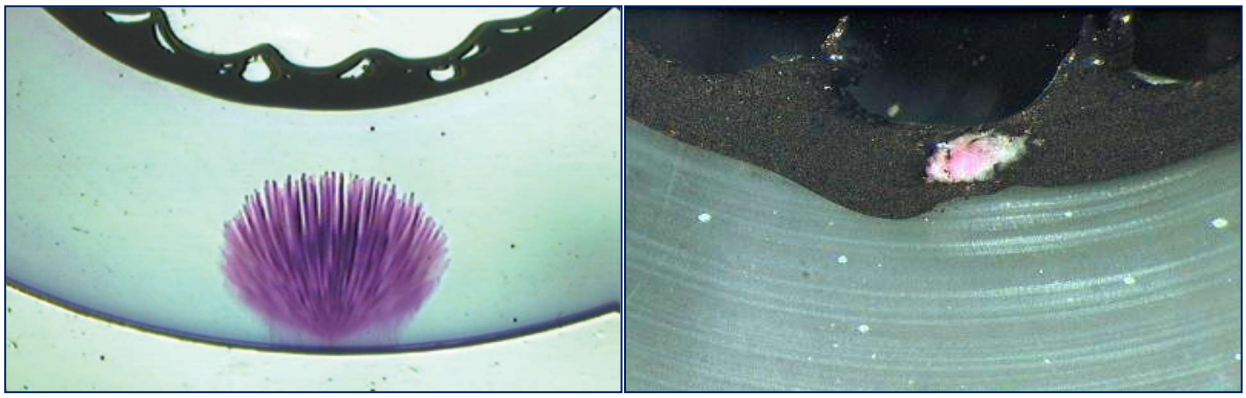
In 1950s, the 4kV system was fast becoming inadequate to supply the increasing loads and 12kV, was selected as the distribution voltage. As equipment such as cable insulation and low-profile pad-mounted transformers continued to improve, URD service rapidly expanded through the 1950's and 1960's and is now the standard for suburban service.

During the 1960s, extruded dielectric cable was selected to meet the dramatic expansion of electrical service to the URD areas. These extruded dielectric cables were typically installed direct buried. These cables were introduced to utilities featuring high dielectric strength, ease of installation, and low cost. Extruded dielectric insulations include rubber or polyethylene-based materials.

Since the introduction of extruded dielectric cable, the industry has experienced several design and manufacturing deficiencies that contributed to premature failures. Extruded dielectric cables manufactured prior to 1980 have proven to be susceptible to premature failures for a variety of reasons such as: insulation degradation due to moisture, manufacturing imperfections, and neutral corrosion.

The primary modes of failure for polyethylene cables are the formation of water and electrical trees within the insulation or workmanship. Water trees are small tree-like growths, originating from contaminants, defects, or voids in the cable insulation. The growth of these tree-like structures is influenced by moisture, over voltage, temperatures, and electrical stress. Once formed, water trees within the insulation convert to electrical trees and future cable failure.

7.3.2.49 Appendix-C.2-Figure 20: Water Tree (Left) and Contaminant (Right)

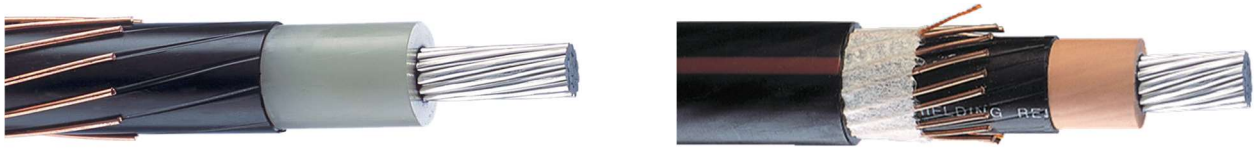


By 1980s, manufacturers developed better performing extruded dielectric materials, but the industry continued to use non-jacketed bare concentric neutral designs. These cables have experienced failures resulting from the corrosion of the cable's bare copper concentric neutral conductor. Over time, the cable's bare concentric corrodes and eventually open circuits. This condition causes high electrical stress within the cable insulation ultimately leading to failure.

7.3.2.50 Appendix-C.2-Figure 21: Typical URD Cable Failure

Extruded dielectric cables, since the 1980s, have been designed to tighter industry specifications and manufacturing quality control measures to improve their performance. Since converting to water-blocked conductors and overall cable jackets, the industry has experienced no impact from cable failures other than due to mechanical damage or workmanship.

7.3.2.51 Appendix-C.2-Figure 22: Bare Concentric Neutral Cable (Left) and Jacketed Cable (Right)



Ethylene Propylene Rubber (EPR) and Tree Retardant Cross-Linked Polyethylene (TRXLPE) are the main extruded insulations in use today. EPR cable is relatively immune to the water treeing phenomenon and has provided reliable service for over 40 years.

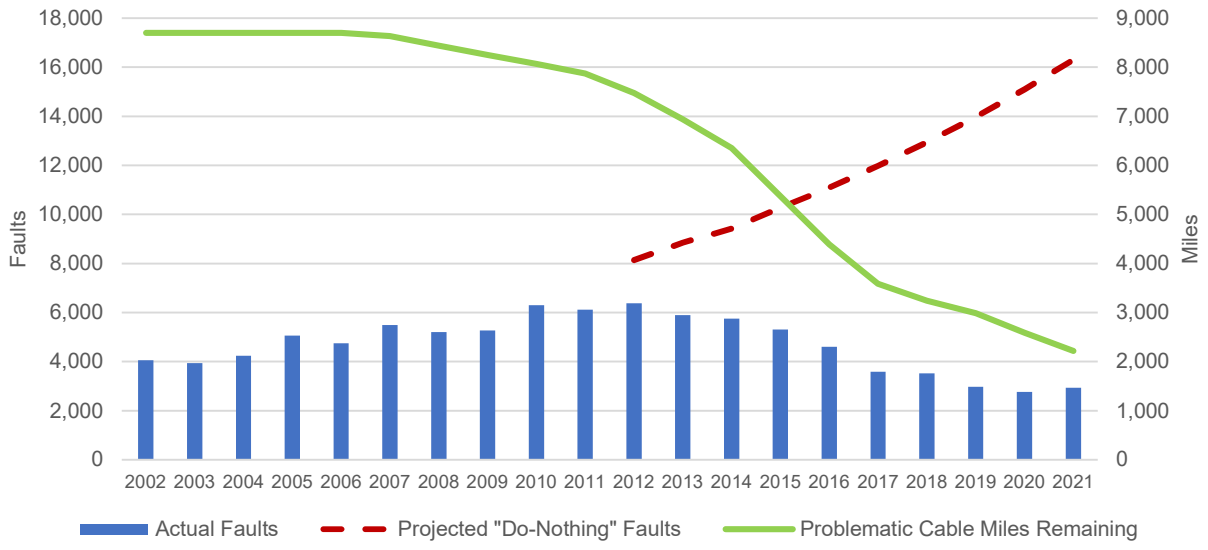
ComEd's URD failures cluster around aging bare concentric cable, which were installed from approximately 1960 to 1985 (~8,700 miles). The remaining 1,800 miles of non-jacketed cross-linked polyethylene (XLPE) population of cable has surpassed its expected 40-year service life. The key failure modes are insulation breakdown and the increased likelihood of having >50% neutral corrosion, which increases resistance of the neutral and leads to increased electrical stresses on the insulation during normal operating load, faults, and lightning induced surges.

Changes in climate and weather will impact the longevity on the aging of non-jacketed cable. Increased high and low temperature extremes, moisture, and lightning activity result in an accelerated loss of cable service life associated with increased electrical stresses, cyclic loading, and increased fault locating activities on the remaining in-service cable. Extreme weather events will adversely impact these known poor performing cables remaining life as an increase in failures can be expected in the ensuing years after an extreme weather event. Similarly, the impact of increased lawn service fertilizer use in residential developments is changing the soil PH levels, which is a likely contributor to the accelerated neutral corrosion of the remaining non-jacketed (exposed neutral).

URD cable failures have historically been a driver of localized or "pocket" customer reliability concerns due to multiple "blue sky" outages.

ComEd has been successful in reducing the population of the 8,700 miles of targeted poor performing non-jacketed URD cable installed during the 1960s thru 1985-time period. Today, the remaining risk population is reduced to ~1,800 miles. This is the result of proactively removing ~6,150 miles of non-jacketed cable and life extension via cable injection of ~750 miles.

7.3.2.52 Appendix-C.2-Figure 23: URD Cable Failures 2002-2021



ComEd continues to invest in proactively replacing URD cable to manage reactive costs and to improve reliability for customers. In the absence of a continued investment in cable replacement programs, the number of URD outages will continue to rise.

7.3.2.53 Appendix-C2: Mainline Cable

There are ~9,200 miles of mainline underground cable in service across the ComEd distribution system. Chicago Region has about ~4,900 miles and the suburban region has ~4,300 miles of mainline cable. The cable is installed in both conduit/manholes and direct buried. Cable inside Chicago Region is typically installed in manhole/conduit systems while cable outside Chicago is installed in manhole/conduit and direct buried. Conduit and manhole cable systems are required to route multiple circuits through congested areas.

Mainline underground cable installed in the City of Chicago and surrounding areas dates back to the turn of the 20th century. At that time, Paper Insulated Lead Covered (PILC) cable was developed and subsequently this cable went into widespread usage.

PILC is manufactured by using electrical grade paper tapes wound around copper conductors, then vacuum dried and impregnated with oil. The impregnated oil core is then covered with a metallic sheath, typically made of a lead alloy.

ComEd predominantly utilized a sector-type design that has three individual cables contained within one lead sheath. This design provides a smaller overall cable diameter when compared to extruded dielectric cable designs, and this advantage allows them to be installed in small diameter conduit.

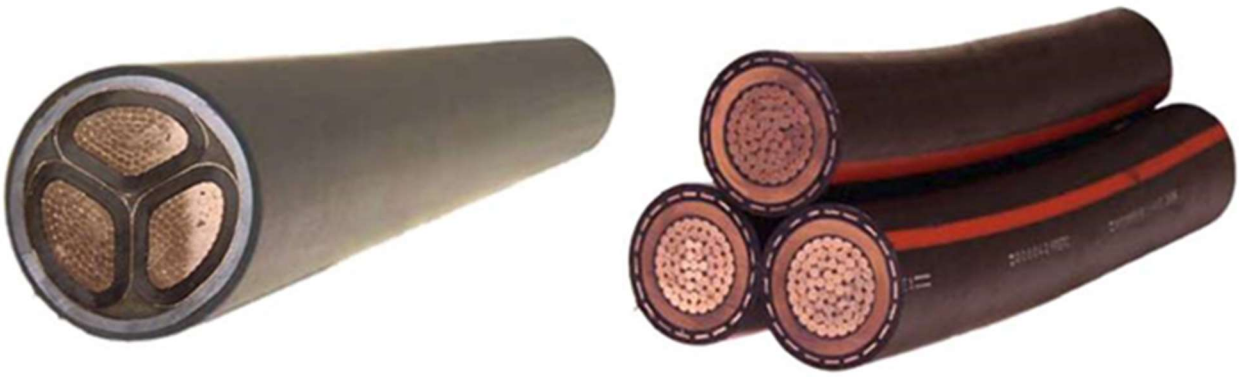
For a cable design introduced over 100 years ago, the reliability of PILC cable has generally been excellent. Cables from the 1920's are still identified following failures. The primary modes of failure for PILC cable are moisture ingress due to leaks or breaks in the lead sheath. The lead sheath of a PILC joint creates a hermetic seal that prevents water and other contaminants from entering the insulation.

Most failures are due to mechanical reasons or workmanship. The normal daily load cycle on a cable causes the cable materials to expand and contract as its temperature changes. Repeated cable expansion and contraction may mechanically fatigue the lead sheath and eventually cracks develop. Over time, cracks will allow moisture to enter the paper insulation and lead to an electrical failure.

To identify leaks that occur along cables and at cable joints, manhole inspections are performed. If repairs are not made, moisture will breakdown the insulating properties of the paper insulation and will result in a failure.

Beginning in 2003 ComEd embarked upon an initiative to minimize the new installation of any lead cable. This was driven by ComEd's commitment to a "greener" environment and to reduce dependence on the more expensive lead cable. ComEd engineers worked with manufactures to develop 12kV flat strap cables insulated with Ethylene Propylene Rubber (EPR) that could fit into existing duct work and use commercially available splicing and terminating components.

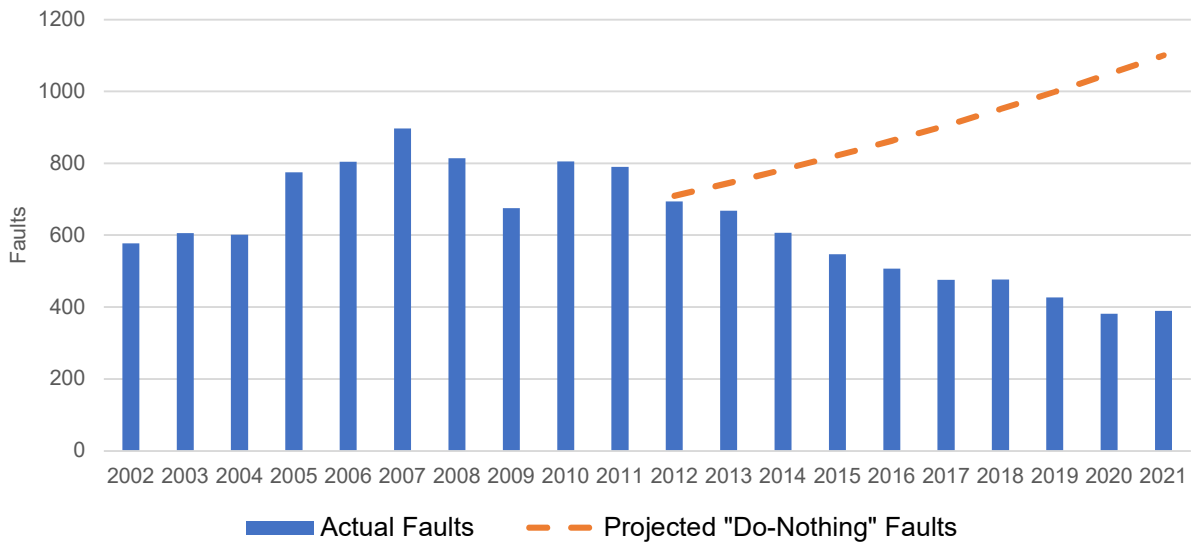
7.3.2.54 Appendix-C.2-Figure 24: Jacketed PILC Cable (Left) and Jacketed Flat Strap Neutral Cable (Right)



There are approximately 32,000 manholes on the ComEd system, with 23,300 located in the City of Chicago and 8,700 located outside in the suburbs, a mix of brick and concrete of various sizes and duct availability and condition. Manholes provide locations where sections of cable can be pulled through the conduit and spliced together.

Mainline cable is a critical component for both the distribution systems. A cable failure reduces system redundancy and resiliency and can interrupt a large number of customers for an extended period of time.

7.3.2.55 Appendix-C.2-Figure 25: Mainline Cable Failures 2002-2021



ComEd is continuing investments in cable replacement for two main reasons.

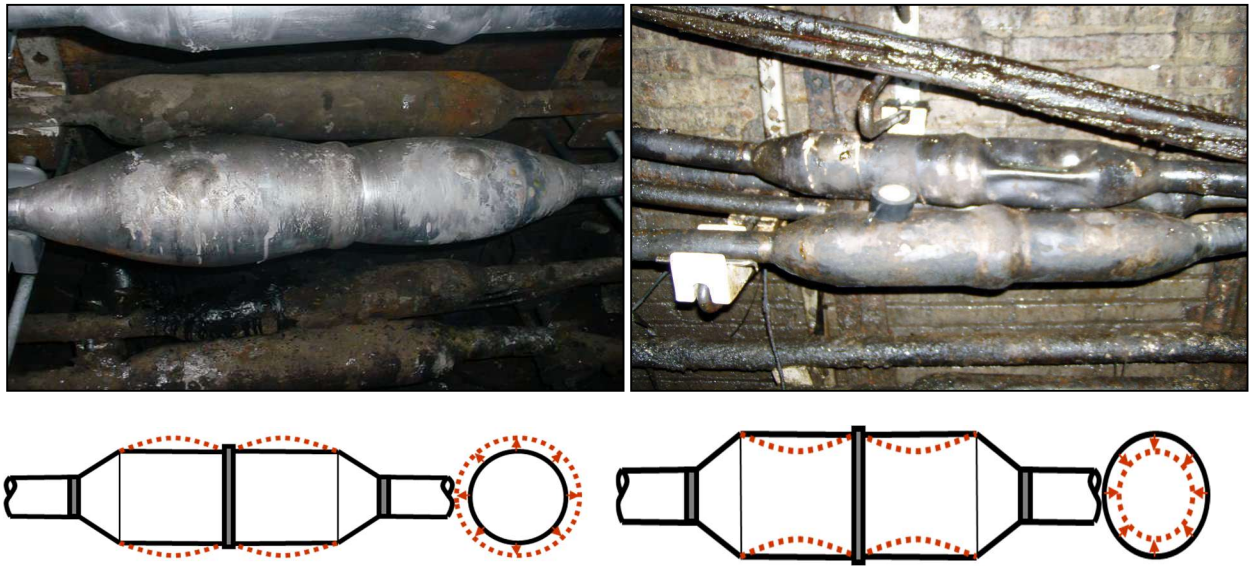
First, emergent cable failures are more costly than planned cable replacements. To limit system risk during a cable failure, particularly a failure during the summer, additional measures must be taken to support loading, such as transferring load or deploying mobile generators. Many of these types of costs can be avoided if replacements are planned during non-peak times.

Second, cables failures can interrupt a large number of customers for a lengthy period of time as well as reduce the level of redundancy on the system itself. In some cases, cable failures can damage adjacent equipment and lead to a larger outage, more costly repair, and additional system risk.

Cable replacement is prioritized based on cable defects identified during manhole inspections.

Cable defects generally include leaking joints, collapsed joints, and bulged joints in paper-lead systems. Generally, the cable segments adjacent to the defect are replaced.

7.3.2.56 Appendix-C.2-Figure 26: Joint (Bulged/Expanded) Left and Joint (Collapsed/Imploded) Right



7.3.2.57 Appendix-C2: Fused Cutouts

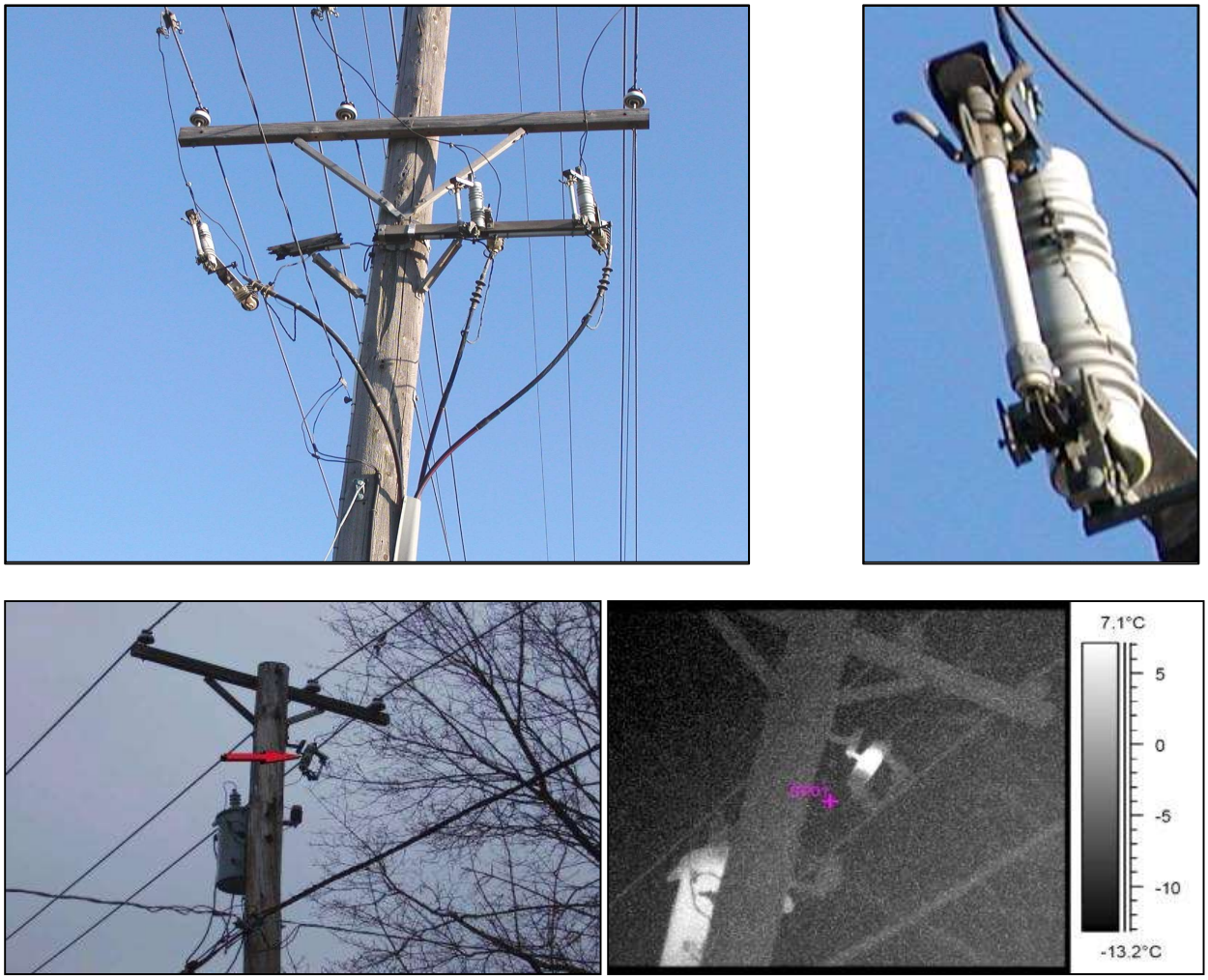
A variety of fuse mountings and fuses are used in the construction and maintenance of the distribution system to protect equipment. The most commonly applied and least expensive type is the open type fused cutout.

A fuse cutout is a combination of a fuse and a switch. It is used in primary overhead feeders to protect equipment and primary conductor from overloads. An overcurrent condition caused by a fault in equipment or on the line will cause the fuse to melt, disconnecting the equipment from the line or a primary line segment from the upstream source. Utility personnel can also open it manually.

There are an estimated 635,000 fuses installed across ComEd's distribution system. The majority of the fuses are installed in cutouts made of porcelain materials.

Significant porcelain cutout quality issues emerged across the utility industry in the late 2000s. Porcelain cutouts develop small cracks that collect water that then freezes leading to fractures and then failure. Cracking of the porcelain body causes the cutout to lose its insulating properties resulting in electric faults. Cracking can also cause carbon tracking, which can lead to burnt crossarms and poles and result in pole-top fires.

7.3.2.58 Appendix-C.2.1-Figure 27: Porcelain cutout failures



Porcelain cutout failures are an issue because, while they can occur at any time, they can occur when a fuse is opened or closed posing a safety concern for utility personnel.

On average, cutout outages account for approximately 8% of the overall system outages.

Three specific types of porcelain cutouts have been identified to be particularly problematic by ComEd including:

- AB Chance
- S&C Electric (2005-2007)
- Cooper Power (2010-2012)

In 2015, ComEd transitioned from porcelain to polymer cutouts to reduce the cracking and failure issues associated with porcelain designs. As compared to porcelain, polymer cutouts have better cold weather reliability, are more durable during transit and installation, and have superior mechanical toughness.

However, ComEd still has thousands of porcelain cutouts on its system and these porcelain cutouts have been experiencing an increasing rate of failures in recent years.

ComEd expects that replacement of porcelain cutouts will continue through at least 2027. As the remaining porcelain cutouts on the system are systematically replaced with polymer, ComEd is improving reliability for customers and the resilience of its system.

7.4 Appendix-D: Additional Details on Grid Plan Initiatives

7.4.1 Appendix-D.1: Community Engagement and Inclusion

Transforming customer experience is a continuous journey and ComEd needs to continuously develop new digital and analytical capabilities to address customers' evolving needs and offer apt energy solutions. This will be an exciting and rewarding journey for ComEd to have the right vision to march forward, leveraging the technology and the community outreach.

Community engagement and inclusion activities include:

- **Digital channels** enable ComEd to reach customers with personalized messaging and enable bi-directional conversations to seek their feedback and address their issues. In general, many customers today—particularly younger customers—expect that companies will communicate personalized information through their preferred digital channels. Customers increasingly want intuitive and convenient digital experiences akin to those they receive from online retailers, the finance industry and technology giants. Like other customer-facing industries today, utilities need to offer these experiences to retain high levels of satisfaction throughout their customer base. ComEd leverages a suite of platforms and programs to gather feedback from its stakeholders and communities to inform decisions in furtherance of the mode of community partnership. These means are a critical piece of ComEd's approach to engaging directly and continuously with the community to understand customers' needs and to validate or realign priorities. ComEd has expanded its digital channels to a whole host of touchpoints that include presence in social media and a contact center support with dedicated support to address queries related to Smart Meter, Energy Efficiency, Payments, Reporting Outage, Account Management etc. Social listening gives ComEd an opportunity to get a pulse of customer sentiment and incorporate their feedback into the service/customer experience strategy. ComEd's digital channels have given customers a choice, control, and convenience on how they wish to engage. ComEd has blended in-person community involvement with online interactions to amplify the impact it is having in the local community.

- **ComEd's customer satisfaction survey** requests customers to rate its performance on fourteen performance measures using a zero-to-ten scale. The survey addresses the following topics as required by the ICC rules: overall satisfaction; reliability; performance; customer service performance; understanding of services; tree trimming performance; billing; and demographics/firmographics.

- **ICC Surveys** The research objectives for the surveys are to provide the ICC with basic knowledge of ComEd's residential and non-residential customers, particularly:

    - Satisfaction with overall electric service

    - Recent outage experiences

    - Opinions of utility services including restoration of power, keeping the public informed, and being accessible

    - Familiarity with various utility services

    - Opinions of utility tree trimming efforts

- Receipt, handling, and ease of use of Commonwealth Edison's billing statements

- Demographic (residential) and firmographic (non-residential) information

- **External Affairs Managers:** ComEd has a team of 19 External Affairs Managers who are charged with connecting directly with municipalities, local government, and community organizations to understand their needs and act as a conduit for community concerns and requests. The External Affairs Managers attend community meetings and events, coordinate storm response in partnership with communities, communicate community priorities and concerns to ComEd leadership, and triage with internal teams to respond to specific requests.

- **LCS Account Managers:** The ComEd Large Customer Service Account Managers oversee Commercial and Industrial customers with electrical usage consumption over 500 kW. The team aids customers with expert recommendations on reliability, the integration of energy efficiency, beneficial electrification, distributed energy resources, community solar, utility-scale energy generation projects, and emerging technologies.

- **LCS – C-Sat Survey:** ComEd conducts bi-annual surveys of its large customers to gather opinions on their experience working with the utility. The survey includes questions on customer satisfaction, value, and engagement with the utility.

7.4.2 Appendix-D.2: Volunteerism Initiatives

ComEd local investments have helped lift communities and address the challenges of today's ever-evolving climate and economy. These investments, in concert with ComEd volunteerism in the community, advance the cause of equity by building more resilient communities. ComEd has partnered with the communities by making needed investments that enhance the quality of life for the families and businesses served. Examples include funding pollinators, green space projects, public electric vehicle chargers, protecting the environment, public safety initiatives and increase access to the arts across northern Illinois.

Volunteerism initiatives include:

- **Employee based donation-funded program with company match:** ComEd is proposing an employee donation-funded bill assistance program, targeted at EIEC customers who need assistance after other resources have been exhausted. In future years, this will be expanded to customer contributions being pledged monthly to their electric bill payments, by sending a check or electing to contribute online, with donations matched.

- **Public School Carbon-Free Assessments and Follow-On Advising:** ComEd intends to provide prioritized access to carbon-free assessments for schools in under resourced communities, within its general public school's education campaign and execution of CEJA-mandated Public Schools Carbon Free Assessments. Additionally, ComEd proposed to lend technical assistance and advising following completion of these EE/solar/electrification assessments, helping schools to act on recommendations and access available ComEd and public funding

- **ComEd Volunteering:** ComEd has always stood up for community outreach and education competitive grant programs for community organizations. Annual grant programs are a part of ComEd's comprehensive investment in the communities served. In 2021, ComEd employees volunteered more than 12,200 hours and raised $2 million to support multiple communities and causes.

- **ComEd Community Investments:** ComEd has partnered with the communities by making needed investments that enhance the quality of life for the families and businesses served. ComEd has consistently seeded local investments to help lift communities and address the challenges of today's ever-evolving

climate and economy. Examples include funding pollinators, green space projects, public electric vehicle chargers, protecting the environment, public safety initiatives and increase access to the arts across northern Illinois.

7.4.3 Appendix-D.3: Economic and Workforce Development Activities

- **ComEd Infrastructure Academy (CONSTRUCT, Business Operations, CRAFT, Youth Construct, EE Incubator/MDI):** ComEd Energy Efficiency continued to prioritize workforce development initiatives in 2022 to expand business and employment opportunities for diverse and local small businesses in the communities it serves. ComEd Energy Efficiency launched the third full year of the Energy Efficiency Service Provider (EESP) Incubator Program and partnered with a Minority Women-Owned business to deliver the program and share firsthand the learnings of growing a small business within the Energy Efficiency industry. This program is designed to educate and train contractors and distributors on ComEd's Energy Efficiency Portfolio offerings so they can participate in EE offerings and grow their businesses as they help their customers save energy and lower their utility bill. Participating organizations are educated on how to best represent the ComEd Energy Efficiency Program to customers and complete energy efficiency projects by leveraging existing workforce development frameworks, community-based agency partnerships, and mentored by other vendors within the Energy Efficiency portfolio. Since program inception, 98 diverse businesses have graduated from the program with 65% being accepted into the EESP network, resulting in 150+ projects completed.

- **Power Up Academy (EOC Summit):** ComEd held an EOC Summit in August of 2022, to focus on developing technical skills amongst diverse candidates in partnership with ComEd EOCs. The intention is to build a diverse pipeline of talent for technical roles in the clean energy space, deepens relationships with engineering contractors and develop connections between newly skilled workers and jobs in the industry.

- **CEWD/NUL Apprenticeship program:** ComEd is partnering with CEWD and National Urban League to develop WFD/Apprenticeship programs with the local electric utility in 5 select cities. This will strengthen relationships with local community and partners, develop focus on building a diverse apprenticeship pipeline in EIECs for the trades and clean energy jobs

- **Big Shoulders - Powering Our Future:** ComEd and Exelon are partnering with Big Shoulders Fund and United Way Metro Chicago to create a first-of-its-kind trades program in 4 Catholic high schools in underserved communities in Chicago. ComEd's representatives will teach students in EIECs and LMI communities about the trades and connect them with careers at ComEd and in the industry.

- **WFD Clean Energy Center of Excellence:** ComEd is proposing to lead a public-private workforce development collaborative that reflects a joint commitment with government, other industry partners, labor, education, and community-based organizations in developing a Workforce Development Center of Excellence to prepare/train/reskill individuals from under-resourced communities for Illinois' clean energy transition. This will build a multi-faceted training and support services approach in under-resourced communities.

- **FEJA Workforce Development Programs:** ComEd has provided incentives for the expansion of renewable energy in Illinois. As per the directives of FEJA legislation ComEd was supposed to invest $30M over a 12-year period (2017-2029) to train underserved, diverse participants with a focus on training persons with a record and foster care (current and alumni) for the solar industry. The funding was equally disbursed every 4 years ($10M in 2017, 2021, and 2025). ComEd had eleven grantee organizations that participated in the FEJA program. Under this program there were three training categories: Solar Pipeline Training, Multi-cultural training, and Craft Apprenticeship. In 2021, these programs served over 327 trainees, where over 57% are people of color (4% undisclosed) and over 13% are women.

- **Solar Training Pipeline Program:** This program prepares job seekers for roles in the solar industry and prepares contractors to bid on solar projects. The training includes a solar bootcamp and is implemented by Elevate Energy, Illinois Central College, OAI, Inc. and the Safer Foundation. The 2021 Solar Training Pipeline program had 73 trainees, 85 percent of them minority residents, and saw an 89 percent graduation rate.

- **Craft Apprenticeship Training Program:** This program provides a pathway to roles in electric industry trades, introduction to solar, and "train-the-trainer" programs delivered by IBEW (International Brotherhood of Electrical Workers) locals at high schools across Illinois. The 2021 program featured an expansion of training programs to new CPS high schools, including Dunbar and Simeon. All 410 trainees in the IBEW program graduated, and 99 percent secured employment.

- **Multicultural Training Program:** This program aims at upskilling trainees from diverse and underserved communities, with training delivered by the Chicago Urban League, National Latino Education Institute (NLEI), ASPIRA of Illinois and Austin Peoples Action Center. The program is also supported by multicultural industry organizations, including the Chatham Business Association and the Hispanic American Construction Industry Association (HACIA). In 2021, there were 220 participants in the Multicultural Training Program, with a 72 percent graduation rate.

- **ComEd Energy Force Ambassador Program:** The ComEd Energy Force Ambassador Program is a one-of-a-kind program that trained adults with developmental disabilities to serve as ambassadors for ComEd's Energy Efficiency Program. ComEd provided training about the basics of energy efficiency, smart grid, and sustainable energy sources for all the selected ambassadors. Following their training, ambassadors helped the public understand the benefits of energy efficiency and conservation at home. They taught people simple, energy-saving tips by creating fun, interactive demonstrations. The 2021 cohort had a record 88,000 customer interactions through 245 engagements.

- **Supplier Workforce Diversity:** In 2022, ComEd launched a Market Development Initiative to increase contracting opportunities for diverse business enterprises and community organizations along with improving diversity and inclusiveness of supplier workforce. ComEd has been dedicated to spending $4 million annually on an average for development initiatives like incubators, training, internships, and job placements. Additionally, $100 million is targeted to be spent on diverse spend annually across Energy Efficiency portfolio. In 2021, ComEd's diverse suppliers contributed in countless ways, including continued support for responding to the challenges of the pandemic. ComEd's spend with diverse suppliers reached $893 million, which represents 42 percent of ComEd's total supply chain spend of $2.1 billion in 2021 – matching the record percentage that it achieved in 2020. Since 2012, ComEd has spent more than $6.4 billion with diversity-certified suppliers, and ComEd is constantly looking for opportunities to increase diverse supplier partnerships. In 2021, ComEd added 153 new diversity-certified partners, bringing the total to 662. ComEd's senior leadership team is helping to create new development opportunities for new diversity-certified suppliers. ComEd has a specific sourcing procedure governing supplier diversity, which is part of the Company Management Model. ComEd facilitates access for all the qualified diverse suppliers to compete for its business, and with the sustained momentum of this effort, ComEd seeks to become a recognized industry leader in diverse-supplier inclusion as a natural part of ComEd's business culture 2022 Supplier Diversity Plan.

- **Energy Efficiency Program:** From 2018 to 2022, ComEd grew diverse spend across all Energy Efficiency programs, spending $50.5M in 2021 which is a 91% increase since 2018. ComEd's Energy Efficiency Program prioritizes workforce development initiatives to expand business and employment opportunities for diverse and local businesses in the communities served. In 2020, ComEd launched the EESP Incubator Program partnered with a women-owned implementation contractor to deliver the program. This program is designed to educate and train diverse contractors and distributors, many located within income-eligible

communities, on ComEd's EE Portfolio offerings. The participating organizations are educated on how to best represent the ComEd EE Program to customers and complete energy efficiency projects by leveraging existing workforce development frameworks, community-based agency partnerships, and support from the portfolio's prime Implementation Contractors. Since its inception, 98 diverse contractors have completed Incubator training, and 65% have been accepted into the ComEd EESP Network. The 2022 cohort consisted of 33 diverse contractors who began their training in March.

- **Economic Development Organizations:** ComEd's Economic Development team has always been persistent in giving a boost to the regional economy and in strengthening the local communities through external partnerships, proactive engagement, and internal collaboration to drive job creation and investment throughout northern Illinois. ComEd's service territory is attracting investment from some of the most innovative and exciting industries in the nation. ComEd has been working with the State of Illinois Department of Commerce and Economic Opportunity (DCEO), Intersect Illinois, over 30 regional economic development organizations ("EDOs"), and numerous real estate brokers and developers to support existing and prospective customers' power needs. The team leverages relationships, data analytics and ComEd's energy-related strengths to support customers' decisions to invest and grow their businesses in northern Illinois.

- **Rider DE (Distribution Extension) Enhancements:** In 2016, ComEd receive unanimous approval from the ICC to modify and modernize a tariff that supports new or expanding businesses throughout northern Illinois by reducing upfront costs for connecting to ComEd's grid. Customers now benefit from an innovative regulatory mechanism that provides large up-front credits for off-property system extensions and accelerated refunds to support economic development. Customers that request new or increased electric service resulting in off-property system work qualify for Rider DE. The program offers a standard $250,000 system extension credit. If the customer portion of the off-property work is less than that amount, the extension is effectively at no cost to the customer. If the customer passes an internal credit risk assessment, the customer is eligible for an extension credit up to five-years of anticipated ComEd delivery service charges further reducing upfront costs. For projects that require a deposit, the customer is eligible for an annual refund based on the actual distribution service charges over 10 years. In addition to normal annual refunds, customers that average over 75% of their load request can receive the remaining deposit refunded after year five. Since modifications to Rider DE were approved, well over 100 new customers have seen significant benefits, enabling more business growth and expansion in northern Illinois.

- **Elk Grove:** ComEd opened a new state-of-the-art substation in Elk Grove Village as well as a new transmission substation in DeKalb to support data center growth specifically in the western O'Hare Airport market. The DeKalb Crego Road Substation is targeted to support the $1 billion-plus Meta/Facebook campus and other new developments that are taking place in the surrounding area. ComEd has also identified and evaluated over 25 large land sites throughout northern Illinois that are ideal locations for large power users to connect to ComEd's grid more easily for electrical service.

STEM Education

ComEd's professionals train the students to think like engineers, solving problems, and identifying innovative solutions through engaging hands-on programs. This program additionally helps future workforce to combat climate change, to modernize the grid, and to leverage new and emerging technologies in their own Chicago communities. Despite the uncertainty and upheaval presented by the pandemic in the last couple of years, ComEd's STEM Programs met each challenge to experience a year of growth, expansion, and streamlined organization for virtual programming. In 2021, 1,092 students in the City of Chicago were benefited by ComEd STEM Programs.

- ComEd conducts extensive educational tours and programs that take place at the Chicago and Rockford Training Centers, to provide exposure to the skilled trades, STEM, and around the construction and utility industry. There are several academic institutions and community groups that have been tied up with the

ComEd's Training Center Smart Energy Hub. Students from various high school and college STEM programs learn from the instructors, subject matter experts and ComEd guest speakers at ComEd's facilities.

- The **"ComEd Tools of the Trade"** is another such program, which offers 7-week apprenticeship for 16-18 years old's who are interested in learning more about the skilled trades and ComEd.

- ComEd has partnered with more than a dozen national organizations that serve minorities in leadership and in energy-related fields and military veterans to attract a talented and diverse workforce. ComEd creates equitable training opportunities through programs like **ComEd's job training program, CONSTRUCT**, and new partnerships like Chicago United's Corporate Inclusion Institute, a nine-month talent development program.

- ComEd inspires tomorrow's energy leaders through programs like **ComEd STEM Home Labs, Youth Ambassadors and Energy Force** that are designed to seek out and cultivate talent from historically underrepresented groups.

- ComEd also provides exposure to the construction and utility sector through a partnership with **Chicago Builds**. Chicago Builds provides two-years of off-campus construction training for Chicago Public School juniors and seniors interested in pursuing a career in the trade after graduating high school. ComEd supported the curriculum by teaching four classes in the first and second semester. These classes provide an introduction to electricity and focuses on career opportunities in the utility and EE industries.

- **EV Rally:** Under the banner of getting more women into STEM (science, technology, engineering, and math) fields, ComEd hosts an EV Rally competition, in which teams work with ComEd women engineers to build the cars of the future. In 2022, 30 Chicago area girls were teamed up in 6 teams and worked for weeks on this competition.

7.4.3.1 Appendix-D.2-Figure 1: ComEd EV Rally 2022

- **Create a Spark 9th-12th:** In this four-year program, students explore energy and engineering topics ranging from engineering design to sustainability issues, including clean energy resources (wind, solar, hydro, nuclear), distributed energy resources, emerging technology, and conservation under the mentorship of ComEd engineers. The program also includes career planning and development of workplace skills.

- **Mercy Boys and Girls:** ComEd has partnered with Mercy Home for Boys and Girls to execute this program yearly where students learn about the power grid and a variety of STEM careers and trades. STEM professionals facilitate small group discussions and lead hands-on activities.

- **STEM Home Labs Mars:** Continuing ComEd's longstanding investment in STEM engagement for Chicago-area youth, this program inspires students to advance their confidence, knowledge, and career paths in STEM through hands-on experiments and work sessions done in their home.

- **UIC CHANCE STEM Academy:** ComEd has partnered with UIC CHANCE to deliver a 5-week summer program (June – July) for rising senior high school students. The program uses a college-level curriculum that includes Engineering (mechanical, electrical, civil and computer engineering), Math, and English, as well as a robust and active mentorship program. ComEd employees enlighten the audience regarding careers at the company and their own career paths.

- **Corporate Relations Mentorship Program:** Provided in partnership with Deloitte, it consists of five (5) weekly sessions during the months of June through July and includes engineering practices, mock interviews, resume building, networking, community engagement and volunteering**.**

- **Ideathon 2.0:** Through Ideathon 2.0, teams of high school students develop innovative solutions to challenges through mobile coding apps which are deployed on Apple and Android app stores. In 2021, 11 students participated from local non-profit organizations and schools including HFS Chicago Scholars, Calculated Genius, Dyett High School and 815 Alive.

- **STEM Home Labs:** The STEM Home Labs Leadership session features a panel discussion with three STEM leaders and a moderator, discussing their STEM careers, the paths they took to achieve careers and the barriers they overcame.

- **DePaul University ComEd Scholars:** Launched in 2018, DePaul College Prep ComEd Scholars who study at DePaul University in a STEM related discipline (especially IT) receive scholarships in the amount of $12k per year for their freshman through senior year.

- **DePaul College Prep ComEd Scholars:** Launched in 2017, ComEd partnered with DePaul College Prep High School on a program that supports a selection of junior and senior students from limited-income households who excel in STEM and are interested in pursuing STEM related careers through scholarship support and employee mentorship.

7.4.4 Appendix-D.4: Customer Programs

ComEd is satisfying the Climate and Equitable Jobs Act (CEJA) while embracing equity more broadly by focusing on increased affordability, resilience, and access across customers and maintaining focus on Equity Investment Eligible Communities (EIECs).

- **Community Leader Quarterly Meeting:** Quarterly roundtables involve ComEd points-of-contact from various departments (such as Customer Channels, Revenue Management, Customer Solutions, Legal and Regulatory), and a broad spectrum of community leaders are engaged (from community organizations, customer advocacy organizations, city, and state agency representatives, etc.). The focus of these rejuvenated quarterly forums is collaboration on behalf of LMI ComEd customers.

- **Cross OpCo Affordability KPIs:** Key Performance Indicators to include percentage of Low-Income Customers Enrolled in assistance programs, and percent of Low-Income Customers current on their bill. The initiative was first introduced in 2021 for a full year reporting in 2022.

- **Customer Information System Transformation:** By end of 2023, ComEd will be able to implement a new system which will have a holistic view of customer's profile, previous interactions, and relevant data to deliver more personalized support to the customers. The aim is to significantly reduce the time and effort needed for implementing changes to system settings and configuration while allowing greater flexibility in the type of programs and services available to the customers.

- **Energy Efficiency:** ComEd has been supporting communities through Energy Efficiency, while achieving the largest energy saving targets in the State's 15-year history of electric Energy Efficiency Programs. From 2018 to 2022, ComEd has built community partnerships, leveraging trusted voices to reach customers where they are, including 25 not-for-profits, investing more than $48 million annually on average, which will result in more than $1.2 billion in bill savings over the lifetime of the efficiency measures. ComEd has offered deeper incentives for non-profits and public sector customers in communities in need, investing over $6 million in 2021 across 22 communities. Further, over the next three years, ComEd has pledged more than $113 million annually to support low-income programs. This is 180% increase over the statutory minimum requirement and $64 million more annually than in previous four years. ComEd is planning $10 million per year on average to help customers fully decarbonize with new electrification measures.

- **EV Readiness Program:** Earlier in 2022, ComEd partnered with Caucus to start a local government EV Readiness Program which is aimed at preparing communities to meet the growing demand for EVs and EV charging infrastructure. This program will provide a broad range of support to communities as they develop and implement programs to promote EVs. Additionally, this program is designed to assist communities who may eventually seek state and federal funds earmarked for the development of EV charging infrastructure and the qualifying local governments will receive free technical assistance and training in a variety of areas to earn the designation of "EV Ready Community." ComEd has pledged financial support of $225,000 to bring this program to life.

- **Give-A-Ray** is a program to provide eligible limited-income customers with the full value of energy from community solar projects at no cost to them, which is intended to deliver on average, $1,000 annually on their energy bills (for three years). This program utilizes Exelon's shareholder funding to cover the cost of subscription fees that enables income eligible customers to participate in "Illinois Solar for All" community solar projects.

- **Low Income Precertification** is an application used by ComEd Customer Service Representatives to provide limited income customers with a personalized set of financial assistance recommendations, based on their unique, self-disclosed circumstances.

- **Smart Assistance Manager (SAM):** The ComEd Residential Energy Efficiency team is committed to improving the overall customer experience and is particularly focused on efforts to assist the most vulnerable communities. As customer expectations evolve the Customer Journey team strives to identify more personalized and collaborative paths based on customer wants, needs, actions, and historical program participation data. In 2022 ComEd Customer Solutions partnered with the internal Customer Experience team to incorporate financial, billing and energy efficiency offerings into their new Smart Assistance Manager (SAM) tool, an online platform that provides personalized recommendations for customers. This online tool is the first of its kind from a utility that will improve discoverability and be a centralized location for customers to learn about which programs and services are best suited to meet their unique needs and circumstances around energy efficiency and financial assistance offerings. In 2021 ComEd released a $6.3M streetlight initiative, which provided free LED upgrades to targeted municipalities in distressed communities. Out of the 43 Streetlight Service Providers, 32% identify themselves as MBE (Minority/Women/Veteran) owned companies.

- **Bill Payment Kiosks:** ComEd is planning to provide its customers with a fee-free bill payment option for cash payments, specifically targeting unbanked customers throughout the City and South- and West-side

neighborhoods. There is a potential to integrate Smart Assistance Manager (SAM) tool within the kiosk interface to help enroll customers in assistance at time of bill payment.

7.4.5 Appendix-D.5: Energy affordability and clean energy access initiatives

- **Community of the Future (CoF):** Since 2016, ComEd has been developing a community partnership model to realize a shared vision of sustainability and resiliency, a model known as Community of the Future (CoF). Working in partnership with the neighborhood of Bronzeville, ComEd has been deploying smart technologies that are connected, green, and resilient to benefit residents and improve grid performance. In 2021, Bronzeville' s CoF continued to demonstrate advanced energy technologies that benefit residents while deepening partnerships with the City of Chicago, Chicago Public Schools, local businesses, non-profit organizations, and committed individuals. ComEd launched its second CoF program in Rockford, IL, focusing on identifying and mobilizing community strengths and leveraging those strengths to bolster sustainability, resiliency, and connectedness internal program integration, and industry stakeholder collaborations. As part of the project, the ComEd Energy Efficiency team has launched a robust outreach campaign to increase energy efficiency education and awareness within the community with a goal of a 5-year 20% usage reduction in the CoF area.

- **Digital Divide Program:** ComEd is modernizing its communications infrastructure by replacing existing facilities with fiber. As part of this effort, it is more efficient to install greater capacity than is currently necessary for utility purposes. ComEd has leveraged its existing and planned reserve of fiber assets, to support its smart grid operations, as middle-mile infrastructure for Internet Service Providers (ISPs) to cost-effectively address the broadband digital divide within North Lawndale. This is an initiative to be the intermediary to the ISP's and enable them to provide equitable access to high-speed broadband internet among the communities in need.

- **Beneficial Electrification (BE) Plan:** In 2022, ComEd proposed a plan that would ramp up to over $100 million per year in incentives, education, and infrastructure support to promote beneficial electrification, with programs designed to reduce upfront costs of EVs and charging equipment, enable broad equitable deployment of charging infrastructure and other electrification technologies, educate customers, and prioritize investments equitably for communities in need. Through a blend of incentives like new rate design options, educational and technical support, ComEd's plan would help promote the transition to clean energy future and marks the latest milestone in the implementation of Climate and Equitable Job (CEJA). The proposed investments would prioritize low-income customers and customers residing in Environmental Justice and Restore, Reinvest, Renew (R3) communities, as defined by the State of Illinois. The key components of the BE Plan include:

    - **Residential Program:** The BE Plan includes $15 million annually for residential sub-programs that include incentives that will reduce upfront costs related to purchase and installation of in-home EV charging stations, and non-transportation electrification equipment (such as building heating and cooling, lawn equipment, electric stoves, etc.). The larger rebates will be offered to low-income customers and those located in environmental justice and/or equity investment eligible communities. For those with the greatest needs have access to resources, ComEd will target 50 percent of its residential program funds for customers in equity investment eligible communities.

    - **Commercial & Industrial (C&I) and Public Sector Program:** To reduce the cost barriers associated with purchasing fleet vehicles and installing charging stations, the plan proposes $63 million annually to support new rebates for fleet electrification, with most of the funding going towards vehicle rebates for public transit, commercial and school fleets. Funding will also support charging installation costs for public sector customers and public charging providers in environmental justice or R3 communities. This is intended to provide additional support to accelerate the benefits of clean transportation to environmental justice and equity investment eligible communities.

Across the C&I and Public Sector Program, ComEd will target more than 40 percent of funding for customers within or primarily serving equity investment eligible communities.

- **New C&I EV Charging Class:** In addition to incentives, ComEd has proposed a dedicated EV charging delivery customer class for commercial and industrial (C&I) customers. The new rate class would significantly reduce upfront infrastructure or "make-ready" costs and would provide customers an alternative to the default demand-based rate structures, which, at low utilization rates, can make the cost of charging high for customers.

- **Customer Education and Pilot Programs:** A $9 million community education program will empower customers to make the transition to electrification. This program will help residential and business customers understand the timeline and impact of electrifying personal vehicles and fleets, as well as how utility programs and rates can benefit them. ComEd has proposed $5 million annually for pilots to study the benefits of various electrification strategies for customers and the grid.

- **Non-Transportation Opportunities:** In addition to EV benefits, the BE Plan offers a broad opportunity to reduce carbon and other emissions across sectors. While most of the BE Plan focuses on clean transportation, ComEd is also proposing a set of non-transportation rebates to work in tandem with energy efficiency offerings to spur adoption of electric technologies in the residential, commercial, and industrial sectors.

- **12kV Conversions:**
  The 4kV to 12kV Conversion program targets some of the oldest and potentially obsolete equipment on the system. There are approximately 1,100 4kV feeders on the ComEd system. Strategic conversion of 4kV to 12kV will provide the benefit of increased operational flexibility and hosting capacity, which could be especially significant with the increased penetration of DER and electrification. The increased operational flexibility that this project provides can also enable greater levels of reliability. Upgrading to 12kV provides a greater number of switching options with adjacent feeders, which allows for faster restore times from outages and more flexibility for maintenance. The conversions will further enhance reliability by allowing the addition of distribution automation devices as well as increased fusing and sectionalizing. The 4kV to 12kV feeder conversions enable ComEd to retire 4kV transformers which are aging and/or obsolete equipment.

  While 4kV can facilitate some level of DER, 12kV systems can accommodate a higher level of DER penetration. The advantage here is that larger DER systems can be accommodated, as well as a higher number of customers who want to install DERs. As DER applications grow and capacity increases, 4kV systems will more quickly reach their capacity limits and be subject to restriction of further DER installations.

- **Energy Efficiency (Voltage Optimization):**
  Voltage Optimization investments are part of Energy Efficiency and enable energy savings for customers without changing their usage patterns. Voltage optimization is accomplished by “flattening” the voltage profile of a feeder. In other words, narrowing the bandwidth of the voltage from the head-end of the feeder to the tail-end. This reduction of voltage allows customers with voltage-sensitive loads to consume less energy, enabling cost reductions and more sustainable energy use.

- **Resilience projects and programs (e.g., bus reconfiguration, increasing margins, N-1, feeder ties)**
  The configuration of buses on substations can have a large impact on the reliability and resilience of the end customers. Some legacy bus configurations on the ComEd system were designed in a fashion that do not lend themselves to be easily or automatically switched after a disturbance, leading outages to be longer than otherwise necessary. The Bus Reconfiguration program entails the implementation of more robust

configurations that can be automatically reconfigured. Specifically, the distribution substation bus program targets high customer count substations with single points of failure that could lead to reduced reliability.

- **ATO Modernization to customers w/ societal impact (water pumping, hospitals)** The ATO (Automatic Throw Over) modernization program targets the replacement of Automatic Throw Over devices that are obsolete, have no replacement parts readily available in case of failure, and have extended well beyond their manufacturer stated service life to the point where replacement is more cost-effective than continued maintenance and repair. ATO service has been available as optional facilities (under rider NS) on the ComEd system since about 1960, offering a means to provide two utility sources to critical loads. One source serves as a preferred or primary source, and the other is a "back-up" to automatically restore the critical loads in the event the preferred source has an outage. Of the nearly 1,400 ATOs in operation, approximately 650 were installed before 1990, 80 of which were designed in the 1950s and '60s. Priority is given to equipment in greatest need of replacement due to parts availability and material condition. Further, among that top priority replacement group, those units serving customers and facilities supporting societal services such as hospitals, water pumping, flood and wastewater treatment, communications, and transportation services are targeted for early inclusion. This investment improves customer reliability by minimizing potential lockouts of sources feeding the units (which interrupts all customers on the units) and potentially avoiding emergency repairs requiring long-duration outages, especially to critical infrastructure.

- **Storm Resiliency:** Includes mobile batteries for targeted resilience in under-resourced communities. Numerous opportunities to expand and scale up the provision of supportive services that augment ComEd's core strengths

- **Mobile Battery Purchases for Under-Resourced Communities:** Mobile batteries for targeted storm resilience in under-resourced communities. The program, currently in development, is intended to mitigate the impacts of outages due to severe weather events or other unplanned interruptions in service.

- **IIJA, DOE, and National Lab partnership work:** Bronzeville has been a key site of DoE research and technology deployment initiatives. The Bronzeville Community Microgrid (BCM) was sited based in accordance with societal resiliency factors such as aligned with the technology demonstration. Such factors also guided the projects in Rockford and locations for MUD chargers and other projects. IIJA grants target increased funding available to EIECs in North Lawndale, Englewood, and South/Southwest Chicago communities.

- **Public transportation resiliency:** The program, which is subject to ongoing discussions with Chicago Transit Authority (CTA) / Pace, focuses on the electrification of bus fleets with special consideration for service disruption risk in EIECs.

- **Climate Friendly Grant:** ComEd is proposing a $1.8 million competitive grant program to promote climate-friendly assistance programs throughout Northern Illinois. ComEd will be awarding up to $450,000 to 4 nonprofit organizations in its service territory to aid limited income customers through climate-friendly programs and cross-promote additional complementary offerings.

- **Low Income Home Energy Assistance Program (LIHEAP)** is a federally administered program which offers financial help to limited-income households to pay heat and electric bills. ComEd works closely with its Community Action Agencies to connect customers to grants and programs like LIHEAP and ComEd's **Supplemental Arrearage Reduction Program (SARP),** which is available to ComEd residential customers who qualify for energy-assistance benefits from LIHEAP. In 2021 alone, ComEd helped connect more than 225,000 eligible customers to more than $146 million in energy assistance.

- **The Percentage of Income Payment Plan (PIPP)** is a choice within Illinois LIHEAP to help manage energy bills year-round. The customers are placed on a Budget Billing plan that is subsidized by a monthly PIPP

benefit amount, determined by a percentage of their household income. Collectively, $13.62 million in PIPP Benefits and PIPP Arrearage credits were disbursed in 2021. In 2022, ComEd implemented PIPP expansion efforts which successfully garnered changes to the Energy Assistance Act and the 2022 Budget Implementation Act (BIMP) to enhance the administration and customer reach of the program.

- **Utility Disconnection Assistance Program (UDAP):** ComEd partnered with the Department of Commerce and Economic Opportunity (DCEO) and the local administering agencies (LAAs) to distribute ~$43.7 million to ~51 thousand customers in UDAP credits. UDAP was administered to customers who received LIHEAP and PIPP from July 2018 to April 2021 and they received a grant up to $5 thousand each.

- **Bill Payment Assistance (BPA) Program:** ComEd partnered with external stakeholders and ICC staff to administer a 2021 BPA program to assist self-verified limited income customers with a grant up to $300. The program assisted over 23 thousand customers with $9.3 million in financial assistance.

- **Emergency Rental Assistance Program (ERAP):** ERAP provides federal funds which can be used for utility arrearage relief by landlords and renters. The Financial Assistance Team successfully partnered with two ERAP administrators, City of Chicago, and the Illinois Department of Human Services (IDHS), to distribute $1.5 million to almost three thousand customers in Emergency Rental Assistance Program grants in 2021. An internal administrative process was expanded to meet the needs of the ERAP administrators to support their multi-round programs and to partner with Revenue Management and ComEd IT to accurately apply grants.

- **Additional energy-assistance options for energy management:** In addition to state and federal grants, ComEd offers residential customers multiple bill-assistance options for having a flexible deferred payments arrangement, budget billing, flexible payment options and energy efficiency offerings for income eligible customers.

- **Financial Assistance/DSM Integration:** This integration effort intends to provide low-income customers and those facing disconnection and arrearages with access to both financial assistance and DSM savings options. It includes integrated marketing and targeted outreach over time, as well as program design changes to integrate financial assistance and energy efficiency programs.

7.4.6 Appendix-D.6: Beneficial Electrification (“BE”)

7.4.6.1 Appendix-D.6: Residential Program

The Residential BE Program will allocate $15 million annually to sub-programs that incentivize the purchase and installation of new BE measures. The program will distribute upfront funding for a wide variety of applications, primarily for electric vehicles but also including non-transportation BE categories.

Those who purchase an electric vehicle or other approved electric equipment will be eligible to apply for a one-time rebate that can offset the purchase cost of the measure. The Sub-programs of the Residential Program and the size of the rebates are summarized in the following table:

7.4.6.2 Appendix-D.6-Table 1: Residential Program Summary

Sub-program	Eligible Measures	Rebate Value	Annual Budget
Residential EV Purchase Sub-program	Passenger Vehicle	$4,000	$6M
	LI/EJ/R3 Passenger Vehicle	$6,000	
	LI/EJ/R3 Used Passenger Vehicle	$3,000	
Residential EV Charging Infrastructure Sub-program	Residential Charging Infrastructure	Up to $2,500	$5M
	LI/EJ/R3 Charging Infrastructure	Up to $3,750	
Residential BE Technology Adoption Sub-program	Supplemental Rebates for High Efficiency Electric Heat Pumps	Up to $3,000	$2M
	Electric Lawn Equipment	$25-$50 per unit	$1M
	Induction / Electric Cooktops	$100-$500 per unit	
	Electric / Heat Pump Clothes Dryers	$50-$200 per unit	
Residential BE Infrastructure Readiness Sub-program	Residential BE Infrastructure	Up to $750 per res. unit, capped at $5,000 for multi-family	$1M

These rebates will help spur EV and BE adoption by combatting the upfront cost barrier that potential BE adopters face. The upfront purchase cost disparity between electric and ICE vehicles is particularly challenging for low-income personal vehicle owners, to whom vehicle purchase costs can represent a large portion of short-term disposable income. The enhanced rebate incentive for low-income customers and residents of EJ and R3 communities meets ICC Staff's suggestion for such a purchase rebate.[92]

As a condition of receiving a Residential EV Charging Infrastructure Sub-program rebate, ComEd requires that the customer enrolls in ComEd's Basic Electric Service Hourly pricing program (Rate BESH) for at least three years. This requirement will provide a strong incentive for customer EV charging to occur during off-peak hours. Hourly pricing provides the clearest signal to a customer of the relative cost to the electric system of charging at that time. This requirement mirrors a recommendation from the ICC Staff BE Workshop report that ComEd include residential make-ready incentives, but that these incentives be contingent upon enrollment in a time-variant rate.[93]

7.4.6.3 Appendix-D.6: Residential EV Charging Infrastructure Sub-program

Annual Budget: $5M

Eligible Measures:
o Residential Charging Infrastructure Rebate: Up to $2,500
o LI/EJ/R3 Charging Infrastructure Rebate: Up to $3,750

Sub-program Description: The Residential EV Charging Infrastructure Sub-program provides incentives for the installation of electric vehicle charging stations for residential customers who enroll in ComEd's Hourly Pricing

[92] Illinois Commerce Commission Beneficial Electrification Workshops Staff Report to the Commission, at 65 (March 30, 2022) ("BE Workshops Staff Report").
[93] BE Workshops Staff Report at 36, 69.

program under Rate BESH (Basic Electric Service Hourly Pricing) for at least three years. Within this sub-program, higher incentive values are provided to low-income customers and those residing in EJ or R3 communities.

Delivery Strategy: An implementation contractor(s) will deliver the program and will work with ComEd to finalize the sub-program design, develop marketing materials, and perform subprogram operations including incentive processing, engagement with the Certified Electric Vehicle Charging Station Installer network, and marketing and outreach activities.

Target Market: This sub-program is designed to engage residential customers in ComEd's service territory, including low-income customers and those residing in EJ or R3 communities. All such customers who take delivery service from ComEd and are enrolled in ComEd's Hourly Pricing program under Rate BESH are eligible for this sub-program.

Marketing Strategy: ComEd will leverage multiple tactics and channels to drive sub-program awareness and participation, similar to the marketing strategies utilized by ComEd's Residential Energy Efficiency Heating and Cooling program, which is both contractor- and customer-facing. In addition, ComEd will perform targeted outreach in support of measure adoption by low-income customers and those residing in EJ and R3 communities.

7.4.6.4 Appendix-D.6: Residential BE Technology Adoption Sub-program

Annual Budget: $3M

Eligible Measures:

- Supplemental Rebates for High Efficiency Electric Heat Pumps: up to $3,000 ($2M annual budget)
- Electric Lawn Equipment: $25-50 per unit; Induction / Electric Cooktops: $100-$500 per unit; Electric / Heat Pump Clothes Dryers: $50-200 per unit ($1M annual budget)

Sub-program Description: This sub-program offers rebates for residential customers to support the adoption of selected beneficial electrification technologies, specifically high efficiency electric heat pumps, electric lawn equipment, induction cooking equipment, and electric clothes dryers. Heat pump rebates will be targeted primarily to low-income multifamily customers, with flexibility to target other customer markets with high barriers to adoption.

Delivery Strategy: An implementation contractor(s) will deliver the sub-program and will work with ComEd to finalize the sub-program design, develop marketing materials, and perform subprogram operations including incentive processing, marketing, and outreach activities. As ComEd finalizes the design of Energy Efficiency Electrification ("EEE") program efforts targeting similar measures, the specific delivery channels of the Residential BE Technology Adoption Sub-program will be tailored to complement those EEE customer offerings to further lower barriers and drive market adoption.

Target Market: This sub-program is geared towards residential customers in ComEd's service territory and has a focus on customers residing in multi-family buildings who are either low income or located in EJ or R3 communities. These customers, who take delivery service from ComEd, are eligible for this sub-program regardless of their choice of supplier. Most of these rebates will be made available to all customers (electric lawn equipment, induction cooking equipment, and electric clothes dryers), but with higher rebates provided to low-income customers or those residing in EJ or R3 communities, similar to ComEd's Energy Efficiency Retail program. Rebates for high efficiency electric heat pumps will be primarily targeted to multi-family customers (specifically, property owners) to assist in lowering barriers to multi-family building electrification.

Marketing Strategy: ComEd will leverage multiple tactics and channels to drive sub-program awareness and participation similar to the marketing strategies utilized by ComEd's Energy Efficiency Retail program. In addition, ComEd will perform targeted outreach in support of measure adoption by low-income customers and those residing

in EJ or R3 communities. For the high efficiency electric heat pump rebates, ComEd will primarily leverage ComEd's Energy Efficiency Multi-Family Upgrades program targeting income eligible customers to drive adoption.

7.4.6.5 Appendix-D.6: Residential BE Infrastructure Readiness Sub-program

Annual Budget: $1M

Eligible Measures:

- Residential BE Infrastructure Rebates: Up to $750 per residential unit, capped at $5,000 for multi-family.

Sub-program Description: This sub-program offers rebates for residential customers, including those in multi-family dwellings, focused on lowering the cost of electrical infrastructure upgrades associated with non-transportation BE adoption (e.g., heat pumps, water heaters, induction cooktops, etc.).

Delivery Strategy: The Residential BE Infrastructure Readiness Sub-program rebates will be delivered alongside EEE program efforts to present a seamless experience for customers. An implementation contractor(s) will deliver the sub-program and will work with ComEd to finalize the sub-program design, develop marketing materials, and perform sub-program operations, marketing, and outreach activities.

Target Market: ComEd is targeting residential (single and multifamily) customers in its service territory, including low-income customers and those residing in EJ or R3 communities. As with other programs, any residential customer taking delivery service from ComEd is eligible for this Sub-program regardless of their choice of supplier.

Marketing Strategy: ComEd will leverage the existing EEE Marketing strategy to co-promote electrical infrastructure rebates as a bundled offering alongside EEE rebates for key residential electrification technologies.

7.4.6.6 Appendix-D.6: C&I and Public Sector Program

ComEd's C&I and Public Sector Program will dedicate $63 million of annual funding to promote fleet vehicles, public transit buses, school buses, new charging stations, and other non-transportation BE measures. The Program includes four sub-programs, several of which offer:

7.4.6.7 Appendix-D.6-Table 2: C&I and Public Sector Program Summary

Sub-program	Eligible Measures	Rebate Value	Annual Budget
C&I and Public Sector EV Purchase Sub-program	LDV Rebate	$5,000	$12.5M
	EJ/R3 LDV Rebate	$7,500	
	MDV Rebate	$20,000	$12.5M
	EJ/R3 MDV Rebate	$30,000	
	HDV Rebate	$50,000	$10M
	EJ/R3 HDV Rebate	$75,000	
	School Bus Rebate	$120,000	$6M
	EJ/R3 School Bus Rebate	$180,000	
	Transit Bus Rebate	$80,000	$6M
	EJ/R3 Transit Bus Rebate	$120,000	
C&I and Public Sector EJ/R3 EV Charging Infrastructure Sub-program	EJ/R3 EV Charging Infrastructure Rebate, L2 Charger	Up to $8,000 per port	$10M
	EJ/R3 EV Charging Infrastructure Rebate, DCFC	Up to $1,000 / kW, min 50 kW	
C&I and Public Sector BE Technology Adoption Sub-program	Commercial & Industrial BE Rebate Pool (Custom)	Custom	$2M
C&I BE Infrastructure Readiness Sub-program	High Efficiency Electric Forklift Infrastructure Rebate	Up to $5,000 per unit, capped at $50,000 per facility	$4M
	Small Business BE Infrastructure Rebate	Up to $10,000 per customer facility	

By focusing on fleet vehicles and transport vehicles used by those who may not own a personal vehicle, ComEd is targeting emissions reductions that will benefit all customers. Providing vehicle purchase incentives targeted at medium-duty vehicles, heavy-duty vehicles, and buses, as was recommended in the ICC Staff report, will produce emissions reductions from some of the most emission intensive vehicles, especially those that travel through EJ and R3 communities.[94] The upfront purchase cost disparity between electric and ICE vehicles can be particularly challenging for fleet owners and large vehicle operators, to whom vehicle purchase costs can represent an abnormally large portion of operating budgets. These fleets and buses can develop their supporting charging infrastructure with the aid of L2 and DCFC infrastructure rebates if they are located or primarily operate in EJ or R3 areas, in line with Staff suggestions.[95] Charging infrastructure rebates are not limited to fleets, however; multi-unit dwellings and public charging providers will be eligible for a rebate if and only if the charger is installed in an EJ or R3 community.[96]

To facilitate open access for all customers to these rebates, no single entity will be permitted to receive more than 5% of the funding from a given sub-program category in a year (except for transit buses, for which there will be a limited pool of potential recipients). Nothing precludes an entity from receiving rebates up to the 5% limit in more than one category. For example, a delivery fleet customer with a mix of light duty and medium duty vehicles could apply for up to 5% of the annual rebate funding in the light duty category, up to 5% of the annual rebate funding in the medium duty category, and up to 5% of the annual rebate funding in the C&I and Public Sector EJ/R3 EV Charging Infrastructure Sub-program.

[94] BE Workshops Staff Report, at 49, 56, 58.
[95] BE Workshops Staff Report at 38-39, 50, 52, 56.
[96] Responsive to BE Workshops Staff Report at 37, 41.

7.4.6.8 Appendix-D.6: C&I and Public Sector EV Purchase Sub-program

Annual Budget: $47M

Eligible Measures:

EV rebate categories are defined as follows:

7.4.6.9 Appendix-D.6-

Table 3: C&I and Public Sector EV Purchase Sub-program Eligible Measures

Measure	Rebate/vehicle	Annual Budget
LDV Rebate	$5,000	$12.5M
EJ/R3 LDV Rebate	$7,500	
MDV Rebate	$20,000	$12.5M
EJ/R3 MDV Rebate	$30,000	
HDV Rebate	$50,000	$10M
EJ/R3 HDV Rebate	$75,000	
School Bus Rebate	$120,000	$6M
EJ/R3 School Bus Rebate	$180,000	
Transit Bus Rebate	$80,000	$6M
EJ/R3 Transit Bus Rebate	$120,000	

Fleet vehicles, Light Duty – any Class 1 or Class 2 electric vehicle registered for commercial use. Examples include taxis, utility vans, full-size pickups, and step vans.

Fleet vehicles, Medium Duty – any Class 3-6 (10,001-26,000 lbs.) electric vehicle registered for commercial use. Examples include walk-in delivery trucks, beverage trucks, and bucket trucks.

Fleet vehicles, Heavy Duty – any Class 7 or 8 (26,001+ lbs.) electric vehicle registered for commercial use. Examples include semi tractors and refuse trucks.

School bus – any electric vehicle 35 feet or longer used for student transport by a K-12 educational entity.

Transit bus – any electric vehicle 30 feet or longer used by a municipal, county, or regional public transit agency for transportation on public roads.

Sub-program Description: The C&I and Public Sector EV Purchase Sub-program offers C&I customers financial incentives on electric fleet vehicles, including school and transit buses, that are registered in the state of Illinois. Within this sub-program, higher incentive values are provided to customers that are in or primarily serve EJ or R3 communities.

Delivery Strategy: An implementation contractor(s) will deliver the sub-program and will work with ComEd to finalize the sub-program design, develop marketing materials, and perform subprogram operations including incentive processing, marketing, and outreach activities.

Target Market: This sub-program targets all C&I customers. All such targeted customers taking delivery service from ComEd are eligible for this sub-program regardless of their choice of supplier. The sub-program will also specifically target and perform outreach in support of measure adoption by C&I customers located in or primarily serving EJ or R3 communities.

Marketing Strategy: The C&I and Public EV Sub-program will leverage multiple tactics and channels to drive sub-program awareness and participation similar to the marketing strategies utilized by the ComEd Energy Efficiency Standard and Instant Discounts programs which are both contractor and customer-facing.

7.4.6.10 Appendix-D.6: C&I and Public Sector EJ/R3 EV Charging Infrastructure Sub-program

Annual Budget: $10M

Eligible Measures:

- EJ/R3 EV Charging Infrastructure Level 2 Rebate: Up to $8,000/port, limit 10 ports
- EJ/R3 EV Charging Infrastructure DCFC Rebate: Up to $1,000/kW, minimum 50 kW, limit $500,000

Sub-program Description: The C&I and Public Sector EJ/R3 EV Charging Infrastructure Subprogram provides incentives for the installation of electric vehicle charging stations for public sector entities and public charging facilities located in or serving EJ or R3 communities. Certified Electric Vehicle Charging Station Installers, as designated by the Commission through their application of Administrative Code Part 468, will submit pre-applications, to include an infrastructure assessment, on behalf of customers to reserve funding for projects. Certified installers then install the equipment in the customer's facility. Any individual customer will be limited to a total of ten Level 2 port rebates and/or up to $500,000 in total DCFC rebate value per year from this sub-program.

Delivery Strategy: An implementation contractor(s) will deliver the sub-program and will work with ComEd to finalize the design, develop marketing materials, and conduct related marketing and outreach activities.

Target Market: This sub-program specifically targets public sector entities, (e.g., municipalities, transit agencies) and publicly accessible chargers located in or primarily serving low-income, EJ, or R3 communities. All such targeted customers taking delivery service from ComEd are eligible for this sub-program regardless of their choice of supplier.

Marketing Strategy: The marketing will be similar to Energy Efficiency's Standard incentive program: primarily contractor-facing with some customer-facing messaging to drive awareness and inform the customer how to access the incentives.

7.4.6.11 Appendix-D.6: C&I and Public Sector BE Technology Adoption Sub-program

Annual Budget: $2M

Eligible Measures:

- Commercial & Industrial BE Rebate Pool: custom rebates

Sub-program Description: The C&I BE Technology Adoption Sub-program provides monetary incentives to business and public sector customers adopting qualifying BE measures. The incentive is determined based on the calculated emissions benefit of an upgrade to a specific application, equipment type, or system (this type of rebate is referred

to as a "Custom" measure). Custom measures are identified and implemented based on site-specific factors. Technical assistance for select projects will be provided to assist in the evaluation and implementation of custom BE projects. The measure list is still under development, to complement EEE efforts, but potential measures may include, but are not limited to, material handling equipment, industrial process technologies, and electric agricultural equipment.

Delivery Strategy: An implementation contractor(s) will deliver the sub-program and will work with ComEd to finalize the sub-program design, develop marketing materials, and conduct subprogram marketing and outreach activities.

Target Market: This sub-program targets all C&I customers. All such targeted customers taking delivery service from ComEd are eligible for this sub-program regardless of their choice of supplier and including customers who have opted out of EEE programs. The sub-program will also specifically target and perform outreach to C&I customers located in or primarily serving EJ or R3 communities.

Marketing Strategy: ComEd will leverage multiple tactics and channels to drive sub-program awareness and participation, similar to the marketing strategies utilized by ComEd's Energy Efficiency Custom Incentive program.

7.4.6.12 Appendix-D.6: C&I BE Infrastructure Readiness Sub-program

Annual Budget: $4M

Eligible Measures:

- Small Business BE Infrastructure Rebate: Up to $10,000 per customer facility
- High Efficiency Electric Forklift Infrastructure Rebate: Up to $5,000 incentive per unit capped at $50,000 per customer

Sub-program Description: The C&I BE Infrastructure Readiness Sub-program offers rebates for two categories of infrastructure upgrades:

- Small Business BE Infrastructure Rebate: Rebates for small business customers located in or primarily serving EJ or R3 communities to help cover costs associated with non-transportation BE adoption (examples include, but are not limited to, heat pumps, water heaters, or commercial food service equipment).
- BE Forklift Infrastructure Rebate: Rebates for commercial and industrial customers to cover costs associated with upgrading from fossil-fuel driven forklift equipment to high efficiency electric (lithium-ion battery) forklift equipment.

Delivery Strategy: An implementation contractor(s) will deliver the sub-program and will work with ComEd to finalize the sub-program design, develop marketing materials, and conduct subprogram marketing and outreach activities.

Target Market: This sub-program targets small business customers (i.e., non-residential private customers with less than 200 kW peak demand and public customers with less than 400 kW peak demand located in EJ or R3 communities (Small Business BE Infrastructure Rebate) and commercial and industrial customers with forklift equipment (BE Forklift Infrastructure Rebate). All such targeted customers taking delivery service from ComEd are eligible for this sub-program regardless of their choice of supplier.

Marketing Strategy: Marketing the Small Business BE Infrastructure Rebate will be integrated into ComEd's Energy Efficiency's C&I Incentive Offerings to convey a seamless, bundled incentive opportunity for eligible customers. The marketing will primarily be contractor-facing with some customer-facing messaging to drive awareness and inform the customer how to access/receive the incentives. Similarly, the BE Forklift Infrastructure Rebate will be marketed

alongside a future EEE offering incentivizing the purchase of lithium-ion battery electric forklift equipment. This will likely be promoted primarily through distributors and equipment manufacturers with some customer-facing messaging focused on building awareness of the offering.

7.4.6.13 Appendix-D.6: Customer Education and Awareness Program

ComEd will dedicate $9 million of BE Plan funding to Customer Education and Awareness efforts. This Program will endeavor to expand knowledge of EVs and the incentives available through ComEd's BE Plan to a wide range of customers, and to provide support for customers and fleets considering BE measures, as suggested by stakeholders and ICC Staff.[97]. This effort will include targeted outreach to engage low-income customers, customers in Environmental Justice or R3 communities to help promote their adoption of BE measures and close any knowledge gap afflicting areas that currently have low levels of EV adoption or public EV infrastructure.

In addition to these initiatives, ComEd will continue the ongoing education and support efforts it has already implemented under the Public Utilities Act ("PUA"), including digital advising tools to inform customer decision-making across energy management solutions and offerings such as EV Toolkit 1.0, the Smart Assistance Manager, and EV Companion.

Efforts to be undertaken in the Customer Education and Awareness Program include:

Education and Awareness Marketing: To expand general customer awareness of EVs, ComEd's educational tools, and incentives available through ComEd's BE Plan, ComEd will employ a host of tactics ranging from advertising and customer newsletters and bill inserts to community event engagement and education. This effort will include targeted outreach to engage low-income customers and those in EJ and R3 communities, helping to secure robust participation from those groups.

C&I Fleet Assessment: To support customer decision-making, ComEd will make available third-party fleet electrification feasibility assessments for C&I customers. A third-party vendor will work with eligible customers to collect, evaluate, and analyze fleet operations data and provide an assessment of the customer's electrification opportunity, costs, and benefits. For large managed accounts, account managers are the primary conduits for these assessments, and ComEd will leverage the managers' direct relationships with their C&I customers to make their availability known. Unmanaged customers will be targeted through direct outreach campaigns focused on customer type. In addition, ComEd will perform targeted outreach to C&I customers located in or primarily serving EJ or R3 communities.

Customer Educational Tools: ComEd intends to make available online, self-service tools that support customer education and inform related decision-making and program access. ComEd's existing EV Toolkit is an example of this kind of tool delivered already under the purview of the PUA. Moving forward, ComEd intends to address range anxiety and customer confusion by making these tools more robust and personalized and intends to make available a Fleet Electrification Toolkit. This Fleet Electrification Toolkit is a web-based resource that allows potential EV fleet adopters to estimate vehicle costs and savings, explore charging options, learn about the pros and cons of EVs, discover rate options, and more.

[97] BE Workshops Staff Report at 52, 56, 71, 74-75.

Acronyms

ACI	Avoided Customer Interruptions
ADA	Americans with Disabilities Act of 1990
ADMS	Advanced Distribution Management System
AI	Artificial Intelligence
AMI	Advanced Metering Infrastructure
AMPs	Asset Management Plans
AMSC	American Superconductor
AOE	Area Outage Emergency
APT	Area Planning Tool
Argonne	Argonne National Laboratory
AS8	Asset Suite
ATO	Automatic Throw Over
ATS	Automatic Transfer Switches
BCM	Bronzeville Community Microgrid
BE	Beneficial Electrification
BESH	Basic Electric Service Hourly Pricing
BESS	Battery energy storage systems
BIPOC	Black, Indigenous, and People Of Color
BSC	Business Service Company
BTM	Behind-the-meter
C&I	Commercial & Industrial
CAIDI	Customer Average Interruption Duration Index
CBD	Central Business District of the City of Chicago
CC&B	Customer Care & Billing
CDL	Commercial Driver's License
CDOT	Chicago Department of Transportation
CE	Capacity Expansion
CEAA	Community Energy Assistance Ambassador Program
CEGIS	ComEd Geographic Information System
CEJA	Climate and Equitable Jobs Act, Public Act 102-0662
CELID	Customers Experiencing Long Interruption Durations
CELID12R3	Customers Experiencing interruptions lasting 12 or more hours for 3 consecutive years
CEMI	Customers Experiencing Multiple Interruptions

CEMI4R3	Customers Experiencing 4 or more outages for 3 consecutive years
CEMS	Customer Energy Management System
CEO	Chief Executive Officer
CET	Consolidated Estimating Tool
CEWD	Center for Energy Workforce Development
CI	Customer Interruption
CIC	Customer Interruption Cost
CIMS	Customer Information and Management System
CIO	Chief Information Officer
CIP	Critical Infrastructure Protection
CIS	Customer Information System
CISS	Corporate and Information Security Services
CM	Corrective Maintenance
CMI	Customer Minutes Interrupted
CO2	Carbon Dioxide
CoF	Community of the Future
ComEd	Commonwealth Edison
COO	Chief Operating Officer
CRMS	Customer Relationship Management System
CSF	Cybersecurity Framework
CSIRP	Cyber Security Incident Response Plan
CSOC	Cyber Security Operations Center
CSR	Customer Service Representative
CSAT	Customer Satisfaction Survey
CT	Customer Target
CTA	Chicago Transit Authority
CYMDIST	Distribution system analysis base package of the CYME software
DA	Distribution Automation
DC	Distribution Center
DCEO	Department of Commerce and Economic Opportunity
DCFC	DC Fast Chargers
DDoS	Distributed Denial of Service
DER	Distributed Energy Resource
DERMS	Distributed Energy Resource Management System

DERs	Distributed Energy Resources
DGA	Dissolved Gas Analysis
DHS	Department of Homeland Security
DLC	Direct Load Control
DLMP	Distribution Load Management Program
DOE	Department of Energy
D-PMU	Distribution Phasor Measurement Units
DR	Demand Response
DRMS	Digital Rights Management Solutions
DSE	Distribution State Estimation
DSM	Demand Side Management
E3	Energy and Environmental Economics consulting firm
EAB	Emerald Ash Borer
ECD	External Crew Dispatching
EDO	Economic Development Organization
EE	Energy Efficiency
EEE	Energy Efficiency Electrification
EEI CAST Test	Edison Electric Institute - Construction and Skilled Trade Occupations Test
EESP	Energy Efficiency Service Provider
EEUP	Equitable Energy Upgrade Program
EIEC	Equity Investment Eligible Communities
EIMA	Energy Infrastructure Modernization Act
E-ISAC	Electricity Information Sharing and Analysis Center
EJ	Environmental Justice
EJC	Environmental Justice Communities
EMS	Energy Management System
EMTP	Electromagnetic Transients Program
EOC	Emergency Operations Center
EOCs	Engineering of Choice contractors
EP	Emergency Preparedness
EPA	U.S. Environmental Protection Agency
ERO	Emergency Response Organization
ESG	Environmental, social, and governance
ESS	Energy storage systems

ETR	Estimated Time to Restoration
EU	Exelon Utilities
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FEJA	Future Energy Jobs Act
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FLISR	Fault Location, Isolation, and Service Restoration
FR	Facility Relocation
FTA	Fault Tree Analysis
GCBs	Gas Circuit Breakers
GHG	Greenhouse gas
GIS	Geographic information system
GW	Gigawatts
HIL	Hardware-in-the-loop
HPFF	High-pressure fluid filled
HSEEP	Homeland Security Exercise and Evaluation Program
HSI	Hyperspectral Imagery
HTS	High Temperature Superconducting
HVAC	Heating, Ventilation and Air-Conditioning system
HVD	High Voltage Distribution
ICC	Illinois Commerce Commission
ICCP	Inter-Control Center Communications Protocol
ICE	Interruption Cost Estimation
ICS	Incident Command System
IDOT	Illinois Department of Transportation
IED	Intelligent Electronic Devices
IEEE	Institute of Electrical and Electronics Engineers
IFTTT	If This Than That
IIJA	Infrastructure Investment and Jobs Act
IIT	Illinois Institute of Technology
ILCS	Illinois Compiled Statutes
ILSFA	Illinois Solar For All
IRA	Inflation Reduction Act

IT	Information Technology
IUBDC	Illinois Utilities Business Diversity Council
IVR	Interactive Voice Recognition system
J.D. Power	J.D. Power & Associates
JIC	Joint Information Center
JOC	Joint Operations Center
LBNL	Lawrence Berkeley National Laboratory
LCS	Large Customer Service
LDV	Light duty vehicles
LED	Light-emitting diode
LGBTQ+	Lesbian, Gay, Bisexual, Transgender, Queer, + (inter-sex, asexual, etc.)
LiDAR	Light Detection and Ranging
LIHEAP	Low Income Home Energy Assistance Program
LMI	Low-and moderate-income
LOTO	Lockout Tag Out
LPFF	Low-pressure fluid filled
LRP	Long Range Plan
LTC	Load Tap Changers
MD	Mobile Dispatch
MDI	Market Development Initiative Research
MEDs	Major Event Days
MISO	Midcontinent Independent System Operator
ML	Machine Learning
MVA	Mega Volt Ampere
MVAR	Mega Volt Amps (Reactive)
MW	Megawatt
MYIGP	Multi-year Integrated Grid Plan
NBIS	National Bridge Inspection Standards
NERC	North American Energy Reliability Corporation
NERC CIP	North American Electric Reliability Corporation Critical Infrastructure Protection
NESC	National Electric Safety Code
NEVI	National Electric Vehicle Infrastructure
NIST	National Institute of Standards and Technology
NMR4	Network Manager Release 4

NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
NTIA	National Telecom and Information Agency
NUL	National Urban League
NWA	Non-Wires Alternative
NWAS	Non-Wire Alternative Solutions
NWS	National Weather Service
O&M	Operations and Maintenance
OCBs	Oil Circuit Breakers
OCC	Operations Control Center
OCPP	Open Charge point Protocol
OEMC	Office of Emergency Management and Communications
OH	Overhead
OH/UG	Overhead/Underground
OMS	Outage Management System
OneMDS	Mobile Dispatch and Mobile Mapping Convergence
OpCo	Operating Company
OpCos	Operating Companies
OPP	Operation Power Play
OSHA	Occupational Safety and Health Administration
OT	Operational Technology
OTSG	Operational Technology Security Controls
PC	Personal Computer
PDs	Project Diagrams
PG&E	Pacific Gas and Electric Company
PI	Public Improvement
PILC	Paper Insulated Lead Covered
PIPP	Percentage of Income Payment Plus
PJM	PJM Interconnection LLC
PLR	Peak Load Reduction
PM	Preventative Maintenance
PME	Pad-Mounted Equipment
PMU	Phasor Measurement Units
POET	Power Outage Economic Tool

PON	Passive Optical Network Technology
PQ	Power Quality
PRC	Protection and Control regulatory standards
PSCFA	Public School Carbon-Free Assessments
PTR	Peak-Time Rebate
PTS	Peak Time Savings
PUA	Public Utilities Act
PV	Photovoltaic System
QA/QC	Quality Assurance/Quality Control
R3	Restore Renew and Reinvest Communities
REACTS	Renewable Energy Advanced Control and Telemetry System
REAL	Regional Economics Applications Laboratory
REG	Resilient Electric Grid
RERMs	Regional Emergency Response Managers
RMS	Remote Monitoring Systems
ROW	Right of Way
RTDS	Real-Time Digital Simulator
RTEP	Regional Transmission Expansion Plan
RTO	Regional Transmission Organization
RTUs	Remote Terminal Units
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAM	Smart Assistance Manager
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control and Data Acquisition
SER	Service Estimate Request
SF6	Sulphur hexafluoride
SIC	System Incident Commander
SIF	Serious Injury or Fatality
SMB	Small Medium Business
SME	Subject Matter Expert
SP	System Performance
SS	Substation
STEM	Science Technology Engineering and Mathematics

T&D	Transmission and Distribution
T&S	Transmission and Substation
TDC	Transmission Distribution Center
TOA4	Transformer Oil Analyst
TOH	Transmission Overhead
TOU	Time-of-use
TPA	Third Party Pole Attachment
TSS	Transmission Substation
TUG	Transmission Underground
UG	Underground
UGT	Underground Transmission
UIC	University of Illinois at Chicago
UOF	Utility of the Future
UOTFFC	Utility of the Future Funding Council
URD	Underground Residential Distribution
US	United States
US PLSS	United States Public Land Survey System
VAR	Volt-Amps Reactive
VO	Voltage Optimization
VRU	Voice Response Unit
VVO	Volt-Var Optimization
XLPE	Cross-lined polyethylene