Final Report
Utility Distribution Audit of Consumers Energy

Part One

Presented to the:

Michigan Public Service Commission

Presented by:

The Liberty Consulting Group

September 23, 2024

1451 Quentin Rd Suite 400
#343
Lebanon, PA 17042

admin@libertyconsultinggroup.com

Table of Contents

Chapter I – Introduction & Executive Summary

A. Introduction

This Part 1 report addresses our:

- Tabulation of electric system asset numbers, miles, configurations and ages to provide an overall depiction of the Consumers electric system
- Examination of asset inspection, maintenance, end of life practices, and application of the National Electrical Safety Code ("NESC")
- Examination of a statistically relevant sample of Consumers Energy ("Consumers") distribution system facilities to evaluate asset conditions and accuracy of records
- Examination of methods for ensuring sufficient stock to supply headquarter districts during normal and storm activities
- Comparison of Consumers' distribution system to similarly situated electric utilities and to the Lansing Board of Water and Light ("LBWL") in the following areas:
    - Asset types
    - Configurations
    - Ages
- Review of inspection and maintenance practices and cycles
- Analysis of reliability metrics and forestry practices.

The following chapters of this report address the results of our work in the preceding areas:

- *Chapter I: Introduction & Executive Summary* describes the work we conducted and summarizes our observations
- *Chapter II: Electric Grid System* tabulates overhead and underground distribution circuit assets, addressing their age, transformer sizes and the numbers of customers served by each size of service transformer
- *Chapter III. Construction Standards and Inspection and Maintenance Practices* describes and assesses standards and inspection and maintenance standards, cycles, and practices
- *Chapter IV: Stratified Facilities Sampling* describes the result of our field examination of a stratified sample of poles and substations
- *Chapter V: Field & Stores Inventory* describes current inventory and provides the results of our inspections of storerooms and storage yards
- *Chapter VI: System Comparisons* describes how the Consumers distribution system components, configurations, and ages at replacement compared to the same characteristics at Ameren-Illinois Company ("AIC") and Commonwealth Edison Company ("ComEd"), two similarly situated investor-owned utilities, and to those at LBWL, a municipal utility serving electricity and water to approximately 100,000 customers
- *Chapter VII: Reliability Comparisons & Vegetation Spending* describes how the Consumers distribution system reliability performance, using standard industry measures, compares to that of ComEd, AIC and LBWL.

B. Executive Summary

This chapter provides an overview of Consumers' distribution system, including its asset components, system protection schemes, construction standards, and inspection and maintenance practices. The following summary lists key observations and characteristics, organized by topic, and later chapters of this report further describe these items.

1. Electric Grid System

- Consumers operates many different low voltage distribution ("LVD") voltages, an unusual circumstance that poses material challenges. Due to the merger with legacy utilities, Consumers' LVD grid uses various voltages and both delta and WYE configurations. This necessitates the use of isolating transformers to connect circuits with different voltages. The diverse and non-standard substation and circuit assets, along with the wide range of isolator transformer capacities, require maintaining mobile substations and additional inventory beyond what proves necessary for standard voltage substations and circuits. Additionally, the impedance of these isolating transformers can lead to system protection and stability challenges.
- Consumers serves approximately three percent of its customers by ungrounded delta circuits. While relatively small in number, all of these delta circuits are ungrounded and the segments downstream from isolators present safety risks for both the public and employees as downed delta wires can remain energized. Additionally, ground faults on ungrounded delta circuits present challenges and identifying and locating them require time and effort.
- We found the use and composition of overhead conductors, underground cables, poles, reclosers, transformers, Distribution Supervisory Control and Data Acquisition ("DSCADA"), Advanced Distribution Management System ("ADMS"), and protective relays reasonably typical. We did not find that Consumers assets are of advanced age as compared to other systems.
- Small-diameter class 5, 6, and 7 poles are more susceptible to breaking during storms, particularly those weakened over time by impacts, such as from vehicles. Consumers classifies 62.5 percent of its wood poles as belonging to these smaller classes.
- Approximately 45 percent of Consumers substations were originally installed between 1903 and 1960, with a large portion installed in the 1950s.
- Consumers has experienced low substation transformer failure rates. Consumers' high voltage distribution ("HVD") transformers have an average age of 45 years, whereas LVD transformers average 34 years in age.
- Consumers' LVD substations employ reclosers for circuit protection. Reclosers are generally less expensive and require less maintenance than circuit breakers. Most of Consumers' LVD reclosers were installed within the last 20 years.
- About 16 to 18 percent of Consumers' customers are served via "back lot" locations that are generally more difficult to access for maintenance and restoration purposes.
- Consumers uses DSCADA systems with Automatic Transfer Recloser ("ATR") schemes to manage power distribution for LVD circuits. These systems automatically isolate faults and redirect power to alternative circuits, restoring service more quickly. Although LVD circuits are not looped like HVD circuits, Consumers can still transfer LVD loads using ATR Loop Schemes across circuits. In 2022, ATR loops reduced Consumers' System Average Interruption Duration Index (SAIDI) by 11.2 minutes.

2. Construction Standards and Inspection and Maintenance Practices

- Consumers' HVD and LVD inspection and maintenance program activities and cycles are appropriate for maintaining or improving the condition of the assets.
- Consumers spends approximately 5 percent of its electric LVD maintenance spending on underground facilities which comprise approximately 13 percent of the LVD system. Consumers spends approximately 98 percent of service restoration costs on overhead facilities which comprise 87 percent of its LVD system.
- Consumers updates its electric construction and design standards whenever NESC guidelines are updated and approved by authorities. The updates apply when new facilities are constructed. This is typical utility practice.
- Consumers O&M spending for distribution overhead lines has increased significantly over the last four to five years while underground line O&M has remained constant.

3. Field Inspections

- Physical inspection of randomly sampled distribution system poles found a small number of instances in which company records did not match what was found in the field (7 percent of poles sampled) and a similar percentage of assets requiring replacement. Very few safety concerns were noted in the field (3 percent of poles sampled).
- We found Consumers substations in good condition. However, we found several minor condition issues that required attention at 15 substations and we identified safety issues at 5 substations, 2 of which related to signage issues and 3 of which related to grounding issues.
- Field inspections revealed no recurring or systemic issues, suggesting overall satisfactory conditions.

4. Field and Stores Inventory

- Consumers utilizes its GIS to record circuit data and locations, while CASCADE is used for tracking substation asset data. The ongoing efforts to complete GIS records for underground and Metro systems are well-managed.
- Our field inspections of the storeroom and storage yard revealed ample stock in good condition. The large quantities of poles, service isolating transformers, and regulators seem well-suited for storm response needs.

5. System Comparisons

- Consumers and AIC have similar overhead and underground assets, similar asset ages, similar inspection and maintenance practices. Consumers' circuits are twice the length of AIC's and are in more tree coverage, and AIC isn't exposed to the same lake generated weather as is Consumers. ComEd, serving primarily the Chicago area and its suburbs, faces unique challenges due to its proximity to Lake Michigan, which influences its weather patterns.
- Consumers' LVD overhead inspection 2-year cycle program represents a good practice.
- AIC trims and removes trees on 4-year cycles for both distribution voltages (4kV and 12kV). ComEd also trims on a 4-year cycle for distribution voltages.

- Consumers is targeting 5-7-9-year tree trimming cycles, depending on circuit voltages, for an average cycle among the circuit voltage levels, or "effective cycle," of 7 years. However, its current average overall cycle is nearly ten years and it still has backlogged circuits awaiting trimming.
- AIC spent $132 million O&M in 2020 for tree clearance trimming and removing trees to maintain its 4-year cycle tree clearance program. AIC's spending for vegetation management decreased to $37 million in 2023, indicating once past the initial trim cycles, the cost to maintain tree clearances reduces. AIC has approximately one-half of Consumers' overhead circuit miles in Illinois which has much less forestry cover than Michigan.
- ComEd spent $104 million in 2020 to maintain its 4-year trim cycle for approximately 67 percent of Consumers' overhead circuit miles. Consumers spent $109 million in 2023 to trim and remove trees for twice the miles of AIC circuits.
- LBWL's progression from upper 3rd quartile all-weather SAIDI in 2016 to 1st quartile SAIDI performance after spending significantly for vegetation management rather than capital for automation shows the value of a reduced tree trim cycle.
- Consumers' SAIDI performance since 2014 has not improved despite increases in total capital and O&M expenditures.

6. *Reliability Comparisons & Vegetation Spending*

- ComEd's 1st quartile reliability is a result of very substantial investments over the last 20 or more years. ComEd's investments included its continuing a 4-year vegetation management program, and the following:
  - An effective inspection and repair program
  - A targeted reliability program
  - A one percent worst performing circuit program
  - An effective CEMI and CELID program
  - An effective circuit sectionalizing and automation program including ATR loops
  - System and URD cable replacement programs.
- Consumers' 2022 and 2023 System Average Interruption Frequency Index ("SAIFI") metrics including and excluding Major Event Days ("MEDs") placed them in the 2nd IEEE quartile, about average among utilities. However, AIC's and LBWL's SAIFIs placed them in the 1st quartile including MEDs and 2nd quartile excluding MEDs. ComEd reports 1st quartile performance for SAIFI, including and excluding MEDs.
- Consumers' 2022 and 2023 Customer Average Interruption Duration Index ("CAIDI") metrics both including and excluding MEDs were in the 4th quartile, worse than average among utilities. In 2022, AIC's CAIDI was in the 2nd quartile including MEDs and in the 3rd quartile excluding MEDs. LBWL's CAIDI was in 1st quartile including MEDs and in the 2nd quartile excluding MEDs. ComEd reports 1st quartile performance for CAIDI, including and excluding MEDs.
- Consumers' 2022 and 2023 SAIDI metrics, placed them in the 4th quartile including MEDs and in the 3rd quartile excluding MEDs. The elevated SAIDI was primarily caused by CAIDI minutes which represents restoration time. ComEd's, AIC's and LBWL's SAIDIs placed them in the 1st quartile including MEDs. AIC and LBWL attained 2nd quartile excluding MEDs while ComEd maintained 1st quartile performance.

- It is important to analyze which components of the electric infrastructure serve as leading contributors to SAIDI under normal operations (excluding MEDs). Consumers' transmission system (owned and operated by ITC) had zero impact on Consumers' 2022 SAIDI. The LVD lines have consistently caused the most SAIDI minutes (approximately 87 percent).
- We found that trees and tree-related wind damage to lines with small poles and old spliced conductor are major causes of SAIDI including MEDs and excluding MEDs.
- Consumers' current 10-year overall tree trimming cycle and later 7-year overall cycle are much longer than AIC's and ComEd's 4-year programs LBWL's 5-year program.
- Consumers' numbers of CEMI 4 (customers that have experienced four or more outages for more than five minutes in the past year) and CELID 8 (customers that have experienced one or more outages longer than eight hours in the past year) are greater than usually acceptable for utilities. In 2023, more than 10 percent of Consumers' customers experienced four or more interruptions and more than 25 percent of its customers experienced interruptions greater than eight hours.
- The use of the "Weather" and "Unknown" cause codes is not precise and masks the actual cause of outages.

Chapter II - Electric Grid System

This chapter describes the Consumers electric distribution system infrastructure and details the principal assets that comprise it, including:

- Distribution system asset types and ages
- Overhead and underground circuit counts, mileage, configurations, type, and voltages
- Asset ages
- System protection, including fuses, automatic transfer switches and loop schemes
- Service transformers kVA and numbers of customers served
- Secondary conductor configuration and locations.

A. Background

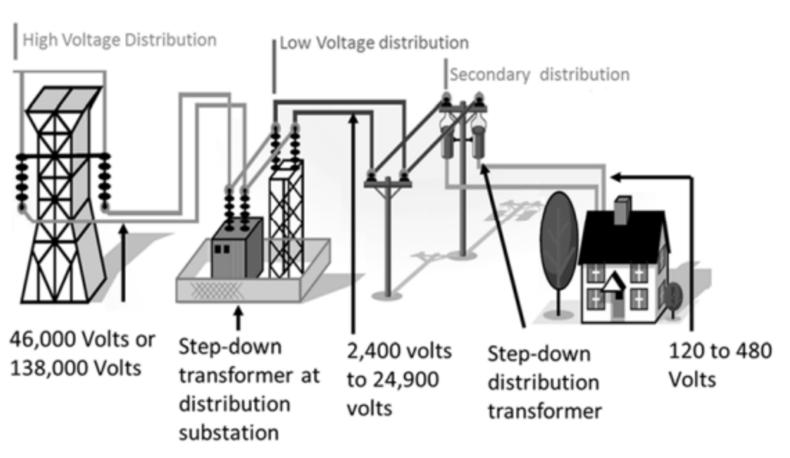
Consumers' electric distribution system serves 1,875,455 customers in 62 counties in the lower peninsula of Michigan, including 1,648,148 residential customers, 225,402 commercial customers, and 1,905 industrial customers. Consumers classifies thirty-nine percent of its LVD circuits as rural. Consumers' annual system peak load megawatts ("MW"), excluding retail open access load, decreased from 7,635 MW in 2016 to 7,529 MW (1.5 percent decrease) in 2022 and energy transferred (gigawatt hours "GWh") remained level from 34,000 GWh in 2016 and 34,000 GWh in 2022.

Electric delivery systems transport electricity from production facilities to customers. Transmission lines carry high-voltage electricity from power plants to substations, which are usually located some distance from end users. These high voltages minimize energy loss during long-distance travel. At the substations, transformers reduce the voltage to lower levels suitable for distribution. Lower voltage circuits branch out to reach all end users then distribute the electricity to them.

Consumers divides its distribution system by voltage into two categories: HVD and LVD. The HVD system operates at higher voltages, transporting electricity from regional transmission companies to substations. At these substations, the voltage is reduced for the LVD system, which then distributes the electricity to customers.

Industrial customers typically receive service directly from the HVD system. Specifically, the HVD grid serves 198 customers at 46 kV and 59 customers at 138 kV. Business and residential customers are primarily served by the LVD system, which mostly consists of overhead lines. However, the LVD system also includes a Metropolitan Underground ("Metro") distribution network that serves six cities. The following diagram from Consumers' 2023 EDIIP illustrates the relationship between the HVD and LVD systems:

Depiction of the Consumers Distribution System



Dedicated organizations manage the HVD system, overseeing the substations and HVD circuits that transfer electricity from the transmission grid to the LVD grid through substations. Separate LVD organizations have responsibility for the overhead and direct buried LVD distribution circuits that serve retail customers. A specialized Metro organization handles the LVD cable networks in conduits, manholes, and vaults, as well as the substations serving the downtown areas of Battle Creek, Flint, Grand Rapids, Jackson, Kalamazoo, and Saginaw.

B. Findings

1. HVD Component Details

Other entities operate the interconnected transmission system that supplies bulk power to the HVD grid that Consumers does own and operate. This HVD grid consists of high voltage distribution circuits operating at 138kV, 69kV, and 46kV, employing 145 HVD substations that interconnect with both the transmission system and the LVD system and make voltage transformations along the course of the HVD grid's operations. Another 164 dedicated customer substations operate on the HVD system. Some HVD circuits have long lengths that can range from about 15 to 20 miles, but many are only a fraction of a mile long. Consumers has configured its HVD circuits as three-phase grounded WYE circuits. The following table summarizes the voltages, quantities, and miles of Consumers' HVD circuits. It highlights that 46 kV circuits constitute the majority of the HVD system.

HVD Circuit Summary

Circuit Type	Number	Miles	Longest	Average
138 kV overhead radial	179	210.5	20.04	1.18
138 kV underground radial	2	4.1	2.05	2.05
69 kV overhead radial	4	3.4	1.90	0.85
46 kV overhead looped*	1,610	3,523.7	18.98	2.19
46 kV overhead radial	785	908.9	15.02	1.16
46 kV underground looped*	37	14.0	1.90	0.38
Total HVD	**2,618**	**4,664.6**		

**wholly or partially*

At least partial looping of much of the HVD system, as the table demonstrates, provides redundancy of supply in the event of system disruptions. The industry-accepted measure of System Average Interruption Duration Index ("SAIDI") comprises a principal measure of the customer consequence of such disruptions. The HVD distribution system component grid contributed approximately 10 percent of the system SAIDI minutes calculated after excluding MEDs for years between 2019 and 2023, except for 2020 when it accounted for a lower, 6 percent. The HVD component's contribution to "all-in" SAIDI minutes (*i.e.*, when measured before excluding MEDs) amounted to much less; for example, only two percent in 2023.

Underground cable comprises a very small part of the HVD distribution system component, measuring approximately 18 miles either directly buried or installed in conduits or duct banks. Consumers has limited HVD underground cables to congested locations or where terrain limitations would affect overhead construction very substantially. Since 2019, Consumers experienced only one HVD cable failure, and it plans to replace that cable with overhead construction. Between 2019 and 2022, Consumers replaced less than one mile of HVD cable.

2. *LVD Component Details*

Aside from a few industrial customers directly connected to its HVD grid, Consumers primarily serves customers through its LVD circuits. Due to mergers with legacy utilities, Consumers' LVD grid operates with various voltages and both delta and WYE configurations. Consumers designates its 8.3 kV, 12.47 kV and 24.9 kV grounded WYE voltages as "standard," while all other voltages are considered non-standard. Out of approximately 62,000 circuit miles, the Company has approximately 32,000 circuit miles of 8.3 kV, 10,600 circuit miles of 12.47 kV, and 15,600 miles of 24.9 kV circuits as illustrated in the LVD Summary Below. The circuits made up of the non-standard voltages make up approximately circuit miles 3,700 miles.

In instances where circuits or circuit segments with non-standard voltages receive service by standard voltage circuits, Consumers uses isolating transformers ("isolators") to convert voltages and configurations, allowing for the connection of circuits with different voltages. The LVD grid contains 1,733 isolators, with only 55 converting standard WYE voltages to downstream non-standard ungrounded delta voltages. Ungrounded delta voltage circuits serve 55,863 customers across 122 delta circuits from 38 substations and 5,361 customers downstream of the aforementioned 55 isolators on WYE circuits. Consumers serves approximately three percent of its customers by ungrounded delta circuits.

The non-standard substation and circuit assets, along with the variety of isolator transformer capacities, require additional mobile substations and stock inventory beyond what proves necessary for standard voltage systems. The impedance of isolating transformers can also cause system protection and stability problems. Though ungrounded delta circuits and segments downstream from isolators are few, they pose safety risks for the public and employees since downed delta wires can stay energized. Circuit breakers trip only when two phases of an ungrounded delta circuit have ground faults. Additionally, ground faults on delta circuits are difficult and time-consuming to detect and locate. The following table summarizes voltages at substation exits, circuit miles, and other LVD data.

LVD Circuit Summary

Voltage	Overhead	Underground	Total	Longest	Circuits	ATR Schemes	Customers	Substations
	(miles)				*(numbers)*			
2.4kV Delta	10	1	11	11	11	0	211	3
4.8kV Delta	113	16	129	105	10	0	2,153	2
7.2kV Delta	41	36	77	9	45	0	7,529	6
11.0kV Delta	728	24	752	104	16	0	11,361	6
12.0kV Delta	259	16	275	59	8	0	5,982	4
13.2kV Delta	365	58	423	74	10	0	10,329	5
13.8kV Delta	0	0	0	0	9	0	10	4
14.4kV Delta	1,109	82	1,191	139	20	0	14,911	8
Total Delta	*2,625*	*233*	*2,858*		*129*	*0*	*52,486*	*38*
4.16 kV WYE	2	0	2	1.3	21	0	23	6
8.32 kV WYE	27,352	4,805	32,157	147	1,202	110	1,011,051	459
12.47 kV WYE	7,763	2,799	10,562	140	545	84	501,148	189
13.8 kV WYE	1	1	2	1	25	0	20	6
24.9 kV WYE	13,831	1,792	15,623	211	472	81	310,500	249
Total WYE	*48,947*	*9,397*	*58,344*		*2,265*	*265*	*1,822,742*	*909*
Undesignated								235
Total LVD	**51,574**	**9,630**	**61,204**		**2,394**	**275**	**1,875,228**	**1,182**

Consumers organizes its LVD operations into 30 headquarter districts. The number of customers served by each district varies, from 16,260 in Benzonia to 212,967 in Flint. The circuit lengths in these districts also differ, with Benzonia having 881 miles and Flint having 4,268 miles. Customer density, or the number of customers per mile of circuit, ranges from 22 customers per mile in Fremont to 569 customers per mile in Adrian

Circuit Miles by Headquarter District

District	OH	UG	Customers	Density	District	OH	UG	Customers	Density
Adrian	2,046	136	48,330	569	Hamilton	2,282	364	59,830	60
Alma	1,747	167	42,091	69	Hastings	1,185	131	27,042	34
Battle Creek	2,152	205	65,375	106	Jackson	3,155	349	92,920	314
Bay City	977	92	30,879	114	Kalamazoo	2,163	738	132,214	105
Benzonia	743	138	16,260	58	Lansing	2,573	688	101,418	239
Big Rapids	1,305	114	28,301	27	Ludington	579	105	23,896	54
Boyne City	774	214	32,449	117	Midland	1,222	204	44,126	87
Cadillac	1,926	149	32,257	28	Muskegon	2,167	509	105,724	138
Clare	2,180	178	43,567	40	North Kent	1,415	465	64,358	56
Coldwater	2,351	102	35,269	58	Owosso	1,824	138	39,063	451
East Kent	678	568	57,784	75	Saginaw	1,895	416	90,576	86
Flint	3,138	1,130	212,867	92	South Monroe	539	105	26,999	414
Fremont	896	66	17,143	22	Tawas	1,229	126	27,256	109
Grand Rapids	1,601	959	209,485	145	Traverse City	1,334	508	43,099	26
Greenville	2,166	178	45,922	26	West Branch	3,333	390	78,728	163
Totals	**51,57**	**9,631**	**1,875,228**	**138**					

3. *Grid Asset Ages*

Asset age presents only one of several factors that affect equipment condition and varies in impact based on asset type. For example, legacy design and materials issues can shorten asset life; *e.g.*, early failing of certain porcelain cutout types, pre-1985 direct buried LVD cable, and substation transformers that a particular company manufactured. Consumers undertakes replacement of such cutouts and LVD cable and monitors high risk transformers.

Overloading assets presents another factor that can shorten reliable life. Overloading of substation transformers and system cables, even for short durations, reduces operating life, and increases failure risk. Consumers has some circuit and substation capacity limitations. During the summer of 2023, the first circuit sections of six Consumers' distribution circuits operated above their ratings and nine substations operated above their ratings. As many as 32 ATR loops for 64 circuits are blocked from transferring load during peak load summer months because of inadequate circuit capacity.

Tree and large limb contact on conductors can reduce the strength of the conductors and supporting structures. Wood pole life depends on tree species, chemical treatment, ground conditions at the pole base, and particularly on invasion of pole surfaces and interiors through decay and insects. Sixty years represents a common wood pole life in the industry, but many can remain dependable for 80 or more years.

Paper Insulated Lead Covered ("PILC") cable can remain dependable for 100 years or more with repair of oil leaks and by minimizing overloading, if not physically damaged. Other factors to consider in assessing remaining asset life include spare parts availability for legacy equipment and the costs of increased maintenance as assets age.

The next table shows by major asset class the percentages of equipment exceeding life expectancy for assets with a determined age.

Aging Asset Summary

Asset Class and Life Expectancy	Aged
LVD Poles over 60 years	12%
HVD Poles over 60 years	4%
Metro cable over 60 years	1.5%
LVD Cable over 30 years	29%
Overhead conductor > 60 years	45%
Substation transformers >50 years	38%
Substation Reclosers >40 years	0%
Substation Oil Circuit Breakers > 40 years	~100%
Substation SF6 Gas Breakers >40 years	0%
Service transformers >50 years	21%

a. <u>LVD & HVD Poles</u>

Consumers system contains approximately 1.1 million poles that carry primary conductors and 400,000 poles that only carry secondary conductors. LVD circuits account for about 93 percent of the poles. Approximately 12 percent of LVD poles and 4 percent of HVD poles are more than 60 years old. The 2023 Consumers Electric Distribution Infrastructure Investment Plan ("EDIIP") reported an average pole age of 65 years.

Consumers Poles by Decade Installed

Decade	LVD	% LVD	HVD	% HVD	Unknown	Total
1920-1929	109	0.00%	0	0.00%		109
1930-1939	52,662	3.20%	365	0.50%		53,027
1940-1949	55,846	3.40%	910	1.10%		56,756
1950-1959	105,236	6.30%	2,163	2.70%		107,399
1960-1969	281,532	16.90%	5,699	7.20%		287,231
1970-1979	253,399	15.20%	4,866	6.10%		258,265
1980-1989	248,982	15.00%	3,210	4.00%		252,192
1990-1999	311,061	18.70%	4,233	5.30%		315,294
2000-2009	185,557	11.10%	3,487	4.40%		189,044
2010-2019	140,165	8.40%	6,835	8.60%		147,000
2020-2029	3,556	0.20%	7,170	9.00%		10,726
Unknown	26,910	1.60%	40,451	51.00%	270	67,631
Total	**1,665,015**		**79,389**		**270**	**1,744,674**

Wood pole strength may deteriorate over time due to wet ground conditions, insects, and decay. Voids can develop inside a wood pole, causing loss of strength. Original pole strength depends on its original diameter (categorized by class number). Small diameter poles, also known as class 5, 6, and 7 poles, are at greater risk of breaking in storms or from applied force (hits by car, for example), especially when further weakened over time. Consumers classifies 62.5 percent of its wood poles in these three smaller classes. On emergent occasions or when Consumers has planned to replace these small-diameter class 5, 6, and 7 poles on primary circuits, it uses stronger, larger diameter class 2, 3, and 4 poles. Consumers also plans to replace in 2024 over a thousand wood poles with strong, long-life iron poles in the Kalamazoo, Greenville, and Tawas areas. Larger diameter wood poles will reduce breakage, thus shortening restoration needs and times after storms, and iron poles even more so at higher pole costs.

b. *Underground Cable*

The Consumers Metro system operates through underground LVD networks in the six cities involved. System cables run in conduit and ducts encased in concrete. About 6.3 miles of cable (1.5 percent) of the 423 miles of Metro cables were installed between 1920 and 1940. Of the 1,423 manholes, 725 were installed between 1900 and 1940.

Consumers directly buries LVD cables in loops for subdivisions and radially for businesses, or on riser poles, substation exits, and on very short sections of mainline circuits. The next table shows approximately 30 percent of LVD underground cable was installed before 1990, with the bulk of LVD underground cable installed from 1990 to 2009. LVD cables installed before the mid-1980s have high failure rates.

LVD Direct Buried Cable

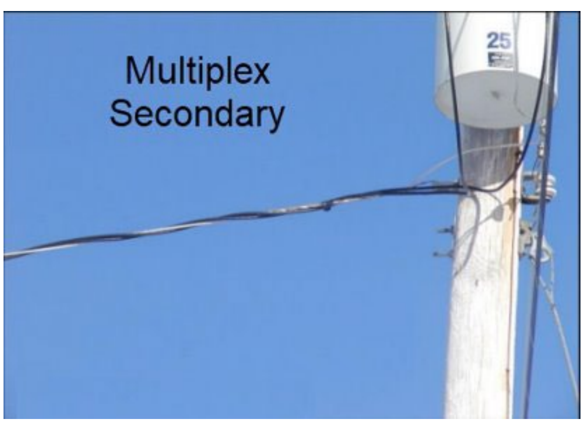
Year	LVD UG Feet *(x1,000)*	Pre-1990
1960-1969	3,239	3.2%
1970-1979	15,407	15.1%
1980-1989	10,884	10.7%
1990-1999	26,302	25.8%
2000-2009	29,248	28.7%
2010-2019	12,476	12.2%
2020-2029	4,349	4.3%
Totals	**101,906**	

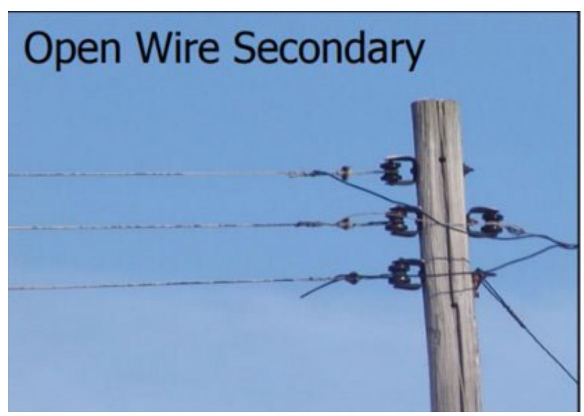
c. *Overhead Conductor*

Consumers installs many types of overhead LVD conductors, principally relying on No. 4 Aluminum Conductor – Steel Reinforced ("ACSR"). Consumers operates less than 1,000 miles of No. 6 copper conductor that are more easily damaged by trees and ice loads.

Secondary circuits and services typically supply 120/240-volt service to customers, but some 480-volt services exist. Consumers operates and maintains approximately 32,000 miles of secondary circuits made up of twenty types or sizes. Approximately 64 percent is located overhead, and 36 percent is underground. About 85 percent of overhead secondary circuits employ Multiplex conductor, which winds all wires together, as opposed to legacy open wire configuration, which comprises the remaining 15 percent. The following illustration from the 2023 Consumers EDIIP illustrates the difference between these two configurations.

Multiplex and Open Wire Configurations for Secondaries





d. *Overhead Framing*

Consumers uses 25 standard types of overhead structure construction, but the most used overhead construction uses crossarm, pole top pin, and dead-end construction.

e. Backlot Laterals and Services

Consumers classifies "backlot" conductors as those that are located more than 50 feet from road centerlines. This includes long runs of primary circuits in corridors in woods and fields. Backlot conductor mileage includes 29,487 miles of overhead primary conductor, 5,770 miles of underground primary cable, and 16,341 miles of secondary overhead conductor. These conductors serve 295,835 (18 percent) of Consumers' residential customers.

Consumers reported that it historically constructed backlot LVD lines in alleys and behind houses in consideration of keeping property frontage and trees free from powerlines. Backlot construction proved the most cost-effective method for connecting houses in rural areas where houses often are set back from the road. Issues with roadside easements and terrain obstructions provided additional factors favoring location of powerlines away from roadways. Modern line and tree work equipment makes backlot access now significantly more difficult. Consumers now seeks to construct LVD lines along roadways, where feasible, to permit easy access for line and tree trimming equipment.

f. Substation Transformers

Substations contain power transformers, circuit breakers and reclosers, switches, protective relays, SCADA, and other devices required to change HVD and LVD primary voltages, and to provide switching for the HVD and LVD electric distribution systems. Consumers operates and maintains 1,144 substations, including 830 substations for its LVD distribution system, 145 substations for its HVD system, 164 for single customer service, and 5 for wholesale customers. Additionally, Consumers serves 30 customer owned substations. Approximately 45 percent of the substations were originally installed between 1903 and 1960, with a large portion installed in the 1950s.

Substation transformer sizes range from three 500 kVA transformers to five 60 MVA transformers. The 2,261 total Consumers substation transformers span 23 different base MVA sizes, with the largest size classes detailed in the following table.

Substation Transformer by Size

Size	Number	Average Age (years)
500 kVA	3	51.0
5 MVA	421	39.1
10 MVA	1,012	29.8
12 MVA	484	18.3
60 MVA	5	6.0
Other Sizes	336	53.1
Total	**2,261**	**32.4**

For 8.3kV to 13.8kV circuits, the percentage of substation transformers over 60 years old is 7 percent. For 4.8kV circuits, less than 16 percent of substation transformers are over 60 years old. The next table lists substation transformer numbers and average ages.

Substation Transformer Summary

Voltage at Circuit Exit	Number	Average Age (years)
11.0 kV Delta	11	41.1
12.0 kV Delta	10	39.2
13.2 kV Delta	9	26.6
13.8 kV Delta	6	45.2
14.4 kV Delta	22	46.9
14.4/24.9 kV Wye Grounded	424	36.1
2.4 kV Delta	3	46.0
2.4/4.16 kV Wye Grounded	6	59.0
4.8 kV Delta	7	60.0
4.8/8.32 kV Wye Grounded	1,204	32.9
7.2 kV Delta	31	29.6
7.2/12.47 kV Wye Grounded	520	27.0
7.9/13.8 kV Wye Grounded	7	33.6
Unknown	1	51.0
Total	**2,261**	**32.4**

g. <u>Substation Transformer Failures</u>

Between 2019 and 2023 Consumers experienced only one HVD transformer failure and 22 LVD substation transformer failures. The following table summarizes these events by year.

Substation Transformer Failure Summary

Category	2019	2020	2021	2022	2023
LVD	4	5	7	2	4
HVD	0	0	0	0	1

During this period the Company removed 20 additional transformers at end-of-life and replaced 19 of those. Fifteen of the 20 end-of-life removals were 50 years or older, with six of them manufactured by the same manufacturer. Consumers had a substation transformer annual failure rate of approximately 0.2 percent during the 5-year 2019 through 2023 period. Data show an average age of 52 for substation transformers replaced during the past 10 years.

h. <u>Reclosers and Circuit Breakers</u>

Consumers' LVD substations employ reclosers for circuit protection. Reclosers are generally less expensive and require less maintenance than circuit breakers. Designed for distribution voltage level circuit protection, reclosers have self-contained automatic fault current sensing, tripping, and reclosing functionality. The LVD substations employ 2,326 reclosers, with only two installed in the 1970s, none in the 1980s, 236 in the 1990s, and the remainder from 2000 to 2024.

Consumers employs circuit breakers for HVD circuits. A few LVD circuits require relays for tripping and reclosing, and Consumers continues to employ 18 older-style oil circuit breakers in its LVD substations. The Company installed five of these legacy oil circuit breakers during the 1950s, twelve in the 1960s, and one in the 1990s.

Consumers uses legacy oil circuit breakers and modern SF6 (gas) circuit breakers for its HVD system designed for 46kV and 138kV. It uses 246 oil circuit breakers and 633 gas circuit breakers for HVD transformer and circuit protection. The oil circuit breakers require more maintenance than gas circuit breakers. Consumers installed oil circuit breakers during the 1950s through the 1980s and the gas circuit breakers during the 1990s through the 2010s. Utilities are replacing their legacy and aged oil circuit breakers because of degrading performance and increasing maintenance costs. The gas circuit breakers have better line clearing performance and require less maintenance costs than oil circuit breakers.

i. *Service Transformers*

Consumers operates nearly 650,000 service transformers that operate at 480 volts or less to serve customers. Approximately 16 percent operate in "back lot" locations, those located more than 50 feet from road centerlines, that frequently present access difficulties. The service transformers include 488,777 pole mounted transformers, 111,612 pad-mounted transformers, 152 subsurface transformers, and 254 vault transformers. Approximately five percent of the service transformers exceed 50 years in age, 33 percent exceed 30 years, and 59 percent exceed 20 years. The maximum number of customers connected to a 100 kVA transformer is 11, to a 75 kVA transformer 10, to a 50 kVA transformer 8, and to a 25 kVA transformer 4 (6.25 kVA per customer). In the worst case, Consumers provides at least 6 kVA of capacity when equally shared from a service transformer. Currently, the minimum size service transformer Consumers installs is 25 kVA. Consumers has connected only one customer to each legacy 10 kVA and 15 kVA transformer.

j. *Circuit Tie Switches, Sectionalizing, and Automation*

Consumers has enabled load transferring on the LVD system component by installing tie switches at 206 locations using mechanical jumpers and at 2,444 locations using manual tie switches. Most of the tie switches operate on the 8.32kV, 12.47kV, and 24.9kV circuits.

Sectionalizing, or "fractionalizing" per Consumers terminology, reduces an overhead circuit into operating segments, each protected by fuses or by a circuit recloser. Sectionalizing does not prevent outages, but reduces the numbers of customers affected, and in many cases outage durations. Consumers' LVD system includes 6,524 automatic mid-circuit reclosers. Longer circuit sectionalization can employ many reclosers; *e.g.*, one long Consumers circuit employs 24 reclosers.

Consumers has been installing DSCADA controlled and monitored Automatic Transfer Recloser ("ATR") schemes that automatically isolate a faulted circuit segment and restores downstream segments by automatically transferring downstream loads to another circuit. Consumers has looped much of the HVD distribution system component but has not looped LVD circuits. However, Consumers can still automatically transfer LVD customer load, under normal load conditions, to other circuits via 153 ATR Loop Schemes on 290 circuits. Through October 2023, Consumers had installed 151 ATR loops benefiting 212,407 customers. Reportedly, the ATR loops placed in 2022 reduced SAIDI by 11.2 minutes in 2022.

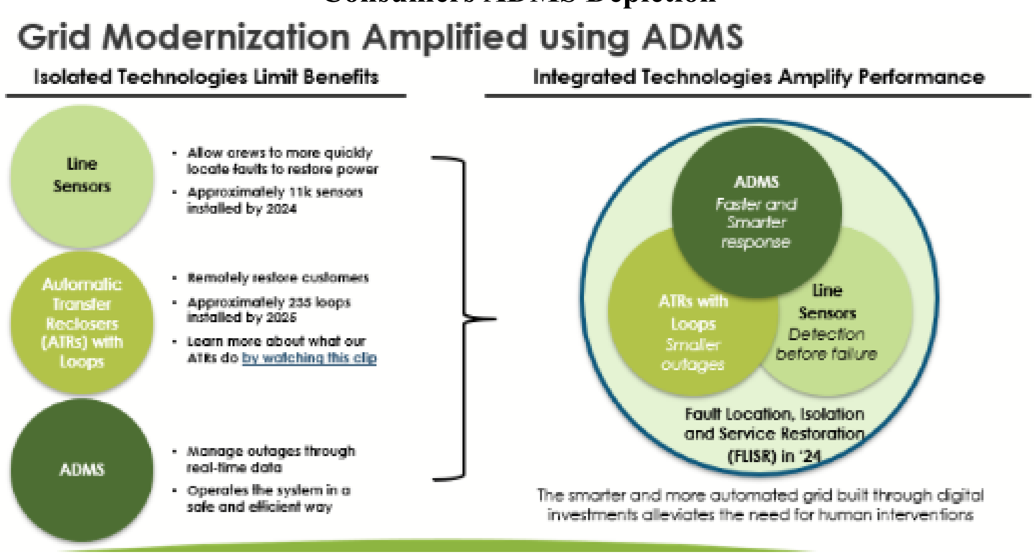
k. Lateral Fuses and Reclosers

Installing fuses on lateral circuits at mainline circuits prevents customers on a mainline circuit from experiencing sustained outages for faults on a lateral circuit. Consumers has 63,588 lateral circuits, 51,091 of them fused. Consumers has an ongoing program to fuse the remaining 11,000 or so lateral circuits by the end of 2025. Consumers is considering but has yet to commence a pilot program to protect some lateral circuits by installing electronic trip savers, a tripping and reclosing device that fits into fuse holders. Consumers has also protected 38 lateral circuits with reclosers and 3 circuits with sectionalizing switches where fusing could not be coordinated with mainline protective devices.

C. Grid Management

Consumers monitors and controls the operation of its electric grid from four centers. The Jackson System Control Center controls HVD lines and HVD substations. The Grand Rapids Distribution Control Center controls LVD substations, and Jackson and Grand Rapids LVD Dispatch Centers manage LVD circuit outages. Consumers maintains a backup system control center at a confidential location. System Operators and Dispatchers all have access to the Advanced Distribution Management System ("ADMS"). This software platform supports distribution management and outage management systems by bringing together the Distribution Management System ("DMS"), Field Mapping Applications, and the Outage Management System ("OMS"). The following diagram from the 2023 Consumers EDIIP depicts the integration of systems and equipment that the ADMS brings.

Consumers ADMS Depiction



Consumers' advanced distribution management system also includes Volt-VAR optimization ("VVO"), Conservation Voltage Reduction ("CVR"), and Distribution Power Flow ("DPF"). Consumers also uses other advanced technologies such as PI Historian and Reliability Analytics Monitoring Program ("RAMP"). RAMP uses advanced analytics to identify potential future outage locations, allowing the Company to address a situation before it becomes an outage.

1. DSCADA

DSCADA enables real-time communication between substations, circuit devices, and System Operators. It also allows Planning Engineers to conduct precise load flow studies using real-time circuit data and facilitates ATR loop operation. Additionally, DSCADA provides monitoring and control of ATRs, line sensors, voltage regulators, and capacitor banks, helping to maintain voltage levels and reduce reactive current flow.

In 2023, Consumers operated 2,266 LVD circuits, with DSCADA control implemented on 1,773 of them. Grid Operations maintains 100 percent DSCADA control over HVD substations and the HVD side of HVD/LVD substations. On the LVD side of HVD/LVD substations, DSCADA control covers 87.5 percent, and 69 percent of LVD substations are DSCADA-enabled. Consumers plans to install DSCADA at approximately 120 more LVD substations over the next six years. However, a few substations will not be equipped with DSCADA due to being customer-owned, serving a limited number of customers, or not presenting significant reliability concerns.

2. Fault (Line) Sensors

Fault sensor devices installed at specific circuit locations measure load and fault current characteristics in real time and communicate the data to System Operations. Since 2019, sensors have provided fault location data to System Protection Engineers, LVD Planning Engineers, and Operations Engineers. Dispatchers have access to fault indication and fault current data in ADMS in real time, but not fault location data. Fault sensors will provide post fault location data when integrated after a planned upgrade of ADMS software and the full enablement of the Fault Location Isolation and Service Restoration ("FLISR") application in ADMS. Fault location data will become visible to Dispatchers in real time after the completion of the ADMS upgrade and enablement of FLISR. Fault sensors will provide pre-fault and post fault data when integrated with the ADMS after a planned upgrade of ADMS software. Dispatchers will be able to see visual representations of fault sensors after completion of the ADMS upgrade. That visibility will reduce the time required for electric service workers and crews to locate faults. Consumers installed 8,145 fault sensors between 2019 and 2023 and plans to have 12,005 fault sensors installed by the end of 2025.

3. Communications Systems for System Protection Devices and DSCADA

Historically, Consumers used a combination of leased analog telephone company lines, fiber, and 3G cellular in its communications system. Telecommunications carriers no longer support analog phone lines or the 3G cell system. Consumers has converted to a combination of 4G cell technology, fiber, and carrier ethernet communications to provide redundancy in most cases. The Company reported that it has not been experiencing communications bandwidth constraints.

4. System Protection

Consumers uses protective relays to detect HVD line and substation faults and trip circuit breakers to clear them. The company is replacing legacy electromechanical relays from the 1950s and solid-state relays from the 1970s with reliable, multi-function digital programmable relays during transformer replacement or capacity projects. A single digital relay unit typically replaces multiple solid-state and electromechanical relays. Consumers plans to upgrade 52 relay units (panels of relays) each year. The following table summarizes the types of relays, showing that 3,388 legacy electromechanical and digital relays are still in use, making up about 64 percent of the protective relays in service.

Protective Relay Summary

Type	Numbers	Percent of Total
Electromechanical	2,393	45%
Solid-State	995	19%
Digital	1,948	37%
Total	5,335	

5. *Mobile Substations and Voltage Regulators*

Mobile substations typically consist of a power transformer with switching devices set on a trailer movable to substation locations where needed to maintain service (*e.g.*, for regular maintenance of a permanent substation) or to restore service (*e.g.*, when a permanent transformer fails). Most of Consumers' 20 mobile substations can provide several different distribution voltages. Consumers also has five mobile voltage regulators available. The sizes of the mobile substations range from 2.5 MVA to 80 MVA. When connected to the HVD system, the mobile substations can provide temporary service for all LVD system voltages. The 80 MVA mobile substation provides 46 kV from 138 kV for the HVD system.

D. Observations

1. The many different LVD voltages that Consumers operates is unusual and poses material challenges.

Consumers operates 13 different LVD voltages including eight ungrounded delta voltages, seven of which serve a small portion of its system (61,000 customers, or three percent). Most utilities have only two distribution voltages. The need to plan, maintain, operate, and provide inventory for so many distribution voltages creates several challenges. Consumers must maintain additional mobile substations and stock additional equipment to ensure sufficient inventory to maintain and repair circuits. The multiplicity of voltages restricts the ability in many instances to transfer loads when responding to system events and creates the need to use isolating transformers between circuit sections.

The 1,640 miles of delta-configured LVD circuits create a public safety risk, because they remain energized when downed. Consumers plans to convert them to one of the system's three standard configurations across a 10-year duration that will require total investment of about $330 million. The multiplicity of LVD voltages has contributed to the high SAIDI minutes Consumers has experienced. Faults on delta circuits are more difficult to locate and loads on circuits of different voltages cannot be tied absent temporary isolation transformer installation.

2. Consumers' HVD and LVD asset types and ages are consistent with those of other large electric utilities.

Overhead conductors, underground cables, poles, reclosers, transformers, DSCADA, ADMS, and protective relays are reasonably typical. We did not find the Consumers assets to be of advanced age comparatively.

3. Consumers' use of automatic recloser transfer schemes reduces customer interruptions and incrementally improves SAIDI, but these schemes can mask the extent to which tree contact and equipment failures cause outages.

Automatic circuit sectionizing, and fault isolation and load transfer schemes do not reduce the numbers of outages, but they lower the numbers of customer interruptions caused by an outage by reducing the numbers of customers on an isolated circuit segment(s). Consumers uses DSCADA systems with ATR schemes to manage power distribution. These systems automatically isolate faults and redirect power to alternative circuits, restoring service more quickly. Although LVD circuits are not looped like HVD circuits, Consumers can still transfer LVD loads using ATR Loop Schemes across circuits. In 2022, Consumers reported that these loops reduced the SAIDI by 11.2 minutes.

4. Completing the inclusion of asset locations and data into its GIS and improving ADMS capability will make incremental improvements to SAIDI values.

Consumers uses its GIS to store circuit asset data and locations and CASCADE for substation asset data. A detailed GIS is crucial for capital plant management and the effective use of the ADMS. The utility can precisely identify 100 percent of its HVD assets and about 85 percent of its LVD assets with GIS and is working to complete the remaining 15 percent by finalizing data collection for underground and Metro systems. After a planned upgrade of the ADMS software, fault sensors will provide pre-fault and post-fault data, which, when integrated with the ADMS, will allow dispatchers to see visual representations of fault sensors. This improved visibility will reduce the time needed for electric service workers and crews to locate faults, enabling Consumers to reduce interruption duration and improve SAIDI.

5. Well-paced installation of fault sensors, continuing to install fuses on lateral circuits, and upgrading protective relays will also incrementally improve system SAIDI.

Continued installation of fault sensors, fuses, and protective relays should further reduce the number and duration of interruptions across Consumers' distribution system.

6. Consumers provides sufficient service transformer capacity and its ability to identify the connectivity between service transformers and customer meters provides its ADMS system improved ability to identify service transformer outages based on customer outages.

Consumers connects a maximum of 11 customers to a 100 kVA transformer, 10 to a 75 kVA transformer, 8 to a 50 kVA transformer, and 4 to a 25 kVA transformer. In the worst case, at least 6 kVA of capacity is provided per customer from a service transformer. The smallest transformer Consumers currently installs is 25 kVA, and only one customer is connected to each legacy 10 kVA and 15 kVA transformer.

Consumers can identify 100 percent of its HVD assets and approximately 85 percent of its overhead and underground LVD assets using GIS and is actively working to complete the remaining 15 percent. Once Consumers completes the remaining 15 percent of GIS identification, ADMS visibility will be enhanced.

Chapter III – Construction Standards and Inspection and Maintenance Practices

A. Background

This chapter reviews Consumers' electric system inspections and maintenance practices, including

- An overview of overhead and underground HVD, LVD, and substation asset inspection practices. A more detailed analysis is included in Part 2 of this report.
- Effectiveness of maintenance activities and cycles
- Practices for identifying asset end of life
- Compliance with the National Electrical Safety Code ("NESC").

B. Findings

1. *Asset Inspection and Maintenance Programs*

The Part 2 Report reviews in detail Consumers' proactive overhead and underground HVD, LVD, Metro, and Substation inspection and maintenance programs and end of life replacement programs and practices. Salient features, which the following tables summarize, of Consumers' inspection practices include an annual aerial inspection and semiannual ground patrol HVD inspection program, an HVD pole ground line inspection and pole strength testing program on 12-year cycles, a 2-year LVD pole top and pole inspection cycle program, a 4-year Metro manhole and vault inspection program, and a substation inspection program on monthly cycles for HVD substations and on bi-monthly cycles for LVD substations. Substation transformer, circuit breaker, and battery inspection and maintenance programs lead to health scores based on failure risk and consequences to the grid operation. Consumers uses inspection results, maintenance, operational issues, asset age, and health score rankings to determine asset end of life and priorities for replacements.

Inspection Summary

HVD		LVD OH		LVD UG and Metro		Substaton	
Type	*Cycle*	*Type*	*Cycle*	*Type*	*Cycle*	*Type*	*Cycle*
Aerial Pole Top	Annual	Pole Top	2-year	Padmount	2-year	LVD	Semi-monthly
Ground Pole Top	2-year	Pole	2-year	Manholes/Vaults	4-year	HVD	Monthly
Ground Line Pole	12-year						

Proactive inspection programs identify abnormal conditions and replace components before they cause emergent outages. Pole inspection and testing programs identify wood poles deteriorated to the degree that poles do not meet NESC pole strength requirements necessary to withstand expected loads caused by high winds and ice. Consumers replaces weak poles with greater diameter and higher strength poles.

As with many utilities, some portions of Consumers' overhead and underground assets are aged, which means that its inspection and maintenance program activities, cycles, and costs are balanced so that asset conditions are adequately monitored and mitigated to minimize emergent asset failures. Asset age is only one factor in determining end of life.

Since underground cables, whether buried in the ground or in conduits, cannot be inspected and testing them is impractical, Consumers follows a reactive cable repair practice and replaces LVD cables after three failures. A substantial portion of Consumers' LVD underground system consists of pre-1985 cables made of poor-quality material with high failure rates. To mitigate some LVD cable fault causing outages and emergent O&M costs, Consumers proactively rejuvenates these cables experiencing failures. Rejuvenation is accomplished by injecting the cables with an insulating fluid at a cost that is 60 percent less than replacing the cables. The company injecting the cables warrants the injected cables for 20 years.

2. *Electric Construction Standards*

Consumers reports that, historically, its electric construction standards complied with the Michigan Public Service Commission ("MPSC") adopted edition of the NESC at the time. However, some older parts of Consumers' system were acquired from other utilities and the Company believes construction of these systems complied with the NESC in effect at time of their construction. Rebuilding the system to comply with the current edition of NESC would produce extreme rate consequences.

The 2017 NESC Rule 013B states that existing installations, including in-kind replacements, need only comply with the NESC edition or MPSC Order in effect at the time of the initial installation. When adding or replacing equipment or conductors, wires, or other cables on an existing structure, the structure need only meet the NESC edition or MPSC Order in effect at the time, or the latest MPSC adopted edition of the NESC. Therefore, Consumers is not required to update to current NESC standards when replacing deteriorated components on its electric system unless a complete pole or substation is replaced.

Consumers changed its construction standard primarily from Grade C to Grade B in January of 2023, to better reflect environmental loading changes due to worsening weather and to better conform to what its benchmarking showed other utilities to be doing. Consumers now installs fiberglass cross arms on LVD circuits and HVD lines with LVD underbuilt. It is now using steel poles for support of HVD switches and has a pilot program for using ductile iron poles for LVD. Consumers reports a long-term plan to install the ductile iron poles on the three-phase portion of the distribution system when installing new poles in areas anticipated to face more storm impacts.

Approximately 62.5 percent of Consumers' LVD wood poles are small diameter class 5, 6, and 7 poles, which are more susceptible to damage in wind and ice storms. Consumers' new standard is to use stronger class 4 poles, at least, and fiberglass cross arms at dead ends. These standards exceed NESC construction requirements, given applied loads less than or equal to 85 percent of the allowable loading.

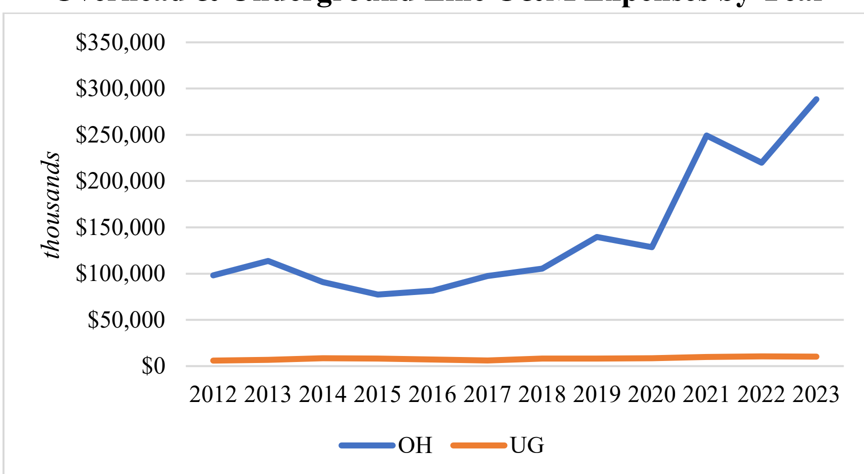
As stated above, Consumers is not required to update existing electric distribution infrastructure to current NESC. Before revisions to the NESC are approved by authorities, the Company revises its construction and design standards, its Work Methods Manual, and notifies and ensures understanding with designers, engineers, and the field operations personnel of the new construction and design standard designs. Consumers then requires that new NESC updated standards are followed for subsequent constructions.

3. Maintenance Costs for Underground vs. Overhead Facilities

Although Consumers was not able to indicate specific dollar differences in costs, it indicated that costs to maintain LVD primary underground facilities are much less than for overhead facilities. Consumers indicates that it spends approximately 5 percent of its electric LVD maintenance spending on underground facilities which are approximately 13 percent of the LVD system and that it spends approximately 98 percent of service restoration costs on overhead facilities.

An analysis of O&M expenses reported through the annual FERC Form 1 shows that Consumers O&M spending for distribution overhead lines has increased significantly over the last four to five years while underground line O&M has remained constant, only slightly increasing in the last year, as seen in the chart below. Total spending for distribution overhead line operation and maintenance has ranged from 4.3 percent of total distribution operation and maintenance expenses to a high of 10.3 percent in 2023 while underground line operation and maintenance has ranged from 0.2 to 0.4 percent. The following chart details actual dollars spent each year on distribution overhead and underground operations and maintenance.

Overhead & Underground Line O&M Expenses by Year



Consumers expended $33.8 million for Corrective Maintenance O&M, an amount that remained about the same since 2019. The next table shows that Service Restoration O&M expenditures have increased since 2019.

Service Restoration O&M in Millions

2019	2020	2021	2022	2023
$92.1	$71.3	$159.7	$113.3	$188.0

C. Observations

1. Consumers updates its electric construction designs whenever NESC guidelines are updated and approved by authorities.

The revised safety standards are applied in practice when new facilities are constructed following the NESC's guideline update. When Consumers replaces a pole, it uses designs and components that meet or exceed the current NESC guidelines. This is typical utility practice. It would be cost prohibitive to bring all legacy infrastructure to current NESC guidelines.

2. Consumers’ O&M spending for distribution overhead lines has increased significantly over the last four to five years while underground line O&M has remained constant, only slightly increasing in the last year.

Consumers spends approximately five percent of its electric LVD maintenance spending on underground facilities, which comprise approximately 13 percent of the LVD system. The Company spends approximately 98 percent of service restoration costs on overhead facilities.

O&M spending for distribution overhead lines has increased significantly over the last four to five years while underground line O&M has remained constant, only slightly increasing in the last year. Total spending for distribution overhead line operation and maintenance has ranged from 4.3 percent of total distribution operation and maintenance expenses to a high of 10.3 percent in 2023 while underground line operation and maintenance has ranged from 0.2 to 0.4 percent.

Chapter IV – Stratified Facilities Sampling

A. Background

This chapter presents the results of our field inspections of a statistically derived selection of poles and 77 substations on Consumers' electric grid with the purpose of verifying Consumers' asset records, assessing condition, and identifying any safety issues. This chapter also describes asset types, numbers, ages, circuit configurations, and numbers of service transformer customers.

1. Comprehensive System Data Logging

The RFP for this engagement called for development of detailed information about system components, configurations, and performance data. We sought to categorize distribution system components comprehensively for purposes of meeting this requirement and to provide a foundation for the assessments of organization, planning, processes, and activities that comprise Part 2 of this engagement. Working with Consumers, we identified the major electric distribution system infrastructure components, including vintage, of the Consumers system.

We requested the following list of assets and attributes. The following details the distribution system data collected and assimilated into our database to support Part 1 and Part 2 tasks:

1. Secondary circuits
    a. Mileage for each type of secondary (*e.g.*, triplex, UG, open wire, etc.).
2. Primary and sub-transmission/high voltage distribution circuits (by circuit)
    a. Circuit name/number
    b. Substation name
    c. Voltage (if multiple voltages exist on a circuit, include a list of each).
    d. Underground or Overhead (underground/overhead percentages for circuits with both)
    e. Length of circuit
    f. Wire types (copper, aluminum, composite, whether covered or bare)
    g. Circuit system type (*e.g.*, delta, wye)
    h. Circuit configuration (looped or radial)
    i. Construction standards by voltage class for pole tops. (*e.g.,* open-wire on crossarms, spacer cable, armless, or other company-specific primary construction type)
    j. Map identifying each work headquarters location and the areas supported
    k. Geographic location by work headquarters
    l. Nature of area served: rural, urban, or mixed
    m. Customers and types of customers (residential, commercial, industrial)
    n. Customers per mile
    o. Back/rear-lot and front-lot/street-side locations
    p. Bare (ASCR), tree wire, and spacer cable
    q. Numbers of smart grids and mid-circuit reclosers
    r. 10-year IEEE 1366 Standard reliability performance (SAIDI, SAIFI, CEMI, CELID)
    s. Circuits identified as worst performing and basis for determination
    t. Last date trimmed
    u. Last inspection date
3. Service and substation transformers:

   a. Number and identifier
   b. kVA size
   c. Type (*e.g.*, pole, pad, underground)
   d. Age
   e. Associated circuit number/name
   f. GIS location coordinates
   g. Customers Numbers served (minimum, median, and maximum)
      - Intended
      - Actual
   h. Numbers of customers (residential and commercial) served
4. Substations:
   a. Name/Identifier
   b. Transmission
   c. GIS location coordinates
   d. Sub-transmission or Distribution (by high and low voltage)
   e. Year Installed
   f. Customers Numbers served (minimum, median, and maximum)
      - Intended
      - Actual
5. Poles
   a. Pole number or ID
   b. Associated circuit number/name
   c. GIS location coordinates
   d. Type and material (*e.g.*, creosote preserved, penta preserved)
   e. Year installed
   f. Class (*e.g.*, Class 1, Class 2)
   g. Height (*e.g.*, 35-foot, 40-foot, 45-foot)
   h. Last inspection date
   i. Last treatment date/reinforcement date
6. Third-party attachments
   a. Joint Use and Joint Ownership agreements
   b. Third-party utilities attached
   c. Date initially installed
7. Maintenance cycles
   a. List of equipment subject to maintenance cycles
   b. Asset maintenance cycles for each equipment type
   c. Vegetation management cycles by voltage and construction type
8. Customer numbers
   a. By class (residential, commercial, industrial)
   b. By geography (town or district)
   c. By SIC code (standard industrial classification).
9. 10-year measures of SAIDI, SAIFI, CAIDI, ASAI, MAIFI, CEMI 0 through 10+, CELID8, CELID24, and CELID48.

We worked with Company personnel to rationalize and verify response completeness. We then created a large data aggregation and tracking database describing the distribution system to permit the design of samples to test each attribute involved. The database also facilitated the design of samples in a manner that enabled statistically valid observations regarding those attributes. The resulting database of Consumers distribution infrastructure represents more than 5,000 distribution circuits, 1.7 million poles, 1,200 substations, 2,300 substation transformers, 600,000 service transformers, and 6,000 conductor segments. In total, the database includes 20 tables, 650 data fields, and 2.5 million data records inventorying distribution infrastructure and capturing field sampling inspection data eventually amassed.

2. *Stratified Sampling Methodology*

Using this database capturing extensive detail about the distribution infrastructure of Consumers, we worked with expert statisticians to design a stratified statistical sample of infrastructure components, employing a statistically significant sample size. We identified distribution substations and poles (and associated conductor spans) as the two major asset classes we would examine physically for conformity to records and standards and for health and fitness for purpose condition.

Our statisticians developed a two-stage sampling approach for Consumers' distribution assets, accounting for the need to travel for field testing of physical assets. In the first stage, service centers were chosen as the primary sampling units based on probability proportional to size, meaning centers with more assets in the target subpopulation had a higher chance of selection. These service centers were selected with replacement, allowing them to be sampled independently more than once. Consequently, larger locations had a greater likelihood of being selected multiple times in the first stage. To ensure representation across Michigan, the first stage of substation sampling was stratified by the physical location of substations in the northern and southern regions of the state.

In the second stage, individual assets were sampled as secondary units from the service centers selected in the first stage. To address potential differences in asset age, the assets were stratified by age within their subpopulations at each service center. For example, a pole older than the median age of poles in its service center was grouped with other older poles from the same center in the same stratum.

This two-stage approach offers several advantages. First, it reduces the number of locations required for asset testing, which lowers both costs and travel time. Second, it maximizes the number of assets included in the overall sample. Ultimately, this design reduces administrative burden while enhancing the amount of information collected about the assets.

Sample size scenarios, for a range of point estimates, for Consumers’ poles and substations are presented in the following two tables:

Consumers Poles - Sample Size Scenarios

Population of Interest	Scenario	Point Estimate	Margin of Error (95%)	Lower Bound_95 (Point Estimate - Margin of Error)	Upper Bound_95 (Point Estimate + Margin of Error)
Poles	6-PSU, 108-SSU	9.5%	5.9%	3.6%	15.4%
		14.9%	5.9%	8.9%	20.8%
		19.5%	7.8%	11.8%	27.3%
	6-PSU, 144-SSU	9.4%	4.7%	4.7%	14.1%
		14.3%	6.6%	7.7%	20.9%
		19.1%	8.7%	10.4%	27.8%

Consumers Substations - Sample Size Scenarios

Population of Interest	Scenario	Point Estimate	Margin of Error (95%)	Lower Bound_95 (Point Estimate - Margin of Error)	Upper Bound_95 (Point Estimate + Margin of Error)
Substations	6-PSU, 60-SSU	0.0%	0.0%	0.0%	0.0%
		1.7%	4.3%	-2.6%	6.0%
		5.0%	8.8%	-3.8%	13.8%
	6-PSU, 108-SSU	0.9%	2.4%	-1.5%	3.3%
		2.8%	4.9%	-2.1%	7.7%
		4.6%	5.7%	-1.1%	10.4%

The recommended sampling plan specified the following point estimates for both poles and substations necessary to achieve a +/- 10 percent margin of error at a 95 percent confidence level:

- Substations: 60 to 108 Substations from at least six regions
- Poles: 108 to 144 Poles from at least six regions.

The statisticians applied a random sampling process (with replacement) to the data we collected describing these assets, producing a recommended stratified sample of substations and poles for field inspection. We provided the selected samples to Consumers to create the driving routes needed to complete field inspections of all sample items.

3. Attributes Tested

Following development of the sampling plan, we designed electronic sampling forms to support the collection of assessment data and photographs during the field inspection process. To evaluate conformity of assets in the field to Company records, we employed 10 attributes for substations and 26 attributes for poles. To assess condition, we inspected 24 pole attributes and 17 substation attributes. The following table lists the attributes that were tested through the physical inspection process.

Asset Attributes Sampled

Asset	Consistency with Records	Condition
Poles and Spans	Pole Tag Service Center Sub-transmission Circuit Primary Circuit # Phases Mainline/Lateral Voltage Additional Voltage Wye/Delta Front/Back Lot Substation Year Inspected Trim Cycle Last Tree Trim Installation Date Height Class Support Type Conductor Conductor Size Transformer # Switches # Fuses # Reclosers # Capacitors # Joint Users Attached	Conductor Sub-transmission Conductor Distribution Conductor Secondary Open Wire Secondary Triplex Vegetation Mgt Pole Equipment Cross arm and insulator Grounding Lightning Arrestors Transformers Switches Fuses Reclosers Capacitors Riser Cable Animal Mitigation Guy Wire Guy Wire Guard Streetlights Joint Users Attached Pole Base Pole Shaft Pole Top
Substations	Substation ID Installation Date HVD Voltage LVD Voltage # Transformers # Circuit Breakers # Batteries Battery Ages Battery Types Battery IDs	Transformers Circuit Breakers/Reclosers Fence and Gate Yard Yard Grounding Overhead Bus Insulators Switches Riser Cables Lighting Protection Animal Mitigation Batteries Oil Levels LTC/Regulator Control Building Control Relay Panels Other equipment as necessary

Our team of experienced inspectors conducted the field inspection and documented the results of that inspection in our database. The following sections describe the results.

B. Findings

1. Pole Inspection Results

In late May and early June 2024, we inspected 144 Consumers poles for consistency with records, condition issues, and safety issues. These inspections included the spans associated with the poles involved. Consumers has attached pole number tags on each pole and identified the locations of each pole in its GIS, making easy location of poles for these inspections and when needed for engineering and field operations activities. The next table shows the number of poles and percentages of those inspected for which we found issues. Some poles exhibited issues in more than one category.

Results of Consumers Pole Inspections

Measure	Records Mismatch	Condition Issues	Safety Issues
Numbers of Poles	10	8	4
Percentage of Poles Inspected	7%	6%	3%

a. <u>Pole Records Matching</u>

We found the following records issues, detailed in the following table:

- 2 poles with missing or unreadable pole identification number tags
- 5 poles replaced but without recording the replacements
- 1 pole with a recloser added without recording the addition
- 1 pole with unrecorded attachments
- 1 pole with three fuses for which the records showed one fuse.

Mismatches with Consumers' Pole Records

Pole #	Headquarters	Mismatch
0665358	Cadillac	Shows one fuse rather than 3 fuses
0863453	Cadillac	Record did not indicate attached joint use
0567977	Cadillac	Record did not indicate new recloser
0490885	Cadillac	Shows 1940 pole – Pole is new
0127684	Cadillac	Shows 1955 pole – Pole is new
0811683	Cadillac	Shows 1948 pole – Pole is new
1066438	Hamilton	Shows 1950 class 6 pole – Pole is new class 5
0955694	Lansing	No pole tag, shows 1967 pole – Pole is newer
0029757	Lansing	Cannot read tag
1663128	South Monroe	Record did not indicate attached joint use

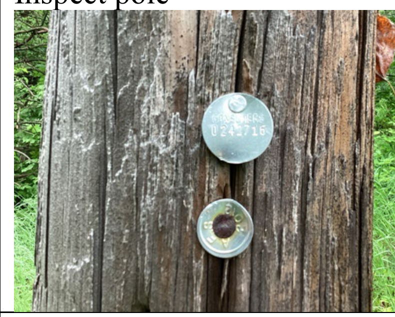
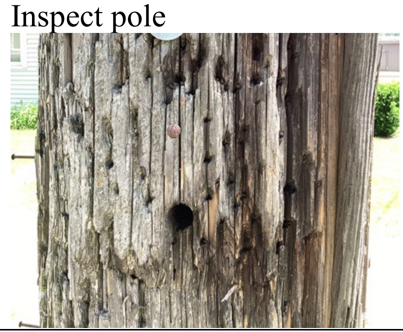
Our inspections identified no other records mismatches related to primary and secondary conductors, attachments, and circuit voltages.

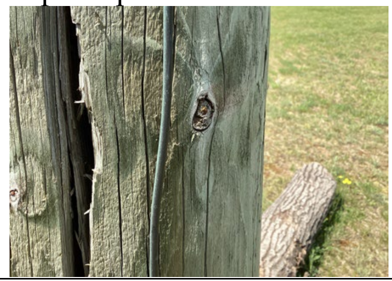
b. *Pole Conditions Needing Attention*

Our inspections identified eight poles whose condition warranted near term attention, as the following table summarizes:

- 2 poles Consumers should re-inspect before considering replacing
- 5 poles that should be replaced
- 1 pole whose span should be inspected for trimming.

Consumers Poles Conditions Needing Attention

Pole #	Headquarters	Pole Condition	Photo
0242716	Cadillac	Minor cracks in 1989 pole	Inspect pole 
0569583	Cadillac	Deep split in 1940 pole	Replace pole 
1264988	Cadillac	Shaft is deteriorated in 1940 pole	Inspect pole 
0863453	Cadillac	Span needs trimmed	Inspect; trim as required 

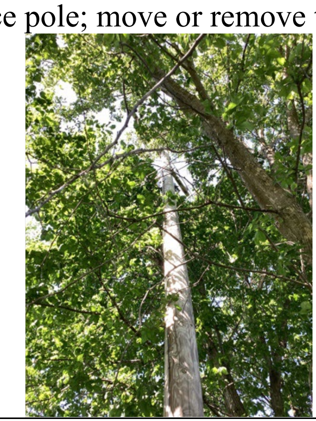
1182242	Cadillac	Large deep split in 2007 pole	Replace pole 
1037874	Hamilton	Pole base has shell rot in 1939 pole	Replace pole 
1307060	Hamilton	Pole base has shell rot in 1960 pole	Replace Pole 
1378995	Lansing	Split in 1990 pole	Replace pole 

c. *Pole Safety Issues*

We found the following safety issues, which the next table summarizes:

- 3 poles missing guy guards that increase wire visibility to the public
- 1 pole with de-energized service wires on the ground
- 1 transformer pole with a split shaft surrounded by a tree, creating an energized tree shock hazard.

Pole Safety Issues Needing Attention

Pole #	Headquarters	Condition	Issue	Photo
0527099	Big Rapids	Missing guy guard	Need for public to see guy wire	
0863453	Cadillac	Missing guy guard	Need for public to see guy wire	
0343101	Hamilton	Pole with de-energized service wires on the ground	Safety issue	
1378995	Lansing	Transformer pole surrounded by tree	Shock hazard	Replace pole; move or remove tree 

2. *Substation Inspections*

In late May and early June 2024, we inspected 77 Consumers substations for consistency with company records, condition, and safety. The next table shows the number of substations and percentages of those inspected for which we found the following issues. Some substations exhibited issues in more than one category.

Results of Consumers Substation Inspections

Measure	Records Mismatch	Condition Issues	Safety Issues
Number of Substations	4	15	5
Percentage of Total Inspected	5%	19%	6%

a. Substation Records Matching

We found records matching issues at only four substations, which the following table summarizes. Another three mismatches preliminarily identified were confirmed as matching after further review.

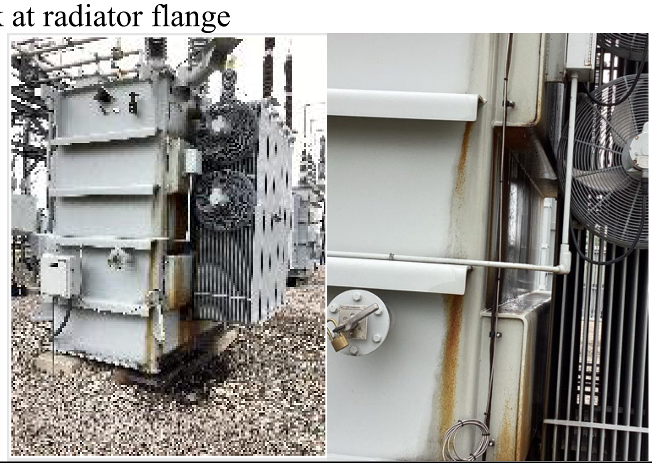
Mismatches with Consumers' Substation Records

Name	Headquarters	Mismatch
Wealthy Street	Grand Rapids	Voltage on record incorrect
Diesel	Grand Rapids	2 actual transformers; records show 1
Bayberry	Grand Rapids	4 actual regulators; records show 3
Stevens	Grand Rapids	5 actual regulators; records show 3

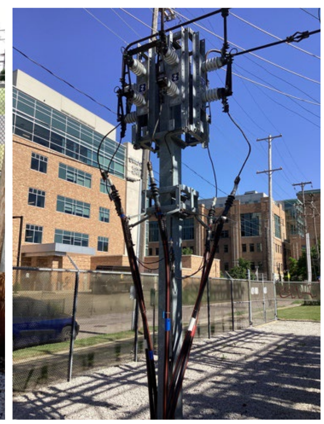
b. Substation Conditions Needing Attention

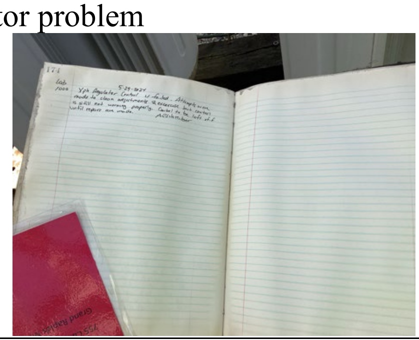
Principal elements of our substation condition reviews included gates, fencing, yards, buses, switches, reclosers, circuit breakers, transformers, regulators, control buildings, batteries, and relay panels. We found Consumers substations in good condition. However, we found minor issues at fifteen substations that Consumers should address. The next table lists the substations with conditions that require attention.

Substation Conditions Needing Attention

Headquarters	Condition
Grand Rapids	Active oil leak at radiator flange 

Kalamazoo	Fan bearing noise; broken pressure and temperature gauges 
Kalamazoo	Switch red lamp not lit; may indicate trip coil issue
Muskegon	Signs of overheating at some point. No hotspot noted at this time. 
Grand Rapids	Apparently inactive oil leak requires cleanup 
Greenville	Fence gap and dead squirrel require fencing correction or animal guard 

Muskegon	Transformer #1 temporary oil cooler is tagged 
Kalamazoo	Needs animal fence guarding and stone at telecom gated area
Kalamazoo	Animal guard needs reset 
Kalamazoo	Vegetation; unraveled feeder; animal guarding; tank pressure gauge glass broken    

Grand Rapids	No animal guards on regulators 
Greenville	No fence animal guarding 
Grand Rapids	Tx #1 LTC low slightly low, fence missing animal guard, overgrown vines   
Grand Rapids	Logbook shows regulator problem 

Coldwater	Need more crushed stone at gate 

c. *Substation Safety Issues*

We inspected all assets in the substations for safety issues. We identified two minor signage issues, two fence grounding issues, and two needing guarding/securing energized area issues. The next table summarizes our findings.

Substation Safety Issues Needing Attention

Headquarters	Issue
Grand Rapids	No substation name visible to make public aware for emergencies 
Muskegon	Ungrounded barbed wire fence
Grand Rapids	Energized cable termination touchable; ungrounded gate 

Greenville	No substation name visible to make public aware for emergencies 
Kalamazoo	Unlocked customer grounding resistor enclosure and no barbed wire 

C. Observations

1. Field inspections did not identify recurring issues in Consumers' company records, asset conditions, or safety, indicating generally satisfactory conditions.

Inspections disclosed several specific issues that management can promptly address without major delay or resource additions. However, they do not provide indication of a system poorly reflected in records, lacking fitness for intended use, or generating widespread public or employee safety risks. Our use of a sampling approach makes it appropriate, however, for management to examine their nature and extent more substantially and to plan and execute solutions proportionate to the underlying issues.

Summary Inspection Results

Asset Inspected	Records Mismatch		Condition Issues		Safety Issues	
	Number	%	Number	%	Number	%
Substations	4	5%	11	14%	5	6%
Poles & Spans	10	7%	8	6%	4	3%

2. We found no issues requiring major, systematic response, but observed relatively marginal change needs.

Circuit Planners should conduct post storm reviews to ensure up-to-date records following storm work to address records mismatches. Consumers should include guy guard inspection in circuit inspections and ensure prompt follow-up to address any missing or damaged guards.

3. A moderate number of GIS pole records have not been updated to reflect recent pole replacements.

We identified nine mismatches out of the 144 poles inspected, primarily related to recently replaced poles or installed equipment. Consumers indicated that prompt updates are not always completed for poles replaced by contractors performing storm work.

4. The observed rate of poor pole conditions requiring management attention was low.

We did not find what we would consider high numbers of poles with material condition issues. Vegetation conditions showed few exceptions as well.

5. We did not observe significant numbers of safety issues involving poles.

We did observe one issue that created the potential for an energized tree in the vicinity of a house.

6. We found very few mismatches in Consumers' substation records.

Exceptions included a mismatch of records in 4 of 77 substations reviewed.

7. The substations reviewed exhibited significantly better conditions than we have often found.

We observed a high standard of maintenance across the substations, including well-grounded fences and gates, Plexiglas barriers on fencing to prevent animal intrusions, proper crushed stone coverage, and the absence of vegetation encroachment or debris. Oil levels and transformer gas blanket pressures were well-maintained, with no significant active oil leaks or signs of past leaks, and the paint was generally in good condition. However, we did note a few minor issues, such as one active oil leak, some missing animal protection, and an unlit indicator lamp. The only major safety concern we identified was insufficient clearance around energized exit cable terminations.

Chapter V – Field & Stores Inventory

A. Background

This chapter reviews Consumers' method for recording its installed assets inventory and reviews how it manages its asset stock inventory. It addresses our examination of stores locations and materials and equipment housed there.

B. Findings

1. Asset Field Inventory

Consumers uses its Geographic Information System ("GIS") to store circuit asset data and locations, and CASCADE to record substation asset data. A comprehensive and accurate GIS is crucial for understanding capital plant and for the effective use of the ADMS in monitoring and controlling the electric systems. Consumers can precisely identify 100 percent of its HVD assets and approximately 85 percent of its overhead and underground LVD assets using GIS. The utility is working to complete the remaining 15 percent by finalizing the GIS data collection for its underground and Metro systems.

Consumers integrated most of its electric grid assets into its GIS between 2005 and 2008. From 2018 to 2021, the company conducted a field inventory to update and collect new assets. It transitioned its pole assets from a Computer Aided Design ("CAD") program to the GIS, which is now used for managing circuit asset inventory. GIS Technicians, part of the Electric Distribution Support group within the Consumers Electric Distribution Analytics Department, oversee the GIS data, handling updates, modifications, and deletions based on field-completed design documents.

2. Inventory of Spare New Stock

The Company uses its formal Supply Chain Planning and Inventory Analytics Procedure 0001 - Inventory Optimization Procedure for guiding its inventory planning and optimization. Inventory Analysts review and monitor inventory opportunities and appropriate inventory levels, using SAP software, based on usage, predictability, and criticality; and maintaining optimized levels of inventory necessary to meet forecasted demand within desired levels of risk to meet needs required to provide continuity of supply for electric service. The Company monitors levels of critical spares based on needs for service restoration, continuity of service, and maintaining system grid integrity. Examples of critical spares include service transformers, isolating transformers, and wood poles. Inventory control is managed by the Supply Chain and Shared Services Field Operations organizations.

The Company's SAP program generates inventory stock transfers to field operations based on either manual entry or by SAP generated work order reservation, which then generates need for procurements by automatic triggering when stock supply is diminished. SAP monitors the effect of transfers on stock supplies and when stock is physically received in the field. SAP automatically generates reports.

Consumers' Inventory Analysts, business owners, and Subject Matter Experts annually review inactive and excess materials from inventory using a formal process to determine whether material should be kept in inventory. This process permits identification of salvage value and resulting write-offs.

3. *Stores Inventory*

The Grand Rapids and Jackson Headquarters house the Materials Distribution Centers, which receive and then distribute the materials to the 30 Headquarters storerooms and yards. Consumers' vendor Powerline Supply's facility at Reed City houses some HVD materials. Some meters are stored at Consumers' Meter Technology Center because meter configuration occurs before distribution to storerooms. New assets, including substation transformers, undergo inspection at the Alma facilities before distribution to other storerooms. Consumers' Supply Chain has arrangements with transformer and conductor suppliers to reserve production slots and to expedite resupply to replenish inventory during catastrophic events.

The next table shows that power transformers and wire make up most of the value of stored electric equipment as of November 2023.

Electric Inventory Stock as of 11/14/2023

Equipment	Value	Quantity	Equipment	Value	Quantity
Bushings	$722,567	457	Crossarms	$1,096,533	9,120
Circuit Breakers	$1,101	12	Poles	$3,303,574	3,785
Circuit Breakers	$2,213,113	710	Wire	$20,140,446	14,914,305
Cutouts	$2,071,807	26,283	Overhead Transformers	$10,129,756	7,780
Insulators	$770,929	33,738	Padmount Transformers	$2,745,877	974
Padmount Equipment	$660,097	1,449	3-phase Transformers	$2,897,164	
Power Transformers	$25,172,052	81	Isolators	$3,548,165	
Total	**$75,478,181**				

Consumers operates two main materials distribution centers, at the Jackson (East) and Grand Rapids (West) service centers. These larger distribution centers further supply the storerooms and storage yards at other smaller Headquarters. When necessary, stock moves from one Headquarter to another.

We visited the Cadillac service center and the Jackson distribution center and interviewed the Supply Chain Director and Distribution Center Managers. The local pole supplier has reportedly had sufficient pole stock from which to transport poles to work sites directly during storm restoration work. The storerooms and outside storage yards contained substantial numbers of new undamaged transformers, poles, and other stock. See the photographs below. All stock items observed were in new condition and marked for inventory control.

Consumers Service Center and Distribution Center Photographs

Cadillac storeroom

Cadillac stored poles

Cadillac stored poles

Cadillac service and isolator transformers

Jackson Distribution Center

Several long corridors of materials

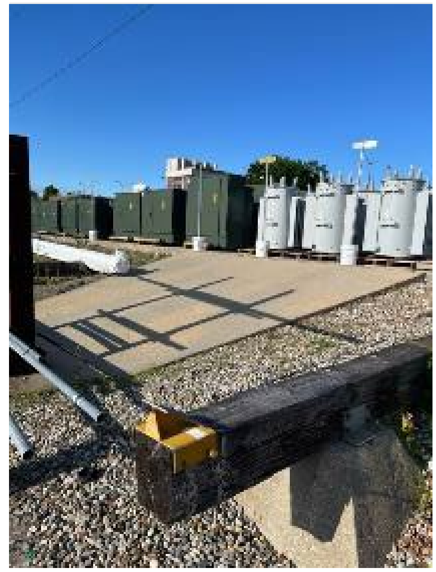
Jackson wire, transformers, switches

Jackson secondary pole yard

Jackson transformers

Jackson padmount transformers


Reels of wire


Transformers

Consumers stores the bulk of inventory at the Jackson and Grand Rapids Material Distribution Centers, but each Headquarter storeroom and yard has a share of inventory. Substation asset inventory is held at Jackson and Alma. Consumers stocks only class 2, 3, and 4 poles in pole yards at the two material distribution centers and at the 30 headquarters. These poles do not include those held off-site for restorations and upcoming projects. Poles held recently included:

- 1,009 Class 2 poles ranging from 40 feet to 65 feet
- 1,457 Class 3 poles ranging from 40 feet to 60 feet
- 695 Class 4 poles ranging from 35 to 40 feet.

Consumers recently stocked 12,567 service transformers ranging from 25kVA to 500kVA, 414 isolating transformers ranging from 100kV to 500kVA, and 345 voltage regulators.

C. Observations

1. Consumers makes typical use of its GIS for recording circuit data and location and uses CASCADE to record installed substation asset data; ongoing work to complete recording of underground and Metro GIS records is sound.

Use of a comprehensive GIS proves essential for managing capital assets and effectively using the ADMS for monitoring and controlling electric systems. Consumers has accurately identified 100 percent of its HVD assets and about 85 percent of its LVD assets, with efforts underway to complete the remaining 15 percent for underground and Metro systems.

2. Consumers supply chain methods, including procurement, stock storage, and stock distribution, contain all elements necessary to effectively ensure stock availability when and where needed, that the stock remains in good condition, and that damaged or obsolete stock is economically salvaged.

The SAP program manages inventory stock transfers to field operations, either through manual entry or work order reservations. It automatically triggers procurement when stock levels are low, monitors stock supply and receipts and generates reports. All stock items observed were in new condition and marked for inventory control.

3. Our review of storeroom and storage yard found stock plentiful and in good condition.

We reviewed the Grand Rapids and Jackson Materials Distribution Centers, which receive and then distribute the materials to the 30 Headquarters storerooms and yards. We found sufficient stock of good quality available for distribution.

4. The substantial numbers of poles, service isolating transformers, and regulators appeared appropriate for storm responses.

We visited the Cadillac service center and Jackson distribution center, interviewing the Supply Chain Director and Distribution Center Managers. The local pole supplier maintained sufficient stock for direct transport during storm restoration. The storerooms and storage yards held ample new, undamaged transformers, poles, and other supplies.

Chapter VI – System Comparisons

A. Background

This chapter compares the distribution system of Consumers with two similarly situated utilities—Ameren Illinois Company ("AIC") and Commonwealth Edison Company ("ComEd") and two Michigan-based utilities, DTE Energy ("DTE") and Lansing Board of Water & Light ("LBWL"), Michigan's largest municipal utility. The comparison focuses on system characteristics, including asset ages, overhead and underground miles, and customer density. It also examines the levels of operation and maintenance ("O&M") and capital expenditures ("CapEx") for each utility.

B. Electric Distribution System Comparison

The table below compares the number of residential, commercial, and industrial customers across the five utilities. ComEd is the largest utility in this group by customer count, while LBWL is the smallest. Consumers is similar in size to AIC and has a comparable mix of customer types. DTE Energy and ComEd both serve large urban and suburban areas, but DTE serves a significantly higher number of industrial customers. The following table provides a detailed breakdown of the customer numbers for each utility.

Numbers of Customers by Type

Customer Type	Consumers	DTE	AIC	ComEd	LBWL
Residential	1,648,148	1,996,956	1,061,975	3,713,755	97,933
Commercial	225,402	204,822	166,436	395,530	12,906
Industrial	1,905	67,162	965	1,887	96
Total	**1,875,455**	**2,268,940**	**1,229,376**	**4,111,172**	**110,935**

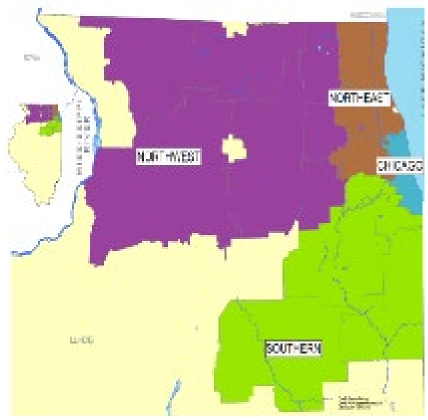
We selected AIC and ComEd as comparator companies due to their relevance and regional similarities. AIC was chosen for its coverage of most of central and southern Illinois and because it shares some infrastructural characteristics with Consumers' service area, despite differences in asset conditions and the absence of ungrounded delta circuits. While AIC and ComEd experience wind, ice storms, and tornadoes, they are not subject to the lake-effect weather that impacts Michigan, where Consumers operates.

LBWL was included in the comparison due to its notable reliability improvements over the past decade, achieving top quartile rankings in SAIDI, CAIDI, and SAIFI metrics among IEEE utilities. The next chapter includes comparisons of these metrics across each of the five utilities for which we made comparisons. Liberty engaged with LBWL personnel, who were receptive and cooperative in providing necessary data. The following table highlights the differences in overhead and underground distribution circuits across the utilities' service areas, followed by a brief overview of each comparator company.

Comparison of Circuit Miles in Service Territory

Circuit Miles	Consumers	DTE	AIC	ComEd	LBWL
Overhead Distribution Miles	51,574	28,548	32,048	34,648	2,126
Overhead Distribution %	84%	687%	82%	52%	70%
Underground Distribution Miles	9,630	13,357	7,311	31,982	919
Underground Distribution %	16%	32%	19%	48%	30%
Total	**61,204**	**41,905**	**39,359**	**66,630**	**3,045**
Service Territory (square miles)	28,300	7,600	67,700	11,428	97

Commonwealth Edison



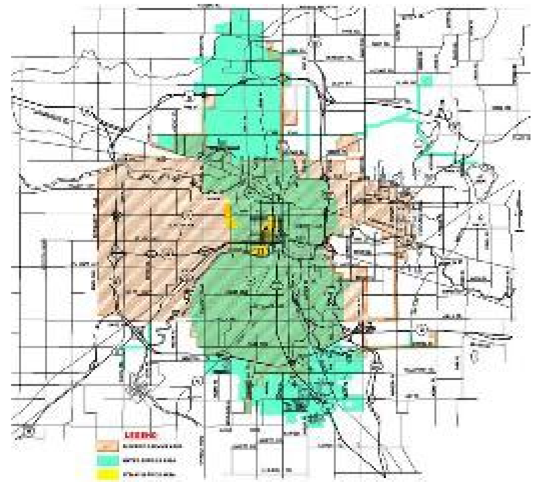
- Illinois's largest electric utility with 4.1 million customers
- Serving Urban Chicago and surrounding suburban areas
- 11,428 miles[2] of service territory,
- 66,630 circuit miles
- 52 percent Overhead, 48 percent underground
- 32 percent Urban, 59 percent Suburban, 9 percent Rural
- 4 regions – Chicago, N, S, NW
- Chicago and North regions have highest circuit mile densities

Ameren Illinois

- 1.2 million customers
- Largely rural, overhead construction distribution system
- Average customer density 31 customers per circuit mile – mix of towns and farms
- 35 percent of sub-transmission and 25 percent distribution circuit miles require vegetation management
- 4 regions – N, S, E, W
  - o North serves 4 of top 5 largest city metro areas in Illinois
  - o South & West – hilly riparian area
  - o East – least circuits and lowest density

Lansing Board of Water & Light

- 111,000 electric customers, 58,000 water customers
- Provides electric, water, steam, and chilled water
- Largest municipally owned utility in Michigan
- 71 miles of transmission lines
- 2,126 circuit miles of overhead distribution
- 919 circuit miles of underground distribution



LBWL reported that it serves no rural areas. The LBWL electric system comprises 138kV transmission, 69kV subtransmission, and 13.2kV and 4.16kV circuits. It operates 31,215 poles and 637 miles of 13.2kV and 4.16kV overhead distribution circuits, with 15 percent of these being 4.16kV. Additionally, it has 360 miles of underground cables, including 215 miles in ducts and manholes, some of which are 100-year-old lead sheath Paper Insulated Lead Covered ("PILC") cables. The remaining distribution cables are direct buried, located in both front and rear lots. LBWL's mainline circuits are radial but feature two feeds and at least three circuit tie points. The utility has nearly completed updating its asset data in its GIS, which includes information on streetlights and trees. LBWL also manages 1,400 manholes and numerous vaults.

C. Distribution System Asset Ages

ComEd's distribution infrastructure is notably aged. As of 2020, the median age of its copper overhead distribution conductors was approximately 66 years, with over 40 percent of these conductors exceeding this age. The median age of ComEd's direct buried underground residential distribution (URD) cable was about 23 years. Additionally, the median age of ComEd's wood poles had risen to around 49 years, with approximately 370,000 poles over 60 years old and about 110,000 exceeding 70 years. Around 43 percent of ComEd's 12kV transformers, 21 percent of its 34kV transformers, and 40 percent of its 69kV transformers were over 60 years old, with some transformers surpassing 90 years. Approximately 16 percent of all circuit breakers were over 60 years old, including about 70 of the 4/12kV breakers, primarily in the Chicago and North Regions, which were over 90 years old.

A significant portion of AIC's assets have unknown ages, including materials purchased in bulk or lacking identifiable units or serial numbers, such as primary wire, cable, crossarms, and poles. AIC's system, which includes more than 1.25 million poles, 63 percent have an unknown age. For those with known ages, 9 percent are 60 years or older, suggesting that approximately 113,000 poles could be at least 60 years old. From 2012 to 2020, AIC replaced or installed an average of about 20,000 poles annually. In contrast, AIC has better data on the age of its major substation equipment. About 19 percent of substation transformers and 29 percent of substation breakers were over 60 years old as of 2020. The newer substation reclosers, known as "Vipers," range from 0 to 20 years old.

Known equipment ages between AIC and Consumers are similar; Consumers has a slightly greater percentage of poles and substation transformers more than 60 years old. Neither company determines when to replace assets based only on age.

D. Inspection & Maintenance Practices

Consumers' circuits are, on average, twice as long as AIC's and are in a state with more extensive forest coverage. Consumers, ComEd, and AIC employ similar inspection and maintenance practices and rely on the results of these inspections, tests, and operational issues. They use a health and risk score ranking method to determine when major assets should be replaced, rather than relying on average asset ages for replacement.

Comparison of Primary Circuits, Poles, Service Transformers, and Forest Coverage

Item	Consumers		ComEd		AIC		LBWL	
	Total	*%UG*	*Total*	*%UG*	*Total*	*%UG*	*Total*	*%UG*
Circuit Miles	61,204	16%	66,630	48%	39,359	19%	3,045	30%
No. Circuits	2,387		5,629		2,472		-	
Avg Miles per Circuit	26 miles		12 miles		16 miles		-	
Customers per circuit mile	31		62		31		32	
% Rural Circuits	39%		9%		48%		0%	
# Substations	1,182		810		966		22	
# Poles	1.75 million		1.4 million		1.3 million		31,000	
% Poles over 60 Years	12%		26%		9%		-	
% LVD (5kV) Substation Transformers > 60 years	<1%		43%		33%		-	
% HVD (15kV) Substation Transformers > 60 years	13%		40%		12%		-	
#Service Transformers	650,000		506,552		375,983		-	
Statewide % Forest	54%		-		14%		-	

1. Underground Assets

AIC and Consumers replace direct buried underground cable after three failures. Both utilities regularly inspect manholes, vaults, cable splices, padmount transformers, and switchgear. However, only Consumers performs injection of direct buried LVD cable. DTE does not perform injection either.

LBWL inspects and repairs its manholes and vaults by taking 360-degree photographs of their interiors. The utility plans to document all work done in these areas to update the original data. When replacing old brick-walled manholes or installing new ones, LBWL uses pre-cast units and upgrades old 4-inch conduits to 5-inch conduits.

2. *Inspection and Tree Trim Cycles*

LBWL conducts overhead distribution inspections every two years, which include thumping poles with a hammer to detect internal voids and boring to measure shell thickness if voids are found. These inspections also incorporate infrared and corona inspections to identify hot connections and radio noise issues.

For pole replacements, LBWL uses class 3 and class 4 poles for street applications and class 5 poles only for backlots. The utility is upgrading its class 3 sixty-foot poles to class 1 and 1H poles. Cables, which account for 49 percent of customer interruption minutes, are a significant factor in CAIDI. While LBWL is replacing outdated 100-year-old PILC cables, it does not yet have a proactive replacement program for PILC or early URD cables prone to failure. However, its specification of 133 percent insulation level has minimized URD cable failures. LBWL ensures there is no backlog in cable repairs, promptly addressing trunkline failures and delaying repairs on direct-buried URD cables only for a few days. Ten years ago, LBWL used insulating fluid injection on URD cables, and none of these cables have since failed.

The following table shows that Consumers' 2-year LVD inspection cycles and pole strength testing are more rigorous than AIC's 4-year cycle for circuits and 12-year cycle for pole strength. Consumers inspections and pole strength testing are also more rigorous than ComEd's 2-year mainline/4-year lateral taps cycle and 10-year pole strength cycles. However, Consumers' extended tree trimming cycles fall short compared to AIC's and ComEd's 4-year cycle and LBWL's 5-year cycle. AIC, ComEd, and LBWL have successfully met their trimming cycle targets, while Consumers' targeted 7-year overall tree trim cycle is currently at nearly 10 years.

Comparison of Overhead Inspection and Tree Trim Cycles

Item	Consumers	AIC	ComEd	LBWL
Distribution Circuit Inspections	2-year	4-year cycle	Mainline 2 years Lateral taps 4 years	2-year
Subtransmission Circuit Inspections	Annual	Annual	Annual	2-year
Pole Strength Testing Distribution	2- year (suspect poles only)	12-year	10-year	2-year
Pole Strength Subtransmission	12-year	12-year	10-year	2-year
Distribution Tree Trim Cycles	5-7-9-year cycles	4-year	4-year	5-year

ComEd employs a groundline pole inspection program on a 10-year cycle to maintain its aged wood pole plant and has implemented a new practice of replacing weak poles, and installing all new poles, with poles having greater diameter (stronger) than the poles it historically installed.

LBWL attributes its SAIDI improvements since 2014 to the implementation of a 5-year tree trimming cycle for its distribution system. Initially, public resistance to tree cutting and removal was a concern, but this opposition has diminished as reliability has improved. In 2014, LBWL faced significant storm damage due to inadequate tree trimming, prompting the utility to establish a 5-year cycle for distribution trees and expand its tree management resources.

At the time, LBWL identified the absence of a cyclic tree trimming program as the primary cause of the storm damage. With only two in-house crews available for addressing urgent tree issues, LBWL recognized the need for a more systematic approach. As a result, the utility implemented a 5-year tree trimming cycle for its distribution system, a 3-year cycle for its transmission system, and now utilizes an increased number of tree contractors. They maintain standard clearances for transmission and distribution lines, including removing overhanging limbs on distribution circuits and trimming from ground to sky on transmission circuits. LBWL has secured a first right of refusal contract with its vendor for year-round tree crews dedicated to cycle work, plus three in-house crews for non-cycle tasks. For storm response, LBWL can mobilize additional tree crews from its vendor, assigning two crews per line crew. The trimming cycle is organized by city quarter sections rather than individual circuits.

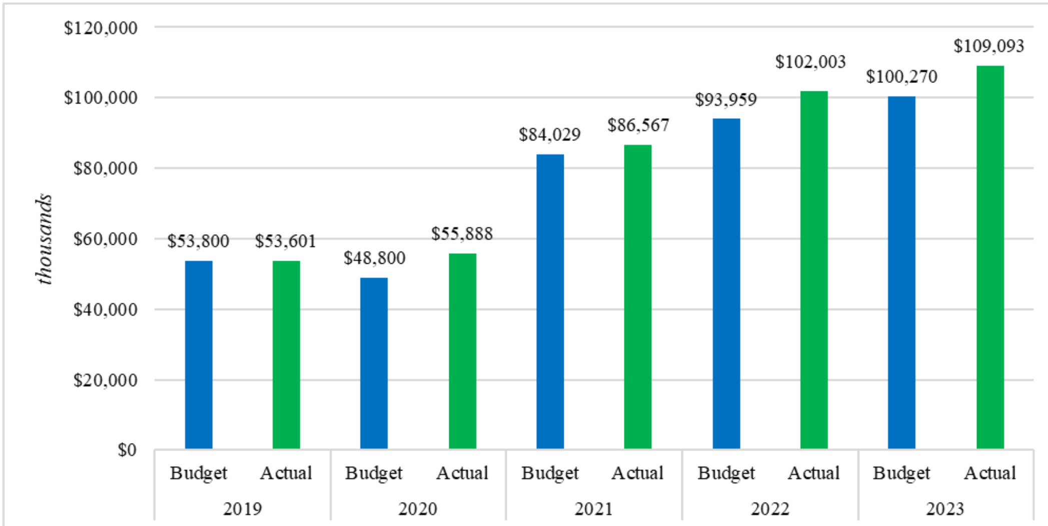
LBWL has finished two 5-year cycles, with the second cycle being less expensive than the first due to the extensive work completed during the initial cycle. The first enhanced cycle cost around $46 million, while the second cycle cost approximately $23 million due to COVID-related pricing.

LBWL has chosen not to implement distribution automation on its system. Instead, it has achieved IEEE 1st quartile performance by focusing on the primary cause of outages, trees. For example, the storm that struck Michigan on July 1, 2024, affected about 10 percent or 188,000 Consumers' customers and a very low number of LBWL's customers. The utility's aggressive tree trimming efforts have significantly reduced infrastructure damage and improved metrics such as SAIDI, CAIDI, and SAIFI.

3. *Comparing Forestry Spending*

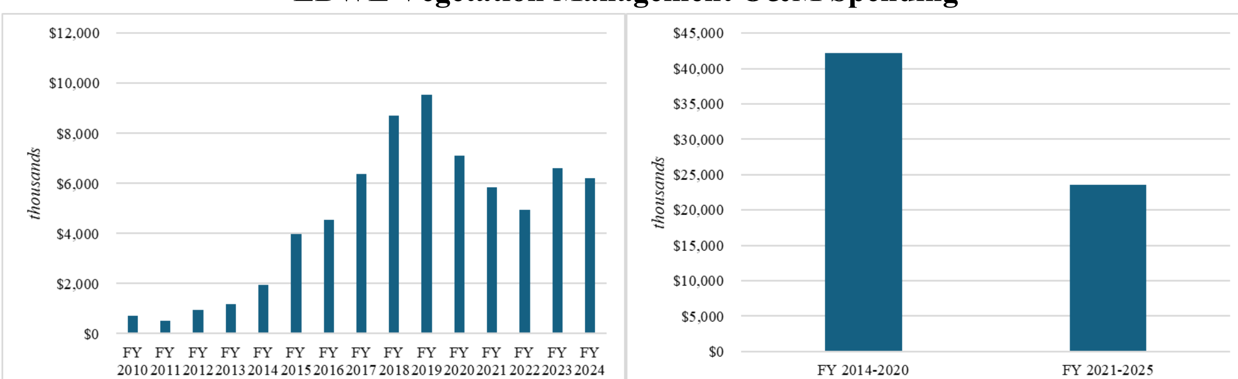
AIC's vegetation management costs increased gradually to $62 million in 2019, then surged to $132 million in 2020 as the company aimed to achieve its 4-year LVD tree trimming cycles. By 2022, AIC had fully completed its latest 4-year cycle. However, its 2023 vegetation management spending decreased to $37 million. ComEd spent $104 million in 2020 to maintain its 4-year trim cycle. Consumers has been steadily ramping up its forestry spending to reach its targeted 5-7-9-year trim cycles. Additional details on tree trimming cycles are discussed in Part 2 of this report.

Consumers Forestry O&M Spending



LBWL vegetation management spending increased significantly following their storm in 2014, peaking in 2019. The following charts show annual and 5-year cycle costs.

LBWL Vegetation Management O&M Spending



4. *Consumers Energy and DTE Energy Historic Capital and O&M Summary*

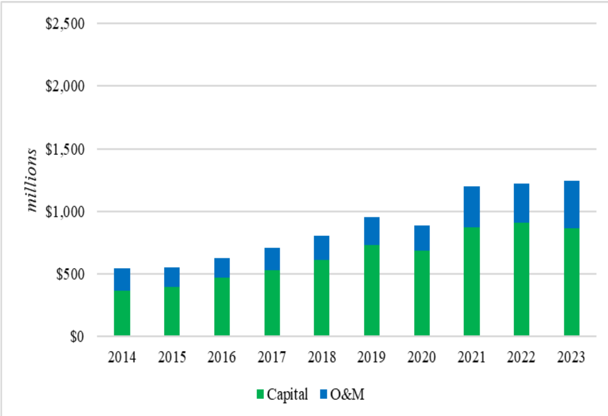
Consumers and DTE provided data that aligned their historical capital and O&M expenditures with their projected expenditures in their distribution plan. The following summary analyzes the historical portion of that analysis, using 2014 as a starting point, the earliest year for which DTE could produce data that aligns with its distribution plan capital and O&M categories. This data shows overall expenditure level changes in nominal dollars. Later portions of this chapter normalize these same values by each Company's customer numbers, to place these overall values in context and to permit more direct comparisons.

a. *Total Capital and O&M Summary*

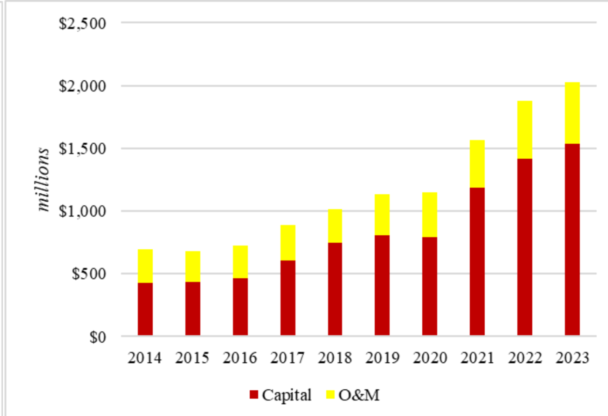
The following chart summarizes the total capital and O&M expenditures by Consumers and DTE.

Consumers and DTE Historic Capital and O&M Comparison *(millions)*

Consumers



DTE



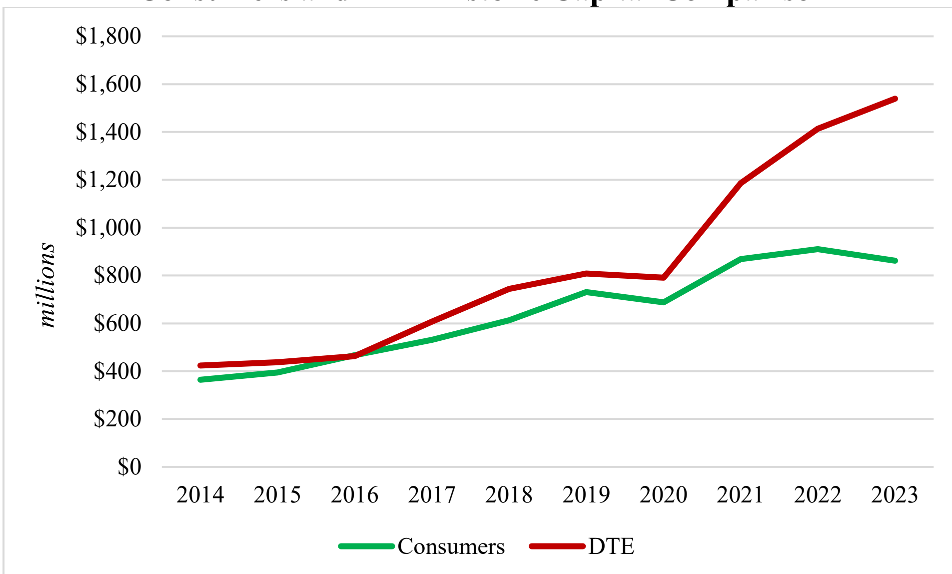
Each company has increased total expenditures substantially over the past 10 years. Consumers expenditures increased from a five-year (2014 through 2018) total of $3.2 billion to $5.5 billion over the five years that followed, an increase of 70 percent. DTE's expenditures increased by over 100 percent across the same five-year periods. The following table summarizes these comparisons and compound annual growth rate ("CAGR") calculations for each company's expenditures. The CAGR calculations show Consumers rate of expenditure growth approaching 10 percent and DTE's growth approaching 13 percent.

CAGR Summary – Capital and O&M

Company	Dollars *(millions)*			CAGR		
	2014-2018	2019-2023	2014-2023	2014-2018	2019-2023	2014-2023
Consumers	$3,227.7	$5,499.6	$8,727.3	10.4%	6.9%	9.7%
DTE	$3,999.3	$7,752.2	$11,751.5	10.0%	15.7%	12.7%

The following table and chart report the capital expenditure amounts of each Company over the same historical period.

Consumers and DTE Historic Capital Comparison



Company	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Consumers	$364.1	$394.7	$466.4	$531.2	$612.3	$730.7	$687.9	$868.1	$910.1	$861.3
DTE	$423.6	$436.8	$462.9	$607.0	$744.4	$808.4	$791.2	$1,186.5	$1,413.7	$1,539.1

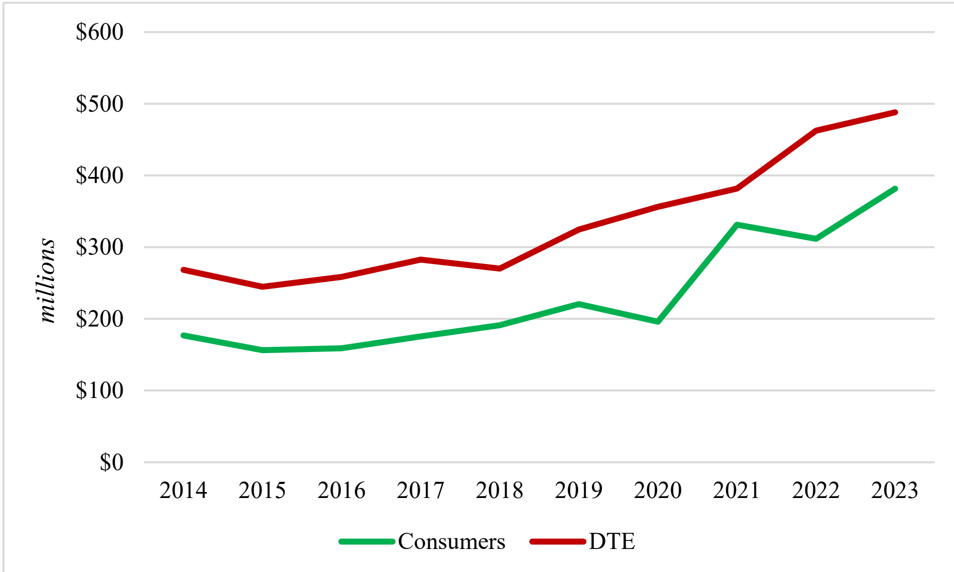
millions

Each Company's capital expenditures grew substantially over the 10-year period: Consumers by 71 percent and DTE by 115 percent. CAGR calculations show Consumers capital expenditure growth of 10 percent per year and DTE increases exceeding 15 percent per year.

CAGR Summary – Capital

Company	Dollars *(millions)*			CAGR		
	2014-2018	2019-2023	2014-2023	2014-2018	2019-2023	2014-2023
Consumers	$2,368.8	$4,058.1	$6,426.9	13.9%	4.2%	10.0%
DTE	$2,674.7	$5,738.8	$8,413.6	15.1%	17.5%	15.4%

Consumers and DTE Historic O&M Comparison



Consumers O&M expenditures grew substantially over the 10-year period, with 2019 through 2023 amounts exceeding the amounts of the previous five years by 68 percent; the corresponding DTE growth rate proved high as well, at 52 percent. CAGR calculations indicate similar growth patterns in Consumers and DTE O&M expenditures over the period, with amounts for each Company growing moderately during the 2014 through 2018 period before increasing substantially in the subsequent five-year (2019 through 2023) period.

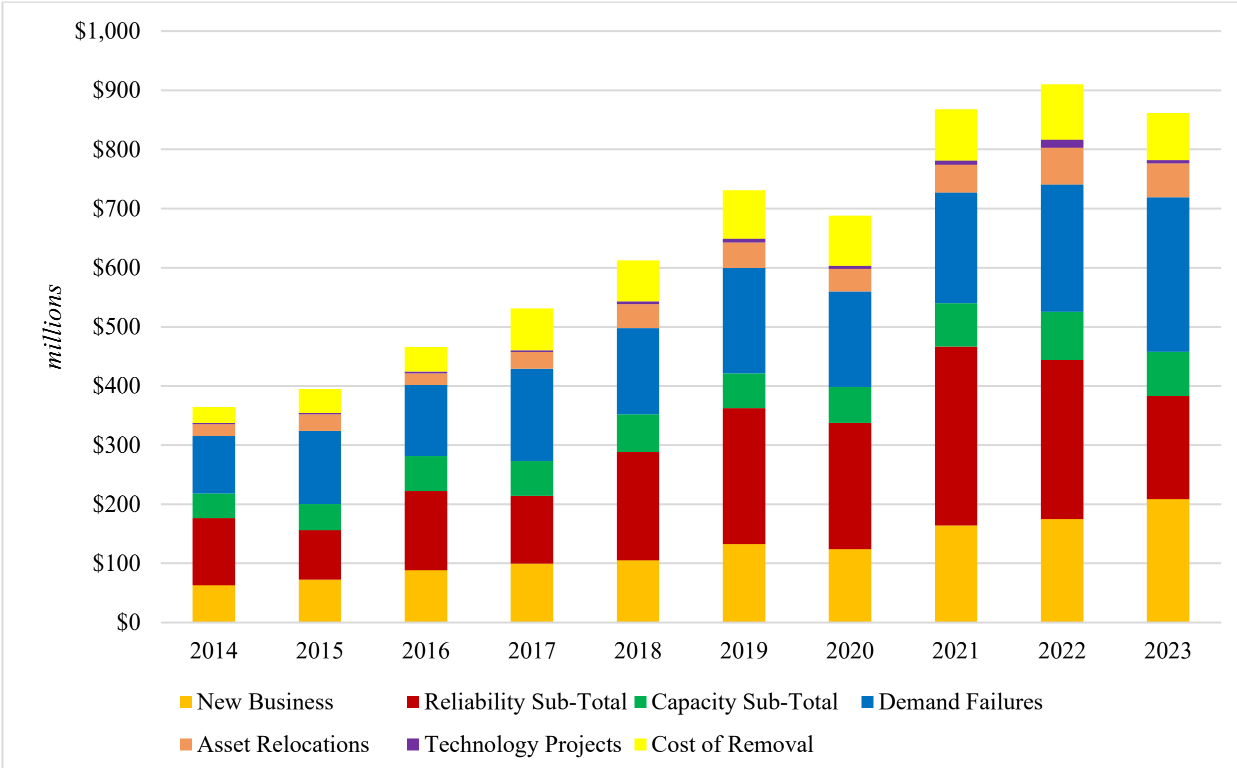
CAGR Summary – O&M

Company	Dollars *(millions)*			CAGR		
	2014-2018	2019-2023	2014-2023	2014-2018	2019-2023	2014-2023
Consumers	$858.9	$1,441.5	$2,300.5	2.0%	14.7%	8.9%
DTE	$1,324.6	$2,013.4	$3,338.0	0.2%	10.7%	6.9%

b. Capital Summary

Consumers and DTE report capital expenditures using different categories. The following tables and charts summarize the changes in each of their respective categories over the past 10 years.

Changes in Consumers Capital



Category	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
New Business	$62.7	$72.8	$88.2	$99.9	$105.2	$132.6	$124.3	$163.9	$174.8	$208.5
Lines - Reliability	$75.1	$39.7	$86.5	$57.7	$79.6	$83.6	$55.5	$97.5	$93.2	$56.6
Substations - Reliability	$9.1	$13.0	$16.6	$19.0	$16.5	$20.4	$19.1	$22.5	$20.9	$18.0
Automation and Protection	$11.7	$16.0	$20.6	$30.4	$50.1	$93.8	$74.9	$76.8	$57.3	$33.4
Rehabilitation	$17.8	$14.5	$10.9	$7.2	$37.3	$32.2	$61.7	$101.4	$97.2	$64.5
Grid Capabilities and Resiliency	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$2.6	$4.6	$0.6	$1.7
Reliability Sub-Total	$113.8	$83.3	$134.6	$114.4	$183.4	$230.0	$213.7	$302.8	$269.3	$174.2
Capacity - Lines and Substations	$41.8	$44.3	$58.9	$58.7	$52.9	$42.4	$40.9	$42.4	$51.3	$44.9
Capacity - NB and CVR	$0.0	$0.0	$0.0	$0.0	$10.3	$16.5	$19.7	$30.9	$30.3	$30.4
Capacity - Interconnections	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Capacity Sub-Total	$41.8	$44.3	$58.9	$58.7	$63.2	$58.9	$60.6	$73.2	$81.7	$75.3
Demand Failures	$97.2	$124.1	$119.8	$156.2	$145.9	$177.7	$161.2	$187.3	$214.8	$261.0
Asset Relocations	$19.4	$27.7	$19.5	$28.1	$40.5	$43.7	$38.7	$47.2	$62.3	$57.3
Technology Projects	$3.1	$2.6	$3.5	$3.0	$4.9	$6.4	$4.6	$6.8	$13.7	$5.4
Cost of Removal	$26.1	$40.0	$41.8	$70.8	$69.3	$81.4	$84.9	$86.9	$93.7	$79.5
Total	**$364.1**	**$394.7**	**$466.4**	**$531.2**	**$612.3**	**$730.7**	**$687.9**	**$868.1**	**$910.1**	**$861.3**

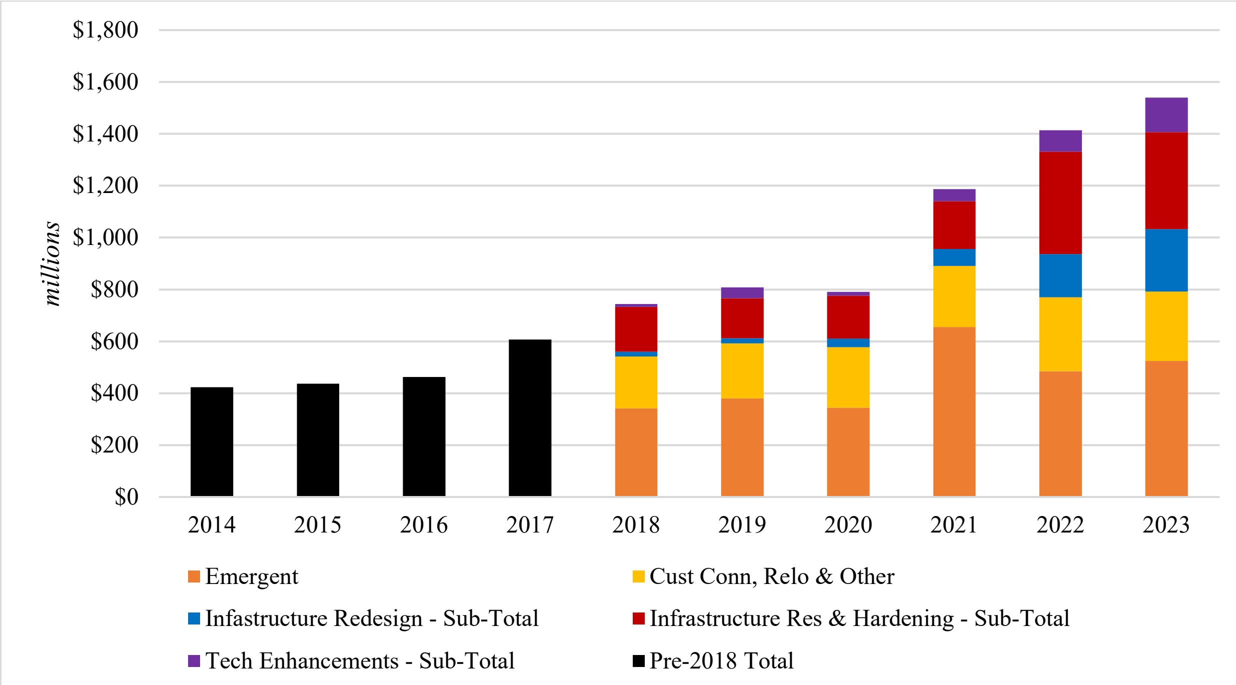
Category	2014-2018	2019-2023	2014-2023	14-18 CAGR	19-23 CAGR	14-23 CAGR
New Business	$428.8	$804.0	$1,232.8	13.8%	12.0%	14.3%
Lines - Reliability	$338.6	$386.5	$725.1	1.5%	-9.3%	-3.1%
Substations - Reliability	$74.2	$100.8	$175.0	15.9%	-3.1%	7.8%
Automation and Protection	$128.9	$336.2	$465.1	43.7%	-22.7%	12.3%
Rehabilitation	$87.7	$357.1	$444.9	20.2%	18.9%	15.4%
Grid Capabilities and Resiliency	$0.0	$9.5	$9.5			
Reliability Sub-Total	$629.4	$1,190.0	$1,819.4	12.7%	-6.7%	4.9%
Capacity - Lines and Substations	$256.7	$221.9	$478.6	6.1%	1.5%	0.8%
Capacity - NB and CVR	$10.3	$127.8	$138.0		16.4%	
Capacity - Interconnections	$0.0	$0.0	$0.0			
Capacity Sub-Total	$267.0	$349.7	$616.7	10.9%	6.3%	6.8%
Demand Failures	$643.2	$1,001.9	$1,645.1	10.7%	10.1%	11.6%
Asset Relocations	$135.3	$249.1	$384.4	20.2%	7.0%	12.8%
Technology Projects	$17.1	$36.9	$54.0	12.0%	-4.1%	6.3%
Cost of Removal	$247.9	$426.4	$674.4	27.7%	-0.6%	13.2%
Total	**$2,368.8**	**$4,058.1**	**$6,426.9**	**13.9%**	**4.2%**	**10.0%**

The data indicates the key drivers of the growth in Consumers capital expenditures in the last five years of the period over the previous five years ($1.689 billion or 71 percent). The major contributors to that increase include the following areas, with the amount of dollars each contributed to the overall $1.689 billion increase and the percent that amount represented of the overall increase.

- *Reliability*: increased by $560.6 million (33 percent of the total increase), with sub-categories of significance that included:
    - Automation and Protection: increased by $207.3 million (12 percent of the total increase)
    - Rehabilitation: $269.4 million (16 percent of the total increase)
- *New Business*: increased by $375.1 million (22 percent of the total increase)
- *Demand Failures*: increased by $358.7 million (21 percent of the total increase)
- *Capacity – NB and CVR*: increased by $117.5 million (7 percent of the total increase)
- *Cost of Removal*: increased by $178.5 million (11 percent of the total increase).

Accounting system changes and reporting differences left DTE unable to produce pre-2018 data using the same categories that it subsequently used for cost tracking and reporting. Therefore, similar observations about changes in expenditures by categories are not possible.

Changes in DTE Capital *(millions)*



Category	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Emergent					$341	$380	$345	$656	$485	$525
Cust Conn, Relo & Other					$200	$212	$232	$235	$285	$267
4.8kV and 8.3 kV CC					$3	$7	$4	$13	$58	$56
CODI					$11	$10	$18	$26	$48	$99
Subtran Hardening/Redesign					$2	$1	$6	$20	$43	$65
System Loading					$2	$2	$6	$4	$4	$14
Station Upgrade					$0	$0	$0	$4	$15	$6
All Other					$0	$0	$0	$0	$0	$1
Infastructure Redesign - Sub-Total					***$18***	***$20***	***$34***	***$66***	***$167***	***$241***
4.8kV Hardening					$40	$48	$57	$67	$161	$130
4.8kV Relay Improvement					$3	$2	$2	$3	$5	$0
Pole Top Maintenance					$37	$27	$35	$32	$83	$85
CEMI - Freq Outage Program					$22	$22	$27	$23	$60	$63
URD, Cable, Breaker and Other Replacment Programs					$49	$36	$28	$40	$55	$63
Stategic UG Pilot					$0	$0	$0	$0	$0	$3
Substations					$7	$5	$6	$9	$10	$18
Other					$16	$14	$10	$9	$19	$11
Infrastructure Res & Hardening - Sub-Total					***$174***	***$155***	***$165***	***$183***	***$394***	***$374***
Grid Telecom & Automation					$0	$0	$0	$18	$23	$22
Distribution Automation					$0	$0	$0	$0	$1	$0
Modernize Grid Mgmt					$0	$0	$0	$0	$12	$28
Other					$11	$42	$15	$29	$47	$83
Tech Enhancements - Sub-Total					**$11**	**$42**	**$15**	**$47**	**$83**	**$133**
Total	**$424**	**$437**	**$463**	**$607**	**$744**	**$808**	**$791**	**$1,186**	**$1,414**	**$1,539**

Category	2018-2020	2021-2023	19-23 CAGR
Emergent	$1,066.2	$1,664.9	8.4%
Cust Conn, Relo & Other	$644.0	$786.8	6.0%
4.8kV and 8.3 kV CC	$13.9	$126.8	69.6%
CODI	$39.1	$173.1	77.1%
Subtran Hardening/Redesign	$9.4	$127.4	159.6%
System Loading	$9.5	$21.4	72.9%
Station Upgrade	$0.0	$24.7	
All Other	$0.1	$1.2	
Infastructure Redesign - Sub-Total	$71.9	$474.6	86.9%
4.8kV Hardening	$145.6	$358.6	28.1%
4.8kV Relay Improvement	$6.4	$8.2	-100.0%
Pole Top Maintenance	$98.8	$200.0	32.7%
CEMI - Freq Outage Program	$70.2	$146.3	31.0%
URD, Cable, Breaker and Other Replacment Programs	$113.7	$157.6	14.6%
Stategic UG Pilot	$0.0	$3.5	
Substations	$18.7	$37.0	35.5%
Other	$40.0	$39.3	-5.1%
Infrastructure Res & Hardening - Sub-Total	$493.3	$950.5	24.7%
Grid Telecom & Automation	$0.0	$63.0	
Distribution Automation	$0.0	$0.9	
Modernize Grid Mgmt	$0.0	$39.9	
Other	$68.4	$158.7	18.3%
Tech Enhancements - Sub-Total	$68.4	$262.5	33.1%
Total	**$2,343.9**	**$4,139.3**	**17.5%**

With the more limited historical data available for DTE, we performed an analysis of the growth in capital categories between the 2018 through 2020 period and the 2021 through 2023 period. The data indicates the key drivers of the growth in DTE capital expenditures in the latter three years of the period over the preceding three years ($1.795 billion or 77 percent). The major contributors to that increase include the following areas, with the amount of dollars each contributed to the overall $1.795 billion increase and the percent that amount represented of the overall increase.

- *Emergent*: increased by $598.7 million (33 percent of the total)
- *Infrastructure Res & Hardening*: increased by $457.1 million (25 percent of the total)
- *Infrastructure Redesign*: increased by $402.7 million (22 percent of the total)
- *4.8kv Hardening*: increased by $213.0 million (12 percent of the total).

c. *O&M Summary*

The following table summarizes changes, in total and by category, of Consumers O&M expenditures.

Changes in Consumers O&M *(millions)*

Category	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
O&M Assoc w/Construction	-$2.0	-$1.8	$1.1	-$2.5	$0.9	-$1.7	$0.0	-$0.3	$0.0	$0.0
Non-Forestry Reliability	$4.5	$3.1	$3.1	$3.2	$3.8	$3.4	$4.2	$5.4	$6.4	$6.2
Forestry Reliability	$40.4	$37.3	$50.9	$50.3	$52.4	$53.6	$55.9	$86.6	$102.0	$109.1
Ops, Mtc & Mtr w/o Svc Rest	$49.0	$42.7	$33.6	$32.9	$35.6	$33.2	$28.8	$35.8	$35.7	$34.7
Service Restoration	$47.0	$38.2	$35.5	$50.2	$53.9	$92.1	$71.3	$159.7	$113.3	$188.0
Field Operations	$22.6	$25.6	$22.5	$27.1	$29.7	$26.9	$22.7	$31.2	$36.4	$31.1
Compliance and Controls	$0.0	$0.0	$0.0	$0.0	$0.0	$0.5	$1.4	$1.7	$1.7	$1.2
Operations Performance	$5.7	$3.8	$4.8	$7.9	$8.0	$7.0	$5.7	$4.0	$6.8	$3.9
Operations Management	$9.5	$7.4	$7.6	$6.5	$6.8	$5.7	$6.1	$7.3	$9.5	$7.4
Unallocated	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total	**$176.7**	**$156.3**	**$159.2**	**$175.5**	**$191.2**	**$220.8**	**$196.1**	**$331.4**	**$311.7**	**$381.6**

Category	2014-2018	2019-2023	2014-2023	14-18 CAGR	19-23 CAGR	14-23 CAGR
O&M Assoc w/Construction	-$4.3	-$2.0	-$6.3		-72.3%	-44.4%
Non-Forestry Reliability	$17.7	$25.6	$43.4	-4.2%	15.8%	3.5%
Forestry Reliability	$231.3	$407.2	$638.5	6.7%	19.4%	11.7%
Ops, Mtc & Mtr w/o Svc Rest	$193.9	$168.1	$362.1	-7.7%	1.1%	-3.8%
Service Restoration	$224.8	$624.4	$849.1	3.5%	19.5%	16.7%
Field Operations	$127.5	$148.4	$275.9	7.1%	3.7%	3.6%
Compliance and Controls	$0.0	$6.5	$6.5		27.8%	
Operations Performance	$30.3	$27.4	$57.7	8.7%	-13.5%	-4.2%
Operations Management	$37.7	$35.9	$73.6	-8.0%	6.5%	-2.8%
Unallocated	$0.0	$0.0	$0.0			
Total	**$858.9**	**$1,441.5**	**$2,300.5**	**2.0%**	**14.7%**	**8.9%**

The data indicates the two key drivers of the growth in Consumers O&M expenditures in the last five years of the period over the previous five years ($582.6 million or 68 percent). These include the following categories, with the amount of dollars each contributed to the overall $582.6 million increase and the percentage that amount represented of the overall increase.

- *Service Restoration*: increased by $399.6 million (69 percent of the total increase)
- *Forestry Reliability*: increased by $175.8 million (30 percent of the total increase).

The following table summarizes changes, in total and by category, of DTE O&M expenditures.

Changes in DTE O&M *(millions)*

Category	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Regional Customer Operations	$50.4	$54.9	$57.8	$57.4	$50.4	$50.8	$50.8	$52.4	$70.7	$65.5
Substations	$30.1	$34.1	$31.7	$30.8	$29.5	$27.4	$24.5	$20.6	$24.2	$17.5
System Operations	$18.6	$20.0	$9.3	$9.3	$10.7	$9.6	$12.0	$8.1	$8.3	$6.8
Storm & Storm Functions*	$107.5	$44.8	$44.4	$69.8	$51.5	$50.2	$46.5	$79.7	$59.9	$183.8
Engineering	$16.2	$15.6	$13.4	$13.8	$15.5	$14.3	$11.7	$11.1	$12.7	$8.7
Customer Excellence Tree Trim**	$0.0	$0.0	$0.0	$0.0	$0.0	$0.8	$6.0	$0.2	$0.1	$0.1
Scheduling & Coordination/Miss Dig	$5.2	$4.6	$4.6	$4.6	$5.9	$6.2	$6.0	$8.1	$7.2	$8.8
Operational Technology	$0.0	$0.5	$0.8	$2.1	$3.3	$3.3	$3.4	$2.8	$1.9	$3.6
Customer Trans/Automation***	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$7.4	$3.3
VP Staff	$2.1	$4.0	$3.5	$2.8	$3.9	$3.1	$3.7	$3.7	$6.0	$2.8
Inventory Reserve	$0.5	$0.7	$5.6	$0.5	$2.2	-$1.1	$2.9	$5.0	$4.1	$1.9
Canceled Capital Projects	$0.0	$0.0	$3.5	$2.8	$2.8	$1.1	$3.0	$2.0	$1.3	$3.2
Telecom	$6.4	$5.3	$4.5	$4.9	$5.6	$6.0	$7.1	$7.6	$7.8	$7.6
Accounting Transactions	-$4.1	$3.4	$5.4	-$0.2	-$0.2	$0.0	$0.0	$0.0	$0.0	$0.0
Tree Trim	$35.4	$57.0	$74.2	$84.3	$89.1	$152.6	$178.7	$180.4	$250.9	$174.5
Total	**$268.3**	**$244.8**	**$258.8**	**$282.7**	**$270.1**	**$324.5**	**$356.3**	**$381.8**	**$462.6**	**$488.1**

Category	2014-2018	2019-2023	2014-2023	14-18 CAGR	19-23 CAGR	14-23 CAGR
Regional Customer Operations	$270.9	$290.4	$561.2	0.0%	6.5%	3.0%
Substations	$156.2	$114.3	$270.5	-0.5%	-10.6%	-5.8%
System Operations	$67.9	$44.9	$112.8	-12.9%	-8.3%	-10.6%
Storm & Storm Functions*	$318.0	$420.1	$738.1	-16.8%	38.3%	6.1%
Engineering	$74.4	$58.5	$132.9	-1.2%	-11.7%	-6.7%
Customer Excellence Tree Trim**	$0.0	$7.1	$7.1		-42.6%	
Scheduling & Coordination/Miss Dig	$24.8	$36.2	$61.1	3.3%	8.8%	6.0%
Operational Technology	$6.6	$15.0	$21.6		1.9%	
Customer Trans/Automation***	$0.0	$10.8	$10.8			
VP Staff	$16.3	$19.3	$35.6	16.4%	-3.1%	2.9%
Inventory Reserve	$9.5	$12.9	$22.3	41.8%		15.5%
Canceled Capital Projects	$9.0	$10.6	$19.6		30.3%	
Telecom	$26.7	$36.2	$63.0	-3.5%	6.2%	2.0%
Accounting Transactions	$4.3	$0.0	$4.3	-54.6%		-100.0%
Tree Trim	$339.9	$937.1	$1,277.0	25.9%	3.4%	19.4%
Total	**$1,324.6**	**$2,013.4**	**$3,338.0**	**0.2%**	**10.7%**	**6.9%**

* Some yrs include storm functions
** Moved to Tree Trim as of 2021
***New category as of 2022 (prior year costs included in other categories)

As with Consumers, two categories drove the growth in DTE O&M expenditures in the last five years of the period over the previous five years ($688.7 million or 52 percent). These include the following categories, with the amount of dollars each contributed to the overall $688.7 million increase and the percentage that amount represented of the overall increase.

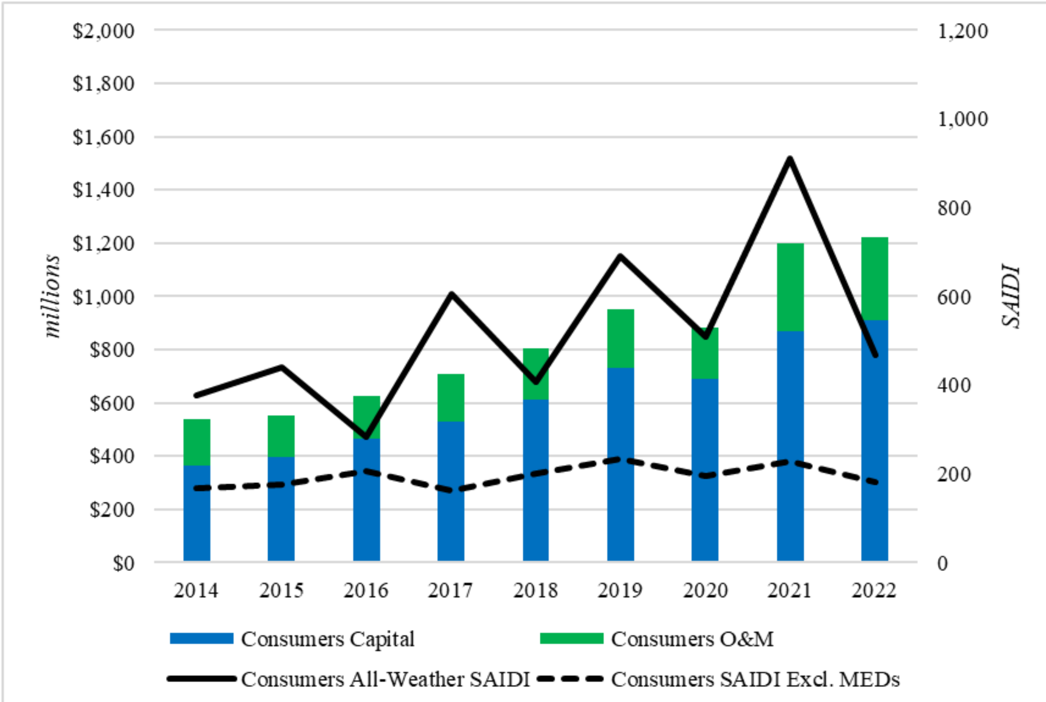
- *Tree Trim*: increased by $597.2.6 million (87 percent of the total increase)
- *Storm & Storm Functions*: increased by $102.1 million (15 percent of the total increase).

d. Expenditures versus SAIDI

The following graphs combine the previous data summarized earlier in this Section and compare 2014 through 2023 expenditure levels with SAIDI performance over that same period.

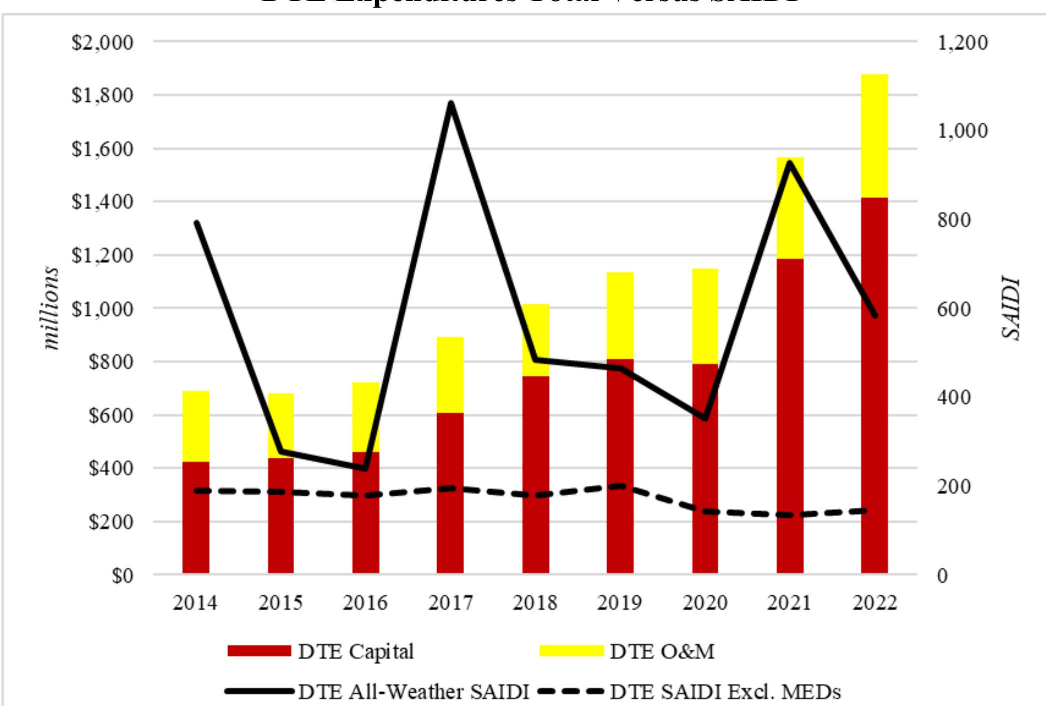
Using the same categorical spend data that Consumers provided that linked historical versus EDIIP spend, we charted the increase in those annual amounts of expenditure versus SAIDI performance. Despite the increases in ***total capital and O&M expenditures*** both Total SAIDI and SAIDI excluding MEDs have remained fairly stable, with a slight upward trend (as has the amount by which Consumers value exceeded the 2nd quartile value). Consumers' 2014 All-Weather SAIDI (*i.e.*, MED impacts not excluded) value of 168 increased to 182 in 2022.

Consumers Expenditures Total Versus SAIDI



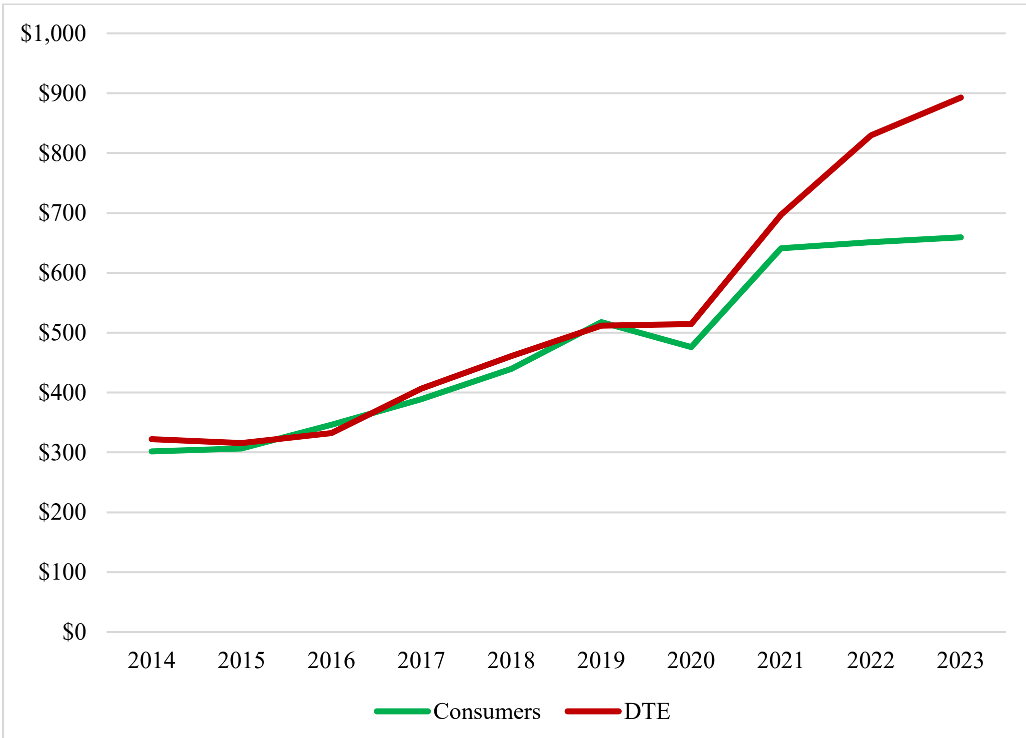
DTE's SAIDI with MEDs excluded improved over the period, reaching the 2nd quartile in 2021, and generally trended downward (improved) over the period. As noted previously, DTE expenditures increased over this period.

DTE Expenditures Total Versus SAIDI



The following charts normalize the historical Consumers and DTE expenditure data on a ***per customer basis***. Consumers and DTE expenditures on a per customer basis tracked closely from 2014 through 2020. Thereafter, however, DTE's per customer expenditures began to outpace Consumers'.

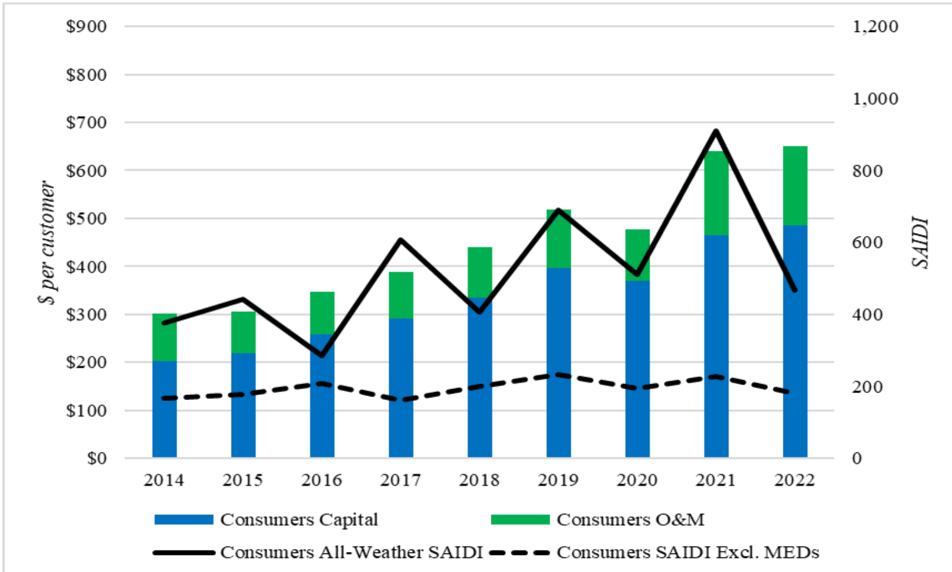
Consumers and DTE Total Expenditures per Customer *(in millions)*



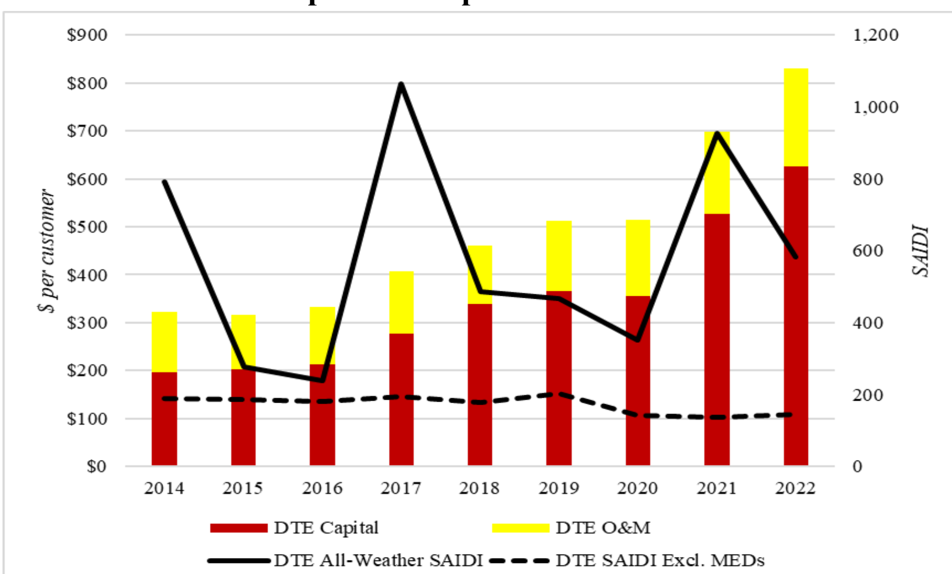
Company	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Consumers	$301.7	$306.6	$346.3	$388.7	$439.8	$517.7	$476.1	$641.1	$651.3	$659.3
DTE	$322.1	$315.7	$332.1	$406.4	$460.9	$511.8	$514.3	$697.2	$829.5	$892.7

The following charts depict these per-customer numbers and incorporate SAIDI performance results from each Company over the same period.

Consumers Total Expenditures per Customer Versus SAIDI



DTE Total Expenditures per Customer Versus SAIDI

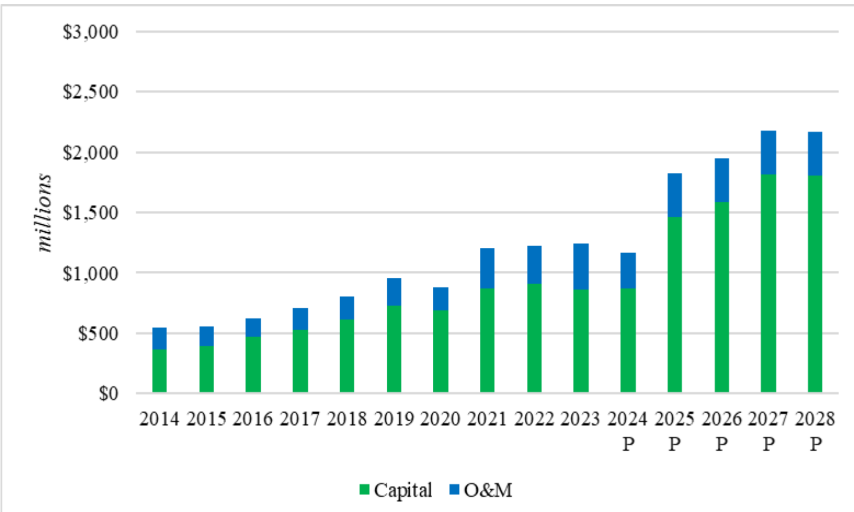


5. *Consumers Energy and DTE Energy Historic and Projected Capital and O&M*

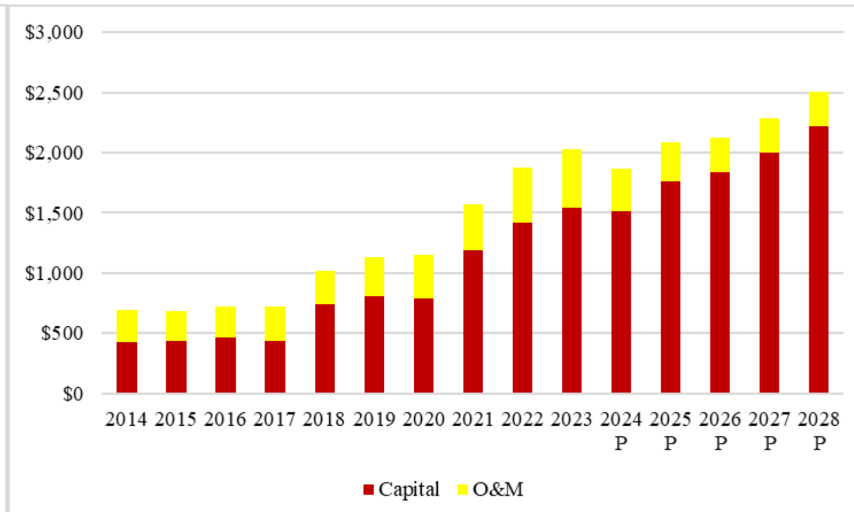
This section of the chapter compares the historical expenditures made by Consumers and DTE with those included in its most recent five-year plans. The following chart adds to the previous presentation of historical capital and O&M data the expenditure levels proposed by Consumers and DTE for the 2024 through 2028 period. Part 2 of this report describes these planned expenditures in greater detail.

Historical and Projected Capital and O&M Comparison *(in millions)*

Consumers



DTE



Company	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024 P	2025 P	2026 P	2027 P	2028 P
Consumers	$540.9	$551.1	$625.6	$706.7	$803.5	$951.5	$884.0	$1,199.5	$1,221.8	$1,242.9	$1,166.2	$1,824.9	$1,949.1	$2,178.4	$2,167.3
DTE	$691.9	$681.6	$721.7	$889.7	$1,014.4	$1,132.9	$1,147.4	$1,568.3	$1,876.3	$2,027.3	$1,862.8	$2,087.9	$2,124.3	$2,285.9	$2,502.9

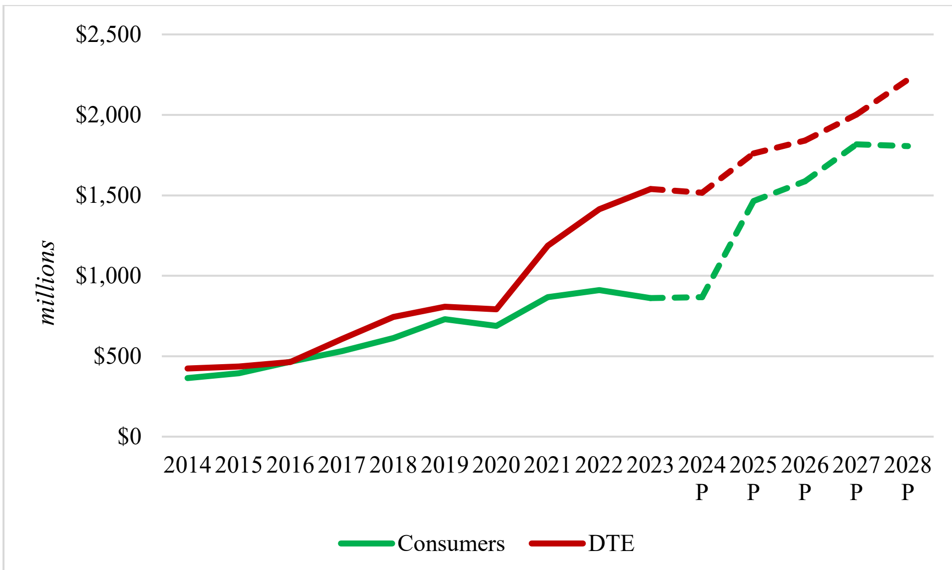
The substantial increases in expenditures described earlier in this section grow further in each company's five-year plans. The following table summarizes the previously-described five-year comparisons and CAGR calculations and incorporates 2024-2028 values. The CAGR calculations show Consumers plans, as presented, include a 16.8 percent CAGR while DTE's include a 7.8 percent CAGR.

CAGR Summary – Capital and O&M *(millions)*

Company	Expenditures			CAGR			
	2014-2018	2019-2023	2024-2028	2014-2019	2019-2023	2024-2028	2014-2018
Consumers	$3,227.7	$5,499.6	$9,285.8	10.4%	6.9%	16.8%	10.4%
DTE	$3,999.3	$7,752.2	$10,863.8	10.0%	15.7%	7.7%	9.6%

The following charts and tables break down these total expenditures between capital and O&M amounts.

Historic and Projected Capital Comparison

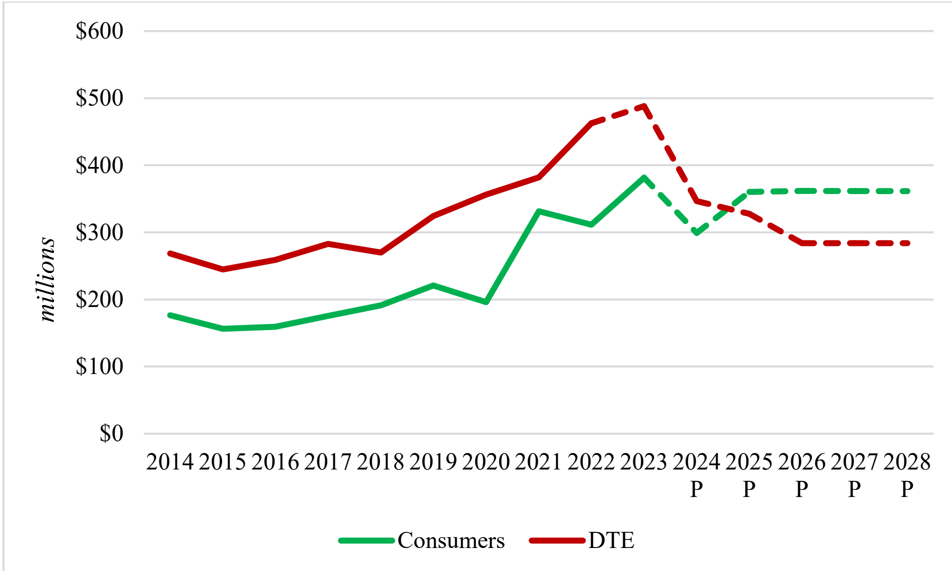


Each Company's five-year plans project capital expenditures that increase even further from the growth rates experienced historically. CAGR calculations show Consumers projected 2024-2028 capital expenditure growth of 20.1 percent per year. DTE's projections show lessened increases, at 10.0 percent per year.

CAGR Capital Summary – Historical and Projected

Company	Dollars *(millions)*			CAGR			
	2014-2018	2019-2023	2024-2028	2014-2018	2019-2023	2024-2028	2014-2028
Consumers	$2,368.8	$4,058.1	$6,426.9	13.9%	4.2%	20.1%	12.1%
DTE	$2,674.7	$5,738.8	$8,413.6	15.1%	17.5%	10.0%	12.6%

Historic and Projected O&M Comparison



Consumers EDIIP projects O&M expenditures that produce a CAGR of 4.8 percent over the 2024 through 2028 period. DTE's five-year plans meanwhile reduce expenditures as compared to historical amounts.

CAGR O&M Summary – Historical and Projected

Company	Dollars *(millions)*			CAGR			
	2014-2018	2019-2023	2024-2028	2014-18	2019-23	2024-2028	2014-2028
Consumers	$858.9	$1,441.5	$2,300.5	2.0%	14.7%	4.8%	5.2%
DTE	$1,324.6	$2,013.4	$3,338.0	0.2%	10.7%	-4.9%	0.4%

6. *Michigan and Illinois Utilities Spending and Reliability Comparisons*

The historical and projected expenditures described previously in this section of the report use data provided by Consumers and DTE. Their historical data, as well as the amounts they project in their forward-looking five-year distribution plans, include categories of expenditures that do not permit "apples to apples" comparisons to the two comparable utilities (ComEd and Ameren Illinois) for which we have made system characteristics and reliability comparisons elsewhere in this chapter. In an effort to normalize the differences between the four companies' expenditures (both historical and as proposed in their respective grid plans), this section of the report uses FERC Form 1 data to conduct a summary analysis. While not perfectly aligned with the data summarized previously, this data does permit a means for comparison. We used the following two categories of FERC Form 1-reported expenditures:

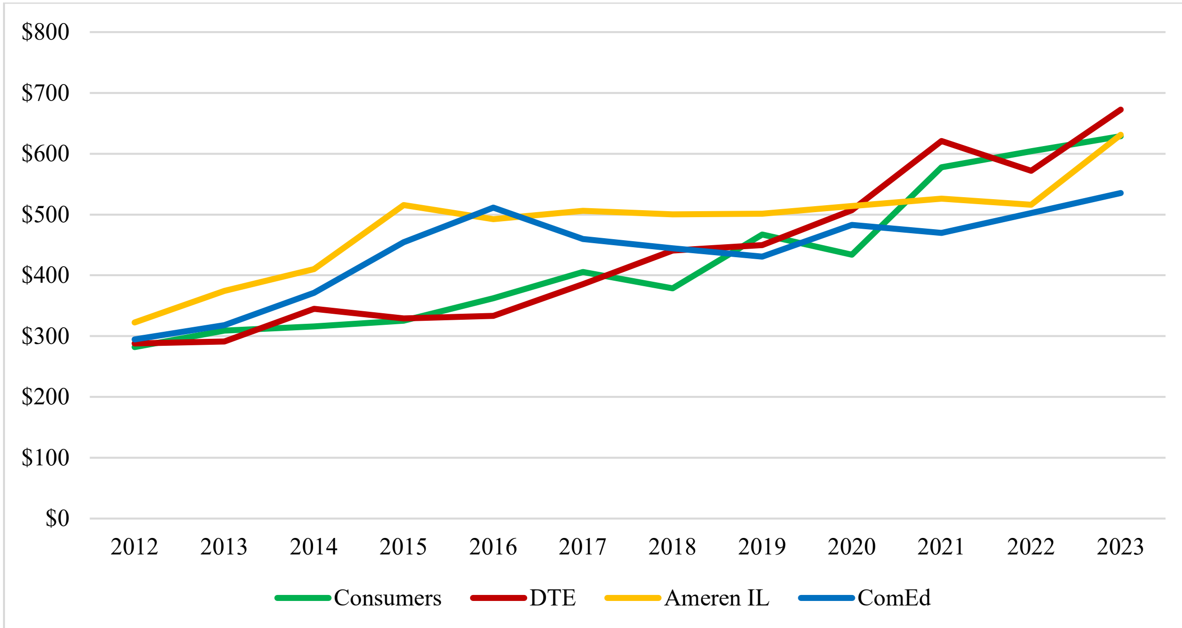
- Total Distribution Additions to Plant in Service
- Total Distribution O&M Expense.

For reference, the following table summarizes the percent of O&M and Capital captured by the two FERC categories used as compared to the Consumers and DTE-provided historical-grid plan data used for the analysis described in the immediately-preceding sections. As the chart indicates, the FERC categories demonstrate somewhat similar patterns with those of Consumers and DTE capital and O&M expenditures through 2019. They begin to diverge thereafter. Note that the FERC amounts reflect the value of capital additions in those years, not expenditures. The following table reports dollars in millions.

Consumers and DTE Internal vs. FERC Capital and O&M Relationship

O&M	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Consumers FERC	$183.8	$171.5	$167.8	$185.8	$202.6	$237.6	$215.7	$347.0	$327.5	$381.9
Consumers Historical	$176.7	$156.3	$159.2	$175.5	$191.2	$220.8	$196.1	$331.4	$311.7	$381.6
Percent	104%	110%	105%	106%	106%	108%	110%	105%	105%	100%
DTE FERC	$292.2	$267.2	$283.3	$304.6	$287.1	$302.9	$305.8	$338.4	$345.4	$428.6
DTE Historical	$268	$245	$259	$283	$270	$324	$356	$382	$463	$488
Percent	109%	109%	109%	108%	106%	93%	86%	89%	75%	88%
Capital	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Consumers FERC	$382	$413	$486	$551	$489	$621	$590	$734	$805	$804
Consumers Historical	$364	$395	$466	$531	$612	$731	$688	$868	$910	$861
Percent	105%	105%	104%	104%	80%	85%	86%	85%	88%	93%
DTE FERC	$449	$443	$442	$539	$683	$692	$826	$1,059	$949	$1,099
DTE Historical	$424	$437	$463	$607	$744	$808	$791	$1,186	$1,414	$1,539
Percent	106%	101%	95%	89%	92%	86%	104%	89%	67%	71%

FERC-Reported Capital and O&M per Customer



Company	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Consumers	$282.0	$309.2	$315.9	$325.5	$362.2	$405.3	$378.6	$467.3	$434.0	$577.8	$603.8	$628.8
DTE	$288.0	$291.1	$345.1	$329.0	$333.5	$385.5	$440.7	$449.7	$507.2	$621.1	$572.1	$672.5
Ameren IL	$322.5	$374.6	$410.2	$515.8	$492.5	$506.0	$500.2	$501.3	$514.0	$525.9	$516.3	$631.2
ComEd	$294.6	$317.9	$371.2	$454.3	$511.1	$459.7	$444.4	$430.6	$482.8	$469.9	$502.3	$535.4

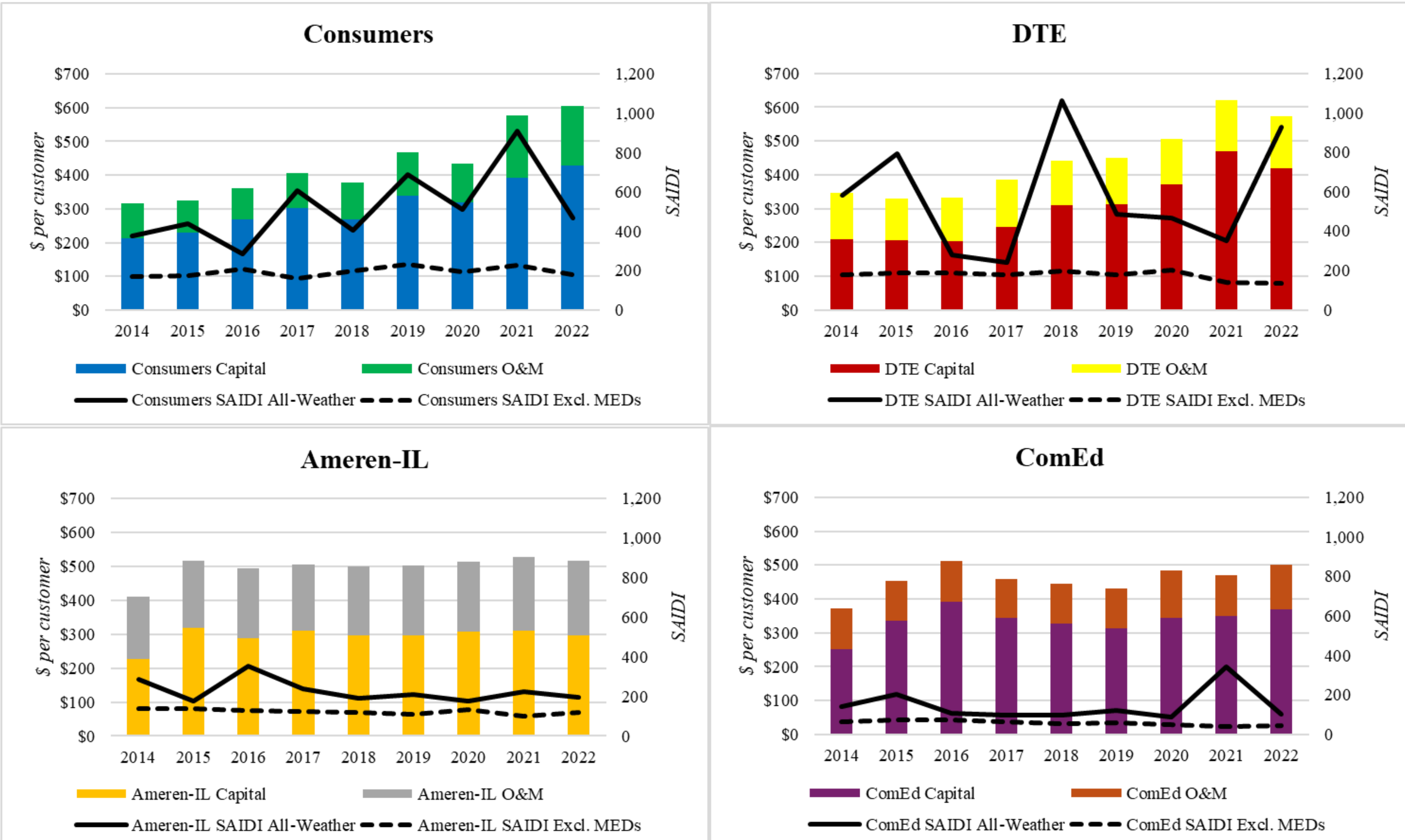
The previous chart and table show the increased spend per customer for the two Illinois utilities that began in 2014 and continued through 2017. In 2018, the amounts for ComEd and Ameren Illinois began to flatten for several years, while Consumers and DTE expenditures per customer began to increase. CAGR calculations demonstrate the increased period growth for Consumer and DTE versus ComEd and Ameren Illinois, with amounts ranging from approximately 60 to 90 percent higher.

FERC-Reported CAGR Summary – Capital and O&M per Customer *(millions)*

Company	2014-2018	2019-2023	2014-2023	14-18 CAGR	19-23 CAGR	14-23 CAGR
Consumers	$1,787	$2,712	$4,499	4.6%	7.7%	8.0%
DTE	$1,834	$2,823	$4,657	6.3%	10.6%	7.7%
Ameren IL	$2,425	$2,689	$5,113	5.1%	5.9%	4.9%
ComEd	$2,241	$2,421	$4,662	4.6%	5.6%	4.2%

The following charts summarize per-customer expenditures for the two Michigan and two Illinois companies, as compared to their respective SAIDI values over the same period. The two Illinois companies began the period with lower SAIDI results, which remained low, and continued a downward trend across the period.

SAIDI Versus FERC-Reported Expenditure Comparisons



E. Observations

1. Consumers targets 5-7-9-year cycles, depending on circuit voltages, but its current average overall cycle approaches ten years.

We observed several differences between Consumers and AIC. Consumers' circuits are twice as long and located in areas with denser tree coverage compared to AIC. Additionally, AIC does not experience the same lake-effect weather conditions that impact Consumers. ComEd and AIC maintain a 4-year trimming and removal cycle for distribution lines, while Consumers is targeting 5-7-9-year cycles based on circuit voltage. However, Consumers' current overall effective trim cycle is nearly ten years.

2. LBWL attained 1st quartile SAIDI after increasing O&M to reduce its tree trim cycle rather than investing in capital for automation.

We found that LBWL infrastructure is a small scale of Consumers infrastructure, except it only has two distribution voltages and doesn't have the exposure of rural circuits.

3. Consumers would need to spend more to attain a four-year trim cycle necessary to reduce tree-caused SAIDI.

In 2020, AIC spent $132 million for tree trimming and removal to sustain its 4-year cycle program. By 2023, this spending dropped to $37 million, reflecting lower ongoing costs after the initial trim cycles. AIC's vegetation management costs are lower partly because Illinois has less forestry cover compared to Michigan and AIC manages about half the circuit miles of Consumers.

In contrast, Consumers spent $109 million in O&M in 2023 for tree maintenance across twice the circuit miles as AIC. To achieve a similar 4-year trim cycle and reduce tree-related SAIDI, Consumers will need to invest more in vegetation management. With an expected annual increase of about 20 percent in O&M spending beyond 2024, Consumers' costs will remain higher compared to AIC due to its larger circuit network.

4. Consumers' SAIDI performance has not improved despite increases in total capital and O&M expenditures.

Consumers expenditures increased from a five-year (2014 through 2018) total of $3.6 billion to $6.6 billion over the five years that followed, an increase of 83 percent. CAGR calculations show Consumers rate of expenditure growth approaching 10 percent during these years. Consumers EDIIP projects O&M expenditures that produce a CAGR of 4.8 percent over the 2024 through 2028 period and 2024-2028 capital expenditure growth of 20.1 percent CAGR per year.

Despite the increases in *total capital and O&M expenditures* both Total SAIDI and SAIDI excluding MEDs have trended upward (as has the amount by which Consumers value exceeded the 2nd quartile value).

Chapter VII – Reliability Comparisons & Vegetation Spending

A. Background

This chapter addresses Consumers', AIC's, and LBWL's SAIDI, SAIFI, CAIDI, and vegetation spending. The chapter also includes a review of Consumers' causes of outages and Customers Experiencing Multiple Interruptions ("CEMI") and Customers Experiencing Long Interruption Durations ("CELID") compared to AIC's and ComEd's reliability metrics.

Reliability across utilities is assessed by two key metrics: the frequency of customer interruptions and the duration required to restore service. The Institute of Electrical and Electronics Engineers ("IEEE") has set standard benchmarking indices to compare utility performance. The System Average Interruption Frequency Index ("SAIFI") measures the number of interruptions per customer. The Customer Average Interruption Duration Index ("CAIDI") calculates the average duration of these interruptions. SAIDI combines these metrics, representing the total average minutes of interruption experienced by customers over the year. For a detailed description of Consumers' reliability programs, see the *EDIIP Reliability Programs* chapter of the Part 2 Report.

Given the unpredictability of extreme weather events like ice storms, tornadoes, lightning storms, and hurricanes, the IEEE has developed two sets of reliability metrics: those that include Major Event Days ("MEDs") and those that exclude them. Metrics excluding MEDs provide insight into the system's performance under typical conditions. The IEEE gathers data from its utility members, calculates quartile ranges, and publishes the data from the previous year each October.

B. Findings

1. *All Weather (Including MEDs) Reliability Metrics*

IEEE 2022 data including MEDs shows that Consumers' SAIDI, including MEDs, is in the 4th quartile. This ranking is primarily influenced by CAIDI (Duration of the average interruption), which is also in the 4th quartile. Consumers' SAIFI (Frequency of interruptions) is in the 2nd quartile, reflecting a middle position among utilities. In contrast, AIC, a Midwest utility with similar characteristics to Consumers, ranks in the 1st quartile for both SAIDI and SAIFI, though its CAIDI is in the 2nd quartile. ComEd ranks in the 1st quartile for all three reliability metrics in 2022.

2022 IEEE Percentiles (Including MEDs)

Metric	Consumers	DTE		AIC	ComEd	LBWL
SAIDI	4th	4th		1st	1st	1st
SAIFI	2nd	2nd		1st	1st	1st
CAIDI	4th	2nd		2nd	1st	1st

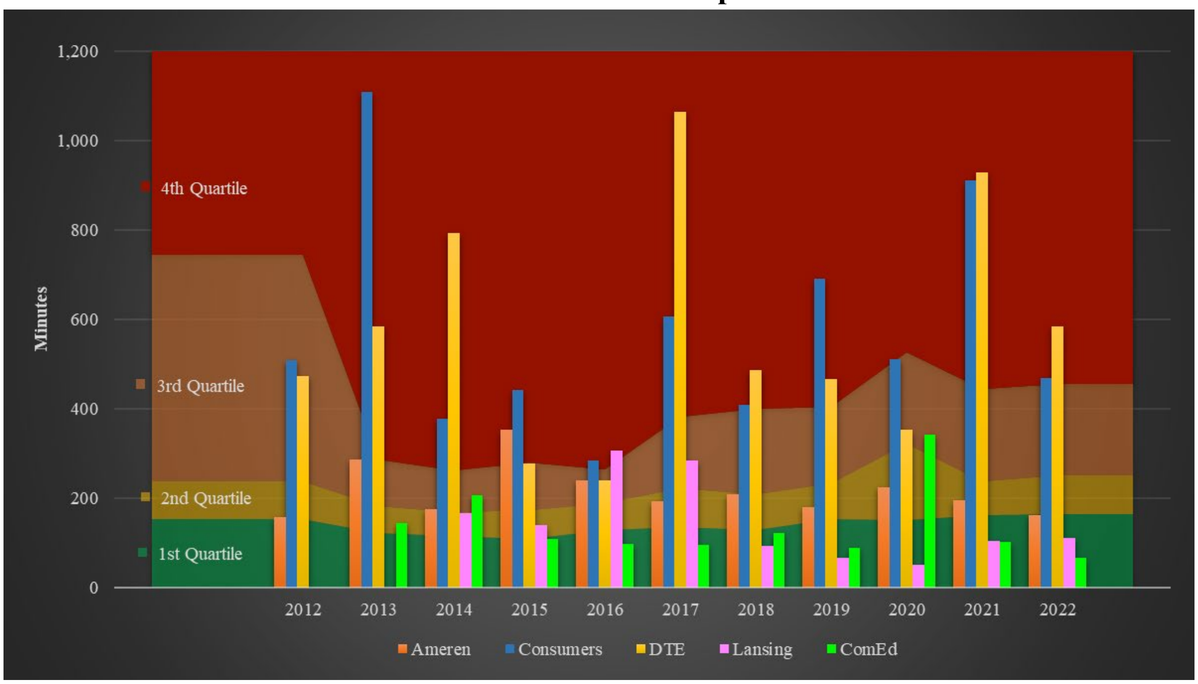
In 2023, Consumers faced two catastrophic storms that, while not significantly increasing the number of customer interruptions, led to prolonged restoration times for those affected. Consumers' CAIDI minutes, including MEDs, were twice as high in 2023 compared to 2022.

Consumers Reliability Metrics Including MEDs (All Weather)

Metric	2022	2023	Change
SAIDI	468 minutes	913 minutes	95%
SAIFI	1.30 interruptions	1.37 interruptions	5%
CAIDI	360 minutes	666 minutes	85%

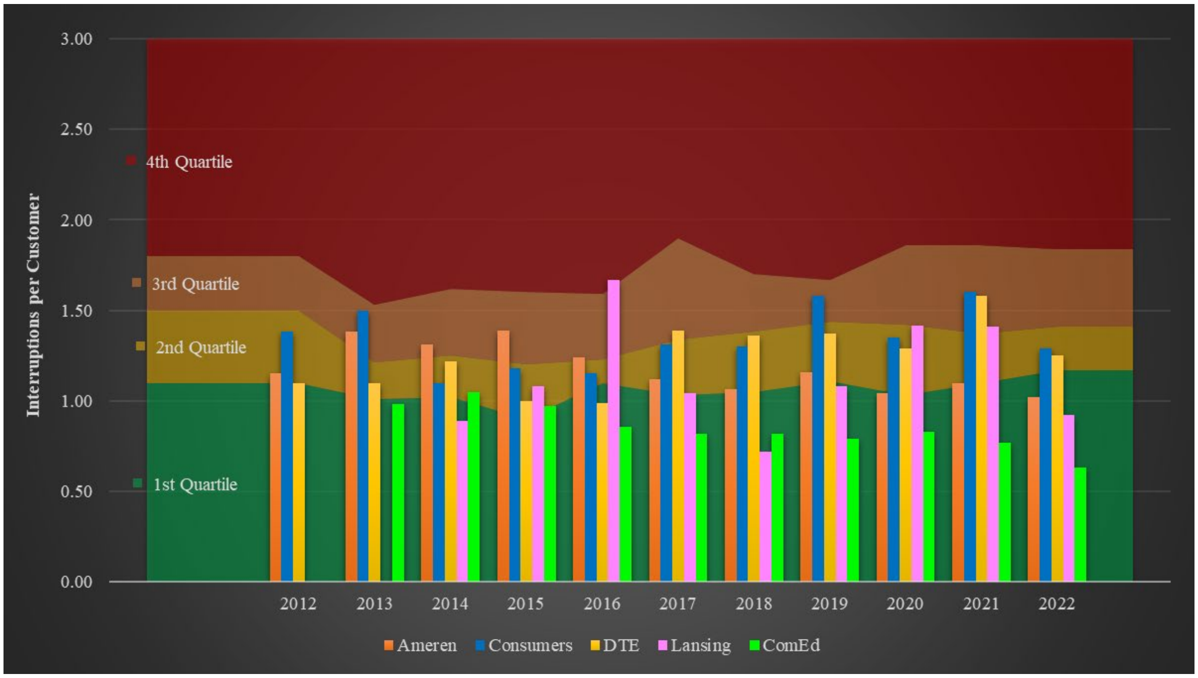
The following chart depicts the All Weather SAIDI trends for Consumers, DTE, ComEd, AIC, and LBWL. Since 2013, Consumers has consistently been in the 3rd or 4th quartile, while AIC has been in the 2nd quartile since 2017 until it recently moved to 1st quartile in 2022. ComEd has mainly maintained a 1st quartile ranking since 2015, with a one exception. LBWL has also been in the 1st quartile since 2018. In 2022, Consumers' All Weather SAIDI was 468 minutes, but it worsened to 913 minutes in 2023. In contrast, AIC's All Weather SAIDI was 162 minutes in 2022 and increased to 592 minutes in 2023.

SAIDI All Weather Comparison



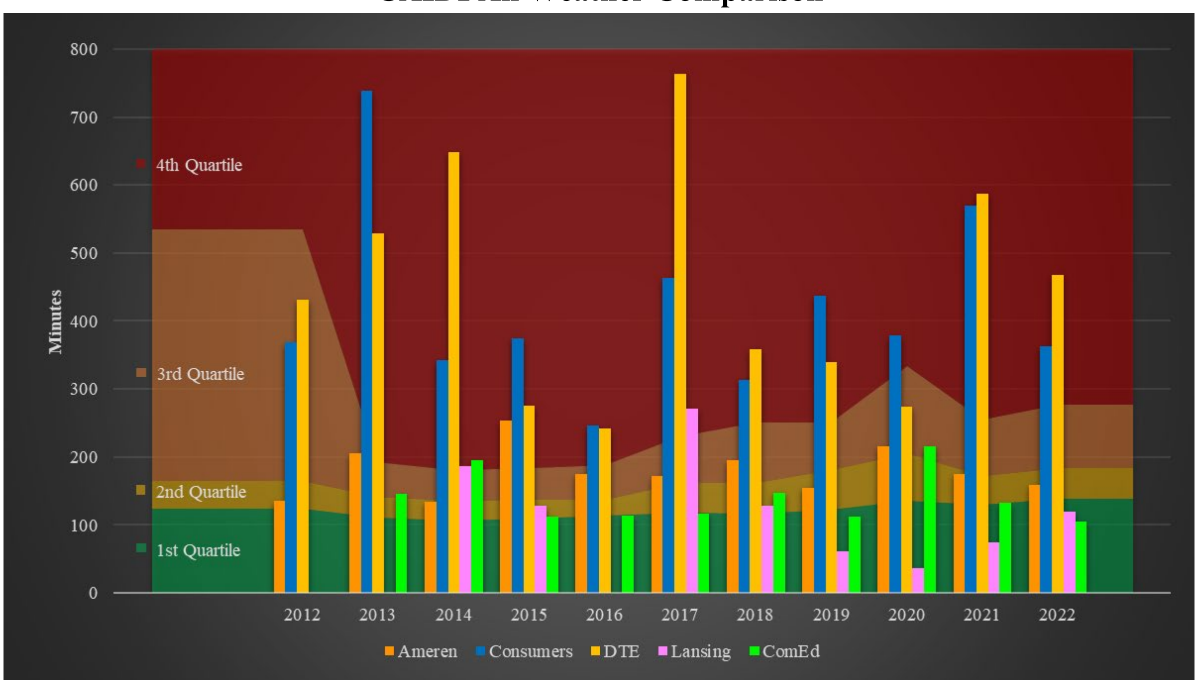
The next chart depicts the All Weather SAIFI trends for Consumers, ComEd, AIC, and LBWL. AIC's All Weather SAIFI improved year over year, reaching the 1st quartile in 2022. LBWL's SAIFI was variable until 2022, when it also achieved the 1st quartile. Consumers' All Weather SAIFI has fluctuated between the 2nd and 3rd quartiles, landing in the 2nd quartile in 2022. It recorded 1.30 interruptions in 2022 and slightly worsened to 1.37 interruptions in 2023. In comparison, AIC's SAIFI was 1.02 in 2022 but increased to 1.33 in 2023. ComEd's SAIFI has shown a steady improvement since 2014.

SAIFI All Weather Comparison



The next chart highlights the significant difference in restoration times among Consumers, AIC, ComEd, and LBWL. Since 2013, Consumers' All Weather CAIDI has consistently been in the 4th quartile. AIC has been in the 2nd or 3rd quartile since 2016, while LBWL has been in the 1st quartile since 2018. In 2022, Consumers took an average of 360 minutes to restore power, whereas AIC took 159 minutes. By 2023, Consumers' All Weather CAIDI increased to 666 minutes, while AIC's rose to 444 minutes. ComEd maintained a 1st or 2nd quartile CAIDI throughout this period.

CAIDI All Weather Comparison



2. *Reliability Metrics Excluding MEDs*

Consumers' SAIDI, excluding MEDs, ranks in the 3rd quartile, primarily due to its CAIDI (Duration of the average interruption), which is in the 4th quartile. Consumers' SAIFI (Frequency of interruptions) is in the 2nd quartile. In comparison, ComEd's and AIC's SAIDI and SAIFI are in the 1st quartile, while AIC's CAIDI is in the 2nd quartile and ComEd's CAIDI is in the 1st quartile.

2022 IEEE Percentiles (Excluding MEDs)

Metric	Consumers	DTE	AIC	ComEd	LBWL
SAIDI	3rd	3rd	2nd	1st	2nd
SAIFI	2nd	2nd	2nd	1st	2nd
CAIDI	4th	3rd	3rd	1st	2nd

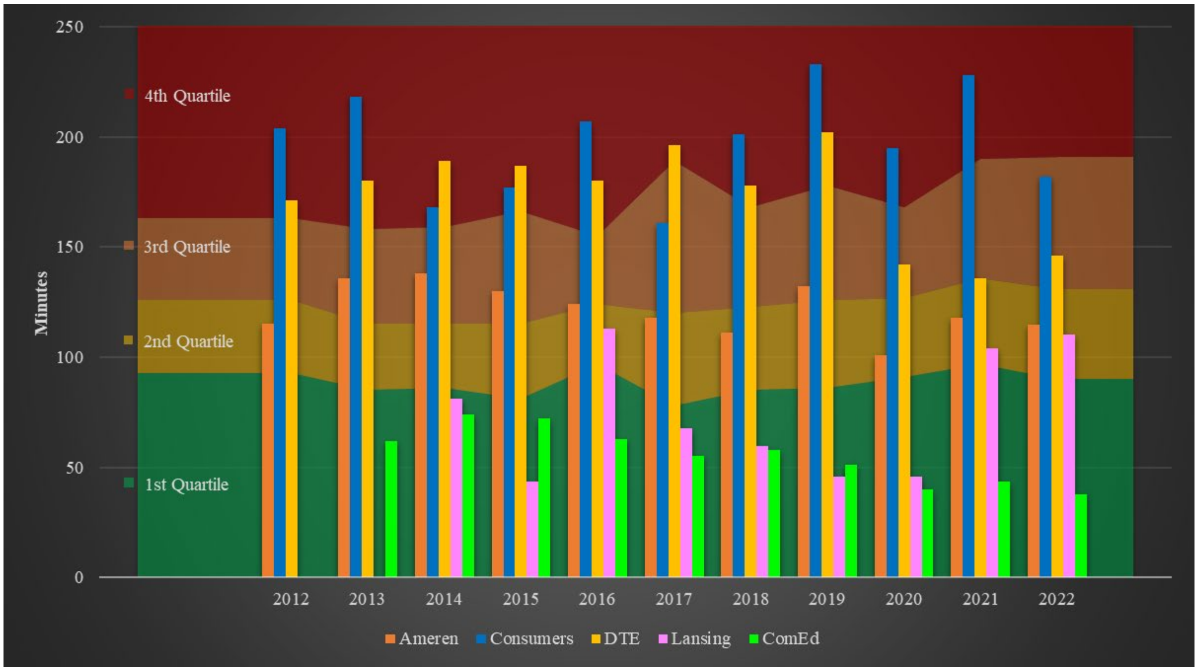
Consumers' 2023 SAIDI, SAIFI, and CAIDI, excluding MEDs, improved slightly compared to 2022. This suggests that the impact of blue and grey sky events (smaller storms that do not produce MEDs) in 2023 was like that in 2022.

Consumers' Reliability Metrics (Excluding MEDs)

Metric	2022	2023	Change
SAIDI	182 minutes	176 minutes	3%
SAIFI	0.96 interruptions	0.96 interruptions	0%
CAIDI	189 minutes	185 minutes	2%

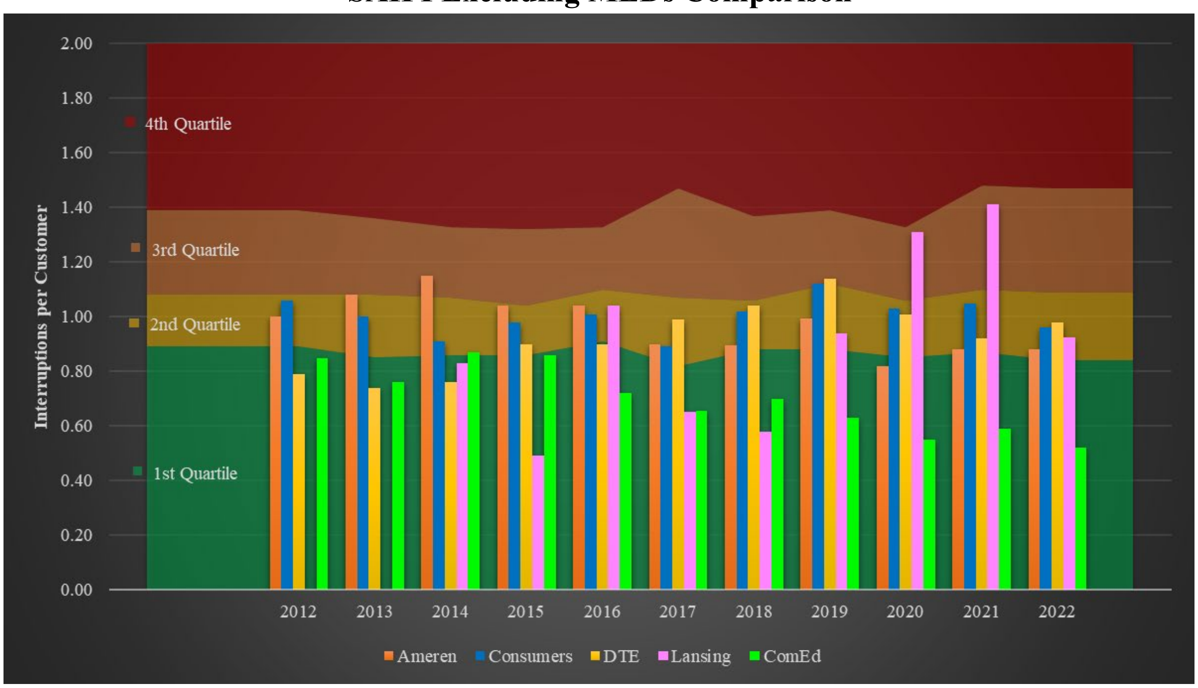
The next chart provides a multi-year overview of reliability performance for SAIDI, excluding MEDs. Since 2012, Consumers has consistently been in the 4th quartile. AIC was in the 3rd quartile until 2016 when they began improving their infrastructure and implementing a 4-year tree trimming cycle, which boosted their ranking to the 2nd quartile. LBWL has maintained a position in the 1st quartile or 2nd quartile since 2014, except for 2016. In 2022, Consumers' SAIDI, excluding MEDs, was 182 minutes and improved slightly to 176 minutes in 2023. In comparison, AIC's SAIDI, excluding MEDs, was 115 minutes in 2022 and improved slightly to 114 minutes in 2023. ComEd's SAIDI has been under 50 minutes since 2020.

SAIDI Excluding MEDs Comparison



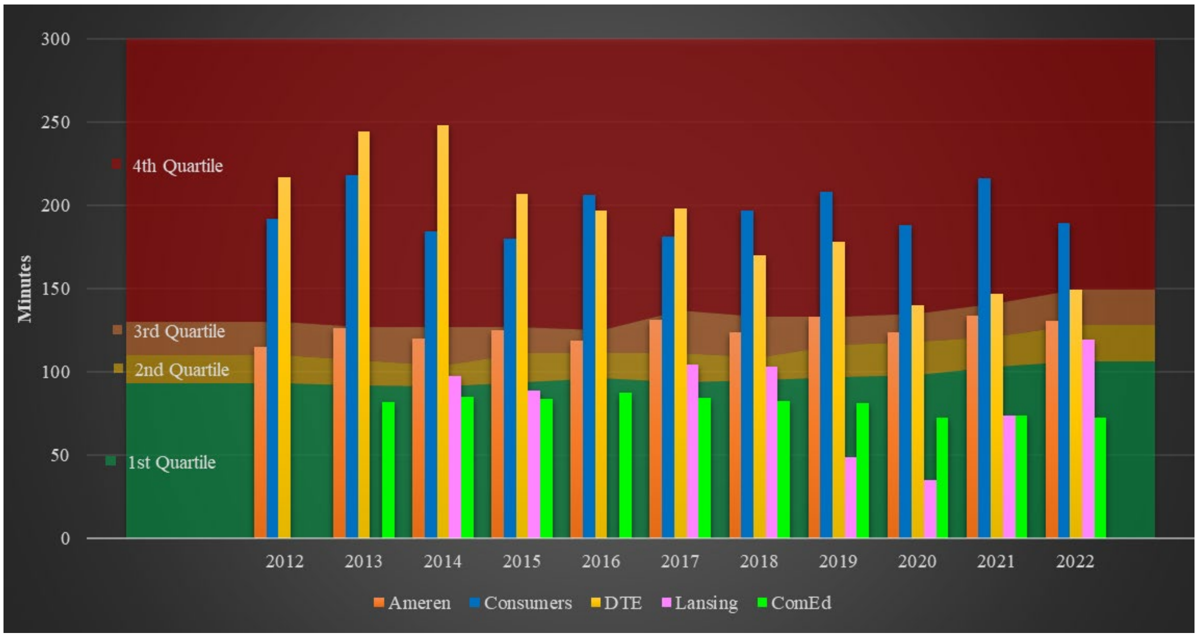
Since 2012, both Consumers and AIC have consistently been in the 2nd quartile for SAIFI, as shown in the next chart. ComEd has been consistently in the 1st quartile since 2012. LBWL has generally been in the 1st or 2nd quartile, except for 2020 and 2021, and was in the 2nd quartile in 2022. In 2022, Consumers' SAIFI, excluding MEDs, was 0.96 and remained at 0.96 in 2023. In contrast, AIC's SAIFI, excluding MEDs, was 0.88 in 2022 and improved to 0.82 in 2023, ComEd's SAIFI, excluding MEDs, was 0.52 in 2022 and increased slightly to 0.61 in 2023.

SAIFI Excluding MEDs Comparison



The next chart highlights the differences in power restoration times among Consumers, ComEd, AIC, and LBWL. Since 2012, Consumers' CAIDI, excluding MEDs, has consistently been in the 4th quartile, while AIC has been in the 3rd quartile and LBWL in the 1st or 2nd quartile. In 2022, Consumers took an average of 189 minutes to restore power after an interruption, compared to 130 minutes for AIC. In 2023, Consumers' CAIDI, excluding MEDs, slightly improved to 185 minutes, whereas AIC's CAIDI worsened to 139 minutes. ComEd has maintained a CAIDI of under 100 minutes, excluding MEDs, since 2013.

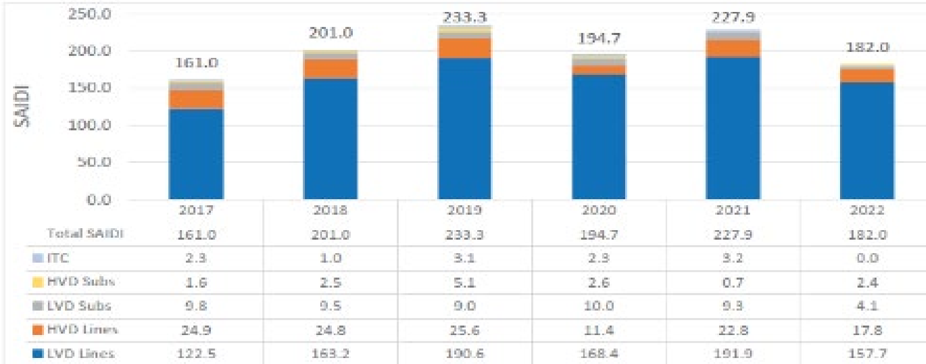
CAIDI Excluding MEDs Comparison



3. HVD, LVD, and Substations

Analyzing the components of the electric infrastructure that most affect SAIDI under normal conditions (excluding MEDs) is crucial. As shown in the chart below, the transmission system (ITC) had no impact on Consumers' 2022 SAIDI of 182 minutes. Consumers' focus on maintaining substations and proactive capital improvements in both HVD and LVD substations has minimized substation equipment failures' impact on SAIDI, with only 2 minutes and 4.1 minutes, respectively, when excluding MEDs. Additionally, significant investment and aggressive tree trimming of the HVD lines have improved SAIDI, reducing their contribution to just 17.8 minutes.

SAIDI Minutes Excluding MEDs by Asset Type



As shown in chart above, LVD lines are the primary factor driving Consumers' SAIDI, excluding MEDs, accounting for 157.7 minutes, or 87 percent, of the total 184 minutes in 2022. LVD lines have consistently been the major contributor to SAIDI minutes.

4. *Causes of Interruptions – All Weather*

The following table shows the causes of interruptions in Consumers electric infrastructure, including MEDs. Vegetation has remained the largest cause by a significant margin, with Equipment and Weather the next two consistently-largest causes.

Interruptions by Cause Including MEDs

Cause Code	2021		2022		2023	
	Number	%	Number	%	Number	%
Equipment	9,865	16%	9,118	19%	7,807	15%
Lightning	1,331	2%	1,196	3%	918	2%
Other	3,423	6%	3,057	6%	2,811	6%
Public	6,097	10%	1,368	3%	1,195	2%
Planned	1,627	3%	0	0%	0	0%
Supply	78	<1%	194	<1%	39	<1%
Unknown	4,075	7%	5,340	11%	5,664	11%
Vegetation	24,167	40%	17,078	35%	18,298	36%
Weather	6,887	11%	6,073	13%	9,291	18%
Wildlife	3,679	6%	4,870	10%	4,678	9%
Total	**61,229**		**48,294**		**50,701**	

5. *Causes of Interruptions – MEDs Excluded*

The following table shows the causes of interruptions in Consumers' electric infrastructure, excluding MEDs. Vegetation has remained the largest cause by a significant margin, with Equipment and Weather the next two consistently-largest causes. This data includes storms that did not reach MED levels, indicating that trees and weather continue to significantly impact customer outages.

Interruptions by Cause Excluding MEDs

Cause Code	2021		2022		2023	
	Number	**%**	**Number**	**%**	**Number**	**%**
Equipment	8,917	19%	8,483	22%	7,295	19%
Lightning	899	2%	768	2%	720	2%
Other	3,176	7%	2,853	7%	2,640	7%
Public	1,578	3%	1,330	3%	1,157	3%
Planned	5,992	13%	0	0%	0	0%
Supply	59	0%	182	1%	37	0%
Unknown	3,615	8%	4,810	13%	4,861	13%
Vegetation	15,476	33%	12,164	32%	12,389	33%
Weather	3,451	7%	3,329	9%	4,220	11%
Wildlife	3,588	8%	4,692	12%	4,595	12%
Total	**46,751**		**38,611**		**37,914**	

Accurately capturing the cause of an interruption is essential for identifying the correct solution and tracking interruption trends. The high percentage of interruptions coded as "Unknown" (over 10 percent) hampers problem analysis and makes it challenging to allocate appropriate remediation and funding. Consumers' circuit engineers should collaborate with dispatchers and field personnel to ensure that interruption cause codes are recorded as accurately as possible.

6. *Tree-Caused Outages*

The interruption cause code tables indicate that vegetation is the primary cause of outages. Additionally, weather-related outages may also involve tree-related issues. According to Consumers' 2023 EDIIP, trees were responsible for 44 percent of all weather-related outages and 38 percent of all non-MED outages. Tree damage can severely impact conductors, crossarms, and poles. Notably, over 60 percent of poles in Consumers' territory are small diameter, which are more prone to breakage and result in longer restoration times and higher CAIDI.

The Part 2 report details Consumers' Forestry Organization. The company's tree trimming cycle for its HVD system is 4.2 years. For the LVD system, Consumers aims for a trimming cycle of four to six years for 14.4kV circuits, six to eight years for 7.2kV circuits, and eight to ten years for 4.8kV circuits (*i.e.*, 5-7-9-year cycle), targeting an overall cycle of seven years.

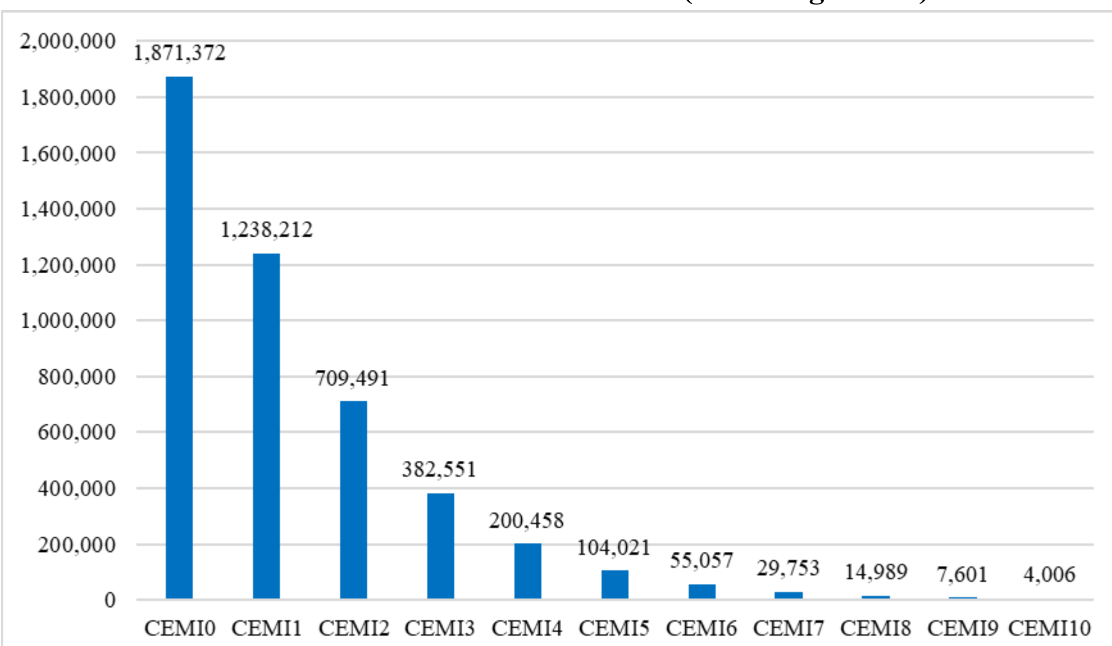
Consumers' LVD system covers 61,000 circuit miles. Between 2021 and 2023, the company trimmed 6,000 miles annually, resulting in an average 10-year trim cycle, an improvement from the 16.2-year cycle in 2018. However, some trees haven't been trimmed in 20 years, and 67 percent of the 2022 trimming was backlog work. Consumers plans to increase its trimming to 7,300 miles per year from 2024 to 2027, aiming for an 8.4-year average cycle. Currently in the third year of a five-year plan, Consumers targets a trim cycle that effectively produces an overall duration of seven years. Both ComEd and AIC employ significantly-shorter four-year cycles, with LBWL now on a five-year cycle.

During our audit field work, we observed numerous poles with fast-growing vines entangled in equipment or in contact with conductors. Utilities commonly address this intrusion by cutting and treating vines at the base of the pole, often utilizing existing resources such as those performing pole inspections or electric service workers. Consumers vegetation specification includes cutting and treating vines at the base of the pole. However, with vine growth faster than tree growth, the Consumers vegetation cycles can leave vines reaching conductors and line equipment before trimming starts on the next cycle.

7. Customers Experiencing Multiple Interruptions

In addition to high-level reliability metrics like SAIDI and CAIDI, it is crucial to address reliability issues for customers who face multiple interruptions or prolonged outages. Customers with multiple interruptions are categorized as Customers Experiencing Multiple Interruptions ("CEMI"), ranging from zero to ten or more interruptions. Over 104,021 Consumers customers experienced five or more interruptions in 2023, including over 4,000 customers who had ten or more interruptions that year.

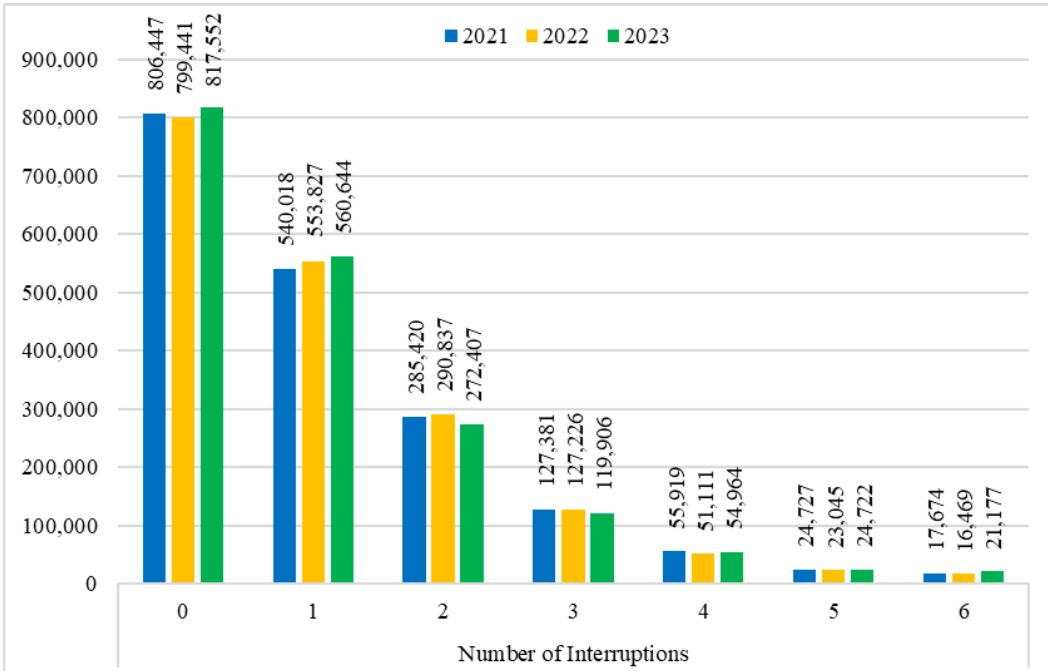
Consumers 2023 CEMI Customers (Including MEDs)



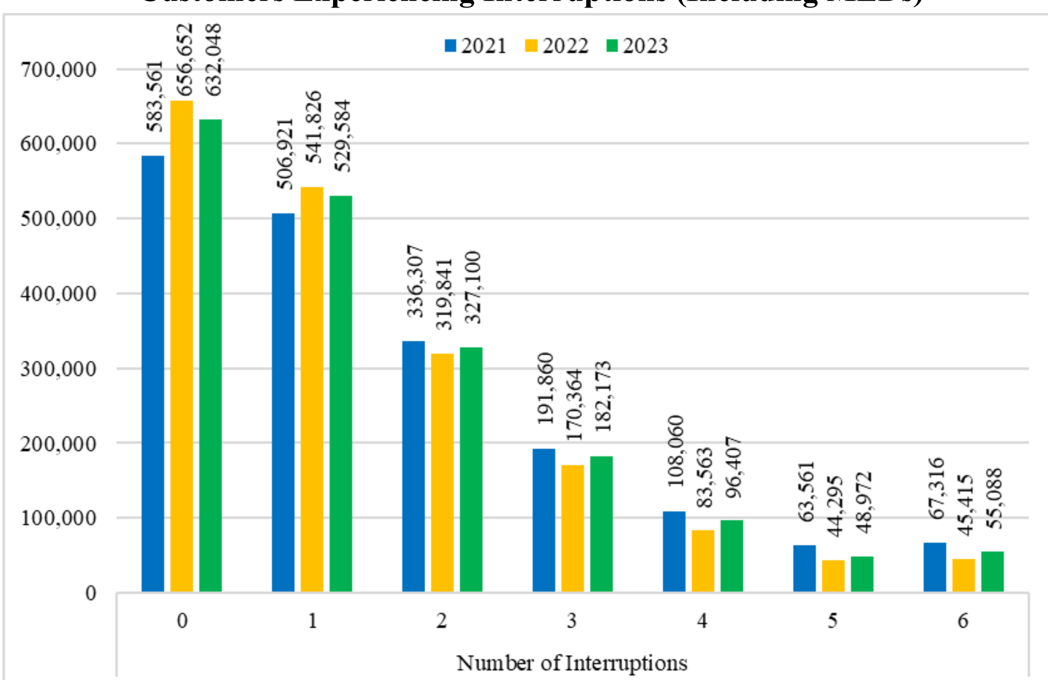
Another way to analyze multiple customer interruptions is to look at the number of customers affected, categorized by the frequency of interruptions in 2021, 2022, and 2023, both with and without Major Event Days (MEDs). The following two charts illustrate the impact of MEDs on the number of outages experienced by customers.

The charts show that including MEDs increases the number of customers experiencing multiple interruptions (2, 3, 4, or more), while the counts of those with 0, 1, or 2 interruptions decrease. For example, in 2023, 21,000 customers experienced 6 interruptions when MEDs were excluded, whereas 55,000 customers faced 6interruptions when MEDs were included. However, the overall distribution of customers across different levels of interruptions remains relatively consistent from year to year.

Customers Experiencing Interruptions (Excluding MEDs)



Customers Experiencing Interruptions (Including MEDs)

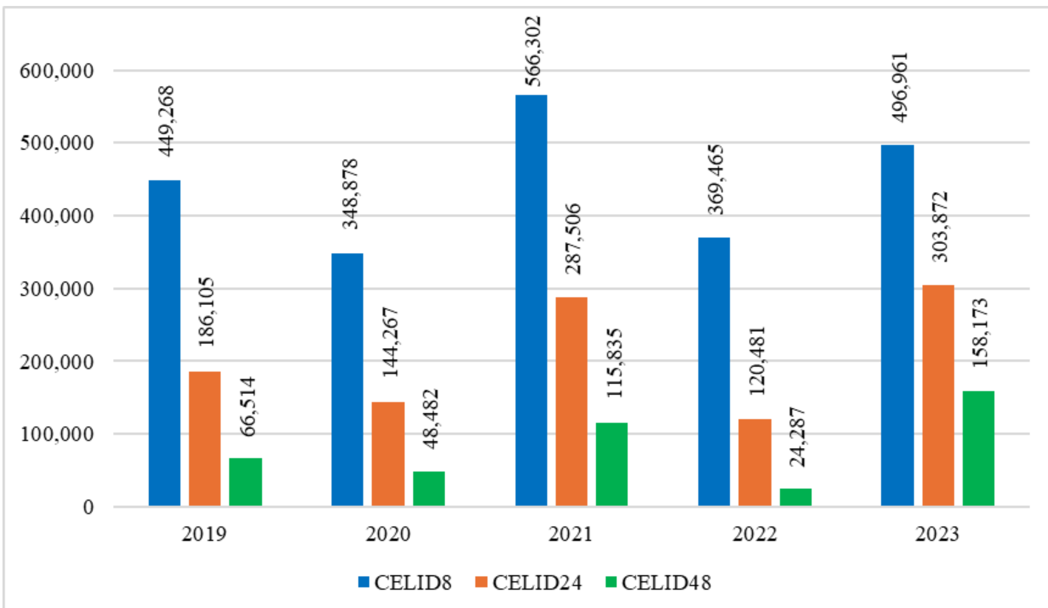


8. Customers Experiencing Long Interruption Duration

The Customers Experiencing Long Interruption Duration ("CELID") metric that tracks the number of hours customers are without power during a year. CELID 8, for example, represents the number of customers who experience 8 or more hours of interruption in a year. Customer tolerance for long interruptions varies by company. Customer research by both Consumers and DTE shows dissatisfaction with long duration and multiple outages.

Due to two catastrophic storms in 2023, 496,961 Consumers customers experienced interruptions of more than 8 hours, and 158,175 were without power for over 48 hours. In 2022, 369,465 customers faced outages lasting more than 8 hours, with 24,287 customers enduring interruptions longer than 48 hours. The next chart summarizes long interruptions as measured by CELID since 2019.

Consumers CELID Hours



9. CEMI and CELID Comparisons to Other Utilities

AIC reports data on customers experiencing 4 or more interruptions (CEMI 4) and outages lasting 12 or more hours (CELID 12), both including and excluding Major Event Days (MEDs). AIC's CEMI 4 numbers were approximately 45,000 in 2021, 47,000 in 2022, and 74,000 in 2023, while CELID 12 figures were around 23,000 in 2021 and 2022 but spiked to 215,000 in 2023. ComEd has ongoing programs to address CEMI and CELID which has led to a continuing reduction of CEMI and CELID since the programs began in 2016.

In 2022, ComEd reported that only 120 customers experienced 10 or more interruptions, compared to 83 customers in 2021. These figures include MEDs. Additionally, more than 80 percent of ComEd's customers experienced zero or just one interruption, with over half of customers experiencing no interruptions at all. ComEd has ongoing programs to proactively identify customers affected by multiple interruptions, allowing engineers to analyze the causes and implement corrective measures.

In contrast, Consumers had over 200,000 CEMI 4 customers in 2023 but doesn't report CELID 12. Instead, its CELID 8 numbers were 566,302 in 2021, 369,465 in 2022, and 496,961 in 2023, with 158,173 customers experiencing CELID 48 in 2023. AIC has programs targeting both CEMI and CELID, whereas Consumers focuses only on CEMI through its LVD Repetitive Outages program, prioritizing the worst-performing zones.

Consumers has about 137,000 LVD circuit zones, with around 25,000 prioritized based on health scores. The company addresses approximately 280 of these zones each year, including those with CEMI issues. Although Consumers reports CELID 8, CELID 24, and CELID 48 to the MPSC, it lacks a dedicated program to reduce these numbers. However, CELID is considered within its worst-performing circuits program, with 89 jobs addressing CELID 8, 34 jobs for CELID 24, and 21 jobs for CELID 48 in 2022. Additionally, Consumers is required to provide bill credits for sustained interruptions under specific conditions.

ComEd does not report CELID but instead adheres to Illinois Commerce Commission requirements, which set a goal of no more than 97 customers experiencing more than 18 hours of total interruption duration over three consecutive years. From January 1, 2020, to December 31, 2022, ComEd met this goal, with only 26 customers exceeding the 18-hour duration target.

10. MAIFI and ASAI

The following table shows DTE, Consumers, and LBWL Momentary Average Interruption Frequency Index ("MAIFI") and Average Service Availability Index ("ASAI") values. MAIFI is defined as the total number of interruptions lasting less than five minutes. ASAI is the percent of time that power is available in a year. DTE began tracking these metrics in 2018. However, momentary interruptions cannot be accurately tracked for all customers until the entire system can be monitored by SCADA or AMDS.

MAIFI and ASAI Reliability

MAIFI

Year	DTE	Consumers	LBWL
2018	4.99	2.98	*
2019	5.05	3.36	*
2020	4.54	2.58	*
2021	5.29	3.28	0.85
2022	4.38	2.57	0.60
2023	5.35	2.25	0.79

** information not available*

ASAI

Year	DTE	Consumers	LBWL
2013	99.89%	99.79%	*
2014	99.85%	99.93%	*
2015	99.95%	99.92%	*
2016	99.95%	99.95%	*
2017	99.80%	99.88%	*
2018	99.91%	99.92%	*
2019	99.91%	99.87%	*
2020	99.93%	99.90%	*
2021	99.82%	99.83%	99.99%
2022	99.89%	99.91%	99.93%
2023	99.71%	99.83%	99.99%

** information not available*

C. Observations

1. Consumers' CEMI 4 and CELID 8 is higher than is usually acceptable for utilities.

In 2023, more than 10 percent of Consumers' customers experienced 4 or more interruptions and more than 25 percent of the customers experienced interruptions greater than 8 hours. As we explain in the accompanying Part 2 report, we find these numbers comparatively very high.

2. Consumers' 2nd quartile 2022 and 2023 SAIFI is average industry performance.

We found that Consumers' 2022 and 2023 SAIFI metrics including and excluding MEDs were in the 2nd IEEE quartile which is about average among utilities. However, AIC's and LBWL's SAIFIs were in the 1st quartile including MEDs and 2nd quartile excluding MEDs.

3. Consumers' 2022 and 2023 CAIDI was in the 4th quartile for both including and excluding MEDs, below average in the industry.

In 2022, AIC's CAIDI was in the 2nd quartile including MEDs and in the 3rd quartile excluding MEDs. LBWL's CAIDI was in 1st quartile including MEDs and in the 2nd quartile excluding MEDs.

4. Consumers' 2022 and 2023 SAIDI metrics were in the 4th quartile including MEDs and in the 3rd quartile excluding MEDs.

Consumers' high SAIDI is mainly due to extended CAIDI minutes, which reflect restoration times. Both AIC's and LBWL's SAIDI scores were in the 1st quartile when including Major Event Days (MEDs) and in the 2nd quartile when excluding them.

5. Consumers' LVD lines contribute approximately 87 percent of SAIDI minutes.

Analyzing which electric infrastructure components contribute most to SAIDI during normal operations (excluding MEDs) is crucial. Consumers' LVD lines have consistently been the largest contributor, accounting for about 87 percent of SAIDI minutes. We found that trees and tree-related wind damage to lines with small poles and old spliced conductor are major causes of SAIDI including MEDs and excluding MEDs.

6. Consumers use of cause codes of Weather and Unknown is not precise.

The cause code "Weather" masks the actual cause of outages such as trees, lightning, ice, for example. As does the cause code "Unknown," used for 11 percent of total interruptions (the fourth leading cause of outages) in 2022 and 2023. More precision would better serve the identification of outage reduction measures.